CS3L Lecture 11

Introduction to Game Theory

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YOUR FINAL PROJECT!

Today, I'll explain the core ideas behind game theory and show you your awesome final project.

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What is "Game Theory"?

Combinatorial
- Sprague and Grundy's 1939 Mathematics and Games
- Board games
- Nim, Domineering, dots and boxes
- Film: *Last Year in Marienbad*
- Complete info, alternating moves
- Goal: Last move

Computational
- R. C. Bell's 1988 Board and Table Games from many Civilizations
- Board games
- Tic-Tac-Toe, Chess, Connect 4, Othello
- Film : *Searching for Bobby Fischer*
- Complete info, alternating moves
- **Goal: Varies**

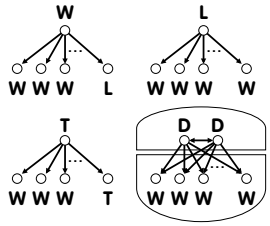
Economic
- von Neumann and Morgenstern's 1944 *Theory of Games and Economic Behavior*
- Matrix games
- Prisoner's dilemma, auctions
- Film : *A Beautiful Mind* (about John Nash)
- **Incomplete** info, simultaneous moves
- Goal: Maximize payoff

What "Board Games" do you mean?

- **No chance, such as dice or shuffled cards**
- **Both players have complete information**
  - No hidden information, as in Stratego & Magic
- **Two players (Left & Right) usually alternate moves**
  - Repeat & skip moves ok
  - Simultaneous moves not ok
- **The game can end in a pattern, capture, by the absence of moves, or …**

Basic Definitions

- **Games are graphs**
  - Position are nodes
  - Moves are edges
- **We strongly solve game by visiting <u>every</u> position**
  - "Playing" every game ever
- **Each position is (for player whose turn it is)**
  - <u>Winning</u> (∃ losing child)
  - <u>Losing</u> (All children winning)
  - <u>Tieing</u> (!∃ losing child, but ∃ tieing child)
  - <u>Drawing</u> (can't force a win or be forced to lose)



Computational Game Theory

- **Large games**
  - Can theorize strategies, build AI systems to play
  - Can study endgames, smaller version of orig
    - Examples: Quick Chess, 9x9 Go, 6x6 Checkers, etc.
  - Can put 18 years into a game [Schaeffer, Checkers]
- **Small-to-medium games**
  - Can have computer <u>strongly</u> solve and…
    - Play against it and teach us strategy
    - Allow us to test our theories on the database, analysis
    - Analyze human-human game and tell us where we erred!
  - Big goal: *Hunt Big Game* – those not solved yet
  - I wrote GAMESMAN in 1988 (20 yrs ago!), the basis of my GamesCrafters research group and the basis for this final project!

GamesCrafters

- **Undergraduate Computational Game Theory Research Group**
- **225 students since 2001**
  - We now average 20/semester!
  - They work in teams of 2+
- **Most return, take more senior roles (sub-group team leads)**
  - <u>M</u>aximization (bottom-up solve)
  - <u>O</u>h, DeepaBlue (parallelization)
  - <u>G</u>UI (graphical interface work)
  - <u>R</u>etro (GUI refactoring)
  - <u>A</u>rchitecture (core)
  - <u>N</u>ew/ice Games (add / refactor)
  - <u>D</u>ocumentation (games & code)