

Introduction to Game Theory

Review for the Final 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

- 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)

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
- rationalizability
 - the p -Beauty Contest
- correlated equilibrium
 - Battle of the Sexes
- trembling-hand perfect equilibria
- epsilon-Nash equilibria
- evolutionarily stable strategies
 - Hawk-Dove game

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 $\Rightarrow$ only need to look at pure strategies
 - minimax game-tree search
 - 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
 - Like subgame-perfect equilibria, but with forests rather than trees
 - Example (in the homework) but no definition
- 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

6a. Repeated Games

- Finitely and infinitely repeated games
 - iterations, stage games
 - Roshambo, IPD, IPD with noise
- strategies for such games
- Differences between theoretical predictions and empirical results
- Examples:
 - ~~➤ Roshambo~~
 - Iterated Prisoner's Dilemma
- Noisy IPD
 - ~~➤ Opponent modeling and noise filtering~~

6b Stochastic Games

- Markov games
 - states, transition probabilities, reward functions, strategies, and equilibria
- Two-player zero-sum stochastic games
 - ~~Backgammon~~
 - expectiminimax
- Evolutionary simulation games
 - replicator and imitate-the-better dynamics
 - lottery games, state-dependent risk preferences
- ~~Imitation dynamics~~
- Evolutionary stag hunt

7a. Incomplete-Information Games

- Regret, maximum regret, minimax regret
- Bayesian games
 - Didn't give a definition, but discussed necessary conditions
- Example of reducing an incomplete-information game to an imperfect-information game
 - uncertainty about payoffs
- Auctions, and equilibrium analysis of them
 - English auction
 - ~~➤ The “dollar auction”~~
 - First-priced sealed-bid
 - Dutch
 - Second-priced sealed-bid

~~7b Cultaptation~~

8 Coalitional Games

- Transferable utility
- Voting game example
- Classes of coalitional games
 - superadditive, additive, constant-sum, convex, simple, proper-simple, etc.
- Payoff sets, pre-imputation and imputation sets, Shapley value, etc.
- Core, stability