



Experiencing Research Through OurCS: Opportunities for Undergraduate Research in Computer Science

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Experiencing Research Through OurCS: Opportunities for Undergraduate Research in Computer Science

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Abstract—We describe a novel research-focused conference for undergraduate women in Computer Science. Pioneered at Carnegie Mellon University in 2007 and refined over four subsequent iterations (in 2011, 2013, 2015, and 2017), OurCS (Opportunities for Undergraduate Research in Computer Science) organizes participants into small teams, led by field experts, to explore open-ended research topics. Sessions devoted to hands-on research total more than 12 hours over the course of three days. Demand for the conference has increased steadily, and the model is ready for export. Regional versions geared towards local academic communities and other underrepresented groups will appear on the scene this year. We describe the model and the expansion plans, and provide evidence of success in strengthening and sustaining the research interests of the participants.

I. WELCOME TO THE CLUB

Women remain stubbornly underrepresented in computer science. The Taulbee Survey notes that women comprised 17.1% of CS doctoral graduates in 2015-16 in the USA, which is lower than the 18.3% reported the previous year [2]. At the same time, the survey shows that undergraduate enrollments in CS are surging, increasing 16.4% in one year. The proportion of women among bachelors graduates in CS was 17.9%, the highest percentage of female CS graduates among respondents since 2002-03. The challenge is to encourage more women from this larger talent pool to pursue research careers.

OurCS was conceived in 2007 as a partnership between industry and Carnegie Mellon and as an extension of the many programs organized through Women@SCS [13] which aim to remove obstacles standing in the way of women moving forward in the field. OurCS seeks to broaden the ranks of women who lead the field of computer science by increasing the number of undergraduate women in the USA who eventually enroll in Ph.D. programs.

Many factors affect women’s participation in research and leadership opportunities, but the outcome is clear: “At the point of career choice, many women are diverted from the academic and research tracks” [3]. From the onset, a specific goal of OurCS has been to encourage students to explore the possibilities of graduate school and to appreciate the value of attaining high level qualifications as the doorway to successful and rewarding careers. Many students lack an understanding of

the research process and have limited opportunities to engage in undergraduate research at their schools, and thus see no alternative to going directly to industry after graduation.

Mor Harchol-Balter [6] advises that “to get into a top graduate school you need prior research experience. . . . [This] does not mean that you need to have published a paper. It does not even mean that your research needs to have yielded a result — results can sometimes take years. We just need to have confidence that you know what doing research is like.”

II. WHAT’S NEW?

Experiences, opportunities, and encouragement are often missing for those who find themselves in a minority situation. OurCS, with its research focus (as opposed to gender focus), offers a venue for affirming and re-affirming women’s academic identity as computer scientists [10]. OurCS is a conference for computer scientists who happen to be women.

We welcome each participant to try her hand at research. Often this is her first such experience. She works in a team on a non-trivial research project, directed by luminaries in the field, and the group effort is sustained over all three days of the conference. This active research experience is the distinguishing hallmark of the conference. Additionally, students learn about, and are encouraged to apply to, summer Research Experience for Undergraduates (REU) programs, giving them a clear next step in developing their research portfolios. Heard at the 2017 wrap-up session: “*Look what you were able to accomplish in one weekend. Think what you can do in three months!*”

OurCS is field-tested. It has been offered five times at CMU. Based on student feedback, more time is now allotted to the group work. Less emphasis is placed on giving information (e.g., talks, panels) and more on doing (e.g., problem solving, poster session, presentations). The students are there to work and learn. In the words of a 2007 participant: “*This conference really lights a fire under your feet about CS research.*”

III. GOALS

The goals of OurCS are that participants will:

- 1) meet others who share their curiosity and interest in computer science,
- 2) explore the research experience in computing domains,

- 3) work hands-on with researchers,
- 4) work in a team to tackle a research problem,
- 5) (optionally) present a poster,
- 6) better understand the possibilities of graduate school and the application process, and
- 7) learn about life in graduate school from the perspectives of faculty and current graduate students.

OurCS is focused on the research experience and aimed specifically at undergraduates. This makes the conference unique and special for these young women. One participant noted: *“I loved the conference. It was very different than other conferences I have attended in the past. It was nice to see a lot of undergraduate females and learn about their schools as well as their research interests and their future plans.”*

IV. THE OURCS MODEL

Three essential elements comprise the OurCS model. We examine these elements in detail in the following three sections.

- 1) DOING RESEARCH: Immerse the student in an authentic research experience, led by field experts, sustained throughout all three days of the conference,
- 2) BEING A RESEARCHER: Demystify the nature and uncertainty of research, as told by a successful and dynamic academic researcher in the opening keynote and by a panel of graduate students who are currently engaged in Ph.D. research at the host institution, and
- 3) PRESENTING RESEARCH: Prepare the student to give an oral presentation to all conference participants about her individual contributions.

V. DOING RESEARCH

At OurCS, students DO actual research: *“It was beneficial to see the research process in action and to participate in it yourself. It was also fun to produce results from your project within a short weekend.”*

Eight “research workshop” sessions, each lasting from one to three hours, frame the conference schedule. Students work in groups (six is the ideal size) to understand a research area, formulate one or more specific research questions, propose solution approaches, prototype and analyze solutions, collect evidence, consider limitations, and ponder future directions. In response to student feedback, the amount of time allocated to the research groups has increased over the years so that it now accounts for more than twelve hours in the schedule. *“Such a nice change to engage and not just listen.”*

Each group is led by one or more prominent researchers from academia (e.g., CMU, University of Pittsburgh, Drexel University) and industry together with graduate student assistants. Participants select from a variety of research topics such as “Chatting with Computers” and “Articulating the Dimensionality of Films Using Machine Learning”. At the most recent conference, a dozen research options were provided so that attendees could rank their selections ahead of time. The full list of team leaders and project descriptions, along with the final team presentations, is published on the website [7].

Since students only have three days to learn skills, explore a topic, and prepare a presentation, the project must be well-structured. We asked a professor who has been involved with OurCS since its inception to describe his design process. He identifies the overall research question and prepares a dataset in advance, and then gets the students going by providing didactic instruction on the problem domain and on the machine learning tools they will use to investigate the question. The problems he selects generally coincide with ones that his Ph.D. students have been working on, so “it’s relatively easy to identify a potential question and prepare the dataset”.

VI. BEING A RESEARCHER

Two sessions provide context and clarity about the life of a researcher. These are the opening keynote talk by a senior woman scientist on the first day, and the graduate student panel on the second day.

Over the years, OurCS has hosted a stellar line up of plenary speakers, including Turing award winner Fran Allen, Jeannette Wing, Manuela Veloso, and more recently, Nancy Amato. Frequently, the speakers stay for the whole conference and make themselves available to talk one-on-one and in small groups. The students place high value on seeing and hearing from these impressive women, and on being able to have personal contact with them. They list them among the most enjoyable parts of the conference: *“I was very encouraged and inspired as a woman in CS and mathematics field.”*

The process and rewards of earning a Ph.D. in computer science are not readily understood by undergraduates. Undergraduates report surprise in learning that admission to a Ph.D. program commonly accompanies a promise of five or more years of financial support from the institution and that other funding opportunities (e.g., NSF Graduate Fellowship) are also available. Educating students about the application process, how to choose among degree program options, and learning to navigate life as a graduate student falls largely to the students on the graduate panel. Seven current graduate students, at a variety of educational stages, speak honestly and openly about their experiences, their successes, and their disappointments. They freely offer advice and support (e.g., *“Send me your research statement and I’ll give you feedback.”*).

The keynote speaker and the graduate students on the panel serve as intentional role models “to young students during vulnerable times in their academic careers. . . . [They] discuss all aspects of their careers, including early struggles and how [they] overcame these difficulties, without indicating that the difficulties resulted from their gender or that women are less capable than men in the computing field. [This] allows young proteges to identify with the role models, to emulate their behaviors, and to gain confidence that they too can succeed in a male-dominated profession.” [12].

VII. PRESENTING RESEARCH

OurCS offers a lunchtime poster session for participants who have done research previously. In 2017, there were 11



Figure: Sarah Loos presents at the first conference in 2007 when a junior at IU. She went on to earn her Ph.D. in CS from CMU in 2015 and now works at Google Research developing deep neural networks to improve automated theorem proving. She will return to IU in 2018 to lead her own OurCS project.

posters. Prizes were awarded to the top three, judged by a small team of faculty and graduate students.

The conference culminates with the team presentations. If the opening keynote, where students *hear* about topical research from a senior woman, can be viewed as one bookend, then the presentations, where each team *shares* the fruits of their labor, is the matching bookend. Each team has eight minutes to present their work to an audience of faculty, research professionals, and peers. This is the highlight of the conference: *“I really enjoyed the participant presentations. It was neat to see what my peers have done and researched.”*

VIII. INGREDIENTS FOR SUCCESS

OurCS requires customary event planning support and it is helpful to hire a project manager to handle site logistics. Here we provide some essential OurCS recommendations, small and large, gained over the years from the experiences of the organizers. Starting one year ahead of the planned OurCS:

- Form a committee of faculty, staff, and graduate students to help with the planning and actual running of the conference. Allow graduate students to play many important roles: introduce the speakers, organize and judge the poster session, serve as panelists to provide observations about graduate school and advice on the application process, and be present throughout as mentors and role models.
- Design the application process and eventually create a distribution list for attendees so you can provide regular updates. Ask students to identify a supportive faculty member at their institution and include these faculty contacts on your distribution list, as this may help reduce the number of students who drop out at the last minute. To prevent misunderstandings about dates and locations, ask attendees to provide their travel details. Expect about 15% of registrants to change their minds about attending.

- Decide on guest speakers and send invitations early. Invite faculty and industry researchers to design projects and lead teams of students. Consider identifying an experienced project leader to act as a mentor to researchers designing an OurCS project for the first time. Scientists from industry may benefit from a “teaching coach” to help set reasonable expectations about what undergraduates can accomplish in the time allowed.
- Build and maintain a conference website, not only for promotion and general information, but also as a repository (and future archive) for detailed descriptions of the research projects offered at your workshop.

