Recruiting/Retaining Women in Computing at Harvard

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Executive Summary: We propose to develop a program to increase the participation of women in Harvard Computer Science, leveraging our network of accomplished women computer science alumnae, borrowing from demonstrated successful programs at other universities, and seizing the opportunity provided by David Malan's outstanding efforts at recruiting and retaining women in CS50. We seek to raise a $500,000 5-year fund to support these activities.

This is the right time to launch a concerted effort. Harvard attracts some of the most talented women in the world, yet they are woefully underrepresented in Computer Science, even as computing becomes part of our daily lives. Although historical data would seem to suggest that the problem is global, and there is nothing we can do locally, many universities have shown that, with effort, this trend can be reversed. This past year we have seen a dramatic change due to CS50: enrollment in CS50 is now 37% female, but more importantly double or triple in absolute terms from just 5 years ago, and this year we saw the percentage of newly declared female CS concentrators jump from 15% to a stunning 43% (while the absolute number of concentrators rose as well). *Clearly the interest is there; our challenge is to make computer science more inclusive and meaningful to smart women.*

This white paper outlines a first set of efforts we would like to launch, concentrating on creating a welcoming and empowered community for women interested in CS at Harvard, exposing our women students to computing in the real world and the role women are playing in industry and academia, and creating an internal effort to propagate successful teaching practices from CS50 throughout the curriculum.

1. WHAT WE WANT TO DO

We propose a concerted effort designed to expose women to the range of opportunities in CS and combat the negative image often portrayed in the media. Our immediate goal is to develop a more welcoming and more attractive environment in CS for women, even while absolute numbers are low. One of our key tools will be to better leverage resources outside of the department (e.g., the Grace Hopper Conference, our own Harvard alumnae), and the other key tool will be to create meaningful community within Harvard CS for the women students.

Three immediate efforts we would like to implement are:

1. Expose our students to the greater community of women in Computing.
Start an ANNUAL program to take women students to the Grace Hopper Conference on Women

in Computing. The goal is to take both undergraduate CS women (rising sophomores) and graduate CS women, along with 2 CS faculty (1 female and 1 male) to the event. Overall we expect to take approximately 20-30 students each year, free of cost. *Our ultimate goal is to enable **every** female CS concentrator to attend once and to take many more outside CS as well.* The Grace Hopper conference is a unique and rich experience for most women students -- for many it is the first time they see themselves as part of a technical community and experience the breadth and diversity within CS. Furthermore, it provides an incredible practical opportunity for networking and interviewing with companies. *The Harvey Mudd report* [1] *suggests that this is one of the top three most effective techniques for increasing the number of women CS majors.* In the fall of 2010, Radhika Nagpal and Margo Seltzer organized our first group trip concentrating on graduate women in all areas of CS. The immediate response was overwhelmingly positive as evidenced by our evaluations, but more importantly, the lasting effect has been a continued community and bond between these women. We believe that this bonding effect is a critical element to our efforts.

2. Improve CS culture and teaching in SEAS
Create a "Research Assistant" position (12 hours/week) for coordinating activities within Harvard to address recruiting/retention of women in CS. This would include (a) setting up an enrollment tracking and reporting system to understand and track the undergrad demographics of CS classes by year, gender, and concentration (b) organizing and managing the Grace Hopper group event and other social events (c) organizing workshops and brainstorming sessions to propagate successful teaching practices from CS50 throughout CS classes (d) enabling students to propose their own activities for women in computing at Harvard.

3. Create an external advisory board of Harvard CS alumnae
We would like to create an external advisory board to help vet ideas we are proposing and to suggest new ideas and directions. Our CS alumnae have a unique view on the undergraduate experience, including what opportunities our students have once they leave the university, what experiences within the university are most essential for success, and what Harvard is doing well and badly from that perspective. We believe that this external viewpoint will be essential for effectively targeting our human resources to the most important solutions.

In addition, we would also like to initiate the following events, although our initial fund-raising goals do not include them.

