

## Formula Sheet for Midterm 2

- **Sample Mean**

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n x_i$$

- **Sample Variance**

$$s_x^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{X})^2$$

- **Covariance and Correlation Coefficient**

$$Cov(X, Y) = s_{xy} = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{X})(y_i - \bar{Y})$$

$$Corr(X, Y) = \rho_{xy} = \frac{Cov(X, Y)}{s_x s_y}$$

- **Addition Formula**

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

- **Conditional Probability**

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

- **Multiplication Rule**

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

- **Bayes' Theorem**

$$P(A_k|B) = \frac{P(B|A_k)P(A_k)}{\sum_{i=1}^n P(B|A_i)P(A_i)},$$

where  $\{A_i\}_{i=1}^n$  is a partition of the sample space.

- **Permutations**

$$P_x^n = \frac{n!}{(n-x)!}$$

- **Combinations**

$$C_x^n = \binom{n}{x} = \frac{n!}{x!(n-x)!}$$

- **Expected Value**

$$\mu = E(X) = \sum_{x_i} (x_i)P(X = x_i)$$

- **Variance**

$$\sigma^2 = \sum_{x_i} (x_i - \mu)^2 P(X = x_i)$$

- **Binomial distribution:**

$$- P(X = x) = \binom{n}{x} p^x (1-p)^{n-x},$$

$$x = 0, 1, \dots, n$$

$$- \mu = np$$

$$- \sigma^2 = np(1-p)$$

- **Poisson distribution:**

$$- P(X = x) = \frac{\lambda^x e^{-\lambda}}{x!}, \quad x = 0, 1, 2, \dots$$

$$- \mu = \lambda$$

- **Uniform Distribution**

$$- f(x) = \begin{cases} \frac{1}{b-a} & a \leq x \leq b \\ 0 & \text{for all other } x \end{cases}$$

$$- \mu = \frac{a+b}{2}, \quad \sigma^2 = \frac{(b-a)^2}{12}$$

- **Normal distribution (notation)**

$$- X \sim N(\mu, \sigma^2) \text{ (notation)}$$

$$- Z = \frac{X-\mu}{\sigma} \sim N(0, 1)$$

- **Linear Combinations:**  $W = aX \mp bY$ ,

$$- \mu_W = a\mu_x \mp b\mu_y$$

$$- \sigma_W^2 = a^2\sigma_x^2 + b^2\sigma_y^2 \mp 2abCov(X, Y)$$