Proposal for a New Course in Computer Science: Ethical Challenges in Technology

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by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Ethical Challenges in Technology

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ABSTRACT

The proposed course, Ethical Challenges in Technology, will be a high-level overview of ethical issues within the technology industry. The stand-alone ethics course will be a combination of technical concept reviews, current event analysis, and case studies of landmark events in the history of computing. Students will analyze specific products and policies that have fundamentally shifted the course of the industry. This material will be specifically designed for undergraduates in their last year of study, preparing students with the necessary tools to evaluate the impact of public-facing industry work. The content will not be limited to students pursuing a career in software development; instead, the curriculum will cover a broad range of professional pursuits within the computing industry. Each unit of the course will incorporate various topics from existing courses in the University of Virginia computer science offering: Algorithms, Cybersecurity, Artificial Intelligence, Machine Learning, and others. Collaborating with professors that teach these topics will ensure that the material is not overly repetitive or beyond the scope of the original course. This structure will allow students to combine existing knowledge with a broad perspective on how these technologies affect the larger industry.

The final deliverable is an interactive course website with a detailed syllabus, a tentative 12-week schedule, a project specification document, and a week of lecture material. The course website will provide links to functioning external communication platforms, Discord and GitHub Discussions, that have been setup for demonstration purposes. The syllabus describes the delivery method for the course content and the expectations for varying types of coursework. This project aims to present a practical, thorough course proposal that will allow undergraduate students to develop an understanding of the ethical implications of work being done by computer scientists.

1 INTRODUCTION

Computer software has the power to fundamentally change the way that society functions and the curriculum taught to undergraduate computer scientists must empower students to connect with the underlying social issues that frame technical challenges [4]. The need for responsible computing professionals is growing as developing technologies involve more complex ethical and social implications. At the University of Virginia (UVA), there are no required courses for a degree in computer science that focus specifically on the ethical ramifications of modern-day computing [1]. Undergraduate students pursuing a Bachelor of Science in Computer Science (BSCS) are required to take a course in ethics and professionalism to satisfy general education requirements for the School of Engineering and Applied Science (SEAS). The course, "STS 4600: The Engineer, Ethics, and Professional Responsibility", is designed for students in their fourth year of study. However, this course is not specific to problems within the computing industry and is not taught by professors from the Department of Computer Science. The course is not a degree requirement for students pursing a Bachelor of Arts in Computer Science (BACS).

2 BACKGROUND

In recent years, there has been increasing scrutiny of technology companies for failing to appropriately address the social implications of their products. The majority of facial recognition systems have reduced accuracy on nonwhite faces [5]. The YouTube recommendation system has been criticized for amplifying misinformation and conspiratorial content [6]. The rise of an Uber-fueled gig economy has the potential to permanently endanger workers' rights [7]. Despite these concerns, major technology firms have continued to grow substantially, experiencing major revenue surges and increasing the size of their workforces [8]. The engineers who work on these systems are often not adequately trained to evaluate the impact of their public-facing industry work. Additionally, private companies cannot train employees on ethical product design without the potential for major conflicts of interest with the business interests of the company executives.

3 RELATED WORK

In order to address these challenges, many top universities are introducing mandatory ethics education for computer science majors [10]. Universities have taken many different approaches for educating undergraduate students on ethics, including stand-alone courses and embedded ethics within existing courses. This study will specifically focus on developing a stand-alone ethics course for computer science majors. Related work will focus on the

existence of stand-alone ethics courses within highly ranked undergraduate computer science programs. While it is important for each course in computer science to incorporate discussions on ethical implications, integrated ethics education is beyond the scope of this study.

3.1 Top Ten Undergraduate Programs

According to a 2021 U.S. News ranking, the ten highest ranking undergraduate computer science programs are shown in Figure 1.

