Package ‘decisionpaths’

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Title Construct and Audit Longitudinal Decision Paths

Version 0.1.0

Description Tools for constructing and auditing longitudinal decision paths from panel data. Implements a decision infrastructure framework for representing institutional AI systems as generators of time-ordered binary decision sequences. Provides functions to build path objects from panel data, summarise per-unit descriptors (dosage, switching rate, onset, duration, longest run), compute the Decision Reliability Index (DRI) following Cronbach (1951) <doi:10.1007/BF02310555>, estimate Shannon decision-path entropy following Shannon (1948) <doi:10.1002/j.1538-7305.1948.tb01338.x>, classify systems by infrastructure type (static, periodic, continuous, human-in-the-loop), and evaluate subgroup disparities in decision exposure and stability. Applications include education, policy, health, and organisational research.

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Depends R (>= 4.1.0)

Imports cli (>= 3.0.0), dplyr (>= 1.0.0), magrittr (>= 2.0.0), rlang (>= 0.4.0), stats, tibble (>= 3.0.0)

Suggests ggplot2 (>= 3.3.0), knitr, patchwork, rmarkdown, testthat (>= 3.0.0), tidyr (>= 1.1.0)

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URL https://github.com/causalfragility-lab/decisionpaths

BugReports https://github.com/causalfragility-lab/decisionpaths/issues

NeedsCompilation no

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`dp_audit` *Run a Decision Path Audit*

Description

Produces an integrated audit summary including path descriptors, the Decision Reliability Index (DRI), Shannon entropy, and optional subgroup equity diagnostics. This is the flagship function of the **decisionpaths** package and implements the five-step decision infrastructure audit described in Hait (2025).

Usage

```
dp_audit(x, group = NULL)
```

Arguments

`x`	A `decision_path` object from `dp_build`.
`group`	Optional character string naming a group variable for stratified DRI and equity diagnostics. The variable must exist in the original data passed to `dp_build`. If the variable is not found in the path data, a warning is issued and equity diagnostics are skipped.

Value

An object of class `dp_audit`, a named list with components:

descriptors Output of `dp_describe`.

dri Output of `dp_dri`.

entropy Output of `dp_entropy`.

equity Output of `dp_equity`, or `NULL` if no group variable is supplied or found.

group The group variable name used (or `NULL`).

References

Hait, S. (2025). *Artificial intelligence as decision infrastructure: Rethinking institutional decision processes*. Preprint.

Examples

```
dat <- data.frame(
  id       = c(1, 1, 1, 2, 2, 2),
  time     = c(1, 2, 3, 1, 2, 3),
  decision = c(0, 1, 1, 1, 1, 0)
)
dp  <- dp_build(dat, id, time, decision)
aud <- dp_audit(dp)
print(aud)
```

`dp_build` *Build a Decision-Path Object from Panel Data*

Description

Converts a longitudinal (panel) data frame into a `decision_path` object, the core data structure used by all other functions in the package. Supports unbalanced panels and optional outcome and group variables.

Usage

```
dp_build(
  data,
  id,
  time,
  decision,
  outcome = NULL,
  group = NULL,
  decision_labels = c("0", "1")
)
```

Arguments

`data`	A data frame in long format (one row per unit-wave).
`id`	Unquoted name of the unit identifier column.
`time`	Unquoted name of the time/wave column (numeric or integer).
`decision`	Unquoted name of the binary decision column (0/1).
`outcome`	Optional. Unquoted name of the outcome column.
`group`	Optional. Unquoted name of a grouping column for equity analysis.
`decision_labels`	Character vector of length 2 labelling decision values 0 and 1. Default `c("0", "1")`.

Value

An object of class `decision_path`, which is a list containing:

paths A tibble with one row per unit-wave (cleaned and sorted).

path_strings A named character vector of decision sequences per unit.

ids Unique unit identifiers.

times Sorted unique time points.

n_units Number of units.

n_waves Maximum number of observed waves.

balanced Logical: TRUE if all units have the same number of waves.

has_outcome Logical: TRUE if outcome was supplied.

has_group Logical: TRUE if group was supplied.

id_var Character name of the id column.

time_var Character name of the time column.

decision_var Character name of the decision column.

outcome_var Character or NULL name of the outcome column.

group_var Character or NULL name of the group column.

decision_labels Character vector of length 2.

Examples

```
dat <- data.frame(
  id       = c(1, 1, 2, 2),
  time     = c(1, 2, 1, 2),
  decision = c(0, 1, 1, 0)
)
dp <- dp_build(dat, id, time, decision)
print(dp)
```

---

dp_describe *Describe Decision Paths*

Description

Computes per-unit path descriptors from a `decision_path` object, including dosage, switching rate, onset wave, duration, and longest run. Returns a flat tibble — one row per unit — so that all descriptors are directly accessible as columns (e.g. `desc$dosage`).

Usage

```
dp_describe(x, by = NULL)
```

Arguments

x	A decision_path object from dp_build.
by	Optional character string naming a group variable for stratified summaries. Defaults to x$group_var if set in dp_build.

Value

A tibble of class dp_describe with one row per unit and columns:

id Unit identifier (column name matches original data).

n_periods Number of observed waves for this unit.

treatment_count Number of waves with decision = 1.

dosage Proportion of waves with decision = 1.

switching_rate Proportion of consecutive waves where decision changed.

onset First wave where decision = 1 (NA if never treated).

duration Total number of waves with decision = 1 (same as treatment_count).

longest_run Length of longest uninterrupted run of decision = 1.

path Decision sequence as a string e.g. "0-1-1-0".

group Group value (NA if no group variable supplied).

