SAARLAND UNIVERSITY
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Exercise Sheet 1.
Solution

Exercise 1: Agent Performance and Utility. (1 Point)

Consider both the explanations of performance measure and utility function from the lecture (Intelligent Agents - p. 16, 20). Then, answer the following two questions shortly.

(i) What is the difference between a performance measure and a utility function?

(ii) Describe the relation between the performance measure and the utility function for a learning agent.

(Solution)

(i) The performance measure evaluates how desirable a state of the environment is, independent of the agent, while the utility function is used by the agent to evaluate the desirability of its currently observed state.

(ii) A learning agent can increase its knowledge-base over time. It usually has a performance component which uses a utility function to evaluate the current state based on the available knowledge-base and decides on the next action. To actually learn new facts it gets feedback about its actions from a performance measure, which is integrated to the agent's knowledge-base.

(/Solution)

Exercise 2: Agent Perception. (2 Points)

Review the vacuum cleaning agent and its agent table from the lecture again (Intelligent Agents - p. 11, 13). Let P be the set of possible percepts and T the lifetime of the agent (the total number of percepts it will receive).

(i) What is the size of P for the vacuum cleaning agent?

(ii) How many entries does the lookup table of the vacuum cleaning agent contain after 3 time steps?

(i) if we store only the percepts that were perceived?

(ii) if we store all possible percepts?

(iii) How many entries will the lookup table contain if we store all possible percepts, i.e. all possible percept sequences for the whole life time of the agent? Please give the general formula in respect to the lifetime T.

(Solution)

(i) 4

(ii) (i) 3

(ii) 84

(iii) $\sum_{t=1}^{T} 4^t$

(/Solution)

Exercise 3: Agent Rationality. (2 Points)

Again consider the example of the vacuum cleaner agent with the following specifications:

- The "geography" is known a priori, but not the distribution of dirt and the location of the agent.
- Clean squares stay clean, sucking removes dirt.
- Left and right moves move the agent to the other location, unless they would take the agent outside the room. In this latter situation, the agent stays where it is.
- The only available actions are LEFT, RIGHT, SUCK.
- The agent correctly perceives its location and whether there is dirt.
- The performance measure awards 1 point for each new clean square at each time step.

Given the information above, is the simple vacuum cleaner funtion in Figure 1 rational or not? Please justify your answer by 2-3 sentences.

(Solution) Yes, the function is rational since it makes the agent act rationally based on its percepts. Moreover, the performance measure of the agent solely relies on its percepts (which are limited) and therefore the agent maximizes its expected performance (and not the actual performance) which is a trait of a rational agent.

function REFLEX-VACUUM-AGENT([*location*,*status*]) **returns** an action

  if *status* = *Dirty* **then return** *Suck*
  else if *location* = *A* **then return** *Right*
  else if *location* = *B* **then return** *Left*

Figure 1: Action function of vacuum cleaner agent

(This is just an example, other valid explanations are fine, too) (Argumentations should follow: Intelligent Agents S. 17)

(/Solution)

Exercise 4: State Space. (2 Points)

Consider the state space depicted in Figure 2, where A is the initial state, and F and I are goal states. The transitions are annotated by their costs. List all states that are

(i) solvable,

(ii) dead-ends,

(iii) not reachable from G,

(iv) reachable from H.

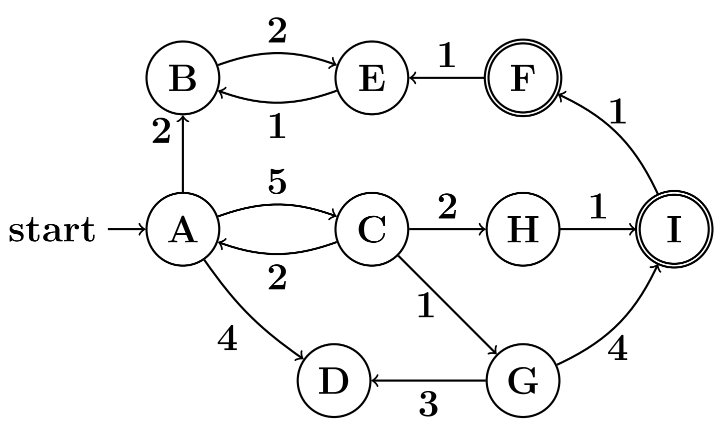

Figure 2: State space used in Exercises 4 and 5.

(Solution)

(i) A, C, F, G, H, I.

(ii) B, D, E.

(iii) A, C, H.

(iv) B, E, F, H, I.

(/Solution)

Exercise 5: Uniform-cost Search and Iterative-deepening Search. (3 Points)

Consider again the state space depicted in Figure 2.

(a) Run uniform-cost search on this problem. Draw the search graph and annotate **each node** with its g **value and the order in which states are selected for expansion**. Draw duplicate nodes, and mark them accordingly by crossing them out. If the choice of the next state to be expanded is not unique, expand the lexicographically smallest state first. (e.g., a before d) Give the solution found by uniform-cost search. Is this solution guaranteed to be optimal? Justify your answer.

(b) Run iterative-deepening search until it finds a solution. For each depth depict the corresponding search tree. Annotate each state with the **order in which states are selected for expansion**. If the choice of the next state to be expanded is not unique, expand the lexicographically smallest state first. Give the solution found by iterative-deepening search. Is this solution guaranteed to be optimal? Justify your answer.