Rank	University	Abbreviation
1	Massachusetts Institute of Technology	MIT
2	Carnegie Mellon University	CMU
2	Stanford University	SU
2	University of California--Berkeley	UCB
5	California Institute of Technology	CalTech
5	Cornell University	CU
5	Georgia Institute of Technology	GT
5	Princeton University	PU
5	University of Illinois--Urbana-Champaign	UIUC
5	University of Washington	UW

Figure 1: Ten Highest Ranking Undergraduate Programs

Utilizing publicly available course directories and curriculum requirements, the keyword "ethic" was searched to identify whether the program offered or required a course dedicated to ethical studies. Of the ten highest ranking programs, all but one department offered a course that was related to ethical impact of computer science. Of these courses, three were required for the completion of a degree in computer science. A complete list of the course titles offered by these undergraduate programs can be found in Figure 2.

School	Term	Course	Require	Website
MIT	Spring 2020	[10.01] Ethics for Engineers: Artificial Intelligence	N	N
CMU	Spring 2019	[17200] Ethics and Policy Issues in Computing	Y	N
SU	Spring 2020	[CS 181] Computers, Ethics, and Public Policy	N	Y
UCB	Spring 2021	[CS 195] Social Implications of Computer Technology	N	Y
CalTech	-	-	-	-
CU	Spring 2021	[CS 1340] Choices and Consequences in Computing	N	Y
GT	Spring 2021	[CS 4873] Computing, Society, and Professionalism	Y	Y
PU	Spring 2021	[COS 534] Fairness in Machine Learning	N	N
UIUC	Spring 2021	[CS 210] Ethical & Professional Issues	Y	N
UW	Spring 2021	[CSE 492e] Computer Ethics	N	Y

Figure 2: Program Course Offerings, Requirements, and Website Availability

Many of the courses listed in Figure 2 had publicly available syllabi or course websites from current or previous years. For the two courses that did not, UIUC and PU, professors teaching the courses were contacted directly for a syllabus request. The syllabi were used to compare grading distributions, course topics, learning objectives, textbook requirements, and assignment types. The courses with publicly available websites provided additional insights for specific assignment ideas and requirements.

3.2 UVA Special Topics Course

In the Spring of 2021 a special-topics elective course, "CS 3501: Everyday Ethics and Quotidian Quandaries for Computer Scientists" was offered for the first time [11]. The stated goal of the course was to "raise awareness and increase understanding of the moral and ethical aspects of computing systems." The full course material was not available at the beginning of the Spring 2021 semester, but was considered as it was added throughout the term. The syllabus for the course and weekly course materials were available freely online. Overarching course themes, learning objectives, and unit topics were heavily considered when deriving the course material for a new standalone ethics course.

3.2 Syllabi Analysis

In response to the rising demand for courses in ethical technology development, researchers have attempted to uncover patterns in syllabi for standalone tech ethics courses. [12] The study by Fiesler et al. analyzed 115 crowd-sourced syllabi from university courses. The study provided a topic mapping to identify which categories were most popular among the syllabi analyzed. The types of learning outcomes of the course were also categories and quantitatively analyzed. While the results of the study showed high variability in the topics and objectives of ethics courses, this lack of standardization suggests there is a lot of room for professors of tech ethics to incorporate a wide variety of topics in their prepared course materials. There is no standardized curriculum for these types of courses, but certain topics are more frequently address than others. Additionally, this study highlights the importance of frequent updates to course content to address the changing landscape of the technology industry. Newly developing technologies require increasingly complex discussions of ethical consequences, so having a section of the course address the most current and relevant issues may include content that varies from year to year.

4 COURSE DESIGN

The course was designed to include a comprehensive syllabus, 12-week schedule, project specification document, and a week of lecture material. The course schedule was designed for a 50-minute class period on Mondays, Wednesdays, and Fridays. The shorter and more frequent class periods are preferred for keeping students actively engaged in frequent discussions. The material could be adapted to fit a 75-minute

4.1 High-Level Course Objectives

By the end of the course, students should be able to understand to meet the following learning objectives:

1. Understand and articulate critical perspectives of computing technologies.

2. Recognize the importance of ethical considerations in software development.
3. Assess the social implications of their specific career goals.
4. Respect diverse opinions and engage in difficult conversations.
5. Evaluate the ethical responsibilities of individuals and organizations.

