Cauchy: $X \sim C(m, d)$

$$f(x) = \frac{1}{\pi d \left(1 + \left(\frac{x-m}{d}\right)^2\right)}$$

Continuous Distributions

Beta
$0 < \alpha$
$0 < \beta$

$$f(x) = \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} x^{\alpha-1}(1-x)^{\beta-1}, \qquad 0 < x < 1$$

$$\mu = \frac{\alpha}{\alpha+\beta}, \qquad \sigma^2 = \frac{\alpha\beta}{(\alpha+\beta+1)(\alpha+\beta)^2}$$

Chi-square
$\chi^2(r)$
$r = 1, 2, \ldots$

$$f(x) = \frac{1}{\Gamma(r/2)2^{r/2}} x^{r/2-1} e^{-x/2}, \qquad 0 \le x < \infty$$

$$M(t) = \frac{1}{(1-2t)^{r/2}}, \qquad t < \frac{1}{2}$$

$$\mu = r, \qquad \sigma^2 = 2r$$

Exponential
$0 < \theta$

$$f(x) = \frac{1}{\theta} e^{-x/\theta}, \qquad 0 \le x < \infty$$

$$M(t) = \frac{1}{1-\theta t}, \qquad t < \frac{1}{\theta}$$

$$\mu = \theta, \qquad \sigma^2 = \theta^2$$

Gamma
$0 < \alpha$
$0 < \theta$

$$f(x) = \frac{1}{\Gamma(\alpha)\theta^\alpha} x^{\alpha-1} e^{-x/\theta}, \qquad 0 \le x < \infty$$

$$M(t) = \frac{1}{(1-\theta t)^\alpha}, \qquad t < \frac{1}{\theta}$$

$$\mu = \alpha\theta, \qquad \sigma^2 = \alpha\theta^2$$

Normal
$N(\mu, \sigma^2)$
$-\infty < \mu < \infty$
$0 < \sigma$

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}, \qquad -\infty < x < \infty$$

$$M(t) = e^{\mu t + \sigma^2 t^2/2}$$

$$E(X) = \mu, \qquad \mathrm{Var}(X) = \sigma^2$$

Uniform
$U(a, b)$
$-\infty < a < b < \infty$

$$f(x) = \frac{1}{b-a}, \qquad a \le x \le b$$

$$M(t) = \frac{e^{tb} - e^{ta}}{t(b-a)}, \qquad t \ne 0; \qquad M(0) = 1$$

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

$$\Gamma(\alpha) \equiv \int_0^\infty x^{\alpha-1} e^{-x}\, dx$$

$\therefore \Gamma(1) = 1 \qquad \Gamma(\tfrac{1}{2}) = \sqrt{\pi}$

$\Gamma(n) = (n-1)!$ if $n \in \mathbb{Z}^+$

Weibull:

$$f(x) = \frac{\beta}{\alpha}\left(\frac{x}{\alpha}\right)^{\beta-1} \cdot \exp\left[-\left(\frac{x}{\alpha}\right)^\beta\right]$$

$0 \le x < \infty$

$\mu = \alpha \cdot \Gamma(1 + 1/\beta)$

Multivariate Hypergeometric

$$f(x) = \frac{\binom{N_1}{x_1}\binom{N_2}{x_2}\cdots\binom{N_k}{x_k}}{\binom{N}{n}}$$

$N_1 + \cdots + N_k = N$

$x_1 + \cdots + x_k = n$

Discrete Distributions

Bernoulli
$0 < p < 1$

$f(x) = p^x(1-p)^{1-x}, \quad x = 0, 1$
$M(t) = 1 - p + pe^t$
$\mu = p, \quad \sigma^2 = p(1-p)$

Binomial
$b(n, p)$
$0 < p < 1$

$f(x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x}, \quad x = 0, 1, 2, \ldots, n$
$M(t) = (1 - p + pe^t)^n$
$\mu = np, \quad \sigma^2 = np(1-p)$

Geometric
$0 < p < 1$

$f(x) = (1-p)^{x-1} p, \quad x = 1, 2, 3, \ldots$
$M(t) = \frac{pe^t}{1-(1-p)e^t}, \quad t < -\ln(1-p)$
$\mu = \frac{1}{p}, \quad \sigma^2 = \frac{1-p}{p^2}$

$\therefore P(X > k) = q^k$

Hypergeometric
$N_1 > 0, \; N_2 > 0$
$N = N_1 + N_2$

$f(x) = \frac{\binom{N_1}{x}\binom{N_2}{n-x}}{\binom{N}{n}}, \quad x \le n, x \le N_1, n - x \le N_2$
$\mu = n\left(\frac{N_1}{N}\right), \quad \sigma^2 = n\left(\frac{N_1}{N}\right)\left(\frac{N_2}{N}\right)\left(\frac{N-n}{N-1}\right)$

Negative Binomial
$0 < p < 1$
$r = 1, 2, 3, \ldots$

$f(x) = \binom{x-1}{r-1} p^r (1-p)^{x-r}, \quad x = r, r+1, r+2, \ldots$
$M(t) = \frac{(pe^t)^r}{[1-(1-p)e^t]^r}, \quad t < -\ln(1-p)$
$\mu = r\left(\frac{1}{p}\right), \quad \sigma^2 = \frac{r(1-p)}{p^2}$

Poisson
$0 < \lambda$

$f(x) = \frac{\lambda^x e^{-\lambda}}{x!}, \quad x = 0, 1, 2, \ldots$
$M(t) = e^{\lambda(e^t - 1)}$
$\mu = \lambda, \quad \sigma^2 = \lambda$

Uniform
$m > 0$

$f(x) = \frac{1}{m}, \quad x = 1, 2, \ldots, m$
$\mu = \frac{m+1}{2}, \quad \sigma^2 = \frac{m^2 - 1}{12}$

Multinomial

$$f(x) = \frac{n!}{x_1!\, x_2! \cdots x_k!} p_1^{x_1} \cdots p_k^{x_k}$$

$x_1 + \cdots + x_k = n$

$p_1 + \cdots + p_k = 1$