

# Package ‘CARNIVAL’

June 19, 2025

**Title** A CAusal Reasoning tool for Network Identification (from gene expression data) using Integer VALue programming

**Version** 2.19.0

**Description** An upgraded causal reasoning tool from Melas et al in R with updated assignments of TFs' weights from PROGENy scores.  
Optimization parameters can be freely adjusted and multiple solutions can be obtained and aggregated.

**URL** <https://github.com/saezlab/CARNIVAL>

**BugReports** <https://github.com/saezlab/CARNIVAL/issues>

**Depends** R (>= 4.0)

**Imports** readr, stringr, lpSolve, igraph, dplyr, tibble, tidyr, rjson, rmarkdown

**biocViews** Transcriptomics, GeneExpression, Network

**License** GPL-3

**LazyData** true

**Encoding** UTF-8

**Suggests** RefManager, BiocStyle, covr, knitr, testthat (>= 3.0.0), sessioninfo

**VignetteBuilder** knitr

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|----------------------|-------------------------------------------------------------------------------------------------------------------|
| addPerturbationNodes | <i>Introduces a perturbation node connecting periphery nodes without a target in the prior knowledge network.</i> |
|----------------------|-------------------------------------------------------------------------------------------------------------------|

---

**Description**

Introduces a perturbation node connecting periphery nodes without a target in the prior knowledge network.

**Usage**

```
addPerturbationNodes(priorKnowledgeNetwork)
```

**Arguments**

priorKnowledgeNetwork  
data.frame with priorKnowledgeNetwork with source, interaction, target columns.

**Value**

data.frame with prior knowledge network with added perturbations

**Author(s)**

Panuwat Trairatphisan, 2020

---

|                      |                                             |
|----------------------|---------------------------------------------|
| checkCarnivalOptions | <i>Checks options provided for CARNIVAL</i> |
|----------------------|---------------------------------------------|

---

**Description**

Checks options provided for CARNIVAL

**Usage**

```
checkCarnivalOptions(carnivalOptions)
```

**Arguments**

carnivalOptions  
all available carnival options

**Value**

returns TRUE if no error found.

---

|           |                                               |
|-----------|-----------------------------------------------|
| checkData | <i>Checks the input data for correctness.</i> |
|-----------|-----------------------------------------------|

---

**Description**

Checks the input data for correctness.

**Usage**

```
checkData(
  perturbations = NULL,
  measurements,
  priorKnowledgeNetwork,
  weights = NULL
)
```

**Arguments**

perturbations  
 measurements  
 priorKnowledgeNetwork  
  
 weights

**Value**

returns list of checked data

**Author(s)**

Enio Gjerga, Olga Ivanova, Attila Gabor, 2020-2021

---

|                      |                                                   |
|----------------------|---------------------------------------------------|
| checkOptionsValidity | <i>Checks if provided option names are valid.</i> |
|----------------------|---------------------------------------------------|

---

**Description**

Checks if provided option names are valid.

**Usage**

```
checkOptionsValidity(solver = getSupportedSolvers()$lpSolve, ...)
```

**Arguments**

solver                    one of the solvers available from getSupportedSolvers().  
 ...                      any possible options from the solver's list

**Value**

TRUE/FALSE depending on the status of the checks

**Examples**

```
checkOptionsValidity(solver="lpSolve")
```

---

```
checkPriorKnowledgeNetwork
```

*Checks prior knowledge network for correct format.*

---

**Description**

Checks prior knowledge network for correct format.

**Usage**

```
checkPriorKnowledgeNetwork(priorKnowledgeNetwork)
```

**Arguments**

priorKnowledgeNetwork

a network with 3 columns: source node ('source'), interaction sign ('interaction') and target node('target').

**Value**

TRUE if everything is correct. Stops pipeline if not.

**Author(s)**

Enio Gjerga, Olga Ivanova 2020-2021

---

```
createInternalDataRepresentation
```

*Creates internal data representation - variables for ILP solvers, on the basis of provided preprocessed data.*

---

**Description**

Creates internal data representation - variables for ILP solvers, on the basis of provided preprocessed data.

**Usage**

```
createInternalDataRepresentation(  
  dataPreprocessed,  
  newDataRepresentation = TRUE  
)
```

**Arguments**

- dataPreprocessed  
list containing preprocessed priorKnowledgeNetwork, measurements, weights (if provided), perturbations (if provided).
- newDataRepresentation  
TRUE by default. For debugging with the old data representation, put to FALSE.

**Value**

variables for the new data representation or data vector (containing preprocessed information on measurement) and variables for the old data representation (CARNIVAL v.<2)

---

defaultCbcSolveCarnivalOptions  
*Sets default CARNIVAL options for cbc.*

---

**Description**

Sets default CARNIVAL options for cbc.

**Usage**

```
defaultCbcSolveCarnivalOptions(...)
```

**Arguments**

- ... any possible options from the solver's list

**Value**

default CbB solver options as a list.