The learning objectives were heavily influenced by the syllabi for CSE 492e and CS 3501. The ability to "understand and articulate complex arguments" was part of a learning objective of CSE 492e, and is important for students as they progress into their professional careers. Having a strong moral instinct is critical in the process of identifying an ethical issue, but the ability to clearly communicate and describe the problem is important for making progress towards a solution. The course also specifically aims to highlight the ethical considerations of software development. This is one of the most popular career paths for undergraduate computer science students [9]. Although not all students will pursue a career in software development, they will likely interact with software development in some form if they become a professional in the computing industry. As such, it was necessary to include specific objectives for understanding the software development career path. The course is aimed at fourth year students, who are also encouraged to explore their own specific career goals. Many students will already have post-graduation jobs, but other will still be exploring their options within the industry. Providing students with the necessary tools to evaluate the impact of their own public-facing work is an essential part of understanding the role that ethical decision making will play in their own lives. It is also important for students to develop the ability to engage in difficult conversations. Many of the issues discussed do not have clear solutions, and a wide variety of perspectives and viewpoints need to be considered to gain a holistic understanding of the issue. Students need to consider opposing viewpoints and respect the diversity of opinions that will be presented. Finally, students should be able to distinguish between the responsibilities of individuals and organizations when it comes to ethical decision making. Many of the case studies in the course focus on the impact of large organizations. However, it is important for students to consider how individual employees within an organization can exercise power and ensure that their personal contributions are aligned with their own ethical standards.

4.2 Topics

The overall topics for the course were derived after directly reviewing the top-ten course list for common themes, reviewing popular topics for a large number of stand-alone ethics courses, and ensuring that existing UVA computer science course subject matters could be easily incorporated. The first week of the algorithmic bias unit cover gender bias, racial bias, a case study on housing discrimination. The second week of the unit will consist of a documentary on facial recognition bias, and a discussion on whether unbiased AI is possible. The automation unit will cover labor displacement, a case study on call centers, reskilling workers, and a socially responsible framework for automating the workforce. The gig economy unit include an overview of the gig workforce, a case study into Door Dash, and a discussion on the current state of California Proposition 22. The Silicon Valley unit will include a discussion on corporate culture within the tech industry, a case study on Susan Fowler, and dialogue on the political and geographical future of Silicon Valley. The first week of the platforms unit will take place over two weeks and will cover the rise of personalized feeds and recommendations, and case study on the YouTube recommendation system, and a discussion on who is responsible for the moderation of user-generated content on social media platforms. The second week will involve a discussion on privacy legislation, a case study on the Donald Trump Twitter ban, and a discussion on an individual's right to free speech on the Internet. The environmental impacts unit will discuss the idea of environmentally friendly software, the effects of big data operations, and a case study on the carbon footprint of cryptocurrency mining operations. The special topics unit will vary by semester depending on relevant topics and specific student interests. The example topics for the week are stock trading mobile applications, remote learning and student privacy, and the effects of the coronavirus pandemic. The regulation unit will address the monopoly scrutiny facing big technology companies, the recent legislation pushes, and the future of regulation

4.3 Coursework

Throughout the semester students will be expected to complete a semester-long project, post twice a week in online discussion forums, participate during in-class breakout group discussions, present a current event talk, and actively assess their well-being.

4.3.1 Project. The structure of the project was based primarily on the final project guidelines for CS 181 at Stanford University [3] and CS 3501 at UVA. The project will consist four major parts: project proposal, midpoint, write-up, and presentation. Students will have the chance to work alone or with a maximum of four team members. There will be a discussion page on the Discord server for students to share their project ideas and identify prospective team members. The specific requirements for those components will be discussed at length in the following section.

