CMPSC 165B: Homework 4

Due on June 3, 2011

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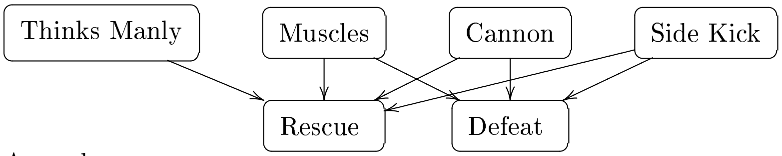
Contents

Problem 1 (Bayesian Belief Networks)



Arc values:

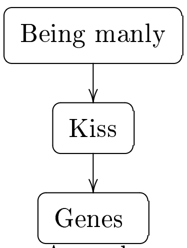
P(Muscles)	
wimpy	.33
average	.33
ripped	.34

P(Cannon)	
big	.33
gigantic	.33
obscene	.34

P(Side Kick)	
comic relief	.5
loyal martyr	.5

P(Thinks Manly)	
T	.5
F	.5

Note, whether or not Sally thinks you're manly is independent of being manly, thus, we don't need more than the above arcs for the above network.



Arc values:

P(Being Manly)	
T	.5
F	.5

Kiss	Being Manly	P(Kiss)
T	T	.5
T	F	.5
F	T	.5
F	F	.5

Genes	Kiss	P(Genes)
T	T	.5
T	F	.5
F	T	.5
F	F	.5

1. As these are independent: P(BeingManly=T) = .5
2. Again, these are independent: P(BeingManly=T) = .5
3. $.5 * .5_{\text{P(Being Manly=T)}} + .5 * .5_{\text{P(Being Manly=F)}} = .25 + .25 = .5$
4. $.5 * .5_{\text{P(Kiss=T)}} + .5 * .5_{\text{P(Kiss=F)}} = .25 + .25 = .5$
5. $.5 * .5_{\text{P(Kiss=T)}} + .5 * .5_{\text{P(Kiss=F)}} = .25 + .25 = .5$, as this is independent of rescuing Sally.

Problem 2 (Conditional Independence)

1. Yes, as they have no common ancestors and Z is not blocking
2. No, as W is a direct decedent of X and Z is not blocking
3. No, as Y remains a common ancestor
4. No, as Y remains a common ancestor
5. Yes given nothing else as they have no common ancestors
6. Yes given nothing else as there is not path from X to Z

Problem 3 (Learning Theory)

Assuming "better" infers more accurate classification in the average case, then no: a naive Bayesian classifier will, in general, perform as well as other classifiers over truly independent attributes.

Problem 4 (Regression)

1. It is a non-linear regression problem because w, which is the unknown to be solved, cannot be expressed as a linear function of $\mathbf{x}$.

2. We can use the log likelihood to find $\hat{w}$:

$$
\begin{aligned}
\ln \mathcal{L}(w|x_i) &= \ln\left(\prod_{i=1}^{n} f(x_i|w)\right) \\
&= \sum_{i=1}^{n} \ln\left(\frac{1}{\sqrt{2\pi}} \exp\left(-\frac{(y_i - e^{wx_i})^2}{2}\right)\right) \\
&= \sum_{i=1}^{n} \ln\left(\frac{1}{\sqrt{2\pi}}\right) - \frac{(y_i - e^{wx_i})^2}{2},\ \hat{\ell} = \frac{\ln \mathcal{L}}{n}
\end{aligned}
$$

$$
\begin{gathered}
\frac{\partial \ln \mathcal{L}}{\partial w} = 0 \Rightarrow \\
\frac{\sum_{i=1}^{n} \ln\left(\frac{1}{\sqrt{2\pi}}\right) - \frac{(y_i - e^{wx_i})^2}{2}}{\partial w} = 0 \Rightarrow \\
\frac{n \ln\left(\frac{1}{\sqrt{2\pi}}\right) - \sum_{i=1}^{n} \frac{y_i^2}{2} - y_i e^{wx_i} + \frac{(e^{wx_i})^2}{2}}{\partial w} = 0 \Rightarrow \\
-\sum_{i=1}^{n} -x_i y_i e^{wx_i} + x_i e^{2wx_i} = 0 \Rightarrow \\
\sum_{i=1}^{n} x_i e^{2wx_i} = \sum_{i=1}^{n} x_i y_i e^{wx_i}
\end{gathered}
$$

Thus, equation ii should be used.