**Examples**

```
#defaultCbcSolveCarnivalOptions()
```

---

defaultCplexCarnivalOptions  
*Sets default CARNIVAL options for cplex.*

---

**Description**

Sets default CARNIVAL options for cplex.

**Usage**

```
defaultCplexCarnivalOptions(...)
```

**Arguments**

... any possible options from the solver's list

**Value**

default CPLEX solver options as a list.

**Examples**

```
defaultCplexCarnivalOptions()
```

---

```
defaultCplexSpecificOptions
```

*Sets default options from cplex documentation.*

---

**Description**

Sets default options from cplex documentation.

**Usage**

```
defaultCplexSpecificOptions(...)
```

**Arguments**

... any possible options from the solver's list

**Value**

default CPLEX solver options as a list.

**Examples**

```
defaultCplexSpecificOptions()
```

---

```
defaultLpSolveCarnivalOptions
```

*Sets default CARNIVAL options for lpSolve.*

---

**Description**

Sets default CARNIVAL options for lpSolve.

**Usage**

```
defaultLpSolveCarnivalOptions(...)
```

**Arguments**

... any possible options from the solver's list

**Value**

default lpSolve solver options as a list.

**Examples**

```
defaultLpSolveCarnivalOptions()
```

---

```
generateLpFileCarnival
                        generateLpFileCarnival
```

---

**Description**

generateLpFileCarnival

**Usage**

```
generateLpFileCarnival(
  perturbations = NULL,
  measurements,
  priorKnowledgeNetwork,
  weights = NULL,
  carnivalOptions = defaultLpSolveCarnivalOptions()
)
```

**Arguments**

|                       |                                                                                                                               |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------|
| perturbations         | (optional, if inverse CARNIVAL flavour is used further) vector of targets of perturbations.                                   |
| measurements          | vector of the measurements (i.e. DoRothEA/VIPER normalised enrichment scores)                                                 |
| priorKnowledgeNetwork | data frame of the prior knowledge network                                                                                     |
| weights               | (optional) vector of the additional weights: e.g. PROGENy pathway scores or measured protein activities.                      |
| carnivalOptions       | the list of options for the run. See defaultLpSolveCarnivalOptions(), defaultCplexCarnivalOptions, defaultCbcCarnivalOptions. |

**Details**

Prepares the input data for the run: transforms data into lp file and .Rdata file. These files can be reused to run CARNIVAL without preprocessing step using runCarnivalFromLp(..)

**Value**

paths to .lp file and .RData file that can be used for runFromLpCarnival()

**Examples**

```

load(file = system.file("toy_perturbations_ex1.RData",
                        package="CARNIVAL"))
load(file = system.file("toy_measurements_ex1.RData",
                        package="CARNIVAL"))
load(file = system.file("toy_network_ex1.RData",
                        package="CARNIVAL"))

## lpSolve
#res1 = generateLpFileCarnival(perturbations = toy_perturbations_ex1,
#                             measurements = toy_measurements_ex1,
#                             priorKnowledgeNetwork = toy_network_ex1,
#                             carnivalOptions = defaultLpSolveCarnivalOptions())

#res1["lpFile"] ##path to generated lp file
#res1["parsedDataFile"] ##path to data file used during generation

## Examples for cbc and cplex are commented out because these solvers are not part of R environment
## and need to be installed separately
##
## cbc
## res2 = generateLpFileCarnival(perturbations = toy_perturbations_ex1,
##                               measurements = toy_measurements_ex1,
##                               priorKnowledgeNetwork = toy_network_ex1,
##                               carnivalOptions = defaultCbcCarnivalOptions())
##
## res2["lpFile"] ##path to generated lp file
## res2["parsedDataFile"] ##path to data file used during generation
##
## cplex
## res3 = generateLpFileCarnival(perturbations = toy_perturbations_ex1,
##                               measurements = toy_measurements_ex1,
##                               priorKnowledgeNetwork = toy_network_ex1,
##                               carnivalOptions = defaultCplexCarnivalOptions())
##
## res3["lpFile"] ##path to generated lp file
## res3["parsedDataFile"] ##path to data file used during generation

```

---

|                |                                                                      |
|----------------|----------------------------------------------------------------------|
| getOptionsList | <i>Returns the list of options needed/supported for each solver.</i> |
|----------------|----------------------------------------------------------------------|

---

**Description**

Returns the list of options needed/supported for each solver.

**Usage**

```
getOptionsList(solver = "", onlyRequired = FALSE)
```

**Arguments**

|              |                                                                            |
|--------------|----------------------------------------------------------------------------|
| solver       | one of the solvers available from <code>getSupportedSolvers()</code>       |
| onlyRequired | logic, set to TRUE if you want to obtain only required options for the run |

**Value**

list of options, solver-dependent

---

getSupportedSolvers      *Returns the list of supported solvers.*

---

**Description**

Returns the list of supported solvers.

**Usage**

```
getSupportedSolvers()
```

**Value**

list of currently supported solvers.

