Formulas after Midterm

Uniform Probability Distribution

$$f(y) = \begin{cases} \dfrac{1}{\theta_2 - \theta_1}, & \theta_2 \le y \le \theta_1 \\ 0, & \text{elsewhere} \end{cases}$$

$$E(Y) = \frac{\theta_1 + \theta_2}{2}$$

$$V(Y) = \frac{(\theta_2 - \theta_1)^2}{12}$$

Bivariate and Multivariate Probability Distributions

$$F(y_1, y_2) = \int_{-\infty}^{y_1} \int_{-\infty}^{y_2} f(t_1, t_2)\, dt_2\, dt_1$$

$$F(x, y) = P(x \le X, y \le Y)$$

Marginal and Conditional Probability Distributions

$$p_1(x) = \sum_{\text{all } y} p(x, y) \qquad p_2(y) = \sum_{\text{all } x} p(x, y)$$

Marginal probability function

$$f_1(x) = \int_{-\infty}^{\infty} f(x, y)dy \qquad f_2(y) = \int_{-\infty}^{\infty} f(x, y)dx$$

Marginal density function

$$p(x \mid y) = \frac{p(x, y)}{p_2(y)}$$

$$F(x \mid y) = P(X \le x \mid Y = y)$$

$$f(x \mid y) = \frac{f(x, y)}{f_2(y)} \qquad f(y \mid x) = \frac{f(x, y)}{f_1(x)}$$

Independent Random Variables

$$F(x, y) = F_1(x)F_2(y)$$

$$p(x,y) = p_1(x)p_2(y)$$

$$f(x,y) = f_1(x)f_2(y)$$

$$f(x,y) = g(x)h(y)$$

If x and y are independent

<u>Formulas before Midterm</u>

Mean of a Sample

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

Variance

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

Standard Deviation

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

Permutation

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

Combination

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

Conditional Probability

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

Conditional Probability (if A and B are independent)

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

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

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

Multiplicative Law of Probability (if A and B are dependent)

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

Multiplicative Law of Probability (if A and B are independent)

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

Additive Law of Probability

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

Additive Law of Probability (if A and B are mutually exclusive and $P(A \cap B) = 0$)

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

Bayes' Rule

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

Expected Value

$$E(Y) = \mu$$

$$E(Y) = \sum_{y} y\, p(y)$$

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

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

$$SD(Y) = \sqrt{V(Y)}$$

Binomial Distribution

$$p(y) = \binom{n}{y} p^y q^{n-y}$$

Geometric Distribution

$$p(y) = q^{y-1}\, p$$

Hypergeometric Distribution

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

Poisson Distribution

$$p(y) = \frac{\lambda^y}{y!}\, e^{-\lambda}$$

Tchebysheff's Theorem

$$P(|Y-\mu| < k\sigma) \geq 1 - \frac{1}{k^2}$$

$$P(|Y-\mu| \geq k\sigma) < \frac{1}{k^2}$$

Cumulative Distribution Function

$$F(y) = P(Y \leq y)$$

Probability Density Function

$$f(y) = \frac{dF(y)}{dy} = F'(y)$$

$$P(a \leq Y \leq b) = \int_a^b f(y)\, dy$$

Expected Value (continuous variable)

$$E(Y) = \int_{-\infty}^{\infty} y\, f(y)\, dy$$

$$E(g(y)) = \int_{-\infty}^{\infty} g(y)\, f(y)\, dy$$