

Package ‘deident’

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Type Package

Title Persistent Data Anonymization Pipeline

Version 1.0.0

Description A framework for the replicable removal of personally identifiable data (PID) in data sets. The package implements a suite of methods to suit different data types based on the suggestions of Garfinkel (2015) <[doi:10.6028/NIST.IR.8053](https://doi.org/10.6028/NIST.IR.8053)> and the ICO ``Guidelines on Anonymization" (2012) <<https://ico.org.uk/media/1061/anonymisation-code.pdf>>.

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Author Robert Cook [aut, cre] (ORCID: <<https://orcid.org/0000-0003-3343-8271>>),
Md Assaduzaman [aut] (ORCID: <<https://orcid.org/0000-0002-8885-6721>>),
Sarahjane Jones [aut] (ORCID: <<https://orcid.org/0000-0003-4729-4029>>)

Maintainer Robert Cook <robert.cook@staffs.ac.uk>

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Contents

adaptive_noise	2
add_blur	3

add_encrypt	4
add_group	5
add_numeric_blur	6
add_perturb	6
add_pseudonymize	7
add_shuffle	8
apply_deident	9
apply_to_data_frame	10
BaseDeident	10
Blurer	11
category_blur	12
create_deident	12
deident	13
deident_job_from_folder	14
Drop	14
Encrypter	14
from_yaml	15
GroupedShuffler	16
lognorm_noise	16
NumericBlurer	17
Perturber	17
Pseudonymizer	18
ShiftsWorked	18
Shuffler	19
starwars	20
white_noise	21
Index	22

adaptive_noise	<i>Function factory to apply white noise to a vector proportional to the spread of the data</i>
----------------	---

Description

Function factory to apply white noise to a vector proportional to the spread of the data

Usage

```
adaptive_noise(sd.ratio = 1/10)
```

Arguments

sd.ratio the level of noise to apply relative to the vectors standard deviation.

Value

a function

Examples

```
f <- adaptive_noise(0.2)
f(1:10)
```

 add_blur

De-identification via categorical aggregation

Description

add_blur() adds an blurring step to a transformation pipeline (NB: intended for categorical data). When ran as a transformation, values are recoded to a lower cardinality as defined by blur. #'

Usage

```
add_blur(object, ..., blur = c())
```

Arguments

object	Either a data.frame, tibble, or existing DeidentList pipeline.
...	variables to be transformed.
blur	a key-value pair such that 'key' is replaced by 'value' on transformation.

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- deident_methods a list of each step in the pipeline (consisting of variables and method)

and methods:

- mutate apply the pipeline to a new data set
- to_yaml serialize the pipeline to a '.yaml' file

See Also

[category_blur\(\)](#) is provided to aid in defining the blur

Examples

```
.blur <- category_blur(ShiftsWorked$Shift, `Working` = "Day|Night")
pipe.blur <- add_blur(ShiftsWorked, `Shift`, blur = .blur)
pipe.blur$mutate(ShiftsWorked)
```

 add_encrypt

De-identification via hash encryption

Description

add_encrypt() adds an encryption step to a transformation pipeline. When ran as a transformation, each specified variable undergoes replacement via an encryption hashing function depending on the hash_key and seed set.

Usage

```
add_encrypt(object, ..., hash_key = "", seed = NA)
```

Arguments

object	Either a data.frame, tibble, or existing DeidentList pipeline.
...	variables to be transformed.
hash_key	a random alphanumeric key to control encryption
seed	a random alphanumeric to concat to the value being encrypted

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- deident_methods a list of each step in the pipeline (consisting of variables and method)

and methods:

- mutate apply the pipeline to a new data set
- to_yaml serialize the pipeline to a '.yaml' file

Examples

```
# Basic usage; without setting a `hash_key` or `seed` encryption is poor.
pipe.encrypt <- add_encrypt(ShiftsWorked, Employee)
pipe.encrypt$mutate(ShiftsWorked)

# Once set the encryption is more secure assuming `hash_key` and `seed` are
# not exposed.
pipe.encrypt.secure <- add_encrypt(ShiftsWorked, Employee, hash_key="hash1", seed="Seed2")
pipe.encrypt.secure$mutate(ShiftsWorked)
```

add_group	<i>Add aggregation to pipelines</i>
-----------	-------------------------------------

Description

add_group() allows for the injection of aggregation into the transformation pipeline. Should you need to apply a transformation under aggregation (e.g. add_shuffle) this helper creates a grouped data.frame as would be done with `dplyr::group_by()`. The function add_ungroup() is supplied to perform the inverse operation.

Usage

```
add_group(object, ...)
```

```
add_ungroup(object, ...)
```

Arguments

object	Either a data.frame, tibble, or existing DeidentList pipeline.
...	Variables on which data is to be grouped.

