

Assignment 1 (Max. 10p)

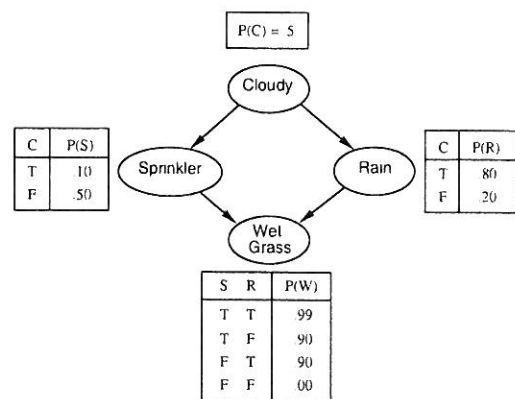
- (a) Explain briefly the meaning of the following terms: **reflex agent, discretization, qualification problem, smoothing, insurance premium, and reinforcement learning.** (Max. 6p)
- (b) Derive the conditionalized version of the Bayes' rule

$$P(\phi | \psi \wedge \chi) = \frac{P(\psi | \phi \wedge \chi)P(\phi | \chi)}{P(\psi | \chi)}$$

where $\phi, \psi,$ and χ are any propositional sentences. (Max. 4p)

Assignment 2 (Max. 10p) Consider the Bayesian network illustrated in the figure. The four Boolean random variables residing in the nodes of the network are abbreviated by $C, S, R,$ and WG .

- (a) Derive a detailed expression for the probability $P(c \wedge \neg s \wedge \neg r \wedge \neg wg)$ and calculate its value. (Max. 3p)
- (b) In addition to this, determine the distribution $\mathbf{P}(C | \neg wg)$. What kind of probabilistic inference is in question in this case? (Max. 4p)
- (c) What is the Markov blanket $mb(R)$? Explain how Markov blankets can be exploited in order to simplify probabilistic expressions such as $P(r | c, \neg s, \neg wg)$. (Max. 3p)



Assignment 3 (Max. 10p) A fire station has only one fire truck. Upon an emergency call, the truck rushes to fight fire and then returns back to the station.

- (a) Design a hidden Markov model (HMM) with two states fs (the truck is at the fire station) and $\neg fs$ to describe the behaviour of this system. Choose transition probabilities to reflect the following properties:
 — On the average, there is an alert once in twelve hours.
 — The expected duration of one fire mission is 3 hours.
 Use one hour time slices in your model. (Max. 4p)
- (b) Write down the corresponding transition matrix Q for the HMM and the transition model $\mathbf{P}(FS_{t+1} | FS_t)$ based on a Boolean random variable FS . (Max. 3p)
- (c) Use the model to determine how many hours a day the truck spends at the fire station in the long run. (Max. 3p)

Assignments 4–5 are given on the reverse side of this sheet!!!

The course name and code, the date, your name, student id, and signature must appear on every answer sheet.
Course feedback: <http://www.cs.hut.fi/Opinnot/Palaute/kurssipalaute.html> (filled in time, +1p)

Assignment 4 (Max. 10p) Hut&Residence Ltd. makes its daily business by trading apartments in Helsinki area. Mr. Big Deal is one of the hardworking salespersons of the company. The table given below lists seven apartments that were recently marketed by him and the outcome of negotiations *Yes*=”sold” or *No*=”not sold”. The last three apartments in the table are potential future assignments of Mr. Big Deal.

Apartment	Suburb	Site	Financial charge	Water charge	Number of rooms	Outcome
1	Kallio	Hired	No	No	1	<i>Yes</i>
2	Kallio	Owned	Yes	Yes	3	<i>Yes</i>
3	Käpylä	Hired	Yes	Yes	3	<i>No</i>
4	Eira	Owned	Yes	No	1	<i>Yes</i>
5	Kallio	Owned	No	Yes	2	<i>No</i>
6	Eira	Owned	No	Yes	2	<i>No</i>
7	Käpylä	Hired	Yes	Yes	1	<i>Yes</i>
8	Käpylä	Hired	No	No	3	?
9	Kallio	Owned	No	Yes	1	?
10	Käpylä	Owned	Yes	Yes	2	?

- (a) Build a decision tree out of the first seven rows of the table using the respective learning algorithm (but without information theoretic calculations). What kinds of apartments are best sold by Mr. Deal? (Max. 4p)
- (b) What is the estimate of the last three apartments getting sold? (Max. 2p)
- (c) What is the expected gain of information (in bits), in view of making a successful deal, if the value of the attribute “Suburb” is determined (assuming that the values of all attributes are unknown)? Use the first seven rows of the table again. (Max. 4p)

Assignment 5 (Max. 10p) The forthcoming Aalto University will be a merge of three universities:

- Helsinki University of Technology (TKK),
- Helsinki School of Economics (HSE), and
- University of Art and Design Helsinki (TaiK).

The percentages of female students enrolled at these universities are 22%, 45%, and 62%, respectively.

- (a) Suppose that we are visiting one campus at random and perceive a group of 11 students out of which 5 are male. What is the most likely hypothesis? Provide calculations to justify your answer. (Max. 4p)
- (b) Suppose that we know that we are in Helsinki where both HSE and TaiK campuses are situated. What is the probability that the 12th student we encounter is female? (Max. 6p)

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