Grundlagen der Wissensverarbeitung

Blatt 8

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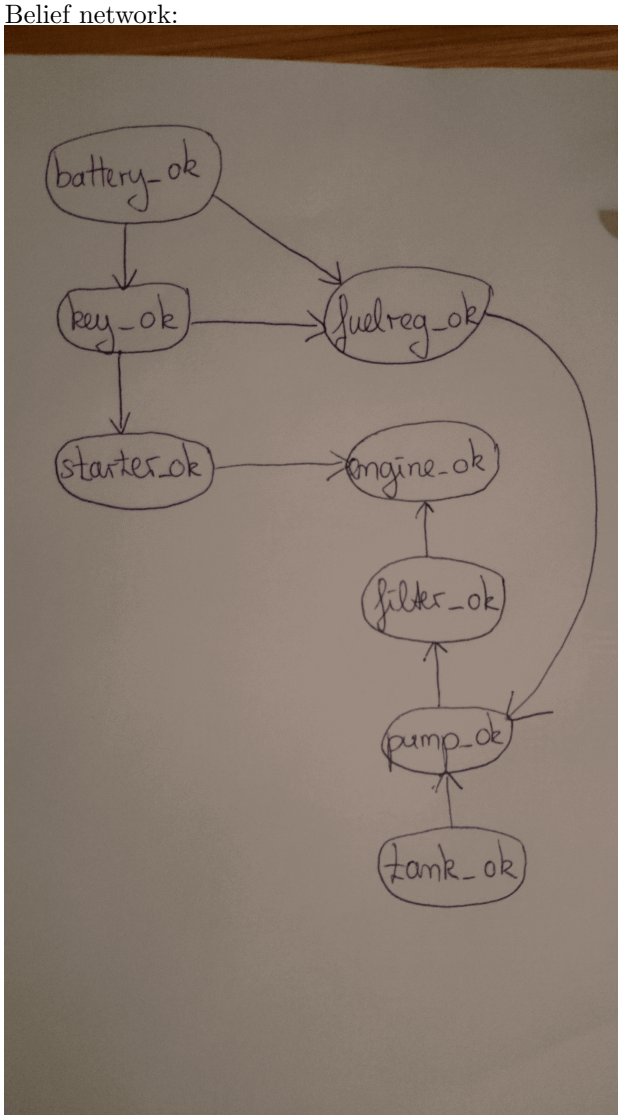
Exercise 1.3: (Diagnosis (cont.))

Car engine.
Belief network:



P(battery_ok) = 0.9
P(key_ok | battery_ok) = 0.9 · 0.9 = 0.81
P(fuelreg_ok | battery_ok, key_ok) = 0.9 · 0.9 · 0.81 = 0.6561
P(starter_ok | key_ok) = 0.9 · 0.81 = 0.729
P(engine_ok | starter_ok, filter_ok) = 0.9 · 0.729 · 0.4782969 = 0.3138106
P(filter_ok | pump_ok) = 0.9 · 0.531441 = 0.4782969
P(pump_ok | tank_ok, fuelreg_ok) = 0.9 · 0.9 · 0.6561 = 0.531441
P(tank_ok) = 0.9

Probability that the battery is working:
P(battery_ok) = 0.9

Probability that the starter is working:
P(starter_ok | key_ok) = 0.9 · 0.81 = 0.729

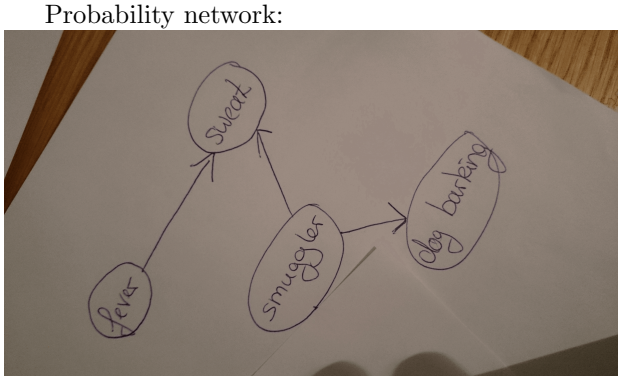
Probability that the engine is working:
P(engine_ok | starter_ok, filter_ok) = 0.9 · 0.729 · 0.4782969 = 0.3138106

