Introduction to Game Theory

Review for the Midterm Exam

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Part 1

- Basic concepts:
  - normal form, utilities/payoffs, pure strategies, mixed strategies
- How utilities relate to rational preferences (not in the book)
- Some classifications of games based on their payoffs
  - Zero-sum
    - Roshambo, Matching Pennies
  - Non-zero-sum
    - Chocolate Dilemma, Prisoner's Dilemma, Battle of the Sexes, Which Side of the Road?
  - Common-payoff
    - Which Side of the Road?
  - Symmetric
    - all of the above except Battle of the Sexes

Part 2

- I've discussed several solution concepts, and ways of finding them:
  - Pareto optimality
    - Prisoner's Dilemma, Which Side of the Road
  - best responses and Nash equilibria
    - Battle of the Sexes, Matching Pennies
    - finding Nash equilibria
  - real-world examples
    - soccer penalty kicks
    - road networks (Braess's Paradox)

Part 3

- maximin and minimax strategies, and the Minimax Theorem
  - Matching Pennies, Two-Finger Morra
- dominant strategies
  - Prisoner's Dilemma, Which Side of the Road, Matching Pennies
  - Elimination of dominated strategies
- rationalizability
  - the *p*-Beauty Contest
- correlated equilibrium
  - Battle of the Sexes
- trembling-hand perfect equilibria
- epsilon-Nash equilibria
- evolutionarily stable strategies
  - Hawk-Dove game

Part 4a

- Extensive-form games
  - relation to normal-form games
  - Nash equilibria
  - subgame-perfect equilibria
  - backward induction
    - The Centipede Game
  - backward induction in constant-sum games

Part 4b

- If a game is two-player zero-sum, maximin and minimax are the same
- If the game also is perfect-information, only need to look at pure strategies
- If the game also is sequential, deterministic, and finite
  - minimax game-tree search - minimax values, alpha-beta pruning
- In sufficiently complicated games, perfection is unattainable
  - must approximate: limited search depth, static evaluation function
- In games that are even more complicated, further approximation is needed
  - Monte Carlo roll-outs

Part 4c

- In most game trees
  - Increasing the search depth usually improves the decision-making
- In pathological game trees
  - Increasing the search depth usually degrades the decision-making
- Pathology is more likely when
  - The branching factor is high
  - The number of possible payoffs is small
  - Local similarity is low
- Even in ordinary non-pathological game trees, *local* pathologies can occur
  - Some research has been done on algorithms to detect and overcome local pathologies, but it's rather limited