# Probability and Statistics (MA6.101)

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## Probability

Probability is a measure of how likely an event or outcome is.

### Important Terms

A *random experiment* is a process by which we observe something uncertain.
An *outcome* is a result of a random experiment.
The *sample space* is the set of all possible outcomes.
An *event* is a subset of the sample space.

### Finite Probability Space

The characteristics of a finite probability space are: * The number of outcomes is finite. * Each outcome $i$ has probability $p_i/geq0$. * $\sum_i p_i = 1$.

In a finite probability space with equally likely outcomes, each outcome has probability $\frac{1}{N}$, where $N$ is the cardinality of the sample space.

### Axioms of Probability

We assign a *probability measure* $P(A)$ or $\Pr(A)$ to an event $A$, which is a value between 0 and 1. This value shows how likely the event is.

The axioms of probability are:

- For any event $A$, $P(A) \geq 0$.
- Probability of the sample space $S$ is $P(S) = 1$.
- If $A_1, A_2, ...$ are disjoint events, then $P(A_1 \cup A_2 \cup A_3 \cup ...) = P(A_1) + P(A_2) + P(A_3) + ....$

From these axioms, we can derive other results:

- $P(A^c) = 1 - P(A)$
- $P(\phi) = 0$

- For any event $A$, $P(A) \leq 1$
- $A \subseteq B \implies P(A) \leq P(B)$
- $P(A - B) = P(A) - P(A \cap B)$