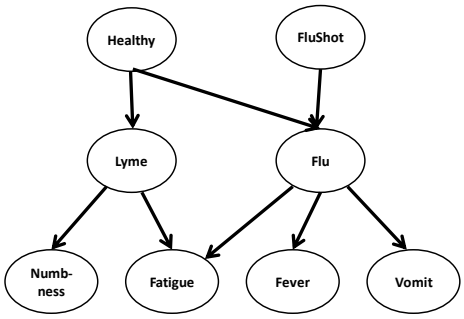

Figure 1: Bayes net defined in `diagnose.py`.

CSE 410 - AI: Homework 3

1) **(5) Free Points!** Install and run the probabilistic graphical model package `pgmpy`. Run the file `diagnose.py` and report the output. For answering the following questions feel free to use this file as a base (renaming it appropriately).

2) **(15) Graphical model questions.** The file `diagnose.py` defines the Bayes net described in Figure 1. Use the source file and figure to answer the following questions

1. What are the total number of entries in the joint probability distribution?
2. What is the probability of $P(fever|\neg flu)$
3. What is the value of $P(flu|\neg healthy, fluShot)$?
4. What is the Markov Blanket of random variable $Healthy$?
5. What is the Markov Blanket of random variable $Fatigue$?

3) **(20) Use the inference functions.** Use the variable elimination functions to perform exact inference and answer the following questions. Import the `VariableElimination` function from `pgmpy.inference`. Use this to create an inference object which you can use to query the model. For example:

```
>       infer=VariableElimination(disease_model)
>       print(infer.query(['Healthy'])['Healthy'])
```

Should print the probability table Φ of being healthy given no additional observations. You can add evidence to the query function by adding a dictionary with the assigned values. For example, the following statement would print the probability table of being healthy given that you have the Flu:

> `print(infer.query(['Healthy'],evidence='Flu':0 )['Healthy'])`

Note, that the '0' is the zero index and actually corresponds to the variable being true, see comments in `diagnose.py`

For the following questions please create a file `exactInference.py` that creates the variables q0–q6, where q0 is the result of the query of being healthy with on other evidence .i.e:

> `q0=infer.query(['Healthy'])['Healthy']`.

The data type should be `DiscreteFactor`. I will check the content of these, so please be consistent with the naming. Compute the probability of having:

1. the flu given that you are experiencing fatigue.
2. the flu given that you are experiencing fatigue and have NOT had a flu shot.
3. the flu given that you are experiencing fatigue and have had a flu shot.
4. the flu given that you are experiencing fatigue and a fever and have had a flu shot.
5. Lyme's given that you are experiencing fatigue and have NOT had a flu shot.
6. Lyme's disease given that you are experiencing fatigue and have had a flu shot.

3) **(20) Approximate inference.** Use the sampling functions built into `pgmpy` to peform approximate inference. Import the `BayesianModelSampling` module from `pgmpy.sampling` and use it to build a rejection sampled method for estimating the probability of having the flu given that you are experiencing fatigue and a fever and have had a flu shot. Generate a plot that has the number of samples on the x-axis and the evolving estimate on the y-axis. Plot the previously computed exact value as a dashed horizontal line. You can either do rejection sampling yourself, or use the built-in rejection sampling method and give the system the correct evidence. Write a function `rejection_estiamte(N)` that takes the number of (non-rejected) samples as an input and returns the estimate. Submit the file as `approximate.py`.

4) **(30) Construct a new Bayes net.** Construct the "awake"' Bayes net from class and call the model `awake_model` (15pts). Use it to preform exact inference and answer the following questions: What is the probability of

1. What is the probability of the person being awake with no evidence at all?
2. What is the probability of the person being awake after observing that there is no light from under the door?
3. What is the probability of the person being awake after hearing a blanket and seeing light under the door?
4. Given that the person is awake, what is the most likely time period?

Extra Credit) **(10)** Repeat Problem 3 using a Gibbs sampler. Compare the performace in terms of the number of samples that you were generated.

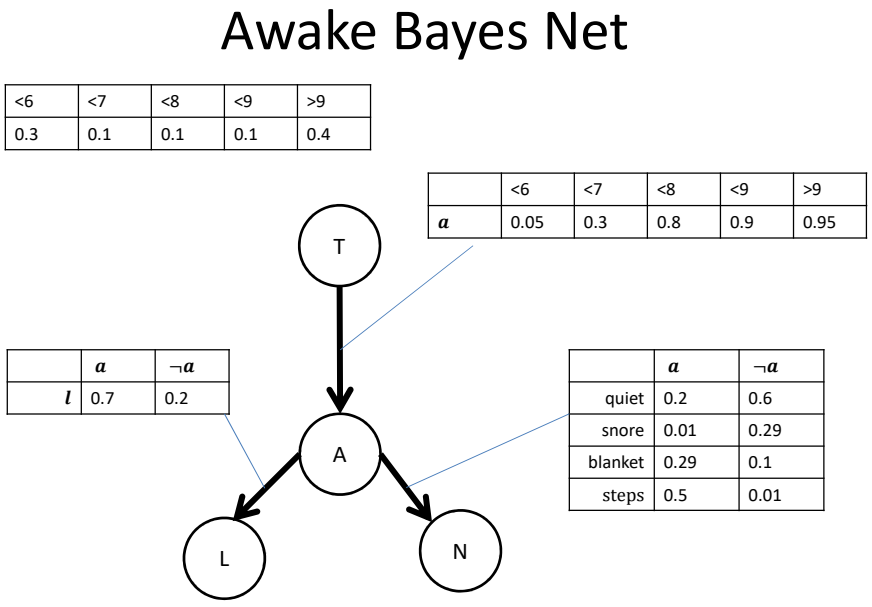

Figure 2: Bayes net from class for doing inference on the person being awake.