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TDDC17 – Lab 3 Parts 2-4

Part II

5 a)

If there has been no observation: 0.02578. If there is icy weather: 0.03472

b)

P(Meltdown | PumpFailureWarning, WaterLeakWarning) = 0.14535
P(Meltdown | PumpFailure, WaterLeak) = 0.2

The chance of a meltdown is higher if there is actual observed failures, and not just observerd warnings.

c)

It is very hard to measure the exact probability of an event causing another. There are so many things that can come from (for example) a pump failure; far more than you could probably keep track of easily.
What if the pump failure suddenly fixes itself? What if the pump failed because the generator for that entire part of the structure failed? What if some spies are trying to sabotage and actually cause a meltdown on purpose?
Also, it's fairly hard to define something as “IcyWeather”. Does that just refer to when it's ice on the ground? How thick does the ice have to be for it to count? Does different thickness imply different statistics?

d)

The domain would change from a boolean to either a number or a range. The range itself could be built up of any range of temperatures in {Absolute Zero, Absolute Zero + 1, …, Absolute Hot - 1, Absolute Hot }. Since we have no defined range, it's hard to say exactly what will happen with the distribution in each P(WaterLeak | Temperature) alternative, but since the prior called for “IcyWeather”, it's safe to assume that (given a reasonable range of, for example, liveable temperatures) the vast majority of chance will be below freezing.

6 a)

The probability table shows the probabilities of each possible state of a given node, influenced by any eventual parent nodes.

b)

A joint probability distribution is the distribution you get when you join at least two different probability distributions. i.e. P(IcyWeather, WaterLeak).

P(Meltdown=F, PumpFailureWarning=F, PumpFailure=F, WaterLeakWaring=F, WaterLeak=F, IcyWeather=F) gives us:
P(IcyWeather) * P(PumpFailure) * P(PumpFailureWarning | PumpFailure) * P(Meltdown | PumpFailure, WaterLeak) * P(WaterLeak | IcyWeather) * P(WaterLeakWarning | WaterLeak) which equates to:
0.95 * 0.9 * 0.95 * 0.999 * 0.9 * 0.95 ≈ 0.69
This is a common state.

c)

P(Meltdown | PumpFailure, WaterLeak) = 0.2
No other variables matter as long as all parent nodes are observed.

d)

P(Meltdown=T | PumpFailureWarning=F, PumpFailure, WaterLeakWaring=F, WaterLeak=F, IcyWeather=F) =
P(IcyWeather) * P(WaterLeak | IcyWeather) * P(WaterLeakWarning | WaterLeak) *
(P(PumpFailure=T) * P(PumpFailureWarning | PumpFailure=T) *
P(Meltdown=T | PumpFailure=T, WaterLeak) +
P(PumpFailure=F) * P(PumpFailureWarning | PumpFailure=F) *
P(Meltdown=T | PumpFailure=F, WaterLeak)) =
0.95 * 0.9 * 0.95 * (0.1 * 0.1 * 0.15 + 0.9 * 0.95 * 0.001) = 0.00191284875

P(Meltdown=F | PumpFailureWarning=F, PumpFailure, WaterLeakWaring=F, WaterLeak=F, IcyWeather=F) =
P(IcyWeather) * P(WaterLeak | IcyWeather) * P(WaterLeakWarning | WaterLeak) *
(P(PumpFailure=T) * P(PumpFailureWarning | PumpFailure=T) *
P(Meltdown=F | PumpFailure=T, WaterLeak) +
P(PumpFailure=F) * P(PumpFailureWarning | PumpFailure=F) *
P(Meltdown=F | PumpFailure=F, WaterLeak)) =
0.95 * 0.9 * 0.95 * (0.1 * 0.1 * 0.85 + 0.9 * 0.95 * 0.999) = 0.7006834012499998

α = 1 / (0.00191284875 + 0.7006834012499998) = 1.4232925382109571

0.00191284875 * α = 0.0027225433526011566 ≈ 0.003 (Chance of meltdown)
0.7006834012499998 * α ≈ 0.997 (Chance of no meltdown)

Part III

2 a)

P(Survives | Radio=F) = 0.98116

P(Survives) = 0.99001

b)

P(Survives) = 0.99505 after the bike variable is added

c)

It would be difficult to come to exact inference, since (as discussed in a previous question) it's difficult to determine how likely an event really is, based on both things that could potentially happen that whomever makes the network haven't remembered, and the fact that values and percentages would, given a near infinite amount of time, change indefinitely, albeit slightly.

An alternative might be approximation, since even with approximation you can get *close* to the exact values. This can be achieved through the use of, for example, a Markov chain.

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Part IV

2 a)

Seeing as (in my implementation), the chance of survival drops when Mr H.S. is introduced (from 0.99532 to 0.99505), decreasing the pump's chance of failure would most definitely increase the chance of survival. In fact, decreasing the chance from 0.1 to 0.09 completely nulls the negative effect Mr H.S. has on the network.

b)

The disjunction in the question is if it is the WaterLeakWarning or PumpFailureWarning that is going off. We can circumvent this by adding a node that contains the probability that any sort of warning is going off (an OR node that connects WaterLeakWarning and PumpFailureWarning).

This change increases the chance of survival to what it was before the introduction of Mr H.S., i.e. P(Survives) = 0.99532.

c)

There are a lot of things that make humans unpredictable. In a tense situation, we might draw a blank at something we might not have in a similar situation, for example. That, coupled with the fact that we are leaving out a lot of variables (is he at the workstation? Did he spill some jelly from his jelly-filled donut onto the warning light so he doesn't see it going off?), we are left with a fairly inaccurate depiction of a human.

d)

For the given example, we would introduce a few new nodes:

IcyWeatherYesterday

IsWinter

IcyWeather would depend on IcyWeatherYesterday, which in turn would depend on IsWinter. The new tables would be something like:

IsWinter = T	**IsWinter = F**
0.5	0.5

IsWinter	**IcyWeatherYesterday = T**	**IcyWeatherYesterday = F**
T	0.8	0.2
F	0.2	0.8

IcyWeatherYesterday	IcyWeather = T	IcyWeather = F
T	0.8	0.2
F	0.2	0.8

These tables being under the assumption that the plant is located in Sweden (or a country with the same type of climate as Sweden).