## Formulae Sheet

$\bar{x} = \frac{\Sigma_{i=1}^{n} x_i}{n}$ $s^2 = \frac{\Sigma_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$

$P(A^c) = 1 - P(A)$ $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

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

Linear combination of random variables $X$ and $Y$ and fixed numbers $a$ and $b$:

$E[aX + bY] = aE[X] + bE[Y]$
$Var(aX + bY) = a^2 Var(X) + b^2 Var(Y)$ if $X$ and $Y$ are independent.

### Discrete Random Variables

Let $X$ be a discrete random variable with a pmf of $f(x)$ then

$$E[X] = \sum_x x f(x)$$

$$Var(X) = E[(X - E[X])^2] = \sum_x (x - E[X])^2 f(x) = E[X^2] - (E[X])^2$$

| **pmf** | $E(X)$ | $Var(X)$ |
|---|---|---|
| $\pi^x(1-\pi)^{1-x}$ | $\pi$ | $\pi(1-\pi)$ |
| $\binom{n}{x}\pi^x(1-\pi)^{n-x}$ | $n\pi$ | $n\pi(1-\pi)$ |
| $(1-\pi)^x\pi$ | $\frac{1-\pi}{\pi}$ | $\frac{1-\pi}{\pi^2}$ |
| $\frac{\lambda^x}{x!}e^{-\lambda}$ | $\lambda$ | $\lambda$ |

### Continuous Random Variables

Let $X$ be a continuous random variable with a pdf of $f(x)$ then

$$E[X] = \int_{x \in \Omega_x} x f(x)\, dx$$

$$Var(X) = E[(X - E[X])^2] = \int_{x \in \Omega_x} (x - E[X])^2 f(x)\, dx = E[X^2] - (E[X])^2$$

| **pdf** | $E(X)$ | $Var(X)$ |
|---|---|---|
| $\lambda e^{-\lambda x}$ | $\frac{1}{\lambda}$ | $\frac{1}{\lambda^2}$ |
| $\frac{1}{b-a}$ | $\frac{b+a}{2}$ | $\frac{(b-a)^2}{12}$ |

| **point estimate** | **critical value** | **standard error** |
| --- | --- | --- |
| $p$ | $z^*$ | $\sqrt{\frac{p(1-p)}{n}}$ |
| $p_1 - p_2$ | $z^*$ | $\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$ |
| $\bar{x}$ | $t^*_{df}$ | $\sqrt{\frac{s^2}{n}}$ |
| $\bar{x}_1 - \bar{x}_2$ | $t^*_{df}$ | $\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ |

$p_{pooled} = \frac{p_1 n_1 + p_2 n_2}{n_1 + n_2}$

$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \epsilon_i$