'Do I Have to Take This Class?': A Review of Ethics Requirements in Computer Science Curricula

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Abstract

ABET criteria for accreditation of undergraduate computer science (CS) degrees require universities to cover within their curricula topics including "local and global impacts of computing solutions on individuals, organizations, and society," and to prepare their students to "make informed judgments in computing practice, taking into account legal, ethical, diversity, equity, inclusion, and accessibility principles" [1]. A growing body of research similarly identifies the need for CS programs to integrate ethics into their degree requirements, both through standalone ethics-related courses and embedded modules or case studies on the ethical impacts in 'technical' courses. The calls for increased attention to CS ethics education have become more pressing with the emergence of sophisticated consumer-ready AI technologies, which pose new ethical challenges in the forms of bias, hallucination, and autonomous decision-making. Yet it remains unclear whether current university curricula are adequately preparing future graduates to confront these challenges. This paper presents a systematic review of the degree requirements of 250 computer science bachelor's degree programs worldwide. We categorize each program according to whether a CS-related ethics course is offered and/or required by the department, finding that almost half of all universities we review do not offer any computing ethics courses, and only 33% of universities require students to take an ethics course to obtain their degree. We analyze differences among public US, private US, and non-US universities and discuss implications for curricular changes and the state of undergraduate computing ethics education.

CCS Concepts

• **Social and professional topics → Computing education**.

Keywords

CS ethics, computing ethics, undergraduate curriculum

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1 Introduction

In this paper, we describe the findings of what is, to our knowledge, the only systematic and comprehensive review of university CS ethics requirements in recent years, covering universities both inside and outside of the United States. We conduct an online search for the undergraduate computer science degree requirements for all universities in the top-200 of the QS *World University Rankings for Computer Science* [19] and all remaining R1-classified US universities. Our findings help to paint a clearer picture of the prevalence of required or optional 'CS ethics' courses across CS degree programs; the differences in course offerings between non-US, US public, and US private universities; and the need for further investment in CS ethics education. Moreover, our data provide opportunities for further research into the curricular structure of CS ethics courses, and the development of ethics courses and requirements over time.

2 Related Work

2.1 Importance of CS Ethics Education

The importance of educating future computer scientists to act ethically and responsibly is well established in academic literature [4, 8, 10, 15] and in professional practice [5, 16]. This relevance is also clear in the IEEE, ACM and AAAI joint report *Computer Science Curricula 2023* [9], which emphasizes that "social and ethical issues" related to the computing profession have only increased in "magnitude and consequence" in recent years with the advent of powerful AI technologies. The report recommends that ethics pedagogy be integrated into degree programs through a combination of standalone courses, embedding in 'technical' courses, and capstone projects.

Although the CS program accrediting authority, ABET, does not specify that CS degree programs *must* include a course on ethics, it does require programs to educate students in such a way that graduates will be able to "recognize professional responsibilities and make informed judgments in computing practice, taking into

account legal, ethical, diversity, equity, inclusion, and accessibility principles consistent with the mission of the institution," [1]. While not prescribing a particular ethical framework, the ABET criteria make clear that the academic CS community considers the ability to reconcile technological developments with societal norms and challenges a central part of a computer scientist's toolkit. These loose expectations are by design, since the 1997 changes to the criteria emphasized "what was learned, not what was taught" [6]. But the extent to which CS programs are actually instilling this skill in their students is unclear.

The calls for increased attention to the ethics and politics of computing in CS curricula extend beyond teachers to students as well. As Ryoo and Blunt [13] document, even high school-level students recognize the urgency of integrating discussions of power and ethics into all aspects of CS education. The authors highlight that children as young as 1st grade (5-6 years old) are "able to identify and describe algorithmic bias," and the high school students they interviewed all "recognized that CS is neither neutral nor apolitical," [13]. In this way, the students in their study push beyond the routine acknowledgement in many computing ethics curricula that 'considering the ethical implications of some technologies is important,' advocating instead for a deeper engagement with the issues of power and inequality involved with every technological development. Doing so, the authors note, leads the students to believe that "the computing field might become a more diverse place if issues of social responsibility and ethics were a key focus of CS programs," In other words, the quality of CS ethics education is a core factor in shaping the future of the CS field, both academically and professionally.

