Assignment 4

TDT4171 — Artificial Intelligence Methods

February 2024

Information

- **Delivery deadline: February 18, 2024 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 13. Probabilistic Reasoning
  - Chapter 15. Making Simple Decisions

  (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 "Course work" → "Information for Guidance Hours" on Blackboard. For other inquires, an email can be sent to tdt4171@idi.ntnu.no.
- Deliver your solution on Blackboard, "Course work" → "Assignment 4 — Delivery". Please upload your assignment as one PDF report.

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

The Surprise Candy Company makes candy in two flavors: 70% are strawberry flavor and 30% are anchovy flavor. Each new piece of candy starts out with a round shape; as it moves along the production line, a machine randomly selects a certain percentage to be trimmed into a square. 80% of the strawberry candies are round, while 90% of the anchovy candies are square. Then each piece is wrapped in a wrapper whose color is either red or brown. 80% of the strawberry candies are chosen randomly to have a red wrapper, while 90% of the anchovy candies are chosen to have a brown wrapper. All candies are sold individually in sealed, identical, black boxes.

Now you, the customer, have just bought a Surprise candy at the store but have not yet opened the box. Consider the three Bayes nets in Figure 1.

a. Which network(s) can correctly represent $\mathbf{P}(Flavor, Wrapper, Shape)$? Consider if each network can represent all dependencies between the variables required to fit with the story?

b. Which network is the best representation for this problem? Consider the size of the representation, and how easily you can deduce the numbers required by the conditional probability tables in your chosen model.

c. Does network (i) assert that $Wrapper$ is independent of $Shape$?

d. What is the probability that your candy has a red wrapper?

e. In the box is a round candy with a red wrapper. What is the probability that its flavor is strawberry?

f. A unwrapped strawberry candy is worth s on the open market and an unwrapped anchovy candy is worth a. Write an expression for the expected value of an unopened candy box.

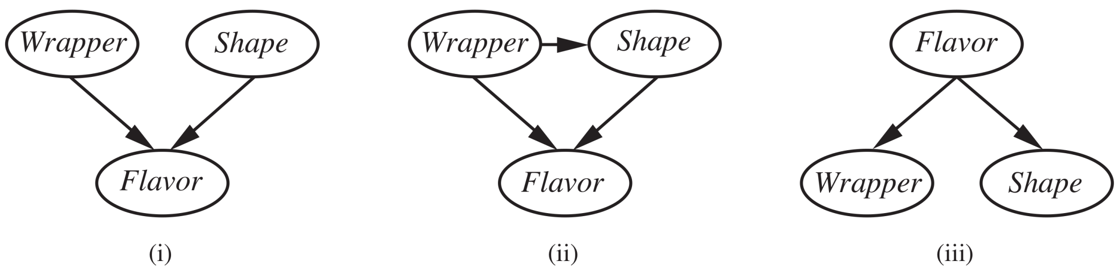

Figure 1: Three proposed Bayes nets for exercise 1

Exercise 2

Economists often make use of an exponential utility function for money: $U(x) = -e^{-x/R}$, where R is a positive constant representing an individual's risk tolerance. Risk tolerance reflects how likely an individual is to accept a lottery with a particular expected monetary value (EMV) versus some certain payoff. As R (which is measured in the same units as x) becomes larger, the individual becomes less risk-averse.

a. Assume Mary has an exponential utility function with $R = \$500$. Mary is given the choice between receiving \$500 with certainty (probability 1) or participating in a lottery which has a 60% probability of winning \$5000 and a 40% probability of winning nothing. Assuming Mary acts rationally, which option would she choose? Show how you derived your answer.

b. Consider the choice between receiving \$100 with certainty (probability 1) or participating in a lottery which has a 50% probability of winning \$500 and a 50% probability of winning nothing. Approximate the value of R (to 3 significant digits) in an exponential utility function that would cause an individual to be indifferent to these two alternatives.