Intro_RPS

About package

The goal of RPStest package is to provide the functionality for the Research Program Strategy (RPS) as explained in the article **"Hypothesis-testing demands trustworthy data-a simulation approach to inferential statistics advocating the research program strategy"** by *Krefeld-Schwalb, Witte & Zenker (2018).* For more details about the theory, please have a look at the main paper and related technical appendix document from here,

- **Main paper:** https://www.frontiersin.org/articles/10.3389/fpsyg.2018.00460/full
- **Appendix:** https://osf.io/gaetn/

About RPS Description

Every step of our simulation mimics 100 t-values for one-sided t-tests sampled from two normal distributions featuring the same variance but different means. One mean is set to zero (x0), the other mean corresponds to the effect size δ of the focal condition (x1), such that $x1 \sim Normal(\delta, 1)$ and $x0 \sim Normal(0, 1)$ The following equation is used o define the sample size, N_{min}, drawn from these distributions that is needed to achieve the power $(1 - \beta)$ given α-error, and the effect size δ.

$$N = (z(1-\alpha) + z(1-\beta))^2/(\delta/\sqrt(2))^2 \tag{1}$$

We next calculated the t-value based on the difference of the means, μ, of these distributions.

$$t = (\mu_{x1} - \mu_{x0})/\sqrt{2/n} \tag{2}$$

The consecutive steps of the research program strategy (RPS) is summarized below;

1. Preliminary Discovery:$p \leq \alpha, \alpha \leq .05$, unknown β
2. Substantial Discovery: $p \leq \alpha, \alpha \leq .05$, known β
3. Preliminary Falsification: $\dfrac{L(d>0|x)}{L(d=0|x)} > \dfrac{1-\beta}{\alpha}$
4. Substantial Falsification: $\dfrac{L(d>\delta|x)}{L(d=0|x)} > \dfrac{1-\beta}{\alpha}$
5. Preliminary Verification: $\dfrac{L(d=\delta|x)}{L(d=0|x)} > \dfrac{1-\beta}{\alpha}$
6. Substanstial Verification:$\dfrac{L(d=\delta|x)}{L(d=0|x)} > \dfrac{1-\beta}{\alpha} \cap \dfrac{L(d|x)}{L(d=\delta|x)} > \dfrac{pdf(P50|d)}{pdf(P95|d)} > 4$

In order to calculate these proportions we used the **density of the respective t-distributions** and calculated the one-sided p-values, p, as well as the the likelihood, L. The Wald-criterion, $\frac{1-\beta}{\alpha}$, was applied for interpreting the corresponding likelihood ratios in steps 3 to 5. As a criterion for substantial verification in step 6 we further used the ratio of the probability density function, pdf, at the 50'th and 95'th percentiles, $P50$ and $P95$, respectively.

Simple Usage

RPStest provides five easy to use functions and attached two more functions for visualization and the summarization of the outputs. As an example, **samplesH1** function requires four arguments;

- Nsample
- alpha
- effectSize
- pow

```
h1 <- RPS::samplesH1(Nsample = 100, alpha = 0.05, effectSize = 0.2, pow = 0.95)

# From the output of samplesH1 function we have;
# Estimated sample size is
h1$Nest
```

```
## [1] 541.1087
```

```
# Non-centrality-parameter of the t-distribution representing H1
h1$ncp
```

```
## [1] 3.289707
```

Simulation Example

```
## Number of simulated tests
Nsample = 100

## Level of significance
alpha = 0.05

### Different effect sizes
effectSize = 0.2

### Different Power
pow = 0.95
```

Here, in the simulation example, the goal is to stimate the minimum sample size N_{min} by using the effect size, δ, and test power, $(1-\beta)$, which together determine the induction quality of data, between the conditions, $d = [0.2]$ and $(1-\beta) = [0.95]$.

For the above parameters, the estimated sample size is obtained as;

```
samph1 <- RPS::samplesH1(Nsample = 100, alpha=alpha, effectSize = effectSize, pow = pow)
round(samph1$Nest, 0)
```

```
## [1] 541
```

Visualization

For the visualizations of the outputs, separate functions are given in **ModelVis.R** file and the wrap-up function (**plot_RPS.R**) is ready to use by selection of the figures when all the necessary inputs are provided. Distinctly, the **ggplot2 syntax** was used for all figures in the package so the obtained graphs are different from the ones you observed in the Shinny app!

The main tool is **plot_RPS.R**, as a wrap-up function to make a general visualization of the outputs by making selection. To illustrate,

```
sampH0 <- RPS::samplesH0(Nsample = 100, alpha = 0.05, effectSize = 0.2,
                         pow = 0.95)

sampH1 <- RPS::samplesH1(Nsample = 100, alpha = 0.05, effectSize = 0.2,
                         pow = 0.95)

sampEmp <- RPS::samplesEmp(Nsample = 100, N = 30, Temp = 3, alphaEmp = 0.05)

# About plotting, you can consider different selections by select argumen
RPS::plot_RPS(sampH0 = sampH0, sampH1 = sampH1, sampEmp = sampleEmp, select = 1)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
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## Warning: Removed 1 rows containing missing values (geom_bar).

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```

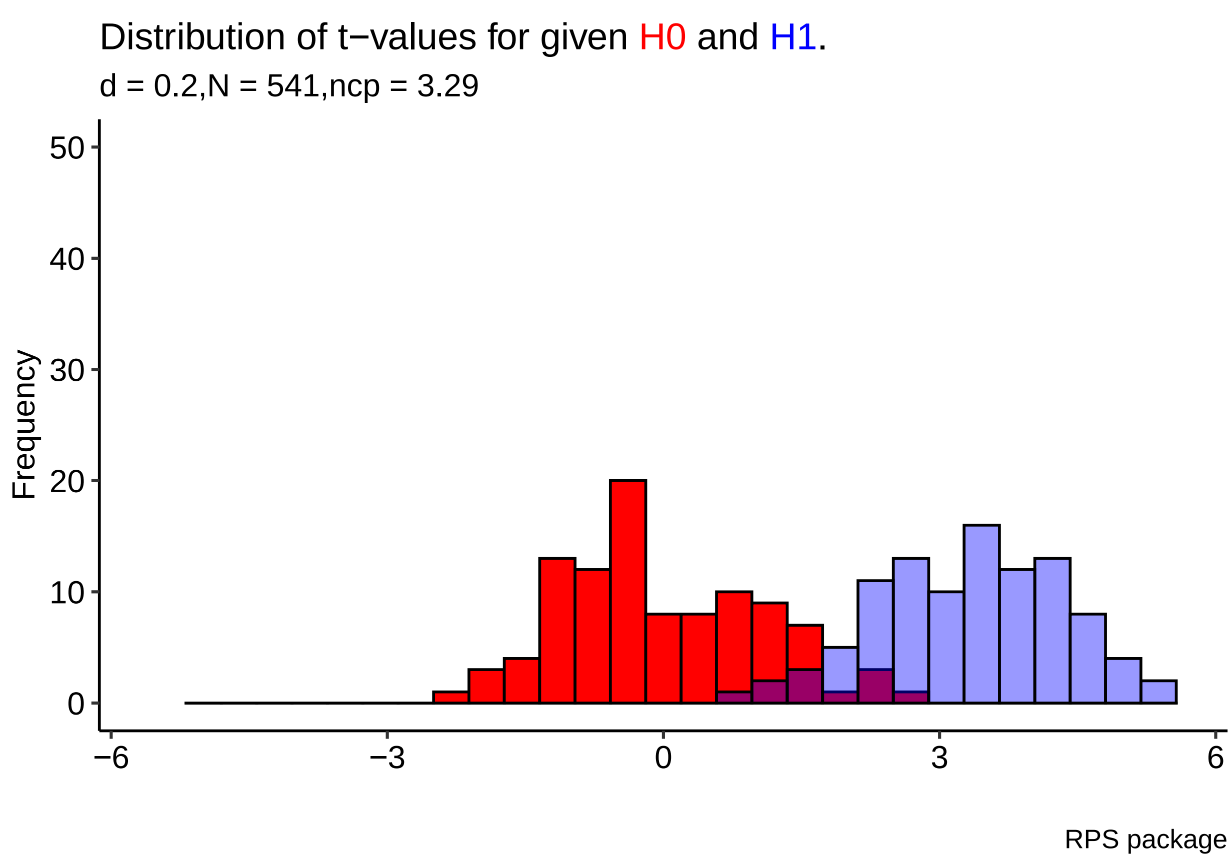

One can use the **Figure functions** separately,

```r
sampH1 <- RPS::samplesH1(Nsample = 100, alpha = 0.05, effectSize = 0.2, pow = 0.95)

# Run this function manually if you want from ModelVis.R script
# figure1(sampH1 = sampH1)
```

Summarizing Results

For the tabularization of the outputs, separate functions are given in **TableOutputs.R** file and the wrap-up function (**table__RPS.R**) is ready to use by selection of the different tables when all the necessary inputs are provided. Similar to visualization, ready to publish tables are generated by using **gt package**.

```r
# The below results are necessary before creating tables generally
# By using sampleH1
samp30 <- RPS::samples30(Nsample = 100, alpha = 0.05, effectSize = 0.2,
          pow = 0.95, samp = sampH1)

sampEmp0 <- RPS::samplesEmp0(Nsample = 100, N = 30, Temp = 3, alphaEmp = 0.05)

# The creation of the
# Table 1: Proportion of correct positive results (prior to data collection)

RPS::table_RPS(sampH0 = sampH0, sampH1 = sampH1, sampEmp = sampEmp,
          sampEmp0 = sampEmp0, samp30 = samp30, select = 1)
```

Step in RPS	Proportion
4. Substantial Falsification	0.81
5. Preliminary Verification	0.75
6. Substantial Verification	0.69
False Negatives: Substantial Falsification - Substantial Verification	0.12
Substantial Verification if N'= N + N/2 271 , 1-beta= 0.99	0.76