2.2 Content of CS Ethics Courses

The most comprehensive review of existing computing ethics courses is provided by Fiesler et al. [3], who analyze 115 syllabi of "tech ethics" courses submitted by CS educators. They find that the majority (58%) of courses in their dataset are offered by or cross listed with the respective university's computer science department, supporting the hypothesis that CS degree programs are integrating computing ethics courses into their curricula. Notably, the authors found 40 instances of courses taught by faculty with degrees in philosophy, compared to only 26 courses affiliated with philosophy departments themselves. Regarding course content, artificial intelligence (AI) was the most common specific course topic (for a single-topic course), while a majority of courses featured modules on *law & policy*, *privacy & surveillance*, *philosophy*, and *inequality, justice & human rights*. A majority of courses focus on ethics and policy as dual focal points, suggesting that these courses combine more abstract discussions of ethical frameworks with applied discussions about how these frameworks are 'translated' through law and policy [7]. The work of Fiesler et al. is helpful in surveying the breadth of existing CS ethics courses, but cannot be used as a representative study of all curricula, particularly with respect to whether an ethics course is required to be taken by students towards degree completion.

In a similar review of syllabi for AI ethics courses specifically, Raji et al. [12] challenge the efficacy of "inserting ethics education into CS curriculum," arguing that "proposals anchored to developing individual morality and understanding fall short of resulting in any noticeable changes to the way in which students conduct research and develop applications," The authors instead stress the importance of institutional practices in place of "moments of individual judgment," concluding that rushed and heavily condensed ethics courses promote "the engineer's natural inclination towards seeing themselves as a solitary saviour," Among other criticisms, the chief argument of Raji et al. is that ethics courses siloed across different departments tend to reinforce a feedback loop of self-importance among CS practitioners, which they call "a continuing aggregation of disciplinary privilege that seeks to make computer scientists claim both 'technical' and 'social' expertises, the latter of which they do not actually have in depth," [12]. In charting a path forward, the authors advocate for a greater incorporation of legal and policy perspectives in AI ethics discussions, and an openness to seeking input from non-technical stakeholders.

2.3 Prior Studies

Smith et al. [17] fielded a survey among university educators soliciting CS instructor perceptions of ethics and barriers to integration of ethics in CS education. Their survey, which was advertised via social media and email, yielded nearly 140 responses, primarily from instructors at US universities. Nearly two-thirds of respondents to the survey reported that the computing course they had taught most often in recent years incorporated ethics content in its curriculum. Moreover, Smith et al. found strong support among the CS educators they surveyed for the incorporation of ethics in computing classrooms, and agreement about the value of ethics in preparing CS graduates for their careers. Notably, the survey's question about barriers to the integration of ethics in computing classrooms revealed that a substantial minority of respondents "desire to leave ethics to other courses or other departments," while 40% of respondents agreed with the statement that "ethics takes away students' attention from core computing courses," [17]. The authors highlight these sentiments among others as significant challenges facing the future of ethics education for CS students, emphasizing the need for increased institutional support for developing and teaching ethics.

Similarly, Stavrakakis et al. [18] surveyed CS instructors and administrators at 61 universities in 23 European countries regarding the teaching of ethics in their CS program. Only 36% of the universities do not teach some form of computer ethics as part of their degree programs, aligning with the similar proportion reported by Smith et al. For these universities, the most cited reasons for not offering ethics content in their curricula were lack of time (73% agree or strongly agree), lack of staff availability (73% agree or strongly agree), and lack of staff expertise (50% agree or strongly agree).

Finally, a 2006 survey of 50 US universities by Michael Quinn [11] reported that 55% of schools required students to take a CS ethics course taught by the department, while 15% required students to take an external ethics course (outside of the CS department). The author specifies that a "random survey of accredited undergraduate programs in computer science" was conducted, but the resulting sample of universities consists predominantly of smaller

public universities; most flagship state schools and large private universities are not included (only 40% of the sample is currently classified as an R1 institution). The unrepresentative sample and age of the study cast doubt on whether that high rate of requiring an ethics course extends to all universities in the US, and whether the same curricular requirements still exist today.

