

Formula Sheet:

Definition 1.1: Mean

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

Definition 1.2: Variance

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

Definition 1.3: Standard Deviation

$$s = \sqrt{s^2} \text{ and } \sigma = \sqrt{\sigma^2}$$

Subset, Union, Intersection,

$$A \subset B, A \cup B, A \cap B$$

DeMorgan's Law

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

Definition 2.3: Sample Space

$$S = \{E_0, E_1, E_2, \dots\}$$

Definition 2.6:

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

$$P(S) = P(E_1 \cup E_2 \cup \dots \cup E_6) = P(E_1) + P(E_2) + \dots + P(E_6) = 1$$

$$P(A) = P(E_1 \cup E_3 \cup E_5) = P(E_1) + P(E_3) + P(E_5) = 1/2$$

Theorem 2.2: Permutation

$$P_r^n = n(n-1)(n-2) \dots (n-r+1) = \frac{n!}{(n-r)!}$$

Theorem 2.3

$$N = \frac{n!}{n_1!n_2!\dots n_k!} \equiv \binom{n}{n_1n_2\dots n_k}$$

Theorem 2.4: Combination

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

Definition 2.9: Conditional Probability

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

Definition 2.10: Independent Events

$$P(A|B) = P(A), \quad P(B|A) = P(B), \quad \text{or} \quad P(A \cap B) = P(A)P(B)$$

Theorem 2.5: Multiplicative Law of Probability

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

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

IF A and B are independent, then  $P(A \cap B) = P(A)P(B)$

Theorem 2.6: The Additive Law of Probability

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

IF A and B are mutually exclusive:

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

Theorem 2.7

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

Theorem 2.8

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

Theorem 2.9: Baye's Theorem

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

Definition 3.2

$$P(Y = y)$$

Definition 3.3

$$p(y) = P(Y = y) \text{ for all } y$$

Theorem 3.1

$$0 \leq p(y) \leq 1 \text{ for all } y$$

$$\sum_y p(y) = 1$$

\*\*For definition 3.4, Theorem 3.2, and Binomial Probability Definition, the equation calculator would not accept a blank on top of the  $\Sigma$  symbol, so I put 0s there instead. \*\*

Definition 3.4

$$E(Y) = \sum_y^0 yp(y)$$

Theorem 3.2

$$E[g(Y)] = \sum_{all\ y}^0 g(y)p(y)$$

Definition 3.5

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

Theorem 3.4

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

Theorem 3.5

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

Theorem 3.6

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

Definition 3.7

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

Binomial Probability Definition

$$\sum_y^0 p(y) = \sum_{y=0}^n \binom{n}{y} p^y q^{n-y} = (q + p)^n = 1^n = 1$$

Theorem 3.7

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

Definition 3.8

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

### Geometric Probability Definition

$$p(Y) = P(Y = y) = q^{y-1} \cdot p$$

### Theorem 3.8

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

### Extra Formulas

A success occurs on or before the nth trial:

$$P(X \leq n) = 1 - (1 - p)^n$$

A success occurs before the nth trial:

$$P(X < n) = 1 - (1 - p)^{n-1}$$

A success occurs on or after the nth trial:

$$P(X \geq n) = (1 - p)^{n-1}$$

A success occurs after the nth trial:

$$P(X > n) = (1 - p)^n$$

### Definition 3.9

$$p(y) = \vdash_{r-1}^{y-1} p^r q^{y-r}, \quad y = r, r+1, r+2$$

### Theorem 3.9

$$\mu = E(y) = \frac{r}{p} \text{ and } \sigma^2 = V(Y) = \frac{r(1-p)}{p^2}$$

### Definition 3.10

$$p(y) = \overline{\{\vdash_y^r\} \vdash_{n-y}^{N-r}} \{\vdash_n^N\}$$

Word didn't like this one, see definition 3.9 for same issue.

$$p(y) = \frac{\binom{r}{y} \binom{N-r}{n-y}}{\binom{N}{n}}$$

Theorem 3.10

$$\mu = E(Y) = \frac{nr}{N} \text{ and } \sigma^2 = V(Y) = n \frac{r}{N} \frac{N-r}{N} \frac{N-n}{N-1}$$

Similar issue here,

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