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MAS V.S. AI field

1. (a) Firstly, multi-agent system (MAS) does not involve solving all the problems or components of intelligence as in artificial intelligence(AI) in order to build effective and useful agents. Secondly, MAS, unlike classical AI, involves social aspects of agency (interacting, cooperating, coordinating, negotiating) which are important parts of intelligent activity in the real-world setting.

Static v.s Dynamic

(b) A static environment does not change while the agent is deliberating while a dynamic environment is constantly changing and can interfere with the agent's actions while the agent is still deliberating. For example, a chess game has a static environment as other pawns remain in their position while a player is going to make a move. On the other hand, the robot soccer game has a dynamic environment as the player with the ball is facing other agents continually changing positions while he plans his next move.

property of IA for dynamic env.

The agent must be reactive in order to maintain an ongoing interaction with environment and respond timely to the corresponding changes.

(c)

Decision Network

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

(i) Chance nodes: Forecast, Weather
Decision node: Umbrella
Utility node: Utility

} type

(ii) P(cloudy)

= P(cloudy, rain) + P(cloudy, no_rain) [Sum Rule]

= P(cloudy|rain)P(rain) + P(cloudy|no_rain)P(no_rain) [Product Rule]

= 0.25x0.3 + 0.2x0.7

= 0.215

expected utility

EU(umbrella)

= P(rain|cloudy)U(rain, umbrella) + P(no_rain|cloudy)U(no_rain, umbrella)

$= \frac{P(cloudy|rain)P(rain)}{P(cloudy)}U(rain, umbrella) + \frac{P(cloudy|no\_rain)P(no\_rain)}{P(cloudy)} U(no\_rain, umbrella)$

$=(\frac{0.25x0.3}{0.215})(70)+ (\frac{0.2x0.7}{0.215})(20)$

=37.4

EU(no_umbrella)

= P(rain|cloudy)U(rain, no_umbrella) + P(no_rain|cloudy)U(no_rain, no_umbrella)

$= \frac{P(cloudy|rain)P(rain)}{P(cloudy)}U(rain, no\_umbrella) + \frac{P(cloudy|no\_rain)P(no\_rain)}{P(cloudy)} U(no\_rain, no\_umbrella)$

$=0+(\frac{0.2x0.7}{0.215})(100)$

=65.1

Since EU(no_umbrella) > EU(umbrella), Tom should not take an umbrella.

2 main step in policy iteration

2. (a) The two main steps in policy iteration are policy evaluation and policy improvement. Policy evaluation computes the utility, U for every state, s given the action specified in a policy as follows.

$$U(s) = R(s) + \gamma \sum_{\substack{\text{state sequences} \\ \text{starting from s}}} P(sequence)U(s')$$

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where R – reward, γ - discount factor, P – probability, s' – next state

Next, policy improvement first uses the updated utilities to compute the $\sum P(\text{sequence})U(s')$ for each state and each action. Then, for each state, it selects the action corresponding to the highest value and updates the policy. The algorithm is iterated until there is no more update in the policy.

show each iteration, on the optimal policy

(b) Let <action for state S, action for state S'> represent a policy P.

P_0 = <a,a>

U(S) = 3 + 0.5U(S)
U(S) = 6

U(S') = 2 + 0.5U(S')
U(S') = 4

State S, action a: P(S)U(S) = 6
State S, action b: P(S')U(S') = 4
∴ State S, action a

State S', action a: P(S')U(S') = 4
State S', action b: P(S)U(S) = 6
∴ State S', action b

P_1 = <a,b>
U(S) = 6
U(S') = 2 + 0.5x6 = 5

State S, action a: P(S)U(S) = 6
State S, action b: P(S')U(S') = 5
∴ State S, action a

State S', action a: P(S')U(S') = 5
State S', action b: P(S)U(S) = 6
∴ State S, action b

∴ Optimal policy = <a, b>

coordination
cooperation
negotiation

MAS vs Single agent

3. (a) When designing additional fighter jet agents, the issues of inconsistency, coordination and the sharing of tasks and information have to be considered. As agents may be self-interested with inconsistent perceptions and goals, conflict arises and have to be managed. On the other hand, coordination involves managing the dependencies between the agents to minimise interference and increase efficacy while the sharing of tasks and information is to distribute tasks to different agents and communicate information effectively from one agent to another to achieve timely response and concurrency.

contract net (RABAE)

(b) Recognition – for the agent to recognize it needs or is better with help for a problem

Announcement – for the agent to broadcast the task specification, which includes task description, constraint and meta-task information, to other agents

Bidding – for other agents to evaluate the marginal cost of carrying out the required task and decide to bid for the task or not
Awarding – for the agent to award the contract to a particular bid and inform all agents that bided the results
Expediting – the successful contractor agent then expedites the task and may carry out sub-contracting

Vickrey Auction

(c) The bidding mechanism is likely truthful as the bidder is assumed to want only one COE. This resembles the Vickrey auction where the dominant strategy is to bid truthfully as overbidding may cause the bidder to pay more than his valuation while underbidding decreases the chances of winning the auction. If the bidder is assumed to want one or more COE, this would give the bidder an incentive to bid insincerely for units other than their first to influence the price the bidder pays.

Coalition game
explain core

(d) Manipulation in voting theory occurs when the voter strategically misrepresent their preferences in order to gain a preferable outcome. The Gibbard-Satterthwaite Theorem suggests that every voting method (aside from dictatorship) is susceptible to strategic manipulation although manipulation itself is computationally complex. For example, in plurality voting involving 3 candidates, a voter may vote for his second choice of candidate solidifying the candidate's success, knowing that his first candidate will not be able to win even with his vote but does not want the third candidate to win.

(e) The core is the set of feasible distribution of payoff to members of a coalition that no sub-coalition can reasonably object to the grand coalition. For example, payoffs ranging from <9, 8> to <11,6> are in the core such that each member has no incentive to deviate and the coalition is stable.

4. (a) Dominant strategy

A	B
i – cooperate, j - cooperate	No dominant strategy pair

(b) Nash equilibrium

A	B
i - defect, j – defect i – cooperate, j - cooperate	i - defect, j - defect

(c) Pareto optimality

A	B
i - cooperate, j - cooperate	i - cooperate, j – defect i - defect, j – cooperate i - cooperate, j - cooperate

(d) Social welfare

A	B
i - cooperate, j - cooperate	i - cooperate, j – defect i - defect, j – cooperate i - cooperate, j - cooperate

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Thank you and all the best for your exams! ☺

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