Day 16: Learning in Games

History of Learning in Games

- Standard way to build a game player:
    - Legal move generator
    - Evaluation function
    - Minimax search (with alpha-beta pruning)
- Learning-based way to build a game player:
    - Legal move generator
    - Parameterized (neural net, etc.) evaluation function
    - Learn from human expert database and/or self play
    - (Optionally, use minimax or expectimax)
- Definitions:
    - Solved: stored or computed actual win/loss values for all possible positions
    - Human-competitive: can compete with humans
    - Superhuman: consistently beats best human players
        - Often just human-competitive player with more processing power
- Menace
    - Used a set of matchboxes to learn to play TicTacToe
    - Didn't actually use a computer
- Checkers
    - Arthur Samuel 1959
        - Used a polynomial evaluation function
            - Linear combination of various metrics
            - Tuned coefficients with self-play

        - Terms that had low correlation were replaced with other metrics
    - Beat a master
  - Patrick Prosser 1970s
    - Undergrad project, state of the art at the time
  - Jonathan Schaeffer 1990s
    - Chinook is the world champion of human-machine checkers
  - Jonathan Schaeffer 2007
    - Solved checkers, meaning that every position has a known payoff value
- Berliner BKG: Backgammon (1978)
  - Used a linear combination of factors
  - Had multiple algorithms for different types of game
  - Backgammon is interesting because it has a branching factor of ~800, making search very difficult
    - ~111 quintillion positions
- Neurogammon (Tesauro 1990)
  - Built using backpropegation
  - Beat all other AI Backgammon players
- HCGammon (Pollack & Blair)
  - Hill climbing for weights with random noice
  - Challenger = champion + noise, if the challenger wins 3/4 then it becomes the champion
    - In a later version, if the challenger won the new champion was a combination of the two. They also fiddled with the threshold.
  - Nannon was developed as a simpler toy version of Backgammon

        - Actually a whole family of games depending on board size, number of checkers, and die size
        - More checkers increases the advantage of an intelligent player over random
- Bellman (1957)
    - Proved that every player in a "Markov game" (like Backgammon) has an expected payoff value
    - The expected value is correct when both players make optimal moves
        - If I make suboptimal moves, the expected value goes down
        - If you make suboptimal moves, the expected value goes up
    - Expected value can be calculated with a 1 ply expectimax lookahead
    - If you have the converged/solved values, you can play perfectly
- Expectimax: like minimax but weighted by the probability of dice rolls