CMSC 498T, Game Theory

Review for the Midterm Exam

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1. Introduction

- 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
2. Analyzing Normal-Form Games

- 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)
3. More about Normal-Form Games

- 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
- evolutionarily stable strategies
  - Hawk-Dove game
- rationalizability
  - the $p$-Beauty Contest
- correlated equilibrium
  - Battle of the Sexes
- trembling-hand perfect equilibrium
- epsilon-Nash equilibrium
4a. Extensive-Form Games

- Extensive-form games
  - relation to normal-form games
  - Nash equilibria
  - subgame-perfect equilibria
  - backward induction
    - The Centipede Game
4b. Game-Tree Search

- Two-player perfect-information zero-sum games
  - the Minimax theorem applies
  - perfect-info => only need to look at pure strategies
  - minimax game-tree search
    - special case of backward induction
    - minimax values, alpha-beta pruning

- In sufficiently complicated games, must compute approximations
  - limited search depth, static evaluation function

- In games that are even more complicated, further approximation is needed
  - Monte Carlo roll-outs
4c. Lookahead Pathology

- Probability of correct decision, critical nodes
  - examples (P-games and N-games)

- General results
  - Pathology is more likely when branching factor is high, granularity is small, local similarity is low
  - Kalah, chess
  - Local pathologies
5. Imperfect-Information Games

- Nodes partitioned into information sets
  - Information set = \{all the nodes you might be at\}
- Behavioral strategies versus mixed strategies
  - Different equilibria in general; same equilibria if there’s perfect recall
- Sequential equilibria
  - Complicated
- Monte Carlo game-tree generation, state aggregation
  - example: Bridge programs
- Information-set search
  - compute a best response to opponent’s strategy
  - paranoid and overconfident opponent models
  - results in kriegspiel, P-games, N-games, kalah
- Brief discussion of poker