

Refactoring Computing Ethics at Illinois

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Given the ever-increasing impact that digital technology has on our society, we call on the University of Illinois to ‘refactor’ its computing ethics curriculum. In this essay, we -- undergraduates from several computing majors -- urge UIUC to adopt a distributed ethics core and require a standalone ethics class for all computing majors.

Synopsis

How should UIUC teach computing ethics? In 1996, a team of computer scientists provided a definitive answer: ethics content ought to be distributed across the curriculum **and** students should take a standalone ethics class. Still, Illinois’ approach consists only of the standalone course: undergraduates in engineering are required to take CS210: Ethical and Professional Issues, a 2-credit hour course focused on prominent ethical issues in the computing field. Anecdotally, however, CS210’s content is often viewed by students as separate from, rather than complementary to, the technical core. Moreover, students in the Grainger College of Engineering only make up ~50% of computing majors -- the remaining computing students thus leave UIUC without having any required ethics instruction. Given the ever-increasing impact that digital technology has on our society, and inspired by similar initiatives at [Harvard](#), [Brown](#), and [Stanford](#), we feel that now is the time for UIUC to “refactor” its computing ethics pedagogy.

We are proposing a bilateral approach to computing ethics at Illinois. First, ethics content should be embedded across the core curriculum. The key benefit of this approach is that by engaging with ethics across their technical coursework, students become “habituated to ethical thinking.” That is, students learn that viewing problems through an ethical lens is a responsibility, not an afterthought, of the computing professional. In addition, we believe that CS210 should be made required for *all* computing undergraduates. At Illinois, graduates from every computing major end up working on the world’s most influential technology. We therefore feel it is imperative for every computing student, regardless of major, to receive robust ethical training.

The University of Illinois has a history of adapting its core curriculum in response to trends in industry and academia. Over the last decade, the university has introduced new courses in burgeoning areas like cloud computing, virtual reality, and web development. In the 21st century, ethics must become an integral component of computer science education; computing curricula, including that at UIUC, should reflect this fact. As undergraduates and fellow Illini, we urge the CS department to recognize the pressing need for more ethics in its curriculum -- and respond accordingly.

Background

Computer science occupies a complicated position in society. On the one hand, it has enabled tremendous good. Personal computers permit widespread access to essential information and services. The Internet and World Wide Web have allowed people to stay connected to their loved ones, despite spatial differences. Smartphones simplify, among other important functions, navigation, food delivery, and transportation.

Still, computing is fraught with ethical and legal challenges. Autonomous driving systems [are killing](#) people; and YouTube recommendation algorithms [purposefully enrage users](#). Advertising technology firms are [violating children's data privacy](#). Big tech companies are facing [antitrust lawsuits](#), and the [rise of cryptocurrencies](#) is prompting questions about freedom and regulation. And these issues seem to be cropping up with increasing frequency: the aforementioned examples occurred in April 2021 alone.

History of Computing Ethics

Although issues of ethics and equity in computing may seem to only now be receiving attention, many computer scientists have been contemplating the externalities of their field for decades. In 1991, the ACM/IEEE published [Computing Curriculum 1991](#) (CC91), a framework for a new computer science curriculum. CC91 specifically names social, ethical, and professional issues as an underlying principle, clearly stating the imperative for undergraduates to understand “the basic cultural, social, legal and ethical issues inherent in the discipline of computing.”

As a result, the NSF funded ImpactCS, a project aimed at fleshing out the core components of a new subject area: Ethical and Social Impact of Computing (ESIC). They published a series of findings, but of particular importance was their [second report](#). In it, the experts behind ImpactCS detail ESIC's knowledge units and subunits and provide guidance on how to develop a curriculum that includes this new subject area. In particular, the report lists two implementation strategies: departments can add a new required course focusing on ESIC or departments can incorporate modules into core computer science courses. When it comes to the recommended implementation, though, the authors are very clear: schools should employ both strategies. If only one strategy is possible, however, the distributed approach is preferred because it allows students to forge stronger connections between technical, ethical, and social problems.

The Illinois Approach

In the years since ImpactCS, computer science departments across the country have introduced ethics content into their curriculum. [Most often](#), this content manifests in a required stand-alone course, distinct in form and function from the rest of the technical curriculum. At the University of Illinois, we have [CS210: Ethical & Professional Issues](#): a 2-credit hour course, housed in the CS department, that is required for engineering majors and designed for upperclassmen. As students, we have identified several problems with this mode of ethics instruction.

