Computing Quantiles, \( p \)-values and Random Numbers in R

**Computing \( p \)-values:** \( p \)-values are the conditional probability to observe data less compatible with the null hypothesis than the observed if the null hypothesis were true. As such, they are the area under the distribution curve of the test statistic in one tail or both tails of the distribution beginning at the observed test statistic value \( x \). Whether you’ll need the left tail or the right tail (or both) depends on the context of the problem.

In R, you can compute the area under a distribution curve with the command

\[
\text{pname}(x, \text{parameters}, \text{lower.tail} = \text{FALSE})
\]

Here, \( p \) stands for probability, \( \text{name} \) is the name of the distribution (see list below), \( x \) is the value of the test statistic and the parameters depend on the choice of distribution. The \text{lower.tail} argument determines which tail of the distribution you want to compute the area of.

**Finding Quantiles:** To find a quantile for a given distribution means to find the number \( x \), such that the area in the right (or left) tail of the distribution is equal to a given number \( p \). In R, this is done with the command

\[
\text{qname}(p, \text{parameters}, \text{lower.tail} = \text{FALSE})
\]

where again \( \text{name} \) is the name of the distribution and the parameters depend on the choice of distribution.

**Creating Random Numbers:** To create a vector of \( n \) random numbers from distribution \( \text{name} \), type \( \text{rname}(n, \text{parameters}) \), where \( \text{parameters} \) are the parameters of the distribution.

Distribution names in R:

- \text{norm} - Normal (parameters \( \mu \) and \( \sigma \))
- \text{exp} - Exponential (parameter \( \lambda \))
- \text{t} - Student’s \( t \) (parameter df)
- \text{f} - F-distribution (parameters \( df_1 = \nu_1 \), \( df_2 = \nu_2 \))
- \text{binom} - Binomial (parameters \( n \) and \( p \)).
- and many more... (see short reference card)

**Example:** \( \text{pnorm}(1.96,0,1) = 0.975 \), \( \text{qnorm}(0.05,0,1,\text{lower.tail} = \text{FALSE}) = 1.645 \)