Assignment 1
Machine Learning 10-701

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1 Probability Review [Ahmed]

1.1 Why just 2 variables? Let's go for 3

1.1.1

From the law of conditional probability,

$$\begin{aligned}\frac{\Pr(A, B \mid C)}{\Pr(B \mid C)} &= \frac{\Pr(A, B, C)}{\Pr(C)} \frac{\Pr(C)}{\Pr(B, C)} \\ &= \frac{\Pr(A, B, C)}{\Pr(B, C)} \\ &= \frac{\Pr(A, D)}{\Pr(D)} \\ &= \Pr(A \mid D) \\ &= \Pr(A \mid B, C)\end{aligned}$$ □

1.1.2

$$\begin{aligned}\sum_B \Pr(A, B \mid C) &= \sum_B \frac{\Pr(A, B, C)}{\Pr(C)} \\ &= \frac{\Pr(A, C)}{\Pr(C)} \\ &= \Pr(A \mid C)\end{aligned}$$ □

1.1.3

Using result from Problem 1.1.1 and Problem 1.1.2,

$$\begin{aligned}\sum_B \Pr(A \mid B, C) \Pr(B \mid C) &= \sum_B \Pr(A, B \mid C) \\ &= \Pr(A \mid C)\end{aligned}$$ □

1.2 Evaluating Test Results

1.2.1

The probability that a transation succeeds given that it was handled by $A2$ is

$$\begin{aligned}
\Pr(Success \mid A = 2) &= \frac{\Pr(Success, A = 2)}{\Pr(A = 2)} \\
&= \frac{|Success, A = 2|}{|A = 2|} \\
&= \frac{2150}{2150 + 500} \\
&= 0.811
\end{aligned}$$

1.2.2

If we recommend $A2$ then we need to see that

$$\begin{aligned}
\Pr(Success \mid A = 2) &\geq \Pr(Success \mid A = 1) \\
0.811 &\geq \frac{6000}{6000 + 1700} \\
0.811 &\geq 0.779
\end{aligned}$$

□

1.2.3

The statement about the probability of $A2$ handling a transaction successfully given $A1$ handled it successfully is given by,

$$\begin{aligned}
\Pr(A2_{success} = 1 \mid A1_{success} = 1) &= \frac{\Pr(A2_{success} = 1, A1_{success} = 1)}{\Pr(A1_{success} = 1)} \\
&\geq \frac{\Pr(A2_{success} = 1) + \Pr(A1_{success} = 1) - 1}{\Pr(A1_{success} = 1)} \\
&= \frac{\frac{2150}{2150+500} + \frac{6000}{6000+1700} - 1}{\frac{6000}{6000+1700}} \\
&= 0.757 \\
&\not\leq 0.70
\end{aligned}$$

□

1.3 Monty Hall Problem

Solving for $\Pr(car3 \mid open2, choose1)$ we get,

$$\begin{aligned}
\Pr(car3 \mid open2, choose1) &= \frac{\Pr(car3, open2 \mid choose1)}{\Pr(open2 \mid choose1)} \\
&= \frac{\Pr(open2 \mid choose1, car3)\Pr(car3 \mid choose1)}{\Pr(open2 \mid choose1)} \\
&= \frac{1 \times \frac{1}{3}}{\frac{1}{2}} \\
&= \frac{2}{3}
\end{aligned}$$

and solving for $\Pr(car1 \mid open2, choose1)$ we get,

$$\begin{aligned}
\Pr(car1 \mid open2, choose1) &= \frac{\Pr(car1, open2 \mid choose1)}{\Pr(open2 \mid choose1)} \\
&= \frac{\Pr(open2 \mid choose1, car1)\Pr(car1 \mid choose1)}{\Pr(open2 \mid choose1)} \\
&= \frac{\frac{1}{2} \times \frac{1}{3}}{\frac{1}{2}} \\
&= \frac{1}{3}
\end{aligned}$$

which gives us,

$$\begin{aligned}
\frac{\Pr(car3 \mid open2, choose1)}{\Pr(car1 \mid open2, choose1)} &= \frac{\frac{2}{3}}{\frac{1}{3}} \\
&= 2
\end{aligned}$$

□

2 Regression [Leila]

2.1 Linear Regression

2.2 Ridge Regression

3 Classification [Dougal]

3.1 Drawing decision boundaries

3.2 Defeating classifiers

4 Coding Competition [Carlton]