MAT 2377 Cheat Sheet

1 Chapter 1: Probabilities

The **sample space** is the set of all possible outcomes.

An **event** is a collection of outcomes in the sample space. Usually this is what we are looking to work with.

We can count items using the k stage procedure.

If we have k stages, each with n_1, n_2, n_3, ... possibilities, then the total number of possiblilites is just $n_1 \cdot n_2 \cdot n_3 \cdot ... \cdot n_k$.

1.1 Ordered Samples

If we have an ordered sample, then we see that picking $1, 2, 3$ is different than picking in a different order $1, 3, 2$.

If we draw r items from a bag of n items:

- If we replace each item after drawing, we have: $n \cdot n \cdot n \cdot ... = n^r$ possibilities
- If we do NOT replace the items, we have: $n \cdot (n-1) \cdot (n-2) \cdot ... \cdot (n-r) = \frac{n!}{(n-r)!} = {}_nP_r$

1.2 Unordered Samples

This is when the order of the samples does not matter, so $1, 2, 3$ would be the same as $1, 3, 2$.

We can see the number of unordered samples possible with r draws in a sample space of size n using:

$$\frac{n!}{(n-r)!r!} = {}_nC_r$$

1.3 Probabilities

The probability of an event A with N total outcomes and a favourable outcomes is just:

$$P(A) = \frac{a}{N}$$

We can add probabilities using the following formula:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$
$$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(A \cap C) - P(B \cap C) + P(A \cap B \cap C)$$

Any 2 events that satisfy the following expression are called **independant.**

$$P(A \cap B) = P(A) \cdot P(B)$$

1.4 Conditional Probability

We say that the probability of event B given that event A has already happened is:

$$P(B|A) = \frac{P(A \cap B)}{P(A)}$$

1.5 Law of Total Probability

This basically works off of the fact that all probabilities must add up to 1.

This is the specific case to 2 events A and B:

$$P(B) = P(B|A)P(A) + P(B|\overline{A})P(\overline{A})$$

This uses the fact that A and $\overline{A}$ are mutually exclusive, and exaustive (covers all of S).

So in general, if we have $A_1, A_2, ..., A_k$ and $A_1, A_2, ..., A_k$ are mutually exclusive and exaustive, then we say:

$$P(B) = P(B|A_1)P(A_1) + P(B|A_2)P(A_2) + ... + P(B|A_k)P(A_k)$$

1.6 Bayes Theorum

This is a way to get the opposite conditional probability to what we have.

If we have $P(A|B)$, among a couple other things, we can obtain $P(B|A)$ with:

$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}$$

2 Chapter 2: Discrete Random Variables

3 Chapter 3: Continuous Random Variables