Preparing Students for HPC Careers in the Energy Sector

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<th>Rice++</th>
<th>• Schools: Engineering, Science, Social Sciences, Humanities, Architecture &amp; Business</th>
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<td>Comp S&amp;E</td>
<td>• Science &amp; engineering (BIOS, CHEM, ESCI, MATH &amp; PHYS) &amp; (BIOE, CAAM, CEE, CHBE, CS, ECE, MECH, MSNE &amp; STAT)</td>
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| Core | • Computational and Applied Mathematics  
• Computer Science  
• Electrical & Computer Engineering  
• Statistics |
Rice: Computing as a Universal Enabler

Data analytics, data mining, and machine learning …

Numerical methods, solvers, modeling, and simulation …

Programming models, languages, compilers, and tool

Cyber-Infrastructure to enable and accelerate research

Fundamental R&D in: computer science, electrical & computer engineering, applied mathematics, statistics, signal processing, imaging, modeling, machine learning, data-science, cyber-security, energy, materials, biomedicine, …
“The [global] computational science community views Rice [University] as a tier-1 HPC site”

2014 IDC Study: Best Practices in Securing Funding for University-based HPC Centers
Energy Capital of the World (data from 2014)

Texas
• 36% of the oil produced in U.S. comes from Texas
• 23% of crude oil produced in the U.S. comes from GOM offshore production
• 389,000 Texans are directly employed by oil & gas
• 1.8 million additional jobs are supported by economic gains from oil & gas industry spending
• Economic Impact on Texas: $308B

Houston
• 3,600+ oil & gas companies around Houston
• 50% of Houston’s employment in energy sector
  • 10% in oil & gas
• 1 in 5 jobs created since 2010 in oil & gas
• 29% of total U.S. oil & gas employment
Performance Tools: HPCToolkit

- Attribute Costs to Code
- Pinpoint & Quantify Scaling Bottlenecks
- Assess Imbalance and Variability
- Analyze Behavior over Time
- Shift Blame from Symptoms to Causes
- Associate Costs with Data

Performance tools can play an important role in guiding development to maximally leverage infrastructure.
• Unstructured grids
• Node-aware optimization
• Intel Parallel Computing Center
  ✓ Accelerating and expanding PETSc
Geo-Mathematical Imaging

- Direct nonlinear methods
- Iterative methods (FWI)
- Attenuation
- Spectral methods
- Micro-seismicity
- Deep learning

Maarten de Hoop, CAAM
Coupled Flow & Reservoir Simulation

Modeling and Simulation of Processes in Porous Media at Field, Darcy and Pore Scales

Beatrice Riviere, CAAM
Private-Public Partnership
A private-public partnership to support cyberinfrastructure operation and development challenges, develop a sustainable and diverse high performance computing, computational science & engineering, and data-science workforce directed at industry needs.
Conference Attendee History

- 2008: 160
- 2009: 200
- 2010: 240
- 2011: 280
- 2012: 300
- 2013: 330
- 2014: 490
- 2015: 500
- 2016: 520
Attendance by Industry Segment

- Oil & Gas: 37%
- IT Industry (Hardware): 26%
- IT Industry (Software): 11%
- National Laboratories: 1%
- Other: 9%
- Academia: 16%
Graduate Student Support to Create Awareness

~$750,000 since 2002

Annual funding

- $180,000
- $160,000
- $140,000
- $120,000
- $100,000
- $80,000
- $60,000
- $40,000
- $20,000
- $-

Funding sources:
- ExxonMobil
- Schlumberger
- CRay
- bc

Year:
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016

Incomplete data

January 9, 2016

Jan E. Odegard
Where/how are fellowships allocated?

• In computational departments
  • Computational and Applied Mathematics
  • Computer Science
  • Earth Science
  • Electrical and Computer Engineering
  • Statistics
  • Applied Physics

• Used to support students already in these programs at Rice
• Used to recruit students to computational programs at Rice
  • Support MSc & PhD students

• Industry partnership also led to the development of the professional masters degree in Computational Science and Engineering
  • 30 credit hours of course work, can be part time
Boot Camps: Industry Summer Training

High-Performance Computing

- Intro to thread-based parallelism
- Intro to MPI
- Performance analysis tools
- GPU Accelerated computing
- Intro to parallel I/O

Data-Science

- Intro to R & Python
- Intro to AWS, Hadoop and Spark
- Intro Unsupervised Learning
- Intro Supervised Learning

Boot camps offered by Ken Kennedy Institute at Rice with leading faculty and researchers as instructors.

Intensive lecture/lab training to quickly acquire basic skills for beginners or intermediate users (can be mid career boost vehicle).
SAVE THE DATE:

March 15-16, 2017
10th Anniversary

2017 Rice Oil & Gas HPC Conference
http://rice2017.og-hpc.org
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