Tasks for part II

5.

a.

Meltdown probability: 0.02578. With ice: 0.03472

b.

P(Meltdown|Warnings) = 0.14535. P(Meltdown|Failures) = 0.2

c.

Since meltdowns are very rare, there is no data to verify the model. The effects of the conditional probabilities that affect the meltdown are probably difficult or impossible to estimate.

d.

One alternative for the domain is integers between 0 and 400 if the temperature unit is kelvin. The probability will be distributed over all the alternatives, so the domain would have to be finite.

6.

a.

The probability of a component's state in a system given the state of other components in the system.

b.

From the slides: "A full joint probability distribution $\mathbf{P}(X1, \ldots, Xn)$, assigns a probability to each of the possible combinations of variable/value pairs"

P(Meltdown=F, PumpFailureWarning=F, PumpFailure=F, WaterLeakWaring=F, WaterLeak=F, IcyWeather=F) =

$= \Pi^{6}_{i=1} \mathbf{P}(X_i \mid X_{i-1}, \ldots, X_1) =$

= P(Meltdown | PumpFailure, WaterLeak) * P(PumpFailureWarning | PumpFailure) * P(PumpFailure) * P(WaterLeakWarning | WaterLeak) * P(WaterLeak | IcyWeather) * P(IcyWeather) =

= 0.999 * 0.95 * 0.9 * 0.95 * 0.9 * 0.95 = 0.69378

Yes, this is a common state, because it is in this state most of the time.

c.

The probability is 0.2. Since meltdown is only a child of PumpFailure and WaterLeak, no other nodes affect the probability for meltdown.

d.

Probability of Meltdown and PumpFailure being true:

0.15 * 0.1 * 0.1 * 0.95 * 0.9 * 0.95 = 0.001218375

Probability of Meltdown being true and PumpFailure being false:

0.001 * 0.95 * 0.9 * 0.95 * 0.9 * 0.95 = 0.000694474

Together:

0.001218375 + 0.000694474 = 0.001913

Probability of Meltdown being false and PumpFailure being true:

0.85 * 0.1 * 0.1 * 0.95 * 0.9 * 0.95 = 0.006904125

Probability of Meltdown and PumpFailure being false:

0.999 * 0.95 * 0.9 * 0.95 * 0.9 * 0.95 = 0.693779276

Together:

0.006904125 + 0.693779276 = 0.7007

α * (0.001913, 0.7007) normalized gives: α = 1.425

The probability of a meltdown is:

α * 0.001913 = 0.00273

Tasks for part III

2.

- It changes from 0.99001 to 0.98116
- Bicycle changes probability of survival to 0.99505

- The complexity of exact inference is NP-hard, and an alternative is approximate inference algorithms.

Tasks for part IV

2.

- It is possible to compensate for the lack of Mr. H. S's experience by reducing the probability of a pump failure in the model.
- We add a node between PumpFailureWarning and WaterLeakWarning that follows the or logic. We then set this node to True, which will propagate through the graph. The chance of survival for Mr H.S. is 0.96504. This is the value seen by querying the survives node. (The extensions made in task IV affected this value.)
- That these factors are the only ones that will affect the outcome.
- We would model the weather with a long row of states that represent one day each. In this way, each node's parent will be the previous day.