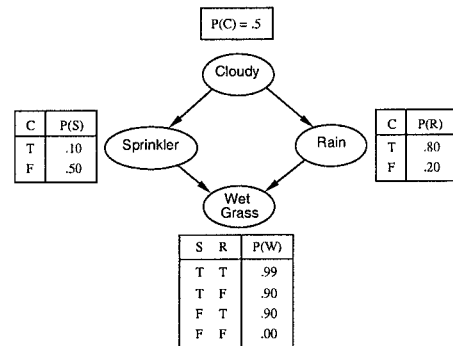


Assignment 1

- (a) Explain the following terms briefly: **degree of truth, joint probability distribution, expected utility, value of information, reinforcement learning** and **version space**. (6p)
- (b) Use the axioms of probability to derive an expression for the probability $P(\phi \leftrightarrow \neg\psi)$ which is based on probabilities $P(\phi)$, $P(\psi)$, and $P(\phi \wedge \psi)$ only. (4p)
Hint: You may use the following result: $P(\phi) = P(\psi)$, if ϕ and ψ are equivalent.

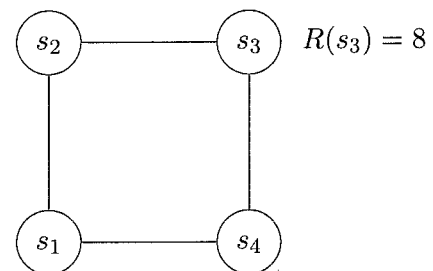
Assignment 2 Consider the Bayesian network given in the figure. Its nodes are Boolean random variables to be abbreviated by C , S , R , and WG in the sequel.

- (a) Give a detailed expression for the probability $P(c \wedge \neg s \wedge r \wedge \neg wg)$ and evaluate it. (3p)
- (b) Determine the distribution $\mathbf{P}(C \mid \neg wg)$ accordingly. What kind of a reasoning task is this? (4p)
- (c) Give the Markov blanket $mb(R)$ for R . Explain how Markov blankets can be exploited to simplify probability expressions like $P(r \mid c, \neg s, \neg wg)$. (3p)



Assignment 3

An agent is situated in a four state environment illustrated in the figure. It can attempt to move from a state to another by executing one of two actions: *move clockwise* C and *move anticlockwise* A . These actions involve uncertainty so that both actions succeed with probability 0.5. In case of a failure, the state of the agent remains unchanged (with probability 0.5). The cost of a *successful* move is 1 unit (clockwise) or 2 units (anticlockwise). The agent receives a reward of 8 units and its operation terminates once it reaches state s_3 .



- (a) The agent executes actions A , C , and A in this order. Which states are reachable by the agent and with what probabilities? (3p)
- (b) What is the optimal policy π for the agent? Determine the expected utilities $U(s_1)$, $U(s_2)$, and $U(s_4)$ for this policy. (4p)
- (c) Perform the *first round* of the value iteration algorithm. (3p)

Note: Assignments continue on the reverse side.

Assignment 4 The Tupajumi Ltd concentrates on trading shares of other housing companies and Bus. Adm. Varma Kauppala is a salesperson hired by the company. Below you will find the data of seven apartments that Kauppala attempted to sell and the outcome of her efforts: **T**="sold" or **F**="not sold". The last three apartments are potentially assigned to Kauppala as her next commissions.

Apartment	Quarter	Site	Financial charges?	Water bill?	Rooms	Outcome
1	Kallio	Hired	No	No	1	T
2	Kallio	Own	Yes	Yes	3	T
3	Käpylä	Hired	Yes	Yes	3	F
4	Eira	Own	Yes	No	1	T
5	Kallio	Own	No	Yes	2	F
6	Eira	Own	No	Yes	2	F
7	Käpylä	Hired	Yes	Yes	1	T
8	Käpylä	Hired	No	No	3	?
9	Kallio	Own	No	Yes	1	?
10	Käpylä	Own	Yes	Yes	2	?

- Build a decision tree using the first seven rows of the table using the decision tree learning algorithm. What kinds of apartments are easiest to sell for Bus. Adm. Kauppala? (4p)
- What is the prognosis for her getting the last three apartments sold? (2p)
- What is the information gain (in bits) in view of a successful transaction, if the value of the attribute "Quarter" is determined (assuming that no attribute values are known)? Use the first seven rows of the table again. (4p)

Assignment 5 The candy factory of Karkkila produces *Jymy* candies in two flavours: strawberry and lemon. *Jymy* candies are wrapped in an indistinguishable way and they are sold in three different mixing ratios in big economy packs which do not indicate the ratio:

- 25% strawberry and 75% lemon
- 50% strawberry and 50% lemon
- 75% strawberry and 25% lemon

- Let us assume that we open a new *Jymy* economy pack and unwrap three candies out of which the first is lemon-flavoured and the rest strawberry-flavoured. What is the most likely hypothesis for the mixing ratio (justify in terms of calculations)? (3p)
- The factory does not reveal the distribution of economy packs produced. Use this to calculate the probability for the fourth candy being lemon flavoured. (7p)

The name of the course, the course code, the date, your name, your student id, and your signature must appear on every sheet of your answers.