PROGRAMS FOR HIGH ACHIEVING STUDENTS

Speakers:
Marie desJardins (UMBC)
Maggie Johnson (Google)
Bruce Porter (UT Austin)
Jennifer Rexford (Princeton)

Moderator:
Nancy Amato (Texas A&M)
FORMAT OF THIS SESSION

- Each speaker will describe programs at their institution (~8 minutes + 2 minutes Q&A)
- 15 minutes joint Q&A at the end
A Commitment to Diversity: What Success Looks Like at UMBC

Dr. Marie desJardins
University of Maryland, Baltimore County
Associate Dean and Professor
College of Eng.& Info. Tech.
Dept. of Computer Science & EE

Snowbird 2016 Panel on
Programs for High-Achieving Students
UMBC at a Glance

- One of eleven University System of Maryland campuses, one of three USM research universities
- About 13,000 students, including 2500 grad students
  - CSEE has the second most majors (after Biological Sciences)
  - About 15% of undergraduates major in CS, CE, or IS
  - 6th largest producer of computing majors in the country (of not-for-profit institutions)
- Famous for diversity, and chess, but not football!
Programs of Interest

- **Scholars (and Affiliates) Programs:** Meyerhoff, CWIT, Cyber, T-Site (and others)
- **Strong emphasis on undergraduate research**
- **Grand Challenge Scholars Programs**
- **BS/MS programs** (in all COEIT BS degrees)
- **Pedagogical innovation:**
  - Freshman course: COMP 101
  - Differentiated instruction: CMSC 201
  - ACTIVE Center
- **BRAID**
- **Student organizations** – SWE, NSBE, SHPE, ACM, CyberDawgs, game design club, student-led hackathons and other events
Scholars Programs

- Center for Women in Technology
  - Goal: increase gender diversity in computing and engineering
- CyberScholars
  - Goal: Increase gender and racial diversity in cybersecurity
- T-SITE
  - Goal: Improve transfer experience for computing majors, especially women and minorities
- Meyerhoff Scholars
  - Goal: Increase the number of minority students receiving PhDs in the sciences
    - UMBC is the #1 generator of African American MD/PhD students in the country
- All programs provide mentoring, focused advising, academic career development programs; most also provide services for affiliated students (non-scholars)
Undergraduate Research

- Undergraduate Research Awards and URCAD (Undergraduate Research & Creative Achievement Day) – over 250 student presentations
- UMBC Review – student journal
- Many (most?) CSEE faculty who are active in research work with undergraduates (often with NSF REUs)
- 7% of CS majors participate in undergraduate research (based on climate survey data)
  - 10% of students with GPA above 3.0, 12% of students with 4.0 GPA
Grand Challenge Scholars Program

- Train a future generation of engineers who are prepared to work on the NAE Grand Challenges
- >100 universities have committed to creating GCSPs
  - UMBC’s is the 26th approved program
  - 17 students in 1st cohort (includes three CS majors and two CS minors)
- Five “threads”:
  - Research
  - Interdisciplinarity
  - Entrepreneurship
  - Global dimensions
  - Service
14 “Grand Challenges” identified and developed by an international team of experts, in four broad areas:

- Sustainability
- Health
- Security
- “Joy of Living” and the human mind

Solutions to these challenges will need:

- Sustained commitment over 10-20+ years
- Interdisciplinary collaboration
- Public policy and economic considerations
- Effective communication with diverse users
Sustainability
(aka “Energy and Environment”)

Make solar energy economical

Provide energy from fusion

Develop carbon sequestration methods

Manage the nitrogen cycle

Provide access to clean water
Health

Engineer better medicines

Advance health informatics
Security

Prevent nuclear terror

Secure cyberspace

Restore and improve urban infrastructure
Joy of Living
(aka “Learning and Computation”)

Reverse engineer the brain

Advance personalized learning

Enhance virtual reality

Engineer the tools of scientific discovery

Images: engineeringchallenges.org
Learning Objectives

- **Program-wide learning objectives** *(core set, plus personalized objectives)*: In their GC activities, students should exhibit:
  - Integrity
  - Perspectivism
  - Realistic vision
  - Teamwork
  - Persistence
  - Flexibility

- **Learning objectives for each area** *(core set, plus personalized objectives)*
Helping People with Computing

- Self-driving cars
- Assistive devices
- Political modeling and forecasting
- Gene sequencing and protein folding
- Urban planning
- Teaching!
Ideas for the Future

- Improved departmental honors program
  - Offer honors classes more regularly
  - Make it more feasible for top students to earn honors

- Connect computing more effectively to real-world problems and challenges
  - GCSP, course content, cocurricular activities, Entrepreneurship Center
Programs for College Students

Maggie Johnson
Director of Education and University Relations
Google, Mountain View CA
Internships

Technical Internships

Build new features and improve our products (and get some extra guidance along the way). Start dates are flexible and are offered year-round, but you’ll need to commit to at least three months of full-time work.