The work of Smith et al., Stavrakakis et al., and Quinn provide insights on the prevalence of ethics content in CS courses, but cannot by themselves provide a holistic view of the extent to which CS students from universities around the world are required to take courses where ethics play a substantial role in the curriculum. The Smith et al. and Stavrakakis et al. studies are limited by the voluntary nature of survey completion, which itself is prone to selection bias. As Smith et al. note, "since the recruitment text [for the survey] included the word 'ethics,' faculty with limited or no interest in ethics may have also declined participation and are therefore potentially underrepresented in the sample," [17]. Quinn's study [11] is likewise based on an unrepresentative sample and is almost 20 years old. It is thus likely that all three studies *overestimate* the extent to which required ethics courses are prevalent across CS course offerings.

To address this limitation, this study seeks to augment these prior findings by conducting a systematic review of CS bachelors degree program requirements from universities spanning six continents. Our study thus benefits from a much larger geographical reach, a larger sample size, and a more balanced sampling covering both universities that do offer CS ethics courses and universities that do not. Importantly, however, our study focuses exclusively on standalone computing ethics courses (which we define in Section 3.4). While we do not take into account CS ethics content embedded within other ('technical') CS courses, we nevertheless recognize the value of this embedding and acknowledge that our study may somewhat undercount degree programs where CS ethics forms an integral part of the curriculum (albeit one that is woven into the technical courses).

3 Methodology

3.1 Study Population

For our review of global CS ethics requirements, we include post-secondary education institutions (universities) from around the world with undergraduate degree programs in computer science. Specifically, we evaluate the bachelor's degree requirements for universities listed in the top-200 of the Quacquarelli Symonds (QS) *World University Rankings for Computer Science* [19]. These rankings provide us with a large list of well-known global universities—both public and private—offering computer science degrees. Hence, we disregard the specific ranking of each university, using 200 as a cutoff to generate a robust sample. We augmented this list with all other (102) Carnegie Classification *Research 1* ("R1") institutions from the United States which offer computer science majors, as we required a sufficiently large sample of US universities to effectively compare trends in degree requirements between public and private universities.

Since we are an English-speaking research team, we necessarily had to exclude universities for which we could not obtain degree requirements information in English. However, where a university's website included a 'native' English translation of the necessary degree information, we kept the university in our sample. Thus, our review of degree requirements includes universities from 33 countries (Fig. 1), representing both universities where the CS degree is taught in English, and universities where a full curriculum/course list for a CS degree taught in a language other than English is available in English on the university's website.

In total, our sample includes 250 universities, comprising 148 from the QS top-200 and 102 additional US universities from the R1 classification list. We focus only on each university's *computer science* bachelor's degree program, even if additional related degrees (e.g. computer engineering, data science) are also offered and disregard the specific degree type (e.g. "bachelor of science" vs. "bachelor of engineering"). The only exceptions are seven universities where a *computer science* major is not offered, in which case we evaluated the *computer engineering* or *software engineering* degree requirements. Where a university offers both a bachelor of science (B.S.) and a bachelor of arts (B.A.) degree for their computer science major, we review the B.S. requirements.

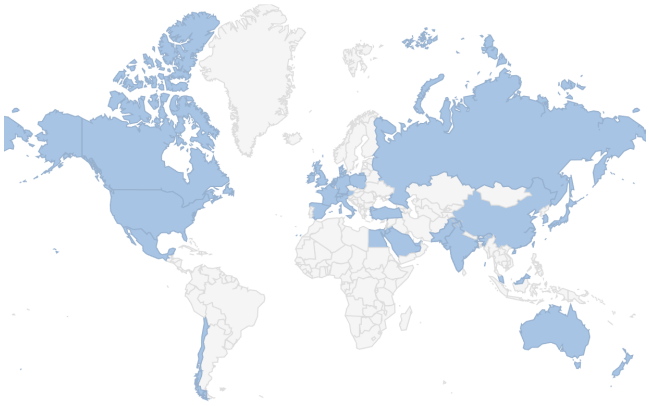

Figure 1: Map of countries included in the study's sample.

3.2 Review of Degree Requirements

For each university in our sample, we conducted an online search for the degree requirements of the applicable computer science degree. We sourced information about degree requirements exclusively from the university's official website (e.g. the CS department website, registrar's office website, etc.). Degree requirements were identified using one of two sources: (1) a list of degree requirements/courses; or (2) a course schedule detailing which courses are to be taken during which semester. Where a degree program allows students to select elective courses, we also reviewed the full list of course offerings from the CS department (often listed on a separate page of the university's or department's website).

