Tutorial 7:
Probabilistic reasoning

Question 1

The idea behind the first question is to understand the limitations of classical logic and its usefulness in reasoning about real-world situations. Different approaches to probabilistic reasoning try to address these limitations in a variety of ways.

Question 2

Estimated P(taxi_arrives)
 = 14 / 20
 = 0.7

Estimated P(taxi_arrives | green_bush_cabs)
 = 6 / 7
 ~= 0.86

Estimated P(cost=[$10-15] | blue_sky_limo)
 = 4 / 4
 = 1.0

Since a number of the Blue Sky Limo cabs did not arrive, we are actually estimating:
P(cost=[$10-15] | blue_sky_limo ^ delay!="Did not arrive")

Question 3

Note that here we are given (supposedly) true probabilities, so we do not have to estimate.

P(Exam|Headache) = P(Exam ^ Headache) / P(Headache)
 = (0.05+0.05) / (0.05+0.10+0.05+0.15)
 = 0.10/0.35
 ~= 0.29

P(Headache|Female) = P(Headache ^ Female) / P(Female)
 = 0.20/0.50
 = 0.40

Question 4

When dealing with problems like this (and question 5), the best way to start is by writing down all of the given facts in the appropriate notation, writing down what you're asked to find in the same notation and working from there.

Random variables: Male or Gender, DropOut.
Support of DropOut = {true, false}.

Abbreviate P(DropOut=true) as P(DropOut).
Similarly for Male.
(Could have instead used Gender, with support {male, female}).

8 out of 10 engineering students are male: P(Male) = 8/10 = 0.8
1 out of 10 engineering students drop out: P(DropOut) = 1/10 = 0.1
9 out of 10 engineering student dropouts are male: P(Male|DropOut) = 9/10 = 0.9

What is the probability of a male engineering student dropping out?

P(DropOut|Male) = P(Male|DropOut) P(DropOut) / P(Male) (Bayes' rule)
= 0.9 * 0.1 / 0.8
= 0.09 / 0.8
=~ 0.11

Question 5

Random variables: Cold, Stiff
Support of Cold = {true, false}. Same for Stiff.

A normal cold causes stiff neck 40% of the time: P(Stiff|Cold) = 0.40

5% of the population has a cold: P(Cold) = 0.05

10% of people who don't have a cold, still have a stiff neck: P(Stiff|-Cold) = 0.10

If you have a stiff neck what are the chances that you suffer from a normal cold?
Note: -Cold means "not a cold", so e.g. P(-Cold) = 1-P(Cold)
or more formally P(-Cold) = P(Cold != true).

P(Stiff) = P(Stiff,Cold) + P(Stiff,-Cold)
= P(Stiff|Cold)P(Cold) + P(Stiff|-Cold)P(-Cold)
= 0.40*0.05 + 0.10*0.95
= 0.02 + 0.095
= 0.115

P(Cold|Stiff) = P(Stiff|Cold)P(Cold)/P(Stiff)
= 0.40*0.05/0.115
=~ 0.17