

Hochschule Bonn-Rhein-Sieg

Probabilistic Methods for Robotics, WS20

Assignment 04

In [1]:

```
import numpy as np
import IPython
```

Your name:

If you have any problems solving this assignment or other open questions, please visit our lea-section:

[https://lea.hochschule-bonn-rhein-sieg.de/ilias.php?](https://lea.hochschule-bonn-rhein-sieg.de/ilias.php?ref_id=829081&cmd=showThreads&cmdClass=ilrepositorygui&cmdNode=v5&baseClass=ilrepositorygui)

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Exercise 1: Semantics of Bayesian networks [20 points]

Let's suppose that we have a very simple line following robot. The robot is a differential drive, so it has two motors. The commands sent to the motors depend on the measurements of two light sensors; the sensors measure whether the robot is within or outside a line and are positioned on the left and right side of the robot. Segments of the line that our robot needs to follow are near a wall, so incorrect motor commands may lead to collisions with the wall.

1.) Let's say that we are interested in diagnosing problems in the line following behaviour, such that we have a joint distribution represented as

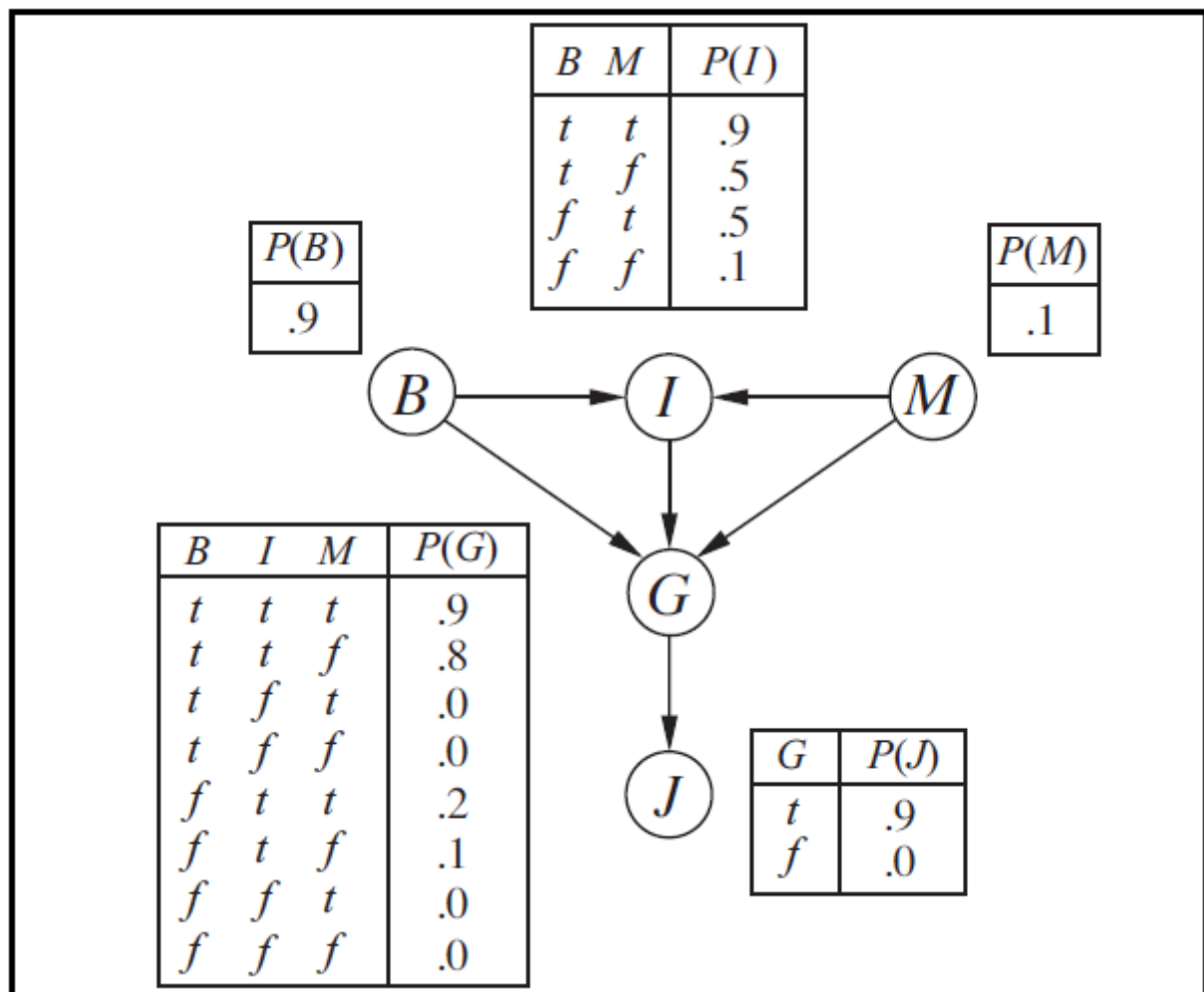
$$P(C, M_1, M_2, S_1, S_2) = P(C|M_1, M_2)P(M_1|S_1, S_2)P(M_2|S_1, S_2)P(S_1)P(S_2)$$

where $M_{1,2}$ and $S_{1,2}$ model the motors and light sensors respectively and C models collisions. Draw the Bayesian network corresponding to $P(C, M_1, M_2, S_1, S_2)$.

2.) Is this a causal or a diagnostic model? Justify your reasoning.

Exercise 2: More Bayesian networks [50 points]

*Source: Russel, Norvig: "Artificial Intelligence, a modern Approach"



Consider the Bayesian network shown in the figure:

1.) Which of the following are asserted by the network structure? Describe your decision.

- (i) $P(B, I, M) = P(B)P(I)P(M)$.
- (ii) $P(J | G) = P(J | G, I)$.
- (iii) $P(M | G, B, I) = P(M | G, B, I, J)$.

2.) Calculate the value of $P(b, i, \neg m, g, j)$

3.) Calculate the probability that someone goes to jail given that they broke the law, have been indicted, and face a politically motivated prosecutor.

4.) A *context-specific* independence allows a variable to be independent of some of its parents given certain values of others. In addition to the usual conditional independences given by the graph structure, what context-specific independences exist in the Bayes net shown in the figure?

In []:

In []:

