Formulas

- Bayes' Theorem: If $B_1, \dots, B_k$ form a partition of the sample space S, and A is any event, then for any $i = 1, \dots, k$,

$$\mathbb{P}(B_i \mid A) = \frac{\mathbb{P}(A \mid B_i)\mathbb{P}(B_i)}{\sum_{j=1}^{k} \mathbb{P}(A \mid B_j)\mathbb{P}(B_j)}.$$

- The following are probability mass functions for distributions we discussed.

  1. Bernoulli with parameter p:

$$f(x) = \begin{cases} p & x = 1 \\ 1-p & x = 0 \\ 0 & \text{otherwise} \end{cases}$$

  2. Geometric with parameter p:

$$f(x) = \begin{cases} (1-p)^{x-1}p & x = 1, 2, \dots \\ 0 & \text{otherwise} \end{cases}$$

  3. Binomial with parameters n, p:

$$f(x) = \begin{cases} \binom{n}{x} p^x (1-p)^{n-x} & x = 0, 1, 2, \dots, n \\ 0 & \text{otherwise} \end{cases}$$

  4. Hypergeometric with parameters N_1, N_2, n:

$$f(x) = \begin{cases} \frac{\binom{N_1}{x}\binom{N_2}{n-x}}{\binom{N_1+N_2}{n}} & \text{for } \max\{0, n-N_2\} \le x \le \min\{N_1, n\} \\ 0 & \text{otherwise} \end{cases}.$$

  5. Negative binomial with parameters r, p:

$$f(x) = \binom{x-1}{r-1} p^r (1-p)^{x-r}, \ x = r, r+1, \dots$$

  6. Poisson with parameter λ:

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

  7. Trinomial with parameters n, p_A, p_B, p_C:

$$f(x, y) = \frac{n!}{x!y!(n-x-y)!} p_A^x p_B^y p_C^{n-x-y} \text{ for } x, y \ge 0 \text{ and } x + y \le n.$$

- The following are probability distribution functions for distributions we discussed.
    1. Uniform on $[a, b]$:
    $$f(x) = \begin{cases} \frac{1}{b-a} & \text{if } x \in [a, b] \\ 0 & \text{otherwise.} \end{cases}$$
    2. Exponential with parameter θ:
    $$f(x) = \begin{cases} \frac{1}{\theta} e^{-x/\theta} & \text{if } x \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$
    3. Gamma with parameters α, θ:
    $$f(x) = \begin{cases} \frac{1}{\Gamma(\alpha)\theta^\alpha} x^{\alpha-1} e^{-x/\theta} & \text{if } x \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$
    4. Chi-square with r degrees of freedom:
    $$f(x) = \begin{cases} \frac{1}{\Gamma(r/2)2^{r/2}} x^{r/2-1} e^{-x/2} & \text{if } x \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$
    5. Normal with parameters μ, σ^2:
    $$f(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right).$$
- Least squares regression line:
$$y = \mu_Y + \rho \frac{\sigma_Y}{\sigma_X}(x - \mu_X).$$