Techniques for Analyzing Stochastic Time-Series Data

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The Naive Bayes Classifier

- Reduce classification to probability. What is $P(class|attribute1, attribute2, ..., attributeN)$.
- Assumes that each attribute is independent of the others. (Hence the "Naive" nickname.)
- For example, let's consider if a car is stolen using $P(stolen|Color, Type)$. Naive Bayes will assume $color = red$ and $type = sportscar$ to be independent.
- Naive Bayes is not sensitive to irrelevant attributes, since the probabilities of such attributes will be similar for all classes.
- Naive Bayes is quick to train, as it requires only one pass-though of the training data.

Naive Bayes in Action

Training Data

Over 170cm	**Eye Color**	**Hair Length**	**Sex**
No	Blue	Short	Male
Yes	Brown	Long	Female
No	Blue	Long	Female
Yes	Brown	Short	Male
Yes	Brown	Short	Female

Only discrete values shown, but we can still interpret real data using normal distributions!

Suppose we are given an unseen data point $\langle No, Blue, Short \rangle$. What should we classify it as?

Naive Bayes in Action

$$
\begin{aligned}
&P(Male|No, Blue, Short) \\
&= \frac{P(No, Blue, Short|Male)P(Male)}{P(No, Blue, Short)} \\
&= \alpha P(Male)\boldsymbol{P(No|Male)P(Blue|Male)P(Short|Male)} \\
&= \alpha \times \tfrac{2}{5} \times \tfrac{1}{2} \times \tfrac{1}{2} \times \tfrac{2}{2} = \boxed{0.1\alpha}
\end{aligned}
$$

$$
\begin{aligned}
&P(Female|No, Blue, Short) \\
&= \alpha P(Female)P(No|Female)P(Blue|Female)P(Short|Female) \\
&= \alpha \times \tfrac{3}{5} \times \tfrac{1}{3} \times \tfrac{1}{3} \times \tfrac{1}{3} = \boxed{0.0\overline{2}\alpha}
\end{aligned}
$$

Since $P(Male|Data) > P(Female|Data)$, we classify the unseen point as Male. For multiple classes, just select the class with the greatest probability!

Support Vector Machines (SVM)

Neural Networks