Exercises Ch1

Exercise 1.1

- **Agent:** anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors

- **Agent function:** mathematically speaking, we say that an agent's behavior is described by the agent function that maps any given percept sequence to an action.

- **agent program:** implementing the agent function to runs on the physical architecture.

- **Rationality:** A rational agent is one that does the right thing-conceptually speaking; every entry in the table for the agent function is filled out correctly

- **Autonomy :**is the ability to make self-directed decisions and control behavior and actions without external intervention. Obtaining independence requires a degree of experience, self-confidence, and critical thinking.

- **reflex agent :** are based on condition-action rules, implemented with an appropriate production system. They are stateless devices which do not have memory of past world states

- **model-based agent :** he most effective way to handle partial observability is for the agent to keep track of the part of the world it can't see now goal-based agent: knowing about the current state of the environment is not always enough to decide what to do.

- **utility-based agent:** base their decisions on classic axiomatic utility theory in order to act rationally
- **learning agent :** all agents can improve their performance through learning.

Exercise 1.2

If we define an agent as anything that can perceive its environment through sensors and act upon that environment through effectors, then not everything can be described as an agent. For example, rocks, trees, and other inanimate objects do not have sensors or effectors and therefore cannot be considered agents.

Clocks can be considered agents if they have sensors for measuring time and effectors for displaying the time and performing certain actions, such as sounding an alarm. In this sense, clocks can be considered agents in a limited context.

The distinction between agents and non-agents does make sense in certain contexts, particularly in fields like artificial intelligence and robotics where the ability to act autonomously and make decisions is a key characteristic of intelligent systems. However, there may be grey areas and edge cases where it is difficult to determine whether something should be considered an agent or a non-agent. Therefore, the distinction between agents and non-agents may not always be clear-cut and may depend on the specific definition being used.

Exercise 1.4

1. Observable and partially observable, deterministic, stochastic and strategic, episodic and sequential, static and dynamic, discrete and continuous, single-agent and multiple-agent.

2. Observable and partially observable, deterministic, stochastic and strategic, episodic and sequential, static and dynamic, discrete and continuous, single-agent and multiple-agent.

3. Observable and partially observable, deterministic and stochastic, sequential, dynamic, continuous, single-agent.

4. Observable and partially observable, deterministic and stochastic, sequential, dynamic, continuous, single-agent.

5. Observable and partially observable, deterministic and stochastic, sequential, dynamic, discrete, single-agent.

6. Observable and partially observable, deterministic and stochastic, sequential, dynamic, discrete, multiple-agent.

Exercise 1.6

- **Playing soccer:**
  - Performance measure: Score as many goals as possible within a time limit.
  - Environment: A rectangular field with two opposing teams consisting of 11 players each, a ball, and goalposts at either end of the field.
  - Actuators: Muscles of players, soccer ball, legs for kicking or blocking the ball.
  - Sensors: Vision sensors to detect the position of the ball and other players, auditory sensors to hear communication from teammates.

- **Shopping for used AI books on the Internet:**
  - Performance measure: Finding and buying desired AI books that meet the buyer's requirements at a reasonable price.
  - Environment: Online marketplace websites, where multiple sellers offer used AI books.
  - Actuators: Computer mouse and keyboard, payment gateway.
  - Sensors: Textual search queries, user reviews, book descriptions, pricing information.

- **Playing a tennis match:**
  - Performance measure: Win the match by scoring more points than the opponent.
  - Environment: A tennis court with a net, tennis rackets, and a ball.
  - Actuators: Muscles of players, tennis racket, legs for moving around the court.

- Sensors: Vision sensors to detect the position of the ball and other players, auditory sensors to hear communication from opponents.

- **Practicing tennis against a wall:**
  - Performance measure: Improve the player's tennis skills by hitting the ball accurately and consistently.
  - Environment: A wall with a line or target drawn on it, a tennis racket, and a ball.
  - Actuators: Tennis racket, muscles of players.
  - Sensors: Vision sensors to detect the position of the ball.
- **Performing a high jump:**
  - Performance measure: Jump over the bar without knocking it down.
  - Environment: A track and field area with a landing pit, a high jump bar, and a runway.
  - Actuators: Muscles of the athlete, legs for running and jumping.
  - Sensors: Visual sensors to see the height of the bar, auditory sensors to hear announcements from officials.

- **Knitting a sweater:**
  - Performance measure: Complete the sweater with the desired pattern and size within the given time frame.
  - Environment: A knitting kit with yarns, needles, and patterns.
  - Actuators: Fingers and hands of the knitter, knitting needles, and yarn.
  - Sensors: Visual sensors to see the pattern, sensory information to feel the texture of the yarn.

