

## **Chapter 1**

### **Sample Mean**

$$\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$$

### **Population Mean**

$$\mu = \frac{1}{N} \sum_{i=1}^N y_i$$

### **Sample Variance**

$$s^2 = \frac{1}{n-1} \sum_{i=1}^n (y_i - \bar{y})^2$$

### **Population Variance**

$$\sigma^2 = \frac{1}{N} \sum_{i=1}^N (y_i - \mu)^2$$

## Sample Standard Deviation

$$s = \sqrt{s^2}$$

## Population Standard Deviation

$$\sigma = \sqrt{\sigma^2}$$

## Empirical Rule

$\mu \pm \sigma$  contains approximately 68% of all the measurements

$\mu \pm 2\sigma$  contains approximately 95% of all the measurements

$\mu \pm 3\sigma$  contains almost all (99.7%) of all measurements

## Chapter 2

### Distributive Laws (Set Theory)

$$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$$

$$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$$

### DeMorgan's Laws

$$\overline{(A \cap B)} = \bar{A} \cup \bar{B}$$

$$\overline{(A \cup B)} = \bar{A} \cap \bar{B}$$

### Axioms for Probability of A

1.  $P(A) \geq 0$
2.  $P(S) = 1$
3. If  $A_1, A_2, A_3, \dots$  form a sequence of pairwise mutually exclusive events in S (that is,  $A_i \cap A_j = \emptyset$  if  $i \neq j$ ), then

$$P(A_1 \cup A_2 \cup A_3 \cup \dots) = \sum_{i=1}^{\infty} P(A_i)$$

### mn Rule

$$mn = m \times n$$

### Permutation Formula

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

### Combination Formula

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

### Multinomial Coefficient Formula

$$N = \binom{n}{n_1 \ n_2 \ \dots \ n_k} = \frac{n!}{n_1! \ n_2! \ \dots \ n_k!}$$

## Conditional Probability

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

As long as  $P(B) > 0$

## Independence Equations

Two events A and B are considered independent if any of the following statements hold:

$$P(A|B) = P(A)$$

$$P(B|A) = P(B)$$

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

## Multiplicative Law of Probability (Dependent)

$$\begin{aligned} P(A \cap B) &= P(A)P(B|A) \\ &= P(B)P(A|B) \end{aligned}$$

## Multiplicative Law of Probability (Independent)

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

## Additive Law of Probability

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

If A and B are mutually exclusive events, where  $P(A \cap B) = 0$

$$P(A \cup B) = P(A) + P(B)$$

## Probability of event A

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

## Partition of S

Let the sets  $B_1, B_2, \dots, B_k$  be such that

1.  $S = B_1 \cup B_2 \cup \dots \cup B_k$
2.  $B_i \cap B_j = \emptyset$ , for  $i \neq j$

Then the collection of sets is said to be a partition of S.

## The Law of Total Probability

$$P(A) = \sum_{i=1}^k P(A|B_i)P(B_i)$$

## Bayes' Rule

$$P(A|B_j) = \frac{P(A|B_j)P(B_j)}{\sum_{i=1}^k P(A|B_i)P(B_i)}$$

## Chapter 3

## Probability Distribution statements

1.  $0 \leq p(y) \leq 1$  for all of y
2.  $\sum_y p(y) = 1$ , where the summation is over all values of y with nonzero probability

### Expected value of Y

$$E(Y) = \sum_y yp(y)$$

### Expected value of g(Y)

$$E[g(Y)] = \sum_{all\ y} g(y)p(y)$$

### Variance of a Random Variable

$$V(Y) = E[(Y - \mu)^2]$$

$$V(Y) = \sigma^2 = E[(Y - \mu)^2] = E(Y^2) - \mu^2$$

### Standard Deviation of a Random Variable

$$\sigma = \sqrt{\sigma^2} = \sqrt{V(Y)}$$

## Theorems for Mean or Expected Value

$$E(c) = c$$

$$E[cg(Y)] = cE[g(Y)]$$

$$E[g_1(Y) + g_2(Y) + \dots + g_k(Y)] = E[g_1(Y)] + E[g_2(Y)] + \dots + E[g_k(Y)]$$

## Binomial Distribution

$$p(y) = P(Y = y) = \binom{n}{y} p^y q^{n-y}, y = 0, 1, 2, \dots, n \text{ and } 0 \leq p \leq 1$$

## Expected Value of a Binomial Distribution

$$\mu = E(Y) = np$$

## Variance of a Binomial Distribution

$$\sigma^2 = V(Y) = npq$$

## Standard Deviation of a Binomial Distribution

$$\sigma = \sqrt{\sigma^2} = \sqrt{V(Y)}$$

## Geometric Distribution

$$p(y) = P(Y = y) = q^{y-1}p, y = 1, 2, 3, \dots, 0 \leq p \leq 1$$

### **Expected Value of a Geometric Distribution**

$$\mu = E(Y) = \frac{1}{p}$$

### **Variance of a Geometric Distribution**

$$\sigma^2 = V(Y) = \frac{1-p}{p^2}$$

### **Standard Deviation of a Geometric Distribution**

$$\sigma = \sqrt{\sigma^2} = \sqrt{V(Y)}$$

### **Hypergeometric Probability Distribution**

$$p(y) = P(Y = y) = \frac{\binom{r}{y} \binom{N-r}{n-y}}{\binom{N}{n}}, y \leq r \text{ and } n - y \leq N - r$$

### **Expected Value of Hypergeometric Distribution**

$$\mu = E(Y) = \frac{nr}{N}$$

### **Variance of Hypergeometric Distribution**

$$\sigma^2 = V(Y) = n \left( \frac{r}{N} \right) \left( \frac{N-r}{N} \right) \left( \frac{N-n}{N-1} \right)$$



### Standard Deviation of Hypergeometric Distribution

$$\sigma = \sqrt{\sigma^2} = \sqrt{V(Y)}$$

### Negative Binomial Probability Distribution

$$p(y) = p(Y = y) = \binom{y-1}{r-1} p^r q^{y-r}, y = r, r+1, r+2, \dots, 0 \leq p \leq 1$$

### Expected Value of Negative Binomial Distribution

$$\mu = E(Y) = \frac{r}{p}$$

### Variance of Negative Binomial Distribution

$$\sigma^2 = V(Y) = \frac{r(1-p)}{p^2}$$

### Standard Deviation of Negative Binomial Distribution

$$\sigma = \sqrt{\sigma^2} = \sqrt{V(Y)}$$

### Poisson Probability Distribution

$$p(y) = \frac{\lambda^y}{y!} e^{-\lambda}, y = 0, 1, 2, \dots, \lambda > 0$$

## Mean and Variance of a Poisson Probability Distribution

$$\mu = E(Y) = \lambda \text{ and } \sigma^2 = V(Y) = \lambda$$

## Lambda of Poisson Probability Distribution

$$\sigma = \sqrt{\sigma^2} = \sqrt{V(Y)}$$