---

getSupportedSolversFunctions  
*Supported solvers functions to work with all solvers in a uniform way.*

---

**Description**

To add a new solver, one must write and add here the functions for 3 steps: solve, obtaining a solution matrix, exporting the solution matrix. More specific functions can be written and called (e.g. check saveDiagnostics in cplex).

**Usage**

```
getSupportedSolversFunctions()
```

**Value**

list of solvers and their corresponding functions.

---

isInputValidCarnival    *Checks validity of all inputs of CARNIVAL*

---

## Description

Checks validity of all inputs of CARNIVAL

## Usage

```
isInputValidCarnival(
  perturbations = NULL,
  measurements,
  priorKnowledgeNetwork,
  weights = NULL,
  carnivalOptions = defaultLpSolveCarnivalOptions()
)
```

## Arguments

**perturbations**    (optional, if inverse CARNIVAL flavour is used further) vector of targets of perturbations.

**measurements**    vector of the measurements (i.e. DoRothEA/VIPER normalised enrichment scores)

**priorKnowledgeNetwork**  
data frame of the prior knowledge network

**weights**    (optional) vector of the additional weights: e.g. PROGENy pathway scores or measured protein activities.

**carnivalOptions**  
the list of options for the run. See defaultLpSolveCarnivalOptions(), defaultCplexCarnivalOptions, defaultCbcCarnivalOptions.

## Value

TRUE if everything passed the checks.

## Examples

```
load(file = system.file("toy_perturbations_ex1.RData",
  package="CARNIVAL"))
load(file = system.file("toy_measurements_ex1.RData",
  package="CARNIVAL"))
load(file = system.file("toy_network_ex1.RData",
  package="CARNIVAL"))

## lpSolve
#isInputValidCarnival(perturbations = toy_perturbations_ex1,
#
#                      measurements = toy_measurements_ex1,
#                      priorKnowledgeNetwork = toy_network_ex1,
#                      carnivalOptions = defaultLpSolveCarnivalOptions())
```

---

|               |                                                                    |
|---------------|--------------------------------------------------------------------|
| parseCplexLog | <i>Parses the cplex log file and reads some basic information.</i> |
|---------------|--------------------------------------------------------------------|

---

### Description

Parses the cplex log file and reads some basic information.

### Usage

```
parseCplexLog(log)
```

### Arguments

|     |                                                                                                                |
|-----|----------------------------------------------------------------------------------------------------------------|
| log | path of log file resulted from a carnival run OR the content of this file read by <a href="#">read_lines</a> . |
|-----|----------------------------------------------------------------------------------------------------------------|

### Value

list variable with following fields: - 'convergence' a table that contains information on the convergence of CPLEX - 'n\_solutions' number of solutions found - 'objective' objective function value - 'termination\_reason': reason of termination

### Author(s)

Attila Gabor, 2021

---

|                       |                                                                                                                                                                                                                      |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| prepareForCarnivalRun | <i>Prepares ILP formulation and writes it to .lp file. Currently supports the old data representation (CARNIVAL v.&lt;2) for debugging and testing if any problems arise with the new way to generate variables.</i> |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

### Description

Prepares ILP formulation and writes it to .lp file. Currently supports the old data representation (CARNIVAL v.<2) for debugging and testing if any problems arise with the new way to generate variables.

### Usage

```
prepareForCarnivalRun(
  dataPreprocessed,
  carnivalOptions,
  newDataRepresentation = TRUE
)
```

**Arguments**

- dataPreprocessed  
list containing preprocessed priorKnowledgeNetwork, measurements, weights (if provided), perturbations (if provided).
- carnivalOptions  
all options of CARNIVAL.
- newDataRepresentation  
TRUE by default. For debugging with the old data representation, put to FALSE.

**Value**

list with all variables and ILP formulation written in .lp file.

---

```
preprocessPriorKnowledgeNetwork
```

*Preprocesses prior knowledge network: correct nodes identifiers for symbols that might break solvers runs, assigns the types for each column: Node1 (character), Sign (numeric), Node2 (character). Stops if interaction/sign column has non-numeric value Detect and remove self-activation (would break loop constraints with CbC)*

---

**Description**

Preprocesses prior knowledge network: correct nodes identifiers for symbols that might break solvers runs, assigns the types for each column: Node1 (character), Sign (numeric), Node2 (character). Stops if interaction/sign column has non-numeric value Detect and remove self-activation (would break loop constraints with CbC)

**Usage**

```
preprocessPriorKnowledgeNetwork(priorKnowledgeNetwork)
```

**Arguments**

- priorKnowledgeNetwork  
a network with 3 columns: source node ('source'), interaction sign ('interaction') and target node('target').

**Value**

preprocessed prior knowledge network with corrected nodes identifiers add 3 columns: Node1, Sign, Node2

**Author(s)**

Enio Gjerga, Olga Ivanova 2020-2021

---

|                 |                                                           |
|-----------------|-----------------------------------------------------------|
| processSolution | <i>Exports the solution matrix to the final solution.</i> |
|-----------------|-----------------------------------------------------------|

---

### Description

Exports the solution matrix to the final solution.

