Due date: Tuesday, September 6, 2022, 2pm. Hint: you might want to consult also the AIMA web pages: http://aima.cs.berkeley.edu/ for the online code repository.

Exercise 1.1 (10 points)

Read chapters 1 (Introduction) and 2 (Intelligent Agents) of the textbook.

1. Define in your own words the following terms: agent, agent function, agent program, rationality, autonomy, reflex agent, model-based agent, goal-based agent, utility-based agent, learning agent. [5 points]

2. Both the performance measure and the utility function measure how well an agent is doing. Explain the difference between the two. [1 point]

3. In this question we explore further the differences between agent functions and agent programs. [2 points]
   (a) Can there be more than one agent program that implements a given agent function?
   (b) Are there agent functions that cannot be implemented by any agent program?
   (c) Given a fixed machine architecture, does each agent program implement exactly one agent function?
   (d) Given an architecture with \( n \) bits of storage, how many possible agent programs are there? Is this enough, that is, might there be environments for which there are no good agent programs?

4. Let us examine the rationality of various vacuum-cleaner agent functions in various environments. [2 points]
   (a) Describe a rational agent function for the modified performance measure that deducts one point for each movement. Does the corresponding agent program require internal state?
   (b) Discuss possible agent designs for the cases in which clean squares can become dirty and the geography of the environment is unknown. Does it make sense for the agent to learn from its experience in these cases? If so, what should it learn?
Exercise 1.2 (10 points) The following exercises all concern the implementation of environments and agents for the vacuum-cleaner world. Programs need to be written in C/C++, Java or Python.

1. Implement a performance-measuring environment simulator for the vacuum-cleaner world depicted in the figure on the right (Figure 2.2 on page 36/38 of our textbook (3rd/4th edition)). Your implementation should be modular so that the sensors, actuators, and environment characteristics (size, shape, dirt placement, etc.) can be changed easily. (Note: for CSC545/ECE537 students only: for some choices of programming languages and operating systems, this step can be skipped because there are already implementations in the online code repository.)

[5 points if done yourself, none if code from AIMA is used. CSC645 students have to write the program themselves.]

2. Implement a simple reflex agent for the vacuum environment in Exercise 1.2.1. Run the environment simulator with this agent for all possible initial dirt configurations and agent locations. Record the agent’s performance score for each configuration and its overall average score.

[5 points]