Package 'TAD'

November 28, 2024

Title Realize the Trait Abundance Distribution

Version 1.0.0

Description This analytical framework is based on an analysis of the shape of the trait abundance distributions to better understand community assembly processes, and predict community dynamics under environmental changes. This framework mobilized a study of the relationship between the moments describing the shape of the distributions: the skewness and the kurtosis (SKR). The SKR allows the identification of commonalities in the shape of trait distributions across contrasting communities. Derived from the SKR, we developed mathematical parameters that summarise the complex pattern of distributions by assessing (i) the R^2, (ii) the Y-intercept, (iii) the slope, (iv) the functional stability of community (TADstab), and, (v) the distance from specific distribution families (i.e., the distance from the skew-uniform family a limit to the highest degree of evenness: TADeve).

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URL https://forgemia.inra.fr/urep/data_processing/tad

BugReports https://forgemia.inra.fr/urep/data_processing/tad/-/issues

Encoding UTF-8

RoxygenNote 7.3.2

Depends R (>= 3.5)

Imports doFuture, foreach, mblm (>= 0.12), methods, stats

Suggests Cairo, covr, dplyr, devtools, future (>= 1.33), ggplot2 (>= 3.5), ggpubr (>= 0.6), knitr, Matrix (>= 1.6), pkgdown, rlang, rmarkdown, roxygen2, testthat (>= 3.0), tinytex

Collate utils.R saving_and_loading_data.R graph.R tad.R data.R

Config/testthat/edition 3

Config/testthat/parallel true

Language en-US

VignetteBuilder knitr

LazyData true

LazyDataCompression bzip2

NeedsCompilation no

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Repository CRAN

Date/Publication 2024-11-28 12:20:02 UTC

Contents

CONSTANTS *The CONSTANTS constant*

Description

Provides a set of constants to prevent typo and provide some defauts values to functions in the TAD. Among those constants are:

- SKEW_UNIFORM_SLOPE_DISTANCE
- SKEW_UNIFORM_INTERCEPT_DISTANCE
- DEFAULT_SIGNIFICATIVITY_THRESHOLD

- DEFAULT_LIN_MOD
- DEFAULT_SLOPE_DISTANCE
- DEFAULT_INTERCEPT_DISTANCE

Usage

```
CONSTANTS
```

Format

An object of class `list` of length 6.

`generate_random_matrix` *Generate random matrix*

Description

Generate and save random matrix

Usage

```
generate_random_matrix(
  weights,
  aggregation_factor = NULL,
  randomization_number,
  seed = NULL
)
```

Arguments

`weights`	the dataframe of weights, one row correspond to a series of observation
`aggregation_factor`	the dataframe of factor to take into account for the randomization
`randomization_number`	the number of random abundance matrix to generate
`seed`	the seed of the pseudo random number generator

Value

a data.frame of randomization_number observations

Examples

```
aggregation_factor_name <- c("Year", "Bloc")
weights_factor = TAD::AB[, c("Year", "Plot", "Treatment", "Bloc")]
aggregation_factor <- as.data.frame(
  weights_factor[, aggregation_factor_name]
)
random_matrix <- TAD::generate_random_matrix(
  weights = TAD::AB[, 5:102],
  aggregation_factor = aggregation_factor,
  randomization_number = 100,
  seed = 1312
)
head(random_matrix)
```

---

launch_analysis_tad *Launch the analysis*

Description

Launch distribution analysis

Usage

```
launch_analysis_tad(
  weights,
  weights_factor,
  trait_data,
  randomization_number,
  aggregation_factor_name = NULL,
  statistics_factor_name = NULL,
  seed = NULL,
  abundance_file = NULL,
  weighted_moments_file = NULL,
  stat_per_obs_file = NULL,
  stat_per_rand_file = NULL,
  stat_skr_param_file = NULL,
  regenerate_abundance_df = FALSE,
  regenerate_weighted_moments_df = FALSE,
  regenerate_stat_per_obs_df = FALSE,
  regenerate_stat_per_rand_df = FALSE,
  regenerate_stat_skr_df = FALSE,
  significativity_threshold = CONSTANTS$DEFAULT_SIGNIFICATIVITY_THRESHOLD,
  lin_mod = CONSTANTS$DEFAULT_LIN_MOD,
  slope_distance = CONSTANTS$DEFAULT_SLOPE_DISTANCE,
  intercept_distance = CONSTANTS$DEFAULT_INTERCEPT_DISTANCE,
  csv_tsv_load_parameters = list()
)
```

