**Probability and Applied Statistics Formula Sheet**

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**Central Tendency**

**Mean**

The mean of a sample of n data points:

µ =

The average or expected value of a set of values.

**Median**

The median is the middle value of an ordered set of values.

For an even-numbered sample set:

For an odd-numbered sample set:

**Mode**

The mode is the most represented value in a set of values.

If every value in a set is equally represented, the set has no mode.

**Variance**

The variance of a sample of n data points:

Variance represents how far a value may deviate from the expected.

**Standard Deviation**

The Standard Deviation for a set of data points:

The Standard Deviation represents the amount of variation of the expected.

**Axioms of Probability**

Three axioms exist to which all calculations of probability must abide.

1. The **total probability** of all events in a set must be equal to 100%.
2. The probability of an event must **not be less than zero**.
3. The probability of all **pairwise mutually exclusive** events in a set is the sum of their probabilities.

**Laws of Probability**

These laws govern the **union** and **intersection** of events.

**Multiplicative Law**

The probability of the intersection of two events “A” and “B” is:

***P(B|A) = P(B)P(A|B)***

If A and B are independent, the probability is simply the product of A and B.

**Additive Law**

The probability of the union of two events “A” and “B” is:

If “A” and “B” are mutually exclusive, the intersection of those events equals 0, and the probability is simply the sum of A and B.

**Dependence and Mutual Exclusion**

Events in a set can be independent, depend on other events occurring, or have mutual exclusivity with other events. Each of these examples influences the probability of an event.

**Dependence and Independence**

If an occurrence of some event “B” has no effect on the occurrence of another event “A”.

Two events “A” and “B” are said to be independent if any of the following holds:

***P(A|B) = P(A)***

The probability of A given B is equal to the probability of A.

***P(B|A) = P(B)***

The probability of B given A is equal to the probability of B.

The probability of the union of A and B is equal to the product of the two probabilities.

**Mutual Exclusivity**

An event is said to be “mutually exclusive” with another event if both events cannot be observed simultaneously.

A great example is the events “heads” and “tails” on a coin.

**Conditional Probability**

The ***Conditional Probability*** of an event “A” given another event “B” has occurred:

*P(A|B) =*

Similarly, the probability of “B” given “A” has occurred:

*P(B|A) =*

**Theorem of Total Probability**

The **Total Probability** of some event “A” can be calculated as:

**Bayes’ Theorem**

The probability of some event Bj given another event A has occurred:

***P(Bj | A) =***

This formula can be translated as “The Probability of Bj given A is equal to the probability of A given Bj occurred, times the probability of Bj, all over the **total probability** of A.”

**Discrete Random Variables**

For many, if not all, of the following distributions concerning random variables, the following conditions exist:

1. The distribution consists of independent, binary trials (the results can be only success or failure.
2. The probability of success stays the same from trial to trial.

**Binomial Distribution**

Binomial Distribution determines the probability that some event can succeed or fail when running some number of trials.

It has associated variables **n** and **y**.

n is the number of trials conducted.

y is the number of successes we wish to observe.

**Mass Function**

The probability mass function for Binomial Distribution tells us the probability of observing y successes in n trials.

**Expected**

**Variance**

**Geometric Distribution**

This distribution determines the probability of finding the first success on a specific trial.

It has associated variable **y**, which corresponds to the number of trials conducted.

**Mass Function**

The pmf for Geometric Distribution tells us the probability of observing the first success on the yth trial.

Shortcuts also exist for cases:

On or before the nth trial

Before the nth trial

On or after the nth trial

After the nth trial

**Expected**

**Variance**

**Hypergeometric Distribution**

This distribution determines the probability of observing a certain number of selections from a subset of a set of elements.

Used when dealing with selections without replacement.

It has four associated variables:

N = Total Number of elements in the set

R = The desired subset of elements

n = Total number of choices in the experiment

Y = the desired amount from the subset

**Mass Function**

**Expected**

**Variance**

**Negative Binomial Distribution**

This distribution determines the probability of observing the rth success of an experiment on the yth trial.

It has 2 associated variables:

**r = the number of successes**

**y = the trial on which we want the rth success to occur**

**Mass Function**

**Expected**

**Variance**