Probability Methods in Engineering

CSE-209

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Lecture 7

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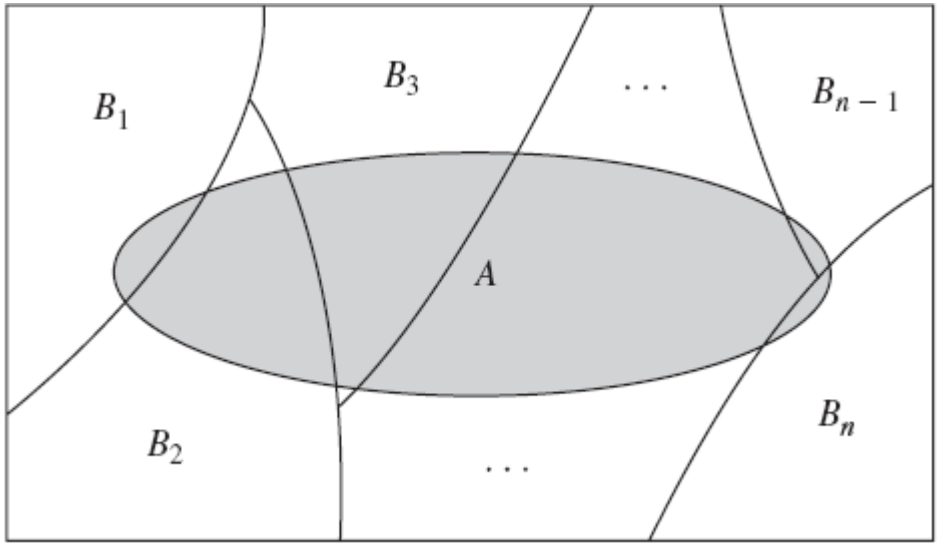
Theorem on Total Probability

- Let $B_1, B_2, \ldots, B_n$ be mutually exclusive events
- Union of all these events is S (partitions of S)
- Let A be union of events

$$A = A \cap S = A \cap (B_1 \cup B_2 \cup B_3 \cup \ldots \cup B_n)$$



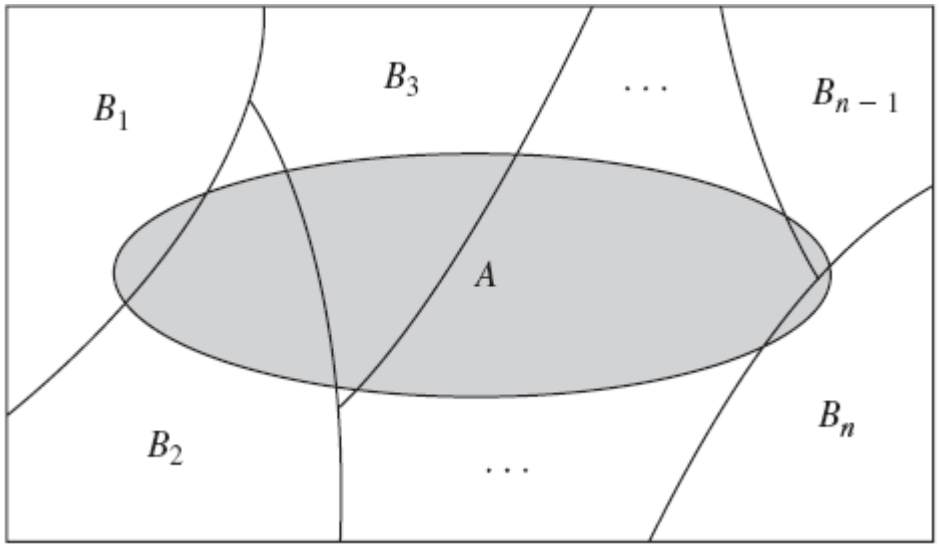
Theorem on Total Probability (cont.)

$$A = (A \cap B_1) \cup (A \cap B_2) \cup \ldots \cup (A \cap B_n)$$

$$P[A] = P[A \cap B_1] + P[A \cap B_2] + \ldots + P[A \cap B_n]$$

$$P[A] = P[A \mid B_1]P[B_1] + P[A \mid B_2]P[B_2] + \ldots + P[A \mid B_n]P[B_n]$$

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



Examples (cont.)

- An urn contains two black balls and three white balls. Two balls are selected at random from the urn without replacement and the sequence of colors is noted. Find the probability that the second ball is white (irrespective of first outcome).

Examples (cont.)

- Two new medicines A and B are introduced in the market. The results are tabulated as given below. Event A gives the number of people using A, B is the event of people using B, event H gives people with health improvement and event N with people without improvement.

	Used A	**Used B**
Improved health	800	600
No improvement	400	200

- What is the size of sample space?
- What is the probability of people getting healthy having used A (hint: $P[H|A]$)?
- What is the probability of people getting healthy irrespective of which medicine they used?

Source: *http://www.zweigmedia.com/ThirdEdSite/tutorialsf3/frames6_5.html*

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 ($e^{-\alpha t}$) with a rate of failure α. The lifetime of bad chips also follows the exponential law, but the rate of failure is 1000α. Suppose that the fraction of good chips is $1-p$ and of bad chips, p. Find the probability that a randomly selected chip is still functioning after t seconds.