ASSIGNMENT 3

TDT4171 - Methods in Artificial Intelligence

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1 Introduction

For our decision problem we tried to come up with a problem we encountered on a daily basis. By doing this, we would be able to easily validate that the results of the decision support system (hereby denoted DSS) were valid. With this report, we would like to elaborate about the problem itself, and both of our own interpretations on specific elements of the problem. The problem description stated that the problem should contain at least ten uncertain and certain probability factors. Our final problem came out to be:

Should I go training?

2 The Model

When the problem had been chosen, the next step were to find out the variables influencing the decision (conditional dependencies), both directly and uncertainties. All of the presented variables is a result of our way of seeing the world, and what we often take in account when doing our decision on whether or not we should go training. The final model, with cleared evidence, is shown in figure 1. The uncertain variables are here represented with a yellow color. The observable values are represented with a skin-tone color. The purple nodes are consequences (a collection of parent variables). Our model is modeled after the "simple method" described in the curriculum [1]

2.1 Known Variables

The following variables are directly influencing our decision and all of these variables are observable before the decision is made.

1. *Training efficiency*

   Muscle Fever
   The degree of muscle fever before going to a training session. Assume three possible values of muscle fever: { None, Some, Intense }. Lower muscle fever influence the efficiency positively.

   Feeling sick
   A measurement on how sick one feels on the day in question. Assume three possible values of sickness: { Yes, Some, No }. As natural as it is, a lower degree of sickness is positive towards the training efficiency.

   Hungry
   A boolean, { Yes, No }, description on whether or not one is hungry before the decision is made. If one is hungry, it will affect the efficiency negatively.

2. *Weather Conditions*

   Temperature
   A measure divided into three categories, describing how the temperature is outside. Possible values are: { Cold, Mild, Warm }. Mild is considered to be the optimal temperature, but it all is dependent on the level of precipitation.

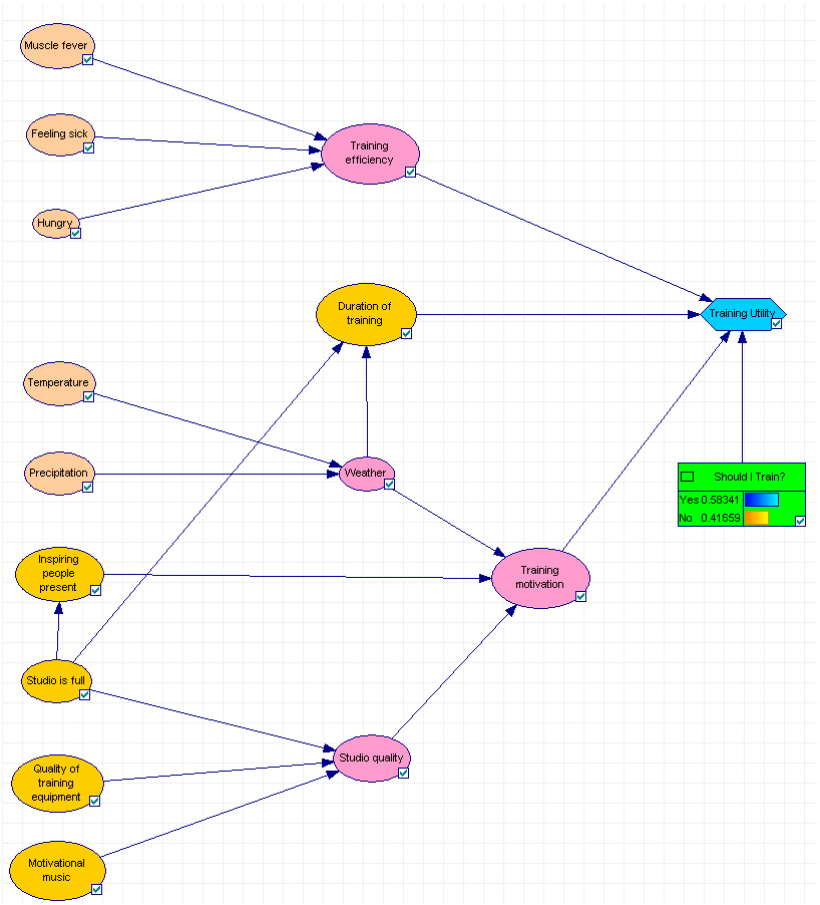

Figure 1: The final model, shown with icons and cleared evidence

Precipitation

A measure on how much rain is outside on any given moment. Possible value are: { Sunny, Drizzle, Heavy, Storm }. Lower degree of precipitation yields higher motivation for training.

