**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

# 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 _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)

**W**

W  W  W    L

**L**

W  W  W    W

**T**

W  W  W    T

**D  D**

W  W  W    W
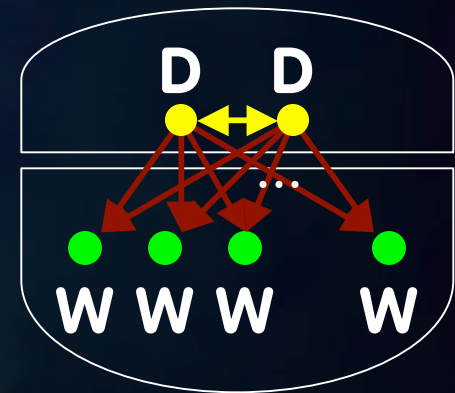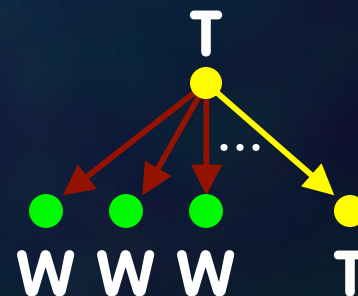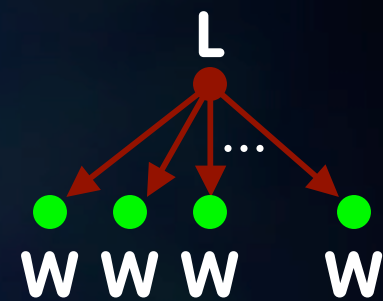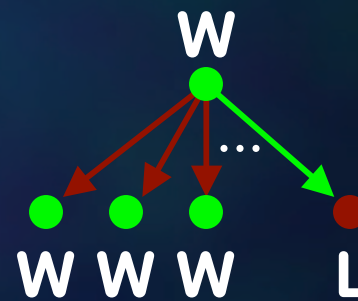
# Example: Tic-Tac-Toe

- **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**
- **Misére is tricky**
  - **3-in-row LOSES**
  - **Pair up and play now, then swap who goes 1st**


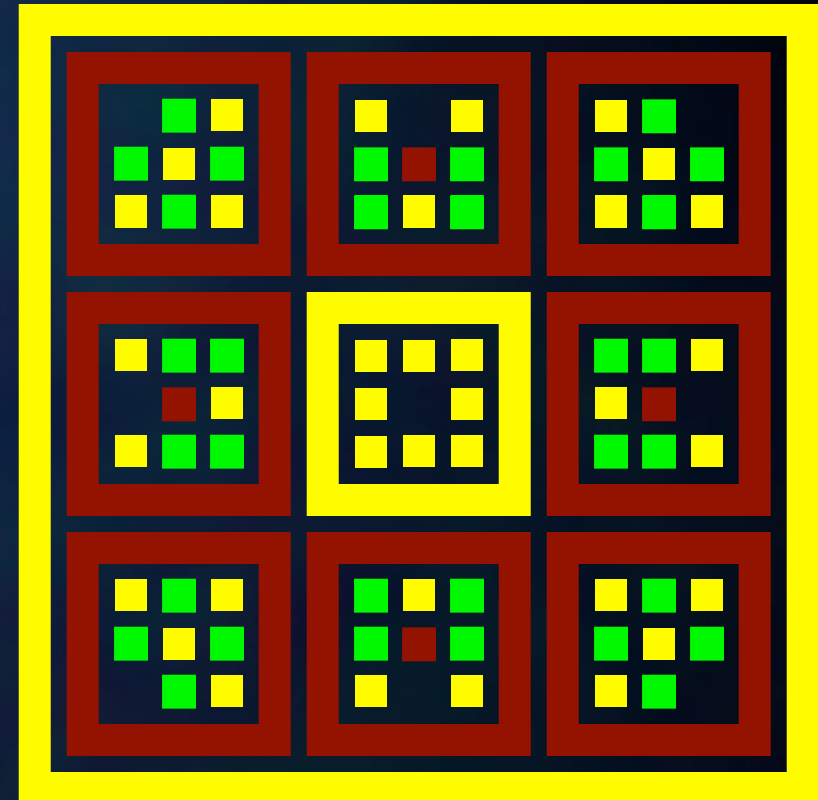
GAMESMAN TicTacToe board
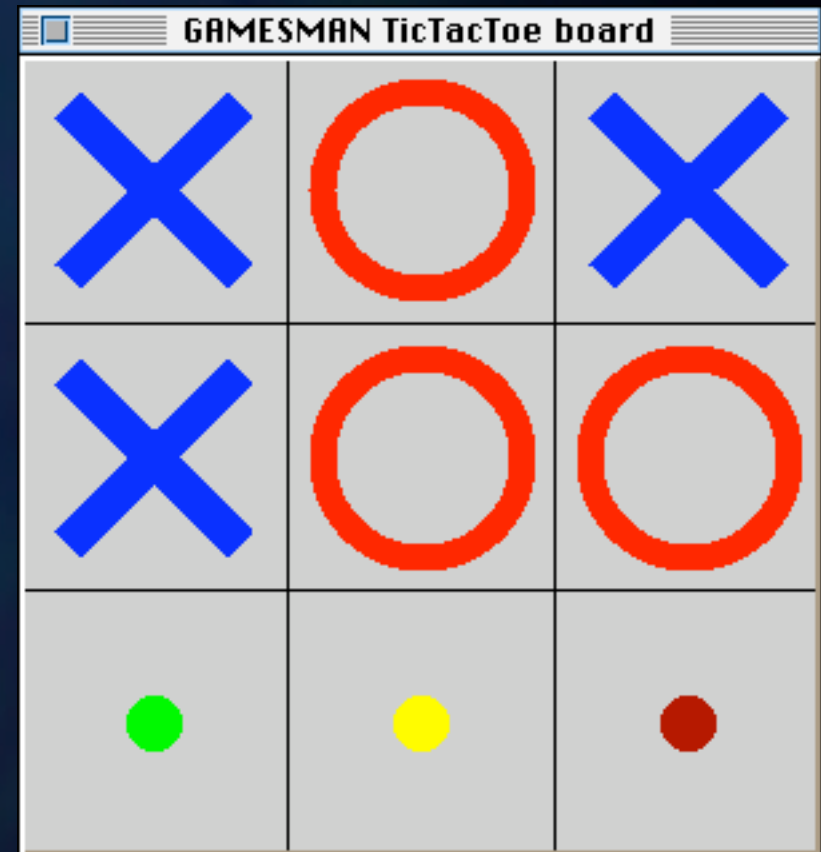
**Values Visualization for Tic-Tac-Toe**

