RECONNECT 2017

Mathematical and Computational tools for Energy Efficiency and Reliability of Data Centers and the Electrical Grid – Individual Interests vs. the Common Good

June 11-17, 2017

Agenda

Bring laptop computer

Sunday, June 11

Check into hotel - Courtyard Marriot, Boone, NC

7:00 PM   Dinner as a group in hotel

Monday, June 12
7:00 - 8:00   Breakfast in the hotel

8:15   Travel to meeting either by foot, car, or shuttle

All meetings are in room 103AWalker Hall on the Appalachian State campus. All lunches and breaks will be in room 105 Walker Hall.

8:45   Welcome, Introductions, and Plans for the Week
Midge Cozzens, Rutgers University, CCICADA and DIMACS Centers

Welcome from Appalachian State Administration
Mark Ginn, Professor of Mathematics, Campus Host

9:30   **Modeling the Energy Future: Part I**
James Case, Consultant, Baltimore Maryland and Ph.D Mathematician. His Ph.D is from the University of Michigan in game theory. His research has focused on many-player non-cooperative game theory and mathematical economics.

Among their many shortcomings, competitive free markets have shown themselves to be remarkably inefficient developers of the planet's limited supply of fossil fuels. A class of energy-driven ― rather than dollar-driven ― models for assessing alternatives will be proposed. Alternatives are needed because unplanned development of the remaining resource seems likely to mean "game over" for the atmosphere.

10:45   Break

11:00   **Modeling the Energy Future: Part II**, James Case

Part II will offer a closer look at control theory and the calculus of variations, tools required for the analysis of the model(s) proposed in Part I.

12:15   Lunch

1:30   Participants in groups will work through the construction of models for specific examples and compare the alternatives using elementary control theory.

3:00   Break

3:15   Continue the discussion begun at 1:30 and look at homework problems.

4:15   Work on homework and begin to think about possible module topics.

6:30   Dinner at the hotel

Room available in the evening for work on homework and socializing.

Tuesday, June 13
7:00 - 8:00   Breakfast in the hotel

8:15   Travel to meeting either by foot, car, or shuttle

8:45   Brief discussion of homework.

9:30   **Introduction**
               Daniel Bienstock, Industrial Engineering and Operations Research; and Applied Physics and Mathematics Professor, Columbia University. His research focuses on optimization and high-performance computing. A second focus of his research involves the use of computational mathematics in the analysis and control of power grids, especially the study of vulnerabilities and of cascading blackouts.

The talk opens with a description of blackouts in the last decade, and a description of how the electric grid works (basic physics) and its operation. The role of renewables will be considered. Cascading failures, and challenges in simulations of them will be explored, in particular the role of race conditions and noise in big data collections.

10:45   Break

11:00   **ACOPF and PF problems,** Daniel Bienstock

The ACOPF and PF problems will be discussed and applications of solving systems of algebraic inequalities. Various methodologies, local vs. global minima, and hierarchies in optimization will be explored.

12:15   Lunch

1:00   **Optimization and Modeling,** Daniel Bienstock

Optimization and Modeling, N-K analysis of grids, bilevel optimization, and broadly interpreted vulnerability analysis. Cyber-physical attacks on the grid, analysis of streaming data. The role of PCA (principal component analysis).

3:00   Break

3:30   Wrap up, homework assignment and suggested topics for modules or technical reports. Begin homework and think about today's talks in light of modules; to be continued after dinner in groups.

6:30   Dinner at the hotel

Wednesday, June 14
7:00 - 8:00   Breakfast in the hotel

8:15   Travel to meeting either by foot, car, or shuttle

8:45   Brief discussion of homework solutions

9:30   **Energy Pricing,** James Case

In 1931, economist Harold Hotelling enunciated a "law" that doomed the real price of gasoline — and other fossil fuels — to rise at an exponential rate as supplies near exhaustion. In fact, after correcting for inflation, the price of gasoline has merely fluctuated (for 87 years) about a relatively constant level. What led Hotelling to his heroically inaccurate prediction, and how can better ones be made?

10:45   Break

11:00   The discussion begun earlier continues by exploring ways to make better predictions.

12:15   Lunch

1:30   **Reducing Power Usage During Peak Hours – A Community Project**
Joe Cazier, Director of the Center for Analytics Research and Education, and Ed Hassler, Assistant Professor of CIS, Appalachian State University

3:00   Break

3:30   **The Mathematics of International Trade,** James Case

Coal, oil, and (liquid) natural gas all trade in global markets. The conventional wisdom regarding such markets rests on a single unifying principle, which modern scholarship has reduced to a concise mathematical theorem. That theorem, along with its various limitations, will be explained, and an alternative approach to the subject explored.

5:00   Think about today's talks in light of modules; form groups and work with group on a topic choice after dinner. All topics reported out in the morning.

6:30   Dinner at the hotel

Thursday, June 15
7:00 - 8:00   Breakfast in the hotel

8:15   Travel to meeting either by foot, car, or shuttle

8:45   Report module topic selections

9:30   **Valuing Uncertainty and Risk in Carbon Emissions and Climate Policy** (work with NASA)
Eric Marland, Mathematics Professor, Appalachian State University

Professor Marland will discuss an approach for dealing with uncertainty and risk in carbon accounting that borrows its basic approach from actuarial science. The concept of a risk charge is motivated and explained as a general method for dealing with uncertainty. After that, some existing implementations and applications will be discussed, along with opportunities and challenges associated with this approach.

10:45   Break

11:00   **Individual Interest vs. the Common Good**
Margaret (Midge) Cozzens, Research Professor, DIMACS, Rutgers University. Her research focuses on applications of game theory and graph theory to problems in ecology and environmental sustainability.

We will explore policies for balancing individual interests with the common good to avoid an eventual "tragedy of the commons". In this area, game theory can model the interactions of multiple agents and show the effects of competing interests. Economic

incentives may influence whether a country or a company is motivated to enter an agreement and then abide by it.

12:15   Field trip to the Energy Center and Beech Mountain to include lunch in town, and visits to the Small Wind Research Demonstration sites. Leave from App State and return there.

6:30   Dinner at the hotel and work on modules after dinner.

Friday, June 16
7:00 - 8:00   Breakfast in the hotel

9:00   **Negative Electricity Prices**
Jason Hoyle, Energy Center, Appalachian State University

10:30 - 2:30   Work on module presentations and lunch

2:30   First module presentations
Joyati Debnath, Professor of Mathematics, Winona State University. She organizes the presentations as she has done in the past.

6:30   Dinner at the hotel

Saturday, June 17
7:00 - 8:00   Breakfast in the hotel

8:15   Travel to meeting either by foot, car, or shuttle

8:45 - 11:30   Group presentations – organized by Joyati Debnath

12:00   Box lunches and departure