Computing Courses for the Sciences: A Small School Perspective

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Background

- Wartburg College: Small (~1800) Liberal Arts College in Waverly, Iowa
- Strong Science Programs
  - Biology
  - Chemistry and Engineering Science
  - Mathematics, Computer Science, and Physics

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Motivation

- Increasing Importance of Interdisciplinary Connections
- Expand on Existing Strength of Combined Department
- Effort to Attract Quality Students to CS Classes

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Obstacles

- Small College Environment
  - Can't support specialized computing classes for various sciences
  - Little computing expertise outside of CS
  - Must have relatively flat prerequisite structure
- Must “Grow” a program organically
  - No new resources likely

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Incremental Steps

- Science Friendly CS 1
- CS Senior Project Collaboration
  - Stereographic Display, Biological Visualizations, Rat Tracking
- Introduction to Computational Science
- Computing in Physics Curriculum
- Revision of Calculus Sequence

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Friendly CS 1

- Using Python as a First Language
  - Very-High level (executable pseudocode)
  - Cover more material with better practical understanding.
  - Popular as a scientific scripting language
- Include Scientific Applications:
  - chaos, graphics/visualizations, simulations, cellular automata.

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Computational Science

- CS Elective Covering
  - Modeling (differential equations)
  - Numerical Methods
  - Visualization
  - Parallel Programming
- Issues:
  - Diverse Majors (CS, Math, Physics, Bio, Chem)
  - Few Prerequisites

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Solution: Project Orientation

- Projects:
  - Non parallel: Lotka-Volterra , Lorenz Attractor, Visualization of Cygnus A ,
  - Parallel: Newton's Basins of Attraction, LaPlace heat flow, Galaxy Collisions
- Progression
  - Mathematical Model, Computational Methods, Visualization, //-ism

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Project Orientation (2)

- Each Project Includes Multiple Levels
  - Phase I: doable (required) for all students
  - Advanced Phases: optional for those students with interest/background
  - Grading structure encouraged all students to attempt some advanced phases
- Some Projects Done in Teams

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Compuational Tools

- Python
- MPI/LAM (PyPar package) On a 19 Node Pentium-4 Linux Cluster.
- Vpython, Graphics, and PPM Files for Visualization
- Stereographic Presentation with SVEN

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Outcome

- Projects Keep Students Active
- Concrete Focus Allows Learning of Necessary Math and Computing
- Project Options Allow Students to Leverage Their Background/Strengths
- Very High Student Evaluations

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Future Developments

- Calculus Sequence Revision
  - Reslicing Calc I and II
  - Applied Calculus: Derivatives and integrals conceptually/computationally through applications.
  - Foundational Calculus: ditto, but symbolically
- Computational Science Minor

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Conclusions

- Our CS Curriculum is Evolving to Better Serve Science (and other) Majors
- Process Also Strengthens CS Major
  - Attracting Quality Students
  - Interdisciplinary Experience
  - Practical Problem-Solving Experience
- Open Question: Buy-In From Sciences

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