Throw Down an AI Challenge

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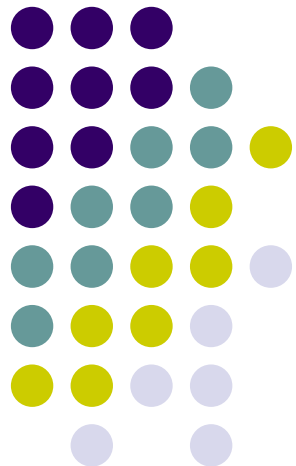
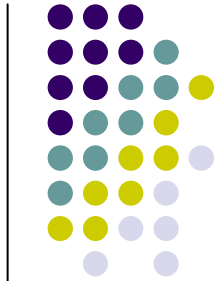


Beginnings



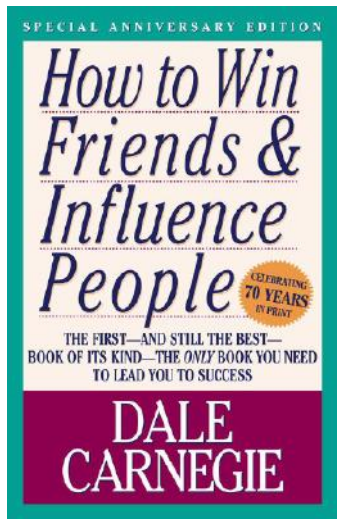
- Recall your introduction to CS.
- Which experiences attracted your interest?
- Which dialog is more likely?
  - “I was really excited to be able to print different patterns of asterisks on the screen. And that *Fibonacci sequence assignment*… Wow!”
  - “I remember programming a text adventure. My code was a *mess* in retrospect, but I really enjoyed the accomplishment.”

Lessons from Game AI and Fitness Coaching

- The goal of AI and Game AI differs significantly:
  - AI researchers: **play optimally** so as to win maximally, or **play humanly** so as to build better cognitive models.
  - Game AI developers: **play engagingly** so as to push the human opponents to their best play… and yet lose to them.
- Weight training: Lift so as to stress and build muscle, but do not lift to failure.

Throw Down a Challenge

- Dale Carnegie: “throw down a challenge”
- Students more likely to pursue CS if early *challenges* are *relevant*, *exciting*, and/or *interesting*.
- Such challenges should be
  - difficult enough to engage
  - not so difficult to lead most students to failure/loss.
- How can AI play a part in engaging students early?



A New Perspective on AI

- AI - the really interesting miscellaneous pile of Computer Science
  - Control beyond classical Control Engineering → Robotics
  - Knowledge beyond Database expressivity → Knowledge Representation & Reasoning
- If it takes intelligence and doesn't fit elsewhere…
- *AI can give intro students a vision of the expansive possibilities of CS!*

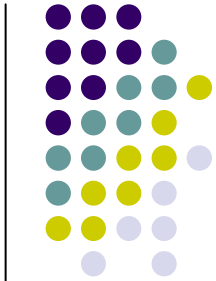
MLExAI

- Machine Learning Experiences in AI (MLExAI)
  - NSF grant DUE CCLI-A&I Award Number 0409497
- Goals:
  - Enhance the student learning experience in the AI course.
  - Increase student interest and motivation to learn AI.
  - Introduce students to an increasingly important research area, thus motivating them to pursue further study.
  - Increase student interest and motivation to build AI applications by allowing them to develop learning systems where they can implement the various concepts covered in the AI course.
- Developed six adaptable, hands-on laboratory projects that can be closely integrated into a one-term AI course
- Phase 2 underway with 20 faculty members contributing

Project: The Game of Clue

- Popular boardgame Clue (a.k.a. Cluedo) serves as a fun focus problem
  - Learn fundamentals of propositional logic and KR&R terminology
  - Solve basic logic problems with and without the aid of a satisfiability solver
  - Implement expert reasoner for deducing Clue case file contents.
  - Several possible advanced projects as well

Minimalist Introduction to Logic



- Build on what they know: Boolean variables → atomic sentences
- Propositional logic allows simple yet rich discussion of logic, e.g.:
  - atomic sentences, operators, literals, truth assignments, (un)satisfiability, models, validity, tautologies, entailment, and logical equivalence.
- Project materials feature brief introduction

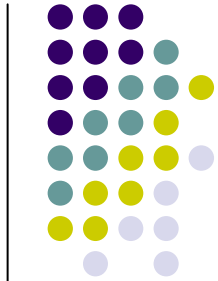
Example Problem

- Amy says, “Bob is a liar.” Bob says, “Cal is a liar.” Cal says, “Amy and Bob are liars.” Who is telling the truth?
- {A⇔¬B, B⇔¬C, C⇔(¬A∧¬B)}
- Conjunctive Normal Form: {{¬A,¬B}, {B,A}, {¬B,¬C}, {C,B}, {¬C,¬A}, {¬C,¬B}, {A,B,C}}
- Project features set of propositional logic word problems
- Conversion to CNF by instructor?

