

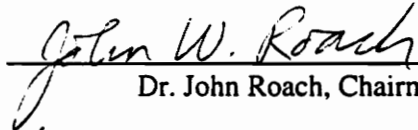
A Logical Typology for Nominal Compounds

by

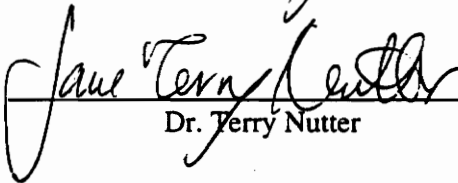
Russell Garvin Modlin

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in
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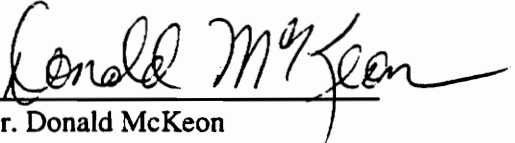
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Computer Science

(ABSTRACT)

Semantic analysis of nominal compounds includes characterizing the semantic relationships implicit among the separate elements of nominal compounds. This thesis presents a typology for nominal compound that classifies the binary relationships implicit in nominal compounds according to their status with regard to the logical properties of transitivity and symmetry. Employing theorems from modal logic, the categories of this logical typology assist in descriptively characterizing the semantics of nominal compounds by supporting inferences concerning the sharing of properties between objects related within nominal compounds. The individual categories of the logical typology are detailed as well as the types of inferences each category supports, but actual inferences about the sharing of properties between related objects cannot be made without a general knowledge data base containing information regarding the attributes of related objects. This thesis additionally describes an implemented computer system that classifies nominal compounds in the categories of the logical typology on the basis of syntactic information concerning the nominals and the taxonomic types of their referents.

Acknowledgements

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Table of Contents

1.0 Introduction	1
1.1 Examples of Nominal Compounds	1
1.2 Semantic Analysis of Nominal Compounds	4
1.3 Overview of Thesis	6
2.0 Approaches to Nominal Compounds	8
2.1 Formal Approaches to Nominal Compounds	8
2.2 Interpretive Approaches to Nominal Compounds	13
2.3 Multiple Compounds	19
3.0 A Logic-Based Typology for Nominal Compounds	22
3.1 Logical Categories	22
3.2 The Logical Typology	30
3.2.1 Transitive, Symmetric Compounds	31
3.2.2 Transitive, Nonsymmetric Compounds	35
3.2.3 Transitive, Asymmetric Compounds	36
3.2.4 Nontransitive, Symmetric Compounds	38

3.2.5	Nontransitive, Nonsymmetric Compounds	39
3.2.6	Nontransitive, Asymmetric Compounds	40
3.2.7	Intransitive, Symmetric Compounds	42
3.2.8	Intransitive, Nonsymmetric Compounds	43
3.2.9	Intransitive, Asymmetric Compounds	44
3.3	Assessing the Logical Typology	45
4.0	Assigning Compounds To Logical Categories	51
4.1	Syntactic Aids to Classification	51
4.2	Semantic Aids to Classification	54
4.3	Determining Logical Categories for Nominal Compounds	59
4.3.1	TN Compounds	60
4.3.2	TS Compounds	62
4.3.3	TA Compounds	64
4.3.4	NA Compounds	66
4.3.5	IN Compounds	70
4.3.6	NN Compounds	72
4.3.7	IS Compounds	73
4.3.8	NS Compounds	73
4.3.9	IA Compounds	75
4.4	Assigning Compounds to Logical Categories	76
5.0	An Empirical Test of the Logical Typology	81
5.1	Methodology	81
5.2	Correctly Classifying Nominal Compounds	86
5.3	An Empirical Test with Ambiguous Senses for Nominals	89
5.4	An Empirical Test with Fixed Senses for Nominals	94
5.5	Results of Classifying Nominal Compounds	99

6.0 Discussion	101
6.1 Summary	101
6.2 Additional Considerations	103
Bibliography	109
Appendix A. Results for Ambiguous Sense Test	111
Appendix B. Results for Fixed Sense Test	165
Appendix C. Interpretations for Nominal Compounds	187
Appendix D. Results from Validation Survey	268
Vita	291

List of Tables

Table 1. Logical Schemata	32
Table 2. Comparison of Warren's Typology to the Logical Typology	48
Table 3. Taxonomic Classes for the Referents of Nominals	58
Table 4. The Status of Reflexivity in the Logical Typology	61
Table 5. Classes of Causal Factors and their Respective Classes of Actions	67
Table 6. Attributes of Referents in the Logical Schemata	78
Table 7. Classification of Nominal Compounds from Survey	88
Table 8. Results of Classifying Compounds with Ambiguous Nominal Senses	90
Table 9. Results of Classifying Compounds with Fixed Nominal Senses	95

List of Illustrations

Figure 1. Examples and Possible Paraphrases of Nominal Compounds	3
Figure 2. Warren's Typology	13
Figure 3. Warren's Typology	14
Figure 4. Attribute Sharing in Relationships from Modal Logic	33
Figure 5. Nominalization Suffixes	53
Figure 6. Patterns in TA Compounds	65
Figure 7. Actions and Affected Targets	71
Figure 8. Taxonomy for Referents	77
Figure 9. Precedence Ordering for Fixed Sense Test	96

1.0 Introduction

1.1 *Examples of Nominal Compounds*

This thesis proposes classifying nominal compounds according to logical properties of semantic relationships existing among the elements of compounds. The classification is intended to support theoretical interpretations of nominal compounds that convey the general nature of the semantic relationships implicit between the compounds' elements and augment models that represent states of affairs described in natural language utterances. Our goal is not to replicate speaker competence but to provide a basis for computationally analyzing the semantics of nominal compounds. Thus our orientation towards nominal compounds is interpretive, seeking to analyze, rather than formally accounting for their presence as linguistic tokens.

Our interpretative approach leads us to apply the term *nominal compound* more freely than many treatments that delimit the class through criteria such as isolation (Bloomfield, 1933), stress (Marchand, 1969), or orthography (Bergsten, 1911). This investigation includes under the heading of nominal compound any sequential cluster of non-genitive nominals, where a nominal is a linguistic unit able to occupy the syntactic role of a noun in a sentence. Gerunds, nouns and derived

nominals are acceptable as nominals in our treatment. As a consequence of our working definition, we consider *silver plate* an acceptable nominal compound just as is the more standard *pie plate*. Despite our more inclusive standards, word strings composed of nominals still fit the description of compounds propounded by Jespersen (1942): "Compounds express a relation between two objects or notions, but say nothing of the way in which the relation is to be understood. That must be inferred from the context or otherwise."

As shown in Figure 1 on page 3, nominal compounds may exhibit a variety of relationships between their elements. The relationship in *pie crust* for an English speaker familiar with the concepts commonly associated with *pie* and *crust* might be expressed as "Crust is an object that is part of another object, in this case a pie." This general paraphrase of the relationship in *pie crust* may apply to other nominal compounds such as *tree trunk*, *car door* and *cat whisker*. The final component of each of these compounds, the head nominal, seems to describe a part of the preceding component. The relationships existing between the components of each of the compounds are unique since the exact relationship is dependent upon specific properties of the individual components, yet all the relationships share an underlying theme.

There are other general relationships applying to broad groups of nominal compounds that involve physical objects. One group of compounds may be characterized as depicting general physical features of physical objects connected to particular objects of concern, as in *building side* or *ocean surface*. Compounds such as *brick house*, *leather saddle*, *marble statue* and *rubber band* seem to describe the material composition of one of the components by the other component. A nominal compound also might consist of an object and a measurable attribute of the object, as in *water temperature* or *circle diameter*. Nor are nominal compounds limited to describing aspects of objects. They may denote the spatio-temporal location of objects or events. *Park bench*, *midnight train*, *city driving* and *noon meal* all could be said to exhibit a spatio-temporal relationship.

The components of a compound may be physical objects related not because one is some aspect of the other, but because of a habitual connection. For instance, a relationship that seems to be a

<i>pie crust</i>	crust that is part of a pie
<i>leather saddle</i>	saddle that is made of leather
<i>water temperature</i>	temperature is an attribute of water
<i>park bench</i>	bench that is located in a park
<i>noon meal</i>	meal that takes place at noon
<i>jelly jar</i>	jar that contains jelly
<i>stamp collection</i>	collection that is a group of stamps
<i>club member</i>	member that is one of a club
<i>Sherman tank</i>	"Sherman" designates variety of tank
<i>gas pump</i>	pump that pumps gas
<i>truck inspection</i>	inspection that is performed on a truck
<i>butter fingers</i>	one's fingers are butter-like
<i>ice cream</i>	no paraphrase

Figure 1. Examples and Possible Paraphrases of Nominal Compounds

productive source of compounds exists in compounds wherein some objects typically contain certain other objects. *Jelly jar*, *pickle barrel* and *whiskey bottle* may be derived from a containment relationship. Collections similarly contain objects but they lack physical delimiters. *Stamp collection*, *buffalo herd*, *data set* and *consonant cluster* are nominal compounds in which the relationship between the elements may be thought of as a grouping of one component into the other. Conversely, nominal compounds may identify separate portions of a group as in *club member*, *army private* or *group leader*. Additionally, titles occur in nominal compounds and may be used to label an object to distinguish it from others of a similar type. A title may be a name that has some historical association with the head noun such as producer, designer, country of origin, etc., or it may be the label given by a classification scheme. *Sherman tank*, *F4 fighter* and *Agner purse* are nominal compounds containing titles.

Another source of relations between the elements of nominal compounds may be actions in which the associated elements participate. In *cat food*, the relationship might be said to arise from the action of eating; in *truck driver*, the source of the relationship seems to be the action of driving. Many English nominals designate an object by the characteristic action that the objects performs or that the object is used in performing. For example, a *pump* is used to pump and *polish* is used

in polishing. Other nominal concepts describe the result of an action, such as *repair* and *throw*. The elements of nominal compounds containing words of this type often seem to be related through an action. An *oil pump* pumps oil, *shoe polish* is for polishing shoes, *car repair* is the repair of a car, and *discus throw* is the throw of a discus. Compounds employing morphological variations of action descriptions to form nominals also may be related through actions, as in *message receipt*, *truck inspection* and *building construction*.

Many nominal compounds can be shortened in linguistic use yet recognizably denote the same object in their abbreviated form. There would be no confusion if a *pie plate* merely were called a *plate* in a conversational exchange. *Pie* supplies additional information about the plate, but it is not essential for identifying the plate. Yet there are nominal compounds that do not exhibit this characteristic. *Ice cream*, for instance, can be shortened to neither *ice* nor *cream* and still convey the same mental concept to a listener. Both components of *ice cream* are necessary for proper identification of the desired object. In addition to compounds similar to *ice cream* that require full articulation, there are nominal compounds that require figurative interpretations, as the actual object identified by the compound is left unspecified. Examples of such compounds include *feather brain* and *butter fingers*. These compounds are used to denote people, but no individual component of the compounds directly refers to people.

1.2 Semantic Analysis of Nominal Compounds

Semantic analysis of nominal compounds includes identifying the implicit relationships between the elements of compounds. The examples set forth in the previous section illustrate a variety of nominal compounds, but they do not comprise a comprehensive listing of all possible relationships that may exist between the components of nominal compounds. The exact natures of semantic relationships depend on the individual components being related, so there is a great variety of pos-

sible semantic relationships that may exist between the elements of nominal compounds. It is not feasible in every case to select correctly a single candidate from numerous alternatives that is the relationship which completely captures the interactions between the elements of a compound.

Fortunately, many relationships implicit between the elements of nominal compounds exhibit similarities to one another. From these similarities, a relatively small number of classes of semantic relationships may be postulated. Key challenges in the semantic analysis of nominal compounds involve identifying an appropriate set of potential semantic relationships between elements of nominal compounds and a method of determining which semantic relationships exist between the components of particular nominal compounds.

The categories of recognized relationships that classify the large range of potential relationships are abstractions of more specific relationships. It is desirable, however, that a semantic classification preserve important semantic distinctions among compounds. For instance, both the compounds *feather pillow* and *stone pillow* seem to exhibit a relationship in which the modifier element specifies the physical composition of the head elements. Thus physical composition may be a candidate category for classifying semantic relationships in nominal compounds. But analysis for the two compounds from the category of physical composition should not obscure the fact that one pillow probably is softer than the other.

One approach to this problem is to subdivide the physical composition category into composition by soft substances versus composition by hard substances. Then it is possible to explicitly specify what differences will be present between articles belonging to the separate subcategories. Another approach is to attach inference rules to the category of physical composition that state that the density or texture of the modifier element may affect the density or texture of the head element. In this thesis, we take the latter approach by proposing general categories in which to classify nominal compounds according to the implicit semantic relationships among their elements. The formal foundations of our proposed categories yield inference rules that may indicate that attributes of one element of a nominal compound may influence the attributes of the other element.

This thesis classifies nominal compounds according to logical properties of their implicit relationships. Within a modal logic framework that provides a natural model of semantic relationships, logical properties of relationships validate rules of inference. The rules of inference are applicable to the related elements of compounds and indicate similarities and dissimilarities between those elements.

1.3 Overview of Thesis

Before presenting our typology for classifying nominal compounds, we discuss in Chapter 2 previous characterizations of the relationships implicit in nominal compounds. Some researchers provide grammatical accounts of nominal compounds, as Lees (1960) did from transformational grammars. Others, such as Leonard (1984), employ less structured justifications for their sets of relationships. Because our approach to nominal compounds is interpretive, we are primarily interested in the semantics of classifications and how to apply classifications to individual compounds.

Chapter 3 presents our modal logic framework for the analysis of nominal compounds through logical properties of their implicit relationships. Because the relationships implicit in nominal compounds are binary, existing between exactly two objects at a time, the relationships must exhibit some form of transitivity and symmetry. These logical properties validate certain modal logic rules of inference that indicate whether attributes of related objects extend to one another. The inference rules potentially may supplement models of natural language semantics.

Chapter 4 details morphological and semantic analysis that implemented computer procedures employ in classifying nominal compounds according to their associated logical properties. The morphological analysis primarily applies to gerundive and derived nominals in order to recognize the semantic type of the nominal. Semantic types for nonderived nominals typically are unvarying.

The computational procedures classify individual nominal compounds by matching their patterns of semantic types to a set of patterns of semantic types that have recognized logical properties.

Chapter 5 reports the results of applying the computational procedures to a data base of compounds. The problem of ambiguity is treated in separate tests. The first test includes ambiguous senses for nominals and accepts ambiguous analyses for compounds. The second test imposes fixed senses on nominals and limits acceptable analyses for compounds. In both tests, the procedures achieve greater than a .90 success rate in correctly classifying nominal compounds according to our model of the logical properties of relationships implicit within them.

The concluding chapter reviews and assesses our approach to analyzing nominal compounds. Our theoretical modal logic framework is at present only a basis for classifying nominal compounds. The rules of inference are not applicable to supplementing models of natural language semantics without further refining representations of the elements of compounds and constraints on the application of the inference rules. We consider these and other difficulties and close by indicating possible extensions and revisions to our thesis.

2.0 Approaches to Nominal Compounds

2.1 Formal Approaches to Nominal Compounds

Our basic approach to nominal compounds in this thesis is interpretive. Our goal is to classify compounds according to logical properties of their implicit relationships, thus providing a way to make explicit through computational means semantic information implicitly present in individual nominal compounds. Formal approaches to nominal compounds such as those of Lees (1960) and Selkirk (1982) seek to detail rules for the production and recognition of nominal compounds. In formal approaches, nominal compounds are surface linguistic features that correspond to semantically interpreted deep structures. Rules guide the production of compounds from deep structures and their recognition. Interpretive approaches such as Finin (1980) and Leonard (1984) primarily focus on analyzing compounds in order to recover deep structures that determine the semantic interpretation of compounds. Interpretive approaches benefit from formal approaches because examination of the processes through which nominal compounds are produced and recognized may assist in recovering semantic information about them.

Word order is important in determining the direction of the modifying relationship in nominal compounds. Jespersen (1942) divided compounds into types based on the order of the modifying relationship. In a final determinative compound, the **head** or final nominal is modified by the preceding nominal as in *gas light*. In initial determinative compounds such as *tip toe*, the head nominal acts as a modifier. This type of compound is rare in English, although it is more frequent in other languages. In a copulative compound, the nominals are conjunctive. The object identified by the compound is at the same time both the head nominal and the preceding nominal, as in *servant girl*. A special class of nominal compounds is termed exocentric, in which the nominals may modify one another, but the head nominal is used synecdochically as a part that stands in place of the whole. *Feather brain* is an example of this form of compound. The majority of compounds in English are final determinative. This classification based on the direction of the modifying relationships in nominal compounds is informative, but it lacks sufficient information for interpretation because it does not indicate the semantics of the modifying relationships.

The interpretations of individual nominal compounds are determined uniquely by their components. Interpretations of individual compounds, however, seem to share underlying themes with the interpretations of other compounds. Many researchers follow Marchand (1969) in distinguishing between two major types of compounds: those that have a nominalized verb in the head of the compound, called **synthetic**, and those that do not, called **primary** compounds. Thus *truck driver* is synthetic while *truck tire* is primary. The compounds belonging to these groups usually are subject to different forms of analysis. The verbal heads of synthetic compounds typically provide the basis for their implicit relationships. The sources of relationships in primary compounds are less clear.

Initially transformational approaches accounted for the production of nominal compounds with rules that generated them from kernel sentences. As originally conceived by Chomsky (1957), kernel sentences explicitly express concepts in full sentential form. A series of rules were postulated to reduce the sentences to nominal compounds. The interpretation provided for a given nominal compound was derived from the sentential relations in the corresponding kernel sentence. The

survey of nominal compounds by Lees (1960) is generally credited as being the most comprehensive of these efforts. His rules formed eight major categories for compounds based on the syntactic roles of the elements of compounds in their kernel sentences. The set of syntactic roles were subject, predicate, "middle object," verb, object and prepositional object. "Middle object" stood for the object of a genitive construction. *Branch*, for example, is a middle object in the clause "A tree has a branch." Determining the appropriate category for a given nominal compound was based in part on the syntactic properties of the nominals in the compound. Some of the syntactic categories Lees employed were **agentive**, **genitive**, **possessive**, **gerundive**, and **infinitival**.

Marchand (1969) also classified nominal compounds according to the syntactic role of the head nominal in the corresponding kernel sentence. His subgroups within the major groups of primary and synthetic were Subject, Predicate, Object and Adverbial Complement. Marchand provided specific semantic rules for interpreting various types of nominal compounds as well as selection preferences for the elements of compounds in each type. For example, he described the type containing the compound *boat ride* as "AB [which] denotes an instance of the activity underlying B with A referring to the place where or from where, the time when, or the instrument with which the activity is performed."

Where Lees and Marchand formed synthetic compounds with syntactic rules by transforming kernel sentences, later researchers such as Selkirk (1982) formed compounds within the English lexicon by using morphological rules following Chomsky's (1970) Lexicalist Hypothesis. Under this view, the relationships implicit in synthetic compounds are not based on syntactic roles corresponding to the verb, but on thematic roles such as Agent, Theme, Goal, and Source. In the lexicon, verbs are marked for a set of roles. The verbal roles include information on semantic preferences for the arguments that can fill the roles. For instance, the verb *construct* has at least two roles, one for the agent who does the construction and one for the constructed object. The synthetic compound *building construction* is analyzed as *an act of construction done to a building*. Selkirk, however, did not provide a comprehensive set of roles.

Detailed sets of thematic roles for verbs are incorporated in case grammars that semantically characterize the actions of verbs. A case grammar can distinguish various senses of verbs and supply information about the effects actions have upon their participants. Levi (1978) grouped the nominalizations of head nouns into three classes: **subjective**, **objective** or **multimodifier**. The compounds then are categorized by the type of nominalization and the role of the modifier nominals in her case grammar: **act**, **product**, **agent** and **patient**. An act is simply an action, that which is performed. An agent is that which performs an action. Products result from actions and patients undergo actions.

A highly general set of case roles such as Levi's reduces the need for analysis of individual actions because most roles may be attributed to most actions. A detailed set of roles, on the other hand, provides a means for making finer interpretive distinctions among nominal compounds. A detailed set of case roles requires semantic analysis of individual actions in order to recognize which cases may be applicable to them. Rhyne (1976) computationally generated compounds from input clauses employing a typology that attributes to actions eight case roles: **performer**, **object**, **goal**, **locus**, **source**, **means**, **cause** and **enabler**. Nominal compounds are formed through pairing of objects filling two of these case roles conjoined, though several of the pairings of case roles do not appear to be productive sources of compounds. For example, the locus of an event and the cause of the event do not form either locus-cause or cause-locus compounds.

The verbal heads of synthetic compounds often indicate the basis of the relationships between their elements. The relationships in primary compounds, on the other hand, are almost entirely implicit. Characterizing the semantic relationships existing between elements of primary compounds is the subject of much debate in the literature. Bergsten (1911) presented a detailed taxonomy of such relationships. His lead in being as specific as possible was followed by Jespersen (1942), Marchand (1969) and others. None of these researchers claimed to have enumerated the complete set of possible relationships; instead they suggested that the set is indeterminate and open-ended, therefore impossible to capture in a finite list. Selkirk (1982) indeed claimed that the set of relationships in primary compounds is unknowable and any attempt at enumeration ultimately will prove fruitless.

Levi (1978) employed a different approach to primary compounds. Rather than seeking the most specific relationships between elements of compounds, she classified primary compounds with nine general semantic relationships: **cause, have, make, use, be, in, for, from** and **about**. Her claim was that compounds are formed from clauses by deleting these nine predicates and that the relationships present between elements of primary compounds can be expressed by reconstructing a clause with the elements of the compound connected through one of the predicates. The **cause, have** and **make** predicates may relate the elements of the compounds either with the head nominal as the object of the corresponding clause or as the subject of the clause, while for the remaining predicates the head nominal is always the subject of the clause. *Tear gas* is expressed with the **cause** predicate as in *gas causes tears*, while *apple cake* is expressed with the **have** predicate as in *cake has apples*. The predicates include more specific relationships so that it is not necessary to enumerate them individually. The more specific relationships, Levi claimed, are wholly predictable on the basis of the semantic characteristics of the surface elements of a compound. Her analysis is equal to a periphrastic equivalent, where some distinctions are made but others still are left unspecified. Downing (1977) and others also classified primary compounds using generalized relationships, but there is no consensus on a set of primary relationships.

Figure 2 on page 13 presents the typology proposed by Warren (1978). Her typology is an example of a coherent scheme for classifying nominal compounds that distinguishes synthetic from primary compounds while accounting for both. The typology provides for a variety of primary relationships and analyzes synthetic compounds via a case grammar. Her major categories are **Source-Result, Copula, Resemblance, Whole-Part, Part-Whole, Size-Whole, Goal-Object, Place-Object, Time-Object, Origin-Object, Purpose** and **Activity-Actor**. Each of these major categories is subdivided, usually on the basis of semantic features of the components of the compounds. Warren makes the inclusive claim that even nominal clusters that other researchers might consider phrases, beyond just compounds, are classifiable in her typology. We illustrate this typology because it is a classic example of a nominal compound typology that specifies in detail both primary and synthetic relationships. In section 3.3 we will compare this typology to our own.

- I. Constitute
 - A. Source-Result
 - 1. Material-Artifact - *clay bird*
 - 2. Matter-Shape - *rain drop*
 - 3. Parts-Whole - *student group*
 - 4. Nonmaterial Substance-Whole
 - a. “Tennis Match” compounds
- *tennis match*
 - b. Subject Matter-Whole - *de-
tective story*
 - B. Copula Compounds
 - 1. Attributive
 - a. Animate head - *girl friend*
 - b. Inanimate head - *house boat*
 - 2. Subsumptive
 - a. Animate head - *boss man*
 - b. Inanimate head - *cypress tree*
 - 3. Adjective-like Modifier - *key issue*
- II. Resemblance - *cherry bomb*
- III. Belonging to
 - A. Whole-Part
 - 1. Whole Discrete, Integral Part
 - a. Object-Part - *spoon handle*
 - b. Group-Member - *Peace
Corps girl*
 - c. Object-Geometrical Outline
- *hillside*
 - d. Residual Class - *telephone
receiver*
 - 2. Whole-Feature
 - a. Object-Quality - *room tem-
perature*
 - b. Object-Extension - *particle
size*
 - c. Object-Abstract Shape -
crime trend
 - 3. Possessor-Belonging
 - a. Possessor-Legal Belonging -
family estate
 - b. Possessor-Habitat - *police
station*
 - c. Authority-Subordinate En-
tity - *county school*

Figure 2. Warren's Typology

- B. Part-Whole
 1. Object-Place - *flower garden*
 2. Object-Time - *golf season*
 3. Part-Object - *armchair*

- C. Size-Whole
 1. Physical Size-Whole - *22-inch board*
 2. Duration-Whole - *3-day affair*
 3. Monetary Value-Whole - *\$200 watch*
 4. Power-Whole - *80 horsepower motor*
 5. Scalar Value-Whole - *A-1 condition*

- IV. Location
 - A. Goal-Object
 1. Goal-Object - *moon rocket*
 2. Direction-Object - *downhill trend*

 - B. Place-Object
 1. Concrete Place, Entity - *ghetto street*
 2. Abstract Place, Entity - *school friends*

 - C. Time-Object - *Sunday paper*

 - D. Origin-Object
 1. Place of Origin - *hospital bill*
 2. Causer-Result - *hay fever*

- V. Purpose
 - A. Relation involves Location
 1. Goal, Object - *water bucket*
 2. Goal, Place - *table cloth*

 - B. Relation involves Time
 1. Goal, Time - *nightdress*
 2. Goal, Object - *dinner time*

 - C. Relation involves Instrumental
 1. Goal, Instrument - *ball bat*
 2. Goal, Causer - *football*

- VI. Activity-Actor
 - A. Object, Single Animate Being - *room clerk*

 - B. Object, Group of People - *crime syndicate*

 - C. Object, Organization - *Finance Department*

Figure 3. Warren's Typology

tive approaches often interpret nominal compounds according to classificatory schemes resembling typologies proposed in formal approaches. But interpretive approaches further must provide explicit methods for assigning compounds to categories in the typology. Representation of words as well as the concepts they denote is key for interpretive approaches, for the representation of these elements typically forms the bulk of the information readily accessible to a computational nominal compound interpreter.

In addition to analyzing primary and synthetic compounds, interpretive approaches such as those of Finin (1980) and McDonald (1982) make provision for idiomatic compounds. Idiomatic compounds are not compositionally analyzable. They have standard interpretations and have become part of the English lexicon. Idiomatic compounds usually receive special treatment in interpretation because compositional analysis of them renders literal interpretations that are not in accord with the accepted interpretations of the compounds. Often idiomatic compounds are metaphoric. *Feather brain* and *sea horse* are examples of idiomatic compounds. Neither *feather* nor *brain* denotes to the same class of objects as does *feather brain*, and neither *sea* nor *horse* denotes to the same object as *sea horse*. The usual approach to idiomatic compounds, as exemplified by both Finin and McDonald, is to include the complete compounds as entries in the lexicon together with their desired interpretations.

There are a number of computational systems that interpret nominal compounds. Leonard (1984) examined a large body of data obtained from literary works written over a period ranging from the early 18th century to the present day. In her study, compounds are assigned to seven categories: **sentence**, **locative sentence**, **annex**, **equative**, **material**, **additive** and **reduplicative**. Each of these categories relates the components of the compound in a fixed manner that is given a standard English paraphrase. In the lexicon words are marked by the presence of features, ranked in four levels by importance in interpretation. If a compound may be interpreted with features from just the primary level, then the analysis of the compound is stopped and the compound is assigned to its categories on the basis of those features. If the primary level features do not lead to a unique interpretation, the secondary features are examined. If the compound still cannot be assigned to

one of the categories based on the primary and secondary level features, third and fourth level features are examined. The features are a mix of semantic and syntactic attributes of the nominals. Primary features may be syntactic or semantic. Some primary features of nominals include plurality, countability, concreteness, relationships to verbs, adjectives or adverbs, whether they are followed by the preposition *to*, and their type, for example human, animal, time, manner, or annex. Secondary features relate nominals to verbs via cases. The tertiary features type the nominals, when applicable, into mechanisms, organizations, body parts, plants, food, furniture, buildings, clothing or disease. The lowest level features group compare concrete objects by size, and are useful in locative relationships. The total set of features is determined according to the information about nominals that best contributes to their classification. During evaluation a set of rules is applied to the nominals of a compound in order to find an appropriate combination of features that assigns the compound to one of the categories. The problem of ambiguity is handled by the ranking of semantic features and assigning preferences to categories: the higher ranked features are considered more significant and interpretations that fall in some categories are preferred to others. More than three quarters of the compounds analyzed in this effort were given correct or partially correct interpretations.

Russell (1975) also presented a high level ontology in combination with a standardized set of features that provides a basis for categorizing the objects which nominals may identify. The major nominal categories she identifies are **space**, **time**, **material**, **active**, **control**, **sensory** and **mental**, reflecting a physical view of the world. The presence, absence, or variable presence of lower-level features additionally are indicated for each concept. The features Russell cites as relevant in the interpretation of nominal compounds are part, shape, contain, fixed, one dimensional, two dimensional, fluid, complex, spatial, temporal, human, man-made, and dynamic. The relationships that may exist between the components of nominal compounds issue from Conceptual Dependency theory and are notable for the inferences they facilitate concerning the related objects. The relationships are divided into two major classes: **functional** and **non-functional**. Functional relationships arise from the typical or designated uses of objects as participants in the primitive

actions of Conceptual Dependency theory. Other relationships, such as material composition, location, source and part-whole, are non-functional. The focus of Russell's research is not to analyze nominal compounds per se, but to provide a categorization of nominals. Therefore she did not present empirical results that assess the effectiveness of her methods.

In contrast to using features to demarcate nominal concepts, Finin (1980) instead created a lexical data base with a type hierarchy of concepts. Explicit relationships between words or their containing hierarchies are used in forming interpretations for a compound by examining slots they may fill with respect to one another. These slots represent attributes of concepts. For instance, any entity has a slot for the material composing it and slots for its parts or the greater unit of which it is a part. An important additional link is the one between some nouns and their characteristic verbs. *Food*, for instance, is a superordinate term for objects of the verb *eat*. The relationships explored to understand the meaning of compounds are not necessarily directly a part of the representation of the elements of the compound, but may arise through intermediaries that provide slots to each of the concepts to be related. In *cat food*, the relationship between the nouns can be described as eater-eaten, using *eat* as an intermediary concept. Since multiple interpretations for certain nominal compounds are possible, a scoring function based on selection preference measures how well one concept fits into the slot of another and chooses the most suitable interpretation. There is no specific set of slots that are common to all concepts. In particular, there is not a comprehensive set of case roles for verbs which often appear as the link between concepts. The total set of potential relationships is open-ended and can be expanded by supplementing the data base. McDonald (1982) employed a similar approach, primarily differing in the manner of selecting a best interpretation. He used a set of heuristics designed to be more robust than Finin's scoring functions to compare the adequacy of candidate meanings.

Both Finin and McDonald relied heavily on the relationship between nominals and verbs. Isabelle (1984) proposed a system that attempts to interpret only those compounds that include a nominalized verb or with head nouns that have a characteristic verb. Verbs are represented individually as functions with a fixed number of arguments, each argument having a semantic prefer-

ence for the nouns that may fill it. The appropriate function is identified in the lexicon. Then, within constraints, the elements of the compound are matched to arguments of the function according to the selection preferences. The meaning of a compound is a function with its appropriate arguments filled in by the nouns in the compound. For instance, *pilot* is defined as “x such that $FLY(x,y,p)$ where y is usually a type of aircraft and p is a location or destination.” With this information, the relationship expressed in *helicopter pilot* could be understood as $FLY(pilot,helicopter,p)$. Isabelle’s approach is an interpretive counterpart of formal approaches to nominal compounds such as that of Selkirk (1982).

While most proposals for interpreting nominal compounds rely on the thesis that nominal compounds abbreviate a proposition, some computational approaches focus on the objects identified by nominal compounds and disregard the precise nature of the relationships implicit between the elements of compounds. Nominal compounds may identify an object or distinguish one object among similar objects by describing some salient feature. A corresponding possible explanation of the source of nominal compounds is that they are used to name novel entities, events, and concepts. The elements of the compound describe the components of the novelty, but leave their relationship unspecified. Deriving names by combining one or more familiar terms is more easily accomplished and produces a more understandable result than generating a single word to describe the same novelty. A characteristic of pragmatic computational approaches to nominal compounds is that they do not try to explain the relationships embodied in compounds: they merely identify the denoted objects. Lehnert (1988) discussed several differing approaches to nominal compound interpretation, including systems that track the objects of discourse and attempt to determine the objects is denoted by nominal compounds.

While the identifying and distinguishing abilities of nominal compounds are undoubtedly important keys to interpreting them fully, this type of approach underutilizes the information present in nominal compounds. The statement “She is a computer science department faculty member” seems to present more information than just a label for a particular professor. Explicating the relational information present in nominal compounds is desirable in nominal compound interpretation.

2.3 *Multiple Compounds*

The discussion of previous investigations of nominal compounds so far has been limited to binary compounds. Binary compounds are composed of exactly two nominals. But nominal compounds may consist of strings of nominals that are greater than two in length. Nominal compounds with more than two nominals are called **multiple compounds**. Jespersen (1942) observed that in binary compounds, the elements of a compound modify one another, identify the same object, or form a conjunction to identify an object. The relationships implicit in binary compounds have been characterized in typologies presented by several researchers. Few typologies make separate provision for multiple compounds.

The prevailing attitude towards multiple compounds is stated succinctly by Warren (1978): "... compounds have two constituents, no more no less. Each constituent can, however, in its turn be made up of one or more compounds or other complex units." Thus the relationships identified in binary compounds are sufficient to account for multiple compounds. A string of n nominals contains $n-1$ binary relationships relating the elements of the compound. By this analysis, *oak tree bird nest* would be described in terms of three modifying relationships: the nominals *oak* and *bird* respectively modifying the nominals *tree* and *nest*, and the nominal compound *oak tree* modifying the nominal compound *bird nest*, ((oak tree)(bird nest)).

Ascertaining the correct order of pairwise combination is a major difficulty in multiple compound interpretation. Both individual nominals and nominal compounds may pair with either individual nominals or nominal compounds. The number of pairwise combinations in a compound expands exponentially with the length of the nominal compound to be interpreted. The expansion is mathematically equivalent to the number of ordered trees with as many vertices as there are nominals in the compound, as indicated by Finin (1980). No complete, satisfactory solution to the problem of ordering pairwise combination in multiple compounds has been proposed. Finin does

note a frequent type of modification exhibited in compounds such as *plate glass window frame* in which the first nominal modifies the second nominal, the second modifies the third, and the third modifies the last, (((plate glass) window) frame). Finin's observation accords with Jespersen's claim that the most frequent type of English nominal compound is final determinative. This observation is a weak guide for interpreting multiple compounds, since there are many exceptions to its order of modification. *Crystal wine glass*, in which the first nominal modifies not the second nominal but the third, is only one example.

Some researchers offer exceptions to the general rule of pairwise combination. The typology advanced by Levi (1978) presents a class of multi-modifier synthetic compounds such as *city trash collection* and *government price supports*. Compounds in this class can be viewed as a pairwise combination of the head nominal separately with each of the modifier nominals. Either modifier could be omitted, yet the remainder still would be a nominal compound. Warren (1980) cites exceptions similar to *September-October term* in which the head nominal is modified by the combination of its predecessors. But the combination of the modifiers does form one of the binary relationships described by Jespersen, so these compounds also may be exhibiting pairwise combination. The proposed exceptions to the rule of pairwise combination are not sufficiently distinguished from nominal compounds exhibiting pairwise combination to upset the thesis that the relationships implicit in nominal compounds are binary.

Multiple compounds are strings of nominals greater than two in length. Analysis of multiple compounds suggests that the relationships implicit among the elements of multiple compounds arise from the pairwise combination of nominal groups composing the compound. In multiple compound interpretation, characterizing the implicit relationships among the elements is partly dependent upon determining which individual nominals and nominal groups in the compound modify one another. But the types of relationships implicit among the elements of multiple compounds seem to be similar to the types of relationships implicit in binary compounds. Thus an accounting of the types of relationships that exist in binary nominal compounds may be applied to

the relationships implicit in multiple compounds, assuming that the correct order of pairwise combination can be ascertained.

This view of multiple compounds has caused most research in nominal compounds to focus primarily upon binary compounds. Our research follows this tradition. In the next chapter we present our typology for nominal compounds that relies on the binary nature of relationships implicit in nominal compounds. We do not attempt to expand our theory to apply to multiple compounds, but assume with precedents that the analysis we provide for binary compounds may be applied to multiple compounds if the order of pairwise combination is determinable.

3.0 A Logic-Based Typology for Nominal Compounds

3.1 *Logical Categories*

In general terms, semantic analysis of nominal compounds consists of making explicit some of the implicit relationships that exist between the elements of compounds. Each nominal in a compound may denote an object, and the composition of nominals in compounds implies that the objects denoted by the component nominals are related in some manner. Semantic properties of objects denoted by nominal compounds as wholes in some cases may be determined by analyzing their separate elements and the relationships in which they exist to one another. Semantic relationships implicit between the elements of nominal compounds vary with the individual elements of the compounds, but many relationships exhibit similarities to one another. Similarities among relationships in compounds form the basis for nominal compound typologies. Semantics for individual nominal compounds then are rendered through the categories to which they belong.

Analyzing nominal compounds through semantic classification of their implicit relationships includes selecting an appropriate set of semantic categories and determining the semantics attached to each category. The key question in selecting appropriate semantic categories concerns which categories can be discovered that correctly identify the various semantic relationships perceived to exist between the elements of compounds. The difficulty of characterizing these relationships arises in every attempt to classify nominal compounds semantically. Jespersen (1942:138) states: "The analysis of the possible sense-relations [in nominal compounds] can never be exhaustive." Levi (1978) claims that the variety of semantic relationships implicit in nominal compounds is confined within a tightly limited range of possibilities, but that the specifics of the relationships are dependent upon the semantic characteristics of the components of the compounds.

The relationships recognized in a typology should classify all nominal compounds or make clear the restricted set to which it applies. A typology also should make clear the semantics attached to each category. Identifying relationships implicit between the elements of nominal compounds is only a preliminary step in nominal compound analysis. Relationships typically have implications, and those implications should be explicated in analyzing compounds. Categories for relationships may support specific inferences for individual compounds that capture implications of their implicit relationships by attaching inference schemata to the categories. Different compounds instantiate the schema with different values, thereby promoting different implications. In this way, general characterizations of relationships implicit in nominal compounds allow for compound-specific implications of the relationships.

Our approach to analyzing nominal compounds is to exploit logical properties of their implicit relationships to develop a typology for compounds with attached inferential schema. As detailed in Chapter 2, modern research into nominal compounds divides the analyzable relationships implicit in compounds into two basic types: between arguments of a verb as in *shoe maker* and *shoe repair*, or between nonverbal concepts directly as in *shoe heel*. The relationships implicit in nominal compounds thus are characterized as binary. Since the relationships implicit in nominal compounds exist between two elements, two-place predicates in first order logic sufficiently represent

them with predicates representing relationships and arguments to predicates representing elements of compounds. The semantics of the relationships may be represented through logical sentences involving the two-place predicates representing the relationships.

By specifying members of a two-place predicate set that adequately represent the relationships implicit in nominal compounds and corresponding inference rules that reflect the implications of the relationships, an interpretive typology for nominal compounds is formed. For a typology for nominal compounds, an important challenge is to isolate an appropriate set of inference rules that capture the semantics of nominal compounds without debasing the accuracy of the representation. One set of valid inference rules is available from the binary form of nominal compounds. Binary relationships exhibit logical properties that yield logically valid inferences. The logical properties exhibited by binary relationships are transitivity, symmetry and reflexivity.

If a relationship is transitive, it allows the inference to be made that when a first object is related to a second object and the second object is related to a third, then the first object is related in the same manner to the third object. Transitivity is characteristic of many primary relationships. Examples of transitive relationships are **contained by** and **type of**. An intransitive relationship for three objects related in the same way as described above assures that the relationship does not exist from the first object to the third object, as in the relationship **is eaten by**. Intransitivity is characteristic of many synthetic relationships. In addition to transitive and intransitive relationships, there also exist nontransitive relationships that do not allow inferences under the described condition of relations among three objects. The nontransitive relationships may or may not exist between the first and third objects. Some nontransitive relationships are **near** and **resembles**.

If relation **R** is transitive, then for all x, y and z ,

$$R(x,y) \ \& \ R(y,z) \ -> \ R(x,z).$$

If relation **R** is intransitive, then for all x, y and z ,

$$R(x,y) \ \& \ R(y,z) \ -> \ \neg R(x,z).$$

If relation **R** is nontransitive, there is no entailment.

A symmetric relationship is such that if it exists from one object to another, then it also obtains from the second object to the first. Thus there is an element of mutuality between the objects in a symmetric relationship. Examples of symmetric relationships include **same as** and **mate of**. If an asymmetric relationship holds from one object to another, it cannot hold from the second object to the first, as in the relationships **contains** and **source of**. Frequently there is a widely recognized corresponding converse asymmetric relationship holding between asymmetrically related elements, for example the converse of **contains** is **is contained by**. A nonsymmetric relationship is neither perfectly symmetric nor asymmetric, such as **meant for**. If one object is related to a second object by a nonsymmetric relationship, the second object may or may not be related to the first object in the same way.

If relation **R** is symmetric, then for all *x* and *y*,

$$R(x,y) \rightarrow R(y,x).$$

If relation **R** is asymmetric, then for all *x* and *y*,

$$R(x,y) \rightarrow \neg R(y,x).$$

If relation **R** is nonsymmetric, there is no entailment.

Finally, binary relationships may be reflexive, irreflexive, or nonreflexive. Reflexivity is a very strong property of relationships that states that every object participates in that relationship with itself. Quasi-reflexivity is a weaker version of reflexivity that states if an object is related to any other in a quasi-reflexive relationship, then it also participates in that relationship with itself. All transitive, symmetric relationships are quasi-reflexive. Any relationship that is either transitive or symmetric but not both may also be quasi-reflexive. Hereafter, we restrict our use of the term *reflexive* to the weaker version, quasi-reflexivity. This logical property is characteristic of relationships such as **same as** and **resembles**. An object participating in an irreflexive relationship cannot be related to itself in the same way it is related to the other object in the relationship. Some irreflexive relationships are **contains** and **mate of**. In nonreflexive relationships, some objects can be related to themselves but other objects cannot. A sample nonreflexive relationship is **affects**. In logical notation, the notions associated with reflexivity are rendered:

If relation R is reflexive, then for all x and y ,

$$R(x,y) \rightarrow R(x,x) \ \& \ R(y,y).$$

If relation R is irreflexive, then for all x and y ,

$$R(x,y) \rightarrow \neg R(x,x) \ \& \ \neg R(y,y).$$

If relation R is nonreflexive, there is no entailment.

We employ logical properties of transitivity and symmetry to characterize the relationships implicit in nominal compounds.¹ These logical properties in first order systems yield information about the occurrence of relationships between objects, but insufficiently characterize the nature of the relationship itself. Modal logic is a branch of logic that offers plausible inferences concerning how properties and relationships may apply similarly to objects related to one another or how there are vital distinctions between objects in their properties and relationships. In our view, modal logic is a powerful mathematical tool that offers a natural means of analyzing the semantic relationships that exist between the elements of nominal compounds. For the purpose of discussion, properties and relationships applying to individual objects collectively are termed *attributes* of that object. *Sharing* is the quality that attributes exhibit for which there is reason to believe that they apply similarly to more than one object. Modal logic inference schemata associated with the logical properties of transitivity and symmetry assist in determining whether there is reason to believe that there are attributes that are shared or not shared by related objects.

First order systems can be modeled in modal logic by representing the objects as worlds and the attributes of objects as theorems in the worlds. The implicit relationships between the elements of nominal compounds may then be viewed as relations between worlds in a modal logic. Depending on the relations existing between worlds in a modal model, certain rules of inference are valid. Of particular interest are the rules of inference Chellas (1980) identifies as **4** and **B**. Rule **4**

¹ Reflexive relationships may relate objects, but they do not yield logically valid inferences that elaborate the modification process acting in nominal compounds because reflexivity is about an object's relationship to itself. For this reason, we do not employ reflexivity in characterizing the relationships implicit in nominal compounds. However reflexivity is useful in determining whether relationships in nominal compounds are transitive or symmetric, as is explained in Chapter 4.

is the rule that primarily determines the *S4* modal logic, valid in universes where worlds are related by transitive relationships. Rule **B** holds in universes where worlds are related by symmetric relationships. This rule gets its name from LEJ Brouwer, who argued for the universal validity of a form of this rule based on intuitionism. Since a modal logic universe may be of any size, two worlds participating in a single relationship that models a binary nominal compound constitute a universe.

The rules **4** and **B** employ two modalities: *necessary* and *possible*. A theorem *H* that must occur in every world related to a particular world *W* within a given universe is *necessary* in *W*. Thus with the knowledge that two worlds are related and one of the worlds exhibits necessary attributes, then it may be inferred that the other world exhibits those attributes. *Necessity* is symbolized by the operator *L*. $L(P(A))$ means that property **P** is necessary for object *A*, and that if *A* is related to *B*, then property **P** applies to *B*, $P(B)$.

A theorem *H* that must occur in some world related to *W* within a universe is *possible* in *W*. With the knowledge that two worlds are related and one of the worlds exhibits possible attributes, it cannot be inferred that the other world exhibits the attributes, but in the absence of disconfirming evidence, the hypothesis may be considered plausible. *Possibility* is symbolized by the operator *M*. $M(P(A))$ means that property **P** is possible for object *A*, and that if *A* is related to *B*, then property **P** may or may not apply to *B*, $P(B)$. The rules of inference that hold in particular modal logic universes affect the application of *necessary* and *possible* in first order models.

Rule **4**, the rule of inference that is relevant to the logical property of transitivity, states that theorem *H* is necessary in any world transitively related to a world in which *H* is necessary. Thus if two objects participate in a transitive relationship, necessary attributes of the first object are necessary for the second object. In intransitive universes, **4** states that there is a theorem *H* that is necessary in a world *W* and that there is a world *W'* related to *W* in which $\neg H$ is possible. Thus if two objects participate in an intransitive relationship, there is a necessary attribute exhibited by the first

object that may be not possible for the second object. There is no version of **4** applicable in non-transitive relationships.

If relation **R** between objects *A* and *B* is transitive, then for any property **P**

$$L(P(A)) \rightarrow L(P(B))$$

If relation **R** between objects *A* and *B* is intransitive, then for some property **P**

$$L(P(A)) \ \& \ M(\neg P(B))$$

If relation **R** between objects *A* and *B* is nontransitive, there is no immediate inference.

B, the rule of inference that is relevant to the logical property of symmetry, states that in any world symmetrically related to a world in which theorem *H* occurs, *H* is possible. Thus if one object is related by a symmetric relationship to another, any attributes of the first object are deemed possible for the second object, which entails that the attribute may hold for any object to which the second object is related. For universes in which worlds are asymmetrically related, **B** states that there are two related worlds, *W* and *W'*, and a theorem *H* occurring in *W* for which $\neg H$ is necessary in *W'*. Thus if one object is related asymmetrically to another object, the first object exhibits an attribute that may be necessarily not exhibited by the second object, and therefore possibly is not exhibited by any object to which the second object is related. There is no version of **B** applicable in nonsymmetric relationships.

