1 Bishop Exercise 8.11

$$P(F=0 \mid D=0) = \frac{P(D=0 \mid F=0)\, P(F=0)}{P(D=0)}$$

$\downarrow$

$$p(D=0 \mid F=0) = \sum_{B,G} P(D=0 \mid G)\, p(G \mid B, F=0)\, p(B) = 0.748$$

$$p(D=0) = \sum_{B,G,F} p(D=0 \mid G)\, p(G \mid B, F)\, p(B)\, p(F) = 0.352$$

$$p(F=0) = 0.1$$

$$\boxed{P(F=0 \mid D=0) = \frac{(0.748)(0.1)}{(0.352)} = 0.213}$$

$$\boxed{p(F=0 \mid D=0, B=0) = 0.110}$$

2 **a**

$$
\begin{array}{c|c}
J & \\
\hline
T & .30 \\
F & .70 \\
\end{array}
$$

$$
\begin{array}{c|cc}
W & \multicolumn{2}{c}{J} \\
 & T & F \\
\hline
T & .4 & .3 \\
F & .2 & .7 \\
\end{array}
$$

$$
\begin{array}{c|cc}
R & \multicolumn{2}{c}{J} \\
 & T & F \\
\hline
T & .5 & .T \\
F & .5 & .6 \\
\end{array}
$$

$$
\begin{array}{c|cc}
B & \multicolumn{2}{c}{J} \\
 & T & F \\
\hline
T & .2 & .5 \\
F & .8 & .5 \\
\end{array}
$$

$$
\begin{array}{c|cc}
C & \multicolumn{2}{c}{J} \\
 & T & F \\
\hline
T & .7 & .3 \\
F & .3 & .7 \\
\end{array}
$$
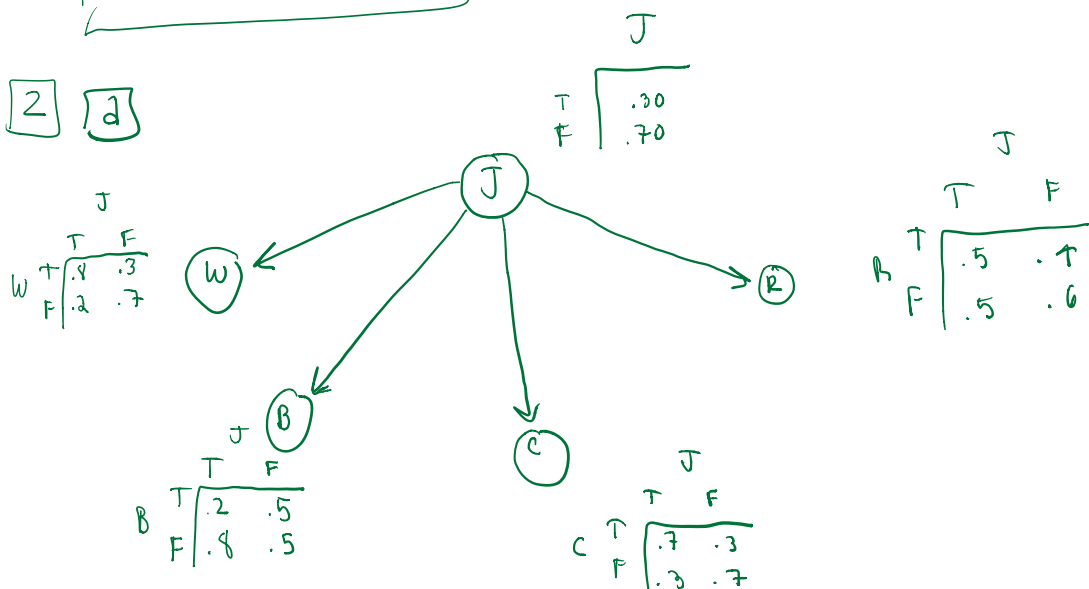
$$P(J=T \mid W=T, B=F, C=F, R=T) = \frac{P(W=T, B=F, C=F, R=T \mid J=T)\, P(J=T)}{\sum_{J=T\,or\,F} P(W=T, B=F, C=F, R=T)}$$

b

$$P(J=T \mid W=T, B=T, C=T, R=T) = \frac{p(J=T, W=T, B=T, C=T, R=T)}{\sum_{J=T\,or\,F} P(W=T, B=T, C=T, R=T)}$$

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Part 3:

After running my hmm_demo.m, the five sentences I picked and their probability of occurrence appeared as below:

s1 = "john saw the cat"
prob1 = 0.0067

s2 = "john ate"
prob2 = 0.1660

s3 = "john saw mary"
prob3 = 0.0191

s4 = "cat saw the john"
prob4 = 0.0040

s5 = "john ate the cat"
prob5 = 0.0059

First, it seems obvious that I've erred in my implementation of the naïve solution, as my probabilities do not seem to match with those of the professor. I spent a good while trying to debug the cause of the error, but alas I could not find it. I apologize for that. I'll pretend that my numbers are indeed correct for the sake of discussion.

Assuming my numbers are correct, then I'm happy to say that the probabilities at least make sense, though they seem quite larger than the professor's. For s1, s2, and s3, I expected these probabilities to have a higher chance of occurrence, reflected in a higher probability value. S1-s3 seem like normal enough sentences, and so I expected to see the probabilities here be larger than the probabilities for my last two sentences, s4 and s5.

For s4 and s5, I thought that perhaps these were less common sentences. Cat saw the john doesn't make much sense taken at face value, unless you take the words "the john" to be a synonym for a toilet, in which case the sentence would make a bit more sense. But, seeing as this is a more uncommon interpretation, I see the probability of occurrence for this sentence is the lowest out of my five sentences, which makes sense. As for s5, this sentence does indeed make sense, but to see it somewhere other than some fiction novel would seem to me very unlikely, as cats are not often seen as food unless either in story or in some dire consequences. Thus, I expected the probability of s5 to be lower than the others as well, which it was.