# Probability Methods in Engineering

CSE-209

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Lecture 8

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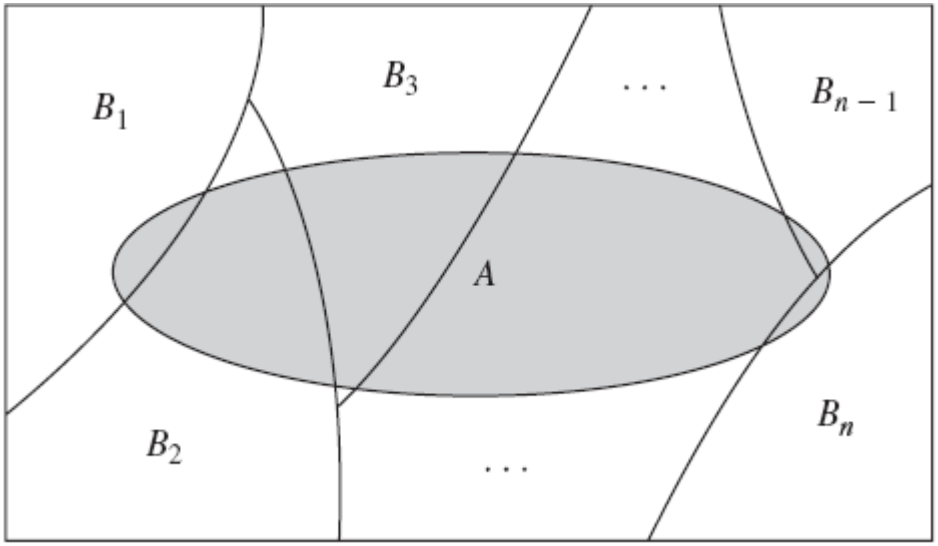
# Bayes' Rule

- Let $B_1, B_2, \ldots, B_n$ be mutually exclusive events
- If event $A$ occurs, what is probability of $B_j$?

$$P[B_j \mid A] = \frac{P[A \cap B_j]}{P[A]} = \frac{P[A \mid B_j]P[B_j]}{P[A]} = \frac{P[A \mid B_j]P[B_j]}{\sum_{k=1}^{n} P[A \mid B_k]P[B_k]}$$

- Simple case of Bayes' Rule is

$$P[B \mid A] = \frac{P[A \mid B]P[B]}{P[A]}$$




- Bayes' Rule
  - Method of calculating $P[B|A]$
  - Provided $P[A|B]$ available

# Examples (cont.)

- In a binary communication systems, a user inputs a 0 or a 1 into the system, and a corresponding signal is transmitted. Secondly, the receiver makes a decision about what was the input to the system, based on the signal it received. Suppose that the receiver makes random decision errors with probability $\varepsilon = 0.1$. Find which input is more probable given that the receiver output is 1. Assume that the input is equally likely to be 0 or 1.

# Examples (cont.)

- In a city, 55% of the adults are males. 10% of males use credit card, whereas 2% of females use credit card. One adult is randomly selected for a survey about usage of credit card. Find the probability that the randomly selected person is a male given that this selected person uses a credit card.

Source: *http://faculty.washington.edu/tamre/BayesTheorem.pdf*

# Examples (cont.)

- A manufacturing process produces a mix of "good" memory chips and "bad" memory chips. The lifetime of good chips follows the exponential law ($e^{-\alpha t}$ where rate is $\alpha$), with a rate of failure 0.00005 per hour. The lifetime of bad chips also follows the exponential law, but the rate of failure is 0.05 per hour. Suppose that the fraction of good chips is 0.9. To identify bad chips, every chip is tested for $t$ seconds prior to leaving the factory. The chips that fail are discarded and the remaining chips are sent out to customers. Find the value of $t$ for which 99% of the chips sent out to customers are good.