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

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Introduction

- Undergraduate Research and Development group to explore computational game theory
- Seven years, 200 students, 65 games
- Engage undergraduates of all levels & interests

Talk overview
- GAMESMAN – core AI infrastructure (Alan)
- Student experience – undergraduate participation (Pat)
- Outreach – engaging the wider community (Yanpei)
- Evaluation – what we’ve learned (Yanpei)
Computational Game Theory

- Finite, 2-person, perfect-information games
  - No chance, hidden info or simultaneous moves
- 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 w/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!
  - Meta-goal: Hunt Big Game – those not solved yet
**GAMESMAN**

- System for solving, playing, and analyzing
  - We care about **strong solutions**, not best guesses
- Exhaustive search of game tree
  - Input: start positions, moves, win conditions
- Game-independent core + game modules
- 240K lines of Open-source code
  - 155K C, 80K Tcl/Tk, 8K Java
  - Some Python, Scheme
  - Major core rewrite in C++ underway
What started with a CLI for tic-tac-toe is now

- Fully interactive GUI
- Several custom databases
- Network (e-harmony) support
- Post-game analysis
- Several very clever solvers
GAMESMAN

Network:
Gamesman Online
Gamesman Mobile

Libraries:
Generic Hash
“Three in a row”

Gamesman Core:
Solvers: Standard, Loopy, Bottom-Up, Alpha-Beta
Databases: Standard, Collision Buckets, File
Analysis: Game Statistics, Open Positions
Advanced Features: Visual Value History, Symmetries
User Interaction: CLI and GUI Framework
Debugging and Diagnostics

Game Modules:
Quarto CLI
Tile Chess CLI
Tic-Tac-Toe CLI
Othello CLI

...
Student Experience

- GamesCrafters founded in 2001
- Targeted recruitment from CS3, word-of-mouth
- Students can return semester after semester!
  - …earning general elective credit each time
Student Experience

- Student-driven, multi-semester team projects
  - Span every CS field & level of student ability!
- Weekly 3 hr meetings, driven by team leads
  - Week 1: Icebreakers, project brainstorm
  - Week 2: Intro tutorials, project & teams selection
  - Weeks 3-4: Extended tutorials, code a game live
  - Weeks 5-13: Work on projects, regular updates
  - Weeks 14-15: Project presentation and feedback
Student Experience

- **GRAND MOB projects**
  - GUI work
  - Retro (GUI refactoring)
  - Architecture (core)
  - New/ice Games
    - (add / refactor)
  - Documentation
    - (games & code)
  - Maximization
    - (bottom-up solve)
  - Oh, DeepaBlue (parallelization)
  - Bug squashing

- **Projects span CS areas**
  - AI: Writing “smart” players
  - DB: How do we store results?
  - HCI: Implementing interfaces
  - Graphics: Values visualizations
  - SE: Lots of SE juice here
    - 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 hashing
Student Experience

- Springboard to opportunities
  - Great stepping-stone for other research groups
- Enriches & grounds the CS curriculum
  - AI, DB, Graphics, Architecture, Networks, etc
- Professional and academic skill development
  - Wallflowers become team leaders
  - Software engineering emphasized
  - End-of-semester presentations
- It’s lots of fun!
Outreach

- Share with the public whenever possible
- CalDay
  - Top attraction in the EECS dept
  - Visitors of all ages
  - Students paired with visitors as they enter
- gamescrafters.berkeley.edu website
  - Each game’s history, rules, and analysis of solution
  - Upcoming web interface (GAMESMAN online)
Outreach – Cal Day
**GamesCrafters**

games analysis members extra software

dots and boxes

**XML**

**History**
The game of Dots and Boxes was studied extensively by Elwyn Berlekamp, who in the late 1960s presented the Dots and Boxes theorem at the University of Calgary. While the game is known as a popular children's game, it is actually very sophisticated in nature. A nim-like Sprague-Grundy theory can be applied to Dots and Boxes, which according to Berlekamp because the theory is supposed to only apply to disjoint impartial games. Dots and Boxes, which does not fit the typical mold of impartial games, where the players fight over the last move, also fails to be disjoint.

**The Board**
Any piece of paper where dots can be drawn maybe be used as a board.

**The Pieces**
Two different color pens.

**Rules**

- **To move**: Connect any vertical or horizontal line between the dots.
- **To win**: To create the most boxes.

Players take turns connecting horizontal or vertical lines between dots. After winning one or more boxes, the player places another line. The playerâ€™s turn ends when he or she cannot make a box.

**Strategies**
- **Odd Advantage**: An easy strategy to follow is to make sure that there is an odd number of moves left. Generally, the player to go first will have the advantage.

**Variants**
- **Misere**: Force your opponent into creating the most boxes.
Evaluation

- The group forms a nurturing community
- Students with diverse GPAs and interests
  - Leadership & tutorial opportunities
  - Student-driven roundtable meetings
- Prepares students for grad school & industry
- 30-40 students per semester
  - Pros & cons to running a group this size
- Overall Alumni feedback very positive
Alumni Feedback

- “It pulled together all of the theoretical concepts from the various CS classes in providing my first practical application of my degree.”

- “It had a significant impact on me. It gave me an intro to the world of AI.”

- “I wish I’d had more time between school & other activities to devote to it.”

- “The diversity of the group brought together people with different perspectives and different skill sets into a greater whole.”

- “It prepared me for a career in SW development in ways my CS classes never could.”

- “It was the defining institution of my undergrad career at Cal.”
Conclusion

- GamesCrafters has engaged over 200 UC Berkeley undergraduates in seven years
  - Research and (open source) Development
  - Community of students who return over and over

- Take-away thoughts
  - After-school R&D activities centered around faculty AI interests are a good thing
  - Board games have served as great fodder
  - We welcome contributors, satellite faculty

See our demonstrations at 11:50am!
Thank you! Questions?