The `R` names for the probability distributions are given in RED. That is, these names can be used after the letters `d`, `p`, `q` and `r` to find the density (PDF), distribution function (CDF), quantile function (inverse CDF), and random generation for a specified probability distribution.

Discrete Distributions

1. **Bernoulli Distribution**

$X \sim Bernoulli(\pi)$

$$P(X = x|\pi) = \pi^x(1-\pi)^{1-x},\ x = 0, 1$$
$$E[X] = \pi$$
$$Var[X] = \pi(1-\pi)$$
$$M_X(t) = \pi e^t + \varrho$$

2. **Binomial Distribution** (binom)

$X \sim Bin(n, \pi)$

$$P(X = x|n, \pi) = \binom{n}{x}\pi^x(1-\pi)^{n-x},\ x = 0, 1, 2, \ldots, n.$$
$$E[X] = n\pi$$
$$Var[X] = n\pi(1-\pi)$$
$$M_X(t) = (\pi e^t + \varrho)^n$$

3. **Poisson Distribution** (pois)

$X \sim Pois(\lambda)$

$$P(X = x|\lambda) = \frac{\lambda^x e^{-\lambda}}{x!}, \quad x = 0, 1, 2, \ldots$$
$$E[X] = \lambda$$
$$Var[X] = \lambda$$
$$M_X(t) = e^{\lambda(e^t - 1)}$$

4. **Geometric Distribution** (geom)

$X \sim Geo(\pi)$

$$P(X = x|\pi) = \pi\varrho^x,\ x = 0, 1, \ldots$$
$$E[X] = \frac{\varrho}{\pi}$$
$$Var[X] = \frac{\varrho}{\pi^2}$$
$$M_X(t) = \frac{\pi}{1 - \varrho e^t}$$

5. **Negative Binomial Distribution** (nbinom)

$X \sim NB(r, \pi)$

$$P(X = x|r, \pi) = \binom{x + r - 1}{r - 1}\pi^r\varrho^x,\ x = 0, 1, 2, \ldots$$
$$E[X] = r\frac{\varrho}{\pi}$$
$$Var[X] = r\frac{\varrho}{\pi^2}$$
$$M_X(t) = \pi^r(1 - \varrho e^t)^{-r}$$

6. **Hypergeometric Distribution** (hyper)

$X \sim Hyper(m, n, k)$

$$P(X = x|m, n, k) = \frac{\binom{m}{x}\binom{n}{k-x}}{\binom{N}{k}},$$

for $x = \max\{0, k-n\}, \ldots, \min\{m, k\}$, where $N = m + n$

$$E[X] = \frac{m \times k}{N}$$
$$Var[X] = \frac{m \times n \times k \times (N - k)}{N^2 \times (N - 1)}$$

Continuous Distributions

7. **Uniform Distribution** (unif)

$X \sim Unif(a, b)$

$$f(x|a, b) = \frac{1}{b-a}, \quad a \le x \le b$$
$$E[X] = \frac{b+a}{2}$$
$$Var[X] = \frac{(b-a)^2}{12}$$
$$M_X(t) = \begin{cases} \dfrac{e^{tb} - e^{ta}}{t(b-a)} & \text{if } t \neq 0 \\ 1 & \text{if } t = 0 \end{cases}$$

8. **Exponential Distribution** (exp)

$X \sim Exp(\lambda)$

$$f(x|\lambda) = \begin{cases} \lambda e^{-\lambda x} & \text{if } x \ge 0 \\ 0 & \text{if } x < 0 \end{cases}$$
$$E[X] = \frac{1}{\lambda}$$
$$Var[X] = \frac{1}{\lambda^2}$$
$$M_X(t) = (1 - \lambda^{-1}t)^{-1} \text{ for } t < \lambda$$

9. **Gamma Distribution** (gamma)

$X \sim \Gamma(\alpha, \lambda)$

$$f(x|\alpha, \lambda) = \begin{cases} \frac{\lambda^\alpha}{\Gamma(\alpha)}x^{\alpha-1}e^{-\lambda x} & \text{if } x \ge 0 \\ 0 & \text{if } x < 0 \end{cases}$$
$$E[X] = \frac{\alpha}{\lambda}$$
$$Var[X] = \frac{\alpha}{\lambda^2}$$
$$M_X(t) = (1 - \lambda^{-1}t)^{-\alpha} \text{ for } t < \lambda$$

10. **Normal Distribution** (norm)

$X \sim N(\mu, \sigma)$

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

where $-\infty < \mu < \infty$ and $0 < \sigma < \infty$.

$$E[X] = \mu$$
$$Var[X] = \sigma^2$$
$$M_X(t) = e^{\mu t + \frac{\sigma^2 t^2}{2}}$$

Distributions Associated with the Normal Distribuiton

11. **Chi-Square Distribution** (chisq)

$X \sim \chi^2_n$

$$f(x) = \begin{cases} \frac{1}{\Gamma\left(\frac{n}{2}\right) 2^{\frac{n}{2}}} \cdot x^{\frac{n}{2}-1} e^{-\frac{x}{2}} & \text{if } x \geq 0 \\ 0 & \text{if } x < 0 \end{cases}$$

$$E[X] = n$$

$$Var[X] = 2n$$

$$M_X(t) = (1-2t)^{-\frac{n}{2}} \text{ for } t < \frac{1}{2}$$

12. **t-Distribution** (t)

$X \sim t_\nu$

$$f(x) = \frac{\Gamma\left(\frac{\nu+1}{2}\right)}{\sqrt{\pi\nu}\,\Gamma\left(\frac{\nu}{2}\right)} \left(1 + \frac{x^2}{\nu}\right)^{-\frac{\nu+1}{2}} \quad \text{for } -\infty < x < \infty$$

$$E[X] = 0$$

$$Var[X] = \frac{\nu}{\nu - 2} \text{ for } \nu > 2$$

13. **F-Distribution** (f)

$X \sim F_{\nu_1,\nu_2}$

$$f(x) = \frac{\Gamma\left(\frac{\nu_1+\nu_2}{2}\right)}{\Gamma\left(\frac{\nu_1}{2}\right)\Gamma\left(\frac{\nu_2}{2}\right)} \left(\frac{\nu_1}{\nu_2}\right)^{\frac{\nu_1}{2}} x^{\frac{\nu_1}{2}-1} \left(1 + \frac{\nu_1}{\nu_2}x\right)^{-\frac{1}{2}(\nu_1+\nu_2)}, \quad x > 0$$

$$E[X] = \frac{\nu_2}{\nu_2 - 2}$$

$$Var[X] = \frac{2\nu_2^2(\nu_1 + \nu_2 - 2)}{\nu_1(\nu_2-2)^2(\nu_2-4)} \text{ provided } \nu_2 > 4$$