Games, optimization bots and fields of fuel

Michael C. Ferris

Joint work with: Leith Nye, Nathan Pelc, James Runde, Rosemary Russ, Will Strinz and Steve Wangen

University of Wisconsin, Madison

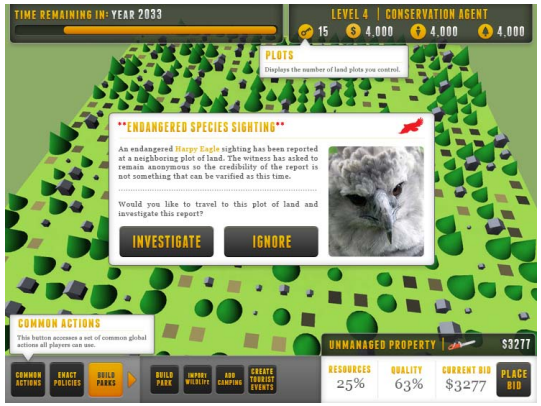
WID, Madison, Wisconsin
January 26, 2015

An interdisciplinary class

CS 699
Agent Programming for Conservation Games

Time: Tuesdays 4:00 - 5:15, Location: WID 4130

If you are interesting in programming for computer games and simulations, and are interested in creating technologies to assist with environmental conservation, the following (2-3 variable credit) 699 course is for you



Instructors

Michael Ferris (UW Computer Science)
(register for CS 699 (independent study, section 10, the class # is 004299))

Ben Shapiro (Wisconsin Institutes for Discovery)
Steven Wangen (Wisconsin Institutes for Discovery)

Prereq: CS 302 or Instructor Consent

As a tutorial in agent-based computational modeling, game programming, artificial intelligence, and ptimization, students participating in this seminar will create AI bots to compete against one another in a prototype video game that simulates rural Wisconsin ecologies and economics. Students will work in teams of at least 2, with complementary expertise in computing and conservation, ecology or economics.

- Class was taught on two occasions
- Mixture of CS, Engineering and CALS students
- One project specified by Doug Reinemann
- Initial developer: Will Strinz (CS undergraduate)

MOPEC

$$\min_{x_i} \theta_i(x_i, x_{-i}, p) \text{ s.t. } g_i(x_i, x_{-i}, p) \leq 0, \forall i$$

$$p \text{ solves } \mathrm{VI}(h(x, \cdot), C)$$

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equilibrium
min theta(1) x(1) g(1)
...
min theta(m) x(m) g(m)
vi h p cons
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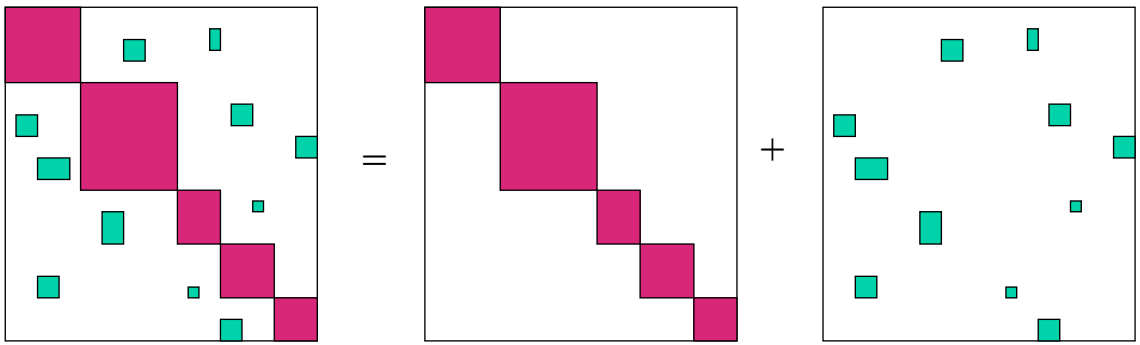
- Reformulate optimization problem as first order conditions (complementarity)
- Use nonsmooth Newton methods to solve complementarity problem
- Precondition using "individual optimization" with fixed externalities



Idea and implementation

- Have real agents, and automated agents, along with shared resource
- Farmers (planting and management, leeching, CO2)
- Economy (supply, demand, max money), Environment (bug index)
- Use in schools and undergraduate classes (e.g. Tom Cox)
- Also used with group of AgEcon experts (faculty Oct 2014)

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- Single player hard to do - introduce bots
- Implement bots using GAMS
  - Information in: same as a real player
  - Key step: approximate other players actions/response function
  - Different objectives
  - Information out: planting and management decisions

- Question for today: How to broaden impact?
- Point your google chrome browser at: fieldsoffuel.org

The collaborators

- GLBRC: John Greenler, Leith Nye, James Runde
- Curriculum and Instruction: Rosemary Russ
- CS: Michael Ferris, Will Strinz (undergraduate)
- Air Force Institute of Technology: Nathan Pelc
- Washington University: Alex Wood Doughty (undergraduate)
- WID: Steve Wangen, Jeff Dischler
- Tufts University: Ben Shapiro

Follow up

- Trails Forward: web-based role playing game that simulates an economy and environment in northern WI (play as lumberjack, housing developer, conservationist)
- Study: 75 minute play sessions with a recorded video chat to capture interactions
- Data will be used to train a program to play like humans so that humans can reason about outcomes of multiple bot-played games
- Question: Can this be used to inform public policy decisions?
- recruitment email coming soon