If relation **R** between objects *A* and *B* is symmetric, then for any property **P**

$$P(A) \rightarrow M(P(B))$$

If relation **R** between objects *A* and *B* is asymmetric, then for some property **P**

$$P(A) \ \& \ L(\neg P(B))$$

If relation **R** between objects *A* and *B* is nonsymmetric, there is no immediate inference.

We categorize nominal compounds according to the status of their implicit relationships with regard to the logical properties of transitivity and symmetry because they support inferences concerning the sharing of attributes between related objects. A binary relationship must be transitive,

intransitive or nontransitive, and at the same time symmetric, asymmetric or nonsymmetric. The combination of these properties yields nine possible categories. All binary relationships must exhibit some combination of these logical properties, and therefore each belongs to one of the categories. In particular, the binary relationships implicit in nominal compounds may be classified into the nine categories. The nine categories formed by the combinations of these logical properties create a classification we call the *logical typology*. Compounds are assignable to categories in the logical typology on the basis of logical properties of their implicit binary relationships.

Because the categories of the logical typology have their basis in logic, information about related objects may be inferred, particularly about their properties and their relationships to other objects. Both transitivity and symmetry provide the information that certain properties and relationships may apply similarly to objects related to one another or that there are vital distinctions between objects in their properties and relationships. The rules *B* and *4* in this context apply to universes consisting of the elements of nominal compounds. As noted by Jespersen (1942), one element in a nominal compound typically identifies the object described by the entire compound directly and the remaining compound element serves to modify that object. Necessary and possible attributes of the identifying nominal describe the object denoted by the compound directly because of the identification process. Attributes of the modifier nominal, however, describe the object identified by the compound only indirectly through the modification process. The rules *B* and *4* assist in characterizing how necessary and possible attributes of modifier nominals in compounds describe the object identified by the compounds. Thus by analyzing the relationships implicit between the elements of nominal compounds through the logical typology, it may be seen how attributes of modifier nominals are reflected in the objects denoted by the compounds. Specific examples of modification in nominal compounds and how the rules *B* and *4* aid in elaborating the modification process are discussed in the next section.

3.2 *The Logical Typology*

In order to apply the inference rules **B** and **4**, it is necessary to determine the necessary, possible and actual attributes of objects that exist in the relationships. However, determining and identifying necessary, possible and actual attributes of objects is an open problem. In the absence of a general knowledge data base that would be a source of information about objects, attributes and their modalities, the inference rules issuing from the logical typology cannot be applied in a valid manner to yield information on compounds. Therefore, because of a lack of information about the semantic properties of their constituents, we will not be able to interpret nominal compounds in this work. Instead we shall classify compounds according to the logical properties of their implicit relationships and suggest that in a suitable context this classification may facilitate deduction about the semantic properties of the objects denoted by nominal compounds. But to demonstrate in this section potential inferences suggested by the logical typology, the following provisional definitions for necessary, actual and possible attributes of objects are proposed:

necessary - defining characteristic that is shared by all objects that the label may identify.

actual - attribute that is exhibited by the individual object to which the label is being used.

possible - attribute that may or may not be exhibited by the individual, but it does occur for some individual object to which the label applies.

Additionally, the term **head** will designate the final element of a compound.

From the rules **B** and **4**, plausible inferences may be made concerning the sharing of attributes between objects that are related through categories in the logical typology. The individual categories of the logical typology are examined in this section. We specify relationships that possess proper combinations of the properties of transitivity and symmetry for each of the categories of the logical typology and present nominal compounds whose implicit relationships exemplify the desired mix of logical properties. Inferences facilitated by membership in each of the categories are detailed.

The categories of the typology are abbreviated with two capital letters, the first letter indicating the status of transitivity in the relationship and the second letter indicating the status of symmetry. The statuses of transitivity again are transitive, intransitive, or nontransitive, and the statuses of symmetry are symmetric, asymmetric, or nonsymmetric. The categories of the logical typology are summarized in Table 1 on page 32 and the applicable inferences are summarized in Figure 4 on page 33.

3.2.1 Transitive, Symmetric Compounds

The inferentially most powerful relationships between elements of nominal compounds are those that are at the same time both transitive and symmetric (TS). The valid modal inference rules for two objects participating in transitive, symmetric relationships state that any attribute necessary to either object also is necessary to the other object. One example of a TS relationship is complete similarity or identity. Compounds of this form are widely recognized in previous research. Jespersen (1942) labels them copula compounds and indicates that they form a special category wherein each element of the compound serves to modify the other. TS relationships are the most informative type in the logical typology because of their comprehensive attribute sharing.

If relation **R** between objects *A* and *B* is transitive and symmetric, then for property **P**

$$L(P(A)) \leftrightarrow L(P(B))$$

$$P(A) \rightarrow M(P(B))$$

The compound *woman doctor*, denoting a physician who is female, has an implicit identity relationship between *woman* and *doctor* that is transitive and symmetric. The woman is a doctor and the doctor is a woman. Both terms describe the object denoted by the compound. The inferences enabled by recognizing that *woman* and *doctor* are in a TS relationship are dependent upon the necessary and actual attributes of *woman* and *doctor*. An example of potential inferences from the

Table 1. Logical Schemata

	Symmetric	Nonsymmetric	Asymmetric
Transitive	TS Is both <i>woman doctor</i>	TN Type of <i>oak tree</i>	TA Contained by <i>arm chair</i>
Nontransitive	NS Form <i>leather saddle</i>	NN Near <i>traffic island</i>	NA Source of <i>spring water</i>
Intransitive	IS Pairs to <i>bridegroom</i>	IN Meant for <i>missile target</i>	IA Exhibits <i>water temperature</i>

rules of modal logic **B** and **4** enabled by establishing a TS relationship between the elements of *woman doctor* and applying the inference rule *modus ponens* follows. Similar examples may be constructed for the other categories of the logical typology.

Initial information, from hypothetical data base and surface analysis of compounds.

<i>Statement</i>	<i>Justification</i>
1. Compound = "woman doctor"	Given.
2. A = "woman"	From 1.
3. B = "doctor"	From 1.
4. R(A,B) is TS	Given.
5. P(X) = "has XX chromosomes"	Given.
6. (X = "woman") -> L(P(X))	Given.
7. Q(X) = "X knows anatomy"	Given.
8. (X = "doctor") -> L(Q(X))	Given.
9. R(X) = "X wears dress"	Given.
10. (X = "woman") -> R(X)	Given.
11. S(X) = "X writes prescriptions"	Given.
12. (X = "doctor") -> S(X)	Given.

- | | | |
|-------|--------------------------|--|
| I. | TS Co-description | <ul style="list-style-type: none"> • What is necessary for A is necessary for B • What occurs for A is possible for B • What is necessary for B is necessary for A • What occurs for B is possible for A |
| II. | TN Inheritance | <ul style="list-style-type: none"> • What is necessary for A is necessary for B |
| III. | TA Containment | <ul style="list-style-type: none"> • What is necessary for A is necessary for B • Something occurs for A that necessarily does not occur for B |
| IV. | NS Form | <ul style="list-style-type: none"> • What occurs for A is possible for B • What occurs for B is possible for A |
| V. | NN Relatedness | |
| VI. | NA Source | <ul style="list-style-type: none"> • Something occurs for A that necessarily does not occur for B |
| VII. | IS Match | <ul style="list-style-type: none"> • What occurs for A is possible for B • What occurs for B is possible for A • Something is necessary for A that possibly does not occur for B • Something is necessary for B that possibly does not occur for A |
| VIII. | IN Target | <ul style="list-style-type: none"> • Something is necessary for A that possibly does not occur for B |
| IX. | IA Exhibits | <ul style="list-style-type: none"> • Something occurs for A that necessarily does not occur for B • Something is necessary for A that possibly does not occur for B |

Figure 4. Attribute Sharing in Relationships from Modal Logic

Derivation 1.

<i>Statement</i>	<i>Justification</i>
13. $L(P(A))$	From 2,6, substitution and modus ponens.
14. $L(P(A)) \rightarrow L(P(B))$	Inference rule 4 from 4.
15. $L(P(B))$	From 13,14 and modus ponens.

Therefore, if a certain chromosomal pattern is a necessary attribute of the object labeled by *woman* and that *woman* is a *doctor*, then the *doctor* has the same necessary attribute.

Derivation 2.

<i>Statement</i>	<i>Justification</i>
16. $L(Q(B))$	From 3,7, substitution and modus ponens.
17. $R(B,A)$ is TS	From 4.
18. $L(Q(B)) \rightarrow L(Q(A))$	Inference rule 4 from 4.
19. $L(Q(A))$	From 16, 18 and modus ponens.

Therefore, if knowing anatomy is a necessary attribute of the social concept *doctor* and the *doctor* is a *woman*, then knowing anatomy is a necessary attribute of that *woman*.

Derivation 3.

<i>Statement</i>	<i>Justification</i>
20. $R(A)$	From 2,10, substitution and modus ponens.
21. $R(A) \rightarrow M(R(B))$	Inference rule B from 4.
22. $M(R(B))$	From 20,21 and modus ponens.

Therefore, if wearing a dress is an attribute of a *woman*. and the *woman* is a *doctor*, then wearing a dress is a possible attribute of the *doctor*.

Derivation 4.

<i>Statement</i>	<i>Justification</i>
23. S(B)	From 3,12, substitution and modus ponens.
24. S(B) - > M(S(A))	Inference rule B from 17.
25. M(S(A))	From 23,24 and modus ponens.

Therefore, if writing prescriptions is an attribute of a *doctor* and the *doctor* is a *woman*, the a possible attribute of the *woman* is that she writes prescriptions.

These sample derivations illustrate the inferences facilitated by the logical typology. The inferences facilitated by **B**, the modal logic rule attached to symmetry, are qualified and seem to be weak. Nevertheless, they still provide a basis for the sharing of attributes. The inference rule **4** is stronger. In order to actually apply these rules, however, necessary and actual attributes of the objects identified by nominals must be specified as well as the context in which the rules are valid.

3.2.2 Transitive, Nonsymmetric Compounds

A relationship that is transitive and nonsymmetric (TN) is exemplified by hyponymy, a subordinate-superordinate relationship. The nonsymmetry of subordinate-superordinate relationships is evident from the fact that in some cases subordinate classes are indistinguishable from their superordinate classes. In many nominal compounds with implicit TN relationships, the superordinate class indeed does include objects not included in the subordinate class, however it is not true in every case. The modal inference rules applicable to TN relationships state that any attributes necessary to the subordinate class object are necessary to the superordinate class object.

If relation **R** between objects *A* and *B* is transitive and nonsymmetric, then for property **P**

$$L(P(A)) \rightarrow L(P(B))$$

TN relationships exist in the compounds *oak tree*, *hound dog*, *teaching profession* and *giving act*. In these examples the first element of the compound designates the subordinate class and the second element designates its corresponding superordinate class. An object denoted by a compound exhibiting this type of relationship could be labeled by either of the components of the compound separately, but there is a distinction between the labels. An *oak* is a *tree*, but a *tree* is not necessarily an *oak*. From the inferences enabled by the TN relationship, if a necessary attribute of *oak* is that it has hard wood, then a necessary attribute of the *tree* is that it has hard wood.

Warren (1978) recognizes these compounds separately from TS compounds through the categories of subsumptive copula compounds versus attributive copula. The TN category is general enough to include her "tennis match" compounds, because *tennis* is a subordinate class of *match* in the same manner as *football* is a subordinate class of *game*.

3.2.3 Transitive, Asymmetric Compounds

The TA category of the logical typology encompasses many relationships that are identified separately in research by others. Warren, for example, devotes several different categories to TA compounds. Because of our approach to nominal compounds through the logical typology, we treat the various types of compounds similarly, though Iris et al. (1988) and others have argued that the relationships need to be treated separately. The core theme of all the TA relationships is containment. The modal inference from transitivity states that attributes necessary to the contents are necessary to the container. But asymmetry indicates that there is an attribute of the contents that necessarily is not an attribute of the container. One obvious attribute of contents that is not an attribute of the container is that it is contained by the container.

If relation **R** between objects *A* and *B* is transitive and asymmetric, then for property **P**

$$L(P(A)) \rightarrow L(P(B))$$

If relation **R** between objects *A* and *B* is transitive and asymmetric, then for some property **P**

$$P(A) \& L(\neg P(B))$$

Containment is a TA relationship. In the compound *soup can*, that which is in the *soup* is likewise in the *can*. Containment relationships are similar to spatial locational relationships. Implicit in the compound *locker room* is a relationship from which it can be deduced that the contents of the *locker* are additionally contents of the *room*. Locative relationships may be generalized to include temporal locations. In the compound *race day*, for instance, what occurs during the *race* occurs during the *day*. The inferences supported by locative TA relationships are based on the necessary attributes of the located objects, that they exist at some place or time. Therefore necessary attributes of the objects to which they relate are that they exist at some place or time. An attribute of a spatio-temporally located or contained object that necessarily is not an attribute of the location or container is that it is located or contained within the location or container.

The notions associated with containment and location extend to grouping relationships, in which a set of objects is considered as a unit. Consider the compound *buffalo herd*. *Buffalo* are located in the *herd*. If a necessary attribute of *buffalo* is that it eats grass, then the *herd* eats grass. We additionally group part-whole relationships such as the one implicit in *arm chair* in the TA category of the logical typology. A part of the *arm* is part of the *chair*. But the *chair* is not considered to be part of the *arm*, reflecting the asymmetry of the relationship. Necessary attributes of the concept *arm* are difficult to ascertain, as the label is capable of being applied in a wide variety of circumstances. One apparent necessary attribute of *arm* is that it is a physical object, and therefore a necessary attribute of *chair* is that it is a physical object. Being part of a chair is an attribute of *arm* that necessarily is not an attribute of *chair*.

The TA category encompasses another relationship in which ideas or information are captured in symbols as in the compound *data record*. *Data* necessarily contains values, and a computer *record*

containing the *data* also contains the values. An attribute of the *data* that is not an attribute of the *record* is that the *data* is recorded in the *record*.

3.2.4 Nontransitive, Symmetric Compounds

Objects participating in nontransitive, symmetric (NS) relationships generally are similar to one another. This is so because the inferences concerning objects in NS relationships issue from symmetry: an attribute of a modifier object may be an attribute of the modified object and conversely, an attribute of the modified object may be an attribute of the modifier. So both objects in an NS relationship may exhibit similar attributes, though there may be some attributes that are not shared by the related objects.

If relation **R** between objects *A* and *B* is nontransitive and symmetric, then for property **P**

$$P(A) \rightarrow M(P(B))$$

Material composition is a staple of nominal compound typologies. Physical composition of one object by another forms an NS relationship between the constituent objects. For the material composition compound *ice sculpture*, the *ice* takes the form of a *sculpture* and the *sculpture* takes the form of *ice*. But it is not correct to state that *ice* and *sculpture* label the same objects, as in a TS relationship. For instance, the *sculpture* could be destroyed while the *ice* is not. The nontransitivity is reflected in the observation that while it is acceptable to consider the *ice* to be taken as a form of *water*, a *sculpture* is not generally considered to be taken as a form of *water*. Many inferences concerning physical similarities are suggested by physical composition. For instance, if the *sculpture* is fragile, it is possible that the *ice* is fragile. Conversely, if the *ice* is clear, it is possible that the *sculpture* is clear.

Another NS relationship is the partial similarity of attributes implicit in metaphorical compounds such as *iron will*. Resemblance is the root of these relationships. *Iron* resembles the *will* and the

will resembles *iron*. There are some core attributes that are shared by the objects, and qualities of both the related objects are suggested by the similarity. In the example, both *iron* and *will* are firm. Bergsten (1911) recognized both similarity between objects and material composition in his early typology of nominal compounds.

3.2.5 Nontransitive, Nonsymmetric Compounds

Nontransitive, nonsymmetric (NN) relationships indicate perhaps the least informative connections between objects. Relationship exists between the elements of NN compounds, but the relationships do not support inferences concerning the sharing or not sharing of attributes between related objects. The characterization of compounds belonging to the NN category provided by the logical typology typically is not as informative as the characterizations of other categories because the relationships are noninferential.

If relation **R** between objects *A* and *B* is nontransitive and nonsymmetric, there is no immediate inference.

Spatial proximity, as reflected in the compound *barn oak*, is an example of an NN relationship. The *oak* that is denoted by the compound is identified by its location near the *barn*, but the *barn* may not be considered to be near the *oak*. The proximity works in one direction. Another object that is near to either the *barn* or the *oak* need not be near the remaining element. Thus physical proximity is nontransitive and nonsymmetric. It is also noninferential, and no conclusions about similarities or dissimilarities of the *barn* and the *oak* are possible.

Relationships between objects that are affected by actions and objects that give rise to actions also are NN. The nominal compounds *gas pump*, *truck driver*, and *window washer* are all of this type. The nominals in these compounds clearly are related by their participation in a common act. But the object affected by the action may not be directly influenced by the object giving rise to the

action. The most that can be said is that there exists a definite relationship between the action participants. So these compounds are NN.

3.2.6 Nontransitive, Asymmetric Compounds

The property of asymmetry imposes direction on a relationship that is nontransitive and asymmetric (NA). The applicable rule from modal logic for NA compounds is that an attribute of one of the elements necessarily is not an attribute of the other element, implying a distinction between related objects. Despite the existence of this distinction, it is possible that the related objects are similar in many ways that are not denied by their distinctiveness.

If relation **R** between objects *A* and *B* is nontransitive and asymmetric, then for some property **P**

$$P(A) \ \& \ L(\neg P(B))$$

The source relationship is nearly universally cited in semantic analyses of nominal compounds. In the compound *spring water*, the *spring* is the source of the *water*. The relationship is not transitive, for if the *water* is the source of another object such as *illness*, it is not a sound conclusion that the *spring* is the source of the *illness*. But the *spring* may well be the source of the *illness*, so the relationship is not intransitive, either. The relationship implicit in *spring water* is asymmetric as well, as the source of an object does not originate from that object. An applicable inference following from this observation is that being the source of water is an attribute of the *spring* that cannot be an attribute of *water*. The existence of other similarities between the related objects is not prohibited in these relationships. For instance, both the *spring* and the *water* may share the attribute of coldness.

An NA nominal compound frequently may have the same nominals as a TA compound but in reverse order. The relationships are not whole-part, however, but provenance relationships. Im-

implicit in *arm chair* is a TA part-whole relationship. Implicit in *chair arm* is a provenance relationship that properly is classified as nontransitive and asymmetric. The justification is that in general when TA compounds are reversed, the implication of containment at the present time is often dropped in favor of an implication of containment in the past, i.e. denoting the source. In the compound *Georgia peach*, a natural reading might consider the relationship of *Georgia* to *peach* as indicating the source of the fruit rather than its present location. Problems with this type of compound are noted in detail by Finin (1982), discussing the example *Chicago flight*. *Chicago* may denote the source, the location, or the destination of the flight. Destinations are pursued under IN compounds, but the source versus location argument sheds interesting light on the logical typology. Location, because of its transitivity, makes a stronger claim concerning the sharing of attributes between related objects than does a relationship denoting source. In order not to make unjustified claims for possible inferences, accepting the source as default rather than location provides a preferred analysis that is NA, not TA. The inferences made for these types of source compounds are similar to those possible for *spring water*.

The NA category additionally contains some relationships implicit in synthetic nominal compounds. Case grammars often postulate a set of roles for objects that may cause or be the source of the actions described by a verb. Causal factors include agents that perform actions and the instruments with which action are performed. Actions that cause and enable subsequent actions also are causal factors. All of these causal factors may be identified as the source of action from various perspectives. Compounds which have implicit relationships between action causal factors and actions, for example *enemy attack* and *student protest*, thus are considered to be NA compounds. By inference, the causal factors have an attribute that the actions necessarily do not possess: the causal factors cause the actions. But the causal factors and actions may share other attributes; for instance both *enemy* and *attack* may be fierce and both *student* and *protest* may be intelligent in a metaphoric sense.

In many case grammars a distinction is made between an act and the product of the act, for instance distinguishing the act *invent* from its product *invention*. The act may be seen as the source of its

product. One might predict on this basis the existence of act-product nominal compounds, but in fact they have proved elusive. A type of compound that is frequent and nearly universally recognized, however, is the combination of a causal factor and a product. *Student invention* and *police protection* are examples of causal factor-product compounds. The relationship between the components of these compounds is similar to that between a causal factor and an act. Thus, just as we do not distinguish between agents and instruments, we do not distinguish between acts and products. The relationship between between a causal factor and a product is considered to be NA.

3.2.7 Intransitive, Symmetric Compounds

Intransitive, symmetric relationships are bidirectional links between two objects that do not extend to other objects, indicating a matching or pairing of the related objects. The rules of modal logic governing two objects in an IS relationship both support and deny similarities between the objects. The property of symmetry states that an attribute of one object possibly is an attribute of the related object, while the property of intransitivity contributes the inference that a necessary attribute of one of the elements possibly may not be an attribute of the related element. While this type of relationship is rarely illustrated or discussed in the literature, McDonald (1982), for one, identifies such a set of compounds.

If relation **R** between objects *A* and *B* is intransitive and symmetric, then for some property **P**

$$L(P(A)) \ \& \ M(\neg P(B))$$

If relation **R** between objects *A* and *B* is intransitive and symmetric, then for property **P**

$$P(A) \ -> \ M(P(B))$$

Bridegroom is a nominal compound in which there is an implicit matching relationship, *marrying*, between the elements of the compound. It is the case that the *bride* marries the *groom* and the

groom marries the *bride*, so the implicit relationship is symmetric. Furthermore the relationship is intransitive, for if either partner is polygamously married to a third person, the remaining partner is not married to that third person. Several inferences are suggested for the sharing of attributes between *bride* and *groom* through the IS category of the logical typology. What occurs for the *groom*, the act of marrying, is possible for the *bride* and vice versa. Something necessary in the *groom* that possibly does not occur for the *bride* is his qualifications to fill the role of groom, maleness in stereotypical marriages. Likewise, there are necessary attributes of the *bride* that the *groom* possibly does not share.

3.2.8 Intransitive, Nonsymmetric Compounds

The relationships implicit in intransitive, nonsymmetric (IN) nominal compounds are links between the objects directed from one of the objects to the other, but may also exist from the second object to the first. The modal logic rule for two objects in an IN relationship states that a necessary attribute of the first object may not be necessarily an attribute of the second object. Thus there is a distinction between the objects participating in IN relationships.

If relation **R** between objects *A* and *B* is intransitive and nonsymmetric, then for some property **P**

$$L(P(A)) \ \& \ M(\neg P(B))$$

Crime prevention is an IN compound. The *crime* is the target of the *prevention*. If someone wanted to prevent the *crime prevention* as in *crime prevention prevention*, he would not be preventing crime. So the relationship implicit in *crime prevention* is intransitive. It also is nonsymmetric, for the *crime* may be targeted towards the *prevention* effort, or it may have another target.

In general, IN relationships only occur in synthetic nominal compounds. In case grammar terms, the patient of an act is the object that undergoes the act - the object towards which the action is

directed. The relationships implicit in the nominal compounds *javelin throwing*, *knife sharpening* and *eating apple* exist between acts and their patients. To avoid confusion with case grammar terminology, the objects that correspond to **patients** and **experiencers** in case grammar are known as **affected targets** for the logical typology.

Relationships between acts and their affected targets are well documented in studies of nominal compounds that include synthetic compounds. Relationships between acts and affected targets belong to the IN category of the logical typology and have associated inference rules. Something is necessary to the affected target that possibly does not apply to the act. In particular, the target is affected by the act. But the schema does not discourage the sharing of other attributes between objects in an IN relationship. For instance if a *missile* is underwater, its *target* may be underwater.

3.2.9 Intransitive, Asymmetric Compounds

The remaining category of the logical typology is for intransitive, asymmetric (IA) relationships. IA relationships are directed links between objects that do not extend to other objects. The rules of modal logic impose restrictions on the potential attribute sharing between IA related objects. Asymmetry yields the rule that there is an attribute of one object that necessarily is not an attribute of the other object. The transitive rule is weaker, but concerns necessary attributes. A necessary attribute of one object possibly is not an attribute of the other. Both the logical properties disconfirm similarities between the related objects, but that does not entail complete dissimilarity.

If relation **R** between objects *A* and *B* is intransitive and asymmetric, then for some property **P**

$$L(P(A)) \ \& \ M(\neg P(B))$$

$$P(A) \ \& \ L(\neg P(B))$$

IA relationships are characteristic of compounds in which the head nominal is exhibited by the modifier nominal. *Car speed* is an example of a nominal compound with an implicit IA relationship. *Speed* is exhibited by the *car*, but the *car* is not in the same way exhibited by *speed*. Therefore the relationship is asymmetric. Further what is exhibited by *speed*, such as a *range*, is not directly exhibited by the *car*. Therefore the relationship is intransitive. Other nominal compounds belonging to the IA category of the logical typology include *water temperature*, *dress color*, *mountain height* and *dance tempo*. An attribute of *car* that is necessarily not an attribute of *speed* is that speed is a feature of the car. A necessary attribute of the *car* that possibly is not an attribute of *speed* is that it is a physical object. Other attributes of *car*, however, may be shared by *speed*: both may be either fast or slow.

3.3 *Assessing the Logical Typology*

The logical typology for nominal compounds provides a means for characterizing relationships implicit in nominal compounds that supports inferences rooted in modal logic concerning the sharing of attributes between related objects. Sharing of attributes between objects indicates that the objects may exhibit similar properties or exist in similar relationships to other objects. The inferential rules attached to the categories of the logical typology issue from the classifiers for the typology: combinations of the logical properties of transitivity and symmetry as they apply to individual binary relationships. These classifiers form a nine category typology.

The inferences supported by the logical typology vary in strength and informative value according to the logical category. Transitive categories yield stronger inferences than symmetric categories, but asymmetric categories yield stronger inferences than intransitive categories. Positive statuses of the logical properties support the sharing of multiple attributes between related objects. Negative statuses deny the sharing of attributes in at least one aspect. Neutral statuses of logical properties

do not support inferences. Therefore the TS category has the strongest inferential properties, while the NN category is noninferential.

The inference schemata attached to the categories of the logical typology cannot be instantiated without knowledge of necessary, possible and actual attributes of related objects. Furthermore the attributes shared through inferences vary according to the context of the relationships. Therefore the logical typology as it stands does not provide inferences. It must be supplemented by a data base of general knowledge that has information regarding the attributes of objects and the contexts in which they are salient. Forming such a data base is a considerable problem, beyond the scope of this thesis. Thus while we may be able to identify the logical properties of relationships implicit in nominal compounds and indicate applicable inference schemata, we are not able to characterize descriptively the implications of the relationships because of the lack of a general knowledge data base.

The logical typology consists of a set of nine categories for semantic relationships. Semantic relationships connect concepts, and the classifiers in the logical typology are the logical properties of semantic relationships that implicitly connect the concepts denoted by the component nominals in compounds. If the basis of our typology were the relationships between the nominals in compounds themselves instead of between the objects the nominals denote, then our typology would capture a set of lexical relations. But since we are concerned with the denoted objects and not the words themselves, our set of possible relationships is semantic.

Our typology for nominal compounds has some resemblance to typologies proposed by other researchers. As documented in Chapter 2, interpretive approaches generally recognize idiomatic compounds that cannot be analyzed compositionally. We accept the lexicalized nature of idiomatic compounds and do not attempt to analyze them. Both formal and interpretive approaches typically divide nominal compounds into synthetic compounds versus primary compounds and analyze each type separately. We also recognize that these are distinct types of compounds. But our analysis only treats these compounds differently in order to achieve the common goal of assigning both

types of compounds to categories in the logical typology. Once compounds are classified by the logical properties of their implicit relationships, the implications of both synthetic and primary compounds are treated similarly.

One method of analyzing synthetic nominal compounds is through the use of a case grammar. The objects denoted by nominals in a compound are assigned to appropriate roles that belong to the actions relating the objects. Fillmore (1968) presents a case grammar to which the logical typology can be compared. Fillmore lists at least six cases for actions or events. The **agentive** case denotes the typically animate instigator of an action. The **instrumental** case is for inanimate forces or objects that are causally involved in an action. The **dative** case indicates the animate being affected by an action or state. The **factitive** case is the case of the object resulting from an action, understood as part of the meaning of an action. The **locative** case identifies the location or spatial orientation of an action. The **objective** case denotes objects that are affected by actions.

The general characterization of events provided by the logical typology encompasses aspects of Fillmore's case grammar. Fillmore's agentive and instrumental cases are causal factors that participate in NA relationships with actions and in NN relationships with affected targets. Affected targets include Fillmore's dative and objective cases, and participate in IN relationships with actions. The factitive case denotes actions themselves. Fillmore's locative case is spatio-temporal, and therefore participates in NA and TA relationships. Thus, within the context of the logical typology, relationships between pairs of Fillmore's case roles belong to some category of the logical typology.

Researchers have not formed a consensus on the number and types of primary relationships implicit in nominal compounds, but the logical typology encompasses types of compounds described by other researchers. Table 2 on page 48 illustrates a comparison of the logical typology to the typology proposed by Warren (1978). The two typologies classify relationships differently at the highest level. Warren's Constitute and Resemblance categories contain many symmetric relationships. The only symmetric relationship Warren places outside these categories is Size-Whole, in the Belonging-To category. The Constitute relationships that are not symmetric are transitive, so all

Table 2. Comparison of Warren's Typology to the Logical Typology

Category	Subcategory	Logical Type	Example
Constitute	Material-Artifact	NS	<i>clay bird</i>
	Matter-Shape	NS	<i>rain drop</i>
	Parts-Whole	TA	<i>student group</i>
	"Tennis Match"	TS	<i>tennis match</i>
	Subject matter-Whole	TA	<i>detective story</i>
	Attributive	TS	<i>house boat</i>
	Subsumptive	TN	<i>cypress tree</i>
	Adjective Modifier	NS	<i>key issue</i>
Resemblance	Resemblance	NS	<i>cherry bomb</i>
Belonging to	Whole-Part	NA	<i>spoon handle</i>
	Whole-Feature	IA	<i>room temperature</i>
	Possessor-Belonging	TA	<i>family estate</i>
	Object-Place	TA	<i>flower garden</i>
	Object-Time	TA	<i>golf season</i>
	Part-Object	TA	<i>armchair</i>
	Size-Whole	NS	<i>22-inch board</i>
Location	Goal-Object	NA	<i>moon rocket</i>
	Direction-Object	NA	<i>downhill trend</i>
	Place-Object	NA	<i>ghetto street</i>
	Time-Object	NA	<i>weekend guest</i>
	Origin-Object	NA	<i>Harlem boy</i>
	Causer-Result	NA	<i>hay fever</i>
Purpose	Purpose, Location	TA	<i>water bucket</i>
	Purpose, Time	NA	<i>nightdress</i>
	Purpose, Instrument	NN	<i>ball bat</i>
Activity-Actor	Activity-Actor	NA	<i>crime syndicate</i>

the relationships in this category exhibit positive logical properties. The relationships in Warren's Location category are all NA, as are Activity-Actor relationships. The Belonging-To category is chiefly composed of TA relationships, though Whole-Part is NA and Whole-Feature is IA. The Purpose category has relationships that are variously TA, NA and NN. This comparison illustrates that all the relationships identified by Warren may be classified according to their logical properties, though such a classification groups the relationships somewhat differently. This is significant, for Warren claims that her typology for nominal compounds encompasses all types of compounds and further can be applied to binary strings of nominals that are not considered compounds by formal linguistics. If Warren's claims are true, then the logical typology accounts for the relationships implicit in nominal compounds.

Warren's typology might be considered more descriptive than the logical typology because Warren presents detailed explanations of the relationships implicit between the components of compounds. In contrast, the logical typology has few categories and makes fewer distinctions. In computational nominal compound analysis, however, the descriptive characterizations of relationships implicit in compounds should not only depict the relationship, but they also should provide any additional information that can be derived from the fact of the existence of the relationship. The logical typology has great potential for providing additional information about relationships, particularly concerning the sharing or not sharing of attributes between related objects. Thus the logical typology might augment Warren's analysis.

Because of the logical inferences it supports, the logical typology is a small set of generalized relationships that aids in descriptively characterizing the relationships implicit in nominal compounds. The precise inferences supported by the logical typology have not been not specified because they are dependent upon attributes of the objects being related. With this information, however, the inferences may assist in determining the attributes of objects identified by compounds. Russell (1975) proposes a classification for nominal compounds that exhibits inferential properties based on conceptual dependency theory. While her classification is not claimed to be complete, the analyses rendered by the categories of Russell's typology do facilitate inference. Analyses rendered

through case grammars also may have inferential properties by attaching semantic rules to the case grammar. The inferences provided by these approaches issue from specific rules attached to the classification schemes.

The basis for our typology for nominal compounds is markedly different from the bases of typologies proposed by other researchers. The classifiers in our scheme are logical properties of binary relationships. While the logical typology at its most general level does not specify all the interesting properties of a relationship, the general logical properties of relationships allow inferences about the sharing of attributes between the elements of nominal compounds. The inferences provided through the logical typology may be useful in augmenting the analyses of others.

Composing an appropriate typology for nominal compounds is only the first step of analyzing nominal compounds; the next step is to devise a method for classifying individual compounds according to the typology. Without a classifying method, a typology for nominal compounds cannot be applied to individual compounds. After classification, the next step in analysis is the employment of the inferential schemata. We are unable to employ the inferential schemata because we lack a data base of general knowledge about the attributes of related objects. Thus our efforts at analysis in this thesis are limited to classifying nominal compounds according to their logical properties. The next chapter presents a method for assigning individual compounds to the categories of the logical typology. Once this method is specified and verified, then, assuming the existence of a general knowledge data base, the logical typology may be considered a suitable high-level scheme for analyzing nominal compounds.

4.0 Assigning Compounds To Logical Categories

4.1 *Syntactic Aids to Classification*

In order to interpret nominal compounds through the logical typology, the logical properties of the relationships implicit between the elements of compounds must be determined. In this chapter a method for analyzing individual nominal compounds in order to assign them to their proper categories in the logical typology is presented. The analysis proceeds from information based on semantic information pertaining to the objects denoted by nominals in compounds and limited syntactic information available from nominals and nominal compounds. In this section, sources of syntactic information are considered. In section 4.2, a framework for semantic analysis is presented. The exact methods for assigning individual compounds to their appropriate categories in the logical typology are detailed and discussed in sections 4.3 and 4.4.

A syntactic description of a language specifies the base units of the language and rules for combining the base units. Nominal compounds in English form a restricted subset of the language, though there is not agreement upon the precise delineation of the subset. This thesis' working definition for nominal compounds, specified in section 1.1, is that they are sequential clusters of nominals.

Nominals thus are the basic syntactic units of nominal compounds and the syntactic rules for combining units place nominals in sequences. The application of syntactic rules is reflected in the order of nominals in compounds.

The order of nominals in sequences is syntactic information that in combination with semantic information may aid in interpreting compounds. Typically, as Jespersen (1942) observed, the head nominals of compounds label the objects denoted by the compounds sufficiently for minimal recognition of the objects. The nominals in compounds preceding the head generally serve as modifiers that provide additional information about the object labeled by the head. Several of the categories of the logical typology as depicted in Chapter 3 are keyed to the sequence of nominals in compounds. For instance, a sequence of two nominals that denote a location and an object may be either a TA compound or an NA compound, depending on the order of the nominals. For these two types of compounds, syntactic information about the order of nominals influences their semantic analysis. Jespersen's observation does not hold for all compounds, but it is a useful heuristic for nominal compound interpretation when combined with semantic analysis.

Nominals themselves in some cases are subject to syntactic formation rules, particularly those that have verbal roots. There are several types of nominals that exhibit verbal roots. When these nominals occur in compounds, often the relationships between the elements of the compounds are based on lexical features of the verbs. The logical typology provides for the interpretation of synthetic compounds based on the roles that the objects designated by the nominals fill with respect to the actions that relate the objects. There are two roles that objects may fill with respect to actions within the framework of the logical typology: causal factor and affected target. The form of some nominals, in particular their suffixes, supplies syntactic clues to the roles the objects they denote may fill with respect to an action. Analyses of the syntactic forms of nominals abound: our adaptation of the observations made by Levi (1978) are summarized in Figure 5 on page 53.

Suffixes that indicate that nominals denote causal factors of actions primarily are agentive suffixes. Agentive suffixes include *-er*, *-or*, *-yst*, or no suffix at all, a condition labeled zero suffix. Example

- | | |
|------|--|
| I. | Causal Factor Nominalization Suffixes
-er, -or, -yst, null
driver, actor, analyst, pump |
| II. | Affected Target Nominalization Suffixes
-ion, -ment, -ance, -ee, al, null
creation, appointment, appearance, employee, target |
| III. | Proceeding Action Nominalization Suffixes
-ing, null
placing, sing |

Figure 5. Nominalization Suffixes

nominals containing these suffixes are *driver*, *actor*, *analyst*, and *pump*. The objects denoted by these nominals cause the action of their verbal roots, i.e. *drive*, *act*, *analyze*, and *pump*, respectively. Causal factor suffixes are the most clearcut and least controversial group of suffixes, almost universally recognized and uniformly exploited in nominal compound interpretation efforts.

Zero suffixes participate in another group of suffixes along with *-ion* and *-ment* about which there is less agreement. Levi indicates that this group may apply to act nominalizations, product nominalizations, and patient nominalizations. An act nominalization denotes an act, such as *invasion* in *enemy invasion*. A product nominalization denotes the product of an act, for instance *import* in *oil import*. A patient nominalization denotes an object undergoing an act, such as *creation* in *designer creation*. The distinctions among these types of nominalizations are based on word formation rules governing these derivational affixes and are reflected in sentential paraphrases of compounds containing them. Sentential paraphrases for the examples are "act of enemy invading," "that which is produced by the act of importing oil," and "designers create creations," respectively. The differences among these types of nominalizations largely are not recognized by the logical typology because of the general case roles the typology provides. The objects denoted by these nominalizations all fill the affected target role. Levi also specifies another suffix, *-ee*, that only applies to patient nominalizations that denote animate objects. *Employee* and *nominee* are examples of this type of nominalization. These nominalizations also denote objects that fit into So all the

types of nominalizations Levi identifies that are nonagentive are characterized as affected targets in our scheme.

An additional verbal suffix that commonly occurs in nominal compounds is *-ing*, which forms gerunds from verbs. Nominals with *-ing* suffixes often denote acts that are occurring. Nominalized verbs with zero suffixes also may denote occurring acts. Objects implicitly related via nominal compounds to occurring acts might fill any of the accepted case roles attached to the act. Other non-zero verbal suffixes constrain the roles that related objects may fill with respect to actions, but compounds with verbal nominalizations bearing *-ing* suffixes and zero suffixes require additional analysis to determine the appropriate roles for related objects. The additional analysis is semantic and is described in the following sections.

4.2 *Semantic Aids to Classification*

The categories of the logical typology are based on the logical properties of semantic relationships between objects. Semantic relationships issue from the circumstances that exist among objects, the exact circumstances of relationships depending on the related objects and their respective attributes. In nominal compounds, related objects are denoted by nominals but relationships between objects often are not specified explicitly and must be determined in some manner. In many cases the relationships between objects are constrained by the possible circumstances that may exist between the denoted objects. An examination of the objects that nominals denote, which we will call *referents* in keeping with traditional labels, may indicate methods for identifying the circumstances that possibly exist between objects. If the circumstances relating objects may be constrained, then the logical properties of the semantic relationships between referents also may be constrained.

The potential referents of nominals compose a tremendous variety. Nominals may designate physical objects, abstractions, actions, collections, and many other concepts or circumstances described in English. A nominal compound as a whole has a referent. Additionally, each individual nominal in a compound has a referent. The interactions between the assorted referents of the individual nominals in a compound that results from the distinctions issuing from different internal representations in most cases helps provide a descriptive characterization of the referent of the compound. A goal of the process of nominal compound interpretation is to infer the descriptive characterizations of the referents of compounds from the association of the referents of the individual nominals composing the compounds.

Classifying nominal compounds in the logical typology requires recognizing the logical properties of relationships that may occur between specified referents. Our hypothesis, supported by similar hypotheses of researchers such as Marchand (1969), Lees (1970), Russell (1975) and Finin (1980), is that referents in certain classes tend to relate to referents belonging to other classes in predictable ways. Classes of referents are based on semantic attributes that each of the referents in a class exhibits. The challenge, then, is to identify appropriate classes of referents based on shared semantic attributes so that the classes of referents themselves indicate the types of relationships in which their class members may participate with other referents. The representation of referents must include sufficient information regarding the attributes of the referents for classifying the relationships in which the referents participate.

There are at least two methods for forming classes of referents with similar attributes. Important semantic features of individual referents may be directly associated with the referents and classes of referents formed by intersecting associated features, or the referents may be sorted in a type hierarchy or taxonomy in which some features for an individual referent are inherited from the referent of which it is a type and other features distinguish the referent from others of the same type. While these two methods for forming classes prove to be representationally equivalent, a taxonomy for referents allows the natural interpretation of the other logical property of binary relationships aside from transitivity and symmetry: reflexivity.

Reflexivity is not used in the characterization of the relationships implicit in nominal compounds. Instead, reflexivity acts as a filter for recognizing which characterizations of relationships apply to particular nominal compounds. Not all combinations of the statuses of reflexivity together with the statuses of transitivity and symmetry are logically consistent. A combination of properties **P** is consistent if and only if there is no relationship **R** such that for some *x* and *y*, both $R(x,y)$ and $\neg R(x,y)$ can be inferred from **P**. Only consistent combinations of logical properties are meaningful in models of description, because in inconsistent models anything at all can be inferred. Therefore only consistent combinations of logical properties are able to characterize the relationships implicit between the nominals of compounds.

There are 27 possible combinations of the statuses of the properties of transitivity, symmetry and reflexivity, but only 14 of these combinations are logically consistent. The proofs for consistency are detailed in the next section with the discussion of the individual categories formed by combining transitivity and symmetry. Using the 14 consistent combinations as the basis for a typology would require the division of two of the categories of the logical typology into three categories apiece and the division of a third category into two (see Table 4 on page 61). This more detailed typology, however, would contribute information neither about the existence of additional relationships between the referents of nominals nor about the sharing or not sharing of attributes between referents. Instead, the status of reflexivity for a relationship serves as a partial indicator of the statuses of transitivity and symmetry in the relationship.

We shall set up our taxonomy for referents so that a referent may participate in a reflexive relationship only with referents with which it has a common ancestor in the taxonomy. Two referents descending from the same taxonomic class, however, are not necessarily linked by a reflexive relationship. Referents that do not descend from the same taxonomic class may participate with one another only in irreflexive relationships. Thus given a proper taxonomy for referents and knowledge of the status of reflexivity in the categories of the logical typology, the logical properties of possible relationships that may exist between two referents may be constrained by examining the respective taxonomic classes of the related referents.

Forming a taxonomy involves determining appropriate classes for referents. The primary purpose of a taxonomy for the referents of nominals within the framework of the logical typology is to assist in assigning nominal compounds to their appropriate logical categories. The bases for the logical categories are the logical properties of the semantic relationships between the referents of nominals. A taxonomy for the referents of nominals therefore should be connected to classes of semantic relationships. Criteria for membership in a taxonomic class for a particular referent, therefore, is that the referent indicates a tendency to relate to referents belonging to other classes in certain ways. Semantic relationships, in our extensional view, are circumstances existing among objects, so the nature of circumstances in which objects occur contributes towards forming a taxonomy for referents.

The form of our taxonomy for referents is heavily influenced by the work of Virkar (1990). The focus of Virkar's research is a universal semantic grammar, mandating explicit semantic representations for words. Virkar follows the guidelines presented by Nida (1973), and we in turn adapt Virkar's taxonomy. Our chief requirement for a taxonomy for referents is that it should be capable of sufficiently characterizing the possible referents of nominals so that compounds composed of the nominals may be classified in the categories of the logical typology. Since nominals designate objects that occur in circumstances, possible circumstances in turn are used to justify our taxonomy.

Physical circumstances occur or exist at locations, perhaps unspecified, in time and space. Many nominals designate temporal and spatial concepts, so our taxonomy for referents includes a distinct **spatio-temporal** class. Within a given set of circumstances, Nida proposes four principle semantic domains consisting of **entities**, **events**, **abstracts** and **relationals**. Nominals may designate members of each of these semantic domains. The root classes of our taxonomy are illustrated in Table 3 on page 58.

The class of entities includes all physical objects capable of occupying spatial locations. Entities may range in size from smaller than subatomic particles to larger than galaxies. Events are processes that cause changes to existing circumstances. In the absence of pre-existing circumstances,

Table 3. Taxonomic Classes for the Referents of Nominals

Class	Semantic Characteristics	Example Nominals
Spatio-Temporal	Location or Time	city, stage, night, season
Entity	Perceptible, Occupies Space	rock, man, building, plant
Event	Effects Changes	explosion, transformation
Abstract	Non-Physical	length, attitude, shape
Relational	Relates referents	interior, predecessor

events may introduce a state of affairs. The properties of entities, such as mass, shape, temperature or speed, and properties of events, such as duration and magnitude, belong to the abstract class of referents. Other abstract referents include *truth*, *love* and *beauty*. Relational referents describe the orientation of referents occurring in circumstances relative to one another. For instance, entities are sometimes described by their components and internal structure. While the components of entities are entities themselves, their internal structure is described by relationals. Concepts named by *in*, *on*, *between* and *after* are all relational concepts.

Most referents of nominals can be more specifically described than by their membership in one of the general classes of entities, abstracts, events, relationals and spatio-temporals. Each of the general classes may be further subdivided into more specific classes based on shared semantic attributes. Some semantic attributes that referents share are the types of relationships in which they tend to participate. For instance, referents that belong to the class *food* share the attribute of participating in a relationship with the concept *eating*. Our hypothesis is that there are groups of referents that tend to participate predictably in certain types of relationships. Identification of the types of relationships in which referents tend to participate is pertinent to classifying compounds in the logical typology, for this information suggests applicable categories in the logical typology. Since *food* tends to be the affected target of *eating*, the presence of the nominal "food" in a compound may suggest an IN or NN relationship for the compound. The types of relationships in which different

referents tend to participate are shared semantic attributes that provide bases for forming subclasses within the basic classes of the taxonomy for referents. In order to propose specific semantic attributes pertinent to classifying nominal compounds in the categories of the logical typology, each of individual categories shall be reviewed in turn.

4.3 Determining Logical Categories for Nominal Compounds

In order for any typology for nominal compounds to be employed effectively in the interpretation of nominal compounds, there must exist a method for assigning individual compounds to their appropriate categories. The logical typology is our typology for nominal compounds. Recognizing the logical properties of semantic relationships implicit in nominal compounds requires considerable analysis. In previous sections of this chapter, various types of syntactic and semantic information that contribute to the classification of nominal compounds were introduced. In this section, this information is detailed with respect to compounds belonging to each of the categories in the logical typology.