### Usage

```
processSolution(
  solutionMatrix,
  variables,
  dataPreprocessed,
  carnivalOptions,
  newDataRepresentation = TRUE
)
```

### Arguments

|                       |                                                                                                                       |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------|
| solutionMatrix        | the output matrix from ILP solver containing variables list (rows) and their values in different solutions (columns). |
| variables             | list of nodes, edges and measurements variables generated by createLpFormulation_v2.                                  |
| dataPreprocessed      | list containing preprocessed priorKnowledgeNetwork, measurements, weights (if provided), perturbations (if provided). |
| carnivalOptions       | all options of CARNIVAL.                                                                                              |
| newDataRepresentation | TRUE by default. For debugging with the old data representation, put to FALSE.                                        |

### Value

Carnival results exported from the solution matrix. see runCARNIVAL for details.

---

|             |                                      |
|-------------|--------------------------------------|
| readOptions | <i>Reads options from json file.</i> |
|-------------|--------------------------------------|

---

### Description

Reads options from json file.

### Usage

```
readOptions(jsonFileName = "inst/carnival_cplex_parameters.json")
```

### Arguments

|              |                                               |
|--------------|-----------------------------------------------|
| jsonFileName | path to json files with setups for the solver |
|--------------|-----------------------------------------------|

**Value**

full list of options

---

|             |             |
|-------------|-------------|
| runCARNIVAL | runCARNIVAL |
|-------------|-------------|

---

**Description**

runCARNIVAL

**Usage**

```
runCARNIVAL(
  inputObj = NULL,
  measObj = measObj,
  netObj = netObj,
  weightObj = NULL,
  solverPath = NULL,
  solver = c("lpSolve", "cplex", "cbc", "gurobi"),
  timelimit = 3600,
  mipGAP = 0.05,
  poolrelGAP = 1e-04,
  limitPop = 500,
  poolCap = 100,
  poolIntensity = 4,
  poolReplace = 2,
  alphaWeight = 1,
  betaWeight = 0.2,
  threads = 0,
  cleanTmpFiles = TRUE,
  keepLPFiles = TRUE,
  clonelog = -1,
  dir_name = getwd()
)
```

**Arguments**

|            |                                                                                                                                                                    |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| inputObj   | Data frame of the list for target of perturbation - optional or default set to NULL to run invCARNIVAL when inputs are not known.                                  |
| measObj    | Data frame of the measurement file (i.e. DoRothEA normalised enrichment scores) - always required.                                                                 |
| netObj     | Data frame of the prior knowledge network - always required.                                                                                                       |
| weightObj  | Data frame of the additional weight (i.e. PROGENy pathway score or measured protein activities) - optional or default set as NULL to run CARNIVAL without weights. |
| solverPath | Path to executable cbc/cplex file - default set to NULL, in which case the solver from lpSolve package is used.                                                    |
| solver     | Solver to use: lpSolve/cplex/cbc (Default set to lpSolve).                                                                                                         |

|               |                                                                                                                                                                                                                                                                    |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| timelimit     | CPLEX/Cbc parameter: Time limit of CPLEX optimisation in seconds (default set to 3600).                                                                                                                                                                            |
| mipGAP        | CPLEX parameter: the absolute tolerance on the gap between the best integer objective and the objective of the best node remaining. When this difference falls below the value of this parameter, the linear integer optimization is stopped (default set to 0.05) |
| poolrelGAP    | CPLEX/Cbc parameter: Allowed relative gap of accepted solution comparing within the pool of accepted solution (default: 0.0001)                                                                                                                                    |
| limitPop      | CPLEX parameter: Allowed number of solutions to be generated (default: 500)                                                                                                                                                                                        |
| poolCap       | CPLEX parameter: Allowed number of solution to be kept in the pool of solution (default: 100)                                                                                                                                                                      |
| poolIntensity | CPLEX parameter: Intensity of solution searching (0,1,2,3,4 - default: 4)                                                                                                                                                                                          |
| poolReplace   | CPLEX parameter: Replacement strategy of solutions in the pool (0,1,2 - default: 2 = most diversified solutions)                                                                                                                                                   |
| alphaWeight   | Objective function: weight for mismatch penalty (default: 1 - will only be applied once measurement file only contains discrete values)                                                                                                                            |
| betaWeight    | Objective function: weight for node penalty (default: 0.2)                                                                                                                                                                                                         |
| threads       | CPLEX/CBC parameter: Number of threads to use default: 0 for maximum number possible threads on system                                                                                                                                                             |
| cleanTmpFiles | logic (default=TRUE), specifying if the tmp files made by solvers should be cleaned after run.                                                                                                                                                                     |
| keepLPFiles   | logic (default=TRUE), specifying if the LP file should be kept.                                                                                                                                                                                                    |
| clonelog      | determines if CPLEX clones the log files in case of multi-threaded optimization, default: -1, (no cloning)                                                                                                                                                         |
| dir_name      | Specify directory name to store results. by default set to NULL                                                                                                                                                                                                    |

## Details

Run CARNIVAL pipeline using to the user-provided list of inputs or run CARNIVAL built-in examples. The function is from v1.2 of CARNIVAL and is left for backward compatibility.