3.3 Identifying 'CS Ethics Courses'

We define "CS ethics course" (or "computing ethics course") and the associated degree requirement loosely, allowing for a wide range of content, format (e.g. lecture vs. seminar), number of credits,

Table 1: Distribution of universities by country

Country	Count	Country	Count
United States	145	Malaysia	2
United Kingdom	17	Saudi Arabia	2
Australia	11	Taiwan	2
Canada	8	Turkey	2
China (incl. Hong Kong)	7	Belgium	1
India	7	Chile	1
Italy	6	Denmark	1
Germany	4	Egypt	1
Russia	4	France	1
Netherlands	3	Israel	1
Singapore	3	Jordan	1
South Korea	3	Mexico	1
Spain	3	New Zealand	1
Switzerland	3	Pakistan	1
Austria	2	Poland	1
Ireland	2	United Arab Emirates	1
Japan	2		
		Total	250

and ethical and moral values. However, we establish the following requirements for a "CS ethics course" for the purposes of our study:

(1) *The course must be a standalone course where the primary focus of the course is the ethical, legal, policy or social implications of computing technology*. Thus, this requirement precludes courses where ethics is one of many topics, or where discussions of ethical implications are embedded within instruction of technical content (e.g. "Intro to CS" or "Computer Security" courses with ad-hoc discussion of ethical implications). Provided that this condition is met, there is no requirement that the computing ethics course be taught by the CS department itself.
(2) *The course must not be a general ethics course* which is not specifically oriented towards the ethics of computing technology.
(3) *The course must have a fixed title and subject matter*. We exclude 'special topics' courses where the topic is changed from semester to semester primarily for practical reasons.

Examples of the CS ethics courses we identified through our study are included in Table 2.

3.4 Coding Criteria

In reviewing CS degree requirements with respect to CS ethics courses, we categorized each university's CS degree into one of four categories:

(1) *A CS ethics course is required* ("**REQUIRED**") — The degree program has a requirement for students to take a CS-related ethics course offered by the department (or an affiliated department). This includes the case where there is a CS ethics requirement with multiple CS ethics course options that satisfy the requirement.

Table 2: Examples of Identified CS Ethics Courses

Requirement Type	Course Title	University
REQUIRED	The Ethics of Artificial Intelligence and Automation	Johns Hopkins University
REQUIRED	Professional Computing Issues	King Abdulaziz University
OPTION	Ethics and Policy Issues in Computing	Carnegie Mellon University
ELECTIVE	Legal Aspects of Computing	The University of Hong Kong

Table 3: CS Ethics Requirement Adoption by Institution Type

	US Public	US Private	non-US	Total
Count	106	39	105	250
REQUIRED	45.3%	25.6%	23.8%	33.2%
OPTION	5.7%	15.4%	1.9%	5.6%
ELECTIVE	14.2%	23.1%	12.4%	14.8%
NOT OFFERED	34.9%	35.9%	61.9%	46.4%

(2) *A CS ethics course may be used to satisfy a CS degree requirement* ("**OPTION**") — The degree program has a specific (i.e. named) requirement (not a general 'elective' category) that may be satisfied by taking a CS ethics course. This category differs from category 1 in that it is possible to complete the degree without having to take the CS ethics course.
(3) *A CS ethics course is offered as an elective course* ("**ELECTIVE**") — The CS department offers one or more CS ethics courses, which may be used as elective courses. Taking the course counts towards graduation, but taking that specific course is not necessary to graduate. In contrast to category 2, these courses do not fulfill a *specific* degree requirement.
(4) *The department does not offer any CS ethics courses* ("**NOT OFFERED**") — The CS department does not offer a CS ethics course.

4 Findings

Table 3 shows the distribution of CS ethics requirement adoption by type of university. Our US-based research team is particularly interested in whether there is any significant difference in ethics requirements between CS programs at public, state-funded universities and private universities in the United States, so we have split US universities into these two categories while grouping all non-US universities together.

Overall, more than half of the CS bachelor's programs we reviewed *offered* an ethics-related CS course, while only one third *required* students to take a CS ethics course in order to graduate.