The syntactic information available to aid in classification includes the order of the nominals in a compound and suffixes that appear on nominalized verbs. The order of nominals often indicates the direction of the relationship between the elements of compounds. Suffixes reflect the roles that the objects denoted by the nominals may fill with respect to the action of their verbal root. Semantic information describing the referents of nominals is less well-defined than the syntactic information describing compounds and nominals. Semantically, referents are classified in a taxonomy with root classes for spatio-temporal referents, entity referents, event referents, abstract referents, and relational referents. Only relationships between referents descending from the same taxonomic

class may exhibit the logical property of reflexivity. Beneath the high level classes of the taxonomy, referents are arranged in a type hierarchy of subclasses based on similarity of semantic attributes possessed by the referents. Careful selection of the attributes used to type referents facilitates the nominal compound classification process.

4.3.1 TN Compounds

Typically, any referent may be designated by more than one nominal. In some cases, designating an object by one nominal provides more specific information about the object than designating it by another nominal. For instance, *oak*, *tree*, and *plant* all may be used to designate a single object. The label *oak* provides more specific information about the object than does the label *tree*, which in turn provides more specific information than does *plant*. The variety of referents identified by one sense of *oak* are included in the referents of a sense of *tree*. In a taxonomy, *oak* would be identified as a type of *tree*.

Taxonomic relationships are transitive and nonsymmetric. *Oak tree* is a TN compound. As these relationships are primary, there are no characteristic verbal suffixes appearing on the nominals to indicate this type of relationship between the elements of compounds. The most apparent syntactic feature of TN compounds is the order of their nominals: the nominal that more specifically designates the referent of the compound as a whole precedes the nominal that designates the object in more general terms.

TN relationships may be reflexive or nonreflexive, but not irreflexive. If a transitive, nonsymmetric relationship R were irreflexive, then for two objects a and b if it is the case that $R(a,b)$, by irreflexivity $\neg R(a,a)$ and $\neg R(b,b)$ may be inferred. Since R is nonsymmetric, there are two objects x and y such that both $R(x,y)$ and $R(y,x)$ obtain. Since R is transitive, $R(x,x)$ and $R(y,y)$ follow

Table 4. The Status of Reflexivity in the Logical Typology

Logical Category	Status of Reflexivity
TS	Reflexive
TN	Reflexive, Nonreflexive
TA	Irreflexive
NS	Reflexive, Nonreflexive, Irreflexive
NN	Reflexive, Nonreflexive, Irreflexive
NA	Irreflexive
IS	Irreflexive
IN	Irreflexive
IA	Irreflexive

by logical inference, contradicting the irreflexivity of **R**. Therefore transitive, nonsymmetric relationships cannot be irreflexive.

Through the transitivity of TN relationships, if object **a** is related to object **b** and **b** is in turn related to object **c**, then **a** is related to **c**. Therefore a necessary attribute of object **a** is a necessary attribute of object **c**. Every object in the referent taxonomy is taxonomically related to at least some other referent in the taxonomy, as every member of a root class is taxonomically related to the root. We propose including in the semantic information concerning a referent a taxonomic link to a more general referent of which it may be considered a type. A taxonomy of referents results from inclusion of this semantic information. The taxonomy facilitates the recognition of the existence of TN relationships between referents.

The process of identifying TN compounds is straightforward. By exploiting the order of the nominals and semantic information about the referents of the individual nominals, a TN relationship in a nominal compound may be recognized if the referent of the first nominal is linked to the referent of the second nominal by 1) a single taxonomic link indicating the second referent is a more general type of the first referent, or by 2) a chain of links connecting intermediate referents, where each referent is a more general type of the one preceding, beginning with the referent of the modifier nominal and ending with the referent of the head nominal. The search process for taxonomic links between the referents of nominals in compounds consists of following all the links stemming from the referents of the modifier nominals attempting to discover at the end of links the referents of head

nominals. If the search is successful, the compound belongs to the TN category of the logical typology.

Successful recognition of TN compounds relies on the specifics of the semantic representations of referents. The construction of a taxonomy of referents directly influences the success of TN compound classification. We have adapted the taxonomy proposed by Virkar (1990) so that it conforms with semantic categories derived through the logical typology.

4.3.2 TS Compounds

Both nominals in a binary compound exhibiting a transitive, symmetric relationship designate the referent of the compound, but in different ways. The individual nominals are separate, dissimilar labels for the same object within the compound's linguistic context. One apparent syntactic pattern of nominals in TS compounds is that the nominals may exhibit agentive verbal suffixes, as in the compounds *woman farmer* and *farmer woman*. When this pattern occurs, the referent of the uninflected nominal is a performer of the action designated by the verbal root of the inflected nominal. Semantic qualifications exist for this type of compound, but the presence of agentive verbal suffixes on nominals is a frequent syntactic indicator of a TS compounds. The order of the labels for an object does not conform to a readily distinguishable pattern for use in recognizing TS compounds.

A relationship R must be reflexive if R is both transitive and symmetric. For any a and b related by R , by symmetry $R(a,b)$ establishes $R(b,a)$. From transitivity, $R(a,a)$ and $R(b,b)$ follow. The existence of transitive, symmetric relationships between referents are detectable semantically in some cases by examining the taxonomic links necessary for recognizing TN compounds. Because the relationships are reflexive, the referents of individual nominals either occupy the same position in the type hierarchy or are both descendants of a single higher node. The object labeled by the

nominal compound as a whole qualifies as a referent of the higher node. For instance, the referents of the nominals in the TS compound *student nurse* are both less general types of humans and the referent of the compound also is human. By comparing the ancestors of referents of individual nominals in the taxonomy and finding similarities, TS compounds may be recognized. Since every node in a type hierarchy is a descendant of the root node of the hierarchy, if unconstrained this semantic qualification has the undesirable result that any two referents descending from the same root taxonomic class might be considered as participating in a TS relationship. To avoid such a result, the level of the nearest joint ancestor and the number and type of intervening generalizations must be constrained.

There are examples of nominals that appear in TS compounds but do not exhibit agentive verbal suffixes nor are linked through the taxonomy to the referent of the other nominal in the compound. These nominals may designate a wide variety of objects, the referent depending on the context. *Test* and *target* are two such nominals. When these nominals occur as modifiers in compounds, it is possible that they are able to identify separately the object designated by the head nominal of the compound. In the compounds *test load* and *target date*, either the modifier nominal or the head nominal is sufficient to denote the referent of the compound as a whole. These co-describing nominals are represented by subclasses within the class of abstract referents.

TS compounds in which a nominal bears an agentive verbal suffix are detected not by searching for a common ancestor in a taxonomy but by syntactic means. A semantic qualification for establishing the possible existence of a TS relationship between the referents of nominals is to test whether the referent of the uninflected nominal is a likely performer of the action imputed by the inflected nominal. The appropriateness of specific candidate performers for specific actions is a semantic issue that affects the recognition of compounds for all categories that have a verbal component, including at least TS, IS, IN, NA and NN compounds. Our general approach is to designate suitable classes of causal factors for classes of actions.

4.3.3 TA Compounds

In section 3.2.3, several seemingly different types of relationships are identified as all being transitive and asymmetric. A common theme to all the relationships is that the objects denoted by modifier nominals are temporally or spatially dependent on the objects denoted by head nominals. The dependencies can be thought of generally as containment. Different types of TA relationships include spatial-temporal location, containment, grouping, part-whole and symbolic encoding. The semantic patterns of these relationships are summarized in Figure 6 on page 65.

The order of the nominals in TA compounds distinguishes them from NA compounds. The referents of TA compounds are containers that are denoted by the head nominals and modified by nominals denoting objects within the containers. If the order of nominals were reversed, the referents of the compounds are contents of containers and the relationships in the compounds are considered to be nontransitive. TA relationships are primary, so the presence or absence of verbal suffixes on component nominals does not aid in the recognition of TA compounds.

All asymmetric relationships are irreflexive. If an asymmetric relationship R were not irreflexive, then for some object a it would be the case that $R(a,a)$. From the asymmetry of R , it is also then the case that $\neg R(a,a)$, a direct contradiction. Therefore TA relationships, as well as NA and IA relationships, are irreflexive.

Since syntactic information in TA compounds is limited to distinguishing these compounds from NA compounds, recognition of TA compounds primarily must rely on semantic analysis. In contrast to TS and TN relationships, TA relationships may occur between referents belonging to different categories of the referent taxonomy. For example, referents in the spatio-temporal category often participate in TA relationships with referents from other categories as in the compound *tea time*. TA relationships also occur between referents within the same taxonomic category, as in the compound *pickle jar*.

Spatio-temporal location - **object location**

Container - **object container**

Member Group - **object group**

Symbolic Encoding - **object description**

Part-Whole - **part object**

Figure 6. Patterns in TA Compounds

A class of referents may be identified within a taxonomy by specifying a general, high-level referent and including that as the least specific member of the class. Other members of the class may be identified as ancestors of the most general member by their taxonomic links to it. A class of referents in a taxonomy forms a subhierarchy within the taxonomy. Within each of the five taxonomic classes of referents, there are subclasses of referents that typically contain other referents. In the case of the spatio-temporal category, every referent may contain other referents. Abstract containers include *sets* and *groups* for member-group TA relationships. Entity containers appear in several forms depending on their function. *Jars* and *barrels* may contain food and drink, while *arenas* and *pools* may contain designated activities. Events containers include *gatherings* and *harvests*.

While most TA relationships are recognizable through the taxonomic links their referents of the head nominals have to general containers, part-whole TA compounds are found in a different manner. In part-whole TA compounds such as *arm chair*, the modifier nominal designates to an object that typically is part of another object. The objects to which this description applies form subclasses within the taxonomic classes of referents. Recognition of members of these subclasses in the modifier position is a distinctive characteristic of part-whole compounds.

The process of recognizing TA compounds employs both syntactic and semantic information. Semantically, the occurrence of a member of a container or a part subclass indicates that the re-

relationship may be TA. Syntactically the container or part must appear in the head position to be considered a TA, not NA, compound.

4.3.4 NA Compounds

Some nontransitive, asymmetric compounds exhibit patterns similar to those of TA compounds but with the nominals in reverse order. For instance, *dog house* is a TA compound, but *house dog* is NA. These NA compounds are readily identifiable employing the techniques for recognizing TA compound from semantic information on the nominals in reverse order. In addition, NA compounds of this type may be indicated by the presence of a head nominal that designates an object that is typically contained by other objects, such as are denoted by the nominals *contents*, *occupants*, and *filling*.

An NA interpretation indicating source takes precedence over a TA interpretation indicating containment for compounds for which both nominals of the compounds designate containers, as in the compounds *Spring day* and *city building*. Both the head nominals and the modifier nominals in these example compounds designate potential containers. But TA interpretations for these compounds would be misleading at best. Their modifier nominals denote the recognizably larger containers. Thus the modifiers indicate the sources of the heads, instead of being contained by them. In the semantic information attached to referents in the referent taxonomy, we have not made any provision for comparative size, though Russell (1975), Leonard (1984), and others employ comparative size in nominal compound interpretation. Instead, when two containers are related in a nominal compound, the default classification is NA. This heuristic is subject to refinement.

Related referents in general belong to separate taxonomic categories for NA relationships between causal factors and actions that issue from the causal factors. Not every causal factor may be the source of every action. Some referents have tendencies to perform certain actions, as a *bird* tends

Table 5. Classes of Causal Factors and their Respective Classes of Actions

Causal Factors	A c t i o n s	P h y s i c a l	M o v e m e n t	C o n t r o l	S e n s o r y	P h y s i o l o g i c a l	W o r k	B o d i l y	T r a n s f e r	C o m m u n i c a t i v e	I n t e l l e c t u a l	E m o t i v e
Human	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Animal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Plant	Yes	No	No	No	Yes	No	No	No	No	No	No	No
Body Part	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No
Natural	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
Vehicle	Yes	Yes	No	Yes	No	No	Yes	No	No	No	No	No
Tool	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Building	No	No	Yes	No	No	Yes	No	No	No	No	No	No
Literary	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Money	No	No	Yes	No	No	No	No	No	Yes	No	No	No

to *fly* and more generally animals tend to perform bodily functions. An exhaustive listing of the possible or probable causal factor-action correspondences between individual referents would encompass a great deal of knowledge. For the purposes of this thesis, only causal factor-action links between general classes of referents are provided. Classes of causal factors and their corresponding classes of actions are illustrated in Table 5 on page 67. The classes of causal factors and actions are based on semantic types recommended by Virkar (1990).

Human causal factors may be individuals or groups, including nations, populations, and organizations. Humans are not restricted in the types of actions they may perform. **Animals** also include individuals and groups, and they are capable of performing most actions. The exceptions are legal actions, such as buying and selling, that form a subclass of events called **transfers**. **Plants**, by contrast, are only capable of **physiological** actions such as respirating and **physical** actions that most entities are capable of, such as collision or impact.

Body parts are capable of physiological and physical actions, but also may perform **sensory** and **control** actions. Control actions are those in which the causal factor directly influences the movement, performance or existence of an affected target of the action. Among other causal factors, **money** can perform control actions. Money also can perform transfers. **Naturals** are a class that includes naturally occurring physical features such as minerals, mountains and rivers. Naturals perform control and physical actions and in many cases perform **movement**.

The remaining classes of entity causal factors are man-made and divided by function. **Vehicles** are capable of movement, physical actions, **bodily** actions such as cleaning and smoking, and, when specially equipped, sensory actions. **Buildings** are not performers of movement or physical events, but they may perform control actions as well as **work** actions such as repair or construction. **Tools** are versatile causal factors. They are capable of performing most kinds of actions, with the exception of physiological actions and **emotive** actions. **Literary** causal factors may perform emotive actions in addition to **communicative** and **intellectual** actions. Finally there are abstract causal fac-

tors such as programs and algorithms called **math-logic** causal factors that also perform communicative and intellectual actions.

The causal factors and actions identified in this section certainly are not a comprehensive list of all possible causal factors and actions that issue from causal factors. Additionally the actions attributed to the classes of causal factors may be incomplete or in some cases may not apply. This listing reflects the generalized patterns of causal factors and actions that are observed to occur in nominal compounds. The generalized classes of causal factors and actions necessarily introduces a degree of imprecision.

Syntactic information from verbal suffixes may aid in the recognition of synthetic NA compounds. In particular, suffixes that attach to verbs to denote affected targets of actions help identify compounds as synthetic. These suffixes, discussed in section 4.1, include *-ion*, *-ment*, *-ance*, and the null suffix. Once a compound is identified as potentially being synthetic, NA links between the referents may be sought. The order of nominals in synthetic NA compounds does not alter the logical type of the relationship in the compounds, but changes the referent of the compound and how the rules apply to the related objects. The relationships implicit in *battle ship* and *ship battle* are both NA, but the referents of the compounds and the inferences that apply to the compounds are different.

The order of the nominals does play a role in the interpretation of compounds that have proceeding actions. The suffix *-ing* on a verbal root indicates that the action denoted by the verb is a proceeding action. When nominals designating proceeding actions appear in the modifier position of compounds, often the referent of the head nominal is a performer of an action or an instrument with which the action is performed. Thus the presence of proceeding actions in the modifier position is a strong indicator of NA compounds. The compounds *eating animal* and *washing water* are clear examples of this tendency. But in compounds such as *eating apple* and *drinking water*, the head nominal designates the affected target of the action denoted by the modifier nominal. The affected target pattern with *-ing* suffix is a case that violates a general syntactic rule for synthetic

compounds with affected targets: affected targets should appear in the modifier position of the nominal compound. For compounds of this form, IN interpretations must be considered.

The recognition of NA compounds employs both syntactic and semantic information. The syntactic information includes the order of nominals in compounds and verbal suffixes attached to the nominals. The semantic information encompasses the semantic information for recognizing TA compounds as well as semantic links between general classes of events and the objects that may serve as causal factors for event classes.

4.3.5 IN Compounds

Intransitive, nonsymmetric compounds typically are synthetic, existing between an action and its affected target. Nonagentive suffixes on verbal roots are indicators of synthetic relationships between the elements of compounds. Our approach to recognizing IN compounds is similar to our approach to recognizing NA compounds: general classes of events are linked to general classes of affected targets. The classes necessary to recognize IN compounds, however, are more general than the classes necessary to recognize NA compounds. Action-affected target links are illustrated in Figure 7 on page 71.

Not all of the types of actions listed in the previous section affect targets. The classes of events that may affect targets are confined to physical, control, sensory, physiological, bodily, transfer, and intellectual actions. All other actions do not affect targets. Any of the listed actions may affect entity targets. Physical, physiological, and bodily actions do not affect abstract targets, but the other listed actions do. Control actions also may affect events.

IN compounds are order dependent. The head nominal of an IN compound designates the relevant action while the modifier nominal designates the affected target of the action. There is one major

Physical	affects only entities
Control	affects entities, abstracts, and events
Sensory	affects entities and abstracts
Physiological	affects only entities
Bodily	affects only entities
Transfer	affects entities and abstracts
Intellectual	affects entities and abstracts

Figure 7. Actions and Affected Targets

class of exceptions to this rule: compounds in which the modifier nominal denotes a proceeding action with an *-ing* prefix. Compounds of this type were discussed in the previous subsection on NA compounds.

Intransitive relationships are irreflexive. If an intransitive relationship **R** were not irreflexive, then for some **a** it is the case that **R(a,a)**. But by the intransitivity of **R**, $\neg\mathbf{R(a,a)}$ may be logically inferred, creating a contradiction. So IN relationships, as well as IS and IA relationships, are irreflexive.

Syntax plays a primary role in the recognition of IN compounds. Nonagentive verbal suffixes occurring on nominals is a syntactic indicator of IN compounds. Furthermore, the nominals in IN compounds in most cases adhere to the fixed order of the nominalized verb appearing in the head position. Syntax alone, however, is insufficient for recognizing IN compounds as they are ultimately semantically determined by the type of action and the affected target.

4.3.6 NN Compounds

As indicated in section 3.3.8, composing an NA relationship between an causal factor and the act issuing from the causal factor with an IN relationship between the act and its affected target results in a synthetic nontransitive, nonsymmetric relationship between the causal factor and the affected target. Neither nominal in these NN compounds designates an event, so nonagentive verbal suffixes are not an indicator for these compounds.

Agentive verbal suffixes, on the other hand, often do occur in NN compounds. NN relationships between causal factors and affected targets may be indicated through agentive suffixes attached to verbal roots. The relating action is denoted by the verbal root of the agentive nominal. The combination of a nominal with an agentive verbal suffix and a nominal designating a human is recognized as a TS compound because it is likely that the human is performing the action. The combination of a nominal with an agentive verbal suffix and a nominal that has a non-human, non-event referent is considered to be an NN compound because it is less likely that the non-human, non-event referent is performing the action, instead the action is performed on it. The order of the nominals in the compound does not change the interpretation.

There are primary NN compounds in which the implicit relationship is proximity. The NN category of the logical typology also serves as a catch-all category for relationships of uncertain logical properties between entities. If syntactic and semantic analysis of a compound does not indicate the logical properties of a relationship implicit in a particular compound, the compound is classified as NN.

Using the NN category as a catch-all is acceptable because NN relationships are totally non-inferential; hence nothing that does not apply to the relationship between the elements of compounds is asserted. In particular, there is no statement about the sharing or not sharing of attributes between the related objects. Nontransitive, nonsymmetric relationships may be reflexive, irreflexive,

or nonreflexive. Thus NN relationships may exist between any two referents, regardless of taxonomic class.

4.3.7 IS Compounds

Compounds with implicit intransitive, symmetric relationships generally are synthetic. The underlying actions of the implicit relationships match the related objects to one another. The underlying action is not explicit in these compounds, so nonagentive verbal suffixes do not provide syntactic clues for their recognition. These compounds may be identified through semantic analysis. The nominals in the compounds designate objects defined in terms of performing actions. The relating actions are event referents with causal factor-action links to the referents of both nominals in compounds. The actions that underlie IS relationships form a separate subclass in the event category of the referent taxonomy.

IS relationships are irreflexive because they are intransitive. Because the relationships are also symmetric, both related objects exhibit some attribute that the other does not. The related referents may belong to different categories of the taxonomy, but because they both are capable of performing the same action, it is usual for the referents to descend from the same taxonomic category. Changing the order of the nominals in IS compounds changes the referents of the compounds but does not change the relationships implicit between the elements of the compounds.

4.3.8 NS Compounds

Nontransitive, symmetric relationships are implicit in at least two general types of compounds: those interpreted literally such as *brick house* in which the modifier nominal denotes a material composing the object denoted by the head nominal, and those interpreted metaphorically such as

iron will in which the referent of the modifier nominal exemplifies a semantic attribute of the referent of the head nominal. For both general types, the order of the nominals in NS compounds is fixed. NS compounds are not synthetic, so the order of the nominals is the only syntactic information employed in their recognition.

NS relationships may be reflexive, irreflexive, or nonreflexive. The logical property of symmetry alone does not influence the logical property of reflexivity. Related referents may belong to different categories of the taxonomy, a situation that often occurs for compounds with the NS relationship of attribute exemplification. For the NS relationship of material composition, the referents as a rule are entities.

The NS relationship of material composition suggests a subclass of materials in the entity class of the referent taxonomy. Elements, such as gold, silver, and lead, often are used as materials. So are sand, stone, ice and other naturally occurring substances. In addition, there are many man-made materials like brick, plastic, and cloth that are the material bases for other objects. Typically the objects composed from materials have been manufactured, constructed, or processed. Nominal compounds in which the modifier nominal designates a material and the head nominal designates a non-natural or **fabricated** entity generally have implicit NS relationships.

Elements and other materials often used metaphorically to exemplify particular attributes, as for example *ice* exemplifies **cold** and *iron* exemplifies **strong**. Compounds in which the modifier nominal designates a material but the head nominal does not designate any entity may have implicit NS attribute exemplification relationships. For compounds in which the head nominal designates naturally occurring entities, the implicit relationship is usually material composition, but it also may be attribute exemplification. In either case the semantics in modal logic terms of the relationship between the objects is the same: the head exhibits attributes of the modifier. This feature shows that the inferences supported by the logical typology must be constrained before they are applied. The actual inferences for the relationships of material composition and attribute exemplification may be similar in form but should be different in content.

Objects exemplifying particular shapes often appear as the referents of modifier nominals in NS attribute exemplification compounds. Shapes are suggested through familiar objects as in the compounds *box camera*, *sheet ice*, *head lettuce* and *finger lakes*. Because the objects must have discernible shapes, the head nominals in this type of NS compound designate entities.

Recognition of NS compounds is primarily semantic, aided by the invariant order of the nominals in the compounds. The semantic classes of referents employed in the recognition of NS compounds are materials, shapes and body parts for modifier nominals and non-natural entities versus all other classes of referents for head nominals.

4.3.9 IA Compounds

Relationships that are intransitive and asymmetric in general deny the sharing of attributes between the related objects. Typically IA relationships exist between an object and one of its characteristic attributes. The order of the nominals in IA compounds is fixed. The referents of the head nominals are characteristic attributes of the referents of the modifier nominals. IA compounds are primary, so the presence of verbal suffixes on component nominals is not an indicator of IA compounds. IA relationships are irreflexive because they are intransitive as well as asymmetric. Therefore the related referents may descend from different categories of the taxonomy.

All referents in all taxonomic classes may have attributes. Thus there are no apparent semantic constraints on the referents of modifier nominals in IA compounds. The attributes of referents, however, are abstract and form a subclass in the abstract class of the referent taxonomy. The class of attributes can be subdivided further into attributes of entities, attributes of abstracts, attributes of events, attributes of spatio-temporals, and attributes of relationals. For instance, *height*, *weight*, and *shape* are attributes of entities, *duration* is an attribute of events, and *magnitude* is an attribute of some abstracts. Some attributes may be characteristic of referents in more than one of the

referent classes. For instance, *appeal* may be an attribute of referents in any of the taxonomic classes.

The process of recognizing IA compounds is straightforward. The order of nominals in IA compounds is invariant: the head nominal designates an attribute and the modifier nominal designates the object to which the attribute applies. Semantically the attribute must be capable of modifying its object.

4.4 Assigning Compounds to Logical Categories

Semantic and syntactic information employable in the recognition of the logical properties of relationships implicit between the elements of nominal compounds for each category of the logical typology is detailed in the previous section. Provided with the appropriate semantic and syntactic information, a computational nominal compound interpreter is able to classify nominal compounds by checking for each compound whether it meets the semantic and syntactic qualifications for each of the logical categories in turn. If for some category or categories a nominal compound meets the qualifications, then the relationship in the compound is recognizable by the logical typology.

In order to classify nominal compounds in the logical typology, all of the syntactic and semantic information specified in section 4.3 must be accessible to the nominal compound interpreter. The representation of the limited syntactic information required by the interpreter does not present extraordinary difficulty. The syntactic information for an individual compound consists of the order of the nominals in the compound and whether any agentive verbal suffixes or nonagentive verbal suffixes are appended to verbal roots to form one or more of the nominals. The order of the nominals in a compound is determinable through inspection, and verbal suffixes on compounds can be recognized through morphological analysis.

I.	Entity	
	A.	Fabricated
		1. Container
		2. Literary
		3. Vehicle
		4. Tool
		5. Building
		6. Material
	B.	Natural
		1. Human
		2. Animal
		3. Plant
		4. Body Part
		5. Element
		6. Substance
		7. Geographical
II.	Abstract	
	A.	Referential
	B.	Group
	C.	Part
	D.	Contents
	E.	Literary
	F.	Math-Logic
	G.	Attribute
	H.	Shape
III.	Event	
	A.	Grouping
	B.	Physical
	C.	Movement
	D.	Control
	E.	Sensory
	F.	Physiological
	G.	Work
	H.	Bodily
	I.	Transfer
	J.	Communicative
	K.	Intellectual
	L.	Emotive
	M.	Join
IV.	Relational	
V.	Spatio-Temporal	
	A.	Time (location)
	B.	Space (location)

Figure 8. Taxonomy for Referents

Table 6. Attributes of Referents in the Logical Schemata

Logical Category	Semantic Patterns
TS	Referents have taxonomic links to a common ancestor Modifier is referential One referent is actor, the other human
TN	Modifier is a taxonomic descendant of head
TA	Head is a type of container Explicit part-whole link
NS	Modifier is a type of material
NN	One referent is a causal factor, the other an affected target Referents are both entities
NA	Modifier is a container Head is contents One referent is event, the other is a causal factor
IS	Both referents are causal factors of a joining event
IN	Head is event, modifier is affected target Modifier is preceding event, head is affected target
IA	Head is an attribute

The precise nature of semantic information that contributes to interpreting nominal compounds through the logical typology is less well-defined than the syntactic information. The semantic information concerns semantic attributes of the referents of individual nominals composing compounds. A taxonomy for referents with five categories is proposed that distinguishes entities, events, abstract, relationals and spatio-temporals. Within each of the taxonomic categories are tangled type hierarchies based on taxonomic links between referents. There are other links between referents besides taxonomic links. There are part-whole links that exist only within taxonomic categories as well as links between causal factors and actions, between actions and affected targets, and between referents and attributes that may exist between referents in different classes. These links between categories appear as semantic patterns of subclasses of referents in the discussion of section 4.4. Subclasses of referents equate to subtrees of the tangled hierarchies within the various taxonomic categories. The root referent of a subtree is the maximally general referent that exhibits some distinctive property and every referent in the subclass except the root exhibits a taxonomic link to the root. The tendencies of referents in certain subclasses to participate with referents of certain other subclasses in certain relationships are semantic links between the respective classes.

The objects participating in relationships are designated by nominals in compounds, but the relationships themselves are implicit in the compounds. The subclasses that objects belong to in the taxonomy are determined through the taxonomic links attached to the representation of that object. The logical properties of the semantic links between subclasses correspond to the logical properties of the relationships implicit in nominal compounds. Subclasses for referents within each of the classes of the taxonomy for referents based on our analysis of the categories of the logical typology are proposed in the previous section and summarized in Figure 8 on page 77. The semantic patterns occurring within the various categories of the logical typology are recapitulated in Table 6 on page 78. The proposed subclasses do not necessarily contain every possible referent in every taxonomic category; they do provide, however, semantic information about the referents they contain that is exploitable for the classification of nominal compounds in the logical typology.

The process for interpreting nominal compounds outlined in this chapter is structurally similar to previous efforts in nominal compound interpretation. The general process for nominal compound interpretation followed by previous researchers consists of creating an adequate typology that sufficiently captures the relationships implicit in nominal compounds and devising a method for assigning individual compounds to their proper categories in the typology. In Chapter 3 the logical typology is presented as our typology for the relationships implicit in nominal compounds. Through comparison with typologies presented by other researchers, it is deemed a reasonable basis for classifying the relationships implicit in nominal compounds. In this chapter a representation for nominals and their referents is proposed and a method for assigning compounds to categories is outlined.

The syntactic representation for nominals is based on observations made by a host of researchers. The semantic representation of referents through tangled type hierarchies complete with part-whole links, causal factor-action links, and action-affected target links are preceded in form by the more detailed representations of Finin (1980) and McDonald (1982) and in concept by Russell (1975) and others. The differences in our representation scheme are not notable for their form, but for their content: the classes we propose emerge from our study of the logical typology, a typology for compounds based on the logical properties of the binary relationships between compound elements that facilitates inferences regarding the sharing of attributes between related referents. At this stage, the process for assigning nominal compounds to categories in the logical typology has been detailed. Evaluating the effectiveness of the proposed methods yet remains.

5.0 An Empirical Test of the Logical Typology

5.1 *Methodology*

This chapter reports the results of applying our classification methods to a data base of nominal compounds. The aim of testing the logical typology and its associated classification method is to determine whether the logical typology encompasses the relationships implicit in a set of example nominal compounds and whether the classification method is capable of assigning individual compounds to their proper categories in the logical typology. A nominal compound may elude classification in at least two ways: the classification method may be inadequate for assigning the compound to its proper category, or the logical typology may not provide a suitable category characterizing the relationship implicit in the compound.

The nominal compound examples for our empirical test of the logical typology issue from two major sources. The initial source of compounds is a naval text document that supplies 455 nominal compounds containing 499 distinct nominals. These compounds were the preliminary targets of our investigation, and the lexicon for the empirical test is limited to terms appearing in this document. While application text examples are interesting because they test whether the logical typology

supplies analyses useful for a topic of interest, the provided set of compounds might be homogenous in terms of the relationships implicit between their elements. A test set of only these compounds may be deemed unrepresentative of the class of nominal compounds.

A supplementary set of compounds is composed by culling a large proportion of the nominal compounds cited in the works of Adams (1973), Lees (1960), Levi (1978) and McDonald (1982). The limited lexicon constrains these compounds culled from earlier studies. A contrived set of compounds exemplifying the types of relationships identified by other researchers helps test the completeness of coverage the logical typology offers by ensuring a wide range of relationships for which to account. The compounds cited as examples belonging to various semantic and syntactic categories form a heterogenous collection of nominal compounds that significantly vary in their relationships. For the test, we restricted these compounds to binary compounds, excluding genitive constructions and single word compounds. The total data set of 1403 compounds containing 2506 nominals reduces to a manageable working size of 491 compounds with 508 distinct nominals by discarding compounds that contain only nominals unique to that compound, that is, compounds are discarded if none of their component nominals appears in any of the other compounds. All the types of compounds identified in the works of the cited researchers have multiple exemplars included in the data, thereby preserving the heterogeneity of our data.

The information required to classify nominal compounds in the logical typology issues from three sources: the order of nominals in compounds, the syntactic form of individual nominals in compounds, and semantic information describing the objects denoted by nominals. The order of nominals in a compound is simple to determine from inspection of the compound. Determining the syntactic form of nominals requires a link from the nominal to its verbal root in some cases, particularly for those nominals that have a zero suffix. Therefore some syntactic information needs to be attached to individual nominals or provided through morphological analysis. Semantic information describing the objects designated by nominals generally is not fully available from the surface form of a nominal. The surface form lacks information about the attributes of the denoted objects used in recognizing logical properties of relationships. Nominal compound classification

depends on prestored semantic information describing the objects identified by nominals. A lexicon provides a link from nominals to semantic information concerning the objects they denote.

Our lexicon conceptually consists of a set of ordered pairs, (**nominal, semantic information**), in which **nominal** represents individual nominals that appear in compounds in the data set and **semantic information** represents semantic descriptions of one sense of the nominal from the taxonomy for referents depicted in Chapter 4. Each of the 710 nominals in the reduced data set potentially may designate more than one different type of object. The nominal *bank*, for instance, may designate either to a financial institution or to land along a waterway. The different senses may be appropriate for different compounds, such as *river bank* versus *Wall Street bank*. The nominals in our collection average more than three semantically different senses per nominal. The different senses provided for nominals in our empirical test of nominal compound classification correspond to the senses defining the nominals in *Longman Dictionary of Contemporary English*, a dictionary designed for non-native speakers of English. Virkar (1990) represents the definitions for the subset of English necessary for our empirical test employing a taxonomy similar to that described in Chapter 4. With changes that align it with our taxonomy, we have adopted Virkar's representation.

Each separate sense of a nominal is represented in a separate (**nominal, semantic information**) pair. The representations of these pairs are straightforward to implement in PROLOG, in a rule of the form **Lex_Entry(nominal semantic_information)**. The **semantic_information** variable is a list of primitives denoting the categories within the taxonomy that contain the referents. The primitives include the root category of the taxonomy to which the referent belongs and any intervening referent categories that have taxonomic links from the root up to and including the most specific category of the taxonomy to which the referent belongs. Also included in each lexicon entry is pertinent syntactic information about the nominal, in particular its suffix and verbal root. Another plausible source of the syntactic information could be morphological analysis. Since our approach to nominal compounds is interpretive, not formative, the choice of including the syntactic information in individual lexical entries does not materially affect the content of the empirical test and reduces diversions of our primary effort. A complete entry in the lexicon thus is a predicate in the

form `Lex_Entry(nominal,semantic_information,suffix,root)`. With the PROLOG representation of lexicon entries for all the nominals in the data set, a PROLOG program that assigns individual compounds to their respective categories in the logical typology following the classification methods depicted in section 4.3 is feasible.

The results of classifying a nominal compound through the logical typology indicate the senses of the nominals that denote the objects being related plus the logical properties of the relationship between the objects. The computational classification result for an individual nominal compound in the context of a single category of the logical typology may compare to the actual classification with respect to that category in four ways: the result may be a correct classification, the result may be a classification that is not correct, the result may be no classification when there is one, or the result may correctly be no classification. Statistical measures that summarize the proportion of correct classifications versus incorrect and undiscovered classifications across the data set are **recall** and **precision** rates, respectively. The recall rate is the proportion of nominal compounds in the data set with implicit relationships exhibiting the proper combinations of logical properties that are classified correctly. The precision rate is the proportion of classifications yielded that are correct. Recall and precision rates help assess the effectiveness of our approach to nominal compound classification. Determining the correct interpretations for compounds in the data base is discussed in the next section.

Ambiguity is an inherent feature of natural language utterances that presents serious difficulty in analyzing nominal compounds. Ambiguity allows for multiple analyses of individual nominal compounds. There are at least two sources of ambiguity in analyzing nominal compounds. The nominals in the compounds may have more than one sense by designating more than one object or the objects denoted by the nominals may relate in more than one way. In the case where nominals have multiple senses, different objects identified by a single nominal in a compound may participate in different relationships with the objects denoted by the other nominal. The ambiguous nominal *play* at least has senses denoting recreation as well as a stage production. The compound *horse play* therefore may be analyzed in at least two distinct forms: as an NA compound with the

horse as causal factor performing a *play* action and as a TA compound of the *horse* as a subject being described in a *play*.

Even provided the proper senses of the nominals in compounds, the compounds may be ambiguous if the objects designated by the individual nominals may relate in more than one way. This second type of ambiguity occurs often in compounds in which the relationships implicit between the elements are action-based. Because some objects denoted by nominals are capable of filling more than one role with respect to relating actions, more than one role may apply to an object. Input from contextual information is necessary to make a final determination of the proper role. *System update* is a nominal compound in which the thematic role that *system* fills is ambiguous: the *system* may cause the *update* or the *system* may be affected by the *update*.

Selecting a single best sense for a nominal in a nominal compound is dependent upon the linguistic context of the compound. Linguistic context is absent from the nominal compounds in our study, so there is no reliable means of preferring the choice of one object designated by a nominal over another if both may participate in relationships, nor is there a justification for preferring one type of relationship between objects over another. While a nominal compound interpreter lacking contextual information may approach the problem of ambiguity in many ways - from recognizing all alternative analyses to endeavouring to select a single optimal analysis - computational approaches to nominal compound interpretation historically are oriented primarily towards selecting a single analysis for a compound. The system proposed by McDonald (1982), for example, presents a detailed set of heuristics for choosing preferred analyses for ambiguous compounds, whether the source of the ambiguity is the objects denoted by the component nominals or the type of relationship between the objects. Typically computational nominal compound interpreters include methods for preferring some relationships between objects to others, such as a ordering relationships by preference or selecting unambiguous nominals for study.

The methods for classifying nominal compounds through the logical typology as presented in the previous chapter do not prefer one analysis for a nominal compound over another. In the absence

of linguistic context, the correct analysis for a nominal compound is in fact unknowable. It may be desirable that an interpreter for nominal compounds consider all possible analyses for nominal compounds. In the case in which the proper senses of nominals in binary compounds cannot be determined, one approach is to pair every objects possibly designated by one nominal with every objects possibly designated by the other nominal. The resultant pairs then may be analyzed to determine which pairs are likely to be related and what are the likely logical properties of the relationships between the pairs. The analysis provided for nominal compounds in the absence of known objects designated by the component nominals then could include a listing of the different possible analyses that may apply to an individual compound. Likewise, even when there is no ambiguity about the objects designated by the component nominals in compounds, an interpreter with no means of discrimination should indicate all the relationships that possibly exist between the objects. Since there may exist different analyses for a single nominal compound, in the absence of linguistic context a computational nominal compound interpreter should supply all possible analyses.

The two identified sources of ambiguity in nominal compounds are treated differently in two separate tests. The first test, the results of which are rendered in section 5.3, requires that all senses for nominals be considered in analyzing compounds. In the second test, a single sense is selected for each of the component nominals in compounds and the interpreter employs this information to determine preferred analyses for compounds according to precedence rules. The precedence rules are elaborated upon further in section 5.4.

5.2 Correctly Classifying Nominal Compounds

In order to determine whether classifications for nominal compounds are correct or whether there exist additional classifications that have not been recognized, there must be some form of oracle to

provide such judgments. In initially formulating our thesis, we relied upon the types of relationships implicit in nominal compounds that were identified by other researchers and analyzed these relationships in terms of their logical properties. We classified the nominal compounds in the data base according to the relationships identified by other researchers and grouped compounds in the logical typology by those relationships using methods of classification detailed in Chapter 4.

To validate our approach and classification, we conducted a survey on a small group of five native English speakers. In this way, we would have an oracle to which the results rendered by our program could be compared. Our approach in the survey was to have the participants select how the properties of transitivity and symmetry apply to the individual compounds in the data base. The survey participants then would be classifying compounds in the logical typology directly.

Table 7 on page 88 summarizes the results of our survey versus the initial classification of compounds we performed. The rows of the table reflect our initial classification of compounds. The numbers in each column are the proportion of compounds identified by the survey as supporting the logical inferences resulting from the logical relationship heading each column. The last column indicates the proportion of compounds for which the survey had no concensus. A concensus was defined as more respondents selecting one category than any other. It did not require an absolute majority of the five respondents, or else the vast majority of compounds would not have been classified. The first column heading is TNS, which is a combination of the TS and TN categories of the logical typology. Our reasons for combining these categories are explained in the next section. The row for intransitive, symmetric compounds has no entries because as explained in the next section, we did not have a significant numbers of compounds in the data base classified in our initial analysis as having this type of relationship. The complete results of our survey are reported in Appendix D.

Participants in the survey found judgments regarding logical properties of relationships implicit in nominal compounds extremely difficult to make. Some participants remarked that they were unable to make cognizant decisions even after repeated examples and discussion. In general, the re-

Table 7. Classification of Nominal Compounds from Survey

	TNS	TA	NS	NN	NA	IS	IN	IA	None
TNS	.28	.12	0	.07	.02	.24	0	.05	.21
TA	.27	.18	.04	.03	.07	.11	.03	.07	.20
NS	.46	.13	.04	.08	0	.04	0	.04	.21
NN	.21	.25	0	.04	.07	0	.18	.11	.14
NA	.27	.09	.05	.01	.10	.04	.09	.13	.22
IS	-	-	-	-	-	-	-	-	-
IN	.19	.08	.03	.01	.06	.06	.22	.23	.13
IA	.25	.16	.10	.04	.02	.12	.04	.12	.16
Total	.26	.13	.04	.03	.07	.08	.08	.12	.19

spondents classified compounds into the logical categories in the same proportion for each type of relationship. The TNS, TA, and IA categories were the most popular with the respondents, possibly because the inferences for these categories were the easiest to comprehend. From examining the surveys, individuals tended to strongly prefer a subset of the categories and their responses were largely limited to that subset. The subset of preferred responses varied by individual.

The classification of compounds from the survey does not accord with our initial classification. Extensive analysis of the results does not seem to indicate any trend when comparing the relationships implicit in nominal compounds identified by other researchers to the responses provided by the survey. We are forced to conclude that we cannot rely on our survey. Our methodology may have been flawed and our survey group undoubtedly was too small to achieve a reliable consensus. The variety of responses for every compound means that even one or two additional participants in the survey might greatly change the results. What we can conclude is that judging the logical inferences proceeding from the properties of relationships implicit in compounds is a difficult task.

Being unable to rely on the results of the survey leaves us at a loss for an oracle by which to judge the results rendered by our computer program. For this reason, we use our initial classification of compounds as an oracle. This entails that the results provided by the computer are only evaluated with respect to our best judgment. Critical investigators are invited to examine the entire data set

of nominal compounds analyzed in the empirical test together with classifications provided by both the oracle and the computational interpreter by consulting the appendices.

5.3 An Empirical Test with Ambiguous Senses for

Nominals

The 491 nominal compounds in the data set offer 1121 different acceptable analyses. There are more than twice as many acceptable analyses as compounds for a combination of reasons. Some nominals are ambiguous and may designate more than one object. Another source of ambiguous analyses is the fact that two objects potentially may participate in more than one type of relationship. The computational nominal compound interpreter detailed in this thesis supplies 1103 correct classifications for nominal compounds in the data set. Eighteen other analyses are not supplied, for an overall recall rate of .986. The nominal compound interpreter also supplies 66 incorrect analyses for nominal compounds in the data set, yielding a precision rate of .944. The interpreter failed to provide any analysis for 5 of the 491 nominal compounds in the data set. The recall and precision rates vary for the individual categories. The TA category achieves the highest rates of recall and precision by achieving perfect recall and a precision rate of .986. The recall rate for NS compounds is the lowest at .895, while the precision rate for TN and TS compounds is .856. A summary of results is presented in Table 8 on page 90.

IS compounds are not sought in the current implementation of the nominal compound interpreter. The relationships implicit between the elements of IS compounds are actions in which the elements mutually participate. Both the elements of the compound are causal factors of the relating action and serve as affected targets of the action if the other element is considered the causal factor. The

Table 8. Results of Classifying Compounds with Ambiguous Nominal Senses

Category	Compounds	Recall	Precision
TS/TN	79	.987	.856
TA	211	1.000	.986
NS	38	.895	.944
NN	119	.992	.944
NA	321	.991	.935
IN	248	.972	.927
IA	103	1.000	.972
Total	1121	.986	.944

representation for referents that is employed for the empirical test does not indicate which actions pair causal factors in this manner: hence the interpreter is unable to test for the presence of IS compounds in the data base, though at least one, *family friend* is present.

The searches for TS and TN compounds in the data set are combined for the empirical test. The semantic information employed in the recognition of TN compounds includes taxonomic links between referents: the referent of the head nominal is an ancestor of the referent of the modifier nominal in the referent taxonomy. One type of semantic information employed in the recognition of TS compounds similarly consists of taxonomic links from the related referents, as referents related by TS relationships may have taxonomic links to a common ancestor. Since the test for TN compounds subsumes part of the test for TS compounds, the results of separate searches for TS and TN compounds overlap. In a type hierarchy that does not make fine distinctions, such as the taxonomy for referents given by Virkar (1990), there are instances in which TS compounds cannot be distinguished from TN compounds. Accordingly, the searches for TS and TN compounds are combined and compounds in these two categories are not distinguished from one another. This fact does not greatly detract from the inferential capacity of the logical typology, since the inferences provided by symmetry simply weakly reinforce the inferences provided by transitivity.

There are 79 TS or TN compounds in the data set. There are three basic types of these compounds: (1) TS compounds in which the object denoted by the one nominal specifies the agent denoted by the other nominal, (2) TS compounds in which the head element is referential, and (3) TS and TN

compounds exhibiting taxonomic links to mutual, low-level ancestors. The nominal compound interpreter properly recognizes 78 of the 79 TS/TN compounds identified by the oracle as well as and improperly recognizes 10 compounds that are not acknowledged as TS/TN. The missed compound is *teaching profession*, which defies the requirement that the compound elements must belong to the same taxonomic class. *Teaching* designates an event and *profession* is defined as abstract.

The coarseness of the type hierarchies within the taxonomic classes of referents proposed by Virkar (1990) leads to spurious TS/TN analyses for some compounds. The compound *sheep dog* is recognized as a TS/TN compound because both are most specifically defined as animals. Likewise *cold* and *sore* are both health related and the compound *cold sore* is incorrectly identified as TS/TN. It is indeed difficult to specify the precise level of detail in the type hierarchies required to exclude this type of spurious analysis. For instance, *truck* and *ship* may both designate modes of transporting cargo, but it is unlikely that the TA compound *truck ship* has a TS/TN analysis. Limiting the types of taxonomic classes that support TS/TN analyses may alleviate this problem.

TA compounds in the data base exhibit one of five core relationships: part-whole, spatio-temporal location, containment, symbolic encoding, and grouping. The computational interpreter recognizes the large number of TA compounds with great success. All 211 TA compounds are recognized, and only three non-TA compounds are identified as being TA. The misidentified compounds share a common head element, *glass*, in the sense of being a container. This sense of *glass* is not correct for any of the compounds *looking glass*, *plate glass*, and *reading glasses*. Extraneous compounds of this form most likely could be eliminated by creating a subclass of containers that are designated for liquids, but that exceeds the specificity of our current representation. The high level of success in classifying TA compounds is attributable to the distinctiveness of the head nominals in the compounds, though for some of the recognized compounds it may seem inappropriate to assign TA analyses. Due to ambiguity and the lack of linguistic context, however, there are possible TA analyses for the compounds.

Two main types of relationships are identified as being nontransitive and symmetric: physical composition and attribute similarity. NS compounds comprise the smallest category in the data base with 38 qualifying entries. Compounds in which the implicit relationship between the elements is physical composition are classified successfully for the most part owing to the distinctiveness of the modifier elements in these compounds. *Oil paint* is the sole physical composition compound missed by the interpreter, because *oil* is not identified as a substance that may compose other substances. *Chicken wire* and *coffee nerves* are NN compounds that are misanalyzed as NS because both exhibit the pattern of an agricultural product modifying another physical entity.

NS compounds in which the implicit relationship is attribute similarity are more difficult to recognize. Again these compounds are identified through their modifier elements, generally exemplifying shapes as in the compound *box camera*. The head elements are entities that assume the attributes given by the modifier elements. *Chain reaction* and *root word* are examples in the data base of NS compounds in which the head elements are not entities, but still exemplify attributes of the modifier elements. Relaxing the requirement that the head elements of NS compounds be entities would allow for the proper analysis of these two compounds, but it also would introduce a host of spurious NS analyses for IA compounds such as *chain strength* and *root size*. Filtering these compounds through the IA category perhaps would assist in avoiding spurious analyses of this type of NS compound, which indicates that the precision of our procedures might be improved by employing preference rules.

