Sustainability + IT

Reporting on a Workshop on the Role of Information Sciences and Engineering in Sustainability (RISES)

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Presented to the SEEDM Workshop
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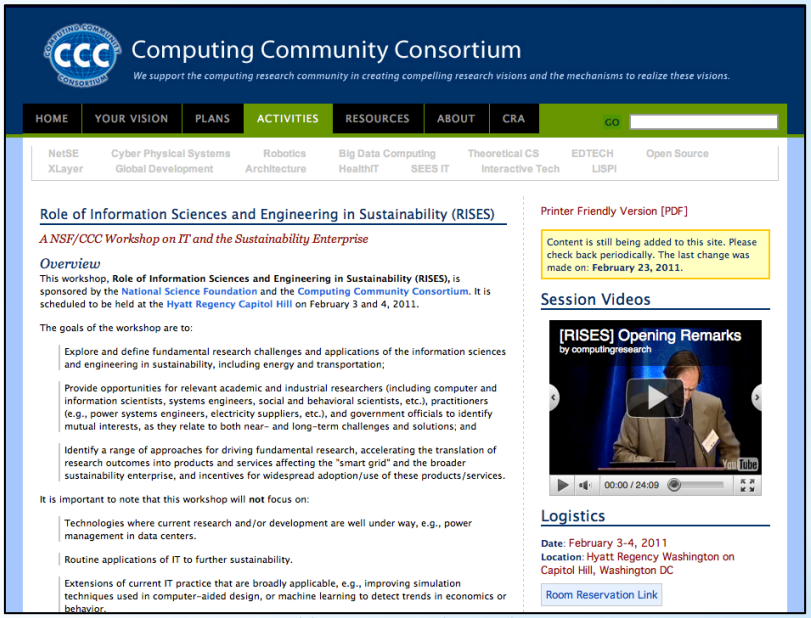
Overview

- A two-day workshop held in Washington, DC, February 3-4, 2011
- Approximately 60 participants
- Multi-disciplinary, with focus on computing
- *Goal: to identify new research opportunities in CISE that address sustainability objectives*



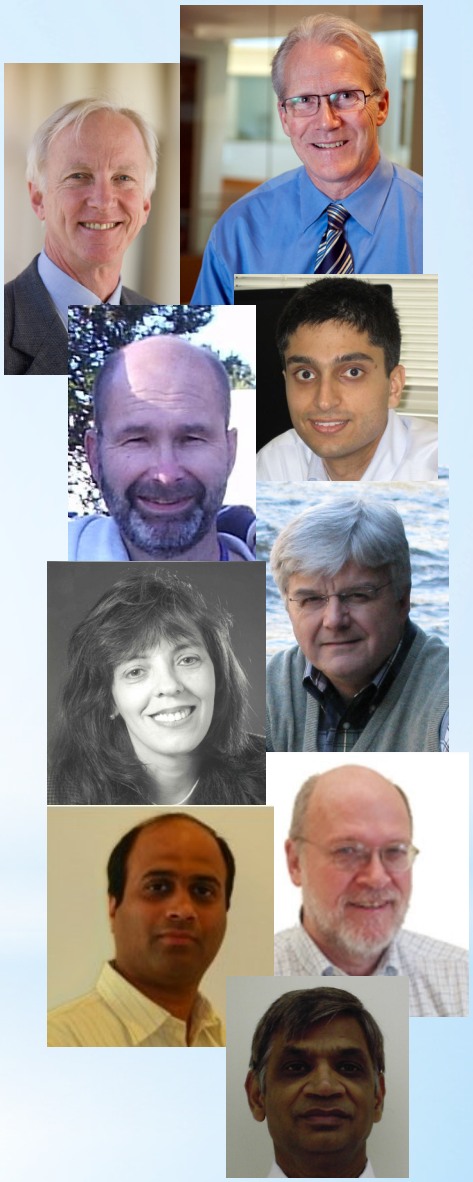
http://cra.org/ccc/seesit

Workshop structure

- Three half-day sessions
  - Two plenary talks, followed by breakout discussions
    - Tim Killeen (NSF/GEO AD), Bill Rouse (Georgia Tech), and Michael Meyer (Georgia Tech)
    - Government panel (DoE Office of Science, ARPA-E, NIST)
    - Bill Tomlinson (UC-Irvine), Carla Gomes (Cornell)
  - Breakouts on CISE research areas as well as sustainability areas
  - Breakouts on "big data," systems integration, and modeling/simulation
- Fourth "wrap-up" session comprising a workshop-wide discussion

Organizing committee

- Bob Sproull, Oracle (co-chair)
- Randy Bryant, CMU (co-chair)
- Doug Fisher, Vanderbilt
- Erwin Gianchandani, CRA/CCC
- Carla Gomes, Cornell
- Bill Rouse, Georgia Tech
- Prashant Shenoy, UMass-Amherst
- David Waltz, Columbia
- Krishna Kant, NSF/CISE



Sustainability

Defining *sustainability*

- "Meeting the needs of present and future generations while substantially reducing poverty and the planet's life support systems"
- Spans natural and built environments, incl. energy, transportation, climate, and biodiversity
- Existing rate of resource consumption and an environmental impact that cannot be sustained

