Embedded Ethics: Pandemic Exposure Notification Systems and Giving Ethical Justifications

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SYNOPSIS

In this follow-up to "Embedded Ethics: Pandemic Contact Tracing and Ethical Trade-Offs" [6], students revisit a trade-off they faced in that first module. There, students brainstormed about the rich data one might collect to build a powerful app for contact tracing, discovered that this may facilitate violations of privacy, considered the harms that can come from this, and recognized the trade-off between protecting privacy and gathering data to support the fight against the spread of a disease such as COVID-19.

This second module comprises pre-class, in-class, and post-class activities. In the technical portion of the module, students learn that seeming solutions like anonymization won't solve privacy concerns. Through a collaborative active-learning exercise, they discover that a policy of limited collection more effectively protects data privacy: if location and private health information are not collected, they cannot be leaked. However, increased privacy comes at the cost of lowered public health protections. In the Philosophy portion of this module, students return to the stakeholders they met in the first module, with a different ethical goal in mind: justifying a design decision to a stakeholder who would have preferred a different ethical trade-off. They practise this through a second collaborative activity and a short, written, homework exercise. All the elements of this module, and the materials that support them, are described in Section 6.

Together these two modules demonstrate how technical design decisions can be ethically informed. After completing these embedded ethics modules, students will be better prepared to recognize and discuss ethical issues, and take them into account in their design decisions—skills that will be increasingly important to their careers.

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KEYWORDS

Embedded Ethics, Software Design, Data Privacy, Public Health, Contact Tracing, Exposure Notification, Stakeholders, Ethical Justification, Graph Applications

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1 ENGAGEMENT HIGHLIGHTS

This module incorporates several of the NCWIT Engagement Practices [2]:

Like the first module, this module fulfills the Make IT Matter engagement practice, Use Meaningful and Relevant Content, by centering the highly relevant topic of COVID-19. This module also Makes Interdisciplinary Connections, linking Computer Science to the humanities discipline of Philosophy by inviting students to consider what ethical reasoning could be used to justify a design decision to a stakeholder who would have preferred a different trade-off be made between privacy and public health.

Furthermore, like the first module, this module also embodies the Grow an Inclusive Community engagement practice. All examples and images avoid stereotypes and include representation of diverse social groups. The in-class portion is also highly interactive, incorporating students' responses into the lecture and including two small-group activities that encourage collaborative learning.

Finally, this second module incorporates the engagement practice Building Student Confidence, by referencing concepts taught and student answers from the first module and homework, acknowledging the progress they have made in ethical decision making, and encouraging them to build upon that foundation when practicing the new skill taught in this module: justification of ethical decisions.

2 LEARNING OBJECTIVES

At the end of this module, students will be able to:

- Understand that anonymization of data does not guarantee privacy.
- Recognize that limiting the amount of data collected can reduce the risk that privacy will be violated.
- Appreciate that there often is no neutral decision; every design choice has consequences.
- Justify a decision to a stakeholder, taking their unique perspective and priorities into consideration.

3 RECOMMENDATIONS

Timing of the Modules. This module is designed to be taught after the module "Embedded Ethics: Pandemic Contact Tracing and Ethical Trade-Offs" [6], though it could be adapted to be a stand-alone module.

If teaching this as a stand-alone module, less class time will be required. However, the instructor would need to introduce at least some concepts from the first module, in particular, the concept of an app to help limit the spread of disease, the potential to violate privacy, and the trade-off between protecting privacy and having a more powerful app. This can be done more quickly if the instructor simply teaches these ideas, but may be a less impactful strategy that having students discover the privacy issue themselves, as is done in the first module. Stakeholders can be introduced through the activities in this module, without any prior exposure to that concept.

If teaching both modules, we recommend spacing them out by at least a couple of weeks. This leaves time for students to ponder potential solutions to the problems raised in module 1 before they are addressed in module 2. It also allows time to grade the homework, so that student answers can be referenced during the lecture (opportunities to do so are pointed out in speaker notes with the slides). Most importantly, separating the two modules avoids giving the impression that ethical design is something students can learn and discard after a single class period. Instead, students are encouraged to continue incorporating ethical thinking throughout the course and in their future work in Computer Science.

If necessary, both modules could be done within the same week, or even within the same class period. If they are combined during the same class period, we'd recommend that the homework from the first module be given as an ungraded solo-writing activity, and the pre-class video for module 2 be shown during class, immediately after the completion of the module 1 material.

Prior Knowledge Needed by Students. This module assumes students are familiar with graph data structures, so it fits well in a CS2 course. To adapt for use in CS0 or CS1, the instructor could represent the data simply as a table and omit any mention of graphs. Alternatively, the instructor could use a graph representation for contact data if they merely introduce the concept of a graph; no graph algorithms are assumed.