Product Management Internships

Get a head start on learning how to drive product development while working at Google speed. Start dates are flexible, but you’ll need to commit to at least three months of full-time work over the summer.

Guide to Technical Development

Having a solid foundation in Computer Science is important in being a successful Software Engineer. This guide is a suggested path for University students to develop their technical skills academically and non-academically through self-paced hands-on learning.
Residencies

Engineering Residency

Start building. A one-year program to transform early-career computer scientists into the next generation of technology leaders.

Make the transition

The professional engineering environment is constantly evolving. Google’s Engineering Residency is specifically designed to accelerate the transition from school to industry - enabling you to have an impact right away.

Learn new skills

At Google, our infrastructure is really complex. As an Engineering Resident, you’ll learn the things that are harder to teach in school - from large-scale distributed processing and Google-style test-driven development, to applied theory and code reviews, to developer workflow and beyond.
Residencies
Applied Computer Science with Android is a Google initiative to help university students understand and apply computer science concepts using the Android platform.
Resources

Google Capacity Award Program

Internships

Engineering Residency

Brain Residency

Applied CS with Android
Student Enrichment Programs

Bruce Porter
Professor and Chairman
Department of Computer Science
University of Texas at Austin
Total Undergraduate Enrollment by Year

- Fall 2010: 1113
- Fall 2011: 1333
- Fall 2012: 1720
- Fall 2013: 2057
- Fall 2014: 2137
- Fall 2015: 1914
- Fall 2016: 1875
5-Year BS/MS Programs

• In 5 years, a BS in CS and an MS in one of:
  – CS
  – Information Science (UI/UX)
  – Computational Science, Engineering and Math

• About 10 new students/year in each program

• Students begin graduate courses in year 4, and take only graduate courses in year 5
Fringe Benefits

• Reduce load on upper-division CS classes
• Improve relations with other departments
• A repeatable way to address the proliferation of CS across campus: “for every X, computational X”
Turing Scholars Honors Program

• Created in 2004
• Started with ~30 students/year, almost exclusively from Texas
• Expanded to ~55 students/year, recruited broadly
• Students progress as a cohort
BS-CS Curriculum

• Core classes:
  – Introduction to Programming
  – Data Structures

  – Computer Organization and Architecture
  – Principles of Computer Systems

  – Discrete Math for CS
  – Algorithms and Complexity

• 5 Upper-division CS electives
Honors Curriculum

• Core classes:
  – Introduction to Programming
  – Data Structures

  – Computer Organization and Architecture
  – Principles of Computer Systems

  – Discrete Math for CS
  – Algorithms and Complexity

• 5 3 Upper-division CS honors electives
Honors Thesis

- *Introduction to Research* (1 hour)
- *Independent Research* (3 hours)
- *Written thesis*, aiming for a publishable result
- *Thesis defense*, presented to *thesis advisor* and 2\textsuperscript{nd} *reader*
Fringe Benefits

- Friendly competition among faculty to teach honors classes
- Surprisingly competent Research Assistants
- Control over admissions; e.g. 28% female; median class rank: 5 (out of 500)
JENNIFER REXFORD
PRINCETON UNIVERSITY
Programs for High-Achieving Students
Snowbird Panel

Jennifer Rexford
Gordon Y.S. Wu Professor of Engineering
Chair of Computer Science
Boutique Education at Scale

• Princeton model: *boutique*
  – Small classes
  – Preceptorial system in larger classes
  – Low ratio of students to teaching assistants (~25:1)
  – Every student conducts research with faculty

• Meets reality: *scale*
  – Rapidly growing majors and enrollment
  – Large classes, even at the upper level
  – Huge IW advising load per faculty member
Undergrad CS Majors by Class Year