## Value

The function will return a list of results containing:

1. weightedSIF: A table with 4 columns containing the combined network solutions from CARNIVAL. It contains the Source of the interaction (Node1), Sign of the interaction (Sign), the Target of the interaction (Node2) and the weight of the interaction (Weight) which shows how often an interaction appears across all solutions.
2. nodesAttributes: A table with 6 columns containing information about inferred protein activity states and attributes. It contains the Protein IDs (Node); how often this node has taken an activity of 0, 1 and -1 across the solutions (ZeroAct, UpAct, DownAct); the average activities across solutions (AvgAct); and the node attribute (measured, target, inferred).
3. sifAll: A list of separate network solutions.
4. attributesAll: A list of separate inferred node activities in each solution.
5. diagnostics: reports the convergence of optimization and reason of the termination. Only for CPLEX solver.

**Author(s)**

Enio Gjerga, 2020 <carnival.developers@gmail.com>

**Examples**

```
load(file = system.file("toy_perturbations_ex1.RData",
  package="CARNIVAL"))
load(file = system.file("toy_measurements_ex1.RData",
  package="CARNIVAL"))
load(file = system.file("toy_network_ex1.RData",
  package="CARNIVAL"))

## lpSolve
#res1 = runCARNIVAL(inputObj = toy_perturbations_ex1,
#                   measObj = toy_measurements_ex1,
#                   netObj = toy_network_ex1,
#                   solver = 'lpSolve')

#res1$weightedSIF ##see @return
#res1$nodesAttributes ## see @return
#res1$sifAll ## see @return
#res1$attributesAll ## see @return

## Examples for cbc and cplex are commented out because these solvers are not part of R environment
## and need to be installed separately
##
## cbc
## res2 = runCARNIVAL(inputObj = toy_perturbations_ex1,
##                   measObj = toy_measurements_ex1,
##                   netObj = toy_network_ex1,
##                   solver = 'cbc')
##
## res2$weightedSIF ##see @return
## res2$nodesAttributes ## see @return
## res2$sifAll ## see @return
## res2$attributesAll ## see @return
##
## cplex
## res3 = runCARNIVAL(inputObj = toy_perturbations_ex1,
##                   measObj = toy_measurements_ex1,
##                   netObj = toy_network_ex1,
##                   solver = 'cplex')
##
## res3$weightedSIF ##see @return
## res3$nodesAttributes ## see @return
## res3$sifAll ## see @return
## res3$attributesAll ## see @return
```

---

|                   |                   |
|-------------------|-------------------|
| runFromLpCarnival | runCarnivalFromLp |
|-------------------|-------------------|

---

**Description**

runCarnivalFromLp

**Usage**

```
runFromLpCarnival(
  lpFile = "",
  parsedDataFile = "",
  carnivalOptions = defaultLpSolveCarnivalOptions()
)
```

**Arguments**

`lpFile` full path to .lp file

`parsedDataFile` full path to preprocessed .RData file

`carnivalOptions` the list of options for the run. See `defaultLpSolveCarnivalOptions()`, `defaultLpSolveCarnivalOptions`, `defaultCbcCarnivalOptions`.

**Details**

Runs CARNIVAL pipeline with prepared data - lp file and Rdata file containing variables for ILP formulation.

**Value**

The function will return a list of results containing:

1. `weightedSIF`: A table with 4 columns containing the combined network solutions from CARNIVAL. It contains the Source of the interaction (Node1), Sign of the interaction (Sign), the Target of the interaction (Node2) and the weight of the interaction (Weight) which shows how often an interaction appears across all solutions.
2. `nodesAttributes`: A table with 6 columns containing information about inferred protein activity states and attributes. It contains the Protein IDs (Node); how often this node has taken an activity of 0, 1 and -1 across the solutions (ZeroAct, UpAct, DownAct); the average activities across solutions (AvgAct); and the node attribute (measured, target, inferred).
3. `sifAll`: A list of separate network solutions.
4. `attributesAll`: A list of separate inferred node activities in each solution.
5. `diagnostics`: reports the convergence of optimization and reason of the termination. Only for CPLEX solver.