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- deident_methods a list of each step in the pipeline (consisting of variables and method)

and methods:

- mutate apply the pipeline to a new data set
- to_yaml serialize the pipeline to a '.yaml' file

Examples

```
pipe.grouped <- add_group(ShiftsWorked, Date, Shift)
pipe.grouped_shuffle <- add_shuffle(pipe.grouped, `Daily Pay`)
add_ungroup(pipe.grouped_shuffle, `Daily Pay`)
```

add_numeric_blur *De-identification via numeric aggregation*

Description

add_numeric_blur() adds an blurring step to a transformation pipeline (NB: intended for numeric data). When ran as a transformation, the data is split into intervals depending on the cuts supplied of the series [-Inf, cut.1), [cut.1, cut.2), ..., [cut.n, Inf] where cuts = c(cut.1, cut.2, ..., cut.n).

Usage

```
add_numeric_blur(object, ..., cuts = 0)
```

Arguments

object	Either a data.frame, tibble, or existing DeidentList pipeline.
...	variables to be transformed.
cuts	The position in which data is to be divided.

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- deident_methods a list of each step in the pipeline (consisting of variables and method)

and methods:

- mutate apply the pipeline to a new data set
- to_yaml serialize the pipeline to a '.yaml' file

add_perturb *De-identification via random noise*

Description

add_perturb() adds an perturbation step to a transformation pipeline (NB: intended for numeric data). When ran as a transformation, each specified variable is transformed by the noise function.

Usage

```
add_perturb(object, ..., noise = adaptive_noise(0.1))
```

Arguments

object	Either a data.frame, tibble, or existing DeidentList pipeline.
...	variables to be transformed.
noise	a single-argument function that applies randomness.

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- `deident_methods` a list of each step in the pipeline (consisting of variables and method)

and methods:

- `mutate` apply the pipeline to a new data set
- `to_yaml` serialize the pipeline to a '.yaml' file

See Also

[adaptive_noise\(\)](#), [white_noise\(\)](#), and [lognorm_noise\(\)](#)

Examples

```
pipe.perturb <- add_perturb(ShiftsWorked, `Daily Pay`)
pipe.perturb$mutate(ShiftsWorked)
```

```
pipe.perturb.white_noise <- add_perturb(ShiftsWorked, `Daily Pay`, noise=white_noise(0.1))
pipe.perturb.white_noise$mutate(ShiftsWorked)
```

```
pipe.perturb.noisy_adaptive <- add_perturb(ShiftsWorked, `Daily Pay`, noise=adaptive_noise(1))
pipe.perturb.noisy_adaptive$mutate(ShiftsWorked)
```

add_pseudonymize *De-identification via replacement*

Description

`add_pseudonymize()` adds a pseudonymization step to a transformation pipeline. When ran as a transformation, terms that have not been seen before are given a new random alpha-numeric string while terms that have been previously transformed reuse the same term.

Usage

```
add_pseudonymize(object, ..., lookup = list())
```

Arguments

<code>object</code>	Either a data.frame, tibble, or existing DeidentList pipeline.
<code>...</code>	variables to be transformed.
<code>lookup</code>	a pre-existing name-value pair to define intended pseudonymizations. Instances of 'name' will be replaced with 'value' on transformation.#'

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- `deident_methods` a list of each step in the pipeline (consisting of variables and method)

and methods:

- `mutate` apply the pipeline to a new data set
- `to_yaml` serialize the pipeline to a '.yaml' file

Examples

```
# Basic usage;
pipe.pseudonymize <- add_pseudonymize(ShiftsWorked, Employee)
pipe.pseudonymize$mutate(ShiftsWorked)

pipe.pseudonymize2 <- add_pseudonymize(ShiftsWorked, Employee,
                                       lookup=list("Kyle Wilson" = "Kyle"))
pipe.pseudonymize2$mutate(ShiftsWorked)
```

add_shuffle

De-identification via random sampling

Description

`add_shuffle()` adds a shuffling step to a transformation pipeline. When ran as a transformation, each specified variable undergoes a random sample without replacement so that summary metrics on a single variable are unchanged, but inter-variable metrics are rendered spurious.

Usage

```
add_shuffle(object, ..., limit = 0)
```

Arguments

<code>object</code>	Either a <code>data.frame</code> , <code>tibble</code> , or existing <code>DeidentList</code> pipeline.
<code>...</code>	variables to be transformed.
<code>limit</code>	integer - the minimum number of observations a variable needs to have for shuffling to be performed. If the variable has length less than <code>limit</code> values are replaced with NAs.