Table 4: Average QS Rank By Requirement Type (US Top-200 Universities)

Requirement Type	Average Rank
REQUIRED	120
OPTION + ELECTIVE	80
NOT OFFERED	65
All US Top-200	83

4.1 US vs. non-US Universities

The difference in distribution of requirement adoption between US and non-US universities suggests a significant difference in attitudes towards the incorporation of ethics into the curriculum between the two types of institutions. Nearly two-thirds (62%) of non-US universities do not offer any ethics course, compared to only 35% of US universities. Nevertheless, the percentage of programs where an ethics course is required (24%) is similar to US private universities (26%), while the percentage of programs with an ethics course as an elective (12%) is slightly less than for US public universities (14%). Yet the lack of flexibility in course selection for many degree programs outside of the US, combined with the fact that many of the non-US bachelor's degrees can be completed in three instead of four years, means that a significant majority of students at these institutions receive no (standalone) CS ethics education during their undergraduate career.

4.2 Public vs. Private US Universities

Only 35% of US public (state-funded) universities in our dataset did not offer an ethics course, 1% less than US private universities (36%) and almost 30% less than non-US universities (62%). Public and private US institutions appear, on the whole, to be much more aligned with respect to the teaching of computing ethics than their international counterparts. Notable, however, is the difference in how US universities incorporate ethics courses into their CS curricula. The percentage of public universities requiring the completion of an ethics course is almost twice as high as for private universities, whereas private schools tend to include CS ethics as an optional or elective course instead.

Given the diverse demographics of the US universities (both public and private) in our pool, we also explore possible variances in ethics requirements based on the 'prestige' or popularity of the CS program. Using only the US universities appearing in the top 200 of the QS World University Rankings for Computer Science, we calculated the average ranking for each of the coding categories (Table 4). The average rank of the 43 included schools is 83, but the average rank of schools that require a CS ethics course (120) is almost 1.5 times as large, while the average for schools that do not offer any ethics courses is significantly lower (65).

5 Discussion

That only 33% of schools require a CS ethics course of their students is more or less in line with our preconceptions. However, we are surprised that nearly half of all universities do not even offer an ethics course specific to the CS major, given that ethical decision-making has been made a core part of the ABET expected student outcomes [1]. While our study purposefully excludes 'general' ethics courses without a specific focus on computing (see Section 3.3), we recognize that ABET's outcome-based approach [6] takes such courses into account in the accreditation process. For students in some CS programs housed inside a college of engineering, there might be an additional college-level or general education requirement for an 'engineering ethics' course. For example, Singapore Management University requires students to take its "Ethics & Social Responsibility" course as part of the school's core curriculum, and Stanford University offers a course in "Ethics, Public Policy, & Technological Change" that satisfies the engineering school's "Technology in Society" requirement. Given the potential overlap of general education requirements, it is understandable that some CS departments may hesitate to add a specific CS ethics requirement to students' already-full course load when some of the same content is covered by general education requirements. Nevertheless, we question whether taking a general 'engineering ethics' course provides sufficient preparation for CS students to tackle the specific ethical challenges associated with the rise of AI, growing data collection and surveillance technologies, and autonomous vehicles.

Regarding the difference in ethics course offerings between US and non-US universities, we posit that the shorter time to degree (3 years vs. 4 years) in some countries (e.g. the United Kingdom) coupled with the lack of student autonomy in choosing courses explains the much lower percentage of schools offering or requiring CS ethics among non-US universities. For most of the non-US institutions in our dataset, there were limited or no opportunities for elective courses. While the lack of course flexibility for these programs accounts for why departments may not offer a computing ethics course [2], we argue that this lack of curricular flexibility is a double-edged sword. When students have less choice in what courses they take, there should be even more of a burden on the department to ensure that the required courses encompass all of the necessary content and skills, including ethical thinking and decision-making. We find evidence here suggesting that CS ethics may be viewed as a more 'expendable' subject that can be left off of the curriculum in order to accommodate other, more 'technical' courses, corroborating the findings of Smith et al. [17].

Similarly concerning to us is the appearance of significant differences in whether CS ethics courses are offered or required based on QS rankings. While we don't accept these rankings as an absolute 'ground truth' for the quality of a CS program, we recognize that they play a not insignificant role in decision-making for many prospective students and faculty [14]. As such, it is worrying that of the 26 US universities in the top 100 of the QS rankings, 14 (54%) do not offer any CS ethics course, compared to only 5 (29%) of the 17 US universities ranked between 100 and 200.