2.2 Unknown Variables

There are also some uncertainties that we are not able to observe before we actually go to the fitness studio, but that still is of importance to our decision. These uncertainties are the following:

1. *Studio Quality*

Is the studio full

The degree of how crowded the fitness studio is. Assume two possible values: {Empty, Half, Full}. This variable affects the *Studio Quality* positively the less crowded the studio is.

Quality of training equipment

The quality of the training equipment in the training studio. Assume two possible val-

ues: {Good, Bad}. This variable affects the *Studio Quality* positively the better quality the training equipment is.

Motivating music playing
Whether there is motivating music present at the training studio. Assume two possible values: {Yes, No}. The variable affects the *Studio Quality* positively if the value is yes

2. *Duration of training*
The duration of the training session. Assume two possible values: {As Planned, Longer Then Planned} The variable is conditionally dependent on *Studio is full* and *Weather*. The reasoning for this is that the duration of the session might not be as planned if the the studio is full, forcing you to spend time on staying in queues and not being able to use your desired equipment, as well as the weather which may cause a longer travel time to and from the training studio if the conditions are bad.

3. *Inspiring people present*
If there are any inspiring persons in the training studio. Assume two possible values: {Yes, No}. The variable's probabilities are conditionally dependent of the probabilities of each value of the unobservable variable *Studio is full*. This connection is present simply because with less people in total, the probability for some of them to be inspiring for you is lower.

3 Utility Function

Our utility function, *Training Utility*, is based upon three chance nodes, where two of them are consequences of observable and uncertain variables. The last node is the uncertain variable *Duration of training*.

1. **Training efficiency:** This is based upon three sub-variables, all observable.
   (a) **Muscle fever** - The probability of training decreases a little bit, when you have muscle fever. Albeit, even with muscle fever it is possible to get good training efficiency if you warm up properly.
   (b) **Feeling sick** - You are more likely to go training if you feel well. Although, if you are a little sick, the efficiency of the training may still be good.
   (c) **Hungry** - If you feel hungry, the training efficiency will decrease.

2. **Training motivation:** This is based upon six sub-variables, some observable, and some unobservable.
   (a) **Studio Quality**
      i. *Studio is full* - If the studio is full, the motivation for training decreases a lot. It will not be possible to immediately use the training equipment one would like. The possibility for standing in line in order to fulfill the training program is demotivating.
      ii. *Quality of training equipment* - If the quality of the training equipment is poor, you may not be able to do every exercise, or even perform as wanted.

iii. *Motivational music* - The music may have some relevance to the motivation when doing an exercise.

(b) **Weather**

i. *Temperature* - If the temperature is different from your preference, you might not be motivated to go training

ii. *Precipitation* - If it rains heavily, you might not want to go out in order to get to the fitness studio.

(c) **Inspiring people present** - When inspiring people is present, one will often get inspiration and increase the motivation.

3. **Duration of training:**

(a) **Weather** - Same description as above

(b) **Studio is full** - Same description as above

Each of these nodes can assume two different values representing good/bad or high/low. The training efficiency node is assumed to be the most important, as this will give the biggest effect on you after the training. Thereafter, the duration of the training is considered second most important. If you train longer than planned, this may cost heavily, in the terms of arriving late for lectures etc. And finally, the motivation are assumed to be least important.

The minimum utility is achieved when the efficiency is low, duration is long and motivation is low. This is awarded a value of zero. The maximum utility is achieved when efficiency and motivation is high, and the duration is as planned. This is awarded a value of one.

Training efficie...	High								Low							
Training motiva...	High				Low				High				Low			
Duration of trai...	As_Planned		Longer_Than_Planned		As_Planned		Longer_Than_Planned		As_Planned		Longer_Than_Planned		As_Planned		Longer_Than_Planned	
Should I Train?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Value	1	0	0.6	0.4	0.7	0.3	0.4	0.6	0.55	0.45	0.2	0.8	0.2	0.8	0	1

Figure 2: Training Utility

4 Probability of Unknown Variables

In this section, we will show the probability distributions for each of the unknown variables. For each of the possible values a node may have, the assigned probabilities sum up to 1. Every probability is set to a number we felt appropriate. Also there have been some minor tweaks of the probabilities in order for the final decision to make sense. Every probability is possibly not optimal, but we tried our best to find reasonable values.