1. Broaden the Image of Computing
Start an outreach program for broadening the image of CS, based on the NCWIT and CMU "CS Roadshow in a box" model. [2] This would be run by **students** and facilitated by our RA; we hope especially to draw on the pool that goes to Grace Hopper. NCWIT studies show that

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[1] *Women in CS: An evaluation of Three Promising Techniques*, Alvarado and Dodds, Harvey Mudd College, Proceedings of SIGSCE, 2010.
[2] NCWIT Roadshow-in-abox and CMU Roadshow (by Women@SCS group).

undergraduate women have a big impact on young audiences who identify with them; at the same time these events have a dramatic effect on the self-esteem and sense of purpose for the presenters themselves. Two immediate venues will be the "Science for Girls" program run by the Cambridge Public Schools and the week long "Cambridge Science Festival". *Our goal is twofold: (a) to tap into the broader Cambridge effort to increase STEM participation (b) to empower our own women by teaching them to empower others.*

2. Hold an Alumnae Symposium and Reunion to celebrate Harvard CS women.
We propose to hold an alumnae reunion, inspired by the recent 1980 reunion of women computer scientists. Harvard CS has many famous and world-changing women alumnae, yet few people at Harvard or elsewhere know this. The goal of the symposium will be to raise awareness -- who our amazing alumnae are, what they have accomplished, and how they got there -- and to establish a bond between current students and our alumnae. Other universities, such as MIT, also hold such events often organized by the MIT alumnae association[3]. For women students, a connection with alumnae can be incredibly inspiring, providing a reflection of what they themselves might consider being or achieving in life.

3. Teaching Fellow and Undergrad Research Program: Start a recruiting network for women teaching fellows and research students. One of the major ways in which our Harvard CS concentrators get trained and intellectually mature is through out-of-class experience within the university, especially by being a Teaching Fellows in one of the introductory courses, such as CS50, CS51, CS60, CS121, CS124. This experience allows students to develop stronger programming/technical skills, better organization skills, project/people management skills, and presentation skills. It also allows them to get to know faculty at a much deeper level. Anecdotal evidence suggests that the Harvard teaching fellow network translates to successful internships and recruiting networks as well as an inroad to summer research. *We would like to make sure our women students get plugged into this network.* Not only is it an important component of intellectual growth and opportunity, but it provides a conduit for direct feedback about how women are experiencing our introductory classes. Exact implementation details remain unclear but could involve information sessions for female students, run by the program RA, about the teaching fellow experience.

2. WHY AND WHY NOW

1. At Harvard, attracting and retaining women in CS has been a long standing challenge for us at both undergraduate and graduate levels; this has been the subject of many crimson articles[4]. Data from past two decades is not encouraging, and it appears the

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[3] "Ellen Swallow Richards' Legacy: MIT Alumnae Make a Difference", The MIT Alumnae Association (AMITA) conference, March 05, 2011.
[4] *Computer Science at Harvard Sees Large Gender Imbalance,* Evan T. R. Rosenman, The Harvard Crimson, April 09, 2010.

problem has gotten worse rather than better. As shown in Table 1, for the 2010-2011 academic year, only 12.5% of our junior and senior concentrators are women; in absolute numbers, the data are simply startling: *among our juniors and seniors, we had only 9 women out of 72 concentrators*. As shown in Figure 2, in introductory classes, such as CS50, enrollments have persisted around the 25% mark with 40-70 female students taking the course each year from 1989-2006 until just recently. Moreover, in more advanced classes enrollments are closer to 15%, reflecting our concentration statistics. While many faculty care about this issue, and many have made individual efforts both within classes and with individual students, the problem clearly is not one that will just go away with time.

Table 1: Concentration Demographics as of January 2011

	Sophomores	**Juniors/Seniors**
Women	19 (43%)	9 (12.5%)
Men	25 (57%)	84 (87.5%)
Total	44	72

2. In the past 5 years, Dr. David Malan, through his outstanding work on the CS50 introductory course, has made huge inroads in attracting women to CS. In the academic year 2010-2011, almost 40% of the students in CS50 were women (186 out of 501) and, more dramatically, *the absolute number is five times more than it was just five years ago, demonstrating that there is a huge untapped computing-interested population of women within Harvard.* During the academic year 2010-2011, we observed the CS50 effect spreading: of the 44 newly declared sophomore concentrators, 19 are women (43%), a dramatic change compared to our junior/senior CS concentrators (12.5%) [Table 1]. *It is clearly a first priority to retain this new class,* as these women move into their junior and senior years, as well as to build on this momentum to promote the positive change throughout the CS experience.

