

# Package ‘SaturnCoefficient’

February 14, 2025

**Title** Statistical Evaluation of UMAP Dimensionality Reductions

**Version** 1.4

**Description** A metric expressing the quality of a UMAP layout. This is a package that contains the `Saturn_coefficient()` function that reads an input matrix, its dimensionality reduction produced by UMAP, and evaluates the quality of this dimensionality reduction by producing a real value in the  $[0; 1]$  interval. We call this real value Saturn coefficient. A higher value means better dimensionality reduction; a lower value means worse dimensionality reduction.  
Reference: Davide Chicco et al. ``The Saturn coefficient for evaluating the quality of UMAP dimensionality reduction results" (2025, in preparation).

**License** GPL-3

**URL** [https://github.com/davidechicco/SaturnCoefficient\\_R\\_package](https://github.com/davidechicco/SaturnCoefficient_R_package)

**BugReports** [https://github.com/davidechicco/SaturnCoefficient\\_R\\_package/issues](https://github.com/davidechicco/SaturnCoefficient_R_package/issues)

**Depends** R ( $\geq 4.0.0$ )

**Imports** MatrixCorrelation, ProjectionBasedClustering, stats, umap

**Suggests** knitr, rmarkdown, testthat ( $\geq 3.0.0$ )

**VignetteBuilder** knitr

**Config/testthat/edition** 3

**Encoding** UTF-8

**RoxygenNote** 7.3.2

**NeedsCompilation** no

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calculatesSaturnContinuityTrustworthiness

*Function that calculates the Saturn coefficient, trustworthiness score, and the continuity score of a UMAP dimensionality reduction*

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## Description

Function that calculates the Saturn coefficient, trustworthiness score, and the continuity score of a UMAP dimensionality reduction

## Usage

```
calculatesSaturnContinuityTrustworthiness(
  original_matrix,
  umap_output_layout,
  VERBOSE
)
```

## Arguments

original_matrix	input matrix
umap_output_layout	output matrix of UMAP applied to original_matrix
VERBOSE	prints some intermediate message to standard output or not

## Value

a dataframe containing the Saturn coefficient, the trustworthiness score, and the continuity score

## Examples

```
this_nrows <- 200
this_ncols <- 100
this_min <- 0
this_max <- 10000
noise_random_matrix <- matrix(runif(n = this_nrows * this_ncols,
  min = this_min, max = this_max), nrow = this_nrows)
input_matrix <- as.matrix(noise_random_matrix)
these_nearest_neighbors <- 15
this_min_dist <- 0.05

library("umap")
custom.settings <- umap::umap.defaults
custom.settings$"n_neighbors" <- these_nearest_neighbors
custom.settings$"min_dist" <- this_min_dist

x_umap <- umap::umap(input_matrix, config=custom.settings)

this_verbose <- FALSE
theseThreeMetrics <- calculatesSaturnContinuityTrustworthiness(input_matrix,
  x_umap$"layout", this_verbose)
print(theseThreeMetrics)
```

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continuity_score	<i>Function that calculates the continuity score of a UMAP dimensionality reduction</i>
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## Description

Function that calculates the continuity score of a UMAP dimensionality reduction

## Usage

```
continuity_score(original_matrix, umap_output_layout, VERBOSE)
```

## Arguments

original_matrix	input matrix
umap_output_layout	output matrix of UMAP applied to original_matrix
VERBOSE	prints some intermediate message to standard output or not

## Value

a real value containing the continuity score

## Examples

```
this_nrows <- 200
this_ncols <- 100
this_min <- 0
this_max <- 10000
noise_random_matrix <- matrix(runif(n = this_nrows * this_ncols,
  min = this_min, max = this_max), nrow = this_nrows)
input_matrix <- as.matrix(noise_random_matrix)
these_nearest_neighbors <- 15
this_min_dist <- 0.05

library("umap")
custom.settings <- umap::umap.defaults
custom.settings$"n_neighbors" <- these_nearest_neighbors
custom.settings$"min_dist" <- this_min_dist

x_umap <- umap::umap(input_matrix, config=custom.settings)

this_verbose <- FALSE
thisCon <- continuity_score(input_matrix, x_umap$"layout", this_verbose)
cat("continuity = ", thisCon, "\n", sep="")
```

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Saturn_coefficient	<i>Function that calculates the Saturn coefficient to quantify the quality of a UMAP dimensionality reduction</i>
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## Description

Function that calculates the Saturn coefficient to quantify the quality of a UMAP dimensionality reduction

## Usage

```
Saturn_coefficient(original_matrix, umap_output_layout, VERBOSE)
```

## Arguments

original_matrix	input matrix
umap_output_layout	output matrix of UMAP applied to original_matrix
VERBOSE	prints some intermediate message to standard output or not

## Value

a real value containing the Saturn coefficient

## Examples

```
this_nrows <- 200
this_ncols <- 100
this_min <- 0
this_max <- 10000
noise_random_matrix <- matrix(runif(n = this_nrows * this_ncols,
  min = this_min, max = this_max), nrow = this_nrows)
input_matrix <- as.matrix(noise_random_matrix)
these_nearest_neighbors <- 15
this_min_dist <- 0.05

library("umap")
custom.settings <- umap::umap.defaults
custom.settings$"n_neighbors" <- these_nearest_neighbors
custom.settings$"min_dist" <- this_min_dist

x_umap <- umap::umap(input_matrix, config=custom.settings)

this_verbose <- FALSE
thisSaturn <- Saturn_coefficient(input_matrix, x_umap$"layout", this_verbose)
cat("Saturn coefficient = ", thisSaturn, "\n", sep="")
```

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`trustworthiness_score` *Function that calculates the trustworthiness score of a UMAP dimensionality reduction*

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## Description

Function that calculates the trustworthiness score of a UMAP dimensionality reduction

## Usage

```
trustworthiness_score(original_matrix, umap_output_layout, VERBOSE)
```

## Arguments

<code>original_matrix</code>	input matrix
<code>umap_output_layout</code>	output matrix of UMAP applied to <code>original_matrix</code>
<code>VERBOSE</code>	prints some intermediate message to standard output or not

## Value

a real value containing the trustworthiness score

## Examples

```
this_nrows <- 200
this_ncols <- 100
this_min <- 0
this_max <- 10000
noise_random_matrix <- matrix(runif(n = this_nrows * this_ncols,
  min = this_min, max = this_max), nrow = this_nrows)
input_matrix <- as.matrix(noise_random_matrix)
these_nearest_neighbors <- 15
this_min_dist <- 0.05

library("umap")
custom.settings <- umap::umap.defaults
custom.settings$"n_neighbors" <- these_nearest_neighbors
custom.settings$"min_dist" <- this_min_dist

x_umap <- umap(input_matrix, config=custom.settings)

this_verbose <- FALSE
thisTW <- trustworthiness_score(input_matrix, x_umap$"layout", this_verbose)
cat("trustworthiness = ", thisTW, "\n", sep="")
```

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