Section 4.1 - Basic Probability Concepts

A **probability experiment** (or random experiment) is a process involving chance in which observations are made and recorded.

In a probability experiment, the individual "things" that are observed are called the **outcomes**.

A **sample space** is a set of all possible outcomes of a probability experiment.

There is not necessarily only one sample space for a probability experiment, but there is usually only one best sample space.

An **event** is any subset of the sample space. In other words, an event is any collection of outcomes of the probability experiment.

An individual outcome is sometimes called a **simple event**.

In a probability experiment, the probability of an event is a number, between 0 and 1, that measures the likelihood of the event.

The probability of an event *A* is written *P(A)*. For any event A,

$$0 \leq P(A) \leq 1.$$

If the event *A* cannot occur, then *P(A)=0*. Sometimes these are called impossible events.

If the event *A* is certain to occur, then *P(A)=1*. These are called certain events.

There are several approaches to assigning the probability of an event...

1. An empirical (experimental) probability is assigned by counting observations:

$$P(A) = \frac{number\ of\ times\ A\ occurred}{number\ of\ trials}$$

2. A theoretical (classical) probability is assigned by assuming equally likely outcomes and counting numbers of outcomes:

$$P(A) = \frac{number\ of\ outcomes\ in\ A}{number\ of\ outcomes\ in\ the\ sample\ space}$$

The **Law of Large Numbers** says that an empirical probability will get closer and closer to the corresponding theoretical probability as the number of trials increases.

If theoretical probabilities are estimated by empirical probabilities, a large number of trials should be used.

3. A geometric probability is a classical probability assigned by measuring and comparing length, area, volume, etc.

4. A subjective probability is a probability estimate based on knowledge of relevant circumstances.

Even if all outcomes are not equally likely, a theoretical probability can often be founding by counting outcomes. We simply give the appropriate "weights" to each outcome, much in the spirit of a weighted mean.

Important fact: The sum of the probabilities of ALL **outcomes** must always equal 1. In other words,

The probability of the sample space is 1.

The **complement** of the event A, denoted by $\bar{A}$, is the set of all outcomes in the sample space that are NOT in A.

$$P(A) + P(\bar{A}) = 1$$

$$P(\bar{A}) = 1 - P(A)$$

$$P(A) = 1 - P(\bar{A})$$

The **odds in favor** of the event *A* are given by $\frac{P(A)}{P(\bar{A})}$.

The **odds against** *A* are given by $\frac{P(\bar{A})}{P(A)}$.

These odds can also be computed by counting outcomes.