Abstract: Computer Science and Social Change Concentration

Computer science students want to use their skills for social change, but they receive little academic support to do so. This paper proposes a computer science and social change concentration ("track") within the Stanford University computer science department.

This paper describes a potential program sheet, along with justifications for each inclusion and a four year plan to describe how students would integrate this program into their studies.

Next, this paper describes the benefits of such a program. Socially-conscious students will be more likely to major in computer science, bringing previously marginalized groups into the field. Computer science students will be more likely to think about social issues, which results in increased self-confidence and culturally relevant apps. Socially-conscious computer scientists will receive support for pursuing their career interests. Computer science professors interested in social issues will more easily be able to teach courses about the intersection of social issues and computer science. Social issues with easy programmatic solutions will be addressed. Finally, society's perception of computer scientists will improve.

However, CS and social change programs are not without their detractors. This paper answers three perceived drawbacks to such a program. First, that a track in CS and social change would not be rigorous. Second, that tracks should match CS research and that CS research is not focused on social change. Third, that interested students can already have their needs met through Human Computer Interaction tracks.

Last, this paper examines trends in academic study and practice of social change.

Contents

Logistics

Guidelines

When designing the program, there were several relevant guidelines:

1. The program must be rigorous in computer science. It should have as many or more difficult computer science classes as other tracks.
    a. The purpose of this requirement is to ensure that the program is, first and foremost, a computer science track and that all students have a strong background in computer science.
    b. In AI, Informatics, Systems, Theory, and Unspecialized, students must take 7 CS classes. In Biocomputation, students must take a minimum of 5 CS classes and two classes that can be either advanced biology or computer science. In Graphics, students must take a minimum of 5 CS classes and 2 classes that can be art, design, or CS. In HCI, students must take a minimum of 4 CS classes and three classes that can be CS or design.
    c. This track matches most closely with Graphics and Biocomputation because its main focus is programming for a particular focus area, thus this track should follow with 5 CS classes and two classes that can either be related to social change or CS.
2. Graduates should be capable of significant implementation projects.
    a. The purpose of this requirement is to ensure that all students have technical depth sufficient to do substantial software development. This is necessary because many students will work at another company's big software project (ie, working on crisis maps at Google.org) or start their own from scratch (ie, Frontline SMS).
    b. The Master's Degree in Computer Science has a similar goal with its Significant Implementation requirement. For simplicity, the same requirement can be used (http://mscs.stanford.edu/degree.php).
3. Graduates should be capable of significant design projects.
    a. The purpose of this requirement is to ensure that all students have the ability to tailor their software to a specific user group. This is necessary because many students will work on projects where software is a small, but important, piece of addressing user needs, and designing their program well is at least as important as the technical underpinning.
    b. The HCI tracks for undergraduates and masters students contain design-based classes. Many of the more advanced classes in those tracks only teach one specific area of design rather than giving a broad overview of design, which is not sufficient for the goals of this requirement. Some advanced CS classes go through a user-centered design process from start to finish, and some d.school classes go through a user-centered design process from start to finish, allowing the student to choose their own project.

4. Graduates should have experience connecting computer science to social change.
    a. The purpose of this requirement is to ensure that all students are exposed to a few of the many ways that programming can be used for service. For many students, CS only evokes traditional research subjects like databases or networks. Gaining experience programming for social change in a variety of areas helps computer scientists see novel ways to use their skills for social change.
    b. There are not many classes that obviously connect CS and social change. "Designing Liberation Technology" and "Beyond Bits and Atoms" are two notable exceptions. Many classes, however, have open-ended final projects. If we can add the constraint that those final projects have a connection to social change, then students taking those classes will see a strong connection between traditional CS research topics and social change.
5. Graduates should know about the theory of social change.
    a. When acting in the intersection of computer science and social change, graduates are expected to deal compassionately with people in other cultures or with disadvantaged communities within their own culture. Also, employers might expect the graduates to have expertise in social issues as well as programming. The purpose of this requirement is to ensure that all graduates are comfortable working with people, knowing their issues, and advocating on their behalf.
    b. There are many existing programs that seek to do this already, including Ethics and Society and the Urban Society and Social Change track within Urban Studies. These programs serve as guidelines.

Program Sheet

The Mathematics, Science, Engineering Fundamentals, Technology in Society, and Writing in the Major, and Core requirements are unchanged.

The classes that fulfill the senior project requirement are unchanged. However, there is the additional requirement that the project must be related to social change.