**Author(s)**

Enio Gjerga, Olga Ivanova 2020-2021 <carnival.developers@gmail.com>

**Examples**

```
lpFilePath = system.file("toy_lp_file_ex1.lp",
  package="CARNIVAL")

parsedDataFilePath = system.file("toy_parsed_data_ex1.RData",
  package="CARNIVAL")

## lpSolve
#res1 = runFromLpCarnival(lpFile = lpFilePath,
#                          parsedDataFile = parsedDataFilePath,
#                          carnivalOptions = defaultLpSolveCarnivalOptions())
```

```

#res1$weightedSIF ##see @return
#res1$nodesAttributes ## see @return
#res1$sifAll ## see @return
#res1$attributesAll ## see @return

## Examples for cbc and cplex are commented out because these solvers are not part of R environment
## and need to be installed separately
##
## cbc
## res2 = runFromLpCarnival(lpFile = lpFilePath,
##                          parsedDataFile = parsedDataFilePath,
##                          carnivalOptions = defaultLpCbcCarnivalOptions())
##
## res2$weightedSIF ##see @return
## res2$nodesAttributes ## see @return
## res2$sifAll ## see @return
## res2$attributesAll ## see @return
##
## cplex
## res3 = runFromLpCarnival(lpFile = lpFilePath,
##                          parsedDataFile = parsedDataFilePath,
##                          carnivalOptions = defaultLpCplexCarnivalOptions())
##
## res3$weightedSIF ##see @return
## res3$nodesAttributes ## see @return
## res3$sifAll ## see @return
## res3$attributesAll ## see @return

```

---

|                    |                    |
|--------------------|--------------------|
| runInverseCarnival | runInverseCarnival |
|--------------------|--------------------|

---

## Description

runInverseCarnival

## Usage

```

runInverseCarnival(
  measurements,
  priorKnowledgeNetwork,
  weights = NULL,
  carnivalOptions = defaultLpSolveCarnivalOptions()
)

```

## Arguments

|                       |                                                                                                         |
|-----------------------|---------------------------------------------------------------------------------------------------------|
| measurements          | vector of the measurements (i.e. DoRothEA/VIPER normalised enrichment scores)                           |
| priorKnowledgeNetwork | data frame of the prior knowledge network                                                               |
| weights               | (optional) vector of the additional weights: e.g. PROGENy pathway score or measured protein activities. |

carnivalOptions

the list of options for the run. See defaultLpSolveCarnivalOptions(), defaultLpSolveCarnivalOptions, defaultCbcCarnivalOptions.

## Details

TODO Replace with correct description

## Value

The function will return a list of results containing:

1. weightedSIF: A table with 4 columns containing the combined network solutions from CARNIVAL. It contains the Source of the interaction (Node1), Sign of the interaction (Sign), the Target of the interaction (Node2) and the weight of the interaction (Weight) which shows how often an interaction appears across all solutions.
2. nodesAttributes: A table with 6 columns containing information about inferred protein activity states and attributes. It contains the Protein IDs (Node); how often this node has taken an activity of 0, 1 and -1 across the solutions (ZeroAct, UpAct, DownAct); the average activities across solutions (AvgAct); and the node attribute (measured, target, inferred).
3. sifAll: A list of separate network solutions.
4. attributesAll: A list of separate inferred node activities in each solution.
5. diagnostics: reports the convergence of optimization and reason of the termination. Only for CPLEX solver.

## Author(s)

Enio Gjerga, Olga Ivanova 2020-2021 <carnival.developers@gmail.com>

## Examples

```
load(file = system.file("toy_measurements_ex1.RData",
                        package="CARNIVAL"))
load(file = system.file("toy_network_ex1.RData",
                        package="CARNIVAL"))

## lpSolve
#res1 = runInverseCarnival(measurements = toy_measurements_ex1,
#                          priorKnowledgeNetwork = toy_network_ex1,
#                          carnivalOptions = defaultLpSolveCarnivalOptions())

#res1$weightedSIF ##see @return
#res1$nodesAttributes ## see @return
#res1$sifAll ## see @return
#res1$attributesAll ## see @return

## Examples for cbc and cplex are commented out because these solvers are not part of R environment
## and need to be installed separately
##
## cbc
## res2 = runInverseCarnival(measurements = toy_measurements_ex1,
##                           priorKnowledgeNetwork = toy_network_ex1,
##                           carnivalOptions = defaultCbcCarnivalOptions())
##
## res2$weightedSIF ##see @return
```

```

## res2$nodesAttributes ## see @return
## res2$sifAll ## see @return
## res2$attributesAll ## see @return
##
## cplex
## res3 = runVanillaCarnival(measurements = toy_measurements_ex1,
##                           priorKnowledgeNetwork = toy_network_ex1,
##                           carnivalOptions = defaultCplexCarnivalOptions())
##
## res3$weightedSIF ##see @return
## res3$nodesAttributes ## see @return
## res3$sifAll ## see @return
## res3$attributesAll ## see @return

```

---

|                    |                    |
|--------------------|--------------------|
| runVanillaCarnival | runVanillaCarnival |
|--------------------|--------------------|

---

## Description

runVanillaCarnival

## Usage

```

runVanillaCarnival(
  perturbations,
  measurements,
  priorKnowledgeNetwork,
  weights = NULL,
  carnivalOptions = defaultLpSolveCarnivalOptions()
)

```

## Arguments

|                       |                                                                                                                                 |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------|
| perturbations         | vector of targets of perturbations.                                                                                             |
| measurements          | vector of the measurements (i.e. DoRothEA/VIPER normalised enrichment scores)                                                   |
| priorKnowledgeNetwork | data frame of the prior knowledge network                                                                                       |
| weights               | (optional) vector of the additional weights: e.g. PROGENy pathway score or measured protein activities.                         |
| carnivalOptions       | the list of options for the run. See defaultLpSolveCarnivalOptions(), defaultLpSolveCarnivalOptions, defaultCbcCarnivalOptions. |

## Details

Runs full CARNIVAL pipeline, vanilla(classic) flavour.

