Unit 2 Day 3

Probability

(4-3) Conditional Probability and Multiplication Rule

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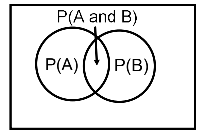
I. Conditional Probability

A **conditional probability** is the probability that an event will occur, when another event is known to occur or to have occurred.

The "probability of B given A" is written as P(B l A) and is found by:

$$P(B \mid A) = \frac{P(A \text{ and } B)}{P(A)}$$



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Example

A machine produces parts that are either good (90%), slightly defective (2%), or obviously defective (8%). Produced parts get passed through an automatic inspection machine, which is able to detect any part that is obviously defective and discard it. What is the quality of the parts that make it through the inspection machine and get shipped? (We want to compute the probability that a part is good **given** that it passed the inspection machine)

$$\frac{\text{good}}{\text{passed}} = \frac{0.90}{1-0.08} = \frac{0.90}{0.92} = 0.978$$

97.8% of the time

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Example

Using a standard deck of playing cards, determine the probability that...

a) The card is a king GIVEN that a face card is drawn.

$$\frac{(\text{K and fc})}{(\text{fc})} \quad \frac{4}{12} = \frac{1}{3}$$

b) The card is face card GIVEN that a red card is drawn.

$$\frac{(\text{fc and red})}{(\text{red})} \quad \frac{6}{26} = \frac{3}{13}$$

c) P (2| number card)=

$$\frac{(2 \text{ and nc})}{(\text{nc})} = \frac{4}{36} = \frac{1}{9}$$

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Example

	BA	MA	PhD	total
male	180	60	240	480
female	159	23	194	376
total	339	83	434	856

a) The person is female GIVEN that he/she has a BA. $\frac{\text{f + BA}}{\text{BA}} = \frac{159}{339}$

b) P(MA l male) = $\frac{\text{MA+M}}{\text{males}}$ $\frac{60}{480} = \frac{1}{8}$

c) P(BA or PhD l female) = $\frac{\text{BA or PhD}}{\text{female}}$ $\frac{159+194}{376}$

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II. Multiplication Rules

Multiplication rules can be used to find the probability of **two or more events** that occur in sequence.

Example

A coin is flipped and a die is rolled. Find the probability of getting tails on the coin and a 4 on the die.

1	2	3	4	5	6
H	H	H	H	H	H
1	2	3	4	5	6
T	T	T	T	T	T

$\frac{1}{12}$

$$\frac{1}{2} \cdot \frac{1}{6} = \frac{1}{12}$$

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Two events A and B are **independent events** if the fact that **A occurs does not affect the probability of B occurring.**

Multiplication Rule: P(A and B) = P(A)•P(B)

Example

Drawing a queen then an ace (replace after drawing)

queen ace

$$\frac{4}{52} \quad \frac{4}{52}$$

$$\frac{1}{13} \cdot \frac{1}{13} = \frac{1}{169}$$

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Example

A Harris poll found that 46% of Americans say they suffer great stress once a week. If three people are selected at random, find the probability that all three will say they suffer from great stress at least once a week.

1st 2nd 3rd

$$0.46 \cdot 0.46 \cdot 0.46$$

$$(.46)^3 = 0.097$$

$$\boxed{9.7\%}$$

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When the outcome of the **first event affects the outcome of the second event**, the events are **dependent events**

Multiplication Rule: P(A and B) = P(A)•P(B|A)

Example

Drawing a queen and then an ace (not replacing)

queen ace

$$\frac{4}{52} \cdot \frac{4}{51}$$

$$\frac{1}{13} \cdot \frac{4}{51} = \frac{4}{663}$$

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Example

Oliver has a bag of batteries (some work and some don't). There are 15 batteries in the bag and 5 of them don't work. What is the probability that Oliver is going to choose two that work, so he can play with his microphone?

1st 2nd

$$\frac{10}{15} \cdot \frac{9}{14}$$

$$\frac{\cancel{2}}{\cancel{3}} \cdot \frac{\cancel{9}^{3}}{\cancel{14}_{7}} = \frac{3}{7}$$

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Independent????

Take 4 cards from the deck

10 of hearts, 10 of clubs, 5 of hearts , and the jack of spades

Are the events A:picking a heart and B: picking a 10 independent of each other?

independent

$$P(A \text{ and } B) = P(A) \cdot P(B)$$

$$\text{heart and } 10 \stackrel{?}{=} \text{heart} \cdot 10$$

$$1/4 \stackrel{?}{=} 2/4 \cdot 2/4$$

$$1/4 = 1/2 \cdot 1/2$$

$$1/4 = 1/4 \; \checkmark$$

Independent

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