National Infrastructure Simulation & Analysis Center

Learning Adaptive Software Agents for the Electric Power Business

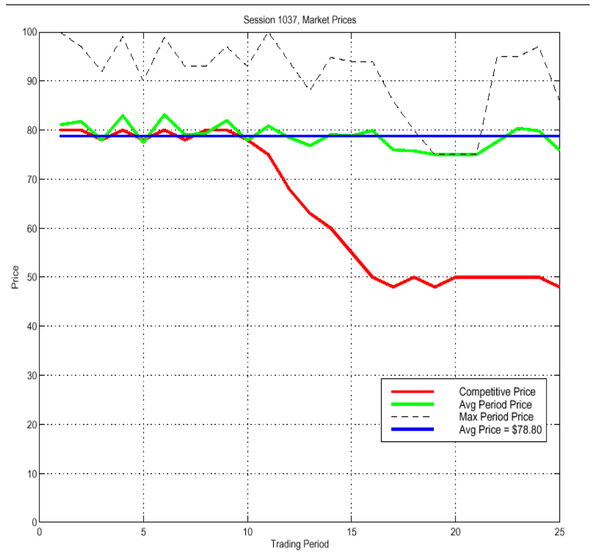
PSERC

PowerWeb Analysis

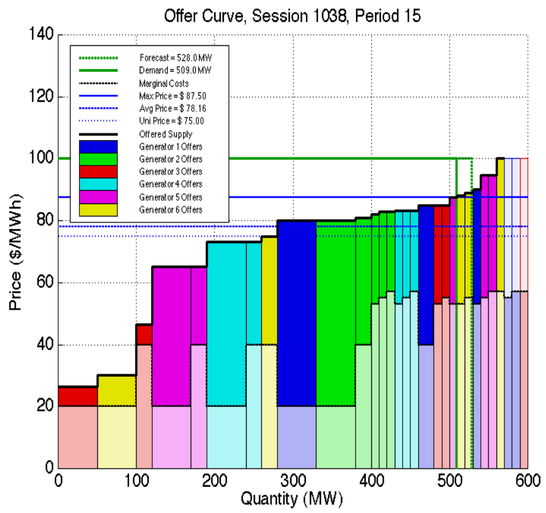
The primary objective for this work is to develop new techniques for incorporating dynamic or adaptive human decision making into the NISAC Agent Based Modeling Environment (N-ABLE). One approach that may prove useful is to utilize neural networks or other artificial intelligence techniques to develop algorithms based on patterns of human decision-making in changing environments.

Cornell University in cooperation with PSERC partners have developed PowerWeb, an environment for testing various power exchange auction markets through tournaments. PowerWeb is designed to allow human players to interact in a competitive "day-ahead" electric energy market in the context of a deregulated electric power industry. The results of PowerWeb are the behaviors of various participants in power markets. The goal of this effort would be to use PowerWeb simulations to create a data set that will be used to develop algorithms that can capture the dynamics of human decision making in power markets.

During the months of November and December 2001, the PSerc Group at Cornell University conducted a series of six tests of different auctions for selling electricity with the help of 18 individuals (3 groups of 6 competitors) who had experience in the power industry. The tests were performed using our web-based platform, PowerWeb, which simulates the characteristics of supplying electricity over a transmission network. In one of those experiments we attempted to duplicate the situation that was actually faced by suppliers in California, namely, high prices for natural gas for some period of time and then, a sudden decrease in those prices. The data from that experiment was supplied to NISAC as an example of a situation where market conditions changed in the middle of the experiment. The question is whether a software agent can be designed to adapt to the situation in the same way that humans did in the experiment.



This plot shows one group in the hybrid auction with inelastic load and variable generation costs. Note that when the generation costs fall the high prices persist. Longer tests are required in order to make any claim about how long they might persist.



The offer curve for period 15 for one of the groups in the hybrid auction with inelastic load and variable generation costs. Generation costs were back to normal at this point but offers, even for baseload units, remain high.

PSERC

Power Systems Engineering Research Center

Universities working with industry to find innovative solutions to challenges facing a restructured electric power industry and to educate the next generation of power industry engineers.

Mission

Universities partnering with industry to:

- *Engage in forward-thinking about future scenarios for the industry and the challenges that might arise from them*
- *Conduct research for innovative solutions to the challenges using multidisciplinary research expertise in a unique multi-campus environment*
- *Facilitate interchange of ideas among academia, industry and government on critical industry issues*
- *Educate the next generation of power industry engineers*

Collaborating Universities

Cornell University - Robert J. Thomas - Center Director
Arizona State University - Gerald Heydt
University of California at Berkeley - Shmuel Oren
Carnegie Mellon University - Sarosh Talukdar
Colorado School of Mines - Rahmat Shoureshi
Georgia Institute of Technology - Sakis Meliopoulos
Howard University - James Momoh
University of Illinois at Urbana - Peter Sauer
Iowa State University - Vijay Vittal
Texas A&M University - Mladen Kezunovic
Washington State University - Anjan Bose
University of Wisconsin-Madison - Robert H. Lasseter
Wichita State University - Ward Jewell

Industrial Members

ABB
Alcatel
Allegheny Power
Alliant Energy
ALSTOM EMM
American Electric Power
American Transmission Co.
Arizona Public Service Corp.
California ISO
Constellation Power Source
Duke Energy
Entergy
Exelon
EPRI
Florida Power & Light
GE Power Systems
Institute de recherche d'Hydro-Quebec (IREQ)
ISO New England
KEPRI
MidAmerican Energy
Mitsubishi Electric
National Grid USA
National Renewable Energy Lab
New York ISO
NxtPhase
PJM Interconnection
Powertech Labs
PowerWorld Corp.
Omaha Public Power District
Oncor
Pacific Gas & Electric
Reliant Energy/HL&P
Salt River Project
Southern Company
Steel Tube Institute of North America
Tennessee Valley Authority
Tri-State G&T
U.S. Department of Energy
Western Area Power Administration

NISAC's core partners are Sandia National Laboratories and Los Alamos National Laboratory.
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.
Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405 ENG-36.