**Value**

The function will return a list of results containing: 1. **weightedSIF**: A table with 4 columns containing the combined network solutions from CARNIVAL. It contains the Source of the interaction (Node1), Sign of the interaction (Sign), the Target of the interaction (Node2) and the weight of the interaction (Weight) which shows how often an interaction appears across all solutions.

2. **nodesAttributes**: A table with 6 columns containing information about inferred protein activity states and attributes. It contains the Protein IDs (Node); how often this node has taken an activity of 0, 1 and -1 across the solutions (ZeroAct, UpAct, DownAct); the average activities across solutions (AvgAct); and the node attribute (measured, target, inferred).

3. **sifAll**: A list of separate network solutions.

4. **attributesAll**: A list of separate inferred node activities in each solution.

5. **diagnostics**: reports the convergence of optimization and reason of the termination. Only for CPLEX solver.

**Author(s)**

Enio Gjerga, Olga Ivanova 2020-2021 <carnival.developers@gmail.com>

**Examples**

```
load(file = system.file("toy_perturbations_ex1.RData",
                        package="CARNIVAL"))
load(file = system.file("toy_measurements_ex1.RData",
                        package="CARNIVAL"))
load(file = system.file("toy_network_ex1.RData",
                        package="CARNIVAL"))

## lpSolve
#res1 = runVanillaCarnival(perturbations = toy_perturbations_ex1,
#                          measurements = toy_measurements_ex1,
#                          priorKnowledgeNetwork = toy_network_ex1,
#                          carnivalOptions = defaultLpSolveCarnivalOptions())

#res1$weightedSIF ##see @return
#res1$nodesAttributes ## see @return
#res1$sifAll ## see @return
#res1$attributesAll ## see @return

## Examples for cbc and cplex are commented out because these solvers are not part of R environment
## and need to be installed separately
##
## cbc
## res2 = runVanillaCarnival(perturbations = toy_perturbations_ex1,
##                           measurements = toy_measurements_ex1,
##                           priorKnowledgeNetwork = toy_network_ex1,
##                           carnivalOptions = defaultCbcCarnivalOptions())
##
## res2$weightedSIF ##see @return
## res2$nodesAttributes ## see @return
## res2$sifAll ## see @return
## res2$attributesAll ## see @return
##
## cplex
## res3 = runVanillaCarnival(perturbations = toy_perturbations_ex1,
```

```
##                                measurements = toy_measurements_ex1,
##                                priorKnowledgeNetwork = toy_network_ex1,
##                                carnivalOptions = defaultCplexCarnivalOptions())
##
## res3$weightedSIF ##see @return
## res3$nodesAttributes ## see @return
## res3$sifAll ## see @return
## res3$attributesAll ## see @return
```

---

|                  |                                                                          |
|------------------|--------------------------------------------------------------------------|
| sendTaskToSolver | <i>Executes the solve on the provided ILP formulation (in .lp file).</i> |
|------------------|--------------------------------------------------------------------------|

---

## Description

Executes the solve on the provided ILP formulation (in .lp file).

## Usage

```
sendTaskToSolver(
  variables,
  dataPreprocessed,
  carnivalOptions,
  newDataRepresentation = TRUE
)
```

## Arguments

|                       |                                                                                                                       |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------|
| variables             | list of nodes, edges and measurements variables generated by createLpFormulation_v2.                                  |
| dataPreprocessed      | list containing preprocessed priorKnowledgeNetwork, measurements, weights (if provided), perturbations (if provided). |
| carnivalOptions       | all options of CARNIVAL.                                                                                              |
| newDataRepresentation | TRUE by default. For debugging with the old data representation, put to FALSE.                                        |

## Value

solution matrix from ILP solver containing variables list (rows) and their values in different solutions (columns).

---

|                    |                                              |
|--------------------|----------------------------------------------|
| setCarnivalOptions | <i>Sets CARNIVAL options for the solver.</i> |
|--------------------|----------------------------------------------|

---

### Description

Sets CARNIVAL options for the solver.

### Usage

```
setCarnivalOptions(solver = getSupportedSolvers()$lpSolve, ...)
```

### Arguments

|        |                                                          |
|--------|----------------------------------------------------------|
| solver | one of the solvers available from getSupportedSolvers(). |
| ...    | any possible options from the solver's list              |

### Value

carnival options as list.