3. Other universities have demonstrated that low female CS enrollment is not fate:
Harvey Mudd, CMU, and even MIT (whose enrollment is now 35% vs 15% in the 90s) have managed to dramatically change their trends. [5] Bringing about that change is a complicated undertaking, but some known factors that have positive effects are (1) building community, (2) exposure to a broader image of computer science early on, and (3) exposure and positive interactions with women computer scientists. The Harvey Mudd report describes the top three tools that were instrumental in their success; in 2006 they launched a concerted effort to recruit

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[5] NCWIT and CRA-W documents on best practices for recruiting/retaining women in CS.

and retain women students, and their enrollments have increased from 10% to a steady 35%. The three key tools were: changes in the introductory course, taking women freshman and sophomores to the Grace Hopper conference, and providing research opportunities for students with introductory CS experience. At Harvard, we are also beginning to see the effects of some of these same techniques, but making them permanent requires a deep commitment.

Overall, we feel that there has never been a better time to engage women in CS when computing is becoming so central to many disciplines.

Figure 2: Historical Enrollments in CS50[6]

Enrollment in CS50

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[6] https://wiki.cs50.net/Enrollment

Women in CS50 (%)
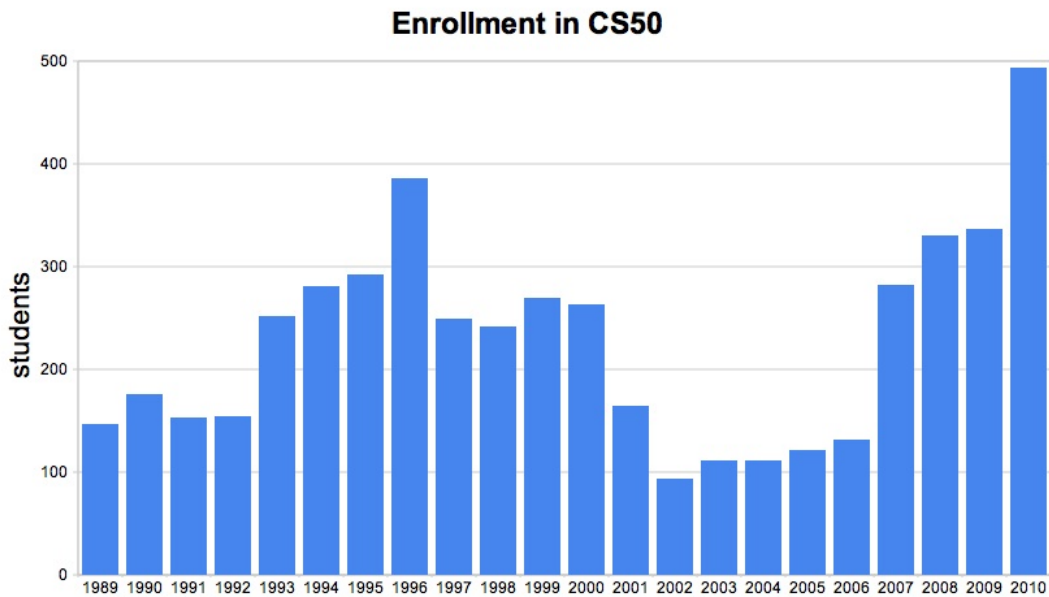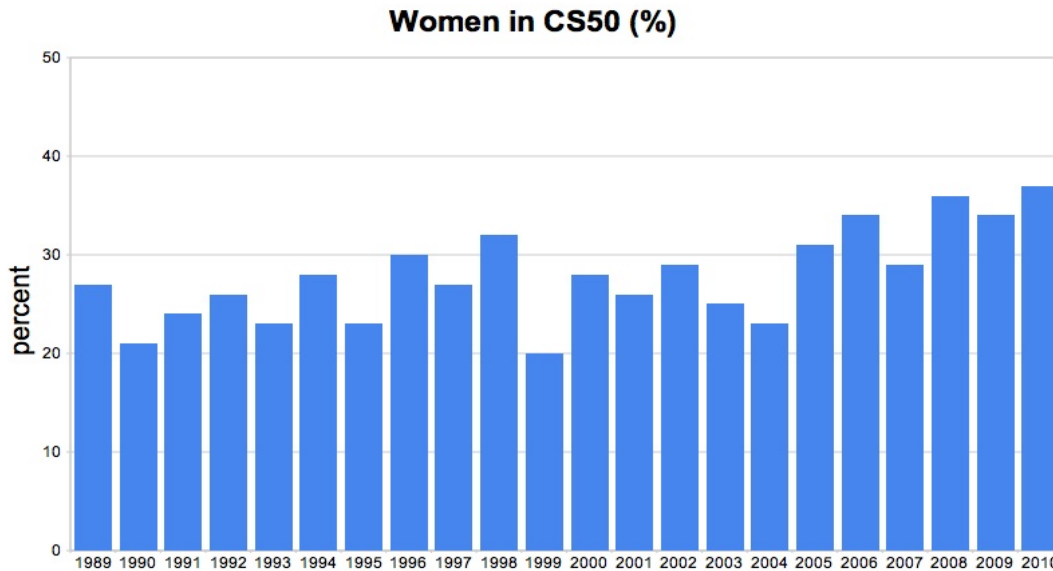
	1989	1995	2000	2005	2010
Women	40 (27%)	66 (23%)	73 (28%)	37 (31%)	186 (37%)
Men	107 (73%)	227 (77%)	190 (72%)	84 (69%)	315 (63%)
Total	147	293	263	121	501