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- deident_methods a list of each step in the pipeline (consisting of variables and method)

and methods:

- mutate apply the pipeline to a new data set
- to_yaml serialize the pipeline to a '.yaml' file

See Also

[add_group\(\)](#) for usage under aggregation

Examples

```
# Basic usage;
pipe.shuffle <- add_shuffle(ShiftsWorked, Employee)
pipe.shuffle$mutate(ShiftsWorked)

pipe.shuffle.limit <- add_shuffle(ShiftsWorked, Employee, limit=1)
pipe.shuffle.limit$mutate(ShiftsWorked)
```

apply_deident	<i>Apply a 'deident' pipeline</i>
---------------	-----------------------------------

Description

Applies a pipeline as defined by deident to a data frame, tibble, or file.

Usage

```
apply_deident(object, deident, ...)
```

Arguments

object	The data to be deidentified
deident	A deidentification pipeline to be used.
...	Terms to be passed to other methods

`apply_to_data_frame` *Apply a 'deident' pipeline to a new data frame*

Description

Apply a 'deident' pipeline to a new data frame

Usage

```
apply_to_data_frame(data, transformer, ...)
```

Arguments

<code>data</code>	The data set to be converted
<code>transformer</code>	The pipeline to be used
<code>...</code>	To be passed on to other methods

`BaseDeident` *Base class for all De-identifier classes*

Description

Create new Deidentifier object
 Setter for 'method' field
 Save 'Deidentifier' to serialized object.
 Apply 'method' to a vector of values
 Apply 'method' to variables in a data frame
 Apply 'mutate' method to an aggregated data frame.
 Aggregate a data frame and apply 'mutate' to each.
 Convert self to a list
 String representation of self
 Check if parameters are in allowed fields

Arguments

<code>method</code>	New function to be used as the method.
<code>location</code>	File path to save to.
<code>keys</code>	Vector of values to be processed
<code>force</code>	Perform transformation on all variables even if some given are not in the data.
<code>grouped_data</code>	a 'grouped_df' object

data	A data frame to be manipulated
grp_cols	Vector of variables in 'data' to group on.
mutate_cols	Vector of variables in 'data' to transform.
type	character vector describing the object. Defaults to class.
...	Options to check exist

Fields

method Function to call for data transform.

Blurer	<i>Deidentifier class for applying 'blur' transform</i>
--------	---

Description

Convert self to a list.

Arguments

blur	Look-up list to define aggregation.
keys	Vector of values to be processed
...	Values to be concatenated to keys

Details

'Blurring' refers to aggregation of data e.g. converting city to country, or post code to IMD. The level of blurring is defined by the list given at initialization which maps key to value e.g. list(London = "England", Paris = "France").

Value

Blurer Apply blur to a vector of values

Fields

blur List of aggregations to be applied. Create new Blurer object

category_blur	<i>Utility for producing 'blur'</i>
---------------	-------------------------------------

Description

Utility for producing 'blur'

Usage

```
category_blur(vec, ...)
```

Arguments

vec	The vector of values to be used
...	Replacement = Regexpattern pairs of arguments

create_deident	<i>Create a deident pipeline</i>
----------------	----------------------------------

Description

Create a deident pipeline

Usage

```
create_deident(method, ...)
```

Arguments

method	A deidentifier to initialize.
...	list of variables to be deidentifier. NB: key word arguments will be passed to method at initialization.

`deident`*Define a transformation pipeline*

Description

`deident()` creates a transformation pipeline of 'deidentifiers' for the repeated application of anonymization transformations.

Usage

```
deident(data, deidentifier, ...)
```

Arguments

<code>data</code>	A data frame, existing pipeline, or a 'deidentifier' (as either initialized object, class generator, or character string)
<code>deidentifier</code>	A deidentifier' (as either initialized object, class generator, or character string) to be appended to the current pipeline
<code>...</code>	Positional arguments are variables of 'data' to be transformed and key-word arguments are passed to 'deidentifier' at creation

Value

A 'DeidentList' representing the untrained transformation pipeline. The object contains fields:

- `deident_methods` a list of each step in the pipeline (consisting of variables and method)

and methods:

- `mutate` apply the pipeline to a new data set
- `to_yaml` serialize the pipeline to a '.yaml' file

Examples

```
#  
pipe <- deident(ShiftsWorked, Pseudonymizer, Employee)  
  
print(pipe)  
  
apply_deident(ShiftsWorked, pipe)
```

```
deident_job_from_folder
```

Apply a pipeline to files on disk.

Description

Apply a deident pipeline to a set of files and save them back to disk

Usage

```
deident_job_from_folder(
  deident_pipeline,
  data_dir,
  result_dir = "Deident_results"
)
```

Arguments

deident_pipeline	The deident list to be used.
data_dir	a path to the files to be transformed.
result_dir	a path to where files are to be saved.

```
Drop
```

R6 class for the removal of variables from a pipeline

Description

A Deident class dealing with the exclusion of variables.

```
Encrypter
```

Deidentifier class for applying 'encryption' transform

Description

Create new Encrypter object
Convert self to a list.