# Tic-Tac-Toe Answer Visualized!

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



Misére 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 <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 (almost 20 yrs ago!), the basis of my GamesCrafters research group

# 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)

# GamesCrafters

**Lines of Code:**

| | |
|---|---|
| 8K | Java |
| 80K | Tcl/Tk |
| 155K | C |

- **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?!"**
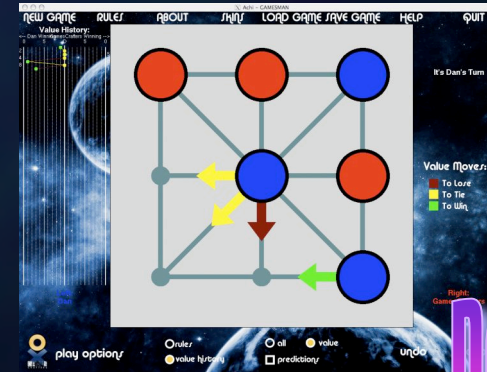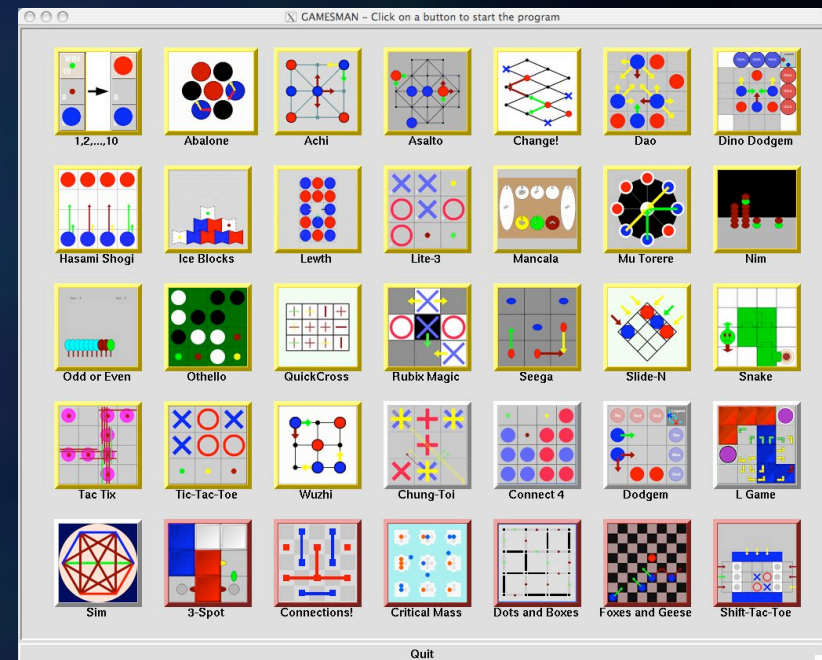
# Alumni Feedback

- **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!**



**2007Sp GamesCrafters**