- First, this course is only required for CS engineering majors. As of Spring 2020, [a little over 50%](#) of undergraduates fall into this category; majors such as Mathematics & Computer Science, Statistics & Computer Science, and any of the CS + X programs are **not** required to take any tech ethics course. Regardless of their major, though, Illinois graduates often end up working on some of the most influential technology in the world. We believe that this fact should be reflected in each major's ethics instruction.
- In addition, CS210 is specifically designed for juniors and seniors. This makes sense: students should have sufficient breadth of technical knowledge by the time they engage with ethics in the manner CS210 requires. However, we believe that ethical thinking, much like the practice of software engineering, is a skill that necessarily must be reinforced over time and, more importantly, from early on in an undergraduate's education. This analogy is important. For example, in a [study of including literate programming tools](#) in an intro programming class, researchers found that students experienced positive attitude shifts towards documentation by the end of the course, despite it not being a primary learning objective. We strongly believe that ethics is a subject matter that should be taught in a similarly-embedded way. This takes us to our final point.
- In the study, the authors also listed a salient reason why students normally pay insufficient attention to literate programming: undergraduates have the perception that documentation is of secondary importance to developing executable code. Arguments against ethics education in computer science curricula are strikingly similar. [To many, doing ethics is not doing computer science.](#) And as students, we have seen this perspective first-hand: many of our fellow Illini seem to shrug off CS210 as an unnecessary requirement, a "blow-off" class. This third problem is therefore more pernicious than the first two: many Illini are graduating -- and often working at the most influential organizations in the world -- without a resolute belief in the importance of ethical thinking. By delivering ethics content through CS210 alone, and given that this course is designed for less than half the computing student body, we believe that UIUC impresses upon students that ethics is in fact distinct from *and* secondary to other areas of computer science.

Our Proposal

As students, we are impelled to push for a more robust ethics curriculum here at Illinois. Fortunately, several other universities -- in particular, Harvard, Stanford, University of Colorado Boulder, and Brown -- and researchers have already begun thinking critically about how to teach computing ethics in the 21st-century. What follows in this section is a proposal by synthesis: considering the unique constraints present at Illinois, the areas of opportunity with the current approach, and the efforts of other schools and researchers, we propose two specific changes to how UIUC's CS department teaches ethics.

Note that this proposal is not meant to be exhaustive, and we are conscious of the time required to institute department-level changes. Instead, our primary aim is to start a conversation around how Illinois can produce more ethically-minded computer science

graduates. It is our hope that this essay, and in particular the following suggestions, causes faculty, administrators, and students to re-evaluate the role of ethics in Illinois' CS curriculum.

1. The core ethics content should be taught through a distributed pedagogy.

The core ethics knowledge units -- namely, professional responsibility, basic elements and skills of ethical analysis, and basic elements and skills of social analysis -- as described by the ImpactCS project, should be learned in a recurring, distributed manner. To many, this idea might seem far-fetched: after all, how could ethics be integrated into CS124: Intro to Computer Science, a course that teaches students about the most basic concepts in computing? And how about in a more theory-heavy course, such as CS421: Programming Languages & Compilers, where the content focuses on software verification and validation? These are important questions; fortunately, they're already being answered. Herein we present two examples of ethics integration in courses at the University of Colorado Boulder and Harvard. These courses were chosen because they closely resemble Illinois' CS124 and CS421, respectively, and therefore serve as concrete examples of what an integrated approach might look like.

Integration in CS124: Intro to Computer Science

At the University of Colorado Boulder (CU), researchers wanted to examine the impact of recontextualizing programming assignments with real-world ethical dilemmas. Specifically, [they replaced two assignments](#) in CS2 -- CU's intro programming course for majors, and, importantly, a class that resembles CS124 in its goals and content -- in this manner. We'll look at the first assignment, Personalized Ads, which covers conditionals and booleans. The learning objectives for this assignment included understanding boolean expressions and implementing multi-way decisions using if/else statements. This is the provided context for the assignment:

Your job is to write a program that decides on an ad to serve to a person on a social media platform. The personalized ad program will prompt the user for information and then return text that describes ads based on their inputs.

Students must implement a variety of decisions that the algorithm must make; one example is advertising food to a user based on their ownership of a dog. As you can see, the assignment forces students to grapple with several questions: How is users' data employed for advertising purposes? How could inferences about a user be drawn from data alone? In the follow-up to the programming assignment, two relevant ethical dilemmas were presented: the Cambridge Analytica scandal and Target's algorithms for identifying whether customers were pregnant (or not).

An additional benefit of this approach was that students were, on average, more engaged with assignments due to the real-world context. Many students indicated that they'd like these types of assignments at CU in the future, and due to the initiative's success, there are plans to recontextualize *all* assignments in the large intro courses.

Given its introductory role in UIUC's curriculum, we believe that CS124 could modify existing assignments to include real-world context. It is also likely that CS128 and CS225 -- other

programming-focused courses -- could design assignments that evince ethical issues while still delivering the high-quality technical instruction characteristic of UIUC.

Integration in CS421: Programming Languages & Compilers

In 2017, Harvard piloted a new model for delivering ethics content in its undergraduate courses. The CS department brought on advanced Ph.D. students and postdocs in philosophy as teaching assistants to identify relevant ethical issues and design ethics “modules” for several core computer science classes. These TAs would then lead one or two class sessions during the semester to explore the issues in greater depth.

