Time Series Analysis of Driver Behavior on Curves

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Introduction

- The number of crashes are disproportionally higher on curves

- Analysis of Driver Behavior on Rural Curves using the SHRP 2 NDS Data (Coming soon!)

- Time Series Analysis (Proof-of-concept)
Description of SHRP 2 NDS Data

- 3000 Drivers
- Six States
- Two Years
- 18 Million Traveled Miles
- 2 Petabytes Data
- Data were collected at 10 HZ

State Space Model

- **Explanatory variables** and stochastic time component

- Explanatory variables can **evolve over time**

- **Intervention effects** is coded as dummy variable

Observation equation: \( Y_t = F_t \theta_t + \nu_t \), with \( \nu_t \sim N(0, V_t) \)

State evolution equation: \( \theta_t = G_t \theta_{t-1} + \omega_t \), with \( \omega_t \sim N_p(0, W_t) \)
State Space Model
State Space Model

1. Intervention Analysis
   - How the driver interacts with traffic and roadway environment?

2. Forecasting Analysis
   - Can we forecast future position based on past observations?
INTERVENTION ANALYSIS WITH STATE SPACE MODEL
Deviation to the Normal Driving Position

On-coming vehicle

Curve

Time (second)

Squared distance to the mean position (m^2)
State Space Model — Intervention Analysis

- Normal Driving Position
- Oncoming vehicle Effect
- Curve Effect
State Space Model — Intervention Analysis

![Graph showing lane deviation over time with annotations for Oncoming vehicle, Normal Driving, and Curve.]
State Space Model – Intervention Analysis

Lane Deviation (Meters) vs. Time (seconds)

Observed Positions
State Space Model—Modeling Results

![Graph showing observed and predicted lane deviation over time](image)

- **Observed**
- **Predicted**
Decomposition for Different Effects

1.44 feet  Normal Driving Variation

+1.41 feet  Oncoming Vehicle Effect

- 1.74 feet  Curve Effect
FORECASTING WITH STATE SPACE MODEL
State Space Model - Forecasting

- Predict vehicle’s future position based on the past observations.

Autocorrelation Function
State Space Model - Forecasting

![Graph showing observed and predicted values over time](image)

**Observed** ○ ○ ○ ○ ○ ○ ○

**Predicted**
Model Diagnostics
Summary

Intervention Analysis evaluated the influence of the oncoming vehicle and the curve on driver behavior.

Forecasting Analysis successfully predict the future positions.

Limitation is difficulty to draw safety implications with statistical significance.
Thanks for your attention!

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