Nontransitive, nonsymmetric relationships between objects also are noninferential. Two broad types of NN relationships are described in Chapter 4: between the causal factor of an act and the act's affected target, and between two objects that are physically proximate. The former type of NN compound is better defined and more readily discernible than the latter. There are 119 compounds in the data base that qualify as NN, and all but a single example, *conscience money*, are successfully classified. The missing compound was not recognized because the nominals do not both designate entities. Additionally, because of the liberal qualifications for recognizing NN

compounds, several compounds that are actually TA also are classified in the NN category. TA classifications are preferable since they are inferential whereas NN analyses are not.

Intransitive, asymmetric compounds are recognized by the distinctiveness of their head elements. The relationships implicit in IA compounds are those between objects and their attributes. In IA compounds, the head elements are attributes of the modifier elements. With semantic tests suitable for matching attributes of entities to entities, attributes of events to events, and attributes of abstracts to abstracts, the interpreter is able to identify all of the 103 IA compounds in the data set. The separate types of attributes belong to separate classes in the referent taxonomy.

Nontransitive, asymmetric compounds comprise the largest class in the data base, with 321 of the 491 compounds having NA analyses. This profusion of NA analyses arises from the two broad semantic patterns, one synthetic, the other primary, that NA compounds may exhibit. Synthetic NA compounds pair an act and its causal factor in any order. The pattern of primary NA compounds is that the modifier element denotes the source of the head element.

The interpreter failed to recognize three compounds as NA: *navigation function*, and two health related compounds, *cold sore* and *sleeping sickness*. Better representation of the semantics of objects related to health is indicated as well in the TS/TN category. As well as missing compounds, the interpreter misidentifies 22 compounds as NA. Of these extra compounds, 16 reflect the incorrect pairing of a causal factor and an act such as in *horse doctor*, *pig iron* and *duck shooting*. Tighter semantic restrictions on the appropriateness of causal factors and their allowable actions and improved morphological analysis could reduce the number of extraneous analyses, though the changes might cause the interpreter to miss valid NA compounds such as *donkey work* and *insect flight*. The remainder of the misidentified NA compounds arise from problems with sources. *Time study*, *time correlation* and *car repair* are examples of compounds in which the modifier element does not indicate the spatio-temporal source of the head element.

Intransitive, nonsymmetric compounds are another large class in the data base, with 241 qualifying entries. The relationships implicit in IN compounds are strictly primary, and their semantic pattern varies only in the case of a modifier that is a verbal nominalization with an *-ing* suffix. In all other cases, the head element of an IN compound denotes an act and the modifier element denotes the affected target of the act. The interpreter missed seven IN compounds in the data base, two because they defy the defining semantic pattern. In the compounds *cut throat* and *hire car*, the act is denoted by the modifier nominal and the affected target is denoted by the head nominal. Other missed IN compounds such as *cold cure*, *home help* and *navigation hazard* reflect weakness in the proposed semantic links between acts and their affected targets. It is difficult, however, to make the links more inclusive without misidentifying many compounds as IN. Even with the present links, 19 compounds that are not IN are recognized as being so. *Water tower*, *reading glasses* and *duck bill* are examples of compounds recognized as IN because their head elements have verbal senses that attempt to take the modifier elements as affected targets.

5.4 *An Empirical Test with Fixed Senses for Nominals*

The second test of the computational nominal compound interpreter eliminates one source of ambiguity in analyzing nominal compounds. For this test, unique senses for the nominals in compounds are selected by the oracle. The interpreter with the selected senses then provides the logical properties of the relationships implicit between the elements of the compounds. The motivation behind this test is to determine how accurately the interpreter classifies compounds when the senses of component nominals are fixed.

The interpreter as presented in the previous chapter imposes no precedence among the types of relationships that may be implicit between the elements of nominal compounds, though in some

Table 9. Results of Classifying Compounds with Fixed Nominal Senses

Category	Compounds	Recall	Precision
TS/TN	42	.976	.976
TA	108	.992	.973
NS	24	.792	.905
NN	28	.774	.960
NA	159	.919	.873
IN	79	.779	.882
IA	51	.980	1.000
Total	491	.906	.925

cases we indicated that a precedence ordering might be useful. Instead, every logical category was considered independently of the other categories in order to discover all possible analyses of compounds. Such an approach is appropriate for compounds lacking any linguistic context. For this test, however, it is desirable that each compound be assigned a unique analysis. This goal requires that some analyses be considered preferable to other analyses for the same compound. Some of the tests for assigning compounds to logical categories overlap with other tests for assigning compounds to categories. In the course of preparing this test, an empirical precedence ordering of the categories of the logical typology emerged.

Overall the computational nominal compound interpreter performs well for this second test. For the 491 compounds in the data base, 445 correct classifications are provided and 46 are missed. Also supplied are 36 incorrect analyses. The TA category has the highest recall rate, .992, while the NN category has the lowest recall rate of .774. The IA category is perfectly precise, in that every compound identified by the interpreter as IA is in fact IA, while the NA category has the lowest precision rate of .873. As in the first test, IS compounds are not detected by the interpreter. Table 9 on page 95 summarizes the results of the fixed sense test.

The tests for transitive, symmetric compounds and transitive, nonsymmetric compounds are merged for the fixed sense test for the same reasons that they are merged for the test of compounds with multiple senses for component nominals; that is, the tests overlap. Therefore compounds in these two categories are not distinguished from one another. Compounds qualify as TS/TN if they

The rules for classifying nominal compounds in the categories of the logical typology were applied in the following order for the fixed sense test.

- | | |
|-------|---------------------------|
| I. | TS/TN |
| II. | IA |
| III. | IN and synthetic NA |
| IV. | spatio-temporal NA and TA |
| V. | synthetic NN |
| VI. | remaining NA and TA |
| VII. | NS |
| VIII. | remaining NN |

Figure 9. Precedence Ordering for Fixed Sense Test

are closely related through the taxonomy of referents regardless of the semantic types, but tests for other types of compounds in the logical typology depend on semantic patterns of compound components. For the compounds in the data base, the taxonomic relationships of TS/TN compounds generally take precedence over all other types of relationships. Therefore for the fixed sense test, the interpreter checks for TS/TN relationships first, and if any are found the interpreter does not seek further analyses.

Compounds belonging to the remaining categories of the logical typology exhibit specific semantic patterns. The semantic patterns of IA compounds do not overlap with patterns for other types of compounds, so a search for IA compounds is conducted after checking for TS/TN compounds. Following the IA search, a combined NA and IN test for compounds containing verbal nominalizations is performed. If a compound has not yet been classified, the interpreter next analyzes it to determine whether it contains nominals that denote spatio-temporal locations that support primary NA or TA analyses. Subsequently synthetic NN compounds that are the combination of an actor and the affected target of the related act are checked.

Certain types of entities, such as furniture and vehicles, may act as spatio-temporal locations in NA and TA compounds. Tests for these types of compounds follow the above tests, immediately preceding tests for other types of TA compounds, such as member-group and subject-description.

Compounds that are not classified by any of the previous tests then are tested to determine if they are NS, and finally NN collocational compounds are sought. The specified order of tests for compound types results from the optimum output of our analytical procedures. Figure 9 summarizes the ordering of the tests for the various types of compounds.

Of the 42 fixed sense TS/TN compounds in the data base, the interpreter successfully recognizes 41, missing only *house boat*. The components of this compound do not exhibit close links to one another in the type hierarchy of referents. The interpreter misidentifies one compound, *sheep dog*, as TS/TN because of the coarseness of the type hierarchy. This compound is classified incorrectly as TS/TN in the ambiguous sense test also.

The fixed sense interpreter achieves a high level of success with intransitive, asymmetric compounds. Of the 51 IA compounds in the data base, 50 are recognized successfully and only the questionable IA compound *animal life* is missed. Furthermore, no compounds that are not IA are classified as IA by the interpreter.

Synthetic nontransitive, asymmetric compounds and intransitive, nonsymmetric compounds are sought in a combined test. Several of the compounds in the data base are ambiguous despite the fixed sense of their components and may be assigned to either of these logical categories. *System initialization, computer activation, computer learning, satellite rotation* and *plant production* are examples of compounds that may be the pairing of an act with either a causal factor or an affected target. Since the searches for synthetic NA and IN compounds are combined, the interpreter must choose from these analyses even when the compound is ambiguous. The analyses provided by the oracle for the compounds are judged to be the most likely analyses for the compounds. Sixteen ambiguous synthetic compounds comprise the majority of the 20 compounds incorrectly identified as NA and the 19 IN compounds that are not recalled. Another eight ambiguous synthetic compounds are the majority of the 12 NA compounds not recalled by the interpreter and the nine compounds misidentified as IN. Better performance in the realm of ambiguous synthetic com-

pounds could be achieved by refining the links between acts, their causal factors and affected targets. Such refinement would improve the results provided by the interpreter considerably.

The remaining three compounds in the IN category that are not recalled also are not recalled in the multiple sense test. *Animal life*, an IA compound, is the only compound misidentified as IN that actually is not NA. For the NA category, two of the remaining four missing compounds also fail the ambiguous sense test. The four remaining primary compounds incorrectly identified as NA are given spatio-temporal analyses. As occurred in the ambiguous sense test, there is overlap between compounds identified as spatio-temporal NA and spatio-temporal TA compounds. *Car barn* again eludes proper classification, a TA compound that is identified incorrectly as NA.

Other than *car barn*, all transitive, asymmetric compounds in the data base are identified by the interpreter. TA compounds typically have distinctive head elements which make their identification highly accurate. There are three compounds that are misidentified as TA: *hire car*, *steam roller*, and *finger lakes*. For each of these, a spatio-temporal analysis is provided for the head nominal after the compound failed to be recognized by the proper higher precedence test.

In the fixed sense test for nontransitive, symmetric compounds, the same four NS compounds that are not recognized in the ambiguous sense test are again not recognized, nor is the compound *finger lakes*, which is given a TA analysis by a higher precedence test. Incorrect NS analyses are given to the NN compounds *plant food* and *coffee cream* for their adherence to the physical composition semantic patterns.

Seven of the 31 NN compounds in the data base are missed, mostly because they are misclassified by higher precedence tests. *Conscience money* is missed entirely, as it was for the ambiguous sense test. The precision rate for NN analyses is high, with only the NS compound *oil paint* misidentified as NN.

5.5 *Results of Classifying Nominal Compounds*

The results of two separate empirical tests conducted on a data base of nominal compounds are reported in previous sections of this chapter. The aims of the tests are to classify nominal compounds according to the categories of the logical typology employing the analytical methods described in Chapter 4. Nominal compounds are potentially ambiguous. There are at least two sources of ambiguity: the senses of the component nominals in compounds and the relationships that exist between the components of the compounds. The two tests are attempts to consider these two sources of ambiguity first together and then by isolating the first source.

The compounds under consideration are free from linguistic context; therefore the senses of the nominals in the compounds cannot be determined through contextual analysis. The initial version of the computational nominal compound interpreter considers all senses for nominals and supplies all possible analyses for compounds. In the second test, senses for component nominals are supplied to the interpreter but the relationships between the components remain ambiguous. Classifications for compounds are selected employing a precedence ordering of the logical categories developed through empirical testing.

We were unable to obtain a reliable oracle for validating our results. In both tests the computer was able to achieve high levels of recall and precision when matched with our initial analysis of compounds in the data base, finding most compounds belonging to each of the logical categories and excluding compounds that do not belong. The performance of the interpreter conceivably could be enhanced by such measures as further refining the referent taxonomy adopted from Virkar (1990) and specifying better the links among acts, their causal factors and their affected targets. Despite the generality of the information provided concerning referents, most compounds under consideration are classified successfully in the absence of linguistic context. There are some compounds in the data base, however, that do not conform to the syntactic and semantic patterns em-

ployed by the interpreter in analyzing compounds and thus mandate enhancement of the current methods.

The results reported in this chapter when compared to our initial analysis exceed the levels of success reported by other researchers attempting to analyze nominal compounds computationally. The interpreter implemented by McDonald (1980), for instance, achieved a .60 success rate. An additional .30 of the compound examples might be analyzed successfully if certain assumptions were made and additional patterns added to his interpreter. Leonard (1984) reports a .628 success rate with an additional .128 near correct or partially correct. The interpreter for the logical typology, by contrast, scores over .90 in both recall and precision for both its tests. Direct comparison of these scores, though, is misleading. First of all, as reported earlier our oracle is unreliable. Furthermore, the categories of the logical typology provide a more general basis for classifying the relationships implicit between the elements of nominal compounds than do the approaches of McDonald and Leonard. Each category of the logical typology potentially contains several of the types of relationships recognized by these researchers. On the other hand, the logical typology requires considerably less information concerning the components of nominal compounds in order to make its analyses.

What is established through the empirical tests of the computational nominal compound interpreter is that by employing syntactic information about nominals and semantic information about the objects they identify, nominal compounds may be classified according to the logical properties of the semantic relationships implicit between their elements. Provided that it is possible to validate our results in future testing, this ability makes feasible the use of the logical typology in classifying nominal compounds. Such a classification supports inferences based on the laws of logic concerning the sharing of attributes between objects that are related in nominal compounds.

6.0 Discussion

6.1 *Summary*

The approach to analyzing nominal compounds advocated in this thesis may be summarized by the following observations:

- I. Our approach to nominal compounds is extensional, focusing on the objects denoted by nominals and relationships between the objects. Nominal compounds consist of a string of nominals, each of the nominals representing an element of the compound. Nominal compounds designate a single object or group of objects. The elements of nominal compounds are implicitly related. The relationships are semantic and exist between the objects designated by the individual nominals in compounds. The implicit relationships between the elements of nominal compounds assist in descriptively characterizing the objects designated by the compounds. So objects designated by nominal compounds may be described partially by capturing relationships implicit among their elements.

- II. The precise relationships implicit in nominal compounds are numerous as each relationship is dependent upon the related objects, but all of the relationships in nominal compounds are binary and thus they exhibit logical properties. The relationships are transitive, intransitive or nontransitive and concurrently symmetric, asymmetric, or nonsymmetric.
- III. The nine possible combinations of these logical properties provide a viable means of classifying the numerous semantic relationships implicit in nominal compounds. The resultant typology, the **logical typology**, is capable of accounting for the semantic relationships proposed in the work of other researchers.
- IV. The logical properties of relationships support inferences through the laws of modal logic regarding the similarity and dissimilarity of attributes of related objects. In order to make the inferences, however, the necessary, actual and possible attributes of objects must be specified.
- V. Classifying individual compounds in the logical typology requires recognizing the logical properties of the implicit relationships imputed to exist between the objects denoted by nominals in the compounds. Potential relationships between objects are manifold, but each exhibits logical properties that places them in individual categories of the logical typology. Certain types of relationships with similar logical properties tend to occur between objects with certain types of semantic characteristics. The salient semantic characteristics of objects that identify the types of relationships in which the objects participate may be employed to classify the referents of nominals in a taxonomy. On the basis of the taxonomic categories and the referents of nominals in compounds, the logical properties of the relationships implicit in compounds become detectable. Syntactic cues also assist in recognizing the logical properties of relationships implicit primarily between the elements of synthetic nominal compounds.
- VI. Nominal compounds are potentially ambiguous in two ways. Each of the component nominals in compounds may designate multiple objects. Additionally relationships from more than one of the logical categories may be candidates for the relationships

implicit between the elements of compounds. Ambiguity needs to be addressed in the analysis of nominal compounds. Every object designated by each nominal in a compound may be paired with every objects designated by the other nominals in the compound and all possible analyses of a compound should be considered. In the absence of context, no preference can be advanced justifiably for any of competing analyses for a nominal compound.

An interpreter based on these principles and tested on a data base of nominal compounds correctly classifies better than .90 of the compounds belonging to the individual logical categories in accordance with our analysis of the database. The results hold for two types of tests conducted with the interpreter. The first test allows for ambiguous senses for the nominals and supplies all possible analyses for compounds. The second test has fixed senses for nominals and prefers some analyses to others. The quality of the results achieved in these tests suggests that it is possible to construct a computational nominal compound interpreter that classifies input nominal compounds according to the logical properties of their implicit relationships with a high degree of success. This conclusion is not certain, however, for we were unable to validate these results with a survey of English speakers.

6.2 *Additional Considerations*

The analysis of nominal compounds provided through the logical typology is novel, though components of the process are not. Semantic analysis of nominal compounds in English dates back at least to the work of Bergsten (1911), who proposed a semantic typology with general descriptions of the compounds belonging to each category. The descriptions serve as the means for classifying compounds in the proposed semantic categories. The semantic patterns and recognizable relationships employed in determining the logical properties of relationships between the elements

of nominal compounds are in many ways similar to typologies and classification methods proposed by other researchers, but the analysis of implications resulting from the relationships is unique.

The unvalidated results achieved by a computational nominal compounds interpreter designed to classify nominal compounds in the logical typology on a data base of nominal compounds exceed the results reported by other researchers. The results still are not perfect, and methods for enhancing the classification procedures were proposed in the discussion of results in Chapter 5. Refining the taxonomy for referents would improve the recognition of TS and TN compounds and allow the interpreter to distinguish between these types of compounds. Tighter constraints on the links between acts, their causal factors and affected targets would improve the recognition of IN, synthetic NA and NN compounds and provide a means for identifying IS compounds. Improving the recognition of TA, NS, and primary NA and NN compounds could be achieved by further restricting the permissible semantic patterns for these compounds. The interpreter already is extremely successful at selecting IA compounds correctly.

One contributing factor to the high success rate of the interpreter is that the categories of the logical typology are very general and the classification process correspondingly is less exacting than for more detailed typologies. The logical categories subsume more specific semantic relationships. The generality of the case grammar employed by the logical typology is one example. It has roles only for acts, causal factors and affected targets. Most other case grammars subdivide these roles, and so may offer more precise descriptions of events. Because of its generality, the logical typology probably is best suited to be a high-level classification for the relationships implicit in nominal compounds, allowing more specific subcategories within the categories we have proposed.

The foremost recommendation for the logical typology is its inferential properties. The inferential schemata attached to the logical categories employ rules of modal logic to facilitate inferences concerning the sharing of properties between related objects. The inferences, however, depend on general knowledge about what are necessary, possible and actual attributes of related objects. Specifying this information is a problem that must be overcome in order to apply the inference

schemata. Another characteristic of the inference schemata is that for some categories the inferences are weak or not very informative. This is a further reason for employing the logical typology as a high-level typology with more specific subcategories. It is likely that more specific relationships have more specific implications that extend beyond those rendered through the logical typology.

The oracle we use to determine the logical properties of relationships implicit between the elements of nominal compounds is our best judgment, which entails subjectivity of the oracle. There clearly are core relationships within the categories that exhibit the appropriate combinations of logical properties, but it is possible that the logical properties of some relationships are misidentified. Finin (1982) points out that the actual relationships implicit in nominal compounds are uncertain and require consensus among researchers. This criticism applies to our efforts to classify nominal compounds in the logical typology at two levels: first, determining appropriate semantic relationships issuing from patterns of nominals, and second, judging the logical properties of those relationships. We recognize the need for further validation of our analysis at both of these levels.

Ambiguity is another problem that requires additional treatment. Compounds may be ambiguous because of multiple senses for nominals or because of multiple potential relationships between nominals. The linguistic context of nominal compounds may assist in limiting both forms of ambiguity. The topic of linguistic context or previous use of the nominals in the context may indicate the proper senses for nominals. Context also may restrict potential relationships, particularly in the case of ambiguous synthetic compounds such as *system update*. The relationship in the compound is not ambiguous in the sentences "John performed a system update" and "There was a system update of the data base." The possible roles that *system* may fill with respect to *update* are constrained in the sentences. Our interpreter analyzes nominal compounds in isolation from their linguistic context. It should be enhanced with formal methods that exploit context to resolve ambiguity in compounds.

Linguistic context also is needed to determine the objects identified by nominal compounds. This thesis focuses on semantically characterizing the objects denoted by compounds, not identifying

them. The objects identified by a nominal compound is an object or group of objects that occurs within the domain being described by the linguistic expressions that are the source of the nominal compound. Given a nominal compound and an appropriate model that represents what is described by the linguistic expressions, determining the object designated by the compound is isolating the relevant constant or constants in the model that represent the object denoted by the compound. If no previously existing constant represents the object, a new constant must be created. Difficulties associated with choosing proper objects designated by nominal compounds have not been solved in general semantic domains. The identification of objects designated by compounds ultimately depends on the linguistic context and involves pragmatic as well as semantic analysis. We have not treated linguistic context nor pragmatics, so identifying the designated objects is beyond the scope of this thesis. The problem, however, must be addressed for complete nominal compound analysis.

The current computational nominal compound interpreter for the logical typology has not been extended to multiple compounds. A general methodology might resemble the approaches advocated by other researchers who also employ semantic typologies to analyze nominal compounds. The objects denoted by nominals in compounds that have multiple nominals are related to one another. A challenge in analyzing multiple compounds beyond that of analyzing binary compounds is to determine which objects exist in binary relationships with which other objects. The number of possible binary combinations of the objects denoted by nominals in multiple compounds increases exponentially according to the number of nominals in the compounds. The exhaustive approach to analyzing nominal compounds is to reduce compounds to their binary components by attempting to pair the object denoted by each nominal in a multiple compounds to every other object denoted by some nominal in the compound. Pairings of objects that form recognizable semantic patterns should not be disregarded when considering analyses of multiple compounds. A precedence ordering of the categories of the logical typology might be employed to help resolve the correct pairings of objects, but additional research is required before such a precedence ordering may be advanced. Once the proper pairings of objects is achieved and the pairings are assigned to appropriate logical categories, the inference schema attached to the logical typology

have potential to offer a unique feature in the analysis of multiple compounds. Composition of the relations proffered by the logical typology is a well-defined formal operation that yields binary relations with distinct logical properties. Through recognition of the hierarchical phrase structure and logical composition, an indirect relationship between two objects may be established and characterized by inference rules.

While the logical typology provides a means for analyzing nominal compounds, it does not account for their production. A formative approach for generating nominal compounds from deep structure requires specifying appropriate word formation rules that shows how compounds are formed and limits their occurrence to certain linguistic contexts. We have not proposed rules for the formation of compounds. Specification of such rules, however, is another possible direction for extension of our analysis.

Finally, the analysis of nominal compounds through the logical typology may shed insight on analyzing linguistic expressions that are syntactically more complex. The relationships implicit between the elements of nominal compounds may be conveyed by a speaker to a listener more explicitly through the use of additional words. Presumably the relationships implicit in nominal compounds are detailed more explicitly by the more complex syntactic forms, but the relationships themselves are the same or at least similar. Thus the analysis of semantic relationships in nominal compounds may have application to relationships expressed in other types of linguistic expression. Russell (1975), for one, conceptually extended a nominal compound interpreter so that it would analyze prepositional phrases. Additional analysis is needed to determine how to apply the approach embodied in the logical typology to other forms of linguistic expression. The broad outline is to model the complex relationships involving multiple objects conveyed through language by multiple binary relations relating exactly two objects or groups of objects. The inference schema associated with the logical categories then may be applied to the binary relations. The inferences produced through the logical typology may assist in representing additional information about the domain of description.

This thesis is significant for its novel method of characterizing and analyzing the relationships between the elements of nominal compounds. Russell (1975) and others employ the concept of classifying nominal compounds in categories that support inferences about implicit relationships, but the foundation of the logical typology is different from these efforts. The categories of the logical typology support inferences rooted in the laws of modal logic. By linking the semantics of relationships implicit in nominal compounds to formal inference mechanisms, inferences provided through the logical typology have a valid theoretical basis. The computational interpreter for nominal compounds implemented for this thesis correctly classifies nominal compounds according to the logical properties of their implicit semantic relationships, but it cannot apply inference rules associated with the logical properties to characterize descriptively the relationships without general knowledge concerning the related objects. The lack of general knowledge is the chief obstacle to applying fully the logical typology to analyzing nominal compounds, though there exist several other problems as cited above. Nevertheless, the logical typology is a promising theoretical basis for analyzing the semantics of nominal compounds.

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Appendix A. Results for Ambiguous Sense Test

This appendix reports the results achieved by the interpreter in classifying nominal compounds in the categories of the logical typology when the nominals composing the compounds have ambiguous senses. The interpreter returns all possible interpretations without regard to likelihood. The interpretations are presented by category, and within the categories the interpretations are sorted by whether they are correct or not. Compounds in each category that are missed by the interpreter are reported also. For the test, the categories of TS and TN compounds are merged and the IS category is not sought.

1. Transitive Symmetric and Transitive Nonsymmetric

Correct TNS interpretations

<i>ice water</i>	water is another label for ice
<i>time period</i>	period is another label for time
<i>time sample</i>	sample is another label for time
<i>duration time</i>	time is another label for duration
<i>sister ship</i>	ship is another label for sister
<i>ship movement</i>	movement is another label for ship

<i>weapon system</i>	system is another label for weapon
<i>launcher system</i>	system is another label for launcher
<i>rocket engine</i>	engine is another label for rocket
<i>candidate word</i>	word is another label for candidate
<i>compound word</i>	word is another label for compound
<i>book review</i>	review is another label for book
<i>book request</i>	request is another label for book
<i>data entry</i>	entry is another label for data
<i>position fix</i>	fix is another label for position
<i>coordinate position</i>	position is another label for coordinate
<i>buffer space</i>	space is another label for buffer
<i>test pilot</i>	pilot is another label for test
<i>scratch test</i>	test is another label for scratch
<i>test weight</i>	weight is another label for test
<i>test pattern</i>	pattern is another label for test
<i>fuel oil</i>	oil is another label for fuel
<i>will power</i>	power is another label for will
<i>power output</i>	output is another label for power
<i>student prince</i>	prince is another label for student
<i>student friends</i>	friends is another label for student
<i>drawing paper</i>	paper is another label for drawing
<i>tissue paper</i>	paper is another label for tissue
<i>life force</i>	force is another label for life
<i>party line</i>	line is another label for party
<i>plate glass</i>	glass is another label for plate
<i>flight operation</i>	operation is another label for flight
<i>test flight</i>	flight is another label for test
<i>radio set</i>	set is another label for radio

<i>radio broadcast</i>	broadcast is another label for radio
<i>radio communication</i>	communication is another label for radio
<i>record price</i>	price is another label for record
<i>wind source</i>	source is another label for wind
<i>wind speed</i>	speed is another label for wind
<i>buffer state</i>	state is another label for buffer
<i>city state</i>	state is another label for city
<i>doctrine message</i>	message is another label for doctrine
<i>response message</i>	message is another label for response
<i>message updates</i>	updates is another label for message
<i>panic reaction</i>	reaction is another label for panic
<i>individual user</i>	user is another label for individual
<i>doctrine entry</i>	entry is another label for doctrine
<i>design document</i>	document is another label for design
<i>talking point</i>	point is another label for talking
<i>program initiation</i>	initiation is another label for program
<i>transmission error</i>	error is another label for transmission
<i>letter error</i>	error is another label for letter
<i>tax rate</i>	rate is another label for tax
<i>family unit</i>	unit is another label for family
<i>piece work</i>	work is another label for piece
<i>input device</i>	device is another label for input
<i>input language</i>	language is another label for input
<i>input interface</i>	interface is another label for input
<i>input sentence</i>	sentence is another label for input
<i>timer input</i>	input is another label for timer
<i>air conditioning</i>	conditioning is another label for air
<i>machine tool</i>	tool is another label for machine

<i>seeing eye</i>	eye is another label for seeing
<i>blood test</i>	test is another label for blood
<i>candle light</i>	light is another label for candle
<i>blinker light</i>	light is another label for blinker
<i>boat ride</i>	ride is another label for boat
<i>fighter plane</i>	plane is another label for fighter
<i>place setting</i>	setting is another label for place
<i>sitting duck</i>	duck is another label for sitting
<i>lover boy</i>	boy is another label for lover
<i>cell block</i>	block is another label for cell
<i>target date</i>	date is another label for target
<i>fruit tree</i>	tree is another label for fruit
<i>sports activities</i>	activities is another label for sports
<i>target structure</i>	structure is another label for target
<i>engagement order</i>	order is another label for engagement
<i>navigation function</i>	function is another label for navigation

Incorrect TNS interpretations

<i>training ship</i>	ship is another label for training
<i>dictionary word</i>	word is another label for dictionary
<i>sheep dog</i>	dog is another label for sheep
<i>day dream</i>	dream is another label for day
<i>grain alcohol</i>	alcohol is another label for grain
<i>income tax</i>	tax is another label for income
<i>weight reduction</i>	reduction is another label for weight
<i>weight range</i>	range is another label for weight
<i>cold sore</i>	sore is another label for cold

television camera camera is another label for television

Missing TNS interpretations

teaching profession teaching is TNS related to profession

2. Transitive Asymmetric

Correct TA interpretations

<i>water tower</i>	water is spatially located in tower
<i>water spot</i>	water is spatially located in spot
<i>water mark</i>	water is spatially located in mark
<i>water drop</i>	water is spatially located in drop
<i>water pipe</i>	water is contained in pipe
<i>water flow</i>	water is spatially located in flow
<i>cooking time</i>	cooking is temporally located in time
<i>read time</i>	read is temporally located in time
<i>time study</i>	time is the topic of study
<i>time study</i>	time is spatially located in study
<i>recovery time</i>	recovery is temporally located in time
<i>search time</i>	search is temporally located in time
<i>time period</i>	time is temporally located in period
<i>satellite time</i>	satellite is temporally located in time
<i>time mark</i>	time is spatially located in mark
<i>time message</i>	time is the topic of message
<i>position time</i>	position is temporally located in time
<i>duration time</i>	duration is temporally located in time
<i>sister ship</i>	sister is spatially located in ship

<i>space ship</i>	space is spatially located in ship
<i>training ship</i>	training is spatially located in ship
<i>ship position</i>	ship is spatially located in position
<i>ship latitude</i>	ship is spatially located in latitude
<i>system dictionary</i>	system is the topic of dictionary
<i>system commands</i>	system is the topic of commands
<i>status algorithms</i>	status is the topic of algorithms
<i>status summaries</i>	status is the topic of summaries
<i>money order</i>	money is spatially located in order
<i>steam engine</i>	steam is spatially located in engine
<i>fire engine</i>	fire is spatially located in engine
<i>rocket engine</i>	rocket is spatially located in engine
<i>pass word</i>	pass is the topic of word
<i>household word</i>	household is the topic of word
<i>candidate word</i>	candidate is the topic of word
<i>compound word</i>	compound is the topic of word
<i>dictionary word</i>	dictionary is the topic of word
<i>word sound</i>	word is spatially located in sound
<i>root word</i>	root is the topic of word
<i>guide book</i>	guide is the topic of book
<i>picture book</i>	picture is the topic of book
<i>book review</i>	book is the topic of review
<i>book request</i>	book is the topic of request
<i>computer literature</i>	computer is the topic of literature
<i>computer hours</i>	computer is temporally located in hours
<i>computer suite</i>	computer is a member of the group suite
<i>control tower</i>	control is spatially located in tower
<i>data entry</i>	data is the topic of entry

<i>data base</i>	data is spatially located in base
<i>coordinate data</i>	coordinate is the topic of data
<i>speed data</i>	speed is the topic of data
<i>character position</i>	character is spatially located in position
<i>position reports</i>	position is the topic of reports
<i>position fix</i>	position is spatially located in fix
<i>coordinate position</i>	coordinate is spatially located in position
<i>breathing space</i>	breathing is spatially located in space
<i>breathing space</i>	breathing is temporally located in space
<i>trunk space</i>	trunk is spatially located in space
<i>trunk space</i>	trunk is temporally located in space
<i>space colony</i>	space is spatially located in colony
<i>buffer space</i>	buffer is spatially located in space
<i>buffer space</i>	buffer is temporally located in space
<i>test pattern</i>	test is the topic of pattern
<i>test pattern</i>	test is spatially located in pattern
<i>oil well</i>	oil is spatially located in well
<i>power output</i>	power is the topic of output
<i>student committee</i>	student is a member of the group committee
<i>student friends</i>	student is a member of the group friends
<i>student decision</i>	student is the topic of decision
<i>wrapping paper</i>	wrapping is the topic of paper
<i>drawing paper</i>	drawing is the topic of paper
<i>tissue paper</i>	tissue is the topic of paper
<i>rice paper</i>	rice is the topic of paper
<i>house boat</i>	house is contained in boat
<i>packing house</i>	packing is spatially located in house
<i>dog house</i>	dog is spatially located in house

<i>life boat</i>	life is spatially located in boat
<i>life boat</i>	life is contained in boat
<i>animal life</i>	animal is temporally located in life
<i>home life</i>	home is temporally located in life
<i>ice fall</i>	ice is temporally located in fall
<i>ice fall</i>	ice is spatially located in fall
<i>ice bag</i>	ice is contained in bag
<i>tea room</i>	tea is spatially located in room
<i>elbow room</i>	elbow is spatially located in room
<i>dressng room</i>	dressng is spatially located in room
<i>search party</i>	search is spatially located in party
<i>party line</i>	party is spatially located in line
<i>party line</i>	party is a member of the group line
<i>garden party</i>	garden is spatially located in party
<i>tea party</i>	tea is spatially located in party
<i>working day</i>	working is temporally located in day
<i>beer glass</i>	beer is contained in glass
<i>hire car</i>	hire is spatially located in car
<i>hire car</i>	hire is contained in car
<i>car barn</i>	car is spatially located in barn
<i>passenger car</i>	passenger is spatially located in car
<i>passenger car</i>	passenger is contained in car
<i>grain agreement</i>	grain is the topic of agreement
<i>grain storage</i>	grain is spatially located in storage
<i>grain decision</i>	grain is the topic of decision
<i>production facility</i>	production is spatially located in facility
<i>radio broadcast</i>	radio is the topic of broadcast
<i>radio communication</i>	radio is the topic of communication

<i>radio channel</i>	radio is spatially located in channel
<i>radio platform</i>	radio is spatially located in platform
<i>price dispute</i>	price is the topic of dispute
<i>price index</i>	price is spatially located in index
<i>classification information</i>	classification is the topic of information
<i>buffer state</i>	buffer is spatially located in state
<i>buffer state</i>	buffer is the topic of state
<i>city state</i>	city is the topic of state
<i>police state</i>	police is spatially located in state
<i>police state</i>	police is the topic of state
<i>review state</i>	review is spatially located in state
<i>review state</i>	review is the topic of state
<i>table talk</i>	table is the topic of talk
<i>table structure</i>	table is spatially located in structure
<i>doctrine table</i>	doctrine is spatially located in table
<i>training requirements</i>	training is the topic of requirements
<i>doctrine message</i>	doctrine is the topic of message
<i>response message</i>	response is the topic of message
<i>message updates</i>	message is the topic of updates
<i>processing paragraphs</i>	processing is the topic of paragraphs
<i>processing requirements</i>	processing is the topic of requirements
<i>battle field</i>	battle is spatially located in field
<i>field work</i>	field is the topic of work
<i>information field</i>	information is spatially located in field
<i>drum storage</i>	drum is spatially located in storage
<i>working storage</i>	working is spatially located in storage
<i>action alerts</i>	action is the topic of alerts
<i>user function</i>	user is a member of the group function

<i>doctrine entry</i>	doctrine is the topic of entry
<i>design document</i>	design is the topic of document
<i>talking point</i>	talking is temporally located in point
<i>talking point</i>	talking is the topic of point
<i>talking point</i>	talking is spatially located in point
<i>boiling point</i>	boiling is temporally located in point
<i>boiling point</i>	boiling is the topic of point
<i>boiling point</i>	boiling is spatially located in point
<i>intercept point</i>	intercept is temporally located in point
<i>intercept point</i>	intercept is the topic of point
<i>intercept point</i>	intercept is spatially located in point
<i>spelling error</i>	spelling is the topic of error
<i>transmission error</i>	transmission is the topic of error
<i>letter error</i>	letter is the topic of error
<i>satellite communications</i>	satellite is the topic of communications
<i>spy satellite</i>	spy is spatially located in satellite
<i>fruit market</i>	fruit is spatially located in market
<i>tax plan</i>	tax is the topic of plan
<i>search algorithm</i>	search is the topic of algorithm
<i>worker teams</i>	worker is a member of the group teams
<i>donkey work</i>	donkey is the topic of work
<i>piece work</i>	piece is a part of work
<i>piece work</i>	piece is the topic of work
<i>fuel line</i>	fuel is spatially located in line
<i>input sentence</i>	input is the topic of sentence
<i>timer input</i>	timer is the topic of input
<i>weight range</i>	weight is spatially located in range
<i>weight range</i>	weight is temporally located in range

<i>air stream</i>	air is spatially located in stream
<i>dream world</i>	dream is spatially located in world
<i>dream castle</i>	dream is spatially located in castle
<i>dream analysis</i>	dream is the topic of analysis
<i>write head</i>	write is spatially located in head
<i>arrow head</i>	arrow is spatially located in head
<i>head noun</i>	head is the topic of noun
<i>machine translation</i>	machine is the topic of translation
<i>bird cage</i>	bird is contained in cage
<i>bird cage</i>	bird is spatially located in cage
<i>bird call</i>	bird is the topic of call
<i>iron age</i>	iron is temporally located in age
<i>ironing board</i>	ironing is spatially located in board
<i>governing body</i>	governing is contained in body
<i>body shop</i>	body is spatially located in shop
<i>blood vessel</i>	blood is contained in vessel
<i>blood vessel</i>	blood is spatially located in vessel
<i>telephone call</i>	telephone is the topic of call
<i>call box</i>	call is contained in box
<i>calling card</i>	calling is the topic of card
<i>light year</i>	light is temporally located in year
<i>pleasure boat</i>	pleasure is spatially located in boat
<i>pleasure boat</i>	pleasure is contained in boat
<i>fighter plane</i>	fighter is spatially located in plane
<i>fighter plane</i>	fighter is a member of the group plane
<i>bush fighter</i>	bush is spatially located in fighter
<i>telephone directory</i>	telephone is the topic of directory
<i>place name</i>	place is the topic of name

<i>fire place</i>	fire is spatially located in place
<i>place setting</i>	place is spatially located in setting
<i>sleeping bag</i>	sleeping is contained in bag
<i>duck bill</i>	duck is the topic of bill
<i>records office</i>	records is spatially located in office
<i>wine bottle</i>	wine is contained in bottle
<i>road block</i>	road is spatially located in block
<i>road block</i>	road is the topic of block
<i>nerve block</i>	nerve is spatially located in block
<i>nerve block</i>	nerve is the topic of block
<i>cell block</i>	cell is a part of block
<i>cell block</i>	cell is spatially located in block
<i>cell block</i>	cell is the topic of block
<i>cold wave</i>	cold is spatially located in wave
<i>safety belt</i>	safety is spatially located in belt
<i>seat belt</i>	seat is spatially located in belt
<i>corn belt</i>	corn is spatially located in belt
<i>flower bed</i>	flower is spatially located in bed
<i>watch tower</i>	watch is spatially located in tower
<i>tear gas</i>	tear is spatially located in gas
<i>gas chamber</i>	gas is spatially located in chamber
<i>retaining wall</i>	retaining is spatially located in wall
<i>target date</i>	target is temporally located in date
<i>date line</i>	date is spatially located in line
<i>departure date</i>	departure is temporally located in date
<i>sword play</i>	sword is the topic of play
<i>playing cards</i>	playing is the topic of cards
<i>steam roller</i>	steam is spatially located in roller

<i>steam bath</i>	steam is contained in bath
<i>apple core</i>	apple is spatially located in core
<i>coffee break</i>	coffee is temporally located in break
<i>music box</i>	music is contained in box
<i>letter drop</i>	letter is spatially located in drop
<i>cough drop</i>	cough is spatially located in drop
<i>nose drop</i>	nose is spatially located in drop
<i>bear country</i>	bear is spatially located in country
<i>sports magazine</i>	sports is the topic of magazine
<i>sports magazine</i>	sports is contained in magazine
<i>sports magazine</i>	sports is spatially located in magazine
<i>finger lakes</i>	finger is spatially located in lakes
<i>letter sequence</i>	letter is spatially located in sequence
<i>situation description</i>	situation is the topic of description
<i>situation analysis</i>	situation is the topic of analysis
<i>target structure</i>	target is spatially located in structure
<i>network structure</i>	network is spatially located in structure
<i>launch vehicle</i>	launch is spatially located in vehicle
<i>surveillance plane</i>	surveillance is spatially located in plane
<i>farm bill</i>	farm is the topic of bill
<i>stage name</i>	stage is the topic of name
<i>equipment name</i>	equipment is the topic of name
<i>engagement order</i>	engagement is spatially located in order
<i>needle mark</i>	needle is spatially located in mark
<i>initialization sequence</i>	initialization is spatially located in sequence
<i>component distances</i>	component is spatially located in distances
<i>component distances</i>	component is a part of distances
<i>initialization notification</i>	initialization is the topic of notification

Incorrect TA interpretations

<i>looking glass</i>	looking is contained in glass
<i>plate glass</i>	plate is contained in glass
<i>reading glasses</i>	reading is contained in glasses

Missing TA interpretations

None

3. Nontransitive Symmetric

Correct NS interpretations

<i>salt water</i>	water is made of salt
<i>ice water</i>	water is made of ice
<i>rose water</i>	water is made of rose
<i>banana oil</i>	oil is made of banana
<i>tissue paper</i>	paper is made of tissue
<i>rice paper</i>	paper is made of rice
<i>paper money</i>	money is made of paper
<i>sheet ice</i>	ice is made of sheet
<i>sheet ice</i>	ice has the form of sheet
<i>ice bag</i>	bag is made of ice
<i>ice cream</i>	cream is made of ice
<i>elbow room</i>	room has the form of elbow

<i>plate glass</i>	glass has the form of plate
<i>glass eye</i>	eye is made of glass
<i>grain alcohol</i>	alcohol is made of grain
<i>fruit market</i>	market is made of fruit
<i>leather worker</i>	worker is made of leather
<i>plant food</i>	food is made of plant
<i>plant material</i>	material is made of plant
<i>head lettuce</i>	lettuce has the form of head
<i>iron curtain</i>	curtain is made of iron
<i>pig iron</i>	iron has the form of pig
<i>bush fighter</i>	fighter is made of bush
<i>chicken fat</i>	fat is made of chicken
<i>chicken feed</i>	feed is made of chicken
<i>corn belt</i>	belt is made of corn
<i>flower bed</i>	bed is made of flower
<i>apple sauce</i>	sauce is made of apple
<i>coffee cream</i>	cream is made of coffee
<i>fruit cake</i>	cake is made of fruit
<i>fruit tree</i>	tree is made of fruit
<i>box camera</i>	camera has the form of box
<i>butter fingers</i>	fingers is made of butter
<i>finger cymbals</i>	cymbals has the form of finger
<i>finger lakes</i>	lakes has the form of finger

Incorrect NS interpretations

<i>chicken wire</i>	wire is made of chicken
<i>coffee nerves</i>	nerves is made of coffee

Missing NS interpretations

<i>root word</i>	root is NS related to word
<i>oil paint</i>	oil is NS related to paint
<i>chain reaction</i>	chain is NS related to reaction
<i>color television</i>	color is NS related to television

4. Nontransitive Nonsymmetric

Correct NN interpretations

<i>water clock</i>	water is spatially proximate to clock
<i>salt water</i>	salt is spatially proximate to water
<i>ice water</i>	ice is spatially proximate to water
<i>water wheel</i>	water is spatially proximate to wheel
<i>water tower</i>	water is spatially proximate to tower
<i>water skier</i>	skier employs water
<i>rose water</i>	rose is spatially proximate to water
<i>water pipe</i>	water is spatially proximate to pipe
<i>sister ship</i>	sister is spatially proximate to ship
<i>weapon system</i>	weapon is spatially proximate to system
<i>launcher system</i>	launcher is spatially proximate to system
<i>steam engine</i>	steam is spatially proximate to engine
<i>fire engine</i>	fire is spatially proximate to engine
<i>rocket engine</i>	rocket is spatially proximate to engine
<i>fuel oil</i>	fuel is spatially proximate to oil
<i>banana oil</i>	banana is spatially proximate to oil

<i>oil paint</i>	oil is spatially proximate to paint
<i>oil well</i>	oil is spatially proximate to well
<i>oil company</i>	oil is spatially proximate to company
<i>student prince</i>	student is spatially proximate to prince
<i>student friends</i>	student is spatially proximate to friends
<i>drawing paper</i>	drawing is spatially proximate to paper
<i>tissue paper</i>	tissue is spatially proximate to paper
<i>rice paper</i>	rice is spatially proximate to paper
<i>house boat</i>	house is spatially proximate to boat
<i>dog house</i>	dog is spatially proximate to house
<i>house dog</i>	house is spatially proximate to dog
<i>life preserver</i>	preserver employs life
<i>horse shoe</i>	horse is spatially proximate to shoe
<i>horse doctor</i>	horse is spatially proximate to doctor
<i>sheet ice</i>	sheet is spatially proximate to ice
<i>ice bag</i>	ice is spatially proximate to bag
<i>ice cream</i>	ice is spatially proximate to cream
<i>police dog</i>	police is spatially proximate to dog
<i>sheep dog</i>	sheep is spatially proximate to dog
<i>plate glass</i>	plate is spatially proximate to glass
<i>beer glass</i>	beer is spatially proximate to glass
<i>glass eye</i>	glass is spatially proximate to eye
<i>car thief</i>	car is spatially proximate to thief
<i>car owner</i>	owner employs car
<i>car barn</i>	car is spatially proximate to barn
<i>passenger car</i>	passenger is spatially proximate to car
<i>grain alcohol</i>	grain is spatially proximate to alcohol
<i>flight director</i>	director employs flight

<i>flight recorders</i>	recorders employs flight
<i>radio set</i>	radio is spatially proximate to set
<i>radio platform</i>	radio is spatially proximate to platform
<i>table wine</i>	table is spatially proximate to wine
<i>table structure</i>	table is spatially proximate to structure
<i>individual user</i>	user employs individual
<i>engine designer</i>	designer employs engine
<i>spy satellite</i>	spy is spatially proximate to satellite
<i>fruit market</i>	fruit is spatially proximate to market
<i>market leader</i>	market is spatially proximate to leader
<i>mine worker</i>	worker employs mine
<i>leather worker</i>	worker employs leather
<i>donkey work</i>	donkey is spatially proximate to work
<i>piece work</i>	piece is spatially proximate to work
<i>fuel waster</i>	waster employs fuel
<i>fuel line</i>	fuel is spatially proximate to line
<i>plant food</i>	plant is spatially proximate to food
<i>plant material</i>	plant is spatially proximate to material
<i>city planner</i>	planner employs city
<i>arrow head</i>	arrow is spatially proximate to head
<i>head lettuce</i>	head is spatially proximate to lettuce
<i>machine tool</i>	machine is spatially proximate to tool
<i>eye opener</i>	opener employs eye
<i>eye dropper</i>	dropper employs eye
<i>bird cage</i>	bird is spatially proximate to cage
<i>jail bird</i>	jail is spatially proximate to bird
<i>iron curtain</i>	iron is spatially proximate to curtain
<i>pig iron</i>	pig is spatially proximate to iron