This initiative was so successful that it became the default way to teach ethics at Harvard: it is now known formally as the [Embedded EthiCS](#) program. Each semester, the program provides roughly 10 computer science courses with ethics modules and philosophers to teach their contents. (The Embedded EthiCS team also maintains a [publicly-available list](#) of the modules they’ve developed, and they encourage other universities to freely use the content.) In Spring 2019, for instance, some of the courses that received modules were CS181: Machine Learning, CS287: Natural Language Processing, and CS152: Programming Languages. In order to illustrate how a seemingly theory-focused course like CS421 might embed ethics content, we present the Module Overview and the Connection to Course Technical Material for Harvard’s Programming Languages course (each section has been condensed for brevity, the full module -- with the description, materials, and assignments/activities -- can be found [here](#)).

Programming Languages (CS152) - 2019 Spring

“Module Overview: Machine ethics is a nascent interdisciplinary field devoted to ensuring that AI-based systems behave in ethically acceptable ways by modifying the way they make decisions to take ethical considerations explicitly into account.

In this module, we discuss two emerging strategies in machine ethics. The first makes use of *ethical design specifications*. The second makes use of *machine moral reasoning*. We consider a series of case studies in machine ethics in order to evaluate the promise and limitations of these two strategies for ensuring ethically acceptable system behavior.

Connection to Course Technical Material: In the lead-up to the module, the course covers automated techniques that can be used to verify that a software system will behave in accordance with its design specifications.”

In sum, the ethics module for Harvard’s Programming Languages introduces the concept of ethical design specifications in context of software verification. Just as a compiler verifies that a piece of program code is well-formed, ethical verification, if done properly, may help mitigate the negative social externalities of computing systems.

Given that CS421 has students implement a common software verification technique -- namely, a compiler for a toy functional programming language -- over the entire semester, we strongly believe that this Embedded EthiCS module could be easily adapted for or inserted directly into this course.

2. In addition to the distribution of core ethics content around the curriculum, CS210 should remain required for engineering majors and become required for non-engineering majors.

The idea that only half the computing student body is required to take an ethics course is untenable. Computing majors, regardless of their home college within the university, will go on to have similar roles, at similar organizations, and writing similar code. Insofar as computing majors not in engineering are still computer scientists, they should receive equivalent ethics training as their peers in Grainger.

Furthermore, distributing the core ethics content, we think, will allow CS210 to go into greater depth and improve student outcomes in the course. If students enter CS210 having already been exposed to ethical thinking in their core courses, then instructors need not justify to students that ethics is worthy of study. To this end, instructors can spend less time introducing basic ethical issues like machine learning bias, software accessibility, and data privacy. It is likely that, with a distributed ethics core, students will have more intimate conversations about ethical issues with instructors and each other, and make the most of their time in the course. No longer will CS210 be the outlier of the curriculum; instead, it will serve more as an ethical capstone, complementary to the technical core and allowing for meaningful introspection, contemplation, and discussion about how students may affect the world once they graduate.

It is important to note that these two suggestions, together, constitute the exact approach that the ImpactCS project, mentioned in an earlier section, recommended back in 1996; namely, distributed core content and a supplementary required course.

This proposal addresses each of the three problems mentioned in the previous section. By making CS210 required for **all** computing majors, UIUC will ensure that each graduate is equipped to respond to ethical dilemmas in the real world. And shifting to a distributed pedagogy guarantees that students are exposed to ethical thinking early and often: as we've seen, this approach may profoundly affect student attitudes towards ethics. UIUC must impress upon its graduates that thinking ethically is a requisite for effective computer science; as students, we believe that instituting these changes will create such an impression.

Conclusion

Our proposal presented in this essay can essentially be boiled down to one belief: Viewing problems through an ethical lens is a responsibility, not an afterthought, of the computing professional. If UIUC takes this to be true, as we believe it should, then it must reflect on how it inculcates in its students this idea. As we've illustrated, there are a number of opportunity areas with the current mode of instruction -- a single required course for CS engineering juniors and seniors -- that upon reflection should be startlingly apparent.

Other schools have already reckoned with ethics education in computing. Most recently Stanford, a university similar to UIUC in computing prestige and engineering pedagogy, [announced](#) that it was collaborating with Harvard's Embedded EthiCS team to build ethics

modules for its core technical classes. Since 2019, Brown University has embedded [Socially Responsible Computing Teaching Assistants \(STA\)](#) into many core classes; similar to Embedded EthiCS, these STAs develop content that connects each course's technical material to its social context. UIUC has a unique opportunity to learn from the successes and mistakes of these early initiatives. It could, without significant changes to existing courses, develop additional ethics content to complement its already-strong technical curriculum.

Illinois is already showing leadership in the domain of ethical computing. The [Just Infrastructures](#) speaker series and Equity and Justice in Computing conversations are prime examples that UIUC realizes that its community ought to grapple with the societal impact of computing. Redesigning the ethics curriculum would be a resounding next step in the department's commitment to producing responsible computer scientists.

It is no secret that digital technology will continue to have a massive impact on society in the 21st century. And the University of Illinois Urbana-Champaign, with its groundbreaking research and world-renowned education, will undoubtedly be a source of tremendous digital innovation in the years to come. But as computer scientists and humans, it is imperative that we ask ourselves: Are the changes we make the ones society truly needs? In our view, creating a robust, distributed ethics curriculum represents a first step towards preparing every Illini to effectively answer this question.