Satisfiability Reasoning

- Student project feedback:
  - Reasoning “black box” unsatisfactory
  - Student desire to implement reasoner
- How many lines of code would it take to implement a simple…
  - … stochastic local satisfiability search?
  - … resolution theorem prover?
- Answer: ~100 lines of Java code each

Input Format



- CNF: {{¬A,¬B}, {B,A}, {¬B,¬C}, {C,B}, {¬C,¬A}, {¬C,¬B}, {A,B,C}}
- Corresponding input file format:

```
-1 -2
1 2
-2 -3
2 3
-3 -1
-3 -2
3 1 2
```

Simple WalkSAT Variant

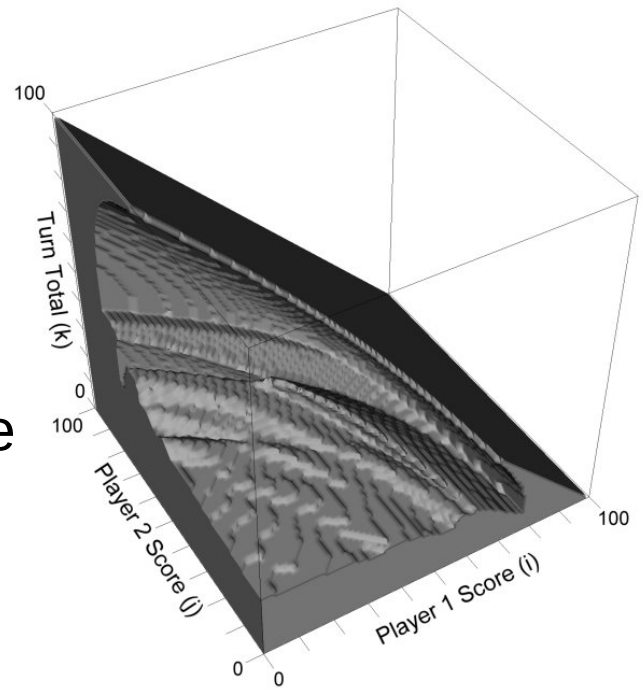
- Generate a random model
- Find all unsatisfied clauses for the model
- iterations = 0
- While there are unsatisfied clauses and iterations < max:
  - Pick a random variable of a random unsatisfied clause and negate it in the model
  - Find all unsatisfied clauses for the new model
  - If more clauses are unsatisfied then revert to the previous model with high probability p
  - iterations = iterations + 1
- Return whether or not clauses are still unsatisfied

Simple Set of Support

- While no contradiction derived
  - Pick the next clause c2 in the support set
  - For each clause c1 before c2:
    - Attempt to resolve c1 and c2, adding result to support set if successful, checking for contradiction
- Resolution:
  - Seek complementary literal in each clause pair
  - For resolved clause, omit
    - Tautologies – (contains complementary literals)
    - Subsumed clauses

Project: Solving the Dice Game Pig

- Using the computation of optimal play for the jeopardy dice game Pig as a central challenge problem, we introduce:
  - dynamic programming, with worked examples, and relevant exercises
  - value iteration, with worked example and exercises
  - several possible advanced projects

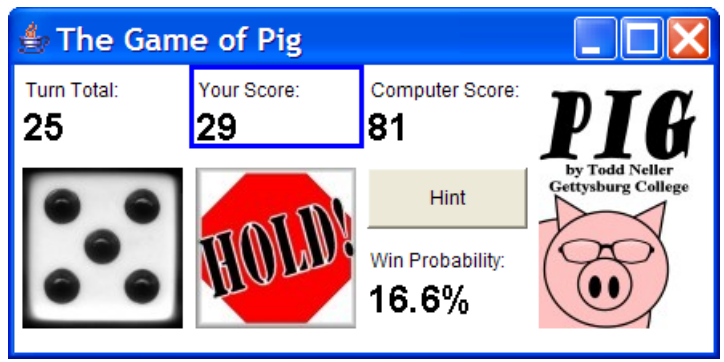


Best Pedagogical Games

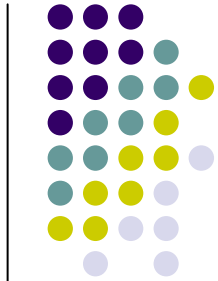
- The best games for teaching
  - Have interesting play, non-trivial decisions
  - Simple rules with few exceptions: easy to learn, requiring little code
- Examples:
  - Solitaire deterministic: Peg Solitaire, Lunar Lockout, SameGame, Minesweeper
  - Two player deterministic: Nim, Checkers, Hex
  - Two player bluff: Liar's Dice, Simplified Poker
  - Jeopardy: Blackjack, **Pig**

Pig Rules

- The first player reaching **100** points wins.
- On each turn, a player rolls a die as many times as desired until either the player **holds** and scores the **sum of the rolls**, or **rolls a 1** and scores **nothing**.



