

# Notes: Total Probability

CS 3130/ECE 3530: Probability and Statistics for Engineers

September 4, 2014

**Brain Teaser:** Monty Hall Problem (See section 1.3 in book)

Also, here: [http://en.wikipedia.org/wiki/Monty\\_Hall\\_problem](http://en.wikipedia.org/wiki/Monty_Hall_problem)

A set of events  $B_1, B_2, \dots, B_n$  is a **partition** of  $\Omega$  if they are pairwise disjoint, that is,  $B_i \cap B_j = \emptyset$  for any  $i, j$ , and if their union is equal to all of  $\Omega$ , that is,  $B_1 \cup B_2 \cup \dots \cup B_n = \Omega$ .

Given a partition  $B_1, B_2, \dots, B_n$  of  $\Omega$ , the **law of total probability** states

$$P(A) = P(A|B_1)P(B_1) + P(A|B_2)P(B_2) + \dots + P(A|B_n)P(B_n)$$

A common application of this rule is for any event  $B$ , where we will have  $B, B^c$  forming a partition of  $\Omega$ . Here the total probability is just two terms:

$$P(A) = P(A|B)P(B) + P(A|B^c)P(B^c)$$

In-Class Problem: You have two urns, one with 4 black balls and 3 white balls, the other with 2 black balls and 2 white balls. You pick one urn at random and then select a ball from the urn. What is the probability the ball is white?

In-Class Problem: You have a system with a main power supply and auxillary power supply. The main power supply has a 10% chance of failure. If the main power supply is running, the auxillary power supply also has a 10% chance of failure. But if the main supply fails, the auxillary supply is more likely to be overloaded and has a 15% chance to fail. What is the probability that the auxillary power will fail?

**Brain Teaser:** Birthday Paradox (See section 3.2 in book)

Also, here: [http://en.wikipedia.org/wiki/Birthday\\_problem](http://en.wikipedia.org/wiki/Birthday_problem)