

Package ‘critpath’

June 6, 2023

Type Package

Title Setting the Critical Path in Project Management

Version 0.2.1

Author Adam Kucharski

Maintainer Adam Kucharski <aqcharski@interia.pl>

Description

Solving the problem of project management using CPM (Critical Path Method), PERT (Program Evaluation and Review Technique) and LESS (Least Cost Estimating and Scheduling) methods. The package sets the critical path, schedule and Gantt chart. In addition, it allows to draw a graph even with marked critical activities. For more information about project management see: Taha H. A. "Operations Research. An Introduction" (2017, ISBN:978-1-292-16554-7), Rama Murthy P. "Operations Research" (2007, ISBN:978-81-224-2944-2), Yuval Cohen & Arik Sadeh (2006) "A New Approach for Constructing and Generating AOA Networks", Journal of Engineering, Computing and Architecture 1. 1-13, Konarzewska I., Jewczak M., Kucharski A. (2020, ISBN:978-83-8220-112-3), Miszczyńska D., Miszczyński M. "Wybrane metody badań operacyjnych" (2000, ISBN:83-907712-0-9).

License GPL-2

Encoding UTF-8

LazyData true

Imports DiagrammeR, ggplot2, reshape2, dplyr, stringr

Suggests knitr, rmarkdown

VignetteBuilder knitr

Depends R (>= 4.0.0)

Date 2023-06-06

RoxygenNote 7.2.3

NeedsCompilation no

Repository CRAN

Date/Publication 2023-06-06 12:20:02 UTC

R topics documented:

cpmexample1	2
cpmexample2	3
lessexample1	3
lessexample2	4
pertexample1	4
pertexample2	5
PERT_newprob	5
PERT_newtime	6
plot_alap	6
plot_asap	7
plot_gantt	8
plot_graphAOA	8
plot_norm	9
plot_TC	10
solve_lessAOA	10
solve_pathAOA	11
Index	14

cpmexample1

Dataset for the CPM method

Description

Fictitious data that is used in the examples. 6 activities, 5 nodes. In this dataset, the activities occur on the edges.

Usage

cpmexample1

Format

A data frame composed of predetermined columns:

from starting activity node

to final activity node

label activity label

time duration of the activity

cpmexample2

Dataset for the CPM method

Description

Example from Miszczyńska D., Miszczyński M. "Wybrane metody badań operacyjnych" (2000, ISBN:83-907712-0-9). 10 activities, 8 nodes. In this dataset, the activities occur on the edges and a list of direct predecessors has been added.

Usage

cpmexample2

Format

A data frame composed of predetermined columns:

label activity label

pred preceding activities

time duration of the activity

lessexample1

Dataset for the LESS method

Description

Fictitious data that is used in the examples. 6 activities, 5 nodes. In this dataset, the activities occur on the edges

Usage

lessexample1

Format

A data frame composed of predetermined columns:

from starting activity node

to final activity node

label activity label

time normal duration of the activity

bound_time the shortest duration of the activity

norm_cost normal cost of the activity

bound_cost boundary cost of the activity

 lessexample2

Dataset for the LESS method

Description

Example from Miszczyńska D., Miszczyński M. "Wybrane metody badań operacyjnych" (2000, ISBN:83-907712-0-9). In this dataset, the activities occur on the edges and a list of direct predecessors has been added.

Usage

lessexample2

Format

A data frame composed of predetermined columns:

label activity label

pred preceding activities

time normal duration of the activity

bound_time the shortest duration of the activity

norm_cost normal cost of the activity

bound_cost boundary cost of the activity

 pertexample1

Dataset for the PERT method

Description

Fictitious data that is used in the examples. 9 activities, 8 nodes. In this dataset, the activities occur on the edges

Usage

pertexample1

Format

A data frame composed of predetermined columns:

from starting activity node

to final activity node

label activity label

opt_time optimistic duration of activity

likely_time the most likely duration of the activity

pes_time pesimistic duration of activity

 pertexample2

Dataset for the PERT method

Description

Example from Miszczyńska D., Miszczyński M. "Wybrane metody badań operacyjnych" (2000, ISBN:83-907712-0-9). 10 activities, 8 nodes. In this dataset, the activities occur on the edges and a list of direct predecessors has been added.

Usage

```
pertexample2
```

Format

A data frame composed of predetermined columns:

label activity label

pred preceding activities

opt_time optimistic duration of activity

likely_time the most likely duration of the activity

pes_time pesimistic duration of activity

PERT_newprob

Probability for the given directive term

Description

Probability for the given directive term

Usage

```
PERT_newprob(new_DT, yourlist)
```

Arguments

new_DT The given project completion date. The parameter must be greater than zero.

yourlist List of objects that make up the solution to the project management problem.

Value

This function calculates the probability of completing the project within the time specified by the user. A normal distribution was assumed.

