Sustainability + IT

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

Prashant Shenoy

University of Massachusetts Amherst
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 issues, and modeling/simulation
- Fourth “wrap-up” session comprising a workshop-wide discussion
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
Modeling & simulation + sustainability

- 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
Privacy and security + sustainability

- 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
Intelligent Systems + sustainability

- Intelligent systems
  - Smart grids and buildings
    - Monitoring & controlling building environment systems
  - Smart transportation
    - Automatically monitoring traffic patterns
  - Detecting patterns of animal behavior or crop performance
  - Cyber-physical systems

- Optimization
  - New objective functions, algorithms, feedback and control
  - E.g., optimizing wind turbine farm locations, smart buildings, etc.
Summary

- Broad-brush lens on sustainability and IT
  - Attempt to reach out and draw in “other” disciplines beyond CISE
  - Educational issues
  - Workshop Report: http://cra.org/ccc/seesit
- Less focus on well-researched power-aware computing area
- More focussed follow-on workshops
  - SEEDM: data management aspects
UMass Efforts in Smart Buildings/Grids

• How to manage the energy footprint of a home or an office building?
  – From data to analytics to recommendations to controls

• How should smart buildings interface with grid/utilities to effectively manage its energy and carbon footprint?
  – Demand-response, pricing signals
Smart/Green Home

- Uses renewable energy sources
- Interfaces with a smart grid
- Smart, programmable appliances
- Uses battery-based energy storage
- Real-time monitoring and some control
- Offers rich problems for optimization, system design,
Research Questions

• How should a smart home perform energy capping, peak load flattening?

• How can batteries used for renewable sources be exploited for demand-side load management?

• How should grid pricing signals be exploited by a smart home?

• Micro-grids: How should homes in a neighborhood cooperate to achieve local sustainability goals?
Research questions

• Home automation protocols for smart home control

• Batteries as an optimization mechanism
Concluding Remarks

• Sustainability the “only way” ahead
• Many challenges: Scale, complexity, ...
• Getting sustainability right is hard

"Tim Harford could well be Britain’s Malcolm Gladwell...insightful and clever.\nAlex Brelie, author of Alice’s Adventures in Wonderland"