Arguments

`weights`	the dataframe of weights, one row correspond to a series of observation
`weights_factor`	the dataframe which contains the different factor linked to the weights
`trait_data`	a vector of the data linked to the different factor
`randomization_number`	the number of random abundance matrix to generate
`aggregation_factor_name`	vector of factor name for the generation of random matrix
`statistics_factor_name`	vector of factor name for the computation of statistics for each generated matrix
`seed`	the seed of the pseudo random number generator
`abundance_file`	the path and name of the RDS file to load/save the dataframe which contains the observed data and the generated matrix
`weighted_moments_file`	the path and name of the RDS file to load/save the dataframe which contains the calculated moments
`stat_per_obs_file`	the path and name of the RDS file to load/save the dataframe which contains the statistics for each observed row regarding the random ones
`stat_per_rand_file`	the path and name of the RDS file to load/save the dataframe which contains the statistics for each random matrix generated
`stat_skr_param_file`	default=NULL You can provide the output to write the SKR statistics results to.
`regenerate_abundance_df`	boolean to specify if the abundance dataframe is computed again
`regenerate_weighted_moments_df`	boolean to specify if the weighted moments dataframe is computed again
`regenerate_stat_per_obs_df`	boolean to specify if the statistics per observation dataframe is computed again
`regenerate_stat_per_rand_df`	boolean to specify if the statistics per random matrix dataframe is computed again
`regenerate_stat_skr_df`	boolean to specify if the stats SKR dataframe is computed again
`significativity_threshold`	the significance threshold to consider that the observed value is in the randomized value
`lin_mod`	Indicates the type of linear model to use for (SKR): choose "lm" or "mblm"
`slope_distance`	slope of the theoretical distribution law (default: slope = 1 intercept = 1.86 skew-uniform distribution family)
`intercept_distance`	intercept of the theoretical distribution law (default: slope = 1 intercept = 1.86 skew-uniform distribution family)

`csv_tsv_load_parameters`
: a list of parameters for each data structure we want to load. Each element must be named after the data structure we want to load.

Value

A `list` of the 9 following named elements:

- raw_abundance_df
- filtered_weights
- filtered_weights_factor
- filtered_trait_data
- abundance_df
- weighted_moments
- statistics_per_observation
- stat_per_rand
- ses_skr

Examples

```
output_path <- file.path(tempdir(), "outputs")
dir.create(output_path)
results <- TAD::launch_analysis_tad(
  weights = TAD::AB[, 5:102],
  weights_factor = TAD::AB[, c("Year", "Plot", "Treatment", "Bloc")],
  trait_data = log(TAD::trait[["SLA"]]),
  aggregation_factor_name = c("Year", "Bloc"),
  statistics_factor_name = (statistics_factor_name <- c("Treatment")),
  regenerate_abundance_df = TRUE,
  regenerate_weighted_moments_df = TRUE,
  regenerate_stat_per_obs_df = TRUE,
  regenerate_stat_per_rand_df = TRUE,
  weighted_moments_file = file.path(output_path, "weighted_moments.csv"),
  stat_per_obs_file = file.path(output_path, "stat_per_obs.csv"),
  stat_per_rand_file = file.path(output_path, "stat_per_rand.csv"),
  stat_skr_param_file = file.path(output_path, "stat_skr_param.csv"),
  randomization_number = 20,
  seed = 1312,
  significativity_threshold = c(0.05, 0.95),
  lin_mod = "lm",
  slope_distance = (
    slope_distance <- TAD::CONSTANTS$SKEW_UNIFORM_SLOPE_DISTANCE
  ),
  intercept_distance = (
    intercept_distance <- TAD::CONSTANTS$SKEW_UNIFORM_INTERCEPT_DISTANCE
  )
)
moments_graph <- TAD::moments_graph(
  moments_df = results$weighted_moments,
  statistics_per_observation = results$statistics_per_observation,
```

```
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  output_path = file.path(output_path, "moments_graph.jpeg"),
  dpi = 100
)
skr_graph <- TAD::skr_graph(
  moments_df = results$weighted_moments,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  output_path = file.path(output_path, "skr_graph.jpeg"),
  slope_distance = slope_distance,
  intercept_distance = intercept_distance,
  dpi = 100
)
skr_param_graph <- TAD::skr_param_graph(
  skr_param = results$ses_skr,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  slope_distance = slope_distance,
  intercept_distance = intercept_distance,
  save_skr_param_graph = file.path(output_path, "skr_param_graph.jpeg"),
  dpi = 100
)

unlink(output_path, recursive = TRUE, force = TRUE)
```

`load_abundance_dataframe`

load_abundance_dataframe

Description

load_abundance_dataframe

Usage

```
load_abundance_dataframe(path, ...)
```

Arguments

`path`	the path to the file to load
`...`	a set of parameters provided to load_depending_on_format may contain some operations to apply to format/cast CSV or TSV data which are almost typeless by default

Value

an abundance dataframe, with the column `number` caster into integers and rownames casted into integers.