Probability that the engine is working after making the observation that the pump is working:
Following changes:
P(pump_ok | tank_ok, fuelreg_ok) = 1.0 · 0.9 · 0.6561 = 0.59049
P(filter_ok | pump_ok) = 0.9 · 0.59049 = 0.531441
P(engine_ok | starter_ok, filter_ok) = 0.9 · 0.729 · 0.531441 = 0.34867844

Exercise 1.4: (Bayesian Probabilities)

Smuggler case.

Probability network:



Complete the missing probabilities and draw the probability network:
P(smuggler) = 0.01 /given
P($\overline{smuggler}$) = 0.99 /calculated: 1 - 0.01

P(dog barking | smuggler) = 0.8 /given
P($\overline{dogbarking}$ | smuggler) = 0.2 /calculated: 1 - 0.8
P(dog barking | $\overline{smuggler}$) = 0.05 /given
P($\overline{dogbarking}$ | $\overline{smuggler}$) = 0.95 /calculated: 1 - 0.05

P(dog barking) = 0.85 /calculated: 0.8 + 0.05
P($\overline{dogbarking}$) = 0.15 /calculated: 1 - 0.85

P(sweat | $\overline{smuggler}$, $\overline{fever}$) = 0 /given
P(sweat | smuggler, $\overline{fever}$) = 0.4 /given
P(sweat | smuggler, fever) = 0.8 /given
P(sweat | $\overline{smuggler}$, fever) = 0.6 /given

P(fever) = 0.013 /given
P($\overline{fever}$) = 0.987 /calculated: 1 - 0.013

Give an example of "explaining away" in the given network:
A status will get more likely or less likely dependent from other conditions. Example: If somebody sweats, we have 2 explanations: fever and smuggler. If we also add the clue dog barking, then the explanation smuggler will get more likely then fever.

Probability that a person is a smuggler given the observation that the drug dog is barking:
P(smuggler | dog barking) = (P(dog barking | smuggler) · P(smuggler)) / P(dog barking) = (P(dog barking | smuggler) · P(smuggler)) / (P(dog barking | smuggler) · P(smuggler) + P(dog barking | $\overline{smuggler}$) · P($\overline{smuggler}$)) = (0.008 / 0.0575) = 0.14 /calculated with Bayes Law

Probability that a suspect is sweating (without any prior observation):
P(sweat) =
P(sweat | $\overline{smuggler}$, $\overline{fever}$) · P($\overline{smuggler}$, $\overline{fever}$) +
P(sweat | smuggler, $\overline{fever}$) · P(smuggler, $\overline{fever}$) +
P(sweat | smuggler, fever) · P(smuggler, fever) +
P(sweat | $\overline{smuggler}$, fever) · P($\overline{smuggler}$, fever) =
(0 · (0.99 · 0.987)) + (0.4 · (0.01 · 0.987)) + (0.8 · (0.01 · 0.013)) + (0.6 · (0.99 · 0.013)) = 0 + 0.003948 + 0.000104 + 0.007722 = 0.011774 /calculated with Law of Total Probability

Probability that a person is a smuggler given both the observations that that person is sweating and that the drug dog barked at him or her:
P(smuggler | sweat, dog barking) =
P(smuggler | $\overline{sweat}$, $\overline{dogbarking}$) · P($\overline{sweat}$, $\overline{dogbarking}$) +
P(smuggler | sweat, $\overline{dogbarking}$) · P(sweat, $\overline{dogbarking}$) +
P(smuggler | sweat, dog barking) · P(sweat, dog barking) +
P(smuggler | $\overline{sweat}$, dog barking) · P($\overline{sweat}$, dog barking) =
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