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

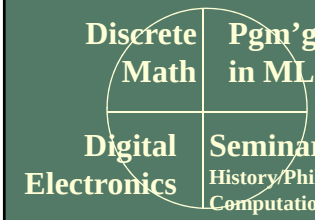
What interests students?
…Ecology, Multi-Media, Biology….

An new Entry Level Program (CS1)

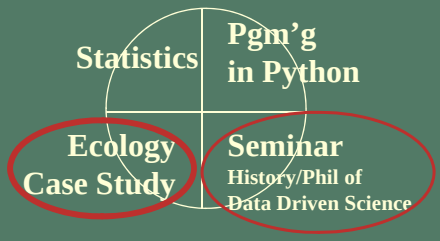
Data & Information: Quantitative Ecology

Strategy: broaden CS1 to address one of these….

Data & Information
Prior Years



Data & Information:
Quantitative Ecology
Fall 2006-7



Will all future IT workers be CS graduates?

Ecology Case Study
The Thousand Year Chronosequence

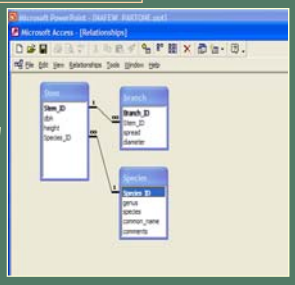
8 PNW forested sites (1kcs) from 50 to 950 yrs old
Ecologists: Nadkarni, vanPelt, McIntosh, et al

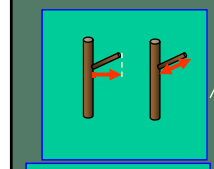
Statistical analysis (in R)
Scientific & Graphics Programming (in Python)
Human Factors of Data Presentation

The Canopy Database Project
Better IT for Ecologists

The 1kcs – its "Torture Test"

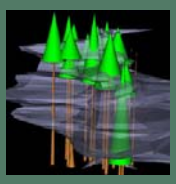
DataBank

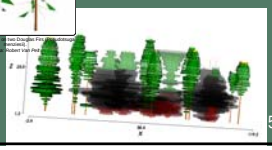




CanopyStats coming….

CanopyView





The *1kcs* Ecology Case Study

How Organized

- 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.**
2. **Using a python program, analyze data from the field trip, and compare to data taken by ecology researchers.**
3. **Extend a python program to compute some key ecology measures.**
4. **Implement in Python, and interpret several simple measures of stand structure.**
5. **Learn about stepwise refinement and functions, code a simple stem map in Python, start project proposal.**
6. **Use R for simple statistics.**
7. **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

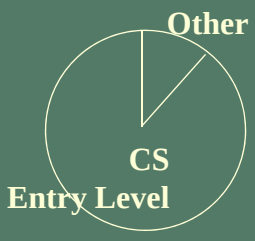
- Very effective 'real world' look at CS in "action"
- Best if team-taught – multidisciplinary faculty essential
- Could be used at Traditional Institutions to
  - introduce inter- or multi- disciplinary studies
  - demonstrate how CS used
  - demonstrate what CS is
- Caveats
  - need a 'canned' case 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
Prior Years



(Estimated)

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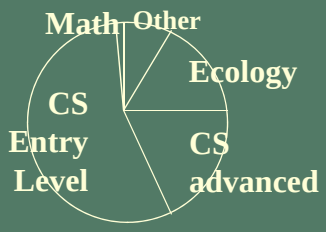

wrt Race-Ethnicity-Gender : better….

Data & Information: Quantitative Ecology
Some Improved Retention

Entry Level CS	Fall	Winter	Spring
D2I to CSF 2006-7	24 intro CS 7 adv CSF 5 adv Non-CS (36 total)	23	18
“other” to CSF 2006-7	--	23	12
Total Retention	24	46	40
Prior Year	27	21	16

←96%→ ←79%→ ←75%→ ←52%→ ←87%→ ←78%→ ←76%→ ←59%→

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 phsyics (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

Broadening CS at the Entry Level Interdisciplinary Science & CS

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….**