The depth requirement follows the general requirements (there must be a minimum of 7 courses of depth, each of which must be taken for at least 3 units. They must total to at least 26 units), with the following course requirements:

1. Implementation Requirement. One course out of the Masters' Siginificant Implementation requirement: CS 140, 143, 144, 145, 148, 210B, 221, 243, 248, or 347.
2. Design Project. One course out of CS 147, 247, 379L, 402, or 424M. Alternately, any d.school class that has a significant project may be taken to fulfill this requirement as long as the student does programming on the level of CS147.
3. Social Practice. Three courses that include a large programming service project. CS 379L, 402, and 424M satisfy this requirement. Any CS class that lets students choose their own final project can satisfy this requirement as long as the student chooses a service project. Examples of courses that can fulfill this requirement, given approval of your advisor, include CS 147, 192, 221, 224N, 224U 224W, 229, 231A, 240H, 247, 248, 270, 272, 275, 277, 341, 348B, 442, 448B
4. Social Theory. One course in one of the following areas: Identities; Education; Development; Governance, including Public Policy, Public Administration, Nonprofit Management; Public Health; Environment and Energy; Ethical Theory, Psychology, or Practice; Conflict Resolution and Social Movements. For some sample course lists, see the Urban Studies concentration in Social Change or the Ethics in Society program.
5. One course that meets the requirements of either Social Practice or Social Theory.

Sample Four Year Plan

Depth courses are in **bold**.

	Fall	Winter	Spring
Frosh	MATH41 CS106A IHUM WRITING	MATH42 PHYSICS41 IHUM CS106B	CS103 PHYSICS43 IHUM
Sophomore	CS107 Math elective Language Writing	CS109 CS110 Language	**Soc Theory Elective** ENG40 Language Sci. Elective
Junior	**CS147** CS161 GER	**CS140** GER Elective	**CS402** TIS Course Elective
Senior	**CS229** GER Engr Fundamentals	**CS275** Math Elective Elective GER	**CS379L** CS194 GER Elective

Benefits

Bring Socially Conscious Students into CS

Many students choose their major based on its perceived applications to make the world a better place. There are many such applications in computer science, but there is not a widespread perception of how computer science can be used for social change. This deters many students from computer science.

Status quo CS education reinforces CS stereotypes. Students with more exposure to computer science at an early age and among their peers are more easily able to dispel the stereotypes on their own. In an ACM meta-analysis of papers on women in computer science, they recommend improving the image of computer science and showing more real-life applications of computer science (38, 44). Thus, a concentration in CS and social change will attract more people to CS, particularly marginalized groups.

David Douglas and Greg Papdopoulos, former vice presidents at Sun Microsystems, argue that "engineering schools are not fully tapping into the energy that's building around environmental and techno responsibility. Students really do want to change the world ... but our schools have to be deliberate in making these connections, or else the best students will be attracted to other avenues" ("Citizen Engineer," 209).

Make CS Students Care about Social Issues

Many computer science students are not exposed to social issues. Computer science is hard, and some CS students only take a handful of classes outside of the major, leaving them relatively uneducated about the society in which their programs will work. According to the National Survey of Student Engagement, only 21% of engineers feel that their coursework encourages understanding of other cultures, a rate that is less than one third of some other disciplines. Having a track based on the intersection of computer science and social change would allow students to have a list of interesting classes that teach them about the world that they can count for their major.

It is important for computer scientists to know and care about other people, other cultures, and their unique experiences because ignorance leads to ineffective applications. Programmers who don't know about vision impaired people might make a website or user interface that is difficult to use with a screen reader. Video game developers might make a game that women won't want to play, furthering the gap between women and men in computer science. Programmers interested in applications for the developing world might not realize that people in the developing world primarily use their mobile phones to consume the internet.

Help Socially Conscious CS Students Pursue Careers

All students can gain career skills from an increased focus on service within the computer science curriculum. According to the National Survey of Student Engagement, students who engaged in service-learning perceived more substantial gains in job- or work-related knowledge and skills than students who had an internship, though both had substantial gains (14). This is a unique benefit, solving an unmet need, because only 33% of engineers participate in service learning (NSSE, 22), a rate that is the worst of any discipline and that is half as high as some other groups. Thus, an increased focus on service-learning among Stanford computer science students will help computer scientists feel more confident in their careers.