`load_statistics_per_obs`

load_statistics_per_obs

Description

load_statistics_per_obs

Usage

```
load_statistics_per_obs(path, ...)
```

Arguments

`path`	the path to the file to load
`...`	a set of parameters provided to load_depending_on_format may contain some operations to apply to format/cast CSV or TSV data which are almost typeless by default

Value

a stats par observations dataframe with rownames casted into integers.

`load_statistics_per_random`

load_statistics_per_random

Description

load_statistics_per_random

Usage

```
load_statistics_per_random(path, ...)
```

Arguments

`path`	the path to the file to load
`...`	a set of parameters provided to load_depending_on_format may contain some operations to apply to format/cast CSV or TSV data which are almost typeless by default

Value

a stats per randon dataframe with distance_to_family and cv_distance_to_family casted into doubles and with rownames casted into integers.

`load_stat_skr_param` *load_stat_skr_param*

Description

load_stat_skr_param

Usage

```
load_stat_skr_param(path, ...)
```

Arguments

`path`	the path to the file to load
`...`	a set of parameters provided to load_depending_on_format may contain some operations to apply to format/cast CSV or TSV data which are almost typeless by default

Value

a stats SKR parameters dataframe with distance_to_family_ses and cv_distance_to_family_ses casted into doubles and with rownames casted into integers.

`load_weighted_moments` *load_weighted_moments*

Description

load_weighted_moments

Usage

```
load_weighted_moments(path, ...)
```

Arguments

`path`	the path to the file to load
`...`	a set of parameters provided to load_depending_on_format may contain some operations to apply to format/cast CSV or TSV data which are almost typeless by default

Value

a weighted moments dataframe with the column `number` caster into integers and rownames casted into integers.

`moments_graph` *moments_graph*

Description

Graph of the distributions' moments (mean, variance, skewness and kurtosis) compared to null model

Usage

```
moments_graph(
  moments_df,
  statistics_per_observation,
  statistics_factor_name,
  statistics_factor_name_breaks = NULL,
  statistics_factor_name_col = NULL,
  output_path = NULL,
  dpi = 600
)
```

Arguments

`moments_df`	Moments data frame (mean, variance, skewness, kurtosis)
`statistics_per_observation`	SES of the Moments data frame and significance compared to null model
`statistics_factor_name`	column of data use for colors discrimination
`statistics_factor_name_breaks`	vector of factor levels of the statistics_factor_name, same dimension than statistics_factor_name_col
`statistics_factor_name_col`	vector of colors, same dimension than statistics_factor_name_breaks
`output_path`	The path to save the graph
`dpi`	The dpi number to use when we generate png/jpg graph

Value

A graph instance

Examples

```
results <- TAD::launch_analysis_tad(
  weights = TAD::AB[, 5:102],
  weights_factor = TAD::AB[, c("Year", "Plot", "Treatment", "Bloc")],
  trait_data = log(TAD::trait[["SLA"]]),
  aggregation_factor_name = c("Year", "Bloc"),
  statistics_factor_name = (statistics_factor_name <- c("Treatment")),
  randomization_number = 100
)

# if you want to display the graph
graph <- TAD::moments_graph(
  moments_df = results$weighted_moments,
  statistics_per_observation = results$statistics_per_observation,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159")
)

plot(graph)

# if you want to save the graph as a file
# either jpg, jpeg, png or svg are
output_path <- file.path(tempdir(), "outputs")
dir.create(output_path)
TAD::moments_graph(
  moments_df = results$weighted_moments,
  statistics_per_observation = results$statistics_per_observation,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  output_path = file.path(output_path, "moment_graph.png")
)

unlink(output_path, recursive = TRUE, force = TRUE)
```

---

null_model_distribution_stats

Compare a value to random values

Description

Compute different statistics (standardized by the distribution of random values).