<i>body fluids</i>	body is spatially proximate to fluids
<i>body shop</i>	body is spatially proximate to shop
<i>blood vessel</i>	blood is spatially proximate to vessel
<i>candle light</i>	candle is spatially proximate to light
<i>gas light</i>	gas is spatially proximate to light
<i>fighter plane</i>	fighter is spatially proximate to plane
<i>bush fighter</i>	fighter employs bush
<i>bush fighter</i>	bush is spatially proximate to fighter
<i>telephone receiver</i>	receiver employs telephone
<i>cave man</i>	cave is spatially proximate to man
<i>duck bill</i>	duck is spatially proximate to bill
<i>chicken fat</i>	chicken is spatially proximate to fat
<i>chicken wire</i>	chicken is spatially proximate to wire
<i>chicken feed</i>	chicken is spatially proximate to feed
<i>office manager</i>	manager employs office
<i>shoe maker</i>	maker employs shoe
<i>shoe polish</i>	shoe is spatially proximate to polish
<i>wine bottle</i>	wine is spatially proximate to bottle
<i>wine press</i>	wine is spatially proximate to press
<i>road block</i>	road is spatially proximate to block
<i>nerve block</i>	nerve is spatially proximate to block
<i>cell block</i>	cell is spatially proximate to block
<i>seat belt</i>	seat is spatially proximate to belt
<i>corn belt</i>	corn is spatially proximate to belt
<i>flower bed</i>	flower is spatially proximate to bed
<i>wall flower</i>	wall is spatially proximate to flower
<i>watch tower</i>	watch is spatially proximate to tower
<i>tear gas</i>	tear is spatially proximate to gas

<i>gas chamber</i>	gas is spatially proximate to chamber
<i>play goer</i>	goer employs play
<i>steam roller</i>	roller employs steam
<i>steam roller</i>	steam is spatially proximate to roller
<i>steam bath</i>	steam is spatially proximate to bath
<i>apple sauce</i>	apple is spatially proximate to sauce
<i>science teacher</i>	teacher employs science
<i>school teacher</i>	teacher employs school
<i>coffee cream</i>	coffee is spatially proximate to cream
<i>coffee nerves</i>	coffee is spatially proximate to nerves
<i>fruit cake</i>	fruit is spatially proximate to cake
<i>fruit tree</i>	fruit is spatially proximate to tree
<i>box camera</i>	box is spatially proximate to camera
<i>butter fingers</i>	butter is spatially proximate to fingers
<i>finger cymbals</i>	finger is spatially proximate to cymbals
<i>target structure</i>	target is spatially proximate to structure
<i>ground controllers</i>	controllers employs ground
<i>home buyers</i>	buyers employs home
<i>television camera</i>	television is spatially proximate to camera
<i>film cutter</i>	cutter employs film

Incorrect NN interpretations

<i>system control</i>	system is spatially proximate to control
<i>control tower</i>	control is spatially proximate to tower
<i>tea room</i>	tea is spatially proximate to room
<i>elbow room</i>	elbow is spatially proximate to room
<i>air gun</i>	air is spatially proximate to gun

<i>blinker light</i>	blinker is spatially proximate to light
<i>network structure</i>	network is spatially proximate to structure

Missing NN interpretations

<i>conscience money</i>	conscience is NN related to money
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5. Nontransitive Asymmetric

Correct NA interpretations

<i>water wheel</i>	wheel is an agent or instrument of water
<i>water wheel</i>	water is an agent or instrument of wheel
<i>water tower</i>	tower is an agent or instrument of water
<i>water spot</i>	spot is an agent or instrument of water
<i>water spot</i>	water is an agent or instrument of spot
<i>ground water</i>	water is the spatial source of ground
<i>ground water</i>	water is an agent or instrument of ground
<i>cooling water</i>	water is an agent or instrument of cooling
<i>water skier</i>	skier is an agent or instrument of water
<i>water mark</i>	water is an agent or instrument of mark
<i>water drop</i>	water is an agent or instrument of drop
<i>water pipe</i>	pipe is an agent or instrument of water
<i>water pipe</i>	water is an agent or instrument of pipe
<i>water flow</i>	water is an agent or instrument of flow
<i>time period</i>	period is the temporal source of time
<i>satellite time</i>	time is the spatial source of satellite
<i>satellite time</i>	satellite is an agent or instrument of time
<i>time mark</i>	mark is the temporal source of time

<i>time sample</i>	sample is the temporal source of time
<i>position time</i>	time is the spatial source of position
<i>duration time</i>	time is the temporal source of duration
<i>sister ship</i>	sister is an agent or instrument of ship
<i>space ship</i>	ship is the spatial source of space
<i>space ship</i>	ship is the temporal source of space
<i>space ship</i>	ship is an agent or instrument of space
<i>training ship</i>	ship is an agent or instrument of training
<i>ship landing</i>	landing is the spatial source of ship
<i>ship landing</i>	ship is an agent or instrument of landing
<i>ship position</i>	position is the spatial source of ship
<i>ship position</i>	ship is an agent or instrument of position
<i>ship course</i>	course is the spatial source of ship
<i>ship course</i>	ship is an agent or instrument of course
<i>ship movement</i>	movement is the spatial source of ship
<i>ship movement</i>	ship is an agent or instrument of movement
<i>ship displacement</i>	displacement is the spatial source of ship
<i>ship displacement</i>	ship is an agent or instrument of displacement
<i>ship latitude</i>	latitude is the spatial source of ship
<i>ship speed</i>	speed is the spatial source of ship
<i>ship speed</i>	ship is an agent or instrument of speed
<i>learning system</i>	system is an agent or instrument of learning
<i>system commands</i>	system is an agent or instrument of commands
<i>system crash</i>	system is an agent or instrument of crash
<i>system initialization</i>	system is an agent or instrument of initialization
<i>system control</i>	system is an agent or instrument of control
<i>air speed</i>	speed is the spatial source of air
<i>air speed</i>	air is an agent or instrument of speed

<i>engine speed</i>	speed is the spatial source of engine
<i>engine speed</i>	engine is an agent or instrument of speed
<i>road speed</i>	speed is the spatial source of road
<i>road speed</i>	road is an agent or instrument of speed
<i>protection money</i>	money is an agent or instrument of protection
<i>stage money</i>	money is the spatial source of stage
<i>stage money</i>	money is an agent or instrument of stage
<i>play money</i>	money is the topic of play
<i>play money</i>	money is an agent or instrument of play
<i>rocket engine</i>	engine is the spatial source of rocket
<i>rocket engine</i>	engine is an agent or instrument of rocket
<i>pass word</i>	word is the spatial source of pass
<i>pass word</i>	pass is an agent or instrument of word
<i>household word</i>	word is the spatial source of household
<i>candidate word</i>	candidate is an agent or instrument of word
<i>compound word</i>	word is the spatial source of compound
<i>dictionary word</i>	word is the topic of dictionary
<i>dictionary word</i>	dictionary is an agent or instrument of word
<i>root word</i>	word is the spatial source of root
<i>book binding</i>	binding is the topic of book
<i>guide book</i>	guide is an agent or instrument of book
<i>book value</i>	value is the topic of book
<i>book value</i>	value is an agent or instrument of book
<i>book value</i>	book is an agent or instrument of value
<i>book review</i>	review is the topic of book
<i>book review</i>	book is an agent or instrument of review
<i>book trade</i>	trade is the topic of book
<i>book trade</i>	trade is an agent or instrument of book

<i>book request</i>	request is the topic of book
<i>book request</i>	book is an agent or instrument of request
<i>computer learning</i>	computer is an agent or instrument of learning
<i>computer programs</i>	computer is an agent or instrument of programs
<i>computer activation</i>	computer is an agent or instrument of activation
<i>control tower</i>	tower is an agent or instrument of control
<i>training control</i>	control is an agent or instrument of training
<i>interceptor control</i>	interceptor is an agent or instrument of control
<i>data entry</i>	entry is the topic of data
<i>data entry</i>	data is an agent or instrument of entry
<i>data type</i>	type is the topic of data
<i>data type</i>	data is an agent or instrument of type
<i>data base</i>	base is the topic of data
<i>data value</i>	value is the topic of data
<i>data value</i>	data is an agent or instrument of value
<i>coordinate data</i>	data is the spatial source of coordinate
<i>data accuracy</i>	accuracy is the topic of data
<i>character position</i>	character is an agent or instrument of position
<i>character position</i>	position is the topic of character
<i>position reports</i>	reports is the spatial source of position
<i>position fix</i>	fix is the spatial source of position
<i>coordinate position</i>	position is the spatial source of coordinate
<i>space suit</i>	suit is the spatial source of space
<i>space suit</i>	suit is the temporal source of space
<i>trunk space</i>	space was contained in trunk
<i>trunk space</i>	trunk is an agent or instrument of space
<i>space colony</i>	colony is the spatial source of space
<i>space colony</i>	colony is an agent or instrument of space

<i>space colony</i>	colony is the temporal source of space
<i>buffer space</i>	space is an agent or instrument of buffer
<i>test pilot</i>	pilot is an agent or instrument of test
<i>drying oil</i>	oil is an agent or instrument of drying
<i>oil well</i>	well is an agent or instrument of oil
<i>oil company</i>	company is an agent or instrument of oil
<i>will power</i>	power is an agent or instrument of will
<i>student power</i>	student is an agent or instrument of power
<i>power plant</i>	plant is an agent or instrument of power
<i>engine power</i>	power is the spatial source of engine
<i>engine power</i>	engine is an agent or instrument of power
<i>student problems</i>	student is an agent or instrument of problems
<i>student friends</i>	student is an agent or instrument of friends
<i>student decision</i>	student is an agent or instrument of decision
<i>wrapping paper</i>	paper is an agent or instrument of wrapping
<i>paper chase</i>	chase is the topic of paper
<i>drawing paper</i>	paper is an agent or instrument of drawing
<i>drawing paper</i>	paper is the topic of drawing
<i>paper money</i>	money is the topic of paper
<i>house cleaning</i>	cleaning is the spatial source of house
<i>house boat</i>	boat is the spatial source of house
<i>house dog</i>	dog is the spatial source of house
<i>life force</i>	force is the temporal source of life
<i>life preserver</i>	preserver is an agent or instrument of life
<i>life preserver</i>	preserver is the temporal source of life
<i>home life</i>	life is the spatial source of home
<i>sea horse</i>	horse is the spatial source of sea
<i>sea horse</i>	horse is an agent or instrument of sea

<i>horse laugh</i>	horse is an agent or instrument of laugh
<i>race horse</i>	horse is an agent or instrument of race
<i>riding horse</i>	horse is an agent or instrument of riding
<i>ice fall</i>	ice is an agent or instrument of fall
<i>ice bag</i>	ice is an agent or instrument of bag
<i>ice cream</i>	ice is an agent or instrument of cream
<i>room service</i>	service is the spatial source of room
<i>room service</i>	room is an agent or instrument of service
<i>elbow room</i>	room is the spatial source of elbow
<i>police dog</i>	dog is an agent or instrument of police
<i>hunting dog</i>	dog is an agent or instrument of hunting
<i>night watch</i>	watch is the temporal source of night
<i>night fighter</i>	fighter is the temporal source of night
<i>night train</i>	train is the temporal source of night
<i>night flight</i>	flight is the temporal source of night
<i>night school</i>	school is the temporal source of night
<i>search party</i>	party is an agent or instrument of search
<i>party line</i>	party is an agent or instrument of line
<i>party line</i>	line is the spatial source of party
<i>party line</i>	line is an agent or instrument of party
<i>garden party</i>	party is the spatial source of garden
<i>garden party</i>	party is an agent or instrument of garden
<i>party members</i>	members is an agent or instrument of party
<i>party members</i>	members is the spatial source of party
<i>party members</i>	members is a part of party
<i>day dream</i>	dream is the temporal source of day
<i>day laborer</i>	laborer is the temporal source of day
<i>looking glass</i>	glass is an agent or instrument of looking

<i>glass eye</i>	eye was contained in glass
<i>car thief</i>	thief is the spatial source of car
<i>car thief</i>	thief was contained in car
<i>car owner</i>	owner is the spatial source of car
<i>car owner</i>	owner was contained in car
<i>car barn</i>	barn is the spatial source of car
<i>car barn</i>	barn was contained in car
<i>plant production</i>	plant is an agent or instrument of production
<i>production facility</i>	facility is an agent or instrument of production
<i>production worker</i>	worker is an agent or instrument of production
<i>insect flight</i>	insect is an agent or instrument of flight
<i>flight director</i>	director is an agent or instrument of flight
<i>flight recorders</i>	recorders is an agent or instrument of flight
<i>flight operation</i>	flight is an agent or instrument of operation
<i>test flight</i>	flight is an agent or instrument of test
<i>plane flight</i>	flight is the spatial source of plane
<i>plane flight</i>	plane is an agent or instrument of flight
<i>plane flight</i>	flight is an agent or instrument of plane
<i>radio set</i>	radio is an agent or instrument of set
<i>radio set</i>	set is an agent or instrument of radio
<i>radio broadcast</i>	radio is an agent or instrument of broadcast
<i>radio communication</i>	radio is an agent or instrument of communication
<i>radio channel</i>	radio is an agent or instrument of channel
<i>record price</i>	price is the topic of record
<i>wind storm</i>	storm is the spatial source of wind
<i>wind storm</i>	wind is an agent or instrument of storm
<i>wind direction</i>	direction is the spatial source of wind
<i>wind direction</i>	wind is an agent or instrument of direction

<i>wind source</i>	source is the spatial source of wind
<i>wind source</i>	wind is an agent or instrument of source
<i>wind speed</i>	speed is the spatial source of wind
<i>wind speed</i>	wind is an agent or instrument of speed
<i>information content</i>	content is a part of information
<i>buffer state</i>	state is an agent or instrument of buffer
<i>city state</i>	state is the spatial source of city
<i>police state</i>	state is an agent or instrument of police
<i>police state</i>	police is an agent or instrument of state
<i>review state</i>	state is an agent or instrument of review
<i>review state</i>	state is the topic of review
<i>review state</i>	review is an agent or instrument of state
<i>table talk</i>	talk is the spatial source of table
<i>table wine</i>	wine is the spatial source of table
<i>table structure</i>	structure is the spatial source of table
<i>doctrine table</i>	table is the topic of doctrine
<i>table maintenance</i>	maintenance is the spatial source of table
<i>training supervisor</i>	supervisor is an agent or instrument of training
<i>training console</i>	console is an agent or instrument of training
<i>doctrine message</i>	message is the topic of doctrine
<i>doctrine message</i>	doctrine is an agent or instrument of message
<i>response message</i>	message is the topic of response
<i>response message</i>	response is an agent or instrument of message
<i>message updates</i>	updates is the topic of message
<i>field work</i>	work is the spatial source of field
<i>field work</i>	field is an agent or instrument of work
<i>field mouse</i>	mouse is the spatial source of field
<i>storage battery</i>	battery is the spatial source of storage

<i>storage battery</i>	battery is an agent or instrument of storage
<i>drum storage</i>	drum is an agent or instrument of storage
<i>operator action</i>	operator is an agent or instrument of action
<i>action button</i>	button is an agent or instrument of action
<i>user loading</i>	user is an agent or instrument of loading
<i>user function</i>	user is an agent or instrument of function
<i>doctrine authorization</i>	authorization is the topic of doctrine
<i>doctrine authorization</i>	doctrine is an agent or instrument of authorization
<i>doctrine entry</i>	entry is the topic of doctrine
<i>doctrine entry</i>	doctrine is an agent or instrument of entry
<i>design choice</i>	choice is the topic of design
<i>design choice</i>	design is an agent or instrument of choice
<i>design document</i>	document is the topic of design
<i>design document</i>	design is an agent or instrument of document
<i>design goal</i>	goal is the topic of design
<i>design goal</i>	design is an agent or instrument of goal
<i>design options</i>	options is the topic of design
<i>engine designer</i>	designer is the spatial source of engine
<i>intercept point</i>	intercept is an agent or instrument of point
<i>investment program</i>	program is an agent or instrument of investment
<i>spelling program</i>	program is an agent or instrument of spelling
<i>program initiation</i>	program is an agent or instrument of initiation
<i>transmission error</i>	error is the topic of transmission
<i>transmission error</i>	transmission is an agent or instrument of error
<i>letter error</i>	error is the topic of letter
<i>letter error</i>	letter is an agent or instrument of error
<i>error estimate</i>	estimate is the topic of error
<i>error estimate</i>	error is an agent or instrument of estimate

<i>satellite rotation</i>	rotation is the spatial source of satellite
<i>satellite rotation</i>	satellite is an agent or instrument of rotation
<i>satellite communications</i>	communications is the spatial source of satellite
<i>satellite communications</i>	satellite is an agent or instrument of communications
<i>spy satellite</i>	satellite is an agent or instrument of spy
<i>market rate</i>	rate is the spatial source of market
<i>market rate</i>	market is an agent or instrument of rate
<i>market leader</i>	leader is the spatial source of market
<i>market leader</i>	leader is an agent or instrument of market
<i>market close</i>	close is the spatial source of market
<i>market close</i>	market is an agent or instrument of close
<i>family man</i>	family is an agent or instrument of man
<i>family problems</i>	family is an agent or instrument of problems
<i>family friend</i>	family is an agent or instrument of friend
<i>search algorithm</i>	algorithm is an agent or instrument of search
<i>police search</i>	police is an agent or instrument of search
<i>soul searching</i>	soul is an agent or instrument of searching
<i>mine worker</i>	worker is the spatial source of mine
<i>mine worker</i>	worker is an agent or instrument of mine
<i>worker teams</i>	worker is an agent or instrument of teams
<i>donkey work</i>	donkey is an agent or instrument of work
<i>piece work</i>	piece is an agent or instrument of work
<i>fuel waster</i>	waster is an agent or instrument of fuel
<i>fuel line</i>	line is an agent or instrument of fuel
<i>input device</i>	device is the topic of input
<i>input device</i>	device is an agent or instrument of input
<i>input language</i>	language is the topic of input
<i>input interface</i>	interface is the topic of input

<i>input interface</i>	interface is an agent or instrument of input
<i>input sentence</i>	sentence is the topic of input
<i>timer input</i>	timer is an agent or instrument of input
<i>spelling checker</i>	checker is an agent or instrument of spelling
<i>vehicle weight</i>	weight is the spatial source of vehicle
<i>weight range</i>	range is an agent or instrument of weight
<i>air gun</i>	gun is the spatial source of air
<i>air gun</i>	gun is an agent or instrument of air
<i>air gun</i>	air is an agent or instrument of gun
<i>air stream</i>	stream is the spatial source of air
<i>air stream</i>	stream is an agent or instrument of air
<i>air stream</i>	air is an agent or instrument of stream
<i>air conditioning</i>	conditioning is the spatial source of air
<i>air conditioning</i>	air is an agent or instrument of conditioning
<i>city wall</i>	wall is the spatial source of city
<i>city planner</i>	planner is the spatial source of city
<i>dream world</i>	world is the temporal source of dream
<i>dream castle</i>	castle is the temporal source of dream
<i>dream analysis</i>	analysis is the temporal source of dream
<i>write head</i>	head is an agent or instrument of write
<i>arrow head</i>	arrow is an agent or instrument of head
<i>head lettuce</i>	lettuce is the spatial source of head
<i>head noun</i>	noun is the spatial source of head
<i>talking machine</i>	machine is an agent or instrument of talking
<i>machine tool</i>	tool is an agent or instrument of machine
<i>machine tool</i>	machine is an agent or instrument of tool
<i>washing machine</i>	machine is an agent or instrument of washing
<i>machine translation</i>	machine is an agent or instrument of translation

<i>seeing eye</i>	eye is an agent or instrument of seeing
<i>eye opener</i>	opener is an agent or instrument of eye
<i>eye dropper</i>	dropper is an agent or instrument of eye
<i>bird cage</i>	bird is an agent or instrument of cage
<i>bird call</i>	bird is an agent or instrument of call
<i>jail bird</i>	bird is the spatial source of jail
<i>jail bird</i>	bird is an agent or instrument of jail
<i>song bird</i>	bird is an agent or instrument of song
<i>curling iron</i>	iron is an agent or instrument of curling
<i>iron age</i>	iron is an agent or instrument of age
<i>ironing board</i>	board is an agent or instrument of ironing
<i>governing body</i>	body is an agent or instrument of governing
<i>body blow</i>	body is an agent or instrument of blow
<i>body blow</i>	blow was contained in body
<i>body fluids</i>	fluids was contained in body
<i>body shop</i>	shop was contained in body
<i>body shop</i>	body is an agent or instrument of shop
<i>spring cleaning</i>	cleaning is the temporal source of spring
<i>spring cleaning</i>	cleaning is the spatial source of spring
<i>spring cleaning</i>	spring is an agent or instrument of cleaning
<i>cleaning woman</i>	woman is an agent or instrument of cleaning
<i>cleaning fluid</i>	fluid is an agent or instrument of cleaning
<i>blood poisoning</i>	blood is an agent or instrument of poisoning
<i>telephone call</i>	telephone is an agent or instrument of call
<i>call girl</i>	girl is an agent or instrument of call
<i>calling card</i>	card is an agent or instrument of calling
<i>candle light</i>	candle is an agent or instrument of light
<i>gas light</i>	light is the spatial source of gas

<i>gas light</i>	light is an agent or instrument of gas
<i>gas light</i>	gas is an agent or instrument of light
<i>blinker light</i>	blinker is an agent or instrument of light
<i>boat ride</i>	ride is the spatial source of boat
<i>boat ride</i>	boat is an agent or instrument of ride
<i>boat ride</i>	ride was contained in boat
<i>fighter plane</i>	plane is the spatial source of fighter
<i>fighter plane</i>	fighter is an agent or instrument of plane
<i>bush fighter</i>	fighter is the spatial source of bush
<i>bush fighter</i>	fighter is an agent or instrument of bush
<i>bull fighting</i>	bull is an agent or instrument of fighting
<i>telephone receiver</i>	receiver is a part of telephone
<i>place name</i>	name is the spatial source of place
<i>place name</i>	place is an agent or instrument of name
<i>place setting</i>	setting is the spatial source of place
<i>place setting</i>	place is an agent or instrument of setting
<i>working man</i>	man is an agent or instrument of working
<i>cave man</i>	man is the spatial source of cave
<i>cave man</i>	cave is an agent or instrument of man
<i>sleeping powder</i>	powder is an agent or instrument of sleeping
<i>sitting duck</i>	duck is an agent or instrument of sitting
<i>duck bill</i>	bill is a part of duck
<i>duck bill</i>	duck is an agent or instrument of bill
<i>chicken fat</i>	fat is a part of chicken
<i>office management</i>	management is the spatial source of office
<i>office management</i>	office is an agent or instrument of management
<i>office manager</i>	manager is the spatial source of office
<i>records office</i>	office is the topic of records

<i>records office</i>	office is the spatial source of records
<i>records office</i>	office is an agent or instrument of records
<i>walking shoes</i>	shoes is an agent or instrument of walking
<i>whipping boy</i>	boy is an agent or instrument of whipping
<i>farm boy</i>	boy is the spatial source of farm
<i>farm boy</i>	boy is an agent or instrument of farm
<i>road block</i>	block is the spatial source of road
<i>road block</i>	road is an agent or instrument of block
<i>nerve block</i>	nerve is an agent or instrument of block
<i>cell block</i>	block is the spatial source of cell
<i>cell block</i>	cell is an agent or instrument of block
<i>seat belt</i>	belt is the spatial source of seat
<i>seat belt</i>	belt is an agent or instrument of seat
<i>corn belt</i>	corn is an agent or instrument of belt
<i>May flower</i>	flower is the temporal source of May
<i>wall flower</i>	flower is the spatial source of wall
<i>watch tower</i>	watch is an agent or instrument of tower
<i>tear gas</i>	gas is an agent or instrument of tear
<i>gas chamber</i>	chamber is the spatial source of gas
<i>gas chamber</i>	chamber is an agent or instrument of gas
<i>retaining wall</i>	wall is an agent or instrument of retaining
<i>reading glasses</i>	glasses is an agent or instrument of reading
<i>target date</i>	date is the spatial source of target
<i>date line</i>	line is the temporal source of date
<i>date line</i>	line is an agent or instrument of date
<i>play goer</i>	goer is the topic of play
<i>play goer</i>	goer is an agent or instrument of play
<i>sword play</i>	sword is an agent or instrument of play

<i>playing cards</i>	cards is an agent or instrument of playing
<i>steam roller</i>	roller is an agent or instrument of steam
<i>apple core</i>	apple is an agent or instrument of core
<i>apple core</i>	core is a part of apple
<i>afternoon tea</i>	tea is the temporal source of afternoon
<i>teaching profession</i>	profession is an agent or instrument of teaching
<i>school teacher</i>	teacher is the spatial source of school
<i>school teacher</i>	teacher is an agent or instrument of school
<i>Sunday school</i>	school is the temporal source of Sunday
<i>teaching fellow</i>	fellow is an agent or instrument of teaching
<i>box camera</i>	camera was contained in box
<i>box camera</i>	camera is an agent or instrument of box
<i>shadow boxing</i>	boxing is the spatial source of shadow
<i>letter drop</i>	drop is the topic of letter
<i>letter drop</i>	letter is an agent or instrument of drop
<i>nose drop</i>	nose is an agent or instrument of drop
<i>nose drop</i>	drop is the spatial source of nose
<i>bear country</i>	country is an agent or instrument of bear
<i>country club</i>	club is the spatial source of country
<i>country club</i>	country is an agent or instrument of club
<i>country butter</i>	butter is the spatial source of country
<i>winter sports</i>	sports is the temporal source of winter
<i>finger movement</i>	finger is an agent or instrument of movement
<i>letter sequence</i>	sequence is the topic of letter
<i>letter sequence</i>	letter is an agent or instrument of sequence
<i>document preparation</i>	preparation is the topic of document
<i>situation parts</i>	parts is the spatial source of situation
<i>situation parts</i>	parts is the temporal source of situation

<i>situation description</i>	description is the spatial source of situation
<i>situation description</i>	description is the temporal source of situation
<i>situation analysis</i>	analysis is the spatial source of situation
<i>situation analysis</i>	analysis is the temporal source of situation
<i>target structure</i>	structure is an agent or instrument of target
<i>target structure</i>	structure is the spatial source of target
<i>network structure</i>	structure is an agent or instrument of network
<i>ground swell</i>	swell is the spatial source of ground
<i>ground swell</i>	ground is an agent or instrument of swell
<i>ground controllers</i>	controllers is the spatial source of ground
<i>ground controllers</i>	controllers is an agent or instrument of ground
<i>vehicle capacity</i>	capacity is the spatial source of vehicle
<i>launch vehicle</i>	vehicle is an agent or instrument of launch
<i>plane crash</i>	crash is the spatial source of plane
<i>plane crash</i>	plane is an agent or instrument of crash
<i>surveillance plane</i>	plane is an agent or instrument of surveillance
<i>farm bill</i>	bill is the spatial source of farm
<i>home help</i>	help is the spatial source of home
<i>home help</i>	home is an agent or instrument of help
<i>home buyers</i>	buyers is the spatial source of home
<i>home buyers</i>	buyers is an agent or instrument of home
<i>color television</i>	television is an agent or instrument of color
<i>television camera</i>	camera is the topic of television
<i>television camera</i>	camera is an agent or instrument of television
<i>television appearance</i>	appearance is the topic of television
<i>stage name</i>	name is the spatial source of stage
<i>equipment name</i>	equipment is an agent or instrument of name
<i>launcher interface</i>	launcher is an agent or instrument of interface

<i>order blank</i>	blank is the spatial source of order
<i>needle mark</i>	needle is an agent or instrument of mark
<i>velocity component</i>	component is a part of velocity
<i>velocity component</i>	component is the spatial source of velocity
<i>group activation</i>	group is an agent or instrument of activation
<i>group activation</i>	activation is the spatial source of group
<i>record activation</i>	activation is the topic of record

Incorrect NA interpretations

<i>drinking water</i>	water is an agent or instrument of drinking
<i>time study</i>	study is the temporal source of time
<i>time study</i>	study is an agent or instrument of time
<i>time correlation</i>	correlation is the temporal source of time
<i>time message</i>	message is the temporal source of time
<i>spending money</i>	money is an agent or instrument of spending
<i>engine repair</i>	repair is the spatial source of engine
<i>fire engine</i>	engine is an agent or instrument of fire
<i>engine size</i>	size is the spatial source of engine
<i>life boat</i>	boat is an agent or instrument of life
<i>life boat</i>	boat is the temporal source of life
<i>horse doctor</i>	horse is an agent or instrument of doctor
<i>dressing room</i>	room is an agent or instrument of dressing
<i>plate glass</i>	glass was contained in plate
<i>steel production</i>	steel is an agent or instrument of production
<i>battle field</i>	field is an agent or instrument of battle
<i>spelling error</i>	error is an agent or instrument of spelling
<i>pig iron</i>	pig is an agent or instrument of iron

<i>blood test</i>	blood is an agent or instrument of test
<i>fire place</i>	place is an agent or instrument of fire
<i>fire place</i>	fire is an agent or instrument of place
<i>duck shooting</i>	duck is an agent or instrument of shooting
<i>reading material</i>	material is an agent or instrument of reading
<i>eating apple</i>	apple is an agent or instrument of eating
<i>rose cutting</i>	rose is an agent or instrument of cutting

Missing NA interpretations

<i>sleeping sickness</i>	sleeping is NA related to sickness
<i>cold sore</i>	cold is NA related to sore
<i>navigation function</i>	navigation is NA related to function

6. Intransitive Nonsymmetric

Correct IN interpretations

<i>drinking water</i>	water is an action directed towards drinking
<i>water clock</i>	clock is an action directed towards water
<i>water spot</i>	water is an action directed towards spot
<i>water spot</i>	spot is an action directed towards water
<i>cooling water</i>	water is an action directed towards cooling
<i>water mark</i>	water is an action directed towards mark
<i>water mark</i>	mark is an action directed towards water
<i>water drop</i>	drop is an action directed towards water
<i>water drop</i>	water is an action directed towards drop
<i>water flow</i>	flow is an action directed towards water
<i>cooking time</i>	cooking is an action directed towards time

<i>read time</i>	read is an action directed towards time
<i>time study</i>	study is an action directed towards time
<i>recovery time</i>	time is an action directed towards recovery
<i>recovery time</i>	recovery is an action directed towards time
<i>search time</i>	search is an action directed towards time
<i>time correlation</i>	correlation is an action directed towards time
<i>time correlation</i>	time is an action directed towards correlation
<i>satellite time</i>	time is an action directed towards satellite
<i>time mark</i>	mark is an action directed towards time
<i>time mark</i>	time is an action directed towards mark
<i>time sample</i>	sample is an action directed towards time
<i>position time</i>	position is an action directed towards time
<i>position time</i>	time is an action directed towards position
<i>duration time</i>	duration is an action directed towards time
<i>sister ship</i>	ship is an action directed towards sister
<i>space ship</i>	ship is an action directed towards space
<i>ship landing</i>	landing is an action directed towards ship
<i>ship position</i>	position is an action directed towards ship
<i>ship position</i>	ship is an action directed towards position
<i>ship course</i>	course is an action directed towards ship
<i>ship movement</i>	movement is an action directed towards ship
<i>ship displacement</i>	displacement is an action directed towards ship
<i>learning system</i>	system is an action directed towards learning
<i>system commands</i>	commands is an action directed towards system
<i>system crash</i>	crash is an action directed towards system
<i>system initialization</i>	initialization is an action directed towards system
<i>system control</i>	control is an action directed towards system
<i>status monitoring</i>	monitoring is an action directed towards status

<i>status upgrade</i>	upgrade is an action directed towards status
<i>speed limit</i>	limit is an action directed towards speed
<i>speed limit</i>	speed is an action directed towards limit
<i>spending money</i>	money is an action directed towards spending
<i>money order</i>	order is an action directed towards money
<i>money supply</i>	supply is an action directed towards money
<i>money creation</i>	creation is an action directed towards money
<i>engine repair</i>	repair is an action directed towards engine
<i>engine size</i>	size is an action directed towards engine
<i>word sound</i>	word is an action directed towards sound
<i>word sound</i>	sound is an action directed towards word
<i>book binding</i>	binding is an action directed towards book
<i>guide book</i>	book is an action directed towards guide
<i>guide book</i>	guide is an action directed towards book
<i>book value</i>	value is an action directed towards book
<i>book review</i>	book is an action directed towards review
<i>book review</i>	review is an action directed towards book
<i>book trade</i>	trade is an action directed towards book
<i>computer learning</i>	learning is an action directed towards computer
<i>computer programs</i>	programs is an action directed towards computer
<i>computer activation</i>	activation is an action directed towards computer
<i>birth control</i>	birth is an action directed towards control
<i>mission control</i>	mission is an action directed towards control
<i>mission control</i>	control is an action directed towards mission
<i>training control</i>	training is an action directed towards control
<i>training control</i>	control is an action directed towards training
<i>interceptor control</i>	control is an action directed towards interceptor
<i>data entry</i>	entry is an action directed towards data

<i>data type</i>	type is an action directed towards data
<i>data base</i>	base is an action directed towards data
<i>data value</i>	value is an action directed towards data
<i>character position</i>	position is an action directed towards character
<i>character position</i>	character is an action directed towards position
<i>position fix</i>	position is an action directed towards fix
<i>position fix</i>	fix is an action directed towards position
<i>coordinate position</i>	coordinate is an action directed towards position
<i>coordinate position</i>	position is an action directed towards coordinate
<i>breathing space</i>	breathing is an action directed towards space
<i>trunk space</i>	space is an action directed towards trunk
<i>buffer space</i>	space is an action directed towards buffer
<i>buffer space</i>	buffer is an action directed towards space
<i>scratch test</i>	scratch is an action directed towards test
<i>scratch test</i>	test is an action directed towards scratch
<i>test weight</i>	test is an action directed towards weight
<i>test weight</i>	weight is an action directed towards test
<i>test pattern</i>	test is an action directed towards pattern
<i>test pattern</i>	pattern is an action directed towards test
<i>drying oil</i>	oil is an action directed towards drying
<i>will power</i>	power is an action directed towards will
<i>will power</i>	will is an action directed towards power
<i>student power</i>	power is an action directed towards student
<i>power output</i>	output is an action directed towards power
<i>power output</i>	power is an action directed towards output
<i>power loss</i>	loss is an action directed towards power
<i>engine power</i>	power is an action directed towards engine
<i>student friends</i>	friends is an action directed towards student

<i>wrapping paper</i>	paper is an action directed towards wrapping
<i>paper chase</i>	chase is an action directed towards paper
<i>drawing paper</i>	paper is an action directed towards drawing
<i>house cleaning</i>	cleaning is an action directed towards house
<i>life force</i>	force is an action directed towards life
<i>life force</i>	life is an action directed towards force
<i>home life</i>	life is an action directed towards home
<i>riding horse</i>	horse is an action directed towards riding
<i>ice fall</i>	fall is an action directed towards ice
<i>ice bag</i>	bag is an action directed towards ice
<i>ice cream</i>	cream is an action directed towards ice
<i>room service</i>	service is an action directed towards room
<i>party line</i>	party is an action directed towards line
<i>party line</i>	line is an action directed towards party
<i>looking glass</i>	glass is an action directed towards looking
<i>glass eye</i>	eye is an action directed towards glass
<i>grain sale</i>	sale is an action directed towards grain
<i>grain storage</i>	storage is an action directed towards grain
<i>plant production</i>	production is an action directed towards plant
<i>steel production</i>	production is an action directed towards steel
<i>insect flight</i>	flight is an action directed towards insect
<i>flight operation</i>	flight is an action directed towards operation
<i>flight operation</i>	operation is an action directed towards flight
<i>test flight</i>	test is an action directed towards flight
<i>test flight</i>	flight is an action directed towards test
<i>plane flight</i>	plane is an action directed towards flight
<i>plane flight</i>	flight is an action directed towards plane
<i>radio set</i>	set is an action directed towards radio

<i>radio set</i>	radio is an action directed towards set
<i>radio broadcast</i>	broadcast is an action directed towards radio
<i>radio channel</i>	channel is an action directed towards radio
<i>price increase</i>	increase is an action directed towards price
<i>price index</i>	index is an action directed towards price
<i>food price</i>	price is an action directed towards food
<i>record price</i>	price is an action directed towards record
<i>wind storm</i>	storm is an action directed towards wind
<i>wind source</i>	wind is an action directed towards source
<i>wind source</i>	source is an action directed towards wind
<i>information retrieval</i>	retrieval is an action directed towards information
<i>table structure</i>	structure is an action directed towards table
<i>table maintenance</i>	maintenance is an action directed towards table
<i>training supervisor</i>	supervisor is an action directed towards training
<i>training requirements</i>	requirements is an action directed towards training
<i>training console</i>	console is an action directed towards training
<i>message updates</i>	updates is an action directed towards message
<i>language processing</i>	processing is an action directed towards language
<i>processing paragraphs</i>	paragraphs is an action directed towards processing
<i>navigation processing</i>	processing is an action directed towards navigation
<i>processing requirements</i>	requirements is an action directed towards processing
<i>field work</i>	field is an action directed towards work
<i>field work</i>	work is an action directed towards field
<i>drum storage</i>	storage is an action directed towards drum
<i>operator action</i>	action is an action directed towards operator
<i>action button</i>	action is an action directed towards button
<i>user loading</i>	loading is an action directed towards user
<i>doctrine authorization</i>	authorization is an action directed towards doctrine

<i>doctrine entry</i>	entry is an action directed towards doctrine
<i>design choice</i>	choice is an action directed towards design
<i>design document</i>	document is an action directed towards design
<i>talking point</i>	talking is an action directed towards point
<i>boiling point</i>	boiling is an action directed towards point
<i>intercept point</i>	point is an action directed towards intercept
<i>intercept point</i>	intercept is an action directed towards point
<i>investment program</i>	program is an action directed towards investment
<i>investment program</i>	investment is an action directed towards program
<i>spelling program</i>	spelling is an action directed towards program
<i>program initiation</i>	initiation is an action directed towards program
<i>spelling error</i>	error is an action directed towards spelling
<i>transmission error</i>	error is an action directed towards transmission
<i>letter error</i>	error is an action directed towards letter
<i>error estimate</i>	estimate is an action directed towards error
<i>error estimate</i>	error is an action directed towards estimate
<i>satellite rotation</i>	rotation is an action directed towards satellite
<i>fruit market</i>	market is an action directed towards fruit
<i>market rate</i>	market is an action directed towards rate
<i>market rate</i>	rate is an action directed towards market
<i>market close</i>	close is an action directed towards market
<i>market close</i>	market is an action directed towards close
<i>climbing rate</i>	climbing is an action directed towards rate
<i>rate cut</i>	cut is an action directed towards rate
<i>tax rate</i>	tax is an action directed towards rate
<i>tax rate</i>	rate is an action directed towards tax
<i>tax cut</i>	cut is an action directed towards tax
<i>tax plan</i>	plan is an action directed towards tax

<i>tax plan</i>	tax is an action directed towards plan
<i>income tax</i>	tax is an action directed towards income
<i>family man</i>	man is an action directed towards family
<i>family friend</i>	friend is an action directed towards family
<i>police search</i>	search is an action directed towards police
<i>soul searching</i>	searching is an action directed towards soul
<i>donkey work</i>	work is an action directed towards donkey
<i>piece work</i>	work is an action directed towards piece
<i>fuel cost</i>	cost is an action directed towards fuel
<i>fuel line</i>	line is an action directed towards fuel
<i>fuel line</i>	fuel is an action directed towards line
<i>input sentence</i>	sentence is an action directed towards input
<i>input sentence</i>	input is an action directed towards sentence
<i>timer input</i>	input is an action directed towards timer
<i>spelling checker</i>	checker is an action directed towards spelling
<i>weight reduction</i>	reduction is an action directed towards weight
<i>weight reduction</i>	weight is an action directed towards reduction
<i>vehicle weight</i>	weight is an action directed towards vehicle
<i>vehicle weight</i>	vehicle is an action directed towards weight
<i>weight range</i>	range is an action directed towards weight
<i>weight range</i>	weight is an action directed towards range
<i>air gun</i>	air is an action directed towards gun
<i>air gun</i>	gun is an action directed towards air
<i>air stream</i>	air is an action directed towards stream
<i>air stream</i>	stream is an action directed towards air
<i>air conditioning</i>	conditioning is an action directed towards air
<i>dream analysis</i>	analysis is an action directed towards dream
<i>write head</i>	write is an action directed towards head

<i>arrow head</i>	head is an action directed towards arrow
<i>machine tool</i>	tool is an action directed towards machine
<i>machine tool</i>	machine is an action directed towards tool
<i>washing machine</i>	machine is an action directed towards washing
<i>machine translation</i>	translation is an action directed towards machine
<i>seeing eye</i>	eye is an action directed towards seeing
<i>bird cage</i>	cage is an action directed towards bird
<i>bird call</i>	call is an action directed towards bird
<i>iron age</i>	age is an action directed towards iron
<i>ironing board</i>	ironing is an action directed towards board
<i>governing body</i>	body is an action directed towards governing
<i>body blow</i>	blow is an action directed towards body
<i>body shop</i>	shop is an action directed towards body
<i>spring cleaning</i>	cleaning is an action directed towards spring
<i>cleaning woman</i>	woman is an action directed towards cleaning
<i>cleaning fluid</i>	fluid is an action directed towards cleaning
<i>blood poisoning</i>	poisoning is an action directed towards blood
<i>blood test</i>	test is an action directed towards blood
<i>telephone call</i>	call is an action directed towards telephone
<i>candle light</i>	light is an action directed towards candle
<i>gas light</i>	gas is an action directed towards light
<i>gas light</i>	light is an action directed towards gas
<i>blinker light</i>	light is an action directed towards blinker
<i>boat ride</i>	boat is an action directed towards ride
<i>boat ride</i>	ride is an action directed towards boat
<i>bull fighting</i>	fighting is an action directed towards bull
<i>place name</i>	name is an action directed towards place
<i>fire place</i>	place is an action directed towards fire

<i>fire place</i>	fire is an action directed towards place
<i>place setting</i>	setting is an action directed towards place
<i>cave man</i>	man is an action directed towards cave
<i>fire sale</i>	sale is an action directed towards fire
<i>sitting duck</i>	duck is an action directed towards sitting
<i>duck shooting</i>	shooting is an action directed towards duck
<i>chicken wire</i>	wire is an action directed towards chicken
<i>chicken feed</i>	feed is an action directed towards chicken
<i>office management</i>	management is an action directed towards office
<i>shoe polish</i>	polish is an action directed towards shoe
<i>wine bottle</i>	bottle is an action directed towards wine
<i>wine press</i>	press is an action directed towards wine
<i>whipping boy</i>	boy is an action directed towards whipping
<i>road block</i>	block is an action directed towards road
<i>nerve block</i>	block is an action directed towards nerve
<i>cell block</i>	block is an action directed towards cell
<i>cold wave</i>	wave is an action directed towards cold
<i>cold wave</i>	cold is an action directed towards wave
<i>safety belt</i>	belt is an action directed towards safety
<i>seat belt</i>	seat is an action directed towards belt
<i>seat belt</i>	belt is an action directed towards seat
<i>corn belt</i>	belt is an action directed towards corn
<i>flower bed</i>	flower is an action directed towards bed
<i>flower bed</i>	bed is an action directed towards flower
<i>reading material</i>	material is an action directed towards reading
<i>target date</i>	target is an action directed towards date
<i>target date</i>	date is an action directed towards target
<i>date line</i>	date is an action directed towards line

<i>departure date</i>	departure is an action directed towards date
<i>sword play</i>	play is an action directed towards sword
<i>playing cards</i>	cards is an action directed towards playing
<i>steam bath</i>	bath is an action directed towards steam
<i>eating apple</i>	apple is an action directed towards eating
<i>apple core</i>	core is an action directed towards apple
<i>coffee cream</i>	cream is an action directed towards coffee
<i>coffee break</i>	break is an action directed towards coffee
<i>shadow boxing</i>	boxing is an action directed towards shadow
<i>letter drop</i>	drop is an action directed towards letter
<i>letter drop</i>	letter is an action directed towards drop
<i>cough drop</i>	drop is an action directed towards cough
<i>cough drop</i>	cough is an action directed towards drop
<i>nose drop</i>	drop is an action directed towards nose
<i>finger movement</i>	movement is an action directed towards finger
<i>letter sequence</i>	letter is an action directed towards sequence
<i>letter sequence</i>	sequence is an action directed towards letter
<i>document preparation</i>	preparation is an action directed towards document
<i>document preparation</i>	document is an action directed towards preparation
<i>situation parts</i>	parts is an action directed towards situation
<i>situation analysis</i>	analysis is an action directed towards situation
<i>target structure</i>	target is an action directed towards structure
<i>target structure</i>	structure is an action directed towards target
<i>network structure</i>	structure is an action directed towards network
<i>network structure</i>	network is an action directed towards structure
<i>ground swell</i>	swell is an action directed towards ground
<i>ground swell</i>	ground is an action directed towards swell
<i>plane crash</i>	crash is an action directed towards plane

<i>farm bill</i>	bill is an action directed towards farm
<i>food supplies</i>	supplies is an action directed towards food
<i>rose cutting</i>	cutting is an action directed towards rose
<i>stage name</i>	name is an action directed towards stage
<i>equipment name</i>	name is an action directed towards equipment
<i>engagement order</i>	engagement is an action directed towards order
<i>needle mark</i>	needle is an action directed towards mark
<i>needle mark</i>	mark is an action directed towards needle
<i>initialization sequence</i>	initialization is an action directed towards sequence
<i>group activation</i>	activation is an action directed towards group
<i>record activation</i>	activation is an action directed towards record

Incorrect IN interpretations

<i>water tower</i>	tower is an action directed towards water
<i>picture book</i>	picture is an action directed towards book
<i>picture book</i>	book is an action directed towards picture
<i>control tower</i>	tower is an action directed towards control
<i>animal life</i>	life is an action directed towards animal
<i>grain agreement</i>	agreement is an action directed towards grain
<i>information content</i>	content is an action directed towards information
<i>information content</i>	information is an action directed towards content
<i>panic reaction</i>	reaction is an action directed towards panic
<i>chain reaction</i>	reaction is an action directed towards chain
<i>call box</i>	box is an action directed towards call
<i>calling card</i>	card is an action directed towards calling
<i>working man</i>	man is an action directed towards working
<i>working man</i>	working is an action directed towards man

<i>sleeping bag</i>	bag is an action directed towards sleeping
<i>sleeping powder</i>	powder is an action directed towards sleeping
<i>duck bill</i>	bill is an action directed towards duck
<i>wall flower</i>	flower is an action directed towards wall
<i>watch tower</i>	tower is an action directed towards watch
<i>reading glasses</i>	glasses is an action directed towards reading
<i>music box</i>	box is an action directed towards music
<i>country club</i>	club is an action directed towards country

Missing IN interpretations

<i>hire car</i>	hire is IN related to car
<i>processing option</i>	processing is IN related to option
<i>spelling problem</i>	spelling is IN related to problem
<i>curling iron</i>	curling is IN related to iron
<i>cold cure</i>	cold is IN related to cure
<i>home help</i>	home is IN related to help
<i>cut throat</i>	cut is IN related to throat
<i>navigation hazard</i>	navigation is IN related to hazard

7. Intransitive Asymmetric

Correct IA interpretations

<i>water mark</i>	mark is an attribute of water
<i>water drop</i>	drop is an attribute of water
<i>water flow</i>	flow is an attribute of water
<i>water temperature</i>	temperature is an attribute of water
<i>cooking time</i>	time is an attribute of cooking

<i>read time</i>	time is an attribute of read
<i>recovery time</i>	time is an attribute of recovery
<i>search time</i>	time is an attribute of search
<i>time period</i>	period is an attribute of time
<i>satellite time</i>	time is an attribute of satellite
<i>time mark</i>	mark is an attribute of time
<i>time sample</i>	sample is an attribute of time
<i>position time</i>	time is an attribute of position
<i>duration time</i>	time is an attribute of duration
<i>ship course</i>	course is an attribute of ship
<i>ship speed</i>	speed is an attribute of ship
<i>training status</i>	status is an attribute of training
<i>launcher status</i>	status is an attribute of launcher
<i>deployment status</i>	status is an attribute of deployment
<i>default status</i>	status is an attribute of default
<i>air speed</i>	speed is an attribute of air
<i>speed limit</i>	limit is an attribute of speed
<i>engine speed</i>	speed is an attribute of engine
<i>road speed</i>	speed is an attribute of road
<i>intercept speed</i>	speed is an attribute of intercept
<i>speed ratio</i>	ratio is an attribute of speed
<i>money order</i>	order is an attribute of money
<i>money supply</i>	supply is an attribute of money
<i>engine size</i>	size is an attribute of engine
<i>word sound</i>	sound is an attribute of word
<i>book value</i>	value is an attribute of book
<i>data type</i>	type is an attribute of data
<i>data base</i>	base is an attribute of data

<i>data value</i>	value is an attribute of data
<i>data accuracy</i>	accuracy is an attribute of data
<i>test weight</i>	weight is an attribute of test
<i>test pattern</i>	pattern is an attribute of test
<i>will power</i>	power is an attribute of will
<i>student power</i>	power is an attribute of student
<i>power output</i>	output is an attribute of power
<i>power loss</i>	loss is an attribute of power
<i>engine power</i>	power is an attribute of engine
<i>student problems</i>	problems is an attribute of student
<i>life force</i>	force is an attribute of life
<i>animal life</i>	life is an attribute of animal
<i>home life</i>	life is an attribute of home
<i>party line</i>	line is an attribute of party
<i>production facility</i>	facility is an attribute of production
<i>flight operation</i>	operation is an attribute of flight
<i>radio set</i>	set is an attribute of radio
<i>radio channel</i>	channel is an attribute of radio
<i>selling price</i>	price is an attribute of selling
<i>food price</i>	price is an attribute of food
<i>record price</i>	price is an attribute of record
<i>wind direction</i>	direction is an attribute of wind
<i>wind source</i>	source is an attribute of wind
<i>wind speed</i>	speed is an attribute of wind
<i>processing option</i>	option is an attribute of processing
<i>user legality</i>	legality is an attribute of user
<i>design choice</i>	choice is an attribute of design
<i>design goal</i>	goal is an attribute of design

<i>design options</i>	options is an attribute of design
<i>talking point</i>	point is an attribute of talking
<i>boiling point</i>	point is an attribute of boiling
<i>intercept point</i>	point is an attribute of intercept
<i>error estimate</i>	estimate is an attribute of error
<i>market rate</i>	rate is an attribute of market
<i>market close</i>	close is an attribute of market
<i>climbing rate</i>	rate is an attribute of climbing
<i>tax rate</i>	rate is an attribute of tax
<i>income tax</i>	tax is an attribute of income
<i>family problems</i>	problems is an attribute of family
<i>family unit</i>	unit is an attribute of family
<i>fuel cost</i>	cost is an attribute of fuel
<i>fuel line</i>	line is an attribute of fuel
<i>spelling problem</i>	problem is an attribute of spelling
<i>weight reduction</i>	reduction is an attribute of weight
<i>vehicle weight</i>	weight is an attribute of vehicle
<i>weight range</i>	range is an attribute of weight
<i>bird call</i>	call is an attribute of bird
<i>iron age</i>	age is an attribute of iron
<i>blood disease</i>	disease is an attribute of blood
<i>telephone call</i>	call is an attribute of telephone
<i>candle light</i>	light is an attribute of candle
<i>gas light</i>	light is an attribute of gas
<i>blinker light</i>	light is an attribute of blinker
<i>boat ride</i>	ride is an attribute of boat
<i>place name</i>	name is an attribute of place
<i>fire place</i>	place is an attribute of fire

<i>shoe polish</i>	polish is an attribute of shoe
<i>road block</i>	block is an attribute of road
<i>nerve block</i>	block is an attribute of nerve
<i>cell block</i>	block is an attribute of cell
<i>date line</i>	line is an attribute of date
<i>language difficulty</i>	difficulty is an attribute of language
<i>vehicle capacity</i>	capacity is an attribute of vehicle
<i>food supplies</i>	supplies is an attribute of food
<i>television appearance</i>	appearance is an attribute of television
<i>stage name</i>	name is an attribute of stage
<i>equipment name</i>	name is an attribute of equipment
<i>engagement order</i>	order is an attribute of engagement
<i>needle mark</i>	mark is an attribute of needle
<i>navigation function</i>	function is an attribute of navigation

Incorrect IA interpretations

<i>letter drop</i>	drop is an attribute of letter
<i>cough drop</i>	drop is an attribute of cough
<i>nose drop</i>	drop is an attribute of nose

Missing IA interpretations

None

Appendix B. Results for Fixed Sense Test

This appendix reports the results achieved by the interpreter in classifying nominal compounds in the categories of the logical typology when the nominals composing the compounds have fixed senses. The interpreter returns all possible interpretations without regard to likelihood. The interpretations are presented by category, and within the categories the interpretations are sorted by whether they are correct or not. Compounds in each category that are missed by the interpreter are reported also. For the test, the categories of TS and TN compounds are merged and the IS category is not sought.