4.3.2 Discussion Forum. Every week students will post in an online discussion forum to reflect on the week's topic or case study. Discussion forum posts are due before class. No late submissions will be accepted, but students will be able to participate in a make-up discussion at the end of the semester. This online forum is designed to ensure that students are held accountable for completing the readings, but do not feel burdened by a high-stress assessment. Some students may feel more comfortable expressing their thoughts in the online forum than during the in-class discussions, so participation will take into account a holistic view of the student's willingness to share their ideas and communicate with other students in the course. Every week will consist of a Pre-Discussion that is due before the Monday class. Students are expected to reflected generally on the assigned readings for the Monday class and their general expectations regarding the weekly topic. The Post-Discussion will be due every Friday before class. This gives students a chance to reflect on how their perspective of the topic has changed based on the case studies and discussion groups. Additional topic-specific reflection questions will be posted on the discussion page. Having the discussions due before class each week will give the students a consistent pattern of deadlines that allow them to build routine. Additionally, having the

Post-Discussion due before the Friday class will allow for the professor to address closing thoughts and ensure that the students do not feel burdened with assignments prior to the start of the weekend.

4.3.3 Participation and Professionalism. The structure of rotational breakout groups and peer evaluations was based loosely on the Spring 2020 offering of "STS 4600: The Engineer, Ethics, and Professional Responsibility" taught by Peter Norton at UVA. In order to help facilitate discussions, breakout sessions will be conducted at various times throughout the course. Students will rotate through four different randomly assigned discussion groups. The size of discussion groups will depend on overall course enrollment but you can expect around five students per group. Each discussion group will meet for a three-week period, after which the students will reflect on their experiences and evaluate their fellow group members. The participation and professionalism grade will be based on group evaluations, attendance, and overall engagement. Students will not be penalized for unavoidable absences, but should notify their discussion group by email and cc the course instructor for visibility. Students are expected to respect the opinions of others and abide by pre-established group norms.

4.3.4 Current Event Talks. This assignment is loosely based on the "Cyber Chat" assignment given during the Fall 2020 offering of "CS 3710: Introduction to Cybersecurity" taught by Angela Orebaugh at UVA. Each student will be expected to sign-up for a five-minute lightning talk on a current event. Throughout the semester, students will present the talks at the end of class on Friday. Specific materials are not required, but the talks are expected to be engaging and informative. For full credit, students will be required to post a brief summary of their talk and links to sources) on the discussion page. There is no specific length requirement, but a sufficient summarization is expected to be around 500 words. Current events are expected to be relevant to any of the themes covered in the course and should be taken from a primary source published during the week of the talk.

4.3.5 Self-Care. The inclusion of a grade for "Self-Care" was based on the CS 181 course offered at Stanford University. This addition was designed to alleviate some of the socially challenges aspects of virtual courses. Throughout the semester, students will be encouraged to spend some time on wellness. Students will reflect on their progress during a bi-weekly judgment-free survey. There will be a chance to give anonymous feedback to course staff and request additional support if needed.

4.4 Project Requirements

The semester-long projects are designed to engage students with the real-world impacts of ethical work in technology. The project must produce a deliverable that engages with the outside world regarding an issue of ethics. An ideal project would concern a problem that is not specific to the UVA community, but exceptional ideas that are specifically impactful on grounds will be considered. Students have a lot of flexibility to choose their medium of delivery. Projects could take the form of a blog post, website, video, or computing artifact. However, project teams must quantify, explain, or demonstrate the impact of their project within the community.

4.4.1 Logistics. Projects may be completed individually or with up to four additional team members. Any teams will need to submit one document per team. The amount of work done for the project is expected to scale with group size, so there is no grading "advantage" for larger groups. There have been three Discord channels designated for project-related conversations. The #idea-brainstorm channel will be used for initial brainstorming of ideas and project deliverables. The #partner-search channel will be used for students to find additional group members. The #proposal will be a change for teams to share their approved project proposals.

4.4.2 Grading Breakdown. Graded evaluations will be spread out throughout the semester. The project proposal will account for 5% of the overall course grade. The midpoint will account for another 5% of the overall grade. The written deliverable and in-class presentation will each be worth 10% of the overall grade.

4.4.3 Important Deadlines. All project-related assignments will be due before class on the Wednesday of the specified week. The deadlines will be available on the Collab assignments page and the course schedule. Students will also receive a verbal reminder of upcoming project-related deadlines during the Monday lecture of the relevant week. The project proposal will be due during Week 4, the midpoint will be due during Week 7, the formal write-up will be due Week 12, and in-class presentation will take place during Week 13.