In sum, these findings cast doubt on whether the curricula at schools without a CS ethics course fully align with the student outcomes required by ABET. In fairness, it is worth examining whether the existing set of CS ethics courses we identify are actually preparing students to *act* to confront ethical challenges in their computing careers. With this in mind, we question whether the ABET accreditation requirement should be more prescriptive in this area, perhaps including an ethics-related content requirement along with "Substantial coverage of algorithms and complexity,"

"Substantial coverage of at least one general-purpose programming language," and "Exposure to computer architecture and organization" in the *Curriculum* section of the program criteria for CS programs [1].

6 Conclusions

In this paper, we analyze the degree requirements of undergraduate Computer Science or Computer Engineering programs at 250 universities around the world. We find that approximately one half of the universities in our study offer a computing-focused ethics course, while only one third require a CS ethics course to be taken as part of the requirements for the CS degree. These figures are significantly lower than those suggested by previous studies [11, 17, 18]. US universities represent a higher proportion of schools where CS ethics is required in comparison to non-US universities. Moreover, we find that public and private universities in the US differ in the distribution of how computing ethics courses are classified, with almost half of US public schools requiring an ethics course. US private universities, by contrast, rely more heavily on offering a CS ethics course as an elective or an option to fulfill a specific degree requirement. In all, we have concerns about the extent to which universities are meeting the ABET requirement to instill in students the ability to make "informed judgments in computing practice, taking into account legal, ethical...principles" [1]. Thus, we question whether a more explicit computing ethics course requirement from ABET might be warranted.

6.1 Limitations

This study faces three primary limitations. First, although we include a large sample of universities from around the globe, particular geographic regions are significantly underrepresented in our data. This has to do both with the existing geographic distribution of universities on the QS Top-200 list (where over 70% of universities are from North America, Europe, Australia or New Zealand), and our study requirement that curricular information be available in English. Thus, we end up undersampling universities in Asia, Africa and South America (as is evident in Table 1). While we have not asserted that our study population is representative of all universities globally, we make conclusions about the difference in attitudes towards CS ethics between US and non-US universities that may be less applicable for universities in underrepresented regions. Nevertheless, we believe our sample of non-US universities is robust enough to form the basis for our conclusions.

Our study is also limited by the lack of an in-depth analysis of the computing ethics courses we identify through our review of CS degree requirements. On the one hand, this is the intentional result of our focus on requirements and not course content, which we reinforced through our broad definition of what constitutes a CS ethics course. We chose to take this broader perspective in part because existing literature [3] already provides insight into the *content* of some computing ethics courses. Nonetheless, our study identifies a larger sample of universities with CS ethics courses (and perhaps a more diverse set of courses), which merit a full analysis of their content. This analysis is needed in order to draw more concrete conclusions about differences in approaches to teaching ethics to CS undergraduates across degree programs or geographic regions.

Finally, we acknowledge that our study may under-count the number of institutions where computing ethics plays an integral role throughout the entire CS curriculum, or where a general (non-CS specific) ethics course is required as part of college or general education requirements. We justify the exclusion of these cases in Section 3, but we recognize that this paper encapsulates only one specific perspective on how ethics is incorporated into CS education.

6.2 Future Work

Our findings provide a strong foundation upon which to continue research into whether and how ethics are incorporated into CS degree programs. As we discuss in Section 6.1, a deeper analysis of the content of the courses we identify as CS ethics degree requirements would help in drawing further conclusions about differences in institutional attitudes towards ethics in CS degrees. The identification of CS ethics courses conducted for this study could be leveraged to generate a robust sample of ethics courses covering a variety of topics and pedagogical approaches.

However, our data is limited in that it only identifies standalone ethics courses, and does not account for the possibility that ethics education is incorporated through the entirety of the degree program. A comparison between 'embedded' and 'standalone' approaches to ethics pedagogy would also advance academic understanding in the context of CS undergraduate programs. A key research question in this regard is whether CS students receive the same educational benefit and have the same career outcomes regardless of how ethics is incorporated in their undergraduate courses.

Finally, we note that many CS degree programs we reviewed have recently updated their degree requirements. While outside the scope of this study, we suspect that many of these updates include changes to whether a computing ethics course is required, or to the content of a preexisting CS ethics course. We hypothesize that these curricular changes are in part motivated by the emergence of new AI technologies and a world of 'big data'. A closer investigation of the temporality of these curricular changes is therefore necessary.

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