Yes	0.65
No	0.35

Figure 3: Motivational Music

Good	0.85
Bad	0.15

Figure 4: Quality of training equipment

Empty	0.15
Half	0.7
Full	0.15

Figure 5: Studio is Full

Studio is full	Empty		Half		Full	
Weather	Good	Bad	Good	Bad	Good	Bad
As_Planned	1	0.6	0.8	0.4	0.2	0
Longer_Than_Planned	0	0.4	0.2	0.6	0.8	1

Figure 6: Duration of Training

Studio is full	Empty	Half	Full
Yes	0.15	0.3	0.5
No	0.85	0.7	0.5

Figure 7: Inspiring People Present

5 Probability of Other Chance Nodes

Quality of traini...	Good						Bad					
Motivational m...	Yes			No			Yes			No		
Studio is full	Empty	Half	Full	Empty	Half	Full	Empty	Half	Full	Empty	Half	Full
Good	1	0.85	0.4	0.9	0.75	0.3	0.65	0.5	0.25	0.55	0.4	0.15
Bad	0	0.15	0.6	0.1	0.25	0.7	0.35	0.5	0.75	0.45	0.6	0.85

Figure 8: Studio Quality

Hungry	Yes									No								
Muscle fever	None			Some			Intense			None			Some			Intense		
Feeling sick	Yes	Some	No	Yes	Some	No	Yes	Some	No	Yes	Some	No	Yes	Some	No	Yes	Some	No
High	0.15	0.5	0.5	0.05	0.48	0.4	0	0.45	0.6	0.2	0.5	1	0.15	0.48	0.95	0.1	0.45	0.9
Low	0.85	0.5	0.5	0.95	0.52	0.6	1	0.55	0.4	0.8	0.5	0	0.85	0.52	0.05	0.9	0.55	0.1

Figure 9: Training efficiency

Weather	Good				Bad			
Inspiring peopl...	Yes		No		Yes		No	
Studio quality	Good	Bad	Good	Bad	Good	Bad	Good	Bad
High	1	0.6	0.8	0.4	0.8	0.4	0.6	0.2
Low	0	0.4	0.2	0.6	0.2	0.6	0.4	0.8

Figure 10: Training motivation

Temperature	Cold				Mild				Warm			
Precipitation	Sunny	Drizzle	Heavy	Storm	Sunny	Drizzle	Heavy	Storm	Sunny	Drizzle	Heavy	Storm
Good	0.85	0.2	0.1	0	1	0.6	0.2	0.01	1	0.8	0.3	0.05
Bad	0.15	0.8	0.9	1	0	0.4	0.8	0.99	0	0.2	0.7	0.95

Figure 11: Weather

6 Evaluation Runs

Being two people doing this exercise together, we filled in evidence to the known variables in turn. Since none of our observable variables are a result of personal preference, but rather pure observations of the current situation we modeled two runs with different choices. The runs were done at slightly different times, and resulted in two different final decisions.