Socially conscious computer scientists will benefit in particular. The computer science department provides many resources to help students find high tech internships. In particular, the computer forum facilitates high tech companies presenting at a career fair and giving career and tech talks. The computer science department does not provide any similar service for students interested in the social change applications of computer science. Computer science nonprofits like InSTEDD, Ushahidi, SamaSource, Envaya, etc, cannot afford the rates necessary to participate in the computer forum, so students who want to program for social change in an internship or as a full time job are left on their own.

Support Socially Conscious CS Professors

Many computer science professors and professionals are interested in social change. Green Computing, Seminar on Teaching Introductory Computer Science, Progressive Tech Law, Ideas for a Better Internet, Designing Liberation Technologies, Perspectives in Assistive Technology, Beyond Bits and Atoms, and Computational Modeling in Cognitive and Social Science are some examples of courses on the intersection of computer science and social change.

Some of these courses are already well supported. For instance, Beyond Bits and Atoms and Cognitive Modeling in Cognitive and Social Science are jointly taught between CS and Education, and they are part of the Learning Design and Technology concentration in Education, so they have a continued supply of interested students and departmental support. The same is not true of all of those classes. For instance, it remains to be seen whether or not Green Computing will get enough enrollment because students can't count the course towards any of their depth requirements, and few computer scientists are taking Ideas for a Better Internet because it is only offered in the Law school.

Adding a track on computer science and social change would create a strong connection between the professors offering these courses and students who would be interested in them. It would allow those students to count these classes toward their major, so the professors could teach classes on the subjects that most interest them.

Develop World-Changing Applications

The nonprofit sector and the developing world can't keep up with the rapid pace of technological innovation because there aren't enough computer scientists working on making applications for those users.

This is not for lack of interest. Hundreds of Stanford computer science students participate at Code the Change's hackathons for social change, and over a third of participants indicate that they would be interested in an internship, volunteer opportunity, or post-graduation career with a social change related organization. Students simply do not know about opportunities in CS and social change because they are not exposed to these opportunities.

As a result, there are many low-hanging fruit in using computer science for social change. It doesn't take much more work to make an application that solves the problem of counterfeit pharmaceuticals killing people (see MPedigree) than it does to solve the problem of mobile/social photo sharing. There are many simple apps that could drastically improve the quality of life of millions of people.

Improve the Perception of CS

There is a negative perception of computer science and computer scientists as geeks who isolate themselves from the world in order to gain financial success. This was one of the motivations for starting the Computing 4 Good program at Georgia Tech. Professor Michael Best describes, "They are down on the ground working on a real problem – using technology to help in global health initiatives or to heal a nation coming out of civil conflict -- not sitting in a lab at Tech ... Students today want to do work where they can see its impact in real terms."

Perceived Drawbacks

It Isn't Rigorous

The proposed program sheet attempts to maintain computer science rigor while still allowing interested students the chance to learn about social change. Graphics and Biocomputation both involve applying computer science to a particular subject area, and they have a minimum of 5 CS depth courses. The same is true of the proposed track in CS and social change.

Furthermore, some parts of the proposed track are uniquely rigorous. With the exception of biocomputation, each of the other tracks has a 100-level course to introduce them to the subject matter. Most of the courses for the proposed track are upper division project courses, ensuring that CS and social change graduates will have at least as many difficult CS classes as their peers.

Additionally, the track includes a great variety of courses from within the CS department. Many Systems graduates haven't taken significant classes in design, and many HCI graduates haven't taken significant classes in implementation. There is a division between the more user-facing concentrations and the more back-end concentrations, with students in each lacking rigor in the other area. The proposed track requires students to take classes in both areas, encouraging a multidisciplinary rigor.

Last, the rigor of a track in computer science and social change is a question of implementation; it is not a fundamental limitation of the idea of computer science and social change. If there are issues with one particular proposal of the track, it is possible to revise the proposal.

Tracks Should Match CS Research

As described in the Benefits section, computer science professors are interested in teaching classes on the intersection of computer science and social issues. As described in the Trends section, there are academic research groups, professional societies, journals, groups within industry, and organizations dedicated to computer science and social change.

Even if that were not true, the argument that tracks should match current research is a self-fulfilling prophecy. The fact that there is not a CS and social change track deters students from studying CS and social change, doing PhD research in it, and continuing on to research CS and social change professionally. It is hard for these professors to teach classes on CS and social change because it won't count for any track, and thus students won't fulfill any requirements by taking the classes, but they teach these classes anyways. The many computer science professionals who have gone against the grain to perform CS and social change research should demonstrate that there is an extraordinary interest in research in this subject.