4.4.4 Project Proposal. The project proposal, around 500 words, should give a brief overview of the ethical issues being considered. Students should describe the type of project deliverable they will be producing and how it will impact the larger community. For larger teams, the group should describe how each team member will actively contribute to the project. It would be helpful for teams to include a brief description of published work related to the proposed project. Any projects that build upon or modify an existing artifact should give explicit credit to the original creator and justify the proposed modifications.

4.4.5 Midpoint. Students should report on their project progress. Specifically, what concrete steps have been taken towards completing the project? The midpoint report should demonstrate substantial progress towards the production of an impactful deliverable. If any circumstances have changed since the project proposal, students should document the changes to their plan and strategies going forward.

4.4.6 Write-Up. The final write-up should include a comprehensive overview of the ethical issue being considered, why it has a significant impact, and why the team chose that topic. Any relevant works considered during the previous stages of the project should be described and appropriately cited. There should be a clear description of the intended project deliverable and the intended impact on the larger community. If applicable, groups can include screenshots, code snippets, links, or supplementary material that helps the reader understand the project deliverable. Teams should reflect on their project's outcomes and how the intended impact compares to the actual implementation.

4.4.6 Presentation. Students should prepare a ten-minute presentation that is engaging, interactive, and clearly demonstrates their project's value. The presentation will be given to other students in the class. Teams should strive to present their material creatively, and the best presentations will be rewarded with a bonus prize at the end of the semester.

4.5 Lecture Content

The deliverable includes an example weeks' worth of lecture material. The content for each day includes a PDF of the lecture slides, topic information, and readings to be completed by the student. The example week provided is for Week 7 of the course, which would correspond to the first week of the Platform unit. The lectures are designed to cover around 45 minutes of class time, with flexible breakout group timing that can be adjusted as needed. The full list of Week 7 discussion prompts are also available on the discussion forum website.

5 COURSE PROCEDURE

The specific course procedures provide an outline of how the material would be taught in an optimal delivery format. The course was designed during Spring 2021, where many courses were delivered entirely online. This course is subsequently designed to accommodate a fully-online student population. Although, the material could be adapted to better suit an in-person environment if necessary. If the recommended course timetable is not available, the material could be adapted to fit the needs of the specific term.

5.1 Logistics

There are 12 weeks of planned course material with a built-in wellness break during the 9th week. Class meetings are online and synchronous via Zoom on the UVA Collab meetings page. These virtual lectures are designed to take place Monday, Wednesday, and Friday. In-class discussions and office hours will utilize a class Discord server. Attendance is required, but students will not be penalized for an unavoidable absence.

5.2 Prerequisites

There are no specific pre-requisite courses that are required before enrollment in the proposed course. However, fourth-year computer science majors will be prioritized for registration. This ensures that the target audience, undergraduate degree candidates, will be given the opportunity to take the course. One week after the initial enrollment period the course will be open to declared computer science students of all years. The course will then open to all students to fill any remaining empty seats. While technical topics will be addressed, no domain-specific knowledge is required to successfully complete the assigned material. The prerequisites section of the syllabus also includes a notice that prospective students should be prepared to engage in difficult and sensitive topics of discussion while maintaining respect for other students' perspectives and ideas. These communication skills will be developed over the course of the term, but it is necessary for students to have a baseline understanding of communication strategies that are essential for productive discussions.

5.3 Communication

Multiple channels of communication will be utilized to replicate the experience of an in-person synchronous course. It is important that students delegate communications to the proper channels to ensure that professors and course staff are notified.

5.3.1 UVA Collab. Lectures will be held via Zoom, accessible on the Online Meetings page. Project materials will be submitted to the Assignments page. Assignment grades will be released within the Gradebook page.

5.3.2 Discord. Informal lecture chats will take place on topic-specific channels. Private discussions for individual discussion groups will be available in group-specific channels that are not monitored by course staff. Office hours will be held in private voice rooms on the Discord server. The complete organizational structure of the Discord server can be found in Figure 3.