Usage

```
null_model_distribution_stats(
  observed_value,
  random_values,
  significance_threshold = c(0.05, 0.95),
  remove_nas = TRUE
)
```

Arguments

observed_value	the observed value
random_values	the random Values
significance_threshold	the array of values used to compute the quantile (c(0.025, 0.975) by default)
remove_nas	boolean - tells weither to remoe NAs or not

Value

a list corresponding to :

- the observed value
- quantile values (minimum significance threshold)
- quantile values (maximum significance threshold)
- significance (observed value not in quantile values)

Examples

```
null_model_distribution_stats(
  observed_value = 2,
  random_values = c(1, 4, 5, 6, 8),
  significance_threshold = c(0.025, 0.975)
)
```

---

save_abundance_dataframe

save_abundance_dataframe

Description

This function provides a secured way to save abundance_dataframe dataframe. The more generic functionprovided by TAD `save_depending_on_format` expects saves object using their name, but saves nothing if the provided name is not correct, or mya even save an unwanted object. This function provides a way to verify the object you want to save, and so, it is more secured.

Usage

```
save_abundance_dataframe(path, object = NULL)
```

Arguments

path	the path of the file to load
object	the object to save

Value

NULL - called for side effects

---

save_statistics_per_obs
save_statistics_per_obs

Description

This function provides a secured way to save statistics_per_obs dataframe. The more generic functionprovided by TAD `save_depending_on_format` expects saves object using their name, but saves nothing if the provided name is not correct, or mya even save an unwanted object. This function provides a way to verify the object you want to save, and so, it is more secured.

Usage

```
save_statistics_per_obs(path, object = NULL)
```

Arguments

path	the path of the file to load
object	the object to save

Value

NULL - called for side effects

save_statistics_per_random *save_statistics_per_random*

Description

This function provides a secured way to save statistics_per_random dataframe. The more generic functionprovided by TAD `save_depending_on_format` expects saves object using their name, but saves nothing if the provided name is not correct, or mya even save an unwanted object. This function provides a way to verify the object you want to save, and so, it is more secured.

Usage

```
save_statistics_per_random(path, object = NULL)
```

Arguments

`path`	the path of the file to load
`object`	the object to save

Value

NULL - called for side effects

save_stat_skr_param *save_stat_skr_param*

Description

This function provides a secured way to save stat_skr_param dataframe. The more generic function-provided by TAD `save_depending_on_format` expects saves object using their name, but saves nothing if the provided name is not correct, or mya even save an unwanted object. This function provides a way to verify the object you want to save, and so, it is more secured.

Usage

```
save_stat_skr_param(path, object = NULL)
```

Arguments

`path`	the path of the file to load
`object`	the object to save

Value

NULL - called for side effects

save_weighted_moments *save_weighted_moments*

Description

This function provides a secured way to save weighted_moments dataframe. The more generic functionprovided by TAD `save_depending_on_format` expects saves object using their name, but saves nothing if the provided name is not correct, or mya even save an unwanted object. This function provides a way to verify the object you want to save, and so, it is more secured.

Usage

```
save_weighted_moments(path, object = NULL)
```

Arguments

`path`	the path of the file to load
`object`	the object to save

Value

NULL - called for side effects

skr_graph *skr_graph*

Description

Graph of the SKR, compared to null model

Usage

```
skr_graph(
  moments_df,
  statistics_factor_name,
  statistics_factor_name_breaks = NULL,
  statistics_factor_name_col = NULL,
  slope_distance = CONSTANTS$SKEW_UNIFORM_SLOPE_DISTANCE,
  intercept_distance = CONSTANTS$SKEW_UNIFORM_INTERCEPT_DISTANCE,
  output_path = NULL,
  dpi = 600
)
```

Arguments

moments_df	moments data frame (mean, variance, skewness, kurtosis)
statistics_factor_name	column of data use for colors discrimination
statistics_factor_name_breaks	vector of factor levels of the statistics_factor_name, same dimension than statistics_factor_name_col
statistics_factor_name_col	vector of colors, same dimension than statistics_factor_name_breaks
slope_distance	slope of the theoretical distribution law (default: slope = 1 intercept = 1.86 skew-uniform)
intercept_distance	intercept of the theoretical distribution law (default: slope = 1 intercept = 1.86 skew-uniform)
output_path	The path to save the graph
dpi	The dpi number to use when we generate png/jpg graph