(Solution)

(a) Search graph is given in Figure 3. The solution is A, C, H, I. It is optimal because uniform cost search is guaranteed to find the optimal solution. The numbers in parenthesis indicate the order of expansion. Crossed-out states are duplicates. The cost of I reached via G is updated when expanding H. This I is then discarded.

(b) Search graph is given in Figure 4. The solution is A, C, G, I. It is not optimal, because it has a cost of 10 instead of 8. This is due to the fact that iterative deepening search returns the first solution found, which is guaranteed to be a shortest solution (3 steps in this case). However, this is not necessarily a cheapest solution because the algorithm ignores action costs.

(/Solution)

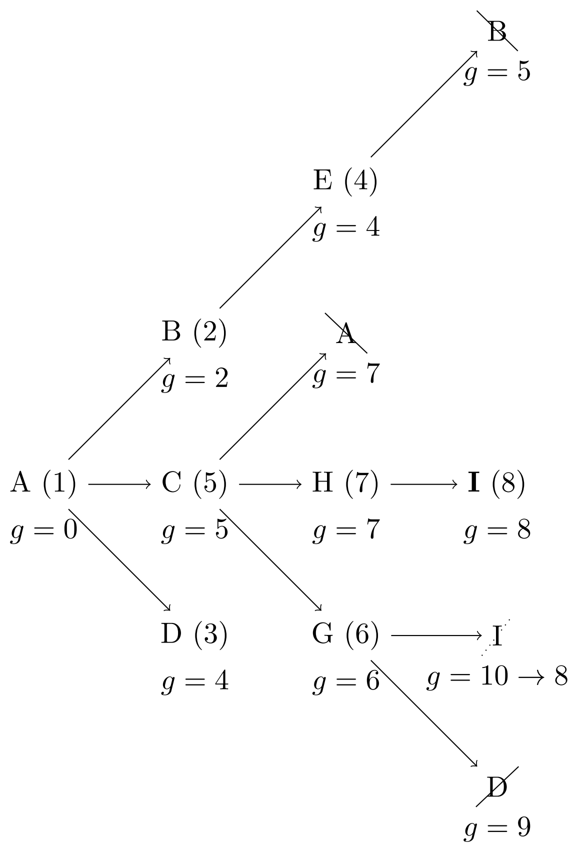

Figure 3: Solution to Exercise 5 (a)

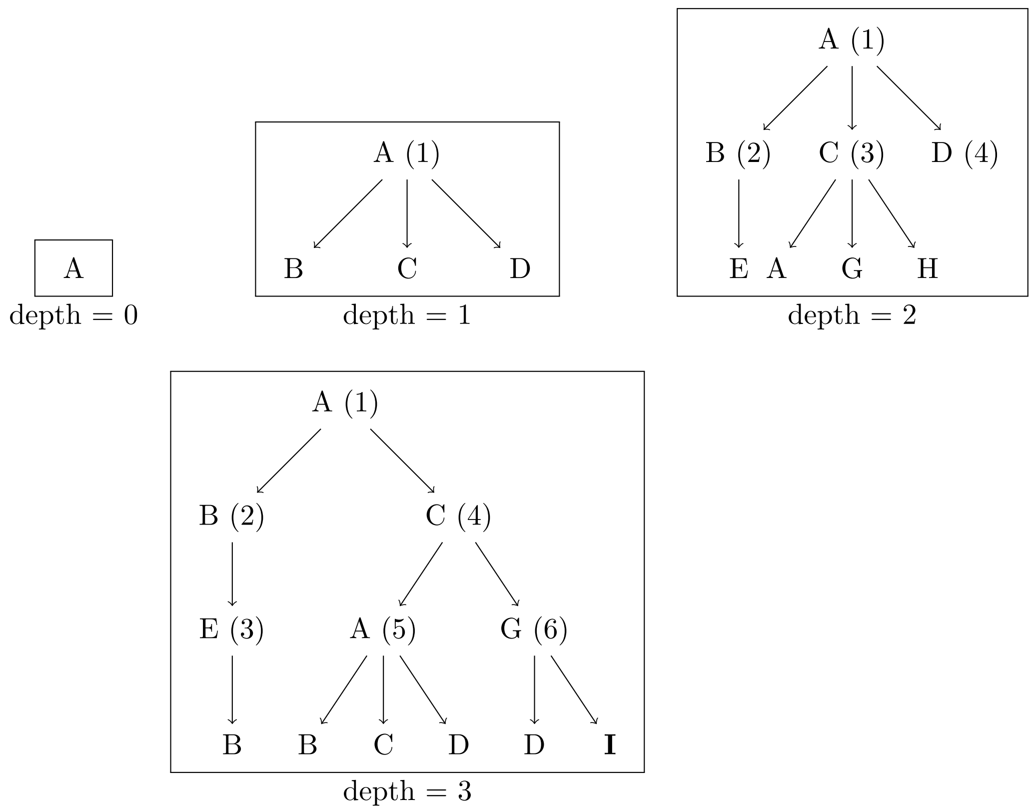

Figure 4: Solution to Exercise 5 (b)