DATA, DEVICES AND INTERACTION LABORATORY

BIG IDEAS

with Michael E. Papka

11/24/2020
WHAT IS A BIG IDEAS CLASS?

- Lectures and discussions of current research and technical developments in computer science for beginning graduate research students. Topics will emphasize open problems and recent scientific advances. Content may vary to reflect research advances in areas such as data analytics, scientific computing, graphics and visualization.
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- Who has active research projects?
- What are NIU CS faculty interests?
- Where do I get more information?
- How do I get involved?
BIT ABOUT ME (EDUCATION)

- Northern Illinois University - Physics (BS)
- University of Illinois @ Chicago - Computer Science (MS)
- University of Chicago - Computer Science (MS, PhD)
- Continuously learning in other areas
  - University of Chicago - Business School (SLLP)
  - Harvard University - Business School (GMP)
  - Stanford University - Hasso Plattner Institute of Design (Design Thinking)
BIG IDEAS

BIT ABOUT ME (CAREER)

▸ Fermi National Accelerator Laboratory (Undergraduate/Graduate)
▸ Argonne National Laboratory
▸ Northern Illinois University
BIT ABOUT ME (RESEARCH)

- Advanced Display Environments and Collaboration Technology
- High Performance Computing (Systems and Environments)
- Internet of Things (Computing Continuum) [Edge Computing]
- Information and Scientific Visualization
- Data Analysis
- Augmented/Virtual Reality
BIT ABOUT THE ddiLAB

» Joint with School of Art and Design and co-directed with Professor Joseph Insley (Time Arts)

» Focused on visualization and data analysis coupled to high-performance computing in the support of science, with side efforts involving the Internet of Things (edge computing) and interdisciplinary activities connected to computing

» Students

» - 1 PhD (Information Visualization)

» - 2 MS (HPC log analysis, machine learning/edge computing)

» - 8 Undergraduates (IoT, VR, and HPC)
BIT ABOUT ME (RESEARCH)

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Cray X-MP/4 supercomputer, 1985
(www.computerhistory.org/revolution/supercomputers/10/25/23)
BIG IDEAS

SUPERCOMPUTERS

Argonne’s Aurora Supercomputer, 2022/23
800 megaFLOPS to ~2 exaFLOPS
800,000,000 to ~2,000,000,000,000,000,000,000 FLOPS
2,500,000,000x
SO WHAT DOES ALL THAT COMPUTE POWER ENABLE?

- Large-Scale Computing on the Connectomes of the Brain
- Global Radiation MHD Simulations of Massive Star Envelopes
- Molecular Design of Dye-Sensitized Solar Cells
- Real-time Computing in support of DIII-D National Fusion Facility
BIG IDEAS

HIGH PERFORMANCE COMPUTING RESEARCH OPPORTUNITIES

- How do you translate theory into simulation?

HIGH PERFORMANCE COMPUTING RESEARCH OPPORTUNITIES

- How do you more efficiently operate a facility?


Bharat Kale, MS Thesis
How do you effectively schedule and operate a resource?

HIGH PERFORMANCE COMPUTING RESEARCH OPPORTUNITIES

▸ How do you evolve traditional HPC environment?

HIGH PERFORMANCE COMPUTING RESEARCH OPPORTUNITIES

- How do you evolve traditional HPC environment to address real-time needs?

How do you evolve traditional HPC environment handle complex workloads?

50% of the ATLAS papers based on 2015 data use the HPC-produced computing in a demonstrable manner:
- These would still eventually be written without the US HPC effort, but they probably would not exist today: the *time-to-science has been dramatically shortened*.

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HIGH PERFORMANCE COMPUTING RESEARCH OPPORTUNITIES

- How do you evolve traditional HPC environment to increase engagement?

HIGH PERFORMANCE COMPUTING RESEARCH OPPORTUNITIES

▸ How do we **enable** scientists to be the most **productive** from **start to finish**?

▸ How do we improve **usability**?

▸ How do we **simplify** supercomputing?
HIGH PERFORMANCE COMPUTING RESEARCH OPPORTUNITIES

- How do we enable scientists to be the most productive from start to finish?

- Problems with science management:
  - Tracking simulations and output: burdensome
  - Finding and reproducing old simulations: difficult
  - Monitoring live simulations: inconvenient, idiosyncratic
  - Post-processing, analysis and archival of results: haphazard
  - Assessing simulation behavior/performance: challenging
How do we enable scientists to be the most productive from start to finish?

- Simulation management and analysis system for Flash (Smaash)
  - Tracking and coordination of data (simulation and meta)
  - Run-time monitoring of simulations and automated analysis of simulation output
  - Method for managing / executing common workflows

How do we enable scientists to be the most productive from start to finish?
High Performance Computing Research Opportunities

How do we enable scientists to be the most productive from start to finish?
INTERNET OF THINGS (COMPUTING CONTINUUM) [EDGE COMPUTING]

AI @ Edge

- Powerful Parallel Edge Computing
- Edge computing and deep learning with feedback for continuous improvement

- Reduced, Compressed data
- New inference (model) Adaptive steering

- Sensors: LIDAR, Software Defined Radios, Hyperspectral Imaging
- Facilities
- Actuators: Servos, Dynamic adaptation
- Artificial Intelligence Deep Learning Inference Lightweight Training

HPC: Deep Learning Training Simulation / Forecast

Slide: Pete Beckman (ANL/NWU)
INTERNET OF THINGS (COMPUTING CONTINUUM) [EDGE COMPUTING]
INTERNET OF THINGS (COMPUTING CONTINUUM) [EDGE COMPUTING]

Use of **Virtual Reality** in Science

- Usability, virtual interactions
- Rendering, realistic data in VR time
VIRTUAL REALITY

SUMMER RESEARCH OPPORTUNITIES (IN PERSON NORMALLY, CURRENTLY VIRTUAL)

www.anl.gov/hr/argonne-career-and-internship-opportunities
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If I have seen further it is by standing on the shoulders of giants.

Sir Isaac Newton