

Exercise: 3

Meeting on January 19th / 21st

Problem 1: Expectation Values

You receive an offer from a big software company for a project as an independent developer. Instead of a fixed sum for your work the offer you a 50% share on the expected profit of 1,000,000 €. However, the project is risky since you know from statistics with similar projects that the probability for success lies only around 20%. You measure your labor investment with 150,000 €.

- (a) Is the project worth it for you?
- (b) An IT consulting agency with experience in such project divides software companies into 4 groups. The worst group, which 40% companies belong to, have a success probability of 10%. The average group, to which 40% of firms belong to, has a success probability of 20%. The good group, to which 10% of firms belong to, has a success probability of 30%, and the best group with the remaining firms has a success probability of 50%. You trust that the consulting agency is realistic in its assessment of groups.

The agency now offers you to determine the company's group. How much money should you spend at most for this assessment?

Problem 2: Decision network for an exam

You are writing a test tomorrow but have neglected studying for it. You are now thinking about your best options for passing the test well. The exam can be easy or hard. Since your tutor has a good reputation, you are estimating that the test will be easy with 60% and hard with 40% probability. The result of the test can be either good, average or bad. You rank their utilities with +10, +5 and -5 respectively. For your preparation you have the options of getting enough sleep or studying through the night, where you estimate the cost with 0 and -2 respectively.

The conditional probabilities mentioned above are listed below:

- (a) What does the decision network look like for this problem? Consider, which nodes flow into the utility.
- (b) Compute the expected utility for the options "sleep" and "study".

Difficulty	Probability
easy	60%
hard	40%

Difficulty/Result	Sleep		Study	
	easy	hard	easy	hard
good	70%	40%	60%	60%
average	20%	40%	30%	30%
bad	10%	20%	10%	10%

Result	Utility
good	10
average	5
bad	-5

Decision	Utility
Sleep	0
Study	-2

Table 1: Probabilities and Utilities for studying for an exam

Problem 3: Markov-Decision-Problem

Consider the following *Markov Decision Problem* with three states $Z \in 1, 2, 3$ and their rewards B with $B_1 = -1$, $B_2 = -2$ and $B_3 = 0$. There is no discount, so $\gamma = 1$. The state $Z = 3$ is a ending state. There are two possible actions a and b in the two states $Z = 1$ and $Z = 2$. The indeterministic transition model is given in Fig. 1.

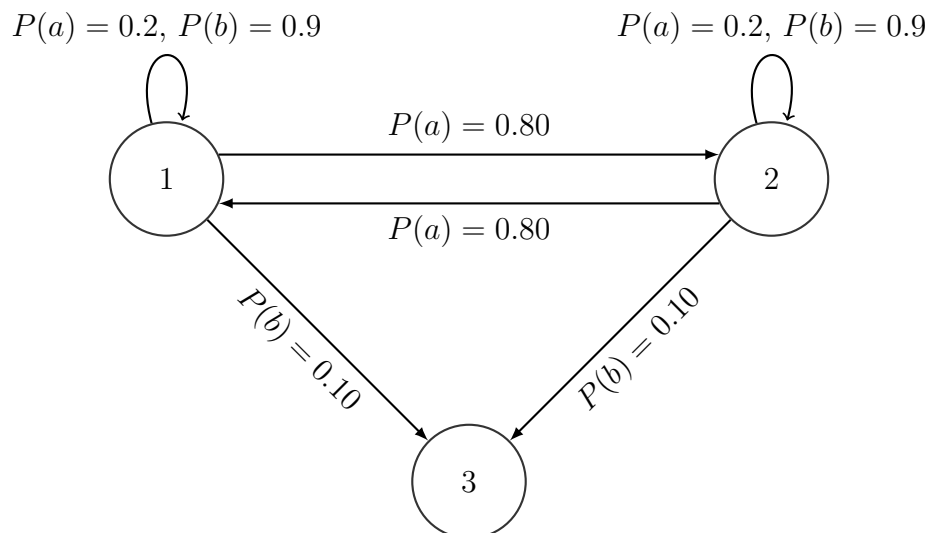


Figure 1: The given indeterministic transition model

- What qualitative remarks can be made about the optimal policy in the states $Z = 1$ und $Z = 2$?
- Use policy iteration to find the optimal policy and with corresponding utility scores in states $Z = 1$ und $Z = 2$. Show the full derivation. Use an initial policy of action b in both states.

Problem 4: Learning Decision Trees

Learn a Decision Tree from the following dataset and determine the assessment for the two test cases.

Fall-Nr.	Clouds	Temperature	Humidity	Wind	Assessment
1	sunny	high	high	no	+
2	sunny	high	high	yes	+
3	cloudy	medium	normal	no	+
4	rainy	high	high	no	-
5	sunny	low	normal	yes	-
6	rainy	low	high	yes	-
7	cloudy	high	high	yes	-
8	sunny	medium	normal	no	+
9	cloudy	medium	high	yes	-
Testfall 1	rainy	medium	high	no	?
Testfall 2	sunny	medium	high	yes	?

Table 2: Dataset and test cases for learning a decision tree

- (a) Determine the decision tree intuitively first, i.e. choose approximately only those attributes which allow for a clear classification on most data points.
- (b) Now learn the decision tree exactly.