Preparing the Future Workforce for Careers in Science and Engineering

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XSEDE
Extreme Science and Engineering Discovery Environment

NSF

Agenda for the Morning

- 9:00 – 10:00 AM
  - Opportunities and Challenges for Curriculum Change
  - Review of Competencies
- 10:00 – 10:30 Break
- 10:30 – 11:30 Industry Panel
- 11:30 – Noon
  - Worksheet to create a program
  - Program examples

Opportunities and Challenges

- Workforce needs in computational science
  - How science and engineering (and social science and humanities) research is done
  - Prepare students for work in private sector, in research, and for graduate school
- Changing how we teach
- Barriers to program implementation

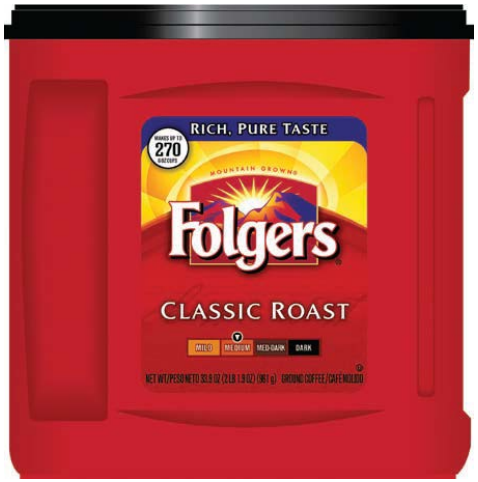
Preparing Students

- Need for a workforce which understands both modeling and simulation principles and applications of models and data analysis at large scale
  - Requirements for high fidelity models of complex systems
  - Managing and understand large datasets – data science
  - Applications across a wide range of science, social science, and increasingly humanities

Crucial Tools for Manufacturing

- At Ford, HPC …allows us to build an environment that continuously improves the product development process, speeds up time-to-market and lowers costs.
- The ongoing use of modeling and simulation resulted in new packaging and product design that propelled the brand to a leading market position over a several-year period.

Ford EcoBoost Technology



Durable coffee package for P&G

Myriad of Examples

- Behavior of new and existing materials at multiple scales
- Climate change and its potential social and economic impacts
- Concentration of environmental contaminants and their impacts on ecosystems and human health
- Genetic markers and disease
- Analysis of huge datasets
  - Market and customer behavior
  - Genomic data
  - Social media

Changing How We Teach

- Getting students actively involved in learning
  - Reducing traditional lectures
  - Increasing inquiry-based learning
- Ideally suited to instruction in computational science
  - Students need technical and analytical skills to create and test models and analyze data
  - Students enhance “soft” skills in teamwork and written and oral communication

Benefits to Students

- Inquiry-based learning is more effective than traditional lecture oriented instruction
  - Students are actively engaged in the learning process
  - Students gain deeper insights and have higher retention rates for the information
  - Facilitates the integration of information across academic disciplines – math, science, engineering, computer science

Challenges to Changing the Curriculum

- We tend to teach in the way we were taught
- Computational science is interdisciplinary
  - Faculty workloads fixed on disciplinary responsibilities
  - Coordination across departments is superficial
  - Expertise at universities is spotty
- Major time commitments are required to negotiate new programs and develop materials
- Curriculum requirements for related fields leave little room for new electives
- Change is hard

Barriers to Program Implementation

- Limited resources and strained workloads
- All of our colleagues don’t see the light
- Access to example materials and datasets
- Access to appropriate infrastructure and technology
- Limits to faculty expertise

Overcoming the Barriers

- Availability of external resources and materials
- Making incremental changes
- Involving potential employers
- Marketing to administrators, faculty, and students
- Inter-institutional collaboration

Sources of Information

- Course syllabi from existing courses
  - Some available through XSEDE
  - Sharing of syllabi with collaborating institutions
- Digital resources on variety of fields
  - NSF digital libraries
  - Collaboratories
  - Consortia
  - Examples: See https://www.osc.edu/~sgordon/workshop/materials

Collaborative Online Materials

- Collaborative courses at XSEDE and Blue Waters
  - Online lectures by central instructor
  - Computer exercises, quizzes
  - Local instructor to advise and grade
- XSEDE Examples
  - Engineering parallel software
  - Applications of Parallel Computers
- Blue Waters Examples
  - High Performance Visualization for Large-Scale Scientific Data Analytics
  - Designing and Building Appliations for Extreme-Scale Systems

Other Resources

- Technical training materials on XSEDE and other sites
- HPCUniversity Resources
- Journals
  - Journal of Computational Science Education
  - Computers in Education
  - Other domain educational journals

Other Materials and Certificates

- XSEDE training materials
  - Online and webcast workshops
  - Future addition of certificates
- Software carpentry
- HPC University
- Links to a variety of sources

Opportunities for Students

- Blue Waters Graduate Fellowship
- XSEDE Scholars
- XSEDE Summer Internships
- Internships with national labs
- See http://hpcuniversity.org/students/opportunities/

Starting a Program

- What do students need to know?
  - Competencies for undergraduate and graduate programs developed as part of several NSF grants and the XSEDE project
  - Review of competencies

Questions and Discussion