Probability Formulas

- $\Pr(E \cup F) = \Pr(E) + \Pr(F) - \Pr(E \cap F)$
- $\Pr(E|F) = \dfrac{\Pr(E \cap F)}{\Pr(F)}$
- $\Pr(E) = \sum_{i=1}^{n} \Pr(E|F_i)\Pr(F_i)$ whenever $F_1, \ldots, F_n$ is a partition of the sample space.
- $\Pr(F|E) = \dfrac{\Pr(E|F)\Pr(F)}{\Pr(E)}$
- $\sum_{k=0}^{n} r^k = \dfrac{1 - r^{n+1}}{1 - r}$ when $r \neq 1$
- $\sum_{k=0}^{\infty} r^k = \dfrac{1}{1 - r}$ when $-1 < r < 1$
- When f is the bivariate probability density or probability mass function for the pair of random variables (X, Y)

$$f_X(x) = \sum_y f(x, y) \text{ in the discrete case}$$

$$f_X(x) = \int_{-\infty}^{\infty} f(x, y)dy \text{ in the continuous case}$$

$$f_Y(y) = \sum_x f(x, y) \text{ in the discrete case}$$

$$f_Y(y) = \int_{-\infty}^{\infty} f(x, y)dx \text{ in the continuous case}$$

$$f_X(x|Y = y) = \frac{f(x, y)}{f_Y(y)}$$

$$f_Y(y|X = x) = \frac{f(x, y)}{f_X(x)}$$

$$f_X(x) = \sum_y f_X(x|Y = y)f_Y(y) \text{ in the discrete case}$$

$$f_X(x) = \int_{-\infty}^{\infty} f_X(x|Y = t)f_Y(t)dt \text{ in the continuous case}$$

$$f_Y(y) = \sum_x f_Y(y|X = x)f_X(x) \text{ in the discrete case}$$

$$f_Y(y) = \int_{-\infty}^{\infty} f_Y(y|X = t)f_X(t)dt \text{ in the continuous case}$$

$$f_Y(y|X = x) = \frac{f_X(x|Y = y)f_Y(y)}{f_X(x)}$$

- Bernoulli.

$$f(0) = q \text{ and } f(1) = p$$

where $0 \leq p \leq 1$ and $q = 1 - p$.

- Binomial.

$$f(k) = \binom{n}{k} p^k q^{n-k} \text{ for } k = 0, 1, \ldots, n$$

where n is a positive integer, $0 \leq p \leq 1$ and $q = 1 - p$.

- Poisson.

$$f(k) = \frac{e^{-\lambda}\lambda^k}{k!} \text{ for } k = 0, 1, \ldots$$

where λ is a positive real number.

- Geometric.

$$f(k) = pq^k \text{ for } k = 0, 1, \ldots$$

where $0 \leq p \leq 1$ and $q = 1 - p$.

- Negative binomial.

$$f(k) = \binom{r+k-1}{r-1} p^r q^k \text{ for } k = 0, 1, \ldots$$

where r is a positive integer, $0 \leq p \leq 1$ and $q = 1 - p$.

- Uniform.

$$f(x) = \frac{1}{b-a} \text{ for } a \leq x \leq b$$

where a and b are real numbers with $a < b$.

- Normal.

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right) \text{ for all real numbers}$$

where μ and σ are real numbers with $\sigma > 0$. When $\mu = 0$ and $\sigma = 1$, the cumulative distribution function is denoted by Φ.

- Exponential.

$$f(x) = \lambda e^{-\lambda x} \text{ for } x \geq 0$$

where λ is a positive real number.

- Gamma

$$f(x) = \frac{\lambda^r x^{r-1} e^{-\lambda x}}{\Gamma(r)} \text{ for } x \geq 0$$

where each of r and λ is a positive real number.