Examples

```
y <- solve_pathAOA(pertexample1, deterministic = FALSE)
PERT_newprob(new_DT = 30, y)
```

PERT_newtime	<i>A new directive term for any probability</i>
--------------	---

Description

A new directive term for any probability

Usage

```
PERT_newtime(new_prob = 0.5, yourlist)
```

Arguments

new_prob	Probability of the project completion. Default set to 0.5.
yourlist	List of objects that make up the solution to the project management problem.

Value

This function computes a new directive term for a probability given by the user. A normal distribution was assumed.

Examples

```
y <- solve_pathAOA(pertexample1, deterministic = FALSE)
PERT_newtime(new_prob = 0.3, y)
```

plot_alap	<i>An ALAP chart</i>
-----------	----------------------

Description

An ALAP chart

Usage

```
plot_alap(yourlist, show_dummy = FALSE, bar_size = 10)
```

Arguments

yourlist	List of objects that make up the solution to the project management problem.
show_dummy	Decides whether dummy activities should be included in the chart. If so, set it to TRUE (set to FALSE by default).
bar_size	Thickness of the bar drawn for activity (set to 10 by default).

Value

Draws an ALAP (activities start and finish As Late As Possible) chart broken down into critical ("CR") and non-critical ("NC") activities. Marks the slack of time.

Examples

```
x <- solve_pathAOA(cpmexample1, deterministic = TRUE)
plot_alap(x)
```

plot_asap

An ASAP chart

Description

An ASAP chart

Usage

```
plot_asap(yourlist, show_dummy = FALSE, bar_size = 10)
```

Arguments

yourlist	List of objects that make up the solution to the project management problem.
show_dummy	Decides whether dummy activities should be included in the chart. If so, set it to TRUE (set to FALSE by default).
bar_size	Thickness of the bar drawn for activity (set to 10 by default).

Value

Draws an ASAP (activities start and finish As Soon As Possible) chart broken down into critical ("CR") and non-critical ("NC") activities. Marks the slack of time.

Examples

```
x <- solve_pathAOA(cpmexample1, deterministic = TRUE)
plot_asap(x)
```

plot_gantt	<i>A Gantt chart</i>
------------	----------------------

Description

A Gantt chart

Usage

```
plot_gantt(yourlist, show_dummy = FALSE, bar_size = 10)
```

Arguments

yourlist	List of objects that make up the solution to the project management problem.
show_dummy	Decides whether dummy activities should be included in the chart. If so, set it to TRUE (set to FALSE by default).
bar_size	Thickness of the bar drawn for activity (set to 10 by default).

Value

Draws a Gantt chart broken down into critical ("CR") and non-critical ("NC") activities. Marks the slack of time.

Examples

```
x <- solve_pathAOA(cpmexample1, deterministic = TRUE)
plot_gantt(x)
```

plot_graphAOA	<i>A graph of connections between nodes</i>
---------------	---

Description

A graph of connections between nodes

Usage

```
plot_graphAOA(input_data, predecessors = FALSE, solved = NULL, fixed_seed = 23)
```

Arguments

input_data	Data frame describing the problem.
predecessors	TRUE if the user data contains a list of immediately preceding activities
solved	List of objects that make up the solution to the project management problem.
fixed_seed	Optional parameter setting random seed to user value to get similar looking plots each time the function is run (set to 23 by default).

Value

The function draws a graph showing dependencies between nodes. The "solved" parameter determines whether there is a critical path in the graph. In that case, you must solve the problem first. In the examples below, the function first draws the graph only on the basis of the data frame and then after determining the critical path.

Examples

```
plot_graphAOA(cpmexample1)
x <- solve_pathAOA(cpmexample1, TRUE)
plot_graphAOA(solved = x)
```

plot_norm

The cumulative distribution function of the normal distribution

Description

The cumulative distribution function of the normal distribution

Usage

```
plot_norm(yourlist)
```

Arguments

yourlist List of objects making up the solution to the project management problem

Value

Draws a graph of the normal distribution with the expected directive term from the PERT method and the standard deviation for this term. The chart also includes lines indicating the schedules of the risk-taker and the belayer.

Examples

```
y <- solve_pathAOA(pertexample1, deterministic = FALSE)
plot_norm(y)
```

plot_TC	<i>Total cost change plot</i>
---------	-------------------------------

Description

Total cost change plot

Usage

```
plot_TC(your_list)
```

Arguments

your_list List containing solved problem

Value

Based on the results of the LESS method, a graph of the total cost value of all iterations is created

Examples

```
z <- solve_lessAOA(lessexample1, 50, 15)
plot_TC(z)
```

solve_lessAOA	<i>Determines the solution using the LESS method. Relationships between activities can be given as a list of predecessors or start and end node numbers.</i>
---------------	--

Description

Determines the solution using the LESS method. Relationships between activities can be given as a list of predecessors or start and end node numbers.

