Solutions to FIT5047 Tutorial on Intelligent Agents

Exercise 1: Rationality

For each of the following assertions, say whether it is true or false, and explain why.

SOLUTION:

(a) An agent that senses only partial information about the state cannot be perfectly rational.

False. Perfect rationality refers to the ability to make good decisions given the sensor information received.

(b) There exists a task environment in which every agent is rational.

True. For example, in an environment with a single state, such that all actions have the same reward, it doesn't matter which action is taken. More generally, any environment that is reward-invariant under a permutation of the actions will satisfy this property.

(c) A perfectly rational poker-playing agent never loses.

False. Unless it draws the perfect hand, the agent can always lose if an opponent has better cards. This can happen for game after game. The correct statement is that the agent's expected winnings are nonnegative.

Exercise 2: Rationality

Describe a rational function for a vacuum agent for the case where each movement costs one point, assuming that once a square has been cleaned, it doesn't get dirty.

SOLUTION:

Such an agent requires a NoOp action to stop moving when it has cleaned all the dirty squares. Now, since the agent's percept doesn't say which squares have been previously cleaned, the agent must have some memory to say whether other squares have already been cleaned.

Exercise 3: PEAS

For each of the following activities, give a PEAS description of the task environment, and characterize it in terms of the properties listed in pages 12-13 in the *Intelligent Agents* classnotes.

SOLUTION: There are many sensible answers.

(a) Playing soccer.

PEAS:

- Performance measure: scoring a goal, passing accurately.
- Environment: soccer field, spectators, operating conditions, referees, other players.
- Actuators: player's legs, head, hands (goal keeper).
- Sensors: player's eyes, ears, hands, legs, body, head.

Properties:

- Partially observable (the agent may not be able to see the whole field).
- Known.
- Multi-agent.
- Stochastic (the ball may not go where it is kicked).
- Sequential (moves depend on previous moves).
- Dynamic (players move around while an agent is performing an action).
- Continuous (in terms of time, positions of players and of the ball).

(b) Performing a high jump.

PEAS:

- Performance measure: height of the jump.
- Environment: running-up track, jump area, high bar, spectators, judges.
- Actuators: jumper's legs.
- Sensors: player's eyes, ears, hands, legs, body, head.

Properties:

- Fully observable.
- Known.
- Single-agent.
- Stochastic (the agent may achieve different heights).
- Sequential (the achieved height depends on the push-off).
- Static (the environment doesn't change).
- Continuous (in terms of time and positions of the agent).

(c) Knitting a sweater.

PEAS:

- Performance measure: quality of work, speed.
- Environment: needles, wool, knitting pattern.
- Actuators: knitter's hands.
- Sensors: knitter's eyes, hands.

Properties:

- Fully observable.
- Known.
- Single-agent.
- Stochastic (the agent may drop a stitch).
- Sequential (a stitch depends on the previous work).
- Static (the environment doesn't change).
- Discrete (each stitch is separate).

Exercise 4: Agent types

For each of the tasks in Exercise 3, consider the following types of agents, and for each type, describe what the agent can do, and how it differs from simpler agents: Simple reflex, Model based, Goal based and Utility based. In addition, for each task, define *one* performance measure for which all the agents would be rational. Justify your answers.

SOLUTION: Note that other solutions are possible.

(a) **Playing soccer.** Let's say that the percepts and actions are the same for all types of agents:

- Percepts: whether agent is in possession of the ball, coordinates in the field, distance from and direction of the goal, and distance from each other player.
- Actions: kick the ball (+ direction), run without the ball (+ direction), and run with the ball (+ direction). All the agents can pass the ball to another agent who is closer to the goal or kick towards the goal.

All the agents would be rational according to the performance measure: **is the ball closer to the goal?**, as they all have the capacity to perceive the goal, and kick the ball in that direction.

- Simple reflex – this agent has rules that tell it how to kick, e.g., "If you get the ball and you are the closest to the goal, turn towards the goal and kick". Note that this agent needs to update all its percepts before it takes action.
- Model based – this agent has a model of how the world evolves as a result of its actions and the actions of other agents – this deals with parts of the world the agent can't see. The agent kicks towards the goal or another player based on its model of the world, but doesn't need to update all its percepts.
- Goal based – this agent has an idea of how the world will change as a result of its actions, and can adjust its actions depending on what it wants to achieve (just knowing what the world looks like is not enough to adjust your actions).

This agent can make a plan where it passes the ball to another agent or kicks towards the goal – the plan may include what other agents will do.

- Utility based – this agent incorporates information about the quality of the result of its actions, e.g., how close he can get the ball to the goal.

(b) **Performing a high jump.**

- Percepts: height of the bar, distance to the bar, ground conditions (e.g., slippery).
- Actions: run and jump.

All agents are rational under this performance measure: **whether the bar was cleared**, as they all have the capacity to perceive the bar, and attempt to clear it.

- Simple reflex – the rule may be "If distance from bar $> X$ run, else jump as hard as you can".
- Model based – if the above are the only relevant conditions, there is no need for a model, because the environment is fully observable.
- Goal based – like the model-based agent.
- Utility based – in this case, the agent can maximize utility by adjusting the expended effort.

(c) **Knitting a sweater.**

- Percepts: position of knitting needles (row number and stitch number), remaining yarn, instructions for a complete sweater, instruction number last executed.
- Actions: knit, purl, reduce, increment, cast on (the knitting needle), cast off, sew together the parts.

All agents are rational under this performance measure: **is the sweater finished?**, as they can all knit, and they can perceive whether the sweater is complete.

- Simple reflex – the rules must be very detailed (stitch by stitch for the entire sweater).
- Model based – this agent has a model of what is the outcome of a knitting action (e.g., you have a bigger section of knit material), but since the environment is fully observable, the model is not really required.
- Goal based – this agent would be able to make a plan to knit the different portions of a sweater using operators that combine several knitting actions.
- Utility based – this agent would be able to judge the quality of the sweater and the knitting speed.