3. HOW WE WILL EVALUATE OUR ACTIVITIES

1. Tracking enrollments: We will set up a systematic way to track enrollments in CS classes by gender, year, and concentration, so that we can more clearly see the trends. Initially we will focus on our early class sequences (CS50, 51, and 61), expanding to track higher level courses as resources permit. While this may seem like an obvious and trivial task, the necessary data come from multiple databases to which we have no direct access, making this a purely manual and human-resource-intensive task. One of the tasks of our program RA will be to set up and maintain this effort.

2. Evaluations of Grace Hopper Conference: Following the methodology used by Harvey Mudd, we will use before and after surveys to evaluate the impact of conference attendance.

3. At the five year point we will undertake a major review of the program.

4. WHAT WILL THESE EFFORTS COST

The first three efforts (Grace Hopper, Program RA, Advisory Board) will be our primary short-term targets. However we are also committed to the remaining three (Outreach, Reunion, Teaching Fellows). The following is an estimate of our expected costs.

From our recent experience taking students to Grace Hopper, it costs approximately $1000 per student, including registration, flights, shared hotel rooms. The conference also provides some fellowships, however they are aimed at universities with much lower financial status then ours. At the same time we do expect that some of our students will sign up as conference volunteers. We expect to take 20-30 students each year and two faculty; this suggests a budget of ~30K/year. The program Research Assistant would be funded at the same level as a department graduate teaching fellow appointment. This includes partial tuition payment as well as a stipend to the student. In addition we would like the program to have a budget to fund food for workshops, social/other events suggested by students, and outreach related materials and costs. This will cost ~50K/year for the RA (salary/tuition) and ~10K/year in expenses. Finally, inviting the external advisory board to visit Harvard for a 2-day workshop and hosting a major event like a Reunion will require raising funds specially for that purpose, but we can take advantage of the many resources provided here at Harvard to make the event a success.

Funding model: Our goal is to develop a strategy for a 5-year funding model after which we will reevaluate whether we need to continue the program at the same level or whether we want to retarget our efforts elsewhere. Ideally we'd like to succeed to the point where this is no longer a topic requiring solutions! However, barring that, we would like to reach a point in 5 years where we have made substantial success and can begin to broaden our efforts to other engineering areas and to other underrepresented groups.

Activity	Annual Budget	5 Years
Grace Hopper trip	$30,000	$150,000
Research Assistant	$50,000	$250,000
Materials and Supplies	$10,000	$50,000
Reunion Efforts	$10,000	$50,000
TOTAL	**$100,000**	**$500,000**

5. BROADER IMPACT

This white paper has focused on Women in Harvard Computer Science. One open question for us is whether the focus on CS is too narrow, and whether we should more broadly target women in all of the School of Engineering and Applied Sciences (SEAS). In addition, women are not the only underrepresented group in CS, our track record with minorities is also poor and less studied. Our group feels that these are equally important, but it is harder to design and evaluate a broad program especially when starting out. Our hope is that as we develop this program it will be a good model for efforts in other areas in SEAS, and that for the closely associated disciplines (Applied Math, Electrical Engineering, Robotics) we will be able to include their undergraduate women in all of the planned activities. As it is, the student body that takes computer science classes is diverse, and many students who study computer science may not concentrate in CS but may select it as a secondary field. We intend to target the program to increase the numbers of women in CS defined broadly, not constrained by concentration. In future years we hope that this model can be adapted to address the other areas and groups.