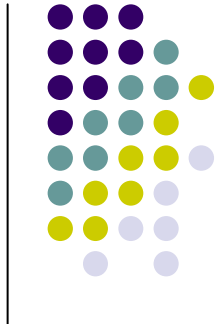
“Hold at 20” Turn Comments



```
// Initialize variables

while () { // Turn not over
     // Roll die
     if () { // 1 rolled
          // Reset turn total and end turn
     }
     else {
          // Add roll to turn total
     }
}
```

“Hold at 20” Turn Code



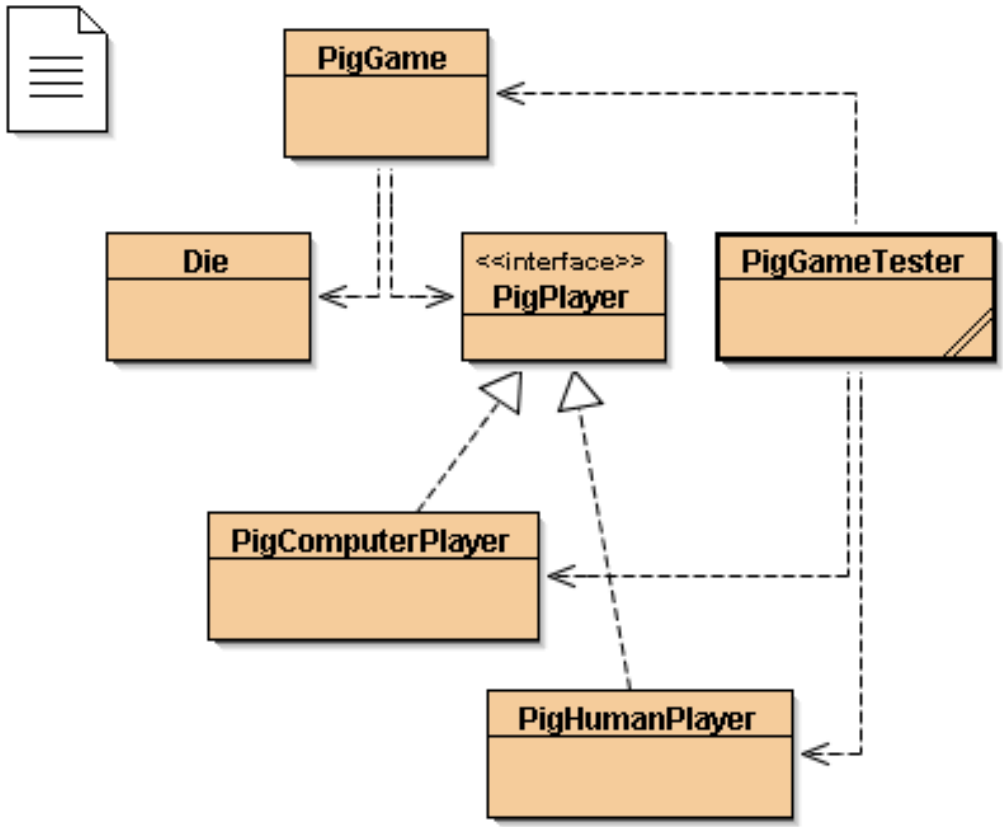
```
Random random = new Random();
int turnTotal = 0;
boolean pigRolled = false;
while (!pigRolled && turnTotal < 20) {
     int roll = random.nextInt(6) + 1;
     System.out.println("Roll: " + roll);
     pigRolled = (roll == 1);
     if (pigRolled)
          turnTotal = 0;
     else
          turnTotal += roll;
}
System.out.println("Score gain: " + turnTotal);
```

Bottom-Up Design

- Simulate a single hold-at-20 turn.
- Given the current score, additionally hold at goal score
- Simulate solitaire game with hold-at-20-or-goal
- Extend to two-player game simulation
- Replace one hold-at-20-or-goal player with a human player.

Object Oriented Design

- Objects:
  - Game
  - Die
  - Player
  - Human player
  - Computer player



Competition

- Such assignments lend themselves to interesting follow-on possibilities:
  - Policy design: Beat hold-at-20-or-goal
  - Design evaluation: Monte Carlo simulation
  - Fun competition: Interface implementation
- Hook: An optimal policy has been computed. Want to know how it's done? → Pig project

More MLExAI Projects

- More MLExAI projects exist:
  - Web User Profiling and Web Document Classification
  - Character Recognition Using Neural Networks
  - Solving the N-Puzzle Problem
  - And more in phase 2!
- More introductory challenges in paper

Conclusion

- Key engaging learning experiences are:
  - Challenging (but not overly challenging)
  - Relevant, exciting, interesting
- AI opens doors to possibilities beyond databases, networking, etc.
- AI's challenge: intro-level assignments
  - Engage with difficult play but do not defeat
  - Stress but do not tear mental muscle