Usage

```
solve_lessAOA(input_data, ICconst, ICslope, predecessors = FALSE)
```

Arguments

input_data Data frame containing the graph structure and activity durations. For the LESS method and start/end nodes you need 7 columns (the order matters):

1. from The number of the node where the activity starts.
2. to The number of the node where the activity ends.
3. label Activity labels.
4. time Normal duration of the activity.

5. bound_time Boundary (the shortest possible) duration of activities.
6. norm_cost Normal costs.
7. bound_cost Boundary costs.

For the LESS method and predecessors list you need 6 columns (the order matters):

1. label Activity labels.
2. pred List of predecessors.
3. time Normal duration of the activity.
4. bound_time Boundary (the shortest possible) duration of activities.
5. norm_cost Normal costs.
6. bound_cost Boundary costs.

ICconst	Intercept of the indirect cost function.
ICslope	Slope of the indirect cost function.
predecessors	TRUE if the user data contains a list of immediately preceding activities If set to FALSE (default), start nad end nodes are used. If is set to TRUE, predecessors list is used.

Value

A list made of a graph and a result set.

Examples

```
z <- solve_lessAOA(lessexample1, 50, 15)
```

solve_pathAOA	<i>Finds a solution using CPM and PERT methods. Relationships between activities can be given as a list of predecessors or start and end node numbers.</i>
---------------	--

Description

Finds a solution using CPM and PERT methods. Relationships between activities can be given as a list of predecessors or start and end node numbers.

Usage

```
solve_pathAOA(
  input_data,
  deterministic = TRUE,
  predecessors = FALSE,
  pert_param = 0
)
```

Arguments

input_data	<p>Data frame containing the structure of the graph and the duration of the activity. For the CPM method and start/end nodes you need 4 columns (the order is important, not the name of the column):</p> <ol style="list-style-type: none"> 1. from The number of the node where the activity starts. 2. to The number of the node where the activity ends. 3. label Activity labels. 4. time Activities duration. <p>For the CPM method and predecessors list you need 3 columns (the order is important, not the name of the column):</p> <ol style="list-style-type: none"> 1. label Activity labels. 2. pred List of predecessors. 3. time Activities duration. <p>For the PERT method and start/end nodes you need 6 columns (the order is important, not the name of the column):</p> <ol style="list-style-type: none"> 1. from The number of the node where the activity starts. 2. to The number of the node where the activity ends. 3. label Activity labels. 4. opt_time Optimistic duration of activities. 5. likely_time The most likely duration of the activity. 6. pes_time Pessimistic duration of activities. <p>For the PERT method and predecessors list you need 5 columns (the order is important, not the name of the column):</p> <ol style="list-style-type: none"> 1. label Activity labels. 2. pred List of predecessors. 3. opt_time Optimistic duration of activities. 4. likely_time The most likely duration of the activity. 5. pes_time Pessimistic duration of activities.
deterministic	A logical parameter specifying the solution method. If set to TRUE (default), the CPM method is used. If is set to FALSE, the PERT method is used.
predecessors	TRUE if the user data contains a list of immediately preceding activities If set to FALSE (default), start nad end nodes are used. If is set to TRUE, predecessors list is used.
pert_param	A parameter that controls the method of calculating the expected value and variance in the PERT method. 0 - classic formula (default), 1 - 1st and 99th percentile of the beta distribution, 2 - 5th and 95th percentile of the beta distribution, 3 - 5th and 95th percentiles of the beta distribution with modification by (Perry and Greig, 1975), 4 - Extended Pearson's and Tukey's formula (Pearson and Tukey, 1965), 5 - Golenko-Ginzburg's full formula (Golenko-Ginzburg, 1988), 6 - Golenko-Ginzburg's reduced formula (Golenko-Ginzburg, 1988), 7 - Farnum's and Stanton's formula (Farnum and Stanton, 1987).

Value

The list is made of a graph, schedule and selected partial results.

Examples

```
x <- solve_pathAOA(cpmexample1, deterministic = TRUE)
y <- solve_pathAOA(pertexample1, deterministic = FALSE)
x <- solve_pathAOA(cpmexample2, deterministic = TRUE, predecessors = TRUE)
y <- solve_pathAOA(pertexample2, deterministic = FALSE, predecessors = TRUE)
```

Index

* datasets

- cpmexample1, 2
- cpmexample2, 3
- lessexample1, 3
- lessexample2, 4
- pertexample1, 4
- pertexample2, 5

cpmexample1, 2
cpmexample2, 3

lessexample1, 3
lessexample2, 4

PERT_newprob, 5
PERT_newtime, 6
pertexample1, 4
pertexample2, 5
plot_alap, 6
plot_asap, 7
plot_gantt, 8
plot_graphAOA, 8
plot_norm, 9
plot_TC, 10

solve_lessAOA, 10
solve_pathAOA, 11