Formula Sheet

1. Binomial (n, p):

$$\begin{aligned} f(x) &= \binom{n}{x} p^x (1-p)^{n-x} \quad x = 0, 1, ..., n; \quad 0 \le p \le 1 \\ E(X) &= np; \quad Var(X) = np(1-p) \end{aligned}$$

2. Multinomial $(n, p_1, p_2, ..., p_k)$

$$\begin{aligned} f(x_1, x_2, ..., x_k) &= \binom{n}{x_1, x_2, ..., x_k} p_1^{x_1} p_2^{x_2} ... p_k^{x_k} \\ \sum p_i = 1, & \qquad \sum x_i = n. \end{aligned}$$

3. Poisson(λ)

$$\begin{aligned} f(x; \lambda) &= \frac{\lambda^x e^{-\lambda}}{x!}, \quad x = 0, 1, 2, ...; \quad \lambda > 0. \\ E(X) &= \lambda, \quad Var(X) = \lambda. \end{aligned}$$

4. Negative Binomial (r, p)

$$\begin{aligned} f(x) &= \binom{x+r-1}{r-1} p^r (1-p)^x \qquad x = 0, 1, 2, ...; \quad 0 \le p \le 1 \\ E(X) &= r(1-p)/p, \quad Var(X) = r(1-p)/p^2. \end{aligned}$$

5. Exponential (θ)

$$\begin{aligned} f(x) &= \frac{1}{\theta} e^{-x/\theta}, \quad x > 0, \theta > 0 \\ E(X) &= \theta, \quad Var(X) = \theta^2. \end{aligned}$$

6. Normal(μ, σ^2)

$$\begin{aligned} f(x) &= \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2} \right] \qquad x \in \Re, \mu \in \Re, \sigma > 0 \\ E(X) &= \mu, \quad Var(X) = \sigma^2. \end{aligned}$$

7. Chi-square(ν)

$$\begin{aligned} f(x; \nu) &= c_\nu x^{\nu/2-1} \exp\left(-x/2\right), \quad x > 0, \nu = 1, 2, 3, ... \\ E(X) &= \nu, \quad Var(X) = 2\nu. \end{aligned}$$

8.

$$s^2_{pooled} = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

9. Straight Line Model:

$$\begin{aligned} \hat{\alpha} &= \bar{y} - \hat{\beta}\bar{x} \sim N\left(\alpha, \sigma^2 \left[\frac{1}{n} + \frac{\bar{x}^2}{S_{xx}} \right] \right) \\ \hat{\beta} &= \frac{S_{xy}}{S_{xx}} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2} \sim N\left(\beta, \frac{\sigma^2}{S_{xx}} \right) \\ s^2 &= \frac{\sum \hat{\varepsilon}_i^2}{n-2} \\ \hat{\varepsilon}_i &= y_i - \hat{\alpha} - \hat{\beta} x_i. \\ \hat{\mu}_0 &= \hat{\alpha} + \hat{\beta} x_0 \sim N\left(\alpha + \beta x_0, \sigma^2 \left[\frac{1}{n} + \frac{(x_0 - \bar{x})^2}{S_{xx}} \right] \right) \end{aligned}$$