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Task part 2

5.
a)
With no observation probability is 0.02578, with icyweather we have a probability of meltdown of 0.03472

b)
P(Meltdown | pumpfailurewarning, waterLeakWarning) = 0.14535.
P(Meltdown | pumpfailure, waterleak) = 0.20000
The difference is that when there is actual water leak och pump failure the risk increases. While its a warning it doesn't necessarily mean that there is a meltdown hence the probability is lower.

c)
When there is very hard for a conditional probability to actually occur in the real world it is hard to get good estimation or in cases where the dependencies between to events are very vague. For example P(Meltdown | waterleak), we don't want to create a water leak to see whether a meltdown occurs or not in the real world.

d)
If we change it to Temperature we can either have a set of different weathers like warm, cold, icy. Another way to do it is to have continuous temperature like 14.4 Celsius degrees etc. For the alternative with three different weathers (warm, cold, icy) we will get a bigger probability table with a size of 3x2 compare to now where we have a 2x2. For the continuous alternative we can't have a probability table since we cant plot all possible values. We could use a function to calculate probability here.

6.

a)
The probability table represents the different probabilites for a node to happen or not to happen. This can be affected by the parents observation of course. So looking at the meltdown we see all probabilites of it to happen which is also based on weather there is a pump failure and/or a water leak.

b)
The joint distribution is all the joint probabilites over the complete graph, all variables and combinations included. The chain rule gives us

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

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

from the semantics of Bayersian Networks we can do the following:

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

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 = 0.693

Yes it is relatively common to be in this state since there is almost a 70 % chance to be in this state.

c)
P(Meltdown | PumpFailure = T , WaterLeak = T) = 0.2
No, it does not matter if we know any other variable than the parents of the node we are looking at. The reason for this is because we know the parents state already. Lets say we didn't know if there were a meltdown or water leak. Changing pumpfailurewarning to T would then result in pump failure to be more likely that would in turn affect Meltdown. But since we know that there is a pump failure the warning doesn't contribute with anything.

d)
P(Meltdown | PumpFailureWarning=F, WaterLeak=F, WaterLeakWarning=F, IcyWeather=F) =
alpha * P(Meltdown, PumpFailureWarning, WaterLeak, WaterLeakWarning, IcyWeather) =

We calculate the probability of Meltdown being true first.

P(Meltdown= T | PumpFailure = T, WaterLeak = F) *
P(PumpFailureWarning = F | PumpFailure = T) *
P(PumpFailure = T) *
P(WaterLeakWarning = F | WaterLeak = F) *
P(WaterLeak = F | icyWeather = F) *
P(icyWeather = F)
+
P(Meltdown = T | PumpFailure = F, WaterLeak = F) *
P(PumpFailureWarning = F | PumpFailure = F) *
P(PumpFailure = F) *
P(WaterLeakWarning = F | WaterLeak = F) *
P(WaterLeak = F | icyWeather = F) *
P(icyWeather = F) =

0.15 * 0.1 * 0.1 * 0.95 * 0.9 * 0.95 + 0.001 * 0.95 * 0.9 * 0.95 * 0.9 * 0.95 = 0.0019

Now we calculate it for when Meltdown is false

(P(Meltdown= F | PumpFailure = T, WaterLeak = F) *
P(PumpFailureWarning = F| PumpFailure = T) *
P(PumpFailure = T) *
P(WaterLeakWarning = F | WaterLeak = F) *
P(WaterLeak = F | icyWeather = F) *
P(icyWeather = F)
+
P(Meltdown = F | PumpFailure = F, WaterLeak = F) *
P(PumpFailureWarning = F | PumpFailure = F) *
P(PumpFailure = F) *
P(WaterLeakWarning = F | WaterLeak = F) *
P(WaterLeak = F | icyWeather = F) *
P(icyWeather = F) =

0.85 * 0.1 * 0.1 * 0.95 * 0.9 * 0.95 + 0.999 * 0.95 * 0.9 * 0.95 * 0.9 * 0.95 = 0.7

now we have that alpha * (0.0019 , 0.7)

if we set alpha to about 1.42470 we get approximately

(0.00271, 0.99729) So there is about 0.271 % chance for a meltdown

Task part 3
1.
we have saved the model in a txt file that is sent with the lab.

2.
P(survives | Radio = F) = 0.98116
P(survives) = 0.99001
So the chances of surviving was decreased by 0.00885

with the bicycle the chances of surviving is the following

P(survives) = 0.99505 so we have a increase of 0.00504

Exact inference is NP-hard (exponential complexity) and other alternatives could be approximation algorithms, topological structural constraints, restrictions on the conditional probabilities.

Task part 4

1. Yes it is possible to compensate. If the pumpfailure probability for false is increased then we wont have pumpfailure as often as now. This will work as long as the H.S guy is not too competent but in our model he is not.

2. What we did is that we added a new node “AtLeastOneAlarm”. If we know this is true and we

haven’t don’t any other observations this will then increase the probability of waterleak or pumpfailure to be true. Which will in turn affect other probabilities.
So if we look at P(survives | AtLeastOneAlarm) = 0.98441

3. It is unrealistic to assume that the probability of a persons behaviours is the same each day. A person can change a lot. For example he can be more tired on day than another day. Something he have done in a specific day can change the probabilities of other things. Because of these things it is complex to model a person.

4. One way to make the model a more dynamic world is to add nodes. For example we could have a YesterdayIcyWeather that is connected to the icyWeather. And then we can look at yesterday and if it is true, then IcyWeather probability to be true will be increased.