Value

A graph instance

Examples

```
results <- TAD::launch_analysis_tad(
  weights = TAD::AB[, 5:102],
  weights_factor = TAD::AB[, c("Year", "Plot", "Treatment", "Bloc")],
  trait_data = log(TAD::trait[["SLA"]]),
  aggregation_factor_name = c("Year", "Bloc"),
  statistics_factor_name = (statistics_factor_name <- c("Treatment")),
  randomization_number = 100,
  slope_distance = (
    slope_distance <- TAD::CONSTANTS$SKEW_UNIFORM_SLOPE_DISTANCE
  ),
  intercept_distance = (
    intercept_distance <- TAD::CONSTANTS$SKEW_UNIFORM_INTERCEPT_DISTANCE
  )
)

graph <- TAD::skr_graph(
  moments_df = results$weighted_moments,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  slope_distance = slope_distance,
  intercept_distance = intercept_distance
)
```

```
plot(graph)

output_path <- file.path(tempdir(), "outputs")
dir.create(output_path)
TAD::skr_graph(
  moments_df = results$weighted_moments,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  slope_distance = slope_distance,
  intercept_distance = intercept_distance,
  dpi = 200,
  output_path = file.path(output_path, "moment_graph.png")
)

unlink(output_path, recursive = TRUE, force = TRUE)
```

---

skr_param_graph *skr_param_graph*

Description

Graph of the parameters computed from the SKR, compared to null model

Usage

```
skr_param_graph(
  skr_param,
  statistics_factor_name,
  statistics_factor_name_breaks = NULL,
  statistics_factor_name_col = NULL,
  slope_distance = CONSTANTS$SKEW_UNIFORM_SLOPE_DISTANCE,
  intercept_distance = CONSTANTS$SKEW_UNIFORM_INTERCEPT_DISTANCE,
  save_skr_param_graph = NULL,
  dpi = 600
)
```

Arguments

skr_param	SES of SKR parameters data frame (SES and Significance)
statistics_factor_name	column of data use for colors discrimination
statistics_factor_name_breaks	vector of factor levels of the statistics_factor_name, same dimension than statistics_factor_name_col

statistics_factor_name_col
: vector of colors, same dimension than statistics_factor_name_breaks

slope_distance
: slope of the theoretical distribution law (default: slope = 1 intercept = 1.86 skew-uniform distribution family)

intercept_distance
: intercept of the theoretical distribution law (default: slope = 1 intercept = 1.86 skew-uniform distribution family)

save_skr_param_graph
: The path to save the graph

dpi
: The dpi number to use when we generate png/jpg graph

Value

A graph instance

Examples

```
results <- TAD::launch_analysis_tad(
  weights = TAD::AB[, 5:102],
  weights_factor = TAD::AB[, c("Year", "Plot", "Treatment", "Bloc")],
  trait_data = log(TAD::trait[["SLA"]]),
  aggregation_factor_name = c("Year", "Bloc"),
  statistics_factor_name = (statistics_factor_name <- c("Treatment")),
  randomization_number = 100,
  slope_distance = (
    slope_distance <- TAD::CONSTANTS$SKEW_UNIFORM_SLOPE_DISTANCE
  ),
  intercept_distance = (
    intercept_distance <- TAD::CONSTANTS$SKEW_UNIFORM_INTERCEPT_DISTANCE
  )
)

# if you want to display the graph
graph <- TAD::skr_param_graph(
  skr_param = results$ses_skr,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  slope_distance = slope_distance,
  intercept_distance = intercept_distance
)

plot(graph)

output_path <- file.path(tempdir(), "outputs")
dir.create(output_path)

# if you want to save the graph as a file
# either jpg, jpeg, png or svg are
```

```
TAD::skr_param_graph(
  skr_param = results$ses_skr,
  statistics_factor_name = statistics_factor_name,
  statistics_factor_name_breaks = c("Mown_Unfertilized", "Mown_NPK"),
  statistics_factor_name_col = c("#1A85FF", "#D41159"),
  slope_distance = slope_distance,
  intercept_distance = intercept_distance,
  save_skr_param_graph = file.path(output_path, "skr_param_graph.jpeg"),
  dpi = 300
)

unlink(output_path, recursive = TRUE, force = TRUE)
```

`weighted_mvsk` *Compute the weighted mean, variance, skewness and kurtosis*

Description

Compute the weighted mean, variance, skewness and kurtosis of data with given weights

Usage

```
weighted_mvsk(data, weights)
```

Arguments

`data`	the data
`weights`	the vector or matrix of weights corresponding to the data (each row corresponding to an iteration of data)

Value

the list of weighted mean, variance, skewness and kurtosis of the data

Examples

```
weighted_mvsk(
  data = c(1, 2, 3),
  weights = matrix(data = c(1, 1, 1, 2, 1, 3), nrow = 2, ncol = 3)
)
```

Index