Interested Students Should Choose HCI

As the program sheet demonstrates, computer science and social change is not solely a design challenge. Just as in computer science as a whole, computer science and social change needs graduates who are capable in implementation and theory in addition to design.

Yes, many nonprofit organizations need simple web applications and data visualization. However, Ushahidi needs security experts to make sure that totalitarian governments can't hack into its crisis maps. People working on crop disease detection in Uganda need machine learning and computer vision to perform a comprehensive disease survey of the crops in the country. The Africa Soil Information System needs 3D graphics works to measure map data. Not to mention that organizations like OpenMRS need people familiar with massive code projects to develop its medical records system for much of the world that cannot afford commercial medical record systems.

David Douglas and Greg Papadopoulos, former vice presidents at Sun Microsystems, write that students interested in engineering and social change should not narrow down into one focus area because "all the really interesting innovation occurs across boundaries, not within a specialty ... our advice is to be as broad as you possibly can, especially as an undergraduate" ("Citizen Engineer," 212). This is true both within computer science (it is necessary to know both design and implementation) and between computer science and social change (it is necessary to know the intersection between computer science and, for instance, law or public policy or public health).

Trends

Broad Trends

David Douglass and Greg Papadopoulos, former vice presidents at Sun Microsystems, and John Boutelle, a technology writer, analyzed trends in engineering and found that there was an increasing interest in social responsibility. They write that today, there is a "groundswell of interest among engineers in extending that same conscientiousness to new areas: to the environment, to the proper use of intellectual property, and to public policy, for example" ("Citizen Engineer," 24).

Academic Research Groups

CMU has an ICT for Sustainable Development group; MIT has the Next Billion Network; Berkeley has an ICT for Development group; the University of Washington has the Change group; Stanford has a Program in Liberation Technologies; and Georgia Tech has a program on Computing 4 Good, Georgia Computes, which is dedicated to K-16 CS outreach, and Computing at the Margins, which researches underserved communities.

Professional Societies and Journals

Computer Professionals for Social Responsibility is both a journal and a professional society. The International Journal of Information Systems and Social Change and the Information and Communication Technologies for Development Collective serve as other examples.

Many journals and societies have some part dedicated to social change. For instance, there is the ACM Special Interest Group on Computers And Society.

Additionally, there is much research that is published in other CS journals that is relevant to computer science and social change: see, for instance, the list of papers at http://orion.qro.itesm.mx/~ccardena/sl4cs.html.

Industry

Industry professionals devote time and energy to these issues. Microsoft has a Technology for Emerging Markets research group. Google and Salesforce donate 1% of their profits and some of their engineering time to causes for public benefit.

Computer Science Social Change Organizations

There are many organizations entirely devoted to computer science and social change. TechChange, TechNow, Code the Change, Random Hacks of Kindness, InSTEDD, Envaya, FrontlineSMS, MPedigree, OpenMRS, and BeneTech are a few examples.

References

The National Survey of Student Engagement (NSSE) includes data on service learning, engineering, and career perceptions.
http://nsse.iub.edu/NSSE_2011_Results/pdf/NSSE_2011_AnnualResults.pdf

ACM has a 2001 meta-analysis on papers regarding women in computer science.
http://women.acm.org/archives/documents/finalreport.pdf

Existing Stanford CS tracks are available in the Undergrad Engineering Handbook.
http://www.stanford.edu/group/ughb/2011-12/UGHB%202011_12_WikiwBookmarks4.pdf

Details on the CS courses outline are available on ExploreCourses and at the Stanford CS departmental website.
http://explorecourses.stanford.edu/CourseSearch/
http://cs.stanford.edu/courses

"Citizen Engineer," a book that Stanford President Hennessy says "engineers and those who work with them should read and discuss over pizza," is about an increasing trend in socially responsible engineering. It is a comprehensive resource about engineering and social change, and it is also available free online.
http://citizenengineer.org/

Further Work

1. Examine existing Engineering and Social Change programs
2. Consider the "Too Many Tracks" perceived drawback.
3. Find more research to support the benefits, answer the drawbacks, and to substantiate the trends.
4. Find research to support student interest in social change
5. Find better research on current perceptions of CS
6. Finish combing through "Citizen Engineer"