Assignment 1

TDT4171 — Artificial Intelligence Methods

January 2025

Information

- **Delivery deadline: January 30, 2025 by 23:59**. No late delivery will be graded! Deadline extensions will only be considered for extraordinary situations such as family or health-related circumstances. These circumstances must be documented, e.g., with a doctor's note ("legeerklæring"). Having a lot of work in other classes is not a legitimate excuse for late delivery.

- Cribbing("koking") from other students is not accepted, and if detected, will lead to immediate failure of the course. The consequence will apply to both the source and the one cribbing.

- Students can **not** work in groups. Each student can only submit a solution individually.

- Required reading for this assignment: Chapter 12. Quantifying Uncertainty (the parts in the curriculum found on Blackboard "Sources and syllabus" → "Preliminary syllabus") of Artificial Intelligence: A Modern Approach, Global Edition, 4th edition, Russell & Norvig

- For help and questions related to the assignment, **ask the student assistants during the guidance hours**. The timetable for guidance hours can be found under "Assignments" on Blackboard. For other inquires, an email can be sent to tdt4171@idi.ntnu.no

- Deliver your solution on Blackboard. Please upload your assignment as one PDF report and one source file containing the code (i.e., one .py file) as shown in Figure 1.

Figure 1: Delivery Example

Note. We are interested in your problem-solving process (i.e., how you arrived at the final results) and not only the final results.

Exercise 1

Consider the set of all possible five-card poker hands dealt fairly from a standard deck of fifty-two cards.

a. How many atomic events are there in the joint probability distribution (i.e., how many five-card hands are there)?

b. What is the probability of each atomic event?

c. What is the probability of being dealt a royal straight flush? Four of a kind?

Exercise 2

Deciding to put probability theory to good use, we encounter a slot machine with three independent wheels, each producing one of the four symbols BAR, BELL, LEMON, or CHERRY with equal probability. The slot machine has the following payout scheme for a bet of 1 coin (where "?" denotes that we don't care what comes up for that wheel):

BAR/BAR/BAR pays 20 coins
BELL/BELL/BELL pays 15 coins
LEMON/LEMON/LEMON pays 5 coins
CHERRY/CHERRY/CHERRY pays 3 coins
CHERRY/CHERRY/? pays 2 coins
CHERRY/?/? pays 1 coin

The **payouts do not stack**. For instance, if you get 3 cherries, you get 3 coins. You **do not** get 6 coins, because of 3 coins for 3 cherries, 2 coins for 2 cherries and 1 coin for 1 cherry. The wheel order matters. Cherries need to be on specific wheels as outlined in the list. Some examples (BAR can be replaced with any "non-cherry"): CHERRY/CHERRY/BAR pays 2, CHERRY/BAR/CHERRY **pays 1**, CHERRY/BAR/BAR pays 1 and BAR/CHERRY/BAR **pays 0**.

a. Compute the expected "payback" percentage of the machine. In other words, for each coin played, what is the expected coin return?

b. Compute the probability that playing the slot machine once will result in a win.

c. Estimate the mean and median number of plays you can expect to make until you go broke, if you start with 10 coins. Run a simulation in Python to estimate this. Add your results to your PDF report.

Exercise 3

This exercise consists of two parts that ask you to run simulations to compute the answers instead of trying to compute exact answers. Add your answers to your PDF report.

Part 1

Peter is interested in knowing the possibility that at least two people from a group of N people have a birthday on the same day. Your task is to find out what N has to be for this event to occur with at least 50% chance. We will disregard the existence of leap years and assume there are 365 days in a year that are equally likely to be the birthday of a randomly selected person.

a. Create a function that takes N and computes the probability of the event via simulation.

b. Use the function created in the previous task to compute the probability of the event given N in the interval $[10, 50]$. In this interval, what is the proportion of N where the event happens with the least 50% chance? What is the smallest N where the probability of the event occurring is at least 50%?

Part 2

Peter wants to form a group where every day of the year is a birthday (i.e., for every day of the year, there must be at least one person from the group who has a birthday). He starts with an empty group, and then proceeds with the following loop:

1. Add a random person to the group.
2. Check whether all days of the year are covered.
3. Go back to step 1 if not all days of the year have at least one birthday person from the group.

a. How large a group should Peter expect to form? Make the same assumption about leap years as in Part 1.