

# Artificial Intelligence (COMP111)

## Exercise 1

Your answer to Question 4 should be submitted on canvas for assignment *Exercise 1* either as a text entry, a text file (txt), a pdf file, or a photo of the handwritten solution. The deadline is Monday, 19th of October, at 6pm. You should also attempt to answer the other questions before your tutorial.

You obtain 1 point (1 percent of the final mark) if you make a reasonable attempt to answer Question 4 *and* actively participate in your tutorial in the week starting Monday 19th of October.

We would like to encourage you to discuss the questions with your fellow students, but do not copy your answer from anybody else.

1. For each of the following activities, give a PEAS description of the task environment (that is, describe a possible performance measure, the environment, the actuators, and the sensors). Classify the task environments into fully observable vs partially observable, deterministic vs stochastic, episodic vs sequential, static vs dynamic, discrete vs continuous.

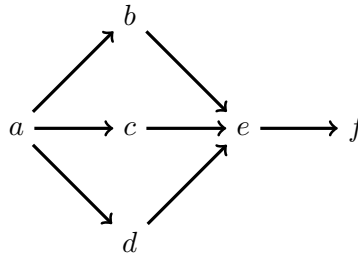
The activities are:

- Football player
  - Robot exploring Mars
  - Shopping for used Computer Science books on the internet
2. Define in your own words (in one or two sentences): simple reflex agents, model-based reflex agents, goal-based agents, utility-based agents, learning agents.
  3. We assume that a *search graph* consists of a set  $S$  of *states* and *arrows* between states such that for all states  $a$  and  $b$ ,  $a \longrightarrow b$  indicates that there is an action which, if performed in state  $a$ , leads to state  $b$ . Search graphs also have a *start state*  $s_{\text{start}}$  and a set  $S_{\text{goal}}$  of *goal states*. (The following questions mostly ignore  $S_{\text{goal}}$ .) If  $a \longrightarrow b$ , then  $b$  is called a *successor* of  $a$ . If

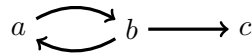
$$a_0 \longrightarrow a_1 \longrightarrow \cdots \longrightarrow a_n$$

then  $a_0 \cdots a_n$  is called a *path* starting at  $a_0$ . The *length* of this path is  $n$ . Thus, the path  $a_0 a_1 a_2 a_3 a_4$  has length 4 and the path consisting of a single state  $a_0$  has length 0. The *search tree* induced by a search graph is the set of paths starting at  $s_{\text{start}}$ .

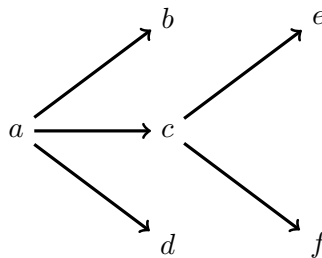
Consider the following search graph with states  $\{a, b, c, d, e, f\}$  and start state  $s_{\text{start}} = a$ .



- List the successors of  $a$ .
  - List the successors of  $b$ .
  - List all paths in this graph starting with  $a$ .
  - Draw the search tree induced by this graph.
4. Consider the following search graph with states  $\{a, b, c\}$  and start state  $s_{\text{start}} = a$ .



- List all paths of length at most 4 in this graph starting with  $a$ .
  - Observe that the search tree induced by this search graph is infinite. Draw the search tree induced by this graph up to depth 4. (The search tree up to depth 4 consists of all paths starting at  $a$  of length at most 4.)
5. Consider the following search graph with states  $\{a, b, c, d, e, f\}$  and start state  $s_{\text{start}} = a$ .



- List all paths in this graph starting with  $a$ .
  - Draw the search tree induced by this search graph.
  - What is the relationship between the search graph and the search tree, in this case?
6. Consider the task of finding a subset  $M$  of the set  $N = \{1, 2, 3, 4\}$  such that the sum of all the elements in  $M$  is equal to 6. (Clearly, the solutions to this task are  $\{1, 2, 3\}$  and  $\{2, 4\}$ .)
- Formulate the scenario as a search problem by defining a
    - set  $S$  of states
    - start state  $s_{\text{start}}$
    - set  $S_{\text{goal}}$  of goal states
    - set  $A$  of actions
    - cost function for each action

The goal states should represent the solutions to the search problem. *Hint.* Use the addition/subtraction by a number from  $\{1, 2, 3, 4\}$  as the actions.
  - Draw the search graph.