IX. EXPANSION PLAN

Since 2007, OurCS has been funded by CMU’s School of Computer Science and companies who are committed to changing the landscape and have the patience to take a long view (5-6 years!) to develop talent. Microsoft Research, Oracle Academy, and Google have been instrumental in realizing the OurCS concept at CMU. The conference covers the participants’ hotel fees and three meals a day, and allows registration costs to be kept at a nominal fee of \$50. This fee serves to establish that the student is serious about attending. Travel costs are borne by the student (in some cases, by the student’s institution), but for many, the travel costs are prohibitive. This limits participation to those with either the financial resources to travel from a distance or those who attend a nearby school.

Over 100 students attended the 2017 conference at CMU, and many more students were left on the waiting list. The demand for spots in 2017 was double what it was in 2015. The students came from 43 different schools in 23 different states, as well as Canada, Qatar, and Puerto Rico. It is time for OurCS to expand beyond one school. There are two dimensions along which expansion can proceed.

A. Geographical locality

Creating a regional version of OurCS will serve a bigger and more geographically dispersed audience. It will be less expensive and require less travel time for attendees. The geographic proximity of the students and the researchers may promote and encourage future collaborations.

A regional OurCS could limit its scope to fewer areas, with multiple teams working on variants of the same project, as opposed to a large menu of possibilities. Such an approach might open funding opportunities (e.g., NSF REU Supplement) or be attractive to local research-oriented companies.

B. Student identity

The second expansion idea involves specifically targeting women (and men) with minority status. A regional OurCS could reach out to students from a certain demographic, invite them to attend, and provide resources to make it happen.

At CMU, students are accepted to the conference in the order in which they register. Places are held for students with disabilities (sponsored through AccessComputing) and for students from CMU, including the CMU-Qatar campus.

Late applicants are added to a waitlist. A regional OurCS could employ a different strategy, such as limiting the number of attendees from a single school, or type of school, or explicitly inviting students from certain schools.

X. OURCS AT IU

Plans are underway to transplant the OurCS model to the Midwest, to be hosted by Indiana University in 2018, attracting participants from schools (large and small) within driving distance of Bloomington [8]. We will draw upon our network of faculty contacts in Indiana schools, cultivated through our efforts organizing regional Grace Hopper conferences [11]. The Indiana Celebration of Women in Computing (InWIC) was the brainchild of Gloria Townsend in 2004, and has been offered biannually ever since (now in the fall of odd numbered years). So as not to compete with InWIC, OurCS at IU will start in fall 2018, specifically October 26–28.

Faculty researchers at IU in Computer Vision, Proactive Health, Security, and Data Science have already committed to designing and running research projects, and we expect to add others in the coming months. Following in CMU's footsteps, we intend to fill out the schedule with projects created by research leaders from industry (e.g., Google Research) and faculty from nearby R1 institutions (e.g., Notre Dame).

The target size for the IU pilot is 70 students. About one third of the seats will be held (initially) for out-of-state students who are first-generation, low-income, or from historically black colleges and universities (HBCUs). We have existing connections with several HBCUs via our REU programs and our past experiences organizing a workshop to teach students from HBCUs how to create a K-12 outreach program for their school [1], [9]. We will offer a number of travel subsidies for out-of-state students who otherwise could not attend. We are contacting individual HBCU faculty members to ask them to recommend this opportunity to their students.

IU's School of Informatics, Computing, and Engineering (SICE) has committed funds and resources to bring OurCS to Indiana University. Google and Oracle Academy are major sponsors and will participate by sending teams of scientists to lead projects, and we are working to involve one or two Indiana-based industries/labs to similarly participate.

XI. ASSESSMENT

“Before this conference I felt like a Ph.D. was out of my league, but now I see it as something attainable that might actually suit my interests and goals very well.”

Throughout this paper we have interjected data and comments from student attendees of OurCS. The comments were collected in surveys developed through consultation with a professional evaluator providing us with some (if limited) evaluation. Students completed three surveys: one (A) as they arrived and registered, one (B) ongoing throughout the conference, and a final survey (C) at the end of the conference. Survey A was used to get some preliminary information on motivation and interest relating to the conference. Survey B

allowed the students to make comments and to “grade” each session and other components of the conference. Survey C aimed to gather post-conference comments on what they had learned, if OurCS had impacted their thoughts for the future, and suggestions for improvements to OurCS.

“I am more sure that I want to go to graduate school and have a better idea of how to achieve it.”

XII. OURCS AND THE FUTURE

Computer science offers many opportunities for women to become future leaders. OurCS creates a valuable step in that direction and is founded on the philosophy that cultural change, including programs that level the playing field, is critical for women to flourish in computing fields [4]. The OurCS model can transfer to other schools (and possibly adapt to other disciplines) where the will to act, and the institutional support to see women reach their full potential, are present.

“I would definitely recommend this workshop to people who have no/little research experience, as it was beneficial to see the research process in action and to participate in it yourself. It was also fun to produce results from your project within a short weekend. Overall I think the experience has motivated me to pursue research in the future and see in what ways computer science can be applied to other fields.”

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