CS has 10-13% of all majors on campus
CS Enrollments

CS has 10% of all *course enrollments* on campus
Independent Work Projects

<table>
<thead>
<tr>
<th>Year</th>
<th>Spring</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2012</td>
<td>69</td>
<td>70</td>
</tr>
<tr>
<td>2012-2013</td>
<td>94</td>
<td>81</td>
</tr>
<tr>
<td>2013-2014</td>
<td>110</td>
<td>103</td>
</tr>
<tr>
<td>2014-2015</td>
<td>117</td>
<td>128</td>
</tr>
<tr>
<td>2015-2016</td>
<td>149</td>
<td>131</td>
</tr>
<tr>
<td>2015-2017</td>
<td>176</td>
<td></td>
</tr>
</tbody>
</table>

Totals:
- Spring: 69 + 94 + 110 + 117 + 149 + 176 = 695
- Fall: 70 + 81 + 103 + 128 + 149 = 539

Note: The totals for 2015-2016 and 2015-2017 are not shown in the bar chart.
CS Faculty

<table>
<thead>
<tr>
<th>Year</th>
<th>Lecturers</th>
<th>Tenure Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-2009</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>2009-2010</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>2010-2011</td>
<td>7.5</td>
<td>21.5</td>
</tr>
<tr>
<td>2011-2012</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>2012-2013</td>
<td>9.5</td>
<td>20.5</td>
</tr>
<tr>
<td>2013-2014</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>2014-2015</td>
<td>13</td>
<td>22.5</td>
</tr>
</tbody>
</table>

Legend:
- Lecturers
- Tenure Track
Scaling

• Teaching support
  – Teaching faculty (“Lecturers”)
  – Master’s program (fully funded as TAs)
  – Undergraduate lab TAs and graders

• Independent-work
  – IW seminars (10-12 students per seminar, with a faculty member and a part-time TA)
  – Led by tenure-track or teaching faculty (”count” like teaching 2/3 of a regular course)
  – Especially for students pursuing their first IW project
## Effect of IW Seminars on Advising

<table>
<thead>
<tr>
<th>Type</th>
<th>2013-14</th>
<th>2014-15</th>
<th>2015-16</th>
<th>Fall 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB Thesis</td>
<td>48</td>
<td>56</td>
<td>42</td>
<td>29</td>
</tr>
<tr>
<td>BSE Thesis</td>
<td>30</td>
<td>20</td>
<td>48</td>
<td>6</td>
</tr>
<tr>
<td>IW Individual</td>
<td>135</td>
<td>169</td>
<td>69</td>
<td>21</td>
</tr>
<tr>
<td>IW Seminar</td>
<td>0</td>
<td>0</td>
<td>121</td>
<td>100</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>213</td>
<td>245</td>
<td>280</td>
<td>176</td>
</tr>
</tbody>
</table>
Outward-Facing IW Seminars (Fall ’15)

- Relationship networks: Social networks and beyond
- Understanding the world with sensors
- Entrepreneurial lessons for computer science
- Online learning and MOOCs
- A brave new data world
- Apps for the environment
Outward-Facing IW Seminars (Spring ’15)

• Deep learning
• Understanding the world with sensors
• Entrepreneurial lessons for computer science
• Using visualization to improve online CS education
• Using publicly available data to learn, explain, evaluate, and improve
• Apps of random kindness
Outward-Facing IW Seminars (Fall’16)

- Policy issues in the Internet of Things
- Information discovery through relationships
- Help future computer scientists learn CS
- Natural language processing
- Apps of random kindness
- CS tools and techniques for digital humanities
- Entrepreneurial lessons for computer science
- Bitcoins, block chains, and smart contracts
- Bioinformatics lab
For High-Achieving Students

• Independent work
  – IW seminars on timely topics
  – One-on-one IW research projects
  – Funding to present papers at conferences

• Graduate courses

• Master’s program
  – Get an MSE after the undergraduate degree
  – E.g., finish undergrad in three years, and get paid to stay another 1-1.5 years!
For High-Achieving Students

- Participating in our teaching mission
  - Undergraduate graders and lab TAs
  - IW or summer projects on scaling our teaching (e.g., automated grading, plagiarism detection)

- Educational outreach
  - IW projects on CS education outreach
  - EPICS team on high-school CS education

- Field trips during fall/spring breaks
  - Entrepreneurship trip to Bay Area
  - Technology policy trip to D.C
Conclusion

• Boutique education at scale
  – By engaging more people: Teaching faculty, MSE students, undergraduate graders and lab Tas
  – By leveraging automation: innovation
  – By changing the structure: IW seminars

• Individual opportunities for students
  – Serving in our teaching mission
  – Participating in research with faculty
  – Engaging with the broader community
QUESTIONS

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