Multi-Agent Systems

Overview

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Game Theory: Normal Form Games

- Normal form games: pay-off matrix, pure and mixed strategies, best response, iterated elimination of strictly dominated strategies (IESDS), Pareto domination and optimality, minimax and maximin value, safety and punishment strategy:
- Pure and mixed Nash Equilibrium (NE) (concept and computation)
- Applications of NE as mutual best response (e.g. Cournot duopoly)
- Application of NE: Vickrey auction, strategic effects, dependence of NE on exogenous parameters (e.g. what happens when utilities change);
- NOT Nash Amplification (fixed point + Sperner):

Game Theory: Sequential Games

- Game tree (extensive form), perfect versus imperfect information;
- Backward induction
- Converting extensive into normal form and identifying NEs;
- Subgame perfect equilibrium
- Generalized backward induction (as applied to concrete example)
- Bargaining in Ultimatum Game: BI solution concept, first offer/mover advantage, tragedy of bargaining
- Repeated games: continued cooperation for sufficiently patient players;
- Shapley value

Exploration vs. Exploitation

- Explanation of the UCB formula:

$$a_{t+1} = \arg\max_a \left\{ Q_t(a) + c\sqrt{\frac{\log t}{N_t(a)}} \right\}$$

- MCTS algorithm

Reinforcement Learning

- Markov Decision Process (MDP), policy π
- Value functions $v_\pi(s)$ and $q_\pi(s, a)$ for given policy π
- Bellman equations for v_π and q_π (including matrix form);
- Bellman optimality equations for v^* and q^*
- Backup diagrams for Bellman (optimality) equations;
- Solving a simple MDP
- Policy evaluation, improvement and iteration;
- Monte Carlo for model-free policy evaluation;
- Temporal differencing (TD)
- SARSA (on-policy)
- Q-learning (off-policy)
- Policy gradient method and REINFORCE
- NOT DQN and MARL