- **Bidding on an item at an auction:**

    - Performance measure: Winning the auction with the lowest possible bid amount while staying within the budget limit.
    - Environment: An auction website, where multiple bidders are competing for items.
    - Actuators: Computer mouse and keyboard, online payment gateway.
    - Sensors: Textual description of the item, current bids, remaining time of the auction.

Exercise 1.9

Pseudocode for goal-based agent program:

```
function goal_based_agent() {
  state = initialize_state()
  while not goal_reached(state) do
    action = choose_action(state)
    state = update_state(state, action)
  end
  return plan_of_actions
}
```

Here, initialize_state() initializes the initial state of the environment, goal_reached(state) checks if the current state satisfies the goal, choose_action(state) selects an action to take in the current state, and update_state(state, action) applies the chosen action to the current state to produce the next state. The function returns a sequence of actions that lead to the goal state.

Pseudocode for utility-based agent program:

```
function utility_based_agent() {
  state = initialize_state()
  while not terminal_state(state) do
    action = choose_action(state)
    state = update_state(state, action)
  end
  return action_with_maximum_utility_from_terminal_state
}
```

Here, terminal_state(state) checks if the current state is a terminal state, meaning there are no further actions to take. action_with_maximum_utility_from_terminal_state is the action that leads to the state with the maximum utility from the terminal state.

Exercise 1.11

a) A simple reflex agent cannot be perfectly rational for this environment because it only reacts based on what it senses at the moment and does not consider past experiences or future consequences.

b) A simple reflex agent with a randomized agent function may outperform a simple reflex agent by exploring different actions and possibly finding a better path to the goal.

```
function randomized_reflex_agent() {
  state = initialize_state()
  while not goal_reached(state) do
    action = choose_randomized_action(state)
    state = update_state(state, action)
  end
  return plan_of_actions
}
```

c) One possible environment where a randomized reflex agent may perform poorly is an environment with a long path to the goal that is partially blocked by obstacles. The randomized agent may get stuck in a loop of trying different actions and not reaching the goal.

d) A reflex agent with state can outperform a simple reflex agent by keeping track of past experiences and using that information to make better decisions.

One possible rational agent of this type is a model-based reflex agent that uses the current state and past experiences to generate a set of rules for choosing actions based on the current state:

```
function model_based_reflex_agent() {
  model = initialize_model()
  state = initialize_state()
  while not goal_reached(state) do
    rule_set = generate_rules(model, state)
    action = choose_best_action(rule_set)
    state = update_state(state, action)
    model = update_model(model, state, action)
  end
  return plan_of_actions
}
```

Here, initialize_model() initializes a model of the environment based on past experiences, generate_rules(model, state) generates a set of rules based on the current state and the model, choose_best_action(rule_set) selects the best action from the generated rule set, and update_model(model, state, action) updates the model based on the new state and action.

Exercise 1.12

• Supermarket bar code scanners: These computer systems are not instances of artificial intelligence as they simply read and process barcodes using pre-programmed rules.

• Web search engines: These computer systems are instances of artificial intelligence as they use complex algorithms to understand natural language queries, analyze the content of web pages, and provide relevant search results based on user intent.

• Voice-activated telephone menus: These computer systems are instances of artificial intelligence as they use speech recognition and natural language processing technologies to interact with users and understand their requests.

• Internet routing algorithms that respond dynamically to the state of the network: These computer systems are instances of artificial intelligence as they use machine learning algorithms to analyze network traffic patterns and make real-time decisions to optimize data routing.

Exercise 1.13

The statement "computers can do only what their programmers tell them" is partially true. While a computer system will only do what it has been programmed to do, modern AI systems are designed to learn from data and improve their performance over time. Therefore, while a programmer may design the initial algorithm or model, the system can adapt and improve without further guidance from the programmer. This implies that computers can be intelligent, but their intelligence is ultimately limited by the scope of their programming and the quality and quantity of their training data.

Exercise 1.14

The statement "animals can do only what their genes tell them" is not entirely true. While an animal's genetic makeup plays a significant role in its behavior and abilities, animals also learn and adapt to their environment through experience and observation. Many species exhibit behaviors that are not solely driven by genetics, such as problem-solving, tool use, and cultural transmission of knowledge between individuals. Therefore, the statement does not imply that animals cannot be intelligent, as intelligence is not solely determined by genetics.