Instructional Team. We strongly recommend keeping the same lecturer(s) and discussion leader(s) for both modules, so that they can be aware of what was discussed in the first module, since students will likely refer back to it. (Graders could more easily be changed, especially if they are given a summary of the previous module.) Additionally, if both modules are being taught, there's even more reason for Computer Scientists to invest in teaming up with Philosophers who are already familiar with the ethical concepts referenced in the modules. But if such a collaboration is infeasible, we've included a brief primer (in section 4) on the Philosophical concepts that would be useful background for Computer Scientists teaching both halves of the in-class lecture.

In-class Activities and Homework. All of our recommendations from the first module still apply to this module. To briefly summarize the main points: We recommend keeping the same groups for the technical and ethical active learning activities—though these groups need not be the same as those used in the first module. We also recommend modelling the kind of discussion desired in the Philosophy activity before sending students into their groups, since students are

still likely to be less familiar with Philosophical discussions (see demo conversation in the Recording of Lecture video, 18:10-21:00). Collecting answers through a Google form may help to keep students on track during the Philosophy activity and allow the instructors to easily collate and respond to the groups' answers when students return to full-class discussions. Finally, we recommend grading the homework, giving a small grade incentive and grading mostly on completion. If more grading hours are available, more time could be spent commenting on student answers—either individually, or as a general overview of common successes/mistakes in the homework that can be shared with the class.

Emphasizing Collaboration. Ethical issues in the workplace are often dealt with in a collaborative fashion. Although there is plenty of collaborative discussion in the lecture component of this module, instructors who wish to emphasize this further may wish to require that the homework be done in groups.

4 EMBEDDED ETHICS EDUCATION

This module was created by the Embedded Ethics Education Initiative (E3I) team at the University of Toronto. E3I is a joint initiative between the Department of Computer Science and the Schwartz Reisman Institute for Technology and Society. The instructional team comprises both Computer Scientists and Philosophers. Originally inspired by the Embedded EthiCS program at Harvard University [3], the goal of E3I is to develop and evaluate methods for empowering the next generation of scientists, educators, and technology developers with the knowledge, skills, and incentive to incorporate ethical considerations in the study of computer science, and as a design principle in the development of computer science technology throughout their careers. See our website [1] for our current projects, including other embedded ethics modules in upper-year Computer Science courses.

We are conducting longitudinal research into the effectiveness of our embedded ethics modules. For students who completed this module and its precursor module, "Embedded Ethics: Pandemic Contact Tracing and Ethical Trade-Offs" [6], we observed a significant increase in their interest in ethics and technology, and in their confidence that they can identify, raise, and discuss ethical issues [5]. We are also beginning to understand the impact on students of experiencing modules in multiple courses in the same semester as well as over time [4]. See our website [1] for our current projects, including other embedded ethics modules in upper-year Computer Science courses.

5 PHILOSOPHY RESOURCES FOR THE INSTRUCTOR

Although the following concepts are not directly referenced in the module materials, they informed the development of the module, and we anticipate that familiarity with these background concepts will deepen the instructor's understanding and aid in answering student questions.

- Argumentation: Introduction to Critical Thinking in Wi-Phi [9] and Epistemology of Disagreement in 1000-Word Philosophy [8].
- Political Philosophy: Social Contract Theory in 1000-Word Philosophy [8] and Contractualism in Stanford Encyclopedia of Philosophy [7].

6 MATERIALS

- The short **pre-class video** explores a possible solution students may have identified after the first module. The video explains why anonymization is not, in fact, an effective method of protecting individuals' personal information, and introduces a more effective method: limited collection.
- The brief **quiz** encourages students to watch the video and checks their understanding of it.
- The **lesson plan** provides an overview of everything that happens in the 50 minutes of class time, and includes the duration and objective of each element.
- The **lecture slides** provide all the material that we projected during the class and also includes speaker notes, which are especially helpful if the Philosophy components are to be taught by a Computer Scientist who may have less background in this area.
- The **Recording of Lecture**, in tandem with the speaker notes in the slides, is intended as a reference for the instructional team delivering the lecture.
- The **Group Activity 1 Worksheet** is focused on technical content. The objective of this activity is to show students the benefit of switching from a contact tracing system to an exposure notification system: it becomes almost impossible to extract additional, private information from the data collected. However, they also see the cost of this switch: giving up the system's capacity for additional analysis. Rather than collecting this worksheet, we had students share their group's answers during a full-class discussion, after the activity.
- The **Group Activity 2 Worksheet** is focused on Philosophy content. The objective of this activity is for students to practice justifying their design choices to a stakeholder who would have preferred a different trade-off between privacy and public health. We asked the groups to defend either a contact tracing system or

an exposure notification system, and had each group input their answers into a Google form, which the instructor then discussed in the final wrap-up to the module. (Google form not included, since each instructional team would need to create their own, in order to have access to their student's responses.)

- The **Homework** asks the same questions as the in-class Philosophy activity, applied to new stakeholders, so that students can cement the ethical skill that they practiced in their groups through solitary reflection. We include a suggested rubric.
- **Additional Resources** directs students to other resources within the university where they can explore further topics in ethics and technology. This list is specific to the University of Toronto, but could be easily adapted for any educational institution.

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