Probability

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Estimating Probability

There are two ways to estimate probability:

- Experiment
- Theoretical

Experimental

$p = \frac{n_{\text{events}}}{n_{\text{trials}}}$
Requires data to be collected.

Theoretical

$p = \frac{n_{\text{ways}}}{n_{\text{outcomes}}}$
For example, the probability of getting a 6 on a dice is $\frac{1}{6}$

Modelling Probability

If A is impossible, $P(A) = 0$, if A is certain, $P(A) = 1$
$P(A') = 1 - P(A)$
If events A and B are $P(A \cap B) = P(A) \times P(B)$

Mutually exclusive

Two events are mutually exclusive events if they cannot both happen.
$P(A \cup B) = P(A) + P(B)$

If events are not mutually exclusive $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
We can test for independence as if two events are independent $P(A \cap B) = P(A) \times P(B)$

Discrete Random Variables

A model is a discrete random variable X if it is:

- Discrete
- The actual values of the outcome of the variable can only be predicted with a given probability.

Discrete Random Variables may have a finite or countably infinite number of outcomes.

Notation

The particular values our DRV can take are denoted by r, this $P(X = r)$ means the probability that the DRV X has the outcome r.
The sum of these probabilities equal 1. Formally, $\sum_{r=1}^{n} P(X = r) = p_1 + p_2 + \cdots + p_n = 1$

Expectation

The most useful measure of central tendency is usually the mean (or the expectation). We can apply a similar idea for DRV. We define the expectation as:
$E(x) = \sum rP(X = r)$
Note we often use the Greek symbol μ to represent $E(x)$ as well.
$\bar{x}$ is the mean when it is a sample. μ is the mean when it is a population.