Addressing enrollment declines & increasing participation
Broadening CS at the Entry Level
Interdisciplinary Science & CS

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NSF’S ICER (CPATH) INITIATIVE
NSF asked: Why is CS in crisis? What can be done?

Northwest Region: www.evergreen.edu/icer

Improve the quality of computing education ....
Attract more people ....
Improve retention....
Strengthen interdisciplinary connections....
Improve CS educational research ....

Northeast: http://www-net.cs.umass.edu/nsf_icer_ne/
Midwest: http://www.cse.ohio-state.edu/~lee/NSF/home.htm
Southeast: http://www.eng.unt.edu/ICERWorkshop/reports.html
What interests students? 
...Ecology, Multi-Media, Biology....

An new Entry Level Program (CS1)

Data & Information: Quantitative Ecology

Strategy: broaden CS1 to address one of these....

Data & Information: Quantitative Ecology

Prior Years

Discrete Math

Pgm’g in ML

Digital Electronics

Seminar History/Phil of Computation

Statistics

Programming in Python

Statistics Programming in Python

Ecology Seminar

History/Phil of Data Driven Science

Will all future IT workers be CS graduates?

Ecology Case Study

The Thousand Year Chronosequence

8 PNW forested sites (1kcs) from 50 to 950 yrs old

Ecologists: Nadkarni, vanPelt, McIntosh, et al

Statistical analysis (in R)

Scientific & Graphics Programming (in Python)

Human Factors of Data Presentation
The Canopy Database Project
Better IT for Ecologists

The 1kcs – its “Torture Test”

• Weekly 3-hour Closed Labs
  • in pairs
  • not in CS Lab
  • Hands-on
  • Lots of attention - 3 faculty, 2 lab aids, lab staff

• Field Trip to Forest Site, resampled tree structure data

• Guest Lectures from ecologists

• Team Project (2 weeks, full time, many extended a lab….)
The *1kcs* Ecology Case Study

The Labs

1. Interpret and critique figures from a prepublication 1kcs paper.
2. Day-long Field Trip.
3. Using a python program, analyze data from the field trip, and compare to data taken by ecology researchers.
4. Extend a python program to compute some key ecology measures.
5. Implement in Python, and interpret several simple measures of stand structure.
6. Learn about stepwise refinement and functions, code a simple stem map in Python, start project proposal.
7. Use R for simple statistics.
8. Run and interpret an R Chi Square test, design a statistical analysis, revise project proposal.

Case Study Projects

1. UI for statistical analysis of 1kcs data in Access, Python, and R
2. Python program to compute habitat index, output data to spreadsheet.
3. Python program to display stem maps and compute canopy cover.
4. Statistical analysis to examine similarities among 3 sites.
5. Python program to make 1kcs data web accessible, with summary statistics.
6. Represent 1kcs sites in ArcGIS, using aerial photos.
7. Web visualization of 1kcs data: PHP and JavaScript, Python, MySQL, and R.
8. Python program to forecast tree growth, using characteristics of next site.
9. Comparison of 6 pseudo-random number generators (PRNGs) using statistics and graphics
10. Python program to generate and visualize forest of a given age using 1kcs.
The 1kcs Ecology Case Study
Using Case Studies

• Very effective ‘real world’ look at CS in “action”
• Best if team-taught – multidisciplinary faculty essential
• Could be used at Traditional Institutions to
  • introduce inter- or multi-disciplinary studies
  • demonstrate how CS used
  • demonstrate what CS is
• Caveats
  • need a ‘canned’ case study or a well-versed faculty
  • developing labs from scratch very time-consuming
  • faculty ability to improvising helps ….  
    • surprising analytical results
    • questions from students can outstrip faculty expertise

Seminar
Philosophy/History of Data-Driven Science

• Weekly Assigned Reading:
  • Aristotle’s Physics (selected readings)
  • Headrick’s, Knowledge in the Age of Reason and Revolution,
  • Kuhn’s The Structure of Scientific Revolutions,
  • Fleck’s Genesis and Development of a Scientific Fact,
  • Fortun & Bernstein’s Muddling Through,
  • Suzuki et al. Tree: A Life Story.
• Weekly (written) Study Questions
• Weekly Seminar Discussions
• Three Assigned Papers (every 3rd week)
Data & Information: Quantitative Ecology
Student Constituency
Diversity wrt Discipline

Data & Information: Quantitative Ecology
Prior Years

Data & Information: Quantitative Ecology
Fall 2006-7

CCSC 2007

Data & Information: Some Improved Retention

<table>
<thead>
<tr>
<th>Entry Level CS</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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<td>D2I to CSF 2006-7</td>
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<td>23</td>
<td>18</td>
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<td>Total Retention</td>
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<td>Prior Year</td>
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<td>21</td>
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</tbody>
</table>

CCSC 2007

“other” to CSF 2006-7

Prior Year

Total Retention

D2I to CSF 2006-7

“other” to CSF 2006-7

Total Retention

Prior Year

CCSC 2007
What now?

- Publish the labs? 3-parts (easy, expected, hard) a good idea
- End of quarter project good – promoted integration
- Comraderie (labs, field trips) seems to have increased retention
- The College’s quantitative learning assessment needs revision
- Do it again?
  - 2007-08 – computational physics (CS, Math, Physics, modeling)
  - 2008-09 – Making Meaning w/ Ontologies (CS, Math, Logic, Linguistics)
  - 2009-10 – repeat this program? (ecologist, computer scientist)
- Considering CS minors NSF CPATH proposal w/ others
  - Add one upper division capstone in addition to the one quarter CS0++

Interdisciplinary Science and CS
Does interdisciplinary CS help?

Preliminary results as per ICER NW recommendations

Improve the quality of computing education?
  Student engagement ↑; ←= content **
Attract more people?
  Yes, some ecology students added CS minor
Improve retention?
  Apparently…but ‘n’ is small **
Strengthen interdisciplinary connections?
  Yes!
Improve CS educational research?
  Raised faculty awareness and started efforts **

** how about small colleges’ collaboration to
  Coordinate assessment, pool ‘n’
Strategies for Interdisciplinary CS

1. Take a broader view of CS (why?)
   • better CS1
   • Deepen the capstone
   • Real-world examples for CS ‘big ideas’
   • ...

2. Capitalize on research collaborations

3. Publish exemplars / offer workshops
   (team-teaching, group work, projects, labs)

4. Alleviate institutional barriers

5. Encourage visitors: industry, labs, etc.

6. Teach accessible, but powerful, 1st languages

7. Encourage experimentation!
   • Animated Forest
   • Computational Linguistics, Ontologies, Semantic Web, Search

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Questions?

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NSF’S ICER (CPATH) INITIATIVE
INTEGRATIVE COMPUTING EDUCATION & RESEARCH NSF

1. CS content changed (changing!) radically....
2. No uniform agreement on the core...
3. Graduates lack a systems approach....
4. Dwindling pipeline....
5. US industry competitiveness threatened....