Sustainability goals

- Decreasing overall energy consumption, while increasing use of renewable energy sources
- Improving transportation to minimize energy usage
- Adapting to climate change by conserving natural habitats
- Eliminating waste by designing products for full reuse and moving toward zero-loss of non-renewable resources
- *Sustainable ecosystem: decision making not based on current costs only, but also future costs and renewability*

CISE + sustainability

"Big data" + sustainability

- Temporal *and* geographic data sets
- Very large, heterogeneous
- Varying levels of confidence
- Oftentimes incomplete
- Examples:
  - Graphical structures, sampled measurements, images, extensive notes/comments, social network data, etc.
  - DNA assays of individual creatures and plants
  - Traffic pattern data
  - *A particular challenge in the area of climate research*
- *(Meta)data provenance/federation/curation/ visualization/analytics/archiving*

Core needs

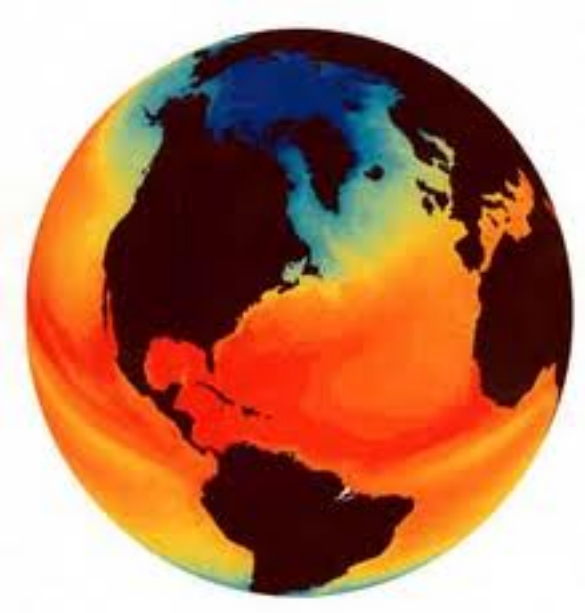
- Common infrastructures of techniques, software, and services to support these data
- One or more "centers" that combine sustainability research, research into the systems aspects of sustainability research, and hosting particular databases
- Benefits: weather modeling, land-use planning and modeling, logistics planning for energy and transportation systems

Privacy and security

- Smart grids, ride sharing and transportation management, etc., will involve aggregations of personal data
- Systems with feedback (e.g., the smart grid) inherently are easy targets for disruption
- Newer and better techniques to provide privacy & security, and to garner the public's trust in these systems

Modeling & simulation

- Simplifying scaling up simulations to the limits of computing power that we have available
- Routinely conforming simulations to observed data
- Testing, debugging, and verifying models and simulations
- Particularly in sustainability:
  - Finding better ways to model and simulate human behavior and behavior changes
  - Making models more transparent to permit non-modelers to inspect and debate



Additional CISE areas

- Optimization
  - New objective functions and algorithms
  - E.g., optimizing wind turbine farm locations, smart buildings, etc.
- Intelligent systems
  - Smart grids
  - Automatically monitoring traffic patterns
  - Monitoring & controlling building environment systems
  - Detecting patterns of animal behavior or crop performance
- Human-centered & social computing
- Cyber-physical systems
- Systems engineering & system integration

"Green IT"

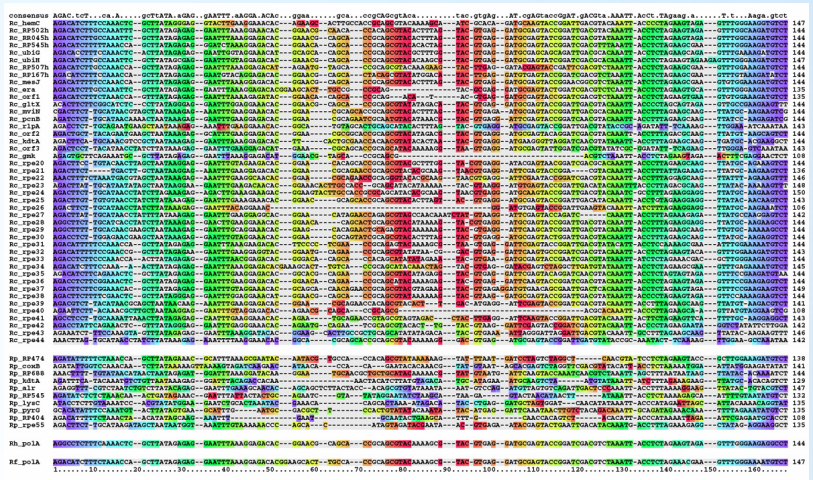
- "Power-aware life-cycle computing"
- "Energy harvesting"
  - Sensors in a cornfield
  - Sensors embedded in structures/ vehicles
- More power-efficient microprocessors
- Dynamic data management software to optimize energy efficiency
- Lots of effort in industry here, so academy must be aware of it

Some new ideas

- Sustainability of sustainable data
- Breadth of the sustainability space + richness of the computational problems
- Challenges particularly in energy and transportation
- Improving the quality and transparency of models
- Understanding human needs and preferences, and encouraging behavioral changes
- Enabling citizen science

Guiding principles

- "Use-inspired fundamental research"
- Deep and long-term collaborations
- Federal investment requiring research to be informed by domain areas
- Education: bringing sustainability into computing curricula



Questions?

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