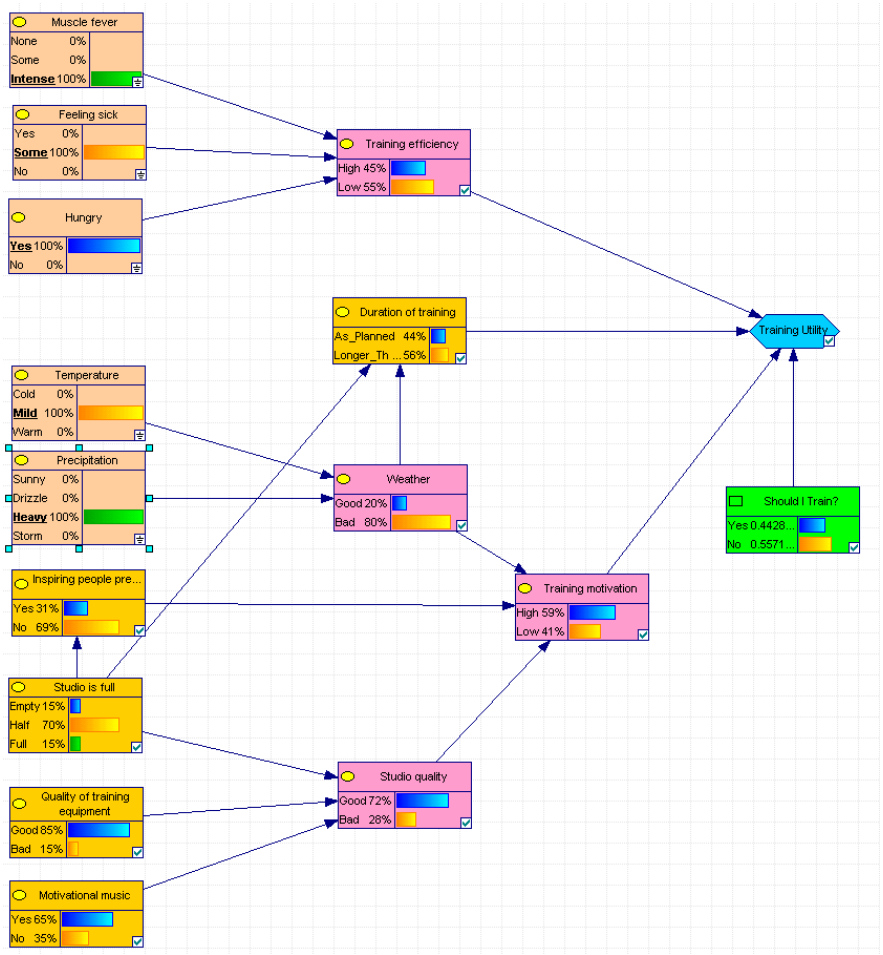

Figure 12: Preference structure for Håkon

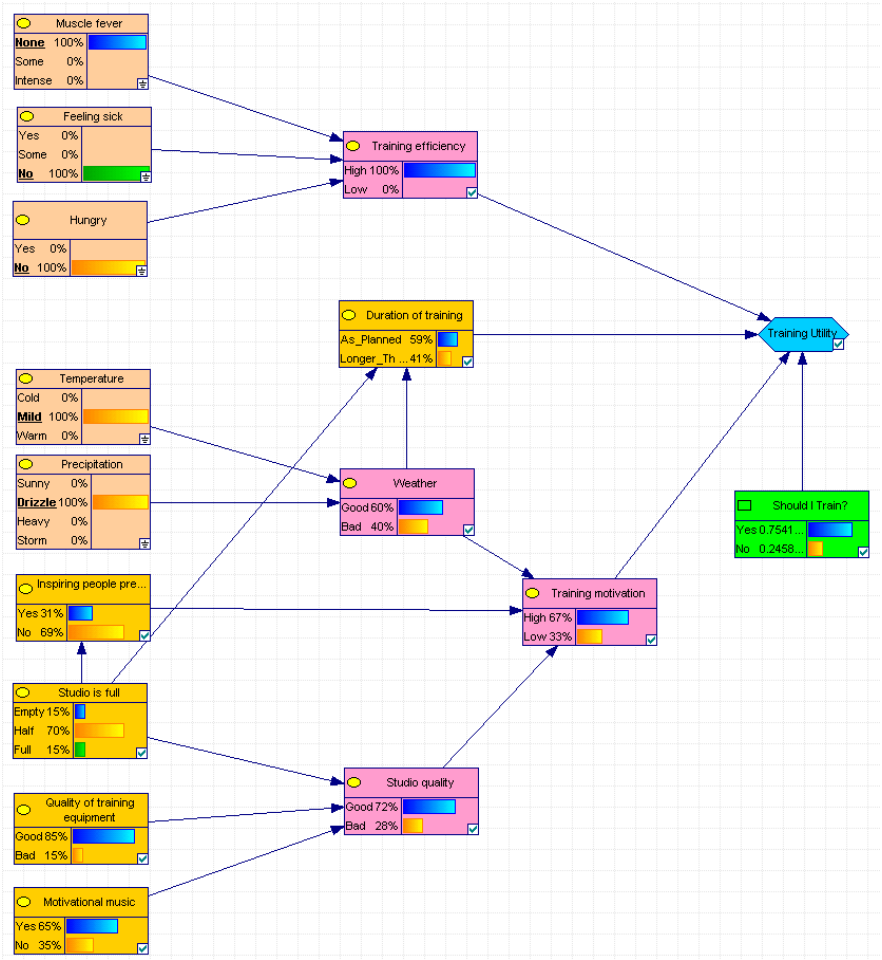

Figure 13: Preference structure for Lars

7 Conclusion

In many ways we are satisfied with the result. Trying to insert different observations into the DSS seems to provide reasonable results. We are of course aware that the model structure is not optimal, and should have been modeled differently. Also some of the probabilities are subject to change. One of the main arguments for the way we modeled our DSS is the complexity of the probability tables. In the beginning, we tried a more reasonable structure. Quickly, it was clear that the workload of that structure and assigning probabilities became to complex. This is one of the key issues when designing a DSS. In order for us to be able to model the system with a fair amount of workload, we had to simplify our understanding of the world and how the variables affected the result. But all in all, we must say the system seems to provide results we are happy with.

References

[1] S. J. RUSSELL AND P. NORVIG, *Artificial Intelligence: A Modern Approach*, Pearson Education, 3 ed., 2009.