Examples

```
dat <- data.frame(
  id       = c(1, 1, 2, 2),
  time     = c(1, 2, 1, 2),
  decision = c(0, 1, 1, 0)
)
dp   <- dp_build(dat, id, time, decision)
desc <- dp_describe(dp)
desc$dosage
desc$path
```

---

dp_dri *Compute the Decision Reliability Index (DRI)*

Description

Computes the Decision Reliability Index (DRI), defined as one minus the mean switching rate across units. A DRI of 1 indicates perfectly consistent decisions; 0 indicates maximum instability.

Usage

```
dp_dri(x, by = NULL)
```

Arguments

x	A decision_path object from dp_build.
by	Optional character string naming a group variable for stratified output. Defaults to x$group_var.

Value

A named list of class dp_dri with components:

group Group variable name used (NA if none).

mean_switching_rate Mean switching rate across units.

DRI Decision Reliability Index = 1 - mean_switching_rate.

unit_dri Per-unit tibble with switching_rate column.

by_group By-group summary tibble (NULL if no group).

group_var Group variable name.

References

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297–334.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). McGraw-Hill.

Examples

```
dat <- data.frame(
  id       = c(1, 1, 1, 2, 2, 2),
  time     = c(1, 2, 3, 1, 2, 3),
  decision = c(0, 1, 1, 1, 1, 0)
)
dp  <- dp_build(dat, id, time, decision)
dri <- dp_dri(dp)
print(dri)
```

---

dp_entropy *Compute Decision Path Entropy*

Description

Computes Shannon entropy (H) of the decision-path distribution, grounded in information theory (Shannon, 1948). Entropy is measured in bits.

Usage

```
dp_entropy(x, by = NULL, mutual_info = FALSE)
```

Arguments

`x`	A `decision_path` object from `dp_build`.
`by`	Optional character string naming a group variable for stratified entropy. Defaults to `x$group_var`.
`mutual_info`	Logical. Compute mutual information between path and group? Default `FALSE`.

Value

An object of class `dp_entropy`, a named list with:

entropy Shannon entropy H in bits.

normalized_entropy H divided by log2(number of unique paths).

path_frequencies Tibble of path strings, counts, and proportions.

n_unique_paths Number of unique decision paths observed.

by_group By-group entropy tibble (NULL if no group variable).

mutual_info Mutual information in bits (NULL if not requested).

group_var Group variable name used.

References

Shannon, C. E. (1948). A mathematical theory of communication. *Bell System Technical Journal*, 27(3), 379–423.

Examples

```
dat <- data.frame(
  id       = c(1, 1, 2, 2),
  time     = c(1, 2, 1, 2),
  decision = c(0, 1, 1, 0)
)
dp  <- dp_build(dat, id, time, decision)
ent <- dp_entropy(dp)
print(ent)
```

`dp_equity` *Compare path descriptors across groups*

Description

Produces simple subgroup summaries for key decision-path descriptors.

Usage

```
dp_equity(x, group)
```

Arguments

`x`	A decision_path object
`group`	Grouping variable name as a character string

Value

A tibble of grouped summaries

`plot.decision_path` *Plot a decision_path object*

Description

Produces a heatmap or spaghetti plot of sampled decision paths across units and time periods.

Usage

```
## S3 method for class 'decision_path'
plot(x, type = "heatmap", sample_n = 50L, ...)
```

Arguments

`x`	A `decision_path` object from `dp_build`.
`type`	Character. `"heatmap"` (default) or `"spaghetti"`.
`sample_n`	Integer. Maximum number of units to display. Default 50.
`...`	Ignored.

Value

A `ggplot2` object.

`plot.dp_audit` *Plot a dp_audit object*

Description

Produces a multi-panel summary figure combining DRI distribution, prevalence over time, dosage distribution, and equity SMDs. Requires **patchwork** for the combined layout; falls back to DRI panel alone.

Usage

```
## S3 method for class 'dp_audit'
plot(x, ...)
```

Arguments

`x`	A `dp_audit` object from `dp_audit`.
`...`	Ignored.

Value

A `ggplot2` or `patchwork` object.

`plot.dp_describe` *Plot a dp_describe object*

Description

Produces density or histogram plots of path descriptor distributions, optionally stratified by group.

Usage

```
## S3 method for class 'dp_describe'
plot(x, metrics = c("dosage", "switching_rate", "onset"), ...)
```

Arguments

`x`	A `dp_describe` object from `dp_describe`.
`metrics`	Character vector of metrics to plot. Defaults to `c("dosage", "switching_rate", "onset")`.
`...`	Ignored.

Value

A `ggplot2` object.

`plot.dp_dri` *Plot a dp_dri object*

Description

Produces a histogram or density plot of per-unit switching rates with the overall DRI marked.

Usage

```
## S3 method for class 'dp_dri'
plot(x, ...)
```

Arguments

x	A dp_dri object from dp_dri.
...	Ignored.

Value

A ggplot2 object.

---

plot.dp_entropy *Plot a dp_entropy object*

Description

Produces a bar chart of the most frequent decision paths.

Usage

```
## S3 method for class 'dp_entropy'
plot(x, top = 10L, ...)
```

Arguments

x	A dp_entropy object from dp_entropy.
top	Integer. Number of top paths to display. Default 10.
...	Ignored.

Value

A ggplot2 object.

---

plot.dp_equity *Plot a dp_equity object*

Description

Produces a dot plot of standardized mean differences (SMDs) across path descriptor metrics and group comparisons.

Usage

```
## S3 method for class 'dp_equity'
plot(x, ...)
```

Arguments

x	A dp_equity object from dp_equity.
...	Ignored.

Value

A ggplot2 object.

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