WORKING WITH PROBABILITY DISTRIBUTIONS IN R

There are **four functions** in R that corresponds to each distribution in R. The root of the function name indicates **the distribution type**. The first **letter-prefix** is interpreted as follows (for a random variable ξ):

- **p** denotes the distribution function (cmf - cumulative mass function), i.e. $\mathrm{F}_\xi(x) = \mathrm{P}\{\xi \le x\}$;
- **q** denotes the quantile function, that is, the inverse to the distribution function, i.e. for given $p \in [0,1]$ it returns x s.t $\mathrm{P}\{\xi \le x\} = p$;
- **d** denotes the pdf (probability distribution function) for **continuous random variables** i.e. a function $\mathrm{p}_\xi(x)$ s.t. $\mathrm{F}_\xi(x) = \int_{-\infty}^{x} \mathrm{p}_\xi(y)dy$
  or pmf (probability mass function) for **discrete random variables**
  i.e a function $\mathrm{p}_\xi(x) = \mathrm{P}\{\xi = x\}$;
- **r** generating pseudo-random numbers with a given distribution.

Examples:
Let random variable ξ have normal distribution with parameters $\mathrm{mean} = 1$, $\mathrm{sd} = 2$. Then the command

1. $\mathrm{pnorm}(3, \mathrm{mean} = 1, \mathrm{sd} = 2)$ calculates $\mathbf{P}\{\xi \le 3\}$;
2. $\mathrm{pnorm}(3, \mathrm{mean} = 1, \mathrm{sd} = 2, \mathrm{lower.tail} = F)$ calculates $\mathbf{P}\{\xi > 3\} (= 1 - \mathbf{P}\{\xi \le 3\})$;
3. $\mathrm{qnorm}(1/3, \mathrm{mean} = 1, \mathrm{sd} = 2)$ calculates x s.t. $\mathbf{P}\{\xi \le x\} = 1/3$;
4. $\mathrm{qnorm}(1/3, \mathrm{mean} = 1, \mathrm{sd} = 2, \mathrm{lower.tail} = F)$ calculates x s.t. $\mathbf{P}\{\xi > x\} = 1/3$;
5. $\mathrm{dnorm}(3, \mathrm{mean} = 1, \mathrm{sd} = 2)$ calculates $\mathbf{p}_\xi(3)$, where $\mathbf{p}_\xi(x) = \frac{1}{\sqrt{8\pi}} \exp\left\{-\frac{(x-1)^2}{8}\right\}$ is pdf function of normal distribution with parameters $\mathrm{mean} = 1$, $\mathrm{sd} = 2$;
6. $\mathrm{rnorm}(1000, \mathrm{mean} = 1, \mathrm{sd} = 2)$ generates 1000 pseudo-random values that simulate a sample of independent normally distributed random variables with parameters $\mathrm{mean} = 1$, $\mathrm{sd} = 2$.

Parameters of functions:

- in functions with the prefixes **p**, **q**, and **d**, the first parameter is the vector of argument values for which the corresponding function must be calculated (distribution function,quantile, density). In functions with the prefix **r** (pseudo - random generators), the first argument is the sample size, i.e. the number of generated elements;
- the following parameters are parameters of the distribution. They are different for different distributions (see the tables below), but they are the same for all functions related to this distribution. For example, for a normal distribution, the mean and sd parameters specify the mean and standard deviation;
- all functions with the prefixes **p** and **q** have a logical parameter lower.tail. Its default value is lower.tail = T.If you set lower. tail=F, the **p**-function will calculate the survival function instead of the distribution function: $\mathbf{P}\{\xi > x\} (= 1 - \mathbf{P}\{\xi \le x\})$ and the **q**-function will calculate the upper quantile, i.e. x s.t. $\mathbf{P}\{\xi > x\} = p$;

- you can set the option log.p=T in the **p**-function if you need to calculate the logarithm of the distribution function.

Absolute continuous distributions	R symbol	Parameters	Domain of parameters
Beta	beta	shape1, shape2	shape1, shape2 > 0
Gamma	gamma	shape, rate	shape, rate > 0
Exponential	exp	rate	rate > 0
Cauchy	cauchy	location, scale	location $\in \mathbb{R}$, scale > 0
Logistic	logis	location, scale	location $\in \mathbb{R}$, scale > 0
Log-normal	lnorm	meanlog, sdlog	meanlog $\in \mathbb{R}$, sdlog > 0
Normal	norm	mean, sd	mean $\in \mathbb{R}$, sd > 0
Uniform	unif	min, max	min$<$max
Weibull	weibull	shape, scale	shape, scale> 0
χ^2 chi-squared	chisq	df	df $\in \mathbb{N}$
Fisher	f	df	df1, df2 > 0
Student's	t	df	df > 0

Discrete distributions	R symbol	Parameters	Domain of parameters
Binomial	binom	size, prob	size$\in \mathbb{N}$, prob $\in [-1, 1]$
Geometric	geom	prob	prob $\in [-1, 1]$
Hypergeometric	hyper	m, n, k	m,n > 0, k$\leq m + n$
Negative binomial	nbinom	size, prob	size$\in \mathbb{N}$, prob $\in [-1, 1]$
Poisson	pois	lambda	lambda > 0