### Examples

```
setCarnivalOptions(solver="lpSolve")
```

---

|               |                                                                                                                                                                                                                            |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| solveCarnival | <i>Main CARNIVAL function to execute the full pipeline: 1) preprocess the data 2) prepare ILP formulation 3) executes the solver on ILP formulation 4) parse the output of the solver and map it to the original data.</i> |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

### Description

Main CARNIVAL function to execute the full pipeline: 1) preprocess the data 2) prepare ILP formulation 3) executes the solver on ILP formulation 4) parse the output of the solver and map it to the original data.

### Usage

```
solveCarnival(dataPreprocessed, carnivalOptions, newDataRepresentation = TRUE)
```

### Arguments

|                       |                                                                                                                       |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------|
| dataPreprocessed      | list containing preprocessed priorKnowledgeNetwork, measurements, weights (if provided), perturbations (if provided). |
| carnivalOptions       | all options of CARNIVAL.                                                                                              |
| newDataRepresentation | TRUE by default. For debugging with the old data representation, put to FALSE.                                        |

**Value**

solution of the ILP problem.

---

|                     |                                                                                                                                                                   |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| solveCarnivalFromLp | <i>Sends the ILP formulation defined in .lp file to solver. Uses parsedDataFile to process the final solution and map the ILP variables back to initial data.</i> |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

**Description**

Sends the ILP formulation defined in .lp file to solver. Uses parsedDataFile to process the final solution and map the ILP variables back to initial data.

**Usage**

```
solveCarnivalFromLp(
  lpFile = "",
  parsedDataFile = "",
  carnivalOptions,
  newDataRepresentation = TRUE
)
```

**Arguments**

|                       |                                                                                                                             |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------|
| lpFile                | path to .lp file that will be used to run the solver.                                                                       |
| parsedDataFile        | path to parsed data file that was created after running <a href="#">prepareForCarnivalRun</a> or in previous CARNIVAL runs. |
| carnivalOptions       | all options of CARNIVAL.                                                                                                    |
| newDataRepresentation | TRUE by default. For debugging with the old data representation, put to FALSE.                                              |

**Value**

solution of ILP problem

---

|              |                                                  |
|--------------|--------------------------------------------------|
| solveWithCbc | <i>Executes cbc solver on provided .lp file.</i> |
|--------------|--------------------------------------------------|

---

**Description**

Executes cbc solver on provided .lp file.

**Usage**

```
solveWithCbc(carnivalOptions)
```

**Arguments**

carnivalOptions

**Value**

returns optimized variables in a solution matrix from CBC

---

|                 |                                                     |
|-----------------|-----------------------------------------------------|
| solveWithGurobi | <i>Executes gurobi solver on provided .lp file.</i> |
|-----------------|-----------------------------------------------------|

---

**Description**

Executes gurobi solver on provided .lp file.

**Usage**

```
solveWithGurobi(carnivalOptions)
```

**Arguments**

carnivalOptions

**Value**

Returns the name of the result files without ".sol" extension.

---

|                             |                                       |
|-----------------------------|---------------------------------------|
| suggestedCbcSpecificOptions | <i>Suggests cbc specific options.</i> |
|-----------------------------|---------------------------------------|

---

**Description**

Suggests cbc specific options.

**Usage**

```
suggestedCbcSpecificOptions(...)
```

**Arguments**

... any possible options from the solver's list

**Value**

additional CbC solver options as a list.

**Examples**

```
suggestedCbcSpecificOptions()
```

---

suggestedCplexSpecificOptions  
*Suggests cplex specific options.s*

---

**Description**

Suggests cplex specific options.s

**Usage**

suggestedCplexSpecificOptions(...)

**Arguments**

... any possible options from the solver's list

**Value**

additional CPLEX solver options as a list.

**Examples**

suggestedCplexSpecificOptions()

---

writeCplexCommandFileFromJson  
*writeCplexCommandFileFromJson*

---

**Description**

writeCplexCommandFileFromJson

**Usage**

```
writeCplexCommandFileFromJson(
  carnivalOptions,
  jsonFileName = "parameters/cplex_parameters_cmd_file.json"
)
```

**Arguments**

carnivalOptions      list of options for the CPLEX solver

jsonFileName      name to JSONfile containing the solver parameters

**Value**

list of params

---

|                 |                                                                                                  |
|-----------------|--------------------------------------------------------------------------------------------------|
| writeParsedData | <i>Saves all provided data together with generated variables for ILP problem in .RData file.</i> |
|-----------------|--------------------------------------------------------------------------------------------------|

---

**Description**

Saves all provided data together with generated variables for ILP problem in .RData file.

**Usage**

```
writeParsedData(  
  variables = variables,  
  dataPreprocessed = dataPreprocessed,  
  filename = "parsedData.RData"  
)
```

**Arguments**

|                  |                                                                                                                       |
|------------------|-----------------------------------------------------------------------------------------------------------------------|
| variables        | list of nodes, edges and measurements variables generated by createLpFormulation_v2                                   |
| dataPreprocessed | list containing preprocessed priorKnowledgeNetwork, measurements, weights (if provided), perturbations (if provided). |
| filename         | filename of the parsed data file.                                                                                     |

**Value**

filename of the parsed data file.

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