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, 30th of September, at 8pm. 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. You should also actively participate in your tutorial in the week starting Monday 30th of September.

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. A *search graph* consists of a set S of *states* and *arrows* (often called *arcs* or *edges*) between them. An arrow between states a and b is depicted as $a \longrightarrow b$. Then $a \longrightarrow b$ indicates that there is an action which, if performed in state a, leads to state b. Search graphs also have a *start state* s_{start} and a set S_{goal} of *goal states*. (The following questions mostly ignore S_{goal}.) If $a \longrightarrow b$, then b is often 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. It is also called a path starting at a_0 and ending at a_n. The *length* of this path is n. Thus, the path $a_0a_1a_2a_3a_4$ 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_{start}.

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

$$\begin{tikzcd}
 & b \arrow[dr] & & \\
a \arrow[ur] \arrow[r] \arrow[dr] & c \arrow[r] & e \arrow[r] & f \\
 & d \arrow[ur] & &
\end{tikzcd}$$

- List the successors of a.
- List the successors of b.
- List all paths starting at a and ending at e.
- List all paths starting at e and ending at a.
- List all paths in this graph starting at a.
- Draw the search tree induced by this graph.

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

$$\begin{tikzcd}
a \arrow[r, bend left] & b \arrow[l, bend left] \arrow[r] & c
\end{tikzcd}$$

- 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 $s_{\text{start}} = a$.

$$\begin{tikzcd}
 & b & e \\
a \arrow[ur] \arrow[r] \arrow[dr] & c \arrow[ur] \arrow[dr] & \\
 & d & f
\end{tikzcd}$$

- 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_{start}
     - set S_{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.

7. (If you have time.) We assume search graphs are finite. A search graph is called a DAG (directed acyclic graph) if it contains no path from a state to itself. For instance, the search graphs in Questions 3 and 5 are DAGs, but the search graph in Question 4 is not. Show that a search graph is not a DAG if, and only if, it contains infinitely many paths.