Technology Logistics

- Presentation followed by question and answer
- Use the question button from Hangouts on Air to pose a question at any time
- Questions will be collected throughout the talk
- Will provide answers at end of the talk
- Note there are time delays between requests and replies because of the technology
- Entire session is recorded and available on YouTube
- Slides will be posted on the chapter website: http://sighpceducation.acm.org/
Today’s Agenda

- Overview of academic programs in computational and data sciences
  - Summary of the number and types of programs
  - Competencies embedded in a number of programs
  - Specific examples of different program types
  - Issues with program implementation and maintenance
Information Sources

- Culling of lists provided by SIAM and others
- Internet search for programs
- Analysis of program websites
- Since the data come from the Internet, we know they are reliable
- Full listing available on HPCUniversity website
## Total Programs

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Foreign</strong></td>
<td>51</td>
<td>26.7</td>
<td>26.7</td>
</tr>
<tr>
<td><strong>Domestic</strong></td>
<td>140</td>
<td>73.3</td>
<td>73.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>191</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
## Undergraduate/Graduate

<table>
<thead>
<tr>
<th>Undergraduate(U) or Graduate(G)?</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grad</td>
<td>157</td>
<td>82.2</td>
<td>82.2</td>
</tr>
<tr>
<td>Undergrad</td>
<td>34</td>
<td>17.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>191</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
Undergrad Program Characteristics

- **Majors** – there are 12 programs with majors in one or more aspects of computational science
- **Minors** – there are 20 minor programs
  - The mean number of undergraduate credit hours is 19 (18 is most typical)
  - Minimum credit hours – 12
  - Maximum credit hours – 28
Wide Range of Names

<table>
<thead>
<tr>
<th>Domestic Undergraduate Program Names</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Math</td>
<td>2</td>
</tr>
<tr>
<td>Bioinformatics/Comp. Biology</td>
<td>2</td>
</tr>
<tr>
<td>Computational Physics</td>
<td>3</td>
</tr>
<tr>
<td>Computational Engineering</td>
<td>2</td>
</tr>
<tr>
<td>Computational Science</td>
<td>11</td>
</tr>
<tr>
<td>Computational Thinking</td>
<td>1</td>
</tr>
<tr>
<td>Data Sciences*</td>
<td>3</td>
</tr>
<tr>
<td>Scientific Computing</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: did not count business data science programs. Data science programs are undercounted.
Program Competencies

- All programs require some mix of computer science, mathematics, and one or more domain sciences
- Mix varies by program type
- Competencies developed as part of several NSF grants and further work with the community can be a guide to program development
  - [http://hpcuniversity.org/educators/competencies/](http://hpcuniversity.org/educators/competencies/)
Graduate Programs

- General programs in computational science or scientific computing – about 20 programs
- Next highest number in computational engineering
- Wide range of other programs focusing on specific domains
Undergraduate Program Examples

- The Ohio State University – Minor in Computational Science
- 18 credit hours
- Core courses
  - Simulation and modeling
    - Choice of introductory course or domain specific options
  - Program and Algorithms
    - Programming for non-computer science majors
  - Numerical Methods
    - Choice of math and engineering courses
  - Capstone research or internship
OSU Elective Courses

- Wide range across many disciplines

Example Elective Courses - OSU Minor

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE 3521</td>
<td>Survey of Artificial Intelligence I: Basic Techniques</td>
</tr>
<tr>
<td>BMI 5730</td>
<td>Introduction to Bioinformatics</td>
</tr>
<tr>
<td>CHEM 5440</td>
<td>Introduction to Computational Chemistry</td>
</tr>
<tr>
<td>MATH 5651</td>
<td>Mathematical Modeling of Biological Processes</td>
</tr>
<tr>
<td>PHYSICS 5740</td>
<td>Quantitative Cell Biology for Engineers and Scientists</td>
</tr>
<tr>
<td>LING 5801</td>
<td>Computational Linguistics</td>
</tr>
<tr>
<td>ECON 4050</td>
<td>Experimental Economics</td>
</tr>
<tr>
<td>GEOG 5221</td>
<td>Spatial Simulation and Modeling in GIS</td>
</tr>
<tr>
<td>PSYCH 5608</td>
<td>Introduction to Mathematical Psychology</td>
</tr>
<tr>
<td>MATH 2568</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>CSE 5441</td>
<td>Introduction to Parallel Computing</td>
</tr>
<tr>
<td>CSE 5544</td>
<td>Introduction to Scientific Visualization</td>
</tr>
<tr>
<td>CIVILEN 5168</td>
<td>Introduction to the Finite Element Method</td>
</tr>
</tbody>
</table>
Capital University Minor

- 21 credit requirement
- Core courses
  - Introduction to computer science
  - Calculus and modeling for biological sciences or calculus I
  - Computational science I
  - Differential equations and dynamical systems
  - Computational and numerical methods
  - Research experience
Capital University Electives

- CSAC 394 - Comp Neuroscience and Psychology
- CSAC 392 - Computational Biology
- CSAC 391 - Computational Chemistry
- CSAC 393 - Computational Environmental Science
- CSAC 396 - Computational Physics
University of Mary Washington

- Data sciences minor – 23 credit hours
- Required courses
  - Introduction to Statistics
  - Linear Algebra
  - Computer Science I
  - Data Mining
  - Modeling and Simulation
Mary Washington Electives

- Computer Science II: Data Structures
- Analytics Application Development
- Foundations and Applications of Data Analytics
- Parallel Processing
Program Organization

- Difficult to tell the administrative arrangements from the websites
- Two major groups
  - Inter-departmental agreements to teach courses and share students/credit hours
  - Lead or dedicated department that controls core courses and relevant instructional resources
Program Issues

- Financial resources for interdisciplinary programs
- Disciplinary course pre-requisites
- Student minimization of effort to graduate
- Marketing
Observations on Elements for Success

- Strong connections to research efforts and/or industry partnerships
- Strong group of participating faculty across multiple disciplines
- Increasing private sector push for qualified employees
- Flexibility in internal financial and appointment arrangements at institutions
- Possible endorsement by professional societies
Questions and Discussion