5.3.3 Course Website. The course website [2] will include up-to-date information on course topics and schedule. Assignment descriptions and deadlines will be regularly updated. The website will also host links to readings and other relevant materials.

5.3.4 GitHub. The GitHub Discussions page will be used for discussion forum instructions and submissions.

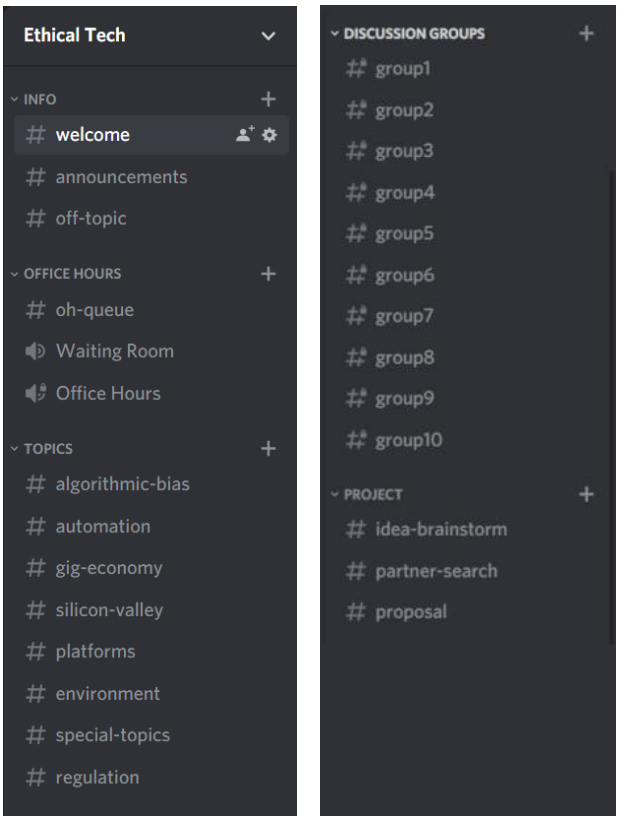

Figure 3: Discord server channels and organizational structure

5.3.5 Email List. Traditional email mailing lists will be used for important announcements, personal administrative inquiries, and notice of unavoidable absences.

5.4 Privacy and Anonymity

Students are expected to create accounts on Discord and GitHub to participate in office hours, lecture chats, and discussion forums. If a student does not already have these accounts, they are expected to make one. Students are not required to register for the sites with their UVA email account. While Discord provides custom channels and the ability to privately chat with other students, it does not allow for threaded conversations and is unsuitable for discussion forums. The GitHub discussion site is publicly visible but will be taken down at the conclusion of the course. Students with privacy concerns are encouraged to make a new GitHub account with a pseudonym that is not connected to any existing online identities. Students who choose to use a pseudonym should notify course staff by email in order to get credit for grading purposes.

7 CONCLUSIONS

This course was designed to meet the increased demand for ethical education in computing science undergraduate programs. In order to better understand the status quo of ethical computing education, the highest-ranking undergraduate computer science programs were analyzed to determine the existence and scope of their standalone courses in technology-related ethics. A special-topics elective course offered at UVA during Spring 2021 focused on ethical challenges for computer scientists also served as a resource for designing the content and structure of the course. The resulting deliverable was a fully comprehensive course website, syllabus, schedule, project assignment, and discussion forum accompanied by a weeks' worth of lecture content on the ethical implications of social media platforms. The course website and discussion forum were hosted using GitHub, and a fully functional Discord server with relevant channels was created.

8 FUTURE WORK

To expand upon the initial concept for the course, additional lecture content is needed to fulfil the requirements for a semester-long course. On top of three lectures, each week should have two discussion posts that include prompt questions specific to the topic at hand. The unit that covers special topics should be updated on a yearly basis to reflect the most relevant news to the technology industry at the given time. Additionally, in-depth consultation should take place with faculty members who teach areas of computer science that have large ethical impact. This would ensure that the scope of the material covered is relevant to their delivery of the course, without being overly repetitive. These professors could also server as guest lecturers from within the department that provide helpful additional context and technical expertise to the units that are most relevant to their field of research.

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