200
150 Students Can’t Be Wrong!
GamesCrafters, a Computational Game Theory Undergraduate Research and Development Group at UC Berkeley

2007-11-13 @ 12:00-13:00 EST in Theatre 3 ICT, 111 Barry St, Carlton, Australia

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Student Groups

Problems

- Nothing to offer to your A+ students after course
- Faculty-student interaction limited
- Students don’t know how to bootstrap into research projects
- Few opportunities for students to shine
- Research, development, art itches not scratched!

Solution!

- Offer student groups that fit your interest
- Students can register as “group meeting” or “research project”
- Meet in the evenings so scheduling easy
- Students can register over and over, choosing bigger projects
- 3 groups founded in ‘01

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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

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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 every position
  - “Playing” every game ever
- Each position is (for player whose turn it is)
  - Winning (∃ losing child)
  - Losing (All children winning)
  - Tieing (∅ losing child, but ∃ tieing child)
  - Drawing (can’t force a win or be forced to lose)

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Example: Tic-Tac-Toe

- **Rules (on your turn):**
  - Place your X or O in an empty slot on 3x3 board
- **Goal**
  - If your make 3-in-a-row first in any row / column / diag, win
  - Else if board is full with no 3-in-row, tie
- **Misère is tricky**
  - 3-in-row LOSES
  - Pair up and play now, then swap who goes 1st

Values Visualization for Tic-Tac-Toe
Tic-Tac-Toe Answer Visualized!

- Recursive Values Visualization Image
- Misère Tic-tac-toe
  - Outer rim is position
  - Inner levels moves
  - Legend
    - Lose
    - Tie
    - Win

Misère Tic-Tac-Toe 2-ply Answer
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 **strongly** 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 (almost 20 yrs ago!), the basis of my GamesCrafters research group

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GamesCrafters

- Undergraduate Computational Game Theory Research Group
- 140 students since 2001
  - We now average 40/semester!
  - They work in teams of 2+
- Most return, take more senior roles (sub-group team leads)
  - Maximization (bottom-up solve)
  - Oh, DeepaBlue (parallelization)
  - GUI (graphical interface work)
  - Retro (GUI refactoring)
  - Architecture (core)
  - New/ice Games (add / refactor)
  - Documentation (games & code)

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GamesCrafters

- Projects span CS areas
  - AI: Writing “intelligent” players
  - DB: How do we store results?
  - HCI: Implementing interfaces
  - Graphics: Values visualizations
  - SE: Lots of SE juice here, it’s big!
    - Defining & implementing APIs
    - Managing open source SW
  - OS: We have our own VM
    - Also eHarmony & net DB
  - PL: We’re defining languages to describes games and GUIs
  - THY: Lots of combinatorics here: position & move hash functions
- Perennial Open Day favorite!
- “Research and Development can be fun?!?”

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Alumni Feedback

- **Student feedback (2006 Student report)**
  - **Problem:**
    - "Undergrads find it hard to participate in research"
  - **Solution:**
    - "Create more activities like [Dan’s groups]"

- "I learned more about real software engineering in GamesCrafters than in my CS classes combined”

- "It pulled together all of the theoretical concepts from the various CS classes in providing my first practical application of my degree. Everything I learned in class was also present in GamesCrafters.”

- "The experience prepared me for a career in software development in ways that my CS classes never could."

- "GamesCrafters was the defining institution of my undergraduate career at Cal.”
Conclusion

- **GamesCrafters**
  - 200 Alumni
  - 65 Games
  - Almost 250K LoC
    - GAMESMAN open source, download!

- **Meta take-away**
  - Think of itches you need scratching; form an undergrad group!
    - Ruby on Rails
    - ACM Prog. Contest
    - … you fill in the blank!

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