

# CS 383: Machine Learning

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Fall 2024

09/26/2024

Lecture 10

# Outline

Probability

Naive Bayes

Confusion Matrix

# Probability & Bayes Derivation

Bayes Rule

Conditional Probability

Marginal Probability

# Outline

Probability

**Naive Bayes**

Confusion Matrix

# Components of a Bayes Model

Identify the evidence, prior, posterior, and likelihood in the equation below

$$p(y = k|\mathbf{x}) = \frac{p(y = k)p(\mathbf{x}|y = k)}{p(\mathbf{x})}$$

# Components of a Bayes Model

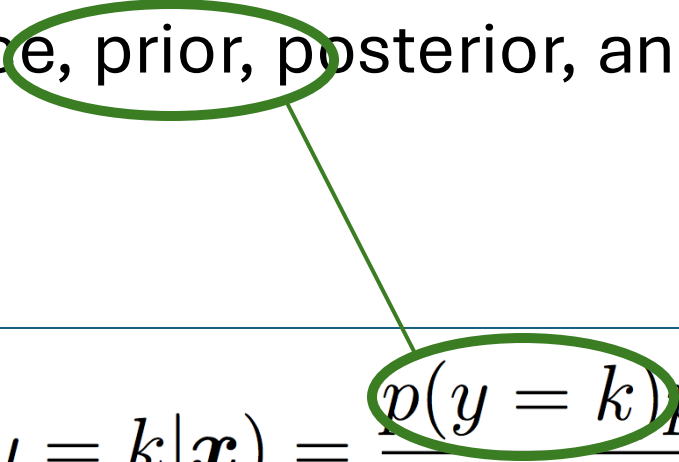
Identify the evidence, prior, posterior, and likelihood in the equation below

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**Evidence:** this is the data (features) we observe, which we think will help us predict the outcome we're interested in

# Components of a Bayes Model

Identify the evidence, prior, posterior, and likelihood in the equation below

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**Prior:** without seeing any evidence (data), what is our prior believe about each outcome (intuition: what is the outcome in the population as a whole?)

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Identify the evidence, prior, **posterior**, and likelihood in the equation below

$$p(y = k | \mathbf{x}) = \frac{p(y = k)p(\mathbf{x} | y = k)}{p(\mathbf{x})}$$

**Posterior**: this is the quantity we are actually interested in.  
\*Given\* the evidence, what is the probability of the outcome?



# Components of a Bayes Model

Identify the evidence, prior, posterior, and likelihood in the equation below

$$p(y = k|\mathbf{x}) = \frac{p(y = k)p(\mathbf{x}|y = k)}{p(\mathbf{x})}$$

**Likelihood:** given an outcome, what is the probability of observing this set of features?

# Naive Bayes Example

	Cat	Documents
Training	-	just plain boring
	-	entirely predictable and lacks energy
	-	no surprises and very few laughs
	+	very powerful
	+	the most fun film of the summer

Test: powerful very fun

$$p(+) = ?$$

$$p(-) = ?$$

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# Laplacian Smoothing

$$\hat{P}(w_i|c) = \frac{\text{count}(w_i, c) + 1}{\sum_{w \in V} (\text{count}(w, c) + 1)} = \frac{\text{count}(w_i, c) + 1}{(\sum_{w \in V} \text{count}(w, c)) + |V|}$$

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