Arguments

hash_key	An alpha numeric key for use in encryption
seed	An alpha numeric key which is concatenated to minimize brute force attacks
keys	Vector of values to be processed
...	Values to be concatenated to keys

Details

'Encrypting' refers to the cryptographic hashing of data e.g. md5 checksum. Encryption is more powerful if a random hash and seed are supplied and kept secret.

Value

Encrypter Apply blur to a vector of values

Fields

hash_key Alpha-numeric secret key for encryption

seed String for concatenation to raw value

from_yaml	<i>Restore a serialized deident from file</i>
-----------	---

Description

Restore a serialized deident from file

Usage

```
from_yaml(path)
```

Arguments

path Path to serialized deident.

Examples

```
deident <- deident(ShiftsWorked, Pseudonymizer, Employee)
.tempfile <- tempfile(fileext = ".yaml")
deident$to_yaml(.tempfile)
```

```
deident.yaml <- from_yaml(.tempfile)
deident.yaml$mutate(ShiftsWorked)
```

GroupedShuffler	<i>GroupedShuffler class for applying 'shuffling' transform with data aggregated</i>
-----------------	--

Description

Convert self to a list.

Character representation of the class

Arguments

limit	Minimum number of rows required to shuffle data
data	A data frame to be manipulated
...	Vector of variables in 'data' to transform.

Details

'Shuffling' refers to the a random sampling of a variable without replacement e.g. [A, B, C] becoming [B, A, C] but not [A, A, B]. "Grouped shuffling" refers to aggregating the data by another feature before applying the shuffling process. Grouped shuffling will preserve aggregate level metrics (e.g. mean, median, mode) but removes ordinal properties i.e. correlations and auto-correlations

Fields

group_on Symbolic representation of grouping variables

limit Minimum number of rows required to shuffle data Create new GroupedShuffler object

lognorm_noise	<i>Function factory to apply log-normal noise to a vector</i>
---------------	---

Description

Function factory to apply log-normal noise to a vector

Usage

```
lognorm_noise(sd = 0.1)
```

Arguments

sd	the standard deviation of noise to apply.
----	---

Value

a function

Examples

```
f <- lognorm_noise(1)
f(1:10)
```

NumericBlurer	<i>Group numeric data into baskets</i>
---------------	--

Description

Group numeric data into baskets

Perturber	<i>R6 class for deidentification via random noise</i>
-----------	---

Description

A Deident class dealing with the addition of random noise to a numeric variable.

Create new Perturber object

Apply noise to a vector of values

Convert self to a list.

Character representation of the class

Arguments

noise a single-argument function that applies randomness.

keys Vector of values to be processed

... Values to be concatenated to keys

Fields

noise.str character representation of noise

method random noise function

Examples

```
pert <- Perturber$new()
pert$transform(1:10)
```

Pseudonymizer	<i>R6 class for deidentification via replacement</i>
---------------	--

Description

A Deident class dealing with the (repeatable) random replacement of string for deidentification.

Create new Pseudonymizer object

Check if a key exists in lookup

Check if a key exists in lookup

Retrieve a value from lookup

Returns self\$lookup formatted as a tibble

Convert self to a list.

Apply the deidentification method to the supplied keys

Arguments

lookup a pre-existing name-value pair to define intended psuedonymizations. Instances of 'name' will be replaced with 'value' on transformation.

keys value to be checked

... values to concatenate to key and check

parse_numerics True: Force columns to characters. NB: only character vectors will be parsed.

Fields

lookup list of mapping from key-value on transform.

ShiftsWorked	<i>Synthetic data set listing daily shift pattern for fictitious employees</i>
--------------	--

Description

A synthetic data set intended to demonstrate the design and application of a deidentification pipeline. Employee names are entirely fictitious and constructed from the [FiveThirtyEight Most Common Name Dataset](#).

Usage

ShiftsWorked

Format

A data frame with 3,100 rows and 6 columns:

Record ID Table primary key (integer)

Employee Name of listed employee

Date The date being considered

Shift The shift-type done by employee on date. One of 'Day', 'Night' or 'Rest'.

Shift Start Shift start time (missing if on 'Rest' shift)

Shift End Shift end time (missing if on 'Rest' shift)

Daily Pay Shift end time (missing if on 'Rest' shift)

Shuffler

Shuffler class for applying 'shuffling' transform

Description

Create new Shuffler object

Update minimum vector size for shuffling

Apply the deidentification method to the supplied keys

Convert self to a list.

Arguments

method	[optional] A function representing the method of re-sampling to be used. By default uses exhaustive sampling without replacement.
keys	Value(s) to be transformed.
...	Value(s) to concatenate to keys and transform @inheritParams Pseudonymizer
limit	integer - the minimum number of observations a variable needs to have for shuffling to be performed. If the variable has length less than limit values are replaced with NAs.

Details

'