1. Transitive Symmetric and Transitive Nonsymmetric

Correct TNS interpretations

<i>ice water</i>	water is another label for ice
<i>time period</i>	period is another label for time
<i>duration time</i>	time is another label for duration
<i>sister ship</i>	ship is another label for sister
<i>weapon system</i>	system is another label for weapon
<i>launcher system</i>	system is another label for launcher

<i>rocket engine</i>	engine is another label for rocket
<i>pass word</i>	word is another label for pass
<i>candidate word</i>	word is another label for candidate
<i>compound word</i>	word is another label for compound
<i>coordinate position</i>	position is another label for coordinate
<i>buffer space</i>	space is another label for buffer
<i>scratch test</i>	test is another label for scratch
<i>test weight</i>	weight is another label for test
<i>test pattern</i>	pattern is another label for test
<i>fuel oil</i>	oil is another label for fuel
<i>student prince</i>	prince is another label for student
<i>tissue paper</i>	paper is another label for tissue
<i>flight operation</i>	operation is another label for flight
<i>test flight</i>	flight is another label for test
<i>radio set</i>	set is another label for radio
<i>radio broadcast</i>	broadcast is another label for radio
<i>radio communication</i>	communication is another label for radio
<i>record price</i>	price is another label for record
<i>buffer state</i>	state is another label for buffer
<i>city state</i>	state is another label for city
<i>panic reaction</i>	reaction is another label for panic
<i>individual user</i>	user is another label for individual
<i>talking point</i>	point is another label for talking
<i>letter error</i>	error is another label for letter
<i>family unit</i>	unit is another label for family
<i>input language</i>	language is another label for input
<i>input sentence</i>	sentence is another label for input
<i>machine tool</i>	tool is another label for machine

<i>blinker light</i>	light is another label for blinker
<i>fighter plane</i>	plane is another label for fighter
<i>lover boy</i>	boy is another label for lover
<i>target date</i>	date is another label for target
<i>fruit tree</i>	tree is another label for fruit
<i>sports activities</i>	activities is another label for sports
<i>target structure</i>	structure is another label for target

Incorrect TNS interpretations

<i>sheep dog</i>	dog is another label for sheep
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Missing TNS interpretations

<i>house boat</i>	house is TNS related to boat
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2. Transitive Asymmetric

Correct TA interpretations

<i>water tower</i>	water is spatially located in tower
<i>water pipe</i>	water is contained in pipe
<i>cooking time</i>	cooking is temporally located in time
<i>read time</i>	read is temporally located in time
<i>recovery time</i>	recovery is temporally located in time
<i>search time</i>	search is temporally located in time
<i>time message</i>	time is the topic of message
<i>position time</i>	position is temporally located in time
<i>training ship</i>	training is spatially located in ship

<i>ship position</i>	ship is spatially located in position
<i>ship latitude</i>	ship is spatially located in latitude
<i>system dictionary</i>	system is the topic of dictionary
<i>status algorithms</i>	status is the topic of algorithms
<i>status summaries</i>	status is the topic of summaries
<i>steam engine</i>	steam is spatially located in engine
<i>fire engine</i>	fire is spatially located in engine
<i>guide book</i>	guide is the topic of book
<i>picture book</i>	picture is the topic of book
<i>book review</i>	book is the topic of review
<i>book request</i>	book is the topic of request
<i>computer literature</i>	computer is the topic of literature
<i>computer hours</i>	computer is temporally located in hours
<i>computer suite</i>	computer is a member of the group suite
<i>data entry</i>	data is the topic of entry
<i>data base</i>	data is spatially located in base
<i>coordinate data</i>	coordinate is the topic of data
<i>speed data</i>	speed is the topic of data
<i>character position</i>	character is spatially located in position
<i>position reports</i>	position is the topic of reports
<i>breathing space</i>	breathing is spatially located in space
<i>trunk space</i>	trunk is spatially located in space
<i>oil well</i>	oil is spatially located in well
<i>student committee</i>	student is a member of the group committee
<i>student friends</i>	student is a member of the group friends
<i>packing house</i>	packing is spatially located in house
<i>dog house</i>	dog is spatially located in house
<i>life boat</i>	life is spatially located in boat

<i>ice bag</i>	ice is contained in bag
<i>tea room</i>	tea is spatially located in room
<i>elbow room</i>	elbow is spatially located in room
<i>dressng room</i>	dressng is spatially located in room
<i>party line</i>	party is spatially located in line
<i>tea party</i>	tea is spatially located in party
<i>working day</i>	working is temporally located in day
<i>beer glass</i>	beer is contained in glass
<i>passenger car</i>	passenger is spatially located in car
<i>grain agreement</i>	grain is the topic of agreement
<i>grain storage</i>	grain is spatially located in storage
<i>grain decision</i>	grain is the topic of decision
<i>radio platform</i>	radio is spatially located in platform
<i>price dispute</i>	price is the topic of dispute
<i>price index</i>	price is spatially located in index
<i>classification information</i>	classification is the topic of information
<i>police state</i>	police is spatially located in state
<i>doctrine table</i>	doctrine is the topic of table
<i>training requirements</i>	training is the topic of requirements
<i>doctrine message</i>	doctrine is the topic of message
<i>response message</i>	response is the topic of message
<i>message updates</i>	message is the topic of updates
<i>processing paragraphs</i>	processing is the topic of paragraphs
<i>processing requirements</i>	processing is the topic of requirements
<i>battle field</i>	battle is spatially located in field
<i>information field</i>	information is spatially located in field
<i>working storage</i>	working is spatially located in storage
<i>action alerts</i>	action is the topic of alerts

<i>doctrine entry</i>	doctrine is the topic of entry
<i>design document</i>	design is the topic of document
<i>intercept point</i>	intercept is spatially located in point
<i>spelling error</i>	spelling is the topic of error
<i>tax plan</i>	tax is the topic of plan
<i>worker teams</i>	worker is a member of the group teams
<i>fuel line</i>	fuel is spatially located in line
<i>timer input</i>	timer is the topic of input
<i>air stream</i>	air is spatially located in stream
<i>dream analysis</i>	dream is the topic of analysis
<i>bird cage</i>	bird is contained in cage
<i>iron age</i>	iron is temporally located in age
<i>ironing board</i>	ironing is spatially located in board
<i>body shop</i>	body is spatially located in shop
<i>blood vessel</i>	blood is contained in vessel
<i>call box</i>	call is contained in box
<i>calling card</i>	calling is the topic of card
<i>light year</i>	light is temporally located in year
<i>pleasure boat</i>	pleasure is spatially located in boat
<i>telephone directory</i>	telephone is the topic of directory
<i>fire place</i>	fire is spatially located in place
<i>sleeping bag</i>	sleeping is contained in bag
<i>records office</i>	records is spatially located in office
<i>wine bottle</i>	wine is contained in bottle
<i>cell block</i>	cell is spatially located in block
<i>cold wave</i>	cold is spatially located in wave
<i>corn belt</i>	corn is spatially located in belt
<i>flower bed</i>	flower is contained in bed

<i>gas chamber</i>	gas is spatially located in chamber
<i>date line</i>	date is spatially located in line
<i>departure date</i>	departure is temporally located in date
<i>steam bath</i>	steam is contained in bath
<i>coffee break</i>	coffee is temporally located in break
<i>music box</i>	music is contained in box
<i>letter drop</i>	letter is spatially located in drop
<i>bear country</i>	bear is spatially located in country
<i>sports magazine</i>	sports is the topic of magazine
<i>situation description</i>	situation is the topic of description
<i>situation analysis</i>	situation is the topic of analysis
<i>farm bill</i>	farm is the topic of bill
<i>component distances</i>	component is a part of distances
<i>initialization notification</i>	initialization is the topic of notification

Incorrect TA interpretations

<i>hire car</i>	hire is spatially located in car
<i>steam roller</i>	steam is spatially located in roller
<i>finger lakes</i>	finger is spatially located in lakes

Missing TA interpretations

<i>car barn</i>	car is TA related to barn
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3. Nontransitive Symmetric

Correct NS interpretations

<i>salt water</i>	water is made of salt
<i>rose water</i>	water is made of rose
<i>banana oil</i>	oil is made of banana
<i>rice paper</i>	paper is made of rice
<i>paper money</i>	money is made of paper
<i>sheet ice</i>	ice has the form of sheet
<i>ice cream</i>	cream is made of ice
<i>plate glass</i>	glass has the form of plate
<i>glass eye</i>	eye is made of glass
<i>grain alcohol</i>	alcohol is made of grain
<i>plant material</i>	material is made of plant
<i>head lettuce</i>	lettuce has the form of head
<i>iron curtain</i>	curtain is made of iron
<i>pig iron</i>	iron has the form of pig
<i>chicken fat</i>	fat is made of chicken
<i>apple sauce</i>	sauce is made of apple
<i>fruit cake</i>	cake is made of fruit
<i>box camera</i>	camera has the form of box
<i>butter fingers</i>	fingers is made of butter

Incorrect NS interpretations

<i>plant food</i>	food is made of plant
<i>coffee cream</i>	cream is made of coffee

Missing NS interpretations

<i>root word</i>	root is NS related to word
<i>oil paint</i>	oil is NS related to paint

<i>chain reaction</i>	chain is NS related to reaction
<i>finger lakes</i>	finger is NS related to lakes
<i>color television</i>	color is NS related to television

4. Nontransitive Nonsymmetric

Correct NN interpretations

<i>water skier</i>	skier employs water
<i>oil company</i>	oil is spatially proximate to company
<i>life preserver</i>	preserver employs life
<i>horse shoe</i>	horse is spatially proximate to shoe
<i>horse doctor</i>	horse is spatially proximate to doctor
<i>car owner</i>	owner employs car
<i>engine designer</i>	designer employs engine
<i>mine worker</i>	worker employs mine
<i>leather worker</i>	worker employs leather
<i>fuel waster</i>	waster employs fuel
<i>city planner</i>	planner employs city
<i>eye opener</i>	opener employs eye
<i>eye dropper</i>	dropper employs eye
<i>office manager</i>	manager employs office
<i>shoe maker</i>	maker employs shoe
<i>tear gas</i>	tear is spatially proximate to gas
<i>science teacher</i>	teacher employs science
<i>school teacher</i>	teacher employs school
<i>coffee nerves</i>	coffee is spatially proximate to nerves
<i>nose drop</i>	nose is spatially proximate to drop
<i>finger cymbals</i>	finger is spatially proximate to cymbals

<i>home buyers</i>	buyers employs home
<i>television camera</i>	television is spatially proximate to camera
<i>film cutter</i>	cutter employs film

Incorrect NN interpretations

<i>oil paint</i>	oil is spatially proximate to paint
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Missing NN interpretations

<i>conscience money</i>	conscience is NN related to money
<i>sheep dog</i>	sheep is NN related to dog
<i>car thief</i>	car is NN related to thief
<i>market leader</i>	market is NN related to leader
<i>plant food</i>	plant is NN related to food
<i>steam roller</i>	steam is NN related to roller
<i>coffee cream</i>	coffee is NN related to cream

5. Nontransitive Asymmetric

Correct NA interpretations

<i>water wheel</i>	water is an agent or instrument of wheel
<i>water spot</i>	water is an agent or instrument of spot
<i>ground water</i>	water is the spatial source of ground
<i>cooling water</i>	water is an agent or instrument of cooling
<i>water mark</i>	water is an agent or instrument of mark
<i>water drop</i>	water is an agent or instrument of drop
<i>water flow</i>	water is an agent or instrument of flow

<i>satellite time</i>	time is the spatial source of satellite
<i>space ship</i>	ship is the spatial source of space
<i>ship landing</i>	ship is an agent or instrument of landing
<i>ship movement</i>	ship is an agent or instrument of movement
<i>ship displacement</i>	ship is an agent or instrument of displacement
<i>learning system</i>	system is an agent or instrument of learning
<i>system crash</i>	system is an agent or instrument of crash
<i>protection money</i>	money is an agent or instrument of protection
<i>stage money</i>	money is the spatial source of stage
<i>play money</i>	money is an agent or instrument of play
<i>household word</i>	word is the spatial source of household
<i>dictionary word</i>	word is the topic of dictionary
<i>control tower</i>	tower is an agent or instrument of control
<i>position fix</i>	fix is the spatial source of position
<i>space suit</i>	suit is the spatial source of space
<i>space colony</i>	colony is the spatial source of space
<i>test pilot</i>	pilot is an agent or instrument of test
<i>power plant</i>	plant is an agent or instrument of power
<i>student decision</i>	student is an agent or instrument of decision
<i>drawing paper</i>	paper is the topic of drawing
<i>house dog</i>	dog is the spatial source of house
<i>home life</i>	life is the spatial source of home
<i>sea horse</i>	horse is the spatial source of sea
<i>horse laugh</i>	horse is an agent or instrument of laugh
<i>race horse</i>	horse is an agent or instrument of race
<i>ice fall</i>	ice is an agent or instrument of fall
<i>police dog</i>	dog is an agent or instrument of police
<i>hunting dog</i>	dog is an agent or instrument of hunting

<i>night watch</i>	watch is the temporal source of night
<i>night fighter</i>	fighter is the temporal source of night
<i>night train</i>	train is the temporal source of night
<i>night flight</i>	flight is the temporal source of night
<i>night school</i>	school is the temporal source of night
<i>search party</i>	party is an agent or instrument of search
<i>garden party</i>	party is the spatial source of garden
<i>party members</i>	members is a part of party
<i>day dream</i>	dream is the temporal source of day
<i>day laborer</i>	laborer is the temporal source of day
<i>plant production</i>	plant is an agent or instrument of production
<i>production facility</i>	facility is an agent or instrument of production
<i>production worker</i>	worker is an agent or instrument of production
<i>insect flight</i>	insect is an agent or instrument of flight
<i>flight director</i>	director is an agent or instrument of flight
<i>flight recorders</i>	recorders is an agent or instrument of flight
<i>plane flight</i>	plane is an agent or instrument of flight
<i>wind storm</i>	wind is an agent or instrument of storm
<i>information content</i>	content is a part of information
<i>review state</i>	state is an agent or instrument of review
<i>table talk</i>	talk is the spatial source of table
<i>table wine</i>	wine is the spatial source of table
<i>training supervisor</i>	supervisor is an agent or instrument of training
<i>training console</i>	console is an agent or instrument of training
<i>field work</i>	work is the spatial source of field
<i>field mouse</i>	mouse is the spatial source of field
<i>storage battery</i>	battery is an agent or instrument of storage
<i>drum storage</i>	drum is an agent or instrument of storage

<i>operator action</i>	operator is an agent or instrument of action
<i>action button</i>	button is an agent or instrument of action
<i>user function</i>	user is an agent or instrument of function
<i>investment program</i>	program is an agent or instrument of investment
<i>satellite rotation</i>	satellite is an agent or instrument of rotation
<i>satellite communications</i>	satellite is an agent or instrument of communications
<i>spy satellite</i>	satellite is an agent or instrument of spy
<i>family man</i>	No interpretation
<i>search algorithm</i>	algorithm is an agent or instrument of search
<i>police search</i>	police is an agent or instrument of search
<i>donkey work</i>	donkey is an agent or instrument of work
<i>input device</i>	device is an agent or instrument of input
<i>input interface</i>	interface is an agent or instrument of input
<i>spelling checker</i>	checker is an agent or instrument of spelling
<i>city wall</i>	wall is the spatial source of city
<i>dream world</i>	world is the temporal source of dream
<i>dream castle</i>	castle is the temporal source of dream
<i>write head</i>	head is an agent or instrument of write
<i>arrow head</i>	head is a part of arrow
<i>head noun</i>	noun is the spatial source of head
<i>talking machine</i>	machine is an agent or instrument of talking
<i>washing machine</i>	machine is an agent or instrument of washing
<i>machine translation</i>	machine is an agent or instrument of translation
<i>seeing eye</i>	eye is an agent or instrument of seeing
<i>bird call</i>	bird is an agent or instrument of call
<i>jail bird</i>	bird is the spatial source of jail
<i>song bird</i>	bird is an agent or instrument of song
<i>curling iron</i>	iron is an agent or instrument of curling

<i>governing body</i>	body is an agent or instrument of governing
<i>body fluids</i>	fluids was contained in body
<i>spring cleaning</i>	cleaning is the temporal source of spring
<i>cleaning woman</i>	woman is an agent or instrument of cleaning
<i>telephone call</i>	telephone is an agent or instrument of call
<i>call girl</i>	girl is an agent or instrument of call
<i>candle light</i>	candle is an agent or instrument of light
<i>gas light</i>	gas is an agent or instrument of light
<i>boat ride</i>	boat is an agent or instrument of ride
<i>bush fighter</i>	fighter is the spatial source of bush
<i>telephone receiver</i>	receiver is a part of telephone
<i>working man</i>	man is an agent or instrument of working
<i>cave man</i>	man is the spatial source of cave
<i>sitting duck</i>	duck is an agent or instrument of sitting
<i>duck bill</i>	bill is a part of duck
<i>walking shoes</i>	shoes is an agent or instrument of walking
<i>farm boy</i>	boy is the spatial source of farm
<i>seat belt</i>	belt is the spatial source of seat
<i>May flower</i>	flower is the temporal source of May
<i>wall flower</i>	flower is the spatial source of wall
<i>watch tower</i>	tower is an agent or instrument of watch
<i>retaining wall</i>	wall is an agent or instrument of retaining
<i>reading glasses</i>	glasses is an agent or instrument of reading
<i>play goer</i>	goer is an agent or instrument of play
<i>sword play</i>	sword is an agent or instrument of play
<i>apple core</i>	core is a part of apple
<i>afternoon tea</i>	tea is the temporal source of afternoon
<i>teaching profession</i>	profession is an agent or instrument of teaching

<i>Sunday school</i>	school is the temporal source of Sunday
<i>teaching fellow</i>	fellow is an agent or instrument of teaching
<i>country club</i>	club is the spatial source of country
<i>country butter</i>	butter is the spatial source of country
<i>winter sports</i>	sports is the temporal source of winter
<i>finger movement</i>	finger is an agent or instrument of movement
<i>situation parts</i>	parts is a part of situation
<i>ground swell</i>	ground is an agent or instrument of swell
<i>ground controllers</i>	controllers is the spatial source of ground
<i>launch vehicle</i>	vehicle is an agent or instrument of launch
<i>plane crash</i>	plane is an agent or instrument of crash
<i>surveillance plane</i>	plane is an agent or instrument of surveillance
<i>home help</i>	home is an agent or instrument of help
<i>stage name</i>	name is the spatial source of stage
<i>launcher interface</i>	launcher is an agent or instrument of interface
<i>order blank</i>	blank is the spatial source of order
<i>navigation function</i>	function is an agent or instrument of navigation
<i>velocity component</i>	component is a part of velocity

Incorrect NA interpretations

<i>system commands</i>	system is an agent or instrument of commands
<i>system initialization</i>	system is an agent or instrument of initialization
<i>system control</i>	system is an agent or instrument of control
<i>spending money</i>	money is an agent or instrument of spending
<i>computer programs</i>	computer is an agent or instrument of programs
<i>computer activation</i>	computer is an agent or instrument of activation
<i>interceptor control</i>	interceptor is an agent or instrument of control

<i>house boat</i>	boat is the spatial source of house
<i>riding horse</i>	horse is an agent or instrument of riding
<i>car thief</i>	thief is the spatial source of car
<i>car barn</i>	barn is the spatial source of car
<i>market leader</i>	leader is the spatial source of market
<i>family friend</i>	No interpretation
<i>body blow</i>	body is an agent or instrument of blow
<i>office management</i>	office is an agent or instrument of management
<i>whipping boy</i>	boy is an agent or instrument of whipping
<i>road block</i>	road is an agent or instrument of block
<i>nerve block</i>	nerve is an agent or instrument of block
<i>playing cards</i>	cards is an agent or instrument of playing
<i>eating apple</i>	apple is an agent or instrument of eating

Missing NA interpretations

<i>computer learning</i>	computer is NA related to learning
<i>drying oil</i>	drying is NA related to oil
<i>wrapping paper</i>	wrapping is NA related to paper
<i>looking glass</i>	looking is NA related to glass
<i>user loading</i>	user is NA related to loading
<i>spelling program</i>	spelling is NA related to program
<i>cleaning fluid</i>	cleaning is NA related to fluid
<i>sleeping powder</i>	sleeping is NA related to powder
<i>sleeping sickness</i>	sleeping is NA related to sickness
<i>cold sore</i>	cold is NA related to sore
<i>safety belt</i>	safety is NA related to belt
<i>television appearance</i>	television is NA related to appearance

6. Intransitive Nonsymmetric

Correct IN interpretations

<i>drinking water</i>	drinking is an action directed towards water
<i>water clock</i>	clock is an action directed towards water
<i>time study</i>	study is an action directed towards time
<i>time correlation</i>	correlation is an action directed towards time
<i>time mark</i>	mark is an action directed towards time
<i>time sample</i>	sample is an action directed towards time
<i>status monitoring</i>	monitoring is an action directed towards status
<i>status upgrade</i>	upgrade is an action directed towards status
<i>money order</i>	order is an action directed towards money
<i>money creation</i>	creation is an action directed towards money
<i>engine repair</i>	repair is an action directed towards engine
<i>book binding</i>	binding is an action directed towards book
<i>book trade</i>	trade is an action directed towards book
<i>birth control</i>	birth is an action directed towards control
<i>mission control</i>	mission is an action directed towards control
<i>training control</i>	training is an action directed towards control
<i>power output</i>	output is an action directed towards power
<i>power loss</i>	loss is an action directed towards power
<i>paper chase</i>	chase is an action directed towards paper
<i>house cleaning</i>	cleaning is an action directed towards house
<i>room service</i>	service is an action directed towards room
<i>grain sale</i>	sale is an action directed towards grain
<i>steel production</i>	production is an action directed towards steel
<i>radio channel</i>	channel is an action directed towards radio

<i>price increase</i>	increase is an action directed towards price
<i>information retrieval</i>	retrieval is an action directed towards information
<i>table structure</i>	structure is an action directed towards table
<i>table maintenance</i>	maintenance is an action directed towards table
<i>language processing</i>	processing is an action directed towards language
<i>navigation processing</i>	navigation is an action directed towards processing
<i>doctrine authorization</i>	authorization is an action directed towards doctrine
<i>design choice</i>	choice is an action directed towards design
<i>program initiation</i>	program is an action directed towards initiation
<i>transmission error</i>	error is an action directed towards transmission
<i>error estimate</i>	estimate is an action directed towards error
<i>fruit market</i>	market is an action directed towards fruit
<i>market close</i>	market is an action directed towards close
<i>rate cut</i>	cut is an action directed towards rate
<i>tax cut</i>	cut is an action directed towards tax
<i>income tax</i>	tax is an action directed towards income
<i>soul searching</i>	searching is an action directed towards soul
<i>piece work</i>	work is an action directed towards piece
<i>weight reduction</i>	reduction is an action directed towards weight
<i>air gun</i>	gun is an action directed towards air
<i>air conditioning</i>	conditioning is an action directed towards air
<i>blood poisoning</i>	poisoning is an action directed towards blood
<i>blood test</i>	test is an action directed towards blood
<i>bull fighting</i>	fighting is an action directed towards bull
<i>place setting</i>	setting is an action directed towards place
<i>fire sale</i>	sale is an action directed towards fire
<i>duck shooting</i>	shooting is an action directed towards duck
<i>chicken wire</i>	wire is an action directed towards chicken

<i>chicken feed</i>	feed is an action directed towards chicken
<i>shoe polish</i>	polish is an action directed towards shoe
<i>wine press</i>	press is an action directed towards wine
<i>reading material</i>	reading is an action directed towards material
<i>shadow boxing</i>	boxing is an action directed towards shadow
<i>cough drop</i>	drop is an action directed towards cough
<i>letter sequence</i>	letter is an action directed towards sequence
<i>document preparation</i>	preparation is an action directed towards document
<i>network structure</i>	structure is an action directed towards network
<i>rose cutting</i>	cutting is an action directed towards rose
<i>engagement order</i>	engagement is an action directed towards order
<i>initialization sequence</i>	initialization is an action directed towards sequence
<i>navigation hazard</i>	navigation is an action directed towards hazard
<i>group activation</i>	activation is an action directed towards group
<i>record activation</i>	activation is an action directed towards record

Incorrect IN interpretations

<i>computer learning</i>	learning is an action directed towards computer
<i>drying oil</i>	drying is an action directed towards oil
<i>wrapping paper</i>	wrapping is an action directed towards paper
<i>animal life</i>	life is an action directed towards animal
<i>looking glass</i>	looking is an action directed towards glass
<i>user loading</i>	loading is an action directed towards user
<i>spelling program</i>	spelling is an action directed towards program
<i>cleaning fluid</i>	cleaning is an action directed towards fluid
<i>sleeping powder</i>	sleeping is an action directed towards powder

Missing IN interpretations

<i>system commands</i>	system is IN related to commands
<i>system initialization</i>	system is IN related to initialization
<i>system control</i>	system is IN related to control
<i>spending money</i>	spending is IN related to money
<i>computer programs</i>	computer is IN related to programs
<i>computer activation</i>	computer is IN related to activation
<i>interceptor control</i>	interceptor is IN related to control
<i>riding horse</i>	riding is IN related to horse
<i>hire car</i>	hire is IN related to car
<i>family friend</i>	family is IN related to friend
<i>body blow</i>	body is IN related to blow
<i>office management</i>	office is IN related to management
<i>whipping boy</i>	whipping is IN related to boy
<i>road block</i>	road is IN related to block
<i>nerve block</i>	nerve is IN related to block
<i>cold cure</i>	cold is IN related to cure
<i>playing cards</i>	playing is IN related to cards
<i>eating apple</i>	eating is IN related to apple
<i>cut throat</i>	cut is IN related to throat

7. Intransitive Asymmetric

Correct IA interpretations

<i>water temperature</i>	temperature is an attribute of water
<i>ship course</i>	course is an attribute of ship
<i>ship speed</i>	speed is an attribute of ship

<i>training status</i>	status is an attribute of training
<i>launcher status</i>	status is an attribute of launcher
<i>deployment status</i>	status is an attribute of deployment
<i>default status</i>	status is an attribute of default
<i>air speed</i>	speed is an attribute of air
<i>speed limit</i>	limit is an attribute of speed
<i>engine speed</i>	speed is an attribute of engine
<i>road speed</i>	speed is an attribute of road
<i>intercept speed</i>	speed is an attribute of intercept
<i>speed ratio</i>	ratio is an attribute of speed
<i>money supply</i>	supply is an attribute of money
<i>engine size</i>	size is an attribute of engine
<i>word sound</i>	sound is an attribute of word
<i>book value</i>	value is an attribute of book
<i>data type</i>	type is an attribute of data
<i>data value</i>	value is an attribute of data
<i>data accuracy</i>	accuracy is an attribute of data
<i>will power</i>	power is an attribute of will
<i>student power</i>	power is an attribute of student
<i>engine power</i>	power is an attribute of engine
<i>student problems</i>	problems is an attribute of student
<i>life force</i>	force is an attribute of life
<i>selling price</i>	price is an attribute of selling
<i>food price</i>	price is an attribute of food
<i>wind direction</i>	direction is an attribute of wind
<i>wind source</i>	source is an attribute of wind
<i>wind speed</i>	speed is an attribute of wind
<i>processing option</i>	option is an attribute of processing

<i>user legality</i>	legality is an attribute of user
<i>design goal</i>	goal is an attribute of design
<i>design options</i>	options is an attribute of design
<i>boiling point</i>	point is an attribute of boiling
<i>market rate</i>	rate is an attribute of market
<i>climbing rate</i>	rate is an attribute of climbing
<i>tax rate</i>	rate is an attribute of tax
<i>family problems</i>	problems is an attribute of family
<i>fuel cost</i>	cost is an attribute of fuel
<i>spelling problem</i>	problem is an attribute of spelling
<i>vehicle weight</i>	weight is an attribute of vehicle
<i>weight range</i>	range is an attribute of weight
<i>blood disease</i>	disease is an attribute of blood
<i>place name</i>	name is an attribute of place
<i>language difficulty</i>	difficulty is an attribute of language
<i>vehicle capacity</i>	capacity is an attribute of vehicle
<i>food supplies</i>	supplies is an attribute of food
<i>equipment name</i>	name is an attribute of equipment
<i>needle mark</i>	mark is an attribute of needle

Incorrect IA interpretations

None

Missing IA interpretations

animal life animal is IA related to life

Appendix C. Interpretations for Nominal Compounds

This appendix presents the interpretations suggested for all nominal compounds in the data base. Interpretations proposed for each compound are grouped together and sorted by whether they are correct or not. Additionally, interpretations that should be recognized but are not are supplied for each compound.

The interpretations of (*drinking water*) are:

- GOOD IN water is an action directed towards drinking
- BAD NA water is an agent or instrument of drinking

The interpretations of (*water clock*) are:

- GOOD IN clock is an action directed towards water
- GOOD NN water is spatially proximate to clock

The interpretations of (*salt water*) are:

- GOOD NS water is made of salt
- GOOD NN salt is spatially proximate to water

The interpretations of (*ice water*) are:

- GOOD TNS water is another label for ice
- GOOD NS water is made of ice
- GOOD NN ice is spatially proximate to water

The interpretations of (*water wheel*) are:

- GOOD NA wheel is an agent or instrument of water
- GOOD NA water is an agent or instrument of wheel
- GOOD NN water is spatially proximate to wheel

The interpretations of (*water tower*) are:

- GOOD TA water is spatially located in tower
- GOOD NA tower is an agent or instrument of water
- GOOD NN water is spatially proximate to tower
- BAD IN tower is an action directed towards water

The interpretations of (*water spot*) are:

- GOOD TA water is spatially located in spot
- GOOD NA spot is an agent or instrument of water
- GOOD NA water is an agent or instrument of spot
- GOOD IN water is an action directed towards spot
- GOOD IN spot is an action directed towards water

The interpretations of (*ground water*) are:

- GOOD NA water is the spatial source of ground
- GOOD NA water is an agent or instrument of ground

The interpretations of (*cooling water*) are:

- GOOD NA water is an agent or instrument of cooling
- GOOD IN water is an action directed towards cooling

The interpretations of (*water skier*) are:

- GOOD NA skier is an agent or instrument of water
- GOOD NN skier employs water

The interpretations of (*rose water*) are:

- GOOD NS water is made of rose
- GOOD NN rose is spatially proximate to water

The interpretations of (*water mark*) are:

- GOOD TA water is spatially located in mark
- GOOD NA water is an agent or instrument of mark
- GOOD IN water is an action directed towards mark
- GOOD IN mark is an action directed towards water
- GOOD IA mark is an attribute of water

The interpretations of (*water drop*) are:

- GOOD TA water is spatially located in drop
- GOOD NA water is an agent or instrument of drop
- GOOD IN drop is an action directed towards water
- GOOD IN water is an action directed towards drop
- GOOD IA drop is an attribute of water

The interpretations of (*water pipe*) are:

- GOOD NA pipe is an agent or instrument of water
- GOOD NA water is an agent or instrument of pipe
- GOOD TA water is contained in pipe
- GOOD NN water is spatially proximate to pipe

The interpretations of (*water flow*) are:

- GOOD TA water is spatially located in flow
- GOOD NA water is an agent or instrument of flow
- GOOD IN flow is an action directed towards water
- GOOD IA flow is an attribute of water

The interpretations of (*water temperature*) are:

- GOOD IA temperature is an attribute of water

The interpretations of (*cooking time*) are:

- GOOD TA cooking is temporally located in time
- GOOD IN cooking is an action directed towards time
- GOOD IA time is an attribute of cooking

The interpretations of (*read time*) are:

- GOOD TA read is temporally located in time
- GOOD IN read is an action directed towards time
- GOOD IA time is an attribute of read

The interpretations of (*time study*) are:

- GOOD TA time is the topic of study
- GOOD TA time is spatially located in study
- GOOD IN study is an action directed towards time
- BAD NA study is the temporal source of time

The interpretations of (*recovery time*) are:

- GOOD TA recovery is temporally located in time
- GOOD IN time is an action directed towards recovery
- GOOD IN recovery is an action directed towards time
- GOOD IA time is an attribute of recovery

The interpretations of (*search time*) are:

- GOOD TA search is temporally located in time
- GOOD IN search is an action directed towards time
- GOOD IA time is an attribute of search

The interpretations of (*time correlation*) are:

- GOOD IN correlation is an action directed towards time
- GOOD IN time is an action directed towards correlation
- BAD NA correlation is the temporal source of time

The interpretations of (*time period*) are:

- GOOD TNS period is another label for time
- GOOD TA time is temporally located in period
- GOOD NA period is the temporal source of time
- GOOD IA period is an attribute of time

The interpretations of (*satellite time*) are:

- GOOD TA satellite is temporally located in time
- GOOD NA time is the spatial source of satellite
- GOOD NA satellite is an agent or instrument of time
- GOOD IN time is an action directed towards satellite
- GOOD IA time is an attribute of satellite

The interpretations of (*time mark*) are:

- GOOD TA time is spatially located in mark
- GOOD NA mark is the temporal source of time
- GOOD IN mark is an action directed towards time
- GOOD IN time is an action directed towards mark
- GOOD IA mark is an attribute of time

The interpretations of (*time message*) are:

- GOOD TA time is the topic of message
- BAD NA message is the temporal source of time

The interpretations of (*time sample*) are:

- GOOD TNS sample is another label for time
- GOOD NA sample is the temporal source of time
- GOOD IN sample is an action directed towards time
- GOOD IA sample is an attribute of time

The interpretations of (*position time*) are:

- GOOD TA position is temporally located in time
- GOOD NA time is the spatial source of position
- GOOD IN position is an action directed towards time
- GOOD IN time is an action directed towards position
- GOOD IA time is an attribute of position

The interpretations of (*duration time*) are:

- GOOD TNS time is another label for duration
- GOOD TA duration is temporally located in time
- GOOD NA time is the temporal source of duration
- GOOD IN duration is an action directed towards time
- GOOD IA time is an attribute of duration

The interpretations of (*sister ship*) are:

- GOOD TNS ship is another label for sister
- GOOD TA sister is spatially located in ship
- GOOD NA sister is an agent or instrument of ship
- GOOD IN ship is an action directed towards sister

GOOD NN sister is spatially proximate to ship

The interpretations of (*space ship*) are:

GOOD TA space is spatially located in ship

GOOD NA ship is the spatial source of space

GOOD NA ship is the temporal source of space

GOOD NA ship is an agent or instrument of space

GOOD IN ship is an action directed towards space

The interpretations of (*training ship*) are:

GOOD TA training is spatially located in ship

GOOD NA ship is an agent or instrument of training

BAD TNS ship is another label for training

The interpretations of (*ship landing*) are:

GOOD NA landing is the spatial source of ship

GOOD NA ship is an agent or instrument of landing

GOOD IN landing is an action directed towards ship

The interpretations of (*ship position*) are:

GOOD TA ship is spatially located in position

GOOD NA position is the spatial source of ship

GOOD NA ship is an agent or instrument of position

GOOD IN position is an action directed towards ship

GOOD IN ship is an action directed towards position

The interpretations of (*ship course*) are:

GOOD NA course is the spatial source of ship

GOOD NA ship is an agent or instrument of course

GOOD IN course is an action directed towards ship

GOOD IA course is an attribute of ship

The interpretations of (*ship movement*) are:

GOOD TNS movement is another label for ship

GOOD NA movement is the spatial source of ship

GOOD NA ship is an agent or instrument of movement

GOOD IN movement is an action directed towards ship

The interpretations of (*ship displacement*) are:

GOOD NA displacement is the spatial source of ship

GOOD NA ship is an agent or instrument of displacement

GOOD IN displacement is an action directed towards ship

The interpretations of (*ship latitude*) are:

GOOD TA ship is spatially located in latitude

GOOD NA latitude is the spatial source of ship

The interpretations of (*ship speed*) are:

GOOD NA speed is the spatial source of ship

GOOD NA ship is an agent or instrument of speed

GOOD IA speed is an attribute of ship

The interpretations of (*system dictionary*) are:

GOOD TA system is the topic of dictionary

The interpretations of (*learning system*) are:

GOOD NA system is an agent or instrument of learning

GOOD IN system is an action directed towards learning

The interpretations of (*system commands*) are:

- GOOD TA system is the topic of commands
- GOOD NA system is an agent or instrument of commands
- GOOD IN commands is an action directed towards system

The interpretations of (*weapon system*) are:

- GOOD TNS system is another label for weapon
- GOOD NN weapon is spatially proximate to system

The interpretations of (*launcher system*) are:

- GOOD TNS system is another label for launcher
- GOOD NN launcher is spatially proximate to system

The interpretations of (*system crash*) are:

- GOOD NA system is an agent or instrument of crash
- GOOD IN crash is an action directed towards system

The interpretations of (*system initialization*) are:

- GOOD NA system is an agent or instrument of initialization
- GOOD IN initialization is an action directed towards system

The interpretations of (*system control*) are:

- GOOD NA system is an agent or instrument of control
- GOOD IN control is an action directed towards system
- BAD NN system is spatially proximate to control

The interpretations of (*status monitoring*) are:

- GOOD IN monitoring is an action directed towards status

The interpretations of (*status upgrade*) are:

GOOD IN upgrade is an action directed towards status

The interpretations of (*training status*) are:

GOOD IA status is an attribute of training

The interpretations of (*launcher status*) are:

GOOD IA status is an attribute of launcher

The interpretations of (*status algorithms*) are:

GOOD TA status is the topic of algorithms

The interpretations of (*status summaries*) are:

GOOD TA status is the topic of summaries

The interpretations of (*deployment status*) are:

GOOD IA status is an attribute of deployment

The interpretations of (*default status*) are:

GOOD IA status is an attribute of default

The interpretations of (*air speed*) are:

GOOD NA speed is the spatial source of air

GOOD NA air is an agent or instrument of speed

GOOD IA speed is an attribute of air

The interpretations of (*speed limit*) are:

GOOD IN limit is an action directed towards speed

GOOD IN speed is an action directed towards limit

GOOD IA limit is an attribute of speed

The interpretations of (*engine speed*) are:

- GOOD NA speed is the spatial source of engine
- GOOD NA engine is an agent or instrument of speed
- GOOD IA speed is an attribute of engine

The interpretations of (*road speed*) are:

- GOOD NA speed is the spatial source of road
- GOOD NA road is an agent or instrument of speed
- GOOD IA speed is an attribute of road

The interpretations of (*intercept speed*) are:

- GOOD IA speed is an attribute of intercept

The interpretations of (*speed ratio*) are:

- GOOD IA ratio is an attribute of speed

The interpretations of (*protection money*) are:

- GOOD NA money is an agent or instrument of protection

The interpretations of (*conscience money*) are:

- MISSED NN Interpretation

The interpretations of (*spending money*) are:

- GOOD IN money is an action directed towards spending
- BAD NA money is an agent or instrument of spending

The interpretations of (*money order*) are:

- GOOD TA money is spatially located in order
- GOOD IN order is an action directed towards money
- GOOD IA order is an attribute of money

The interpretations of (*stage money*) are:

- GOOD NA money is the spatial source of stage
- GOOD NA money is an agent or instrument of stage

The interpretations of (*play money*) are:

- GOOD NA money is the topic of play
- GOOD NA money is an agent or instrument of play

The interpretations of (*money supply*) are:

- GOOD IN supply is an action directed towards money
- GOOD IA supply is an attribute of money

The interpretations of (*money creation*) are:

- GOOD IN creation is an action directed towards money

The interpretations of (*engine repair*) are:

- GOOD IN repair is an action directed towards engine
- BAD NA repair is the spatial source of engine

The interpretations of (*steam engine*) are:

- GOOD TA steam is spatially located in engine
- GOOD NN steam is spatially proximate to engine

The interpretations of (*fire engine*) are:

- GOOD TA fire is spatially located in engine
- GOOD NN fire is spatially proximate to engine
- BAD NA engine is an agent or instrument of fire

The interpretations of (*engine size*) are:

- GOOD IN size is an action directed towards engine

GOOD IA size is an attribute of engine
BAD NA size is the spatial source of engine

The interpretations of (*rocket engine*) are:

GOOD TNS engine is another label for rocket
GOOD TA rocket is spatially located in engine
GOOD NA engine is the spatial source of rocket
GOOD NA engine is an agent or instrument of rocket
GOOD NN rocket is spatially proximate to engine

The interpretations of (*pass word*) are:

GOOD TA pass is the topic of word
GOOD NA word is the spatial source of pass
GOOD NA pass is an agent or instrument of word

The interpretations of (*household word*) are:

GOOD NA word is the spatial source of household
GOOD TA household is the topic of word

The interpretations of (*candidate word*) are:

GOOD TNS word is another label for candidate
GOOD TA candidate is the topic of word
GOOD NA candidate is an agent or instrument of word

The interpretations of (*compound word*) are:

GOOD TNS word is another label for compound
GOOD TA compound is the topic of word
GOOD NA word is the spatial source of compound

The interpretations of (*dictionary word*) are:

GOOD TA dictionary is the topic of word
GOOD NA word is the topic of dictionary
GOOD NA dictionary is an agent or instrument of word
BAD TNS word is another label for dictionary

The interpretations of (*word sound*) are:

GOOD TA word is spatially located in sound
GOOD IN word is an action directed towards sound
GOOD IN sound is an action directed towards word
GOOD IA sound is an attribute of word

The interpretations of (*root word*) are:

GOOD TA root is the topic of word
GOOD NA word is the spatial source of root
MISSED NS Interpretation

The interpretations of (*book binding*) are:

GOOD NA binding is the topic of book
GOOD IN binding is an action directed towards book

The interpretations of (*guide book*) are:

GOOD TA guide is the topic of book
GOOD NA guide is an agent or instrument of book
GOOD IN book is an action directed towards guide
GOOD IN guide is an action directed towards book

The interpretations of (*picture book*) are:

GOOD TA picture is the topic of book
BAD IN picture is an action directed towards book

The interpretations of (*book value*) are:

- GOOD NA value is the topic of book
- GOOD NA value is an agent or instrument of book
- GOOD NA book is an agent or instrument of value
- GOOD IN value is an action directed towards book
- GOOD IA value is an attribute of book

The interpretations of (*book review*) are:

- GOOD TNS review is another label for book
- GOOD TA book is the topic of review
- GOOD NA review is the topic of book
- GOOD NA book is an agent or instrument of review
- GOOD IN book is an action directed towards review
- GOOD IN review is an action directed towards book

The interpretations of (*book trade*) are:

- GOOD NA trade is the topic of book
- GOOD NA trade is an agent or instrument of book
- GOOD IN trade is an action directed towards book

The interpretations of (*book request*) are:

- GOOD TNS request is another label for book
- GOOD TA book is the topic of request
- GOOD NA request is the topic of book
- GOOD NA book is an agent or instrument of request

The interpretations of (*computer literature*) are:

- GOOD TA computer is the topic of literature

The interpretations of (*computer learning*) are:

- GOOD NA computer is an agent or instrument of learning
- GOOD IN learning is an action directed towards computer

The interpretations of (*computer hours*) are:

- GOOD TA computer is temporally located in hours

The interpretations of (*computer programs*) are:

- GOOD NA computer is an agent or instrument of programs
- GOOD IN programs is an action directed towards computer

The interpretations of (*computer activation*) are:

- GOOD NA computer is an agent or instrument of activation
- GOOD IN activation is an action directed towards computer

The interpretations of (*computer suite*) are:

- GOOD TA computer is a member of the group suite

The interpretations of (*birth control*) are:

- GOOD IN birth is an action directed towards control

The interpretations of (*control tower*) are:

- GOOD TA control is spatially located in tower
- GOOD NA tower is an agent or instrument of control
- BAD NN control is spatially proximate to tower
- BAD IN tower is an action directed towards control

The interpretations of (*mission control*) are:

- GOOD IN mission is an action directed towards control
- GOOD IN control is an action directed towards mission

The interpretations of (*training control*) are:

- GOOD NA control is an agent or instrument of training
- GOOD IN training is an action directed towards control
- GOOD IN control is an action directed towards training

The interpretations of (*interceptor control*) are:

- GOOD NA interceptor is an agent or instrument of control
- GOOD IN control is an action directed towards interceptor

The interpretations of (*data entry*) are:

- GOOD TNS entry is another label for data
- GOOD TA data is the topic of entry
- GOOD NA entry is the topic of data
- GOOD NA data is an agent or instrument of entry
- GOOD IN entry is an action directed towards data

The interpretations of (*data type*) are:

- GOOD NA type is the topic of data
- GOOD NA data is an agent or instrument of type
- GOOD IN type is an action directed towards data
- GOOD IA type is an attribute of data

The interpretations of (*data base*) are:

- GOOD NA base is the topic of data
- GOOD TA data is spatially located in base
- GOOD IN base is an action directed towards data
- GOOD IA base is an attribute of data

The interpretations of (*data value*) are:

- GOOD NA value is the topic of data
- GOOD NA data is an agent or instrument of value
- GOOD IN value is an action directed towards data
- GOOD IA value is an attribute of data

The interpretations of (*coordinate data*) are:

- GOOD TA coordinate is the topic of data
- GOOD NA data is the spatial source of coordinate

The interpretations of (*data accuracy*) are:

- GOOD NA accuracy is the topic of data
- GOOD IA accuracy is an attribute of data

The interpretations of (*speed data*) are:

- GOOD TA speed is the topic of data

The interpretations of (*character position*) are:

- GOOD TA character is spatially located in position
- GOOD NA character is an agent or instrument of position
- GOOD NA position is the topic of character
- GOOD IN position is an action directed towards character
- GOOD IN character is an action directed towards position

The interpretations of (*position reports*) are:

- GOOD TA position is the topic of reports
- GOOD NA reports is the spatial source of position

The interpretations of (*position fix*) are:

- GOOD TNS fix is another label for position
- GOOD TA position is spatially located in fix

- GOOD NA fix is the spatial source of position
- GOOD IN position is an action directed towards fix
- GOOD IN fix is an action directed towards position

The interpretations of (*coordinate position*) are:

- GOOD TNS position is another label for coordinate
- GOOD TA coordinate is spatially located in position
- GOOD NA position is the spatial source of coordinate
- GOOD IN coordinate is an action directed towards position
- GOOD IN position is an action directed towards coordinate

The interpretations of (*breathing space*) are:

- GOOD TA breathing is spatially located in space
- GOOD TA breathing is temporally located in space
- GOOD IN breathing is an action directed towards space

The interpretations of (*space suit*) are:

- GOOD NA suit is the spatial source of space
- GOOD NA suit is the temporal source of space

The interpretations of (*trunk space*) are:

- GOOD TA trunk is spatially located in space
- GOOD TA trunk is temporally located in space
- GOOD NA space was contained in trunk
- GOOD NA trunk is an agent or instrument of space
- GOOD IN space is an action directed towards trunk

The interpretations of (*space colony*) are:

- GOOD TA space is spatially located in colony

- GOOD NA colony is the spatial source of space
- GOOD NA colony is an agent or instrument of space
- GOOD NA colony is the temporal source of space

The interpretations of (*buffer space*) are:

- GOOD TNS space is another label for buffer
- GOOD TA buffer is spatially located in space
- GOOD TA buffer is temporally located in space
- GOOD NA space is an agent or instrument of buffer
- GOOD IN space is an action directed towards buffer
- GOOD IN buffer is an action directed towards space

The interpretations of (*test pilot*) are:

- GOOD TNS pilot is another label for test
- GOOD NA pilot is an agent or instrument of test

The interpretations of (*scratch test*) are:

- GOOD TNS test is another label for scratch
- GOOD IN scratch is an action directed towards test
- GOOD IN test is an action directed towards scratch

The interpretations of (*test weight*) are:

- GOOD TNS weight is another label for test
- GOOD IN test is an action directed towards weight
- GOOD IN weight is an action directed towards test
- GOOD IA weight is an attribute of test

The interpretations of (*test pattern*) are:

- GOOD TNS pattern is another label for test

- GOOD TA test is the topic of pattern
- GOOD TA test is spatially located in pattern
- GOOD IN test is an action directed towards pattern
- GOOD IN pattern is an action directed towards test
- GOOD IA pattern is an attribute of test

The interpretations of (*fuel oil*) are:

- GOOD TNS oil is another label for fuel
- GOOD NN fuel is spatially proximate to oil

The interpretations of (*banana oil*) are:

- GOOD NS oil is made of banana
- GOOD NN banana is spatially proximate to oil

The interpretations of (*oil paint*) are:

- GOOD NN oil is spatially proximate to paint
- MISSED NS Interpretation

The interpretations of (*drying oil*) are:

- GOOD NA oil is an agent or instrument of drying
- GOOD IN oil is an action directed towards drying

The interpretations of (*oil well*) are:

- GOOD TA oil is spatially located in well
- GOOD NA well is an agent or instrument of oil
- GOOD NN oil is spatially proximate to well

The interpretations of (*oil company*) are:

- GOOD NA company is an agent or instrument of oil
- GOOD NN oil is spatially proximate to company

The interpretations of (*will power*) are:

- GOOD TNS power is another label for will
- GOOD NA power is an agent or instrument of will
- GOOD IN power is an action directed towards will
- GOOD IN will is an action directed towards power
- GOOD IA power is an attribute of will

The interpretations of (*student power*) are:

- GOOD NA student is an agent or instrument of power
- GOOD IN power is an action directed towards student
- GOOD IA power is an attribute of student

The interpretations of (*power plant*) are:

- GOOD NA plant is an agent or instrument of power

The interpretations of (*power output*) are:

- GOOD TNS output is another label for power
- GOOD TA power is the topic of output
- GOOD IN output is an action directed towards power
- GOOD IN power is an action directed towards output
- GOOD IA output is an attribute of power

The interpretations of (*power loss*) are:

- GOOD IN loss is an action directed towards power
- GOOD IA loss is an attribute of power

The interpretations of (*engine power*) are:

- GOOD NA power is the spatial source of engine
- GOOD NA engine is an agent or instrument of power

GOOD IN power is an action directed towards engine

GOOD IA power is an attribute of engine

The interpretations of (*student prince*) are:

GOOD TNS prince is another label for student

GOOD NN student is spatially proximate to prince

The interpretations of (*student problems*) are:

GOOD NA student is an agent or instrument of problems

GOOD IA problems is an attribute of student

The interpretations of (*student committee*) are:

GOOD TA student is a member of the group committee

The interpretations of (*student friends*) are:

GOOD TNS friends is another label for student

GOOD TA student is a member of the group friends

GOOD NA student is an agent or instrument of friends

GOOD IN friends is an action directed towards student

GOOD NN student is spatially proximate to friends

The interpretations of (*student decision*) are:

GOOD TA student is the topic of decision

GOOD NA student is an agent or instrument of decision

The interpretations of (*wrapping paper*) are:

GOOD TA wrapping is the topic of paper

GOOD NA paper is an agent or instrument of wrapping

GOOD IN paper is an action directed towards wrapping

The interpretations of (*paper chase*) are:

- GOOD NA chase is the topic of paper
- GOOD IN chase is an action directed towards paper

The interpretations of (*drawing paper*) are:

- GOOD TNS paper is another label for drawing
- GOOD TA drawing is the topic of paper
- GOOD NA paper is an agent or instrument of drawing
- GOOD NA paper is the topic of drawing
- GOOD IN paper is an action directed towards drawing
- GOOD NN drawing is spatially proximate to paper

The interpretations of (*tissue paper*) are:

- GOOD TNS paper is another label for tissue
- GOOD NS paper is made of tissue
- GOOD TA tissue is the topic of paper
- GOOD NN tissue is spatially proximate to paper

The interpretations of (*rice paper*) are:

- GOOD NS paper is made of rice
- GOOD TA rice is the topic of paper
- GOOD NN rice is spatially proximate to paper

The interpretations of (*paper money*) are:

- GOOD NS money is made of paper
- GOOD NA money is the topic of paper

The interpretations of (*house cleaning*) are:

- GOOD NA cleaning is the spatial source of house

GOOD IN cleaning is an action directed towards house

The interpretations of (*house boat*) are:

GOOD TA house is contained in boat

GOOD NA boat is the spatial source of house

GOOD NN house is spatially proximate to boat

The interpretations of (*packing house*) are:

GOOD TA packing is spatially located in house

The interpretations of (*dog house*) are:

GOOD TA dog is spatially located in house

GOOD NN dog is spatially proximate to house

The interpretations of (*house dog*) are:

GOOD NA dog is the spatial source of house

GOOD NN house is spatially proximate to dog

The interpretations of (*life force*) are:

GOOD TNS force is another label for life

GOOD NA force is the temporal source of life

GOOD IN force is an action directed towards life

GOOD IN life is an action directed towards force

GOOD IA force is an attribute of life

The interpretations of (*life boat*) are:

GOOD TA life is spatially located in boat

GOOD TA life is contained in boat

BAD NA boat is an agent or instrument of life

The interpretations of (*animal life*) are:

- GOOD TA animal is temporally located in life
- GOOD IA life is an attribute of animal
- BAD IN life is an action directed towards animal

The interpretations of (*life preserver*) are:

- GOOD NA preserver is an agent or instrument of life
- GOOD NA preserver is the temporal source of life
- GOOD NN preserver employs life

The interpretations of (*home life*) are:

- GOOD TA home is temporally located in life
- GOOD NA life is the spatial source of home
- GOOD IN life is an action directed towards home
- GOOD IA life is an attribute of home

The interpretations of (*horse shoe*) are:

- GOOD NN horse is spatially proximate to shoe

The interpretations of (*sea horse*) are:

- GOOD NA horse is the spatial source of sea
- GOOD NA horse is an agent or instrument of sea

The interpretations of (*horse laugh*) are:

- GOOD NA horse is an agent or instrument of laugh

The interpretations of (*race horse*) are:

- GOOD NA horse is an agent or instrument of race

The interpretations of (*horse doctor*) are:

GOOD NN horse is spatially proximate to doctor
BAD NA horse is an agent or instrument of doctor

The interpretations of (*riding horse*) are:

GOOD NA horse is an agent or instrument of riding
GOOD IN horse is an action directed towards riding

The interpretations of (*ice fall*) are:

GOOD TA ice is temporally located in fall
GOOD TA ice is spatially located in fall
GOOD NA ice is an agent or instrument of fall
GOOD IN fall is an action directed towards ice

The interpretations of (*sheet ice*) are:

GOOD NS ice is made of sheet
GOOD NS ice has the form of sheet
GOOD NN sheet is spatially proximate to ice

The interpretations of (*ice bag*) are:

GOOD NS bag is made of ice
GOOD TA ice is contained in bag
GOOD NA ice is an agent or instrument of bag
GOOD IN bag is an action directed towards ice
GOOD NN ice is spatially proximate to bag

The interpretations of (*ice cream*) are:

GOOD NS cream is made of ice
GOOD NA ice is an agent or instrument of cream
GOOD IN cream is an action directed towards ice

GOOD NN ice is spatially proximate to cream

The interpretations of (*tea room*) are:

GOOD TA tea is spatially located in room

BAD NN tea is spatially proximate to room

The interpretations of (*room service*) are:

GOOD NA service is the spatial source of room

GOOD NA room is an agent or instrument of service

GOOD IN service is an action directed towards room

The interpretations of (*elbow room*) are:

GOOD NS room has the form of elbow

GOOD NA room is the spatial source of elbow

GOOD TA elbow is spatially located in room

BAD NN elbow is spatially proximate to room

The interpretations of (*dressing room*) are:

GOOD TA dressing is spatially located in room

BAD NA room is an agent or instrument of dressing

The interpretations of (*police dog*) are:

GOOD NA dog is an agent or instrument of police

GOOD NN police is spatially proximate to dog

The interpretations of (*hunting dog*) are:

GOOD NA dog is an agent or instrument of hunting

The interpretations of (*sheep dog*) are:

GOOD NN sheep is spatially proximate to dog

BAD TNS dog is another label for sheep

The interpretations of (*night watch*) are:

GOOD NA watch is the temporal source of night

The interpretations of (*night fighter*) are:

GOOD NA fighter is the temporal source of night

The interpretations of (*night train*) are:

GOOD NA train is the temporal source of night

The interpretations of (*night flight*) are:

GOOD NA flight is the temporal source of night

The interpretations of (*night school*) are:

GOOD NA school is the temporal source of night

The interpretations of (*search party*) are:

GOOD TA search is spatially located in party

GOOD NA party is an agent or instrument of search

The interpretations of (*party line*) are:

GOOD TNS line is another label for party

GOOD TA party is spatially located in line

GOOD TA party is a member of the group line

GOOD NA party is an agent or instrument of line

GOOD NA line is the spatial source of party

GOOD NA line is an agent or instrument of party

GOOD IN party is an action directed towards line

GOOD IN line is an action directed towards party

GOOD IA line is an attribute of party

The interpretations of (*garden party*) are:

GOOD TA garden is spatially located in party

GOOD NA party is the spatial source of garden

GOOD NA party is an agent or instrument of garden

The interpretations of (*tea party*) are:

GOOD TA tea is spatially located in party

The interpretations of (*party members*) are:

GOOD NA members is an agent or instrument of party

GOOD NA members is the spatial source of party

GOOD NA members is a part of party

The interpretations of (*working day*) are:

GOOD TA working is temporally located in day

The interpretations of (*day dream*) are:

GOOD NA dream is the temporal source of day

BAD TNS dream is another label for day

The interpretations of (*day laborer*) are:

GOOD NA laborer is the temporal source of day

The interpretations of (*looking glass*) are:

GOOD NA glass is an agent or instrument of looking

GOOD IN glass is an action directed towards looking

BAD TA looking is contained in glass

The interpretations of (*plate glass*) are:

- GOOD TNS glass is another label for plate
- GOOD NS glass has the form of plate
- GOOD NN plate is spatially proximate to glass
- BAD TA plate is contained in glass
- BAD NA glass was contained in plate

The interpretations of (*beer glass*) are:

- GOOD TA beer is contained in glass
- GOOD NN beer is spatially proximate to glass

The interpretations of (*glass eye*) are:

- GOOD NA eye was contained in glass
- GOOD NS eye is made of glass
- GOOD IN eye is an action directed towards glass
- GOOD NN glass is spatially proximate to eye

The interpretations of (*hire car*) are:

- GOOD TA hire is spatially located in car
- GOOD TA hire is contained in car
- MISSED IN Interpretation

The interpretations of (*car thief*) are:

- GOOD NA thief is the spatial source of car
- GOOD NA thief was contained in car
- GOOD NN car is spatially proximate to thief

The interpretations of (*car owner*) are:

- GOOD NA owner is the spatial source of car

- GOOD NA owner was contained in car
- GOOD NN owner employs car

The interpretations of (*car barn*) are:

- GOOD TA car is spatially located in barn
- GOOD NA barn is the spatial source of car
- GOOD NA barn was contained in car
- GOOD NN car is spatially proximate to barn

The interpretations of (*passenger car*) are:

- GOOD TA passenger is spatially located in car
- GOOD TA passenger is contained in car
- GOOD NN passenger is spatially proximate to car

The interpretations of (*grain sale*) are:

- GOOD IN sale is an action directed towards grain

The interpretations of (*grain agreement*) are:

- GOOD TA grain is the topic of agreement
- BAD IN agreement is an action directed towards grain

The interpretations of (*grain alcohol*) are:

- GOOD NS alcohol is made of grain
- GOOD NN grain is spatially proximate to alcohol
- BAD TNS alcohol is another label for grain

The interpretations of (*grain storage*) are:

- GOOD TA grain is spatially located in storage
- GOOD IN storage is an action directed towards grain

The interpretations of (*grain decision*) are:

GOOD TA grain is the topic of decision

The interpretations of (*plant production*) are:

GOOD NA plant is an agent or instrument of production

GOOD IN production is an action directed towards plant

The interpretations of (*steel production*) are:

GOOD IN production is an action directed towards steel

BAD NA steel is an agent or instrument of production

The interpretations of (*production facility*) are:

GOOD TA production is spatially located in facility

GOOD NA facility is an agent or instrument of production

GOOD IA facility is an attribute of production

The interpretations of (*production worker*) are:

GOOD NA worker is an agent or instrument of production

The interpretations of (*insect flight*) are:

GOOD NA insect is an agent or instrument of flight

GOOD IN flight is an action directed towards insect

The interpretations of (*flight director*) are:

GOOD NA director is an agent or instrument of flight

GOOD NN director employs flight

The interpretations of (*flight recorders*) are:

GOOD NA recorders is an agent or instrument of flight

GOOD NN recorders employs flight

The interpretations of (*flight operation*) are:

- GOOD TNS operation is another label for flight
- GOOD NA flight is an agent or instrument of operation
- GOOD IN flight is an action directed towards operation
- GOOD IN operation is an action directed towards flight
- GOOD IA operation is an attribute of flight

The interpretations of (*test flight*) are:

- GOOD TNS flight is another label for test
- GOOD NA flight is an agent or instrument of test
- GOOD IN test is an action directed towards flight
- GOOD IN flight is an action directed towards test

The interpretations of (*plane flight*) are:

- GOOD NA flight is the spatial source of plane
- GOOD NA plane is an agent or instrument of flight
- GOOD NA flight is an agent or instrument of plane
- GOOD IN plane is an action directed towards flight
- GOOD IN flight is an action directed towards plane

The interpretations of (*radio set*) are:

- GOOD TNS set is another label for radio
- GOOD NA radio is an agent or instrument of set
- GOOD NA set is an agent or instrument of radio
- GOOD IN set is an action directed towards radio
- GOOD IN radio is an action directed towards set
- GOOD IA set is an attribute of radio
- GOOD NN radio is spatially proximate to set

The interpretations of (*radio broadcast*) are:

- GOOD TNS broadcast is another label for radio
- GOOD TA radio is the topic of broadcast
- GOOD NA radio is an agent or instrument of broadcast
- GOOD IN broadcast is an action directed towards radio

The interpretations of (*radio communication*) are:

- GOOD TNS communication is another label for radio
- GOOD TA radio is the topic of communication
- GOOD NA radio is an agent or instrument of communication

The interpretations of (*radio channel*) are:

- GOOD TA radio is spatially located in channel
- GOOD NA radio is an agent or instrument of channel
- GOOD IN channel is an action directed towards radio
- GOOD IA channel is an attribute of radio

The interpretations of (*radio platform*) are:

- GOOD TA radio is spatially located in platform
- GOOD NN radio is spatially proximate to platform

The interpretations of (*selling price*) are:

- GOOD IA price is an attribute of selling

The interpretations of (*price dispute*) are:

- GOOD TA price is the topic of dispute

The interpretations of (*price increase*) are:

- GOOD IN increase is an action directed towards price

The interpretations of (*price index*) are:

- GOOD TA price is spatially located in index
- GOOD IN index is an action directed towards price

The interpretations of (*food price*) are:

- GOOD IN price is an action directed towards food
- GOOD IA price is an attribute of food

The interpretations of (*record price*) are:

- GOOD TNS price is another label for record
- GOOD NA price is the topic of record
- GOOD IN price is an action directed towards record
- GOOD IA price is an attribute of record

The interpretations of (*wind storm*) are:

- GOOD NA storm is the spatial source of wind
- GOOD NA wind is an agent or instrument of storm
- GOOD IN storm is an action directed towards wind

The interpretations of (*wind direction*) are:

- GOOD NA direction is the spatial source of wind
- GOOD NA wind is an agent or instrument of direction
- GOOD IA direction is an attribute of wind

The interpretations of (*wind source*) are:

- GOOD TNS source is another label for wind
- GOOD NA source is the spatial source of wind
- GOOD NA wind is an agent or instrument of source
- GOOD IN wind is an action directed towards source

GOOD IN source is an action directed towards wind

GOOD IA source is an attribute of wind

The interpretations of (*wind speed*) are:

GOOD TNS speed is another label for wind

GOOD NA speed is the spatial source of wind

GOOD NA wind is an agent or instrument of speed

GOOD IA speed is an attribute of wind

The interpretations of (*information content*) are:

GOOD NA content is a part of information

BAD IN content is an action directed towards information

The interpretations of (*information retrieval*) are:

GOOD IN retrieval is an action directed towards information

The interpretations of (*classification information*) are:

GOOD TA classification is the topic of information

The interpretations of (*buffer state*) are:

GOOD TNS state is another label for buffer

GOOD NA state is an agent or instrument of buffer

GOOD TA buffer is spatially located in state

GOOD TA buffer is the topic of state

The interpretations of (*city state*) are:

GOOD TNS state is another label for city

GOOD TA city is the topic of state

GOOD NA state is the spatial source of city

The interpretations of (*police state*) are:

- GOOD TA police is spatially located in state
- GOOD TA police is the topic of state
- GOOD NA state is an agent or instrument of police
- GOOD NA police is an agent or instrument of state

The interpretations of (*review state*) are:

- GOOD TA review is spatially located in state
- GOOD TA review is the topic of state
- GOOD NA state is an agent or instrument of review
- GOOD NA state is the topic of review
- GOOD NA review is an agent or instrument of state

The interpretations of (*table talk*) are:

- GOOD TA table is the topic of talk
- GOOD NA talk is the spatial source of table

The interpretations of (*table wine*) are:

- GOOD NA wine is the spatial source of table
- GOOD NN table is spatially proximate to wine

The interpretations of (*table structure*) are:

- GOOD TA table is spatially located in structure
- GOOD NA structure is the spatial source of table
- GOOD IN structure is an action directed towards table
- GOOD NN table is spatially proximate to structure

The interpretations of (*doctrine table*) are:

- GOOD TA doctrine is spatially located in table

GOOD NA table is the topic of doctrine

The interpretations of (*table maintenance*) are:

GOOD NA maintenance is the spatial source of table

GOOD IN maintenance is an action directed towards table

The interpretations of (*training supervisor*) are:

GOOD NA supervisor is an agent or instrument of training

GOOD IN supervisor is an action directed towards training

The interpretations of (*training requirements*) are:

GOOD TA training is the topic of requirements

GOOD IN requirements is an action directed towards training

The interpretations of (*training console*) are:

GOOD NA console is an agent or instrument of training

GOOD IN console is an action directed towards training

The interpretations of (*doctrine message*) are:

GOOD TNS message is another label for doctrine

GOOD TA doctrine is the topic of message

GOOD NA message is the topic of doctrine

GOOD NA doctrine is an agent or instrument of message

The interpretations of (*response message*) are:

GOOD TNS message is another label for response

GOOD TA response is the topic of message

GOOD NA message is the topic of response

GOOD NA response is an agent or instrument of message

The interpretations of (*message updates*) are:

- GOOD TNS updates is another label for message
- GOOD TA message is the topic of updates
- GOOD NA updates is the topic of message
- GOOD IN updates is an action directed towards message

The interpretations of (*language processing*) are:

- GOOD IN processing is an action directed towards language

The interpretations of (*processing paragraphs*) are:

- GOOD TA processing is the topic of paragraphs
- GOOD IN paragraphs is an action directed towards processing

The interpretations of (*navigation processing*) are:

- GOOD IN processing is an action directed towards navigation

The interpretations of (*processing requirements*) are:

- GOOD TA processing is the topic of requirements
- GOOD IN requirements is an action directed towards processing

The interpretations of (*processing option*) are:

- GOOD IA option is an attribute of processing
- MISSED IN Interpretation

The interpretations of (*battle field*) are:

- GOOD TA battle is spatially located in field
- BAD NA field is an agent or instrument of battle

The interpretations of (*field work*) are:

- GOOD TA field is the topic of work

- GOOD NA work is the spatial source of field
- GOOD NA field is an agent or instrument of work
- GOOD IN field is an action directed towards work
- GOOD IN work is an action directed towards field

The interpretations of (*field mouse*) are:

- GOOD NA mouse is the spatial source of field

The interpretations of (*information field*) are:

- GOOD TA information is spatially located in field

The interpretations of (*storage battery*) are:

- GOOD NA battery is the spatial source of storage
- GOOD NA battery is an agent or instrument of storage

The interpretations of (*drum storage*) are:

- GOOD TA drum is spatially located in storage
- GOOD NA drum is an agent or instrument of storage
- GOOD IN storage is an action directed towards drum

The interpretations of (*working storage*) are:

- GOOD TA working is spatially located in storage

The interpretations of (*operator action*) are:

- GOOD NA operator is an agent or instrument of action
- GOOD IN action is an action directed towards operator

The interpretations of (*action alerts*) are:

- GOOD TA action is the topic of alerts

The interpretations of (*action button*) are:

- GOOD NA button is an agent or instrument of action
- GOOD IN action is an action directed towards button

The interpretations of (*panic reaction*) are:

- GOOD TNS reaction is another label for panic
- BAD IN reaction is an action directed towards panic

The interpretations of (*chain reaction*) are:

- BAD IN reaction is an action directed towards chain
- MISSED NS Interpretation

The interpretations of (*individual user*) are:

- GOOD TNS user is another label for individual
- GOOD NN user employs individual

The interpretations of (*user legality*) are:

- GOOD IA legality is an attribute of user

The interpretations of (*user loading*) are:

- GOOD NA user is an agent or instrument of loading
- GOOD IN loading is an action directed towards user

The interpretations of (*user function*) are:

- GOOD TA user is a member of the group function
- GOOD NA user is an agent or instrument of function

The interpretations of (*doctrine authorization*) are:

- GOOD NA authorization is the topic of doctrine
- GOOD NA doctrine is an agent or instrument of authorization

GOOD IN authorization is an action directed towards doctrine

The interpretations of (*doctrine entry*) are:

GOOD TNS entry is another label for doctrine

GOOD TA doctrine is the topic of entry

GOOD NA entry is the topic of doctrine

GOOD NA doctrine is an agent or instrument of entry

GOOD IN entry is an action directed towards doctrine

The interpretations of (*design choice*) are:

GOOD NA choice is the topic of design

GOOD NA design is an agent or instrument of choice

GOOD IN choice is an action directed towards design

GOOD IA choice is an attribute of design

The interpretations of (*design document*) are:

GOOD TNS document is another label for design

GOOD TA design is the topic of document

GOOD NA document is the topic of design

GOOD NA design is an agent or instrument of document

GOOD IN document is an action directed towards design

The interpretations of (*design goal*) are:

GOOD NA goal is the topic of design

GOOD NA design is an agent or instrument of goal

GOOD IA goal is an attribute of design

The interpretations of (*design options*) are:

GOOD NA options is the topic of design

GOOD IA options is an attribute of design

The interpretations of (*engine designer*) are:

GOOD NA designer is the spatial source of engine

GOOD NN designer employs engine

The interpretations of (*talking point*) are:

GOOD TNS point is another label for talking

GOOD TA talking is temporally located in point

GOOD TA talking is the topic of point

GOOD TA talking is spatially located in point

GOOD IN talking is an action directed towards point

GOOD IA point is an attribute of talking

The interpretations of (*boiling point*) are:

GOOD TA boiling is temporally located in point

GOOD TA boiling is the topic of point

GOOD TA boiling is spatially located in point

GOOD IN boiling is an action directed towards point

GOOD IA point is an attribute of boiling

The interpretations of (*intercept point*) are:

GOOD TA intercept is temporally located in point

GOOD TA intercept is the topic of point

GOOD TA intercept is spatially located in point

GOOD NA intercept is an agent or instrument of point

GOOD IN point is an action directed towards intercept

GOOD IN intercept is an action directed towards point

GOOD IA point is an attribute of intercept

The interpretations of (*investment program*) are:

- GOOD NA program is an agent or instrument of investment
- GOOD IN program is an action directed towards investment
- GOOD IN investment is an action directed towards program

The interpretations of (*spelling program*) are:

- GOOD NA program is an agent or instrument of spelling
- GOOD IN spelling is an action directed towards program

The interpretations of (*program initiation*) are:

- GOOD TNS initiation is another label for program
- GOOD NA program is an agent or instrument of initiation
- GOOD IN initiation is an action directed towards program

The interpretations of (*spelling error*) are:

- GOOD TA spelling is the topic of error
- GOOD IN error is an action directed towards spelling
- BAD NA error is an agent or instrument of spelling

The interpretations of (*transmission error*) are:

- GOOD TNS error is another label for transmission
- GOOD TA transmission is the topic of error
- GOOD NA error is the topic of transmission
- GOOD NA transmission is an agent or instrument of error
- GOOD IN error is an action directed towards transmission

The interpretations of (*letter error*) are:

- GOOD TNS error is another label for letter
- GOOD TA letter is the topic of error

- GOOD NA error is the topic of letter
- GOOD NA letter is an agent or instrument of error
- GOOD IN error is an action directed towards letter

The interpretations of (*error estimate*) are:

- GOOD NA estimate is the topic of error
- GOOD NA error is an agent or instrument of estimate
- GOOD IN estimate is an action directed towards error
- GOOD IN error is an action directed towards estimate
- GOOD IA estimate is an attribute of error

The interpretations of (*satellite rotation*) are:

- GOOD NA rotation is the spatial source of satellite
- GOOD NA satellite is an agent or instrument of rotation
- GOOD IN rotation is an action directed towards satellite

The interpretations of (*satellite communications*) are:

- GOOD NA communications is the spatial source of satellite
- GOOD NA satellite is an agent or instrument of communications
- GOOD TA satellite is the topic of communications

The interpretations of (*spy satellite*) are:

- GOOD NA satellite is an agent or instrument of spy
- GOOD TA spy is spatially located in satellite
- GOOD NN spy is spatially proximate to satellite

The interpretations of (*fruit market*) are:

- GOOD NS market is made of fruit
- GOOD TA fruit is spatially located in market

- GOOD IN market is an action directed towards fruit
- GOOD NN fruit is spatially proximate to market

The interpretations of (*market rate*) are:

- GOOD NA rate is the spatial source of market
- GOOD NA market is an agent or instrument of rate
- GOOD IN market is an action directed towards rate
- GOOD IN rate is an action directed towards market
- GOOD IA rate is an attribute of market

The interpretations of (*market leader*) are:

- GOOD NA leader is the spatial source of market
- GOOD NA leader is an agent or instrument of market
- GOOD NN market is spatially proximate to leader

The interpretations of (*market close*) are:

- GOOD NA close is the spatial source of market
- GOOD NA market is an agent or instrument of close
- GOOD IN close is an action directed towards market
- GOOD IN market is an action directed towards close
- GOOD IA close is an attribute of market

The interpretations of (*climbing rate*) are:

- GOOD IN climbing is an action directed towards rate
- GOOD IA rate is an attribute of climbing

The interpretations of (*rate cut*) are:

- GOOD IN cut is an action directed towards rate

The interpretations of (*tax rate*) are:

- GOOD TNS rate is another label for tax
- GOOD IN tax is an action directed towards rate
- GOOD IN rate is an action directed towards tax
- GOOD IA rate is an attribute of tax

The interpretations of (*tax cut*) are:

- GOOD IN cut is an action directed towards tax

The interpretations of (*tax plan*) are:

- GOOD TA tax is the topic of plan
- GOOD IN plan is an action directed towards tax
- GOOD IN tax is an action directed towards plan

The interpretations of (*income tax*) are:

- GOOD IN tax is an action directed towards income
- GOOD IA tax is an attribute of income
- BAD TNS tax is another label for income

The interpretations of (*family man*) are:

- GOOD NA family is an agent or instrument of man
- GOOD IN man is an action directed towards family

The interpretations of (*family problems*) are:

- GOOD NA family is an agent or instrument of problems
- GOOD IA problems is an attribute of family

The interpretations of (*family unit*) are:

- GOOD TNS unit is another label for family
- GOOD IA unit is an attribute of family

The interpretations of (*family friend*) are:

- GOOD NA family is an agent or instrument of friend
- GOOD IN friend is an action directed towards family

The interpretations of (*search algorithm*) are:

- GOOD TA search is the topic of algorithm
- GOOD NA algorithm is an agent or instrument of search

The interpretations of (*police search*) are:

- GOOD NA police is an agent or instrument of search
- GOOD IN search is an action directed towards police

The interpretations of (*soul searching*) are:

- GOOD NA soul is an agent or instrument of searching
- GOOD IN searching is an action directed towards soul

The interpretations of (*mine worker*) are:

- GOOD NA worker is the spatial source of mine
- GOOD NA worker is an agent or instrument of mine
- GOOD NN worker employs mine

The interpretations of (*leather worker*) are:

- GOOD NS worker is made of leather
- GOOD NN worker employs leather

The interpretations of (*worker teams*) are:

- GOOD TA worker is a member of the group teams
- GOOD NA worker is an agent or instrument of teams

The interpretations of (*donkey work*) are:

- GOOD TA donkey is the topic of work
- GOOD NA donkey is an agent or instrument of work
- GOOD IN work is an action directed towards donkey
- GOOD NN donkey is spatially proximate to work

The interpretations of (*piece work*) are:

- GOOD TNS work is another label for piece
- GOOD TA piece is a part of work
- GOOD TA piece is the topic of work
- GOOD NA piece is an agent or instrument of work
- GOOD IN work is an action directed towards piece
- GOOD NN piece is spatially proximate to work

The interpretations of (*fuel cost*) are:

- GOOD IN cost is an action directed towards fuel
- GOOD IA cost is an attribute of fuel

The interpretations of (*fuel waster*) are:

- GOOD NA waster is an agent or instrument of fuel
- GOOD NN waster employs fuel

The interpretations of (*fuel line*) are:

- GOOD TA fuel is spatially located in line
- GOOD NA line is an agent or instrument of fuel
- GOOD IN line is an action directed towards fuel
- GOOD IN fuel is an action directed towards line
- GOOD IA line is an attribute of fuel
- GOOD NN fuel is spatially proximate to line

The interpretations of (*input device*) are:

- GOOD TNS device is another label for input
- GOOD NA device is the topic of input
- GOOD NA device is an agent or instrument of input

The interpretations of (*input language*) are:

- GOOD TNS language is another label for input
- GOOD NA language is the topic of input

The interpretations of (*input interface*) are:

- GOOD TNS interface is another label for input
- GOOD NA interface is the topic of input
- GOOD NA interface is an agent or instrument of input

The interpretations of (*input sentence*) are:

- GOOD TNS sentence is another label for input
- GOOD TA input is the topic of sentence
- GOOD NA sentence is the topic of input
- GOOD IN sentence is an action directed towards input
- GOOD IN input is an action directed towards sentence

The interpretations of (*timer input*) are:

- GOOD TNS input is another label for timer
- GOOD TA timer is the topic of input
- GOOD NA timer is an agent or instrument of input
- GOOD IN input is an action directed towards timer

The interpretations of (*spelling checker*) are:

- GOOD NA checker is an agent or instrument of spelling

GOOD IN checker is an action directed towards spelling

The interpretations of (*spelling problem*) are:

GOOD IA problem is an attribute of spelling

MISSED IN Interpretation

The interpretations of (*plant food*) are:

GOOD NS food is made of plant

GOOD NN plant is spatially proximate to food

The interpretations of (*plant material*) are:

GOOD NS material is made of plant

GOOD NN plant is spatially proximate to material

The interpretations of (*weight reduction*) are:

GOOD IN reduction is an action directed towards weight

GOOD IN weight is an action directed towards reduction

GOOD IA reduction is an attribute of weight

BAD TNS reduction is another label for weight

The interpretations of (*vehicle weight*) are:

GOOD NA weight is the spatial source of vehicle

GOOD IN weight is an action directed towards vehicle

GOOD IN vehicle is an action directed towards weight

GOOD IA weight is an attribute of vehicle

The interpretations of (*weight range*) are:

GOOD TA weight is spatially located in range

GOOD TA weight is temporally located in range

GOOD NA range is an agent or instrument of weight

GOOD IN range is an action directed towards weight
GOOD IN weight is an action directed towards range
GOOD IA range is an attribute of weight
BAD TNS range is another label for weight

The interpretations of (*air gun*) are:

GOOD NA gun is the spatial source of air
GOOD NA gun is an agent or instrument of air
GOOD NA air is an agent or instrument of gun
GOOD IN air is an action directed towards gun
GOOD IN gun is an action directed towards air
BAD NN air is spatially proximate to gun

The interpretations of (*air stream*) are:

GOOD TA air is spatially located in stream
GOOD NA stream is the spatial source of air
GOOD NA stream is an agent or instrument of air
GOOD NA air is an agent or instrument of stream
GOOD IN air is an action directed towards stream
GOOD IN stream is an action directed towards air

The interpretations of (*air conditioning*) are:

GOOD TNS conditioning is another label for air
GOOD NA conditioning is the spatial source of air
GOOD NA air is an agent or instrument of conditioning
GOOD IN conditioning is an action directed towards air

The interpretations of (*city wall*) are:

GOOD NA wall is the spatial source of city

The interpretations of (*city planner*) are:

GOOD NA planner is the spatial source of city

GOOD NN planner employs city

The interpretations of (*dream world*) are:

GOOD NA world is the temporal source of dream

GOOD TA dream is spatially located in world

The interpretations of (*dream castle*) are:

GOOD NA castle is the temporal source of dream

GOOD TA dream is spatially located in castle

The interpretations of (*dream analysis*) are:

GOOD TA dream is the topic of analysis

GOOD NA analysis is the temporal source of dream

GOOD IN analysis is an action directed towards dream

The interpretations of (*write head*) are:

GOOD TA write is spatially located in head

GOOD NA head is an agent or instrument of write

GOOD IN write is an action directed towards head

The interpretations of (*arrow head*) are:

GOOD TA arrow is spatially located in head

GOOD NA arrow is an agent or instrument of head

GOOD IN head is an action directed towards arrow

GOOD NN arrow is spatially proximate to head

The interpretations of (*head lettuce*) are:

GOOD NS lettuce has the form of head

- GOOD NA lettuce is the spatial source of head
- GOOD NN head is spatially proximate to lettuce

The interpretations of (*head noun*) are:

- GOOD TA head is the topic of noun
- GOOD NA noun is the spatial source of head

The interpretations of (*talking machine*) are:

- GOOD NA machine is an agent or instrument of talking

The interpretations of (*machine tool*) are:

- GOOD TNS tool is another label for machine
- GOOD NA tool is an agent or instrument of machine
- GOOD NA machine is an agent or instrument of tool
- GOOD IN tool is an action directed towards machine
- GOOD IN machine is an action directed towards tool
- GOOD NN machine is spatially proximate to tool

The interpretations of (*washing machine*) are:

- GOOD NA machine is an agent or instrument of washing
- GOOD IN machine is an action directed towards washing

The interpretations of (*machine translation*) are:

- GOOD TA machine is the topic of translation
- GOOD NA machine is an agent or instrument of translation
- GOOD IN translation is an action directed towards machine

The interpretations of (*seeing eye*) are:

- GOOD TNS eye is another label for seeing
- GOOD NA eye is an agent or instrument of seeing

GOOD IN eye is an action directed towards seeing

The interpretations of (*eye opener*) are:

GOOD NA opener is an agent or instrument of eye

GOOD NN opener employs eye

The interpretations of (*eye dropper*) are:

GOOD NA dropper is an agent or instrument of eye

GOOD NN dropper employs eye

The interpretations of (*bird cage*) are:

GOOD TA bird is contained in cage

GOOD TA bird is spatially located in cage

GOOD NA bird is an agent or instrument of cage

GOOD IN cage is an action directed towards bird

GOOD NN bird is spatially proximate to cage

The interpretations of (*bird call*) are:

GOOD TA bird is the topic of call

GOOD NA bird is an agent or instrument of call

GOOD IN call is an action directed towards bird

GOOD IA call is an attribute of bird

The interpretations of (*jail bird*) are:

GOOD NA bird is the spatial source of jail

GOOD NA bird is an agent or instrument of jail

GOOD NN jail is spatially proximate to bird

The interpretations of (*song bird*) are:

GOOD NA bird is an agent or instrument of song

The interpretations of (*iron curtain*) are:

- GOOD NS curtain is made of iron
- GOOD NN iron is spatially proximate to curtain

The interpretations of (*curling iron*) are:

- GOOD NA iron is an agent or instrument of curling
- MISSED IN Interpretation

The interpretations of (*pig iron*) are:

- GOOD NS iron has the form of pig
- GOOD NN pig is spatially proximate to iron
- BAD NA pig is an agent or instrument of iron

The interpretations of (*iron age*) are:

- GOOD TA iron is temporally located in age
- GOOD NA iron is an agent or instrument of age
- GOOD IN age is an action directed towards iron
- GOOD IA age is an attribute of iron

The interpretations of (*ironing board*) are:

- GOOD TA ironing is spatially located in board
- GOOD NA board is an agent or instrument of ironing
- GOOD IN ironing is an action directed towards board

The interpretations of (*governing body*) are:

- GOOD TA governing is contained in body
- GOOD NA body is an agent or instrument of governing
- GOOD IN body is an action directed towards governing

The interpretations of (*body blow*) are:

- GOOD NA body is an agent or instrument of blow
- GOOD NA blow was contained in body
- GOOD IN blow is an action directed towards body

The interpretations of (*body fluids*) are:

- GOOD NA fluids was contained in body
- GOOD NN body is spatially proximate to fluids

The interpretations of (*body shop*) are:

- GOOD TA body is spatially located in shop
- GOOD NA shop was contained in body
- GOOD NA body is an agent or instrument of shop
- GOOD IN shop is an action directed towards body
- GOOD NN body is spatially proximate to shop

The interpretations of (*spring cleaning*) are:

- GOOD NA cleaning is the temporal source of spring
- GOOD NA cleaning is the spatial source of spring
- GOOD NA spring is an agent or instrument of cleaning
- GOOD IN cleaning is an action directed towards spring

The interpretations of (*cleaning woman*) are:

- GOOD NA woman is an agent or instrument of cleaning
- GOOD IN woman is an action directed towards cleaning

The interpretations of (*cleaning fluid*) are:

- GOOD NA fluid is an agent or instrument of cleaning
- GOOD IN fluid is an action directed towards cleaning

The interpretations of (*blood disease*) are:

GOOD IA disease is an attribute of blood

The interpretations of (*blood poisoning*) are:

GOOD NA blood is an agent or instrument of poisoning

GOOD IN poisoning is an action directed towards blood

The interpretations of (*blood vessel*) are:

GOOD TA blood is contained in vessel

GOOD TA blood is spatially located in vessel

GOOD NN blood is spatially proximate to vessel

The interpretations of (*blood test*) are:

GOOD TNS test is another label for blood

GOOD IN test is an action directed towards blood

BAD NA blood is an agent or instrument of test

The interpretations of (*telephone call*) are:

GOOD TA telephone is the topic of call

GOOD NA telephone is an agent or instrument of call

GOOD IN call is an action directed towards telephone

GOOD IA call is an attribute of telephone

The interpretations of (*call box*) are:

GOOD TA call is contained in box

BAD IN box is an action directed towards call

The interpretations of (*call girl*) are:

GOOD NA girl is an agent or instrument of call

The interpretations of (*calling card*) are:

- GOOD TA calling is the topic of card
- GOOD NA card is an agent or instrument of calling
- BAD IN card is an action directed towards calling

The interpretations of (*candle light*) are:

- GOOD TNS light is another label for candle
- GOOD NA candle is an agent or instrument of light
- GOOD IN light is an action directed towards candle
- GOOD IA light is an attribute of candle
- GOOD NN candle is spatially proximate to light

The interpretations of (*gas light*) are:

- GOOD NA light is the spatial source of gas
- GOOD NA light is an agent or instrument of gas
- GOOD NA gas is an agent or instrument of light
- GOOD IN gas is an action directed towards light
- GOOD IN light is an action directed towards gas
- GOOD IA light is an attribute of gas
- GOOD NN gas is spatially proximate to light

The interpretations of (*light year*) are:

- GOOD TA light is temporally located in year

The interpretations of (*blinker light*) are:

- GOOD TNS light is another label for blinker
- GOOD NA blinker is an agent or instrument of light
- GOOD IN light is an action directed towards blinker
- GOOD IA light is an attribute of blinker
- BAD NN blinker is spatially proximate to light

The interpretations of (*pleasure boat*) are:

- GOOD TA pleasure is spatially located in boat
- GOOD TA pleasure is contained in boat

The interpretations of (*boat ride*) are:

- GOOD TNS ride is another label for boat
- GOOD NA ride is the spatial source of boat
- GOOD NA boat is an agent or instrument of ride
- GOOD NA ride was contained in boat
- GOOD IN boat is an action directed towards ride
- GOOD IN ride is an action directed towards boat
- GOOD IA ride is an attribute of boat

The interpretations of (*fighter plane*) are:

- GOOD TNS plane is another label for fighter
- GOOD TA fighter is spatially located in plane
- GOOD TA fighter is a member of the group plane
- GOOD NA plane is the spatial source of fighter
- GOOD NA fighter is an agent or instrument of plane
- GOOD NN fighter is spatially proximate to plane

The interpretations of (*bush fighter*) are:

- GOOD TA bush is spatially located in fighter
- GOOD NA fighter is the spatial source of bush
- GOOD NA fighter is an agent or instrument of bush
- GOOD NS fighter is made of bush
- GOOD NN fighter employs bush
- GOOD NN bush is spatially proximate to fighter

The interpretations of (*bull fighting*) are:

- GOOD NA bull is an agent or instrument of fighting
- GOOD IN fighting is an action directed towards bull

The interpretations of (*telephone receiver*) are:

- GOOD NA receiver is a part of telephone
- GOOD NN receiver employs telephone

The interpretations of (*telephone directory*) are:

- GOOD TA telephone is the topic of directory

The interpretations of (*place name*) are:

- GOOD TA place is the topic of name
- GOOD NA name is the spatial source of place
- GOOD NA place is an agent or instrument of name
- GOOD IN name is an action directed towards place
- GOOD IA name is an attribute of place

The interpretations of (*fire place*) are:

- GOOD TA fire is spatially located in place
- GOOD IN place is an action directed towards fire
- GOOD IN fire is an action directed towards place
- GOOD IA place is an attribute of fire
- BAD NA place is an agent or instrument of fire

The interpretations of (*place setting*) are:

- GOOD TNS setting is another label for place
- GOOD TA place is spatially located in setting
- GOOD NA setting is the spatial source of place

GOOD NA place is an agent or instrument of setting

GOOD IN setting is an action directed towards place

The interpretations of (*working man*) are:

GOOD NA man is an agent or instrument of working

BAD IN man is an action directed towards working

The interpretations of (*cave man*) are:

GOOD NA man is the spatial source of cave

GOOD NA cave is an agent or instrument of man

GOOD IN man is an action directed towards cave

GOOD NN cave is spatially proximate to man

The interpretations of (*fire sale*) are:

GOOD IN sale is an action directed towards fire

The interpretations of (*sleeping bag*) are:

GOOD TA sleeping is contained in bag

BAD IN bag is an action directed towards sleeping

The interpretations of (*sleeping powder*) are:

GOOD NA powder is an agent or instrument of sleeping

BAD IN powder is an action directed towards sleeping

The interpretations of (*sleeping sickness*) are:

MISSED NA Interpretation

The interpretations of (*sitting duck*) are:

GOOD TNS duck is another label for sitting

GOOD NA duck is an agent or instrument of sitting

GOOD IN duck is an action directed towards sitting

The interpretations of (*duck bill*) are:

GOOD TA duck is the topic of bill

GOOD NA bill is a part of duck

GOOD NA duck is an agent or instrument of bill

GOOD NN duck is spatially proximate to bill

BAD IN bill is an action directed towards duck

The interpretations of (*duck shooting*) are:

GOOD IN shooting is an action directed towards duck

BAD NA duck is an agent or instrument of shooting

The interpretations of (*chicken fat*) are:

GOOD NS fat is made of chicken

GOOD NA fat is a part of chicken

GOOD NN chicken is spatially proximate to fat

The interpretations of (*chicken wire*) are:

GOOD IN wire is an action directed towards chicken

GOOD NN chicken is spatially proximate to wire

BAD NS wire is made of chicken

The interpretations of (*chicken feed*) are:

GOOD NS feed is made of chicken

GOOD IN feed is an action directed towards chicken

GOOD NN chicken is spatially proximate to feed

The interpretations of (*office management*) are:

GOOD NA management is the spatial source of office

- GOOD NA office is an agent or instrument of management
- GOOD IN management is an action directed towards office

The interpretations of (*office manager*) are:

- GOOD NA manager is the spatial source of office
- GOOD NN manager employs office

The interpretations of (*records office*) are:

- GOOD TA records is spatially located in office
- GOOD NA office is the topic of records
- GOOD NA office is the spatial source of records
- GOOD NA office is an agent or instrument of records

The interpretations of (*shoe maker*) are:

- GOOD NN maker employs shoe

The interpretations of (*shoe polish*) are:

- GOOD IN polish is an action directed towards shoe
- GOOD IA polish is an attribute of shoe
- GOOD NN shoe is spatially proximate to polish

The interpretations of (*walking shoes*) are:

- GOOD NA shoes is an agent or instrument of walking

The interpretations of (*wine bottle*) are:

- GOOD TA wine is contained in bottle
- GOOD IN bottle is an action directed towards wine
- GOOD NN wine is spatially proximate to bottle

The interpretations of (*wine press*) are:

- GOOD IN press is an action directed towards wine
- GOOD NN wine is spatially proximate to press

The interpretations of (*whipping boy*) are:

- GOOD NA boy is an agent or instrument of whipping
- GOOD IN boy is an action directed towards whipping

The interpretations of (*lover boy*) are:

- GOOD TNS boy is another label for lover

The interpretations of (*farm boy*) are:

- GOOD NA boy is the spatial source of farm
- GOOD NA boy is an agent or instrument of farm

The interpretations of (*road block*) are:

- GOOD TA road is spatially located in block
- GOOD TA road is the topic of block
- GOOD NA block is the spatial source of road
- GOOD NA road is an agent or instrument of block
- GOOD IN block is an action directed towards road
- GOOD IA block is an attribute of road
- GOOD NN road is spatially proximate to block

The interpretations of (*nerve block*) are:

- GOOD TA nerve is spatially located in block
- GOOD TA nerve is the topic of block
- GOOD NA nerve is an agent or instrument of block
- GOOD IN block is an action directed towards nerve
- GOOD IA block is an attribute of nerve

GOOD NN nerve is spatially proximate to block

The interpretations of (*cell block*) are:

GOOD TNS block is another label for cell
GOOD TA cell is a part of block
GOOD TA cell is spatially located in block
GOOD TA cell is the topic of block
GOOD NA block is the spatial source of cell
GOOD NA cell is an agent or instrument of block
GOOD IN block is an action directed towards cell
GOOD IA block is an attribute of cell
GOOD NN cell is spatially proximate to block

The interpretations of (*cold cure*) are:

MISSED IN Interpretation

The interpretations of (*cold sore*) are:

BAD TNS sore is another label for cold
MISSED NA Interpretation

The interpretations of (*cold wave*) are:

GOOD TA cold is spatially located in wave
GOOD IN wave is an action directed towards cold
GOOD IN cold is an action directed towards wave

The interpretations of (*safety belt*) are:

GOOD TA safety is spatially located in belt
GOOD IN belt is an action directed towards safety

The interpretations of (*seat belt*) are:

GOOD TA seat is spatially located in belt
GOOD NA belt is the spatial source of seat
GOOD NA belt is an agent or instrument of seat
GOOD IN seat is an action directed towards belt
GOOD IN belt is an action directed towards seat
GOOD NN seat is spatially proximate to belt

The interpretations of (*corn belt*) are:

GOOD NS belt is made of corn
GOOD TA corn is spatially located in belt
GOOD NA corn is an agent or instrument of belt
GOOD IN belt is an action directed towards corn
GOOD NN corn is spatially proximate to belt

The interpretations of (*flower bed*) are:

GOOD NS bed is made of flower
GOOD TA flower is spatially located in bed
GOOD IN flower is an action directed towards bed
GOOD IN bed is an action directed towards flower
GOOD NN flower is spatially proximate to bed

The interpretations of (*May flower*) are:

GOOD NA flower is the temporal source of May

The interpretations of (*wall flower*) are:

GOOD NA flower is the spatial source of wall
GOOD NN wall is spatially proximate to flower
BAD IN flower is an action directed towards wall

The interpretations of (*watch tower*) are:

- GOOD TA watch is spatially located in tower
- GOOD NA watch is an agent or instrument of tower
- GOOD NN watch is spatially proximate to tower
- BAD IN tower is an action directed towards watch

The interpretations of (*tear gas*) are:

- GOOD TA tear is spatially located in gas
- GOOD NA gas is an agent or instrument of tear
- GOOD NN tear is spatially proximate to gas

The interpretations of (*gas chamber*) are:

- GOOD TA gas is spatially located in chamber
- GOOD NA chamber is the spatial source of gas
- GOOD NA chamber is an agent or instrument of gas
- GOOD NN gas is spatially proximate to chamber

The interpretations of (*retaining wall*) are:

- GOOD TA retaining is spatially located in wall
- GOOD NA wall is an agent or instrument of retaining

The interpretations of (*reading material*) are:

- GOOD IN material is an action directed towards reading
- BAD NA material is an agent or instrument of reading

The interpretations of (*reading glasses*) are:

- GOOD NA glasses is an agent or instrument of reading
- BAD TA reading is contained in glasses
- BAD IN glasses is an action directed towards reading

The interpretations of (*target date*) are:

- GOOD TNS date is another label for target
- GOOD TA target is temporally located in date
- GOOD NA date is the spatial source of target
- GOOD IN target is an action directed towards date
- GOOD IN date is an action directed towards target

The interpretations of (*date line*) are:

- GOOD TA date is spatially located in line
- GOOD NA line is the temporal source of date
- GOOD NA line is an agent or instrument of date
- GOOD IN date is an action directed towards line
- GOOD IA line is an attribute of date

The interpretations of (*departure date*) are:

- GOOD TA departure is temporally located in date
- GOOD IN departure is an action directed towards date

The interpretations of (*play goer*) are:

- GOOD NA goer is the topic of play
- GOOD NA goer is an agent or instrument of play
- GOOD NN goer employs play

The interpretations of (*sword play*) are:

- GOOD TA sword is the topic of play
- GOOD NA sword is an agent or instrument of play
- GOOD IN play is an action directed towards sword

The interpretations of (*playing cards*) are:

- GOOD TA playing is the topic of cards
- GOOD NA cards is an agent or instrument of playing
- GOOD IN cards is an action directed towards playing

The interpretations of (*steam roller*) are:

- GOOD TA steam is spatially located in roller
- GOOD NA roller is an agent or instrument of steam
- GOOD NN roller employs steam
- GOOD NN steam is spatially proximate to roller

The interpretations of (*steam bath*) are:

- GOOD TA steam is contained in bath
- GOOD IN bath is an action directed towards steam
- GOOD NN steam is spatially proximate to bath

The interpretations of (*eating apple*) are:

- GOOD IN apple is an action directed towards eating
- BAD NA apple is an agent or instrument of eating

The interpretations of (*apple core*) are:

- GOOD TA apple is spatially located in core
- GOOD NA apple is an agent or instrument of core
- GOOD NA core is a part of apple
- GOOD IN core is an action directed towards apple

The interpretations of (*apple sauce*) are:

- GOOD NS sauce is made of apple
- GOOD NN apple is spatially proximate to sauce

The interpretations of (*afternoon tea*) are:

GOOD NA tea is the temporal source of afternoon

The interpretations of (*teaching profession*) are:

GOOD NA profession is an agent or instrument of teaching

MISSED TNS Interpretation

The interpretations of (*science teacher*) are:

GOOD NN teacher employs science

The interpretations of (*school teacher*) are:

GOOD NA teacher is the spatial source of school

GOOD NA teacher is an agent or instrument of school

GOOD NN teacher employs school

The interpretations of (*Sunday school*) are:

GOOD NA school is the temporal source of Sunday

The interpretations of (*teaching fellow*) are:

GOOD NA fellow is an agent or instrument of teaching

The interpretations of (*coffee cream*) are:

GOOD NS cream is made of coffee

GOOD IN cream is an action directed towards coffee

GOOD NN coffee is spatially proximate to cream

The interpretations of (*coffee break*) are:

GOOD TA coffee is temporally located in break

GOOD IN break is an action directed towards coffee

The interpretations of (*coffee nerves*) are:

GOOD NN coffee is spatially proximate to nerves

BAD NS nerves is made of coffee

The interpretations of (*fruit cake*) are:

GOOD NS cake is made of fruit

GOOD NN fruit is spatially proximate to cake

The interpretations of (*fruit tree*) are:

GOOD TNS tree is another label for fruit

GOOD NS tree is made of fruit

GOOD NN fruit is spatially proximate to tree

The interpretations of (*box camera*) are:

GOOD NA camera was contained in box

GOOD NA camera is an agent or instrument of box

GOOD NS camera has the form of box

GOOD NN box is spatially proximate to camera

The interpretations of (*music box*) are:

GOOD TA music is contained in box

BAD IN box is an action directed towards music

The interpretations of (*shadow boxing*) are:

GOOD NA boxing is the spatial source of shadow

GOOD IN boxing is an action directed towards shadow

The interpretations of (*letter drop*) are:

GOOD TA letter is spatially located in drop

GOOD NA drop is the topic of letter

GOOD NA letter is an agent or instrument of drop

GOOD IN drop is an action directed towards letter
GOOD IN letter is an action directed towards drop
BAD IA drop is an attribute of letter

The interpretations of (*cough drop*) are:

GOOD TA cough is spatially located in drop
GOOD IN drop is an action directed towards cough
GOOD IN cough is an action directed towards drop
BAD IA drop is an attribute of cough

The interpretations of (*nose drop*) are:

GOOD TA nose is spatially located in drop
GOOD NA nose is an agent or instrument of drop
GOOD NA drop is the spatial source of nose
GOOD IN drop is an action directed towards nose
BAD IA drop is an attribute of nose

The interpretations of (*bear country*) are:

GOOD TA bear is spatially located in country
GOOD NA country is an agent or instrument of bear

The interpretations of (*country club*) are:

GOOD NA club is the spatial source of country
GOOD NA country is an agent or instrument of club
BAD IN club is an action directed towards country

The interpretations of (*country butter*) are:

GOOD NA butter is the spatial source of country

The interpretations of (*sports activities*) are:

GOOD TNS activities is another label for sports

The interpretations of (*winter sports*) are:

GOOD NA sports is the temporal source of winter

The interpretations of (*sports magazine*) are:

GOOD TA sports is the topic of magazine

GOOD TA sports is contained in magazine

GOOD TA sports is spatially located in magazine

The interpretations of (*butter fingers*) are:

GOOD NS fingers is made of butter

GOOD NN butter is spatially proximate to fingers

The interpretations of (*finger cymbals*) are:

GOOD NS cymbals has the form of finger

GOOD NN finger is spatially proximate to cymbals

The interpretations of (*finger lakes*) are:

GOOD NS lakes has the form of finger

GOOD TA finger is spatially located in lakes

The interpretations of (*finger movement*) are:

GOOD NA finger is an agent or instrument of movement

GOOD IN movement is an action directed towards finger

The interpretations of (*letter sequence*) are:

GOOD TA letter is spatially located in sequence

GOOD NA sequence is the topic of letter

GOOD NA letter is an agent or instrument of sequence

- GOOD IN letter is an action directed towards sequence
- GOOD IN sequence is an action directed towards letter

The interpretations of (*document preparation*) are:

- GOOD NA preparation is the topic of document
- GOOD IN preparation is an action directed towards document
- GOOD IN document is an action directed towards preparation

The interpretations of (*situation parts*) are:

- GOOD NA parts is the spatial source of situation
- GOOD NA parts is the temporal source of situation
- GOOD IN parts is an action directed towards situation

The interpretations of (*situation description*) are:

- GOOD TA situation is the topic of description
- GOOD NA description is the spatial source of situation
- GOOD NA description is the temporal source of situation

The interpretations of (*situation analysis*) are:

- GOOD TA situation is the topic of analysis
- GOOD NA analysis is the spatial source of situation
- GOOD NA analysis is the temporal source of situation
- GOOD IN analysis is an action directed towards situation

The interpretations of (*language difficulty*) are:

- GOOD IA difficulty is an attribute of language

The interpretations of (*target structure*) are:

- GOOD TNS structure is another label for target
- GOOD TA target is spatially located in structure

- GOOD NA structure is an agent or instrument of target
- GOOD NA structure is the spatial source of target
- GOOD IN target is an action directed towards structure
- GOOD IN structure is an action directed towards target
- GOOD NN target is spatially proximate to structure

The interpretations of (*network structure*) are:

- GOOD TA network is spatially located in structure
- GOOD NA structure is an agent or instrument of network
- GOOD IN structure is an action directed towards network
- GOOD IN network is an action directed towards structure
- BAD NN network is spatially proximate to structure

The interpretations of (*ground swell*) are:

- GOOD NA swell is the spatial source of ground
- GOOD NA ground is an agent or instrument of swell
- GOOD IN swell is an action directed towards ground
- GOOD IN ground is an action directed towards swell

The interpretations of (*ground controllers*) are:

- GOOD NA controllers is the spatial source of ground
- GOOD NA controllers is an agent or instrument of ground
- GOOD NN controllers employs ground

The interpretations of (*vehicle capacity*) are:

- GOOD NA capacity is the spatial source of vehicle
- GOOD IA capacity is an attribute of vehicle

The interpretations of (*launch vehicle*) are:

- GOOD TA launch is spatially located in vehicle
- GOOD NA vehicle is an agent or instrument of launch

The interpretations of (*plane crash*) are:

- GOOD NA crash is the spatial source of plane
- GOOD NA plane is an agent or instrument of crash
- GOOD IN crash is an action directed towards plane

The interpretations of (*surveillance plane*) are:

- GOOD TA surveillance is spatially located in plane
- GOOD NA plane is an agent or instrument of surveillance

The interpretations of (*farm bill*) are:

- GOOD TA farm is the topic of bill
- GOOD NA bill is the spatial source of farm
- GOOD IN bill is an action directed towards farm

The interpretations of (*food supplies*) are:

- GOOD IN supplies is an action directed towards food
- GOOD IA supplies is an attribute of food

The interpretations of (*home help*) are:

- GOOD NA help is the spatial source of home
- GOOD NA home is an agent or instrument of help
- MISSED IN Interpretation

The interpretations of (*home buyers*) are:

- GOOD NA buyers is the spatial source of home
- GOOD NA buyers is an agent or instrument of home
- GOOD NN buyers employs home

The interpretations of (*color television*) are:

GOOD NA television is an agent or instrument of color

MISSED NS Interpretation

The interpretations of (*television camera*) are:

GOOD NA camera is the topic of television

GOOD NA camera is an agent or instrument of television

GOOD NN television is spatially proximate to camera

BAD TNS camera is another label for television

The interpretations of (*television appearance*) are:

GOOD NA appearance is the topic of television

GOOD IA appearance is an attribute of television

The interpretations of (*cut throat*) are:

MISSED IN Interpretation

The interpretations of (*rose cutting*) are:

GOOD IN cutting is an action directed towards rose

BAD NA rose is an agent or instrument of cutting

The interpretations of (*film cutter*) are:

GOOD NN cutter employs film

The interpretations of (*stage name*) are:

GOOD TA stage is the topic of name

GOOD NA name is the spatial source of stage

GOOD IN name is an action directed towards stage

GOOD IA name is an attribute of stage

The interpretations of (*equipment name*) are:

- GOOD TA equipment is the topic of name
- GOOD NA equipment is an agent or instrument of name
- GOOD IN name is an action directed towards equipment
- GOOD IA name is an attribute of equipment

The interpretations of (*launcher interface*) are:

- GOOD NA launcher is an agent or instrument of interface

The interpretations of (*order blank*) are:

- GOOD NA blank is the spatial source of order

The interpretations of (*engagement order*) are:

- GOOD TNS order is another label for engagement
- GOOD TA engagement is spatially located in order
- GOOD IN engagement is an action directed towards order
- GOOD IA order is an attribute of engagement

The interpretations of (*needle mark*) are:

- GOOD TA needle is spatially located in mark
- GOOD NA needle is an agent or instrument of mark
- GOOD IN needle is an action directed towards mark
- GOOD IN mark is an action directed towards needle
- GOOD IA mark is an attribute of needle

The interpretations of (*initialization sequence*) are:

- GOOD TA initialization is spatially located in sequence
- GOOD IN initialization is an action directed towards sequence

The interpretations of (*navigation function*) are:

GOOD TNS function is another label for navigation
GOOD IA function is an attribute of navigation
MISSED NA Interpretation

The interpretations of (*navigation hazard*) are:

MISSED IN Interpretation

The interpretations of (*velocity component*) are:

GOOD NA component is a part of velocity
GOOD NA component is the spatial source of velocity

The interpretations of (*component distances*) are:

GOOD TA component is spatially located in distances
GOOD TA component is a part of distances

The interpretations of (*initialization notification*) are:

GOOD TA initialization is the topic of notification

The interpretations of (*group activation*) are:

GOOD NA group is an agent or instrument of activation
GOOD NA activation is the spatial source of group
GOOD IN activation is an action directed towards group

The interpretations of (*record activation*) are:

GOOD NA activation is the topic of record
GOOD IN activation is an action directed towards record

Appendix D. Results from Validation Survey

This appendix reports the results of a survey of five native English speakers as they attempt to discern the logical properties that apply to the relationships implicit in the data base of nominal compounds. By separately choosing how the properties of transitivity and symmetry apply, they effectively are assigning the compounds to the categories of the logical typology. The instructions to the participants are in italics below.

In this survey, you will determine how transitivity and symmetry apply to the relationships in nominal compounds. A nominal compound, for this survey, is the conjunction of two nominals, such as in 'rubber band,' 'paper clip,' 'desk top,' 'water fall,' etc. There are many possible relationships implicit in nominal compounds. We are studying how transitivity and symmetry apply to those relationships.

IMPORTANT NOTE: There are no right or wrong answers to this survey. We want to know what you, as a competent speaker of English, think. Below where we explain what we are looking for, we have used some example nominal compounds and have given some analysis of these compounds. Our analysis may not concur with your analysis. That is fine. We want to know what you think. Please do not be unduly influenced by the examples.

The exact relationships we are studying are between the modifiers in nominal compounds and the nominal compounds themselves. The modifier in a nominal compound is typically the first word in the compound. The modifier delimits and more clearly specifies the concept referred to by a nominal compound. For instance in the compound 'rubber band,' the modifier 'rubber delimits and more clearly specifies the type of object referred to better than 'band' alone does. In this example we are interested in the relationship between 'rubber' and 'rubber band.'

What we want to know is how transitivity and symmetry apply to the relationships between modifiers and compounds. Relationships between two objects are on of transitive, intransitive or nontransitive and at the same time symmetric, asymmetric or nonsymmetric. Your task is to determine how these properties apply to the relationships implicit in nominal compounds.

TRANSITIVE - A relationship between two items A and B is transitive when A is related to B and B is in the same way related to C, then A is also in in the same way related to C. The relationship 'taller than' is transitive. If A is taller than B and B is taller than C, then A is taller than C.

For nominal compounds, the relationship in 'oak tree' might be considered to be transitive. 'Oak' may be related to 'oak tree' in the same way as 'oak tree' is related to 'oak tree plant,' which may be the same way 'oak' is related to 'oak tree plant.' If the suppositions are true, then the relationship in 'oak tree' is transitive.

REMINDER: This example is for explanatory purposes only. Your analysis of this compound may be completely different. Please give us the benefit of your thinking.

INTRANSITIVE - A relationship between two items A and B is intransitive when A is related to B and B is in the same way related to C, then A cannot be in the same way related to C. The re-

relationship 'mother of' is intransitive. If A is the mother of B and B is the mother of C, then A cannot be the mother of C.

For nominal compounds, the relationship in 'paper clip' might be considered to be intransitive. 'Paper' may be related to 'paper clip' in the same way that 'paper clip' is related to 'paper clip fastener.' But 'paper' is not in the same way related to 'paper clip fastener.' If the suppositions are true, then the relationship in 'paper clip' is intransitive.

REMINDER: This example is for explanatory purposes only. Your analysis of this compound may be completely different. Please give us the benefit of your thinking.

NONTRANSITIVE - A relationship between two items A and B is nontransitive when A is related to B and B is in the same way related to C, then A may or may not be in the same way related to C. The relationship 'holding hands with' is nontransitive. If A is holding hands with B and B is holding hands with C, then A may or may not be holding hands with C.

For nominal compounds, the relationship in 'car door' might be considered nontransitive. 'Car' may be related to 'car door' in the same way as 'car door' is related to 'car door handle.' 'Car' may or may not be in the same way related to 'car door handle.' If the suppositions are true, then the relationship in 'car door' is nontransitive.

REMINDER: This example is for explanatory purposes only. Your analysis of this compound may be completely different. Please give us the benefit of your thinking.

SYMMETRIC - A relationship between two items A and B is symmetric if when A is related to B then B is in the same way related to A. The relationship 'holding hands with' is symmetric. If A is holding hands with B, then B is holding hands with A.

For nominal compounds, the relationship in 'student teacher' may be considered symmetric. 'Student' may be related to 'student teacher' in the same way that 'student teacher' is related to 'student.' If the suppositions are true, then the relationship in 'student teacher' is symmetric.

REMINDER: This example is for explanatory purposes only. Your analysis of this compound may be completely different. Please give us the benefit of your thinking.

ASYMMETRIC - A relationship between two items A and B is asymmetric if when A is related to B then B cannot be in the same way related to A. The relationship 'taller than' is asymmetric. If A is taller than B, then B cannot be taller than A.

For nominal compounds, the relationship in 'desk top' might be considered asymmetric. 'Desk' may be incapable of being related to 'desk top' in the same way that 'desk top' is related to 'desk.' If the suppositions are true, then the relationship in 'desk top' is asymmetric.

REMINDER: This example is for explanatory purposes only. Your analysis of this compound may be completely different. Please give us the benefit of your thinking.

NONSYMMETRIC - A relationship between two items A and B is nonsymmetric if when A is related to B then B may or may not be in the same way related to A. The relationship 'facing' is nonsymmetric. If A is facing B, B may or may not be facing A.

For nominal compounds, the relationship in 'ice crusher' might be considered nonsymmetric. 'Ice' may or may not be related to 'ice crusher' in the same way that 'ice crusher' is related to 'ice.' If the suppositions are true, then the relationship in 'ice crusher' is nonsymmetric.

REMINDER: This example is for explanatory purposes only. Your analysis of this compound may be completely different. Please give us the benefit of your thinking.

What we want to know is how transitivity and symmetry apply to the relationships between modifiers and compounds. Relationships between two objects are one of transitive, intransitive or nontransitive and at the same time symmetric, asymmetric or nonsymmetric. Your task is to determine how these properties apply to the relationships in nominal compounds. Please specify for each nominal compound on the following pages whether:

- 1. The compound is transitive, intransitive, or nontransitive; and whether*
- 2. The compound is symmetric, asymmetric, or nonsymmetric.*

There are many compounds on the following pages, some of which may be unfamiliar to you. Please select what is to you the most natural meaning of the compounds when judging the properties of their relationships.

Thank you for participating in this survey.

The results of the survey are reported with the compound first, followed by its classification according to our initial analysis, and then the five responses given in the survey.

<i>Compound and Class</i>	<i>Survey Responses</i>
drinking water - IN	tn ta tn nn ns
water clock - IN	tn tn nn na tn
salt water - NS	ts ts nn in ts
ice water - TNS	ts ts tn ts ts
water wheel - NA	in ta nn na ta
water tower - TA	ta tn nn nn in
water spot - NA	na nn na nn in

ground water - NA	tn ts na tn is
cooling water - NA	is is nn na na
water skier - NN	in na nn ta tn
rose water - NS	tn nn nn ta ta
water mark - NA	in ia na nn in
water drop - NA	ts na ns ia nn
water pipe - TA	ia is nn in is
water flow - NA	ns is ns in ia
water temperature - IA	na na nn in is
cooking time - TA	in ts nn na ts
read time - TA	in is nn ta is
time study - IN	in na nn ts in
recovery time - TA	in ta nn ta ta
search time - TA	in ns nn nn ia
time correlation - IN	in ts ns ta ns
time period - TNS	is in ts na is
satellite time - NA	in ia nn ia ia
time mark - IN	ns in ns in in
time message - TA	in is na in ts
time sample - IN	ia ts ns in ts
position time - TA	is ts nn na na
duration time - TNS	ts ts ts ts ta
sister ship - TNS	is ts nn na tn
space ship - NA	in ts nn ia ts
training ship - TA	in ns nn ts tn
ship landing - NA	na ts nn ta ia
ship position - TA	ia ta nn tn is
ship course - IA	ia nn na ia ns

ship movement - NA	na na nn in ts
ship displacement - NA	na in ts na ns
ship latitude - TA	ia in na in na
ship speed - IA	na is nn tn in
system dictionary - TA	in ia nn na is
learning system - NA	is tn ts na ts
system commands - IN	in is ns ia ta
weapon system - TNS	ts nn nn nn tn
launcher system - TNS	ts tn ns ta ta
system crash - NA	ns nn nn tn ns
system initialization - IN	na ns na nn nn
system control - IN	ia is nn na ns
status monitoring - IN	na ia ns nn ia
status upgrade - IN	ts ta nn ta in
training status - IA	nn na nn nn tn
launcher status - IA	is na nn nn is
status algorithms - TA	na nn nn ta in
status summaries - TA	tn na ns ia is
deployment status - IA	is ta nn tn ia
default status - IA	tn ia nn tn in
air speed - IA	in is na in ts
speed limit - IA	is ts na tn ns
engine speed - IA	na in nn tn ta
road speed - IA	in is na ta nn
intercept speed - IA	tn tn nn tn tn
speed ratio - IA	in ts nn tn is
protection money - NA	is ta nn ns nn
conscience money - NN	tn ts nn ta tn

spending money - IN	is tn ns ta is
money order - IN	is tn nn na is
stage money - NA	tn ts nn ts ta
play money - NA	ts ns nn ts ta
money supply - IA	nn nn nn na nn
money creation - IN	nx in na ia nn
engine repair - IN	in ia nn na is
steam engine - TA	na is na nn ta
fire engine - TA	ta ia nn nn ia
engine size - IA	ta na nn na tn
rocket engine - TNS	ns is na nn ta
pass word - TNS	in nn nn ta ns
household word - NA	in ta nn ia ta
candidate word - TNS	tn ta ns ia ta
compound word - TNS	ta nn nn na tn
dictionary word - NA	ts tn ns ts in
word sound - IA	na na ts ts ts
root word - NS	ts ta nn tn ts
book binding - IN	ia in ns ns ta
guide book - TA	is is nn tn ts
picture book - TA	ts ia nn ts ta
book value - IA	ta ns na ts is
book review - TA	ia nn nn nn tn
book trade - IN	is ia na na is
book request - TA	in ns na ia na
computer literature - TA	in ns ns na in
computer learning - NA	nn tn na ts ia
computer hours - TA	in tn nn na ta

computer programs - IN	in ts ns ts ts
computer activation - IN	na ns nn ia nn
computer suite - TA	ts ia nn ts tn
birth control - IN	ts ia nn nn ns
control tower - NA	in ts nn ts nn
mission control - IN	ia ia nn ia xs
training control - IN	ts ta ns nn ta
interceptor control - IN	ia ta nn ia tn
data entry - TA	tn tn nn tn is
data type - IA	ia ta ns ta ia
data base - TA	ts in nn tn is
data value - IA	ta ns ns tn nn
coordinate data - TA	tn nn is in tn
data accuracy - IA	ta ns ns ta ta
speed data - TA	is is ns in nn
character position - TA	ta ns nn nn ts
position reports - TA	ts tn na is in
position fix - NA	is ts ns ts in
coordinate position - TNS	ta ns is ia nn
breathing space - TA	is ta nn ta ta
space suit - NA	in in ns na ts
trunk space - TA	ts ia ns ts tn
space colony - NA	in ns nn na ts
buffer space - TNS	is na ns in ta
test pilot - NA	ts ta nn na is
scratch test - TNS	is is na is ta
test weight - TNS	in na nn ta is
test pattern - TNS	ts tn ts nn tn

fuel oil - TNS	is is ts nn is
banana oil - NS	ts is nn ts ta
oil paint - NS	ts in tn tn ts
drying oil - NA	is is nn tn ta
oil well - TA	ts ts nn na tn
oil company - NN	na ia nn tn in
will power - IA	ns nn nn ta ns
student power - IA	tn ns nx is nn
power plant - NA	ns nn nn ts is
power output - IN	na ta ts is ia
power loss - IN	ta ns na ts nn
engine power - IA	ns ta ts tn tn
student prince - TNS	ts ia ns na is
student problems - IA	in ta nn ia ta
student committee - TA	ts ia nn ia nn
student friends - TA	ts ts nn tn tn
student decision - NA	nn ta nn ts in
wrapping paper - NA	is ia nn ta ta
paper chase - IN	in ia nn ns in
drawing paper - NA	in ta nn ns ta
tissue paper - TNS	ts ta ns ts ts
rice paper - NS	tn ts nn ts ta
paper money - NS	ts ts nn tn ts
house cleaning - IN	in ta nn ia ia
house boat - TNS	ts is nn is tn
packing house - TA	in ta nn ia tn
dog house - TA	tn ta nn na ta
house dog - NA	ns is nn na ta

life force - IA	ns tn ns is ns
life boat - TA	ns ia nn is ta
animal life - IA	ia ns ns ns is
life preserver - NN	nn is nn nn is
home life - NA	in ns ns tn ts
horse shoe - NN	in in nn na ta
sea horse - NA	in ns nn ta tn
horse laugh - NA	na na nn ts nn
race horse - NA	ts na nn tn ts
horse doctor - NN	in in na ns ta
riding horse - IN	is na nn ia tn
ice fall - NA	na tn nn in is
sheet ice - NS	ns is nn ns nn
ice bag - TA	tn is nn ta ta
ice cream - NS	ts nn nn in nn
tea room - TA	tn na nn ia ns
room service - IN	in in nn ia ts
elbow room - TA	ia ia na tn na
dressing room - TA	in ta nn ns in
police dog - NA	in ta nn nn ia
hunting dog - NA	in ia nn ts tn
sheep dog - NN	in in na ts ta
night watch - NA	na ta na ta nn
night fighter - NA	in ns nn ia tn
night train - NA	in in nn in ta
night flight - NA	ia ns nn ts ts
night school - NA	in tn nn nn is
search party - NA	nn nn ns ns ns

party line - TA	is ns nn ia in
garden party - NA	ia tn nn ts na
tea party - TA	tn na nn is na
party members - NA	ts in nn ns tn
working day - TA	is ts nn ia ia
day dream - NA	ia ts nn ts in
day laborer - NA	in tn nn ta tn
looking glass - NA	is na nn na ia
plate glass - NS	ts is nn ia ts
beer glass - TA	tn ia nn ia tn
glass eye - NS	ts ia nn ta ta
hire car - IN	ia is nn ts tn
car thief - NN	in ia nn ts ta
car owner - NN	ia ia nn ta tn
car barn - TA	tn tn nn ts ts
passenger car - TA	ts tn nn is ta
grain sale - IN	nn ts nn is ts
grain agreement - TA	ia na na ia nn
grain alcohol - NS	ts tn nn ta tn
grain storage - TA	tn nn nn ns in
grain decision - TA	in is na ta in
plant production - NA	na ns na nn in
steel production - IN	in ts na na tn
production facility - NA	ts ns ns ia in
production worker - NA	ns ns tn nn ns
insect flight - NA	ns ts nn ta in
flight director - NA	na ns nn nn ia
flight recorders - NA	in ts nn ta is

flight operation - TNS	na ia ns ia ta
test flight - TNS	nn tn nn tn is
plane flight - NA	is ia ns na ns
radio set - TNS	ts is nn is ns
radio broadcast - TNS	ns tn ns is tn
radio communication - TNS	is is ts is ts
radio channel - IN	ia in nn nn tn
radio platform - TA	ia ia nn na na
selling price - IA	is is ts ts tn
price dispute - TA	nn in nn na is
price increase - IN	ta tn nn ts tn
price index - TA	ia nn nn tn is
food price - IA	ia ta nn ts tn
record price - TNS	ta tn ns ia nn
wind storm - NA	ns ts nn ts tn
wind direction - IA	na is ns ns na
wind source - IA	na ts nn ns tn
wind speed - IA	ta ts ts ts is
information content - NA	ts na ts ia ia
information retrieval - IN	nn na ns nn nn
classification information - TA	in ns ts is is
buffer state - TNS	na na nn tn ns
city state - TNS	ts ia nn ts is
police state - TA	ta ia nn ta in
review state - NA	na tn nn in in
table talk - NA	ia ia nn nn ta
table wine - NA	in ia nn in ta
table structure - IN	ts is ts na ia

doctrine table - TA	in ns ns ts in
table maintenance - IN	in in nn ts ia
training supervisor - NA	nn ts nn ts ta
training requirements - TA	tn tn nn ta in
training console - NA	in ns na ta ns
doctrine message - TA	ts ts ns nn ts
response message - TA	ts tn ns is is
message updates - TA	ts ts ts ns ia
language processing - IN	ix is ns ia ns
processing paragraphs - TA	na ta na nn ia
navigation processing - IN	ia ia ns ta in
processing requirements - TA	nn nn nn ts nn
processing option - IA	ta ta nn ia ts
battle field - TA	in nn na ia is
field work - NA	is is in ta ta
field mouse - NA	ts ta ts in ts
information field - TA	tn nn nn ia tn
storage battery - NA	in is tn ta tn
drum storage - NA	in ia nn ts in
working storage - TA	na nn ns ta is
operator action - NA	nn is tn is is
action alerts - TA	nn is tn is is
action button - NA	nn is nn ia ia
panic reaction - TNS	na ts ns ia in
chain reaction - NS	ns nn nn na nn
individual user - TNS	ts is ns ia ta
user legality - IA	in ta nn ta ia
user loading - NA	nn nn nn ns in

user function - NA	ia in na ta na
doctrine authorization - IN	ts ts ns in ts
doctrine entry - TA	ta ta na ia in
design choice - IN	ts ia nn tn ia
design document - TA	tn is ns na ns
design goal - IA	tn ts in ts ns
design options - IA	ts tn nn ia nn
engine designer - NN	nn is nn tn tx
talking point - TNS	ia ns nn in ix
boiling point - IA	ts na nn ta ia
intercept point - TA	ts ts ts is nn
investment program - NA	tn ts nn ia tn
spelling program - NA	ia ia nn ia ts
program initiation - IN	na ts nn ia in
spelling error - TA	tn ts in ts tn
transmission error - IN	nn in na ts tn
letter error - TNS	tn ts nn ta ta
error estimate - IN	ta tn tn in tn
satellite rotation - NA	na ns nn ts in
satellite communications - NA	nn na ns tn ts
spy satellite - NA	in ts in nn ta
fruit market - IN	tn na nn ia ns
market rate - IA	ia ta nn is is
market leader - NN	in ts nn ts tn
market close - IN	na nn in nn ia
climbing rate - IA	in ta tn ta ta
rate cut - IN	na ns in in is
tax rate - IA	is tn ts na is

4

tax cut - IN	ia ta nn ns ns
tax plan - TA	in ns nn nn in
income tax - IN	in ia nn ts na
family man - NA	ia ia tn ta ia
family problems - IA	nn ia in ia ia
family unit - TNS	ts ts tn ia ts
family friend - IN	ia na tn nn tn
search algorithm - NA	in ia tn ia ts
police search - NA	nn is tn nn tn
soul searching - IN	nn tn in in in
mine worker - NN	ta na nn ta ta
leather worker - NN	nn na in ta tx
worker teams - TA	ts is in ia is
donkey work - NA	in ts na ns ta
piece work - IN	ia na tn ia is
fuel cost - IA	ia ns tn ts is
fuel waster - NN	tn ns in ia ta
fuel line - TA	tn nn in ts ns
input device - NA	nn ts tn ia ts
input language - TNS	is is ns ns xn
input interface - NA	in is is ia ia
input sentence - TNS	in is is tn ta
timer input - TA	tn is ts ta na
spelling checker - NA	is ts in ta ts
spelling problem - IA	tn ts in nn tx
plant food - NN	in na tn nn is
plant material - NS	ts ts tn nn tn
weight reduction - IN	na ts in na in

vehicle weight - IA	ia tn nn tn is
weight range - IA	in ia nn tn ia
air gun - IN	tn ns nn ia ts
air stream - TA	ts tn tn in in
air conditioning - IN	na na tn ta nn
city wall - NA	ta is in ta ta
city planner - NN	in ns nn is in
dream world - NA	ts ia in ns ta
dream castle - NA	is ia tn nn tn
dream analysis - TA	in ns nn na ns
write head - NA	in is ia na in
arrow head - NA	ta ia tn in ta
head lettuce - NS	ts tn in ts in
head noun - NA	in tn na ta ts
talking machine - NA	nn nn in ia tn
machine tool - TNS	in ia ts ns in
washing machine - NA	is nn nn ns tn
machine translation - NA	na na tn ts is
seeing eye - NA	ns ia ts ia in
eye opener - NN	na ta tn ta tn
eye dropper - NN	ia ia in is na
bird cage - TA	tn ia tn ns ns
bird call - NA	ia tn in in is
jail bird - NA	in ts nn ia ia
song bird - NA	nn na nn ia tn
iron curtain - NS	tn ts na ta tn
curling iron - NA	nn ts in is nn
pig iron - NS	in nn na ns ia

iron age - TA	in ia nn in na
ironing board - TA	in ts tn ta tn
governing body - NA	nn ns in ts ix
body blow - IN	in ia in nn tn
body fluids - NA	ta in nn na ia
body shop - TA	nn is nn in nn
spring cleaning - NA	ia tn nn tn tn
cleaning woman - NA	is na in ia na
cleaning fluid - NA	in is nn nn ia
blood disease - IA	tn ns in ia ts
blood poisoning - IN	tn ia in ta ta
blood vessel - TA	tn ts nn ts in
blood test - IN	in is nn in ns
telephone call - NA	is ta tn is ta
call box - TA	in ts in ia is
call girl - NA	nn in ia ts na
calling card - TA	in ta in ts ta
candle light - NA	na ns ts ns tn
gas light - NA	ns nn in is tn
light year - TA	ia ts nn ta ia
blinker light - TNS	na tn nn nn nn
pleasure boat - TA	nn ts tn nn ta
boat ride - NA	tn nn tn in in
fighter plane - TNS	nn tn in ia na
bush fighter - NA	in na nn tn na
bull fighting - IN	na na tn nn ia
telephone receiver - NA	ia na tn ns na
telephone directory - TA	ia ns in ia tn

place name - IA	ia is ts in is
fire place - TA	ts ta nn ia na
place setting - IN	is ta nn ns tn
working man - NA	in is tn ts tn
cave man - NA	ts na in ts nn
fire sale - IN	nn tn in ts is
sleeping bag - TA	in ns in in nn
sleeping powder - NA	na in in ia na
sleeping sickness - NA	nn tn tn ia ta
sitting duck - NA	ia is ia ta na
duck bill - NA	ia tn ia is is
duck shooting - IN	in in nn ts in
chicken fat - NS	tn ts in ts ta
chicken wire - IN	tn na in tn in
chicken feed - IN	in ns in nn nn
office management - IN	tn ta nn na tn
office manager - NN	ta na tn nn tn
records office - TA	ts ns nn in is
shoe maker - NN	na na nn in ix
shoe polish - IN	in ts tn ta ta
walking shoes - NA	in ia in ta in
wine bottle - TA	tn ia tn ts tn
wine press - IN	nn is nn is in
whipping boy - IN	in is na ta na
lover boy - TNS	na ts tn ia ta
farm boy - NA	is ns in nn tn
road block - IN	ta is in ia ts
nerve block - IN	na tn nn ia ts

cell block - TA	ts ns nn tn nn
cold cure - IN	is ts in nn nn
cold sore - NA	ia na nn ta ta
cold wave - TA	nn ts nn ta is
safety belt - NA	in ts tn ts tn
seat belt - NA	in na in ts ts
corn belt - TA	ts nn ia ts na
flower bed - TA	ts nn ta is ia
May flower - NA	nn ts nn na ta
wall flower - NA	nn ta in ns na
watch tower - NA	in ia in na is
tear gas - NN	ns nn in ta na
gas chamber - TA	tn ns nn ns tn
retaining wall - NA	in ns tn nn tn
reading material - IN	in na ns ns ia
reading glasses - NA	in is nn ta tn
target date - TNS	is ta tn ts in
date line - TA	ts ts nn is ts
departure date - TA	ia ts tn ta na
play goer - NA	in ta nn ia ta
sword play - NA	tn ts nn na in
playing cards - IN	in na nn is ta
steam roller - NN	nn ta tn ns ta
steam bath - TA	tn na tn ts ix
eating apple - IN	in nn ta na nn
apple core - NA	ts ts in ia tn
apple sauce - NS	ts ta in in ts
afternoon tea - NA	in nn nn ts in

teaching profession - NA	is ts tn tn tx
science teacher - NN	in is nn nn tx
school teacher - NN	tn ta in ia ts
Sunday school - NA	in na in is tx
teaching fellow - NA	is in in nn nn
coffee cream - NN	in ts tn ta ts
coffee break - TA	ts ia nn ta is
coffee nerves - NN	na in tn ta na
fruit cake - NS	ts ta tn is ts
fruit tree - TNS	na ia tn is tn
box camera - NS	ts is na na ia
music box - TA	nn ta in na ts
shadow boxing - IN	nn ia ia ia nn
letter drop - TA	in ta nn in ta
cough drop - IN	in nn tn ta na
nose drop - NN	in ts nn tn ia
bear country - TA	tn ta in tn na
country club - NA	in tn in ns ia
country butter - NA	tn ts in in tn
sports activities - TNS	ts na ts ia ia
winter sports - NA	in is nn ta ts
sports magazine - TA	ts ts in ta tn
butter fingers - NS	tn is ia ta na
finger cymbals - NN	in is nn nn ts
finger lakes - NS	ts ia nn is na
finger movement - NA	na tn nn in ia
letter sequence - IN	tn is tn in ta
document preparation - IN	ia ia nn nn is

situation parts - NA	ia ts nn na ia
situation description - TA	ts ta is ta in
situation analysis - TA	in is tn ts ns
language difficulty - IA	tn nn in nn tn
target structure - TNS	ia ts nn is is
network structure - IN	ts ns ts ia is
ground swell - NA	ts ta nn ts ia
ground controllers - NA	ia nn in nn tn
vehicle capacity - IA	ia is nn nn is
launch vehicle - NA	nn ts in is ta
plane crash - NA	nn tn in ta ta
surveillance plane - NA	in ts in tn tn
farm bill - TA	in is tn tn na
food supplies - IA	ns is tn na ta
home help - NA	in na nn na tn
home buyers - NN	in ia in ta ia
color television - NS	nn ta in is xs
television camera - NN	is ta tn ta tn
television appearance - NA	in tn ts ia is
cut throat - IN	nn ns na nn na
rose cutting - IN	nn ta nn is tn
film cutter - NN	in tn nn is ia
stage name - NA	ia ia nn ns na
equipment name - IA	ta tn is ta in
launcher interface - NA	ta na tn na ia
order blank - NA	ts in nn ts ts
engagement order - IN	ia in in ia tn
needle mark - IA	nn ts in nn ia

initialization sequence - IN	ta na ts is is
navigation function - NA	ns is tn tn ts
navigation hazard - IN	in is nn tn ta
velocity component - NA	ta ts tn nn in
component distances - TA	ta ts nn in nn
initialization notification - TA	na ns tn is in
group activation - IN	na ts in is ta
record activation - IN	ns ts in nn tn

Vita

Russell Garvin Modlin was born April 16, 1962 in Lawton, Oklahoma. He attended several school systems in Southeast USA and in June, 1980 graduated from Greenbrier East High School in Lewisburg, West Virginia. He received a BS in Computer Science from Virginia Polytechnic Institute and State University in Blacksburg, Virginia in June, 1984. Four years of enlisted service in the United States Army followed, during which time Sergeant Modlin acquired a degree in Russian from the Defense Language Institute at Monterrey, California in 1985 and a MS in Business Administration from the Overseas Education Program of Boston University at Wuerzburg, Germany in 1988. The author reenrolled at Virginia Polytechnic Institute and State University for a MS in Computer Science in August, 1988.

A handwritten signature in cursive script that reads "Russell Garvin Modlin". The signature is written in black ink and is centered on the page.