

Package ‘p3d’

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Title Interactive 3D Visualization of p-Value Surfaces

Version 0.1.0

Description Provides interactive three-dimensional visualization of p-value surfaces for single-sample t-tests. Enables simultaneous exploration of effect size, sample size, and significance level, making the continuous nature of p-values and the moderating effect of sample size visually apparent. Includes both interactive ('rgl', 'plotly') and static (persp()) rendering options. The p-value surface is based on the approach of Infanger and Schmidt-Trucksäss (2019) <[doi:10.1002/sim.8293](https://doi.org/10.1002/sim.8293)>.

License GPL (>= 3)

Encoding UTF-8

URL <https://github.com/ahmetkutuk1/p3d>,
<https://ahmetkutuk1.github.io/p3d/>

BugReports <https://github.com/ahmetkutuk1/p3d/issues>

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Suggests knitr, plotly, rgl, rmarkdown, testthat (>= 3.0.0)

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VignetteBuilder knitr

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plot_p_static	<i>Static 2D perspective plot of p-value surface</i>
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Description

Plots the output of [p_surface](#) using base R's [persp](#) function. This produces a static 3D perspective plot with no external dependencies, making it suitable for PDF output, journal figures, and CRAN checks.

Usage

```
plot_p_static(
  surface,
  theta = 30,
  phi = 20,
  col = "steelblue",
  shade = TRUE,
  alpha = 0.05
)
```

Arguments

surface	A list returned by p_surface .
theta, phi	Viewing angles in degrees. See persp for details. Defaults: theta = 30, phi = 20.
col	Color palette for the surface. Either a single color or a vector of colors matching the number of $d \times n$ grid cells.
shade	Logical; if TRUE (default), the surface is shaded using persp 's shading.
alpha	Significance level. A horizontal plane at $p = \alpha$ is overlaid on the surface. Default: 0.05.

Details

Unlike [plot_p_surface](#), which requires **rgl** or **plotly**, this function uses only base R graphics. It is ideal for inclusion in static documents such as PDF articles and printed reports.

Value

Invisibly returns the input surface object. Called for its side effect (a plot).

Examples

```
# Compute surface
surface <- p_surface(d = seq(-2, 2, 0.1), n = seq(5, 200, 5))

# Static perspective plot
plot_p_static(surface)

# Different viewing angle
plot_p_static(surface, theta = 45, phi = 30)
```

plot_p_surface	<i>Interactive 3D visualization of p-value surface</i>
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Description

Plots the output of `p_surface` as an interactive three-dimensional surface. Two rendering engines are supported: "rgl" (default, interactive window) and "plotly" (HTML widget, ideal for R Markdown / Quarto documents).

Usage

```
plot_p_surface(
  surface,
  engine = c("rgl", "plotly"),
  alpha = 0.05,
  col = NULL,
  show_boundary = TRUE
)
```

Arguments

surface	A list returned by <code>p_surface</code> .
engine	Character; either "rgl" (default) or "plotly". Determines the rendering back-end.
alpha	Significance level. A horizontal plane at $p = \alpha$ is overlaid on the surface. Default: 0.05.
col	Color palette for the surface. If NULL (default), a built-in palette is used.
show_boundary	Logical; if TRUE (default), the intersection curve between the surface and the α -plane is drawn.

Details

The 3D surface shows the p-value as a function of both effect size (d) and sample size (n). The α -plane visualizes the conventional significance threshold. The intersection curve marks the boundary between "significant" and "non-significant" regions.

For engine = "rgl", the **rgl** package must be installed. For engine = "plotly", the **plotly** package must be installed. Both are listed in Suggests.

Value

Invisibly returns the input surface object. Called for its side effect (a plot).

Examples

```
# Compute surface (non-interactive part)
surface <- p_surface(d = seq(-2, 2, 0.1), n = seq(5, 200, 5))
str(surface, max.level = 1)

# Interactive visualization (only in interactive sessions)
if (interactive()) {
  # rgl engine (interactive window)
  plot_p_surface(surface)

  # plotly engine (HTML widget)
  plot_p_surface(surface, engine = "plotly")
}
```

p_curve_2d

Compute 2D p-value curve for a fixed sample size

Description

Computes the p-value as a function of effect size (Cohen's d) for a single, fixed sample size. This is the 2D analogue of [p_surface](#) and is provided for comparison with existing 2D visualization packages such as [pvaluefunctions](#).

Usage

```
p_curve_2d(d, n, alpha = 0.05)
```

Arguments

d	Numeric vector of effect sizes (Cohen's d).
n	Single sample size. Must be >= 2.
alpha	Significance level. Default: 0.05.

Details

The p-value is computed as:

$$p(d) = 2 \left[1 - F_{t(n-1)}(d\sqrt{n}) \right]$$

Value

A data frame with columns:

- d** Effect sizes.
- p** Two-sided p-values.
- significant** Logical; whether $p < \alpha$.

Examples

```
# 2D curve for n = 30
curve_30 <- p_curve_2d(d = seq(-2, 2, 0.1), n = 30)
head(curve_30)

# Compare with 3D surface
surface <- p_surface(d = seq(-2, 2, 0.1), n = c(10, 30, 100))
```

p_surface

*Compute p-value surface for single-sample t-test***Description**

Computes the p-value of a single-sample t-test as a function of effect size (Cohen's d) and sample size (n). Returns a grid of p-values suitable for 3D visualization.

Usage

```
p_surface(d, n, alpha = 0.05)
```

Arguments

d Numeric vector of effect sizes (Cohen's d). Typical range: -2 to 2.
n Numeric vector of sample sizes. Must be ≥ 2 . Typical range: 5 to 200.
alpha Significance level for the critical effect size. Default: 0.05.

Details

The p-value is computed using the formula:

$$p(d, n) = 2 \left[1 - F_{t(n-1)}(d\sqrt{n}) \right]$$

where $F_{t(n-1)}$ is the cumulative distribution function of the t-distribution with $n - 1$ degrees of freedom.

The critical effect size at level α is:

$$d_{crit}(n) = \frac{F_{t(n-1)}^{-1}(1 - \alpha/2)}{\sqrt{n}}$$

Value

A list with the following elements:

d The input vector of effect sizes.
n The input vector of sample sizes.
p A matrix of p-values with dimensions $\text{length}(d) \times \text{length}(n)$.
d_crit A numeric vector of critical effect sizes for each sample size at level alpha.
alpha The significance level used.
grid A data frame with the full grid of (d, n, p) combinations.

Examples

```
# Small example
result <- p_surface(d = seq(-1, 1, 0.1), n = c(10, 30, 100))
str(result)

# Typical use
result <- p_surface(d = seq(-2, 2, 0.05), n = seq(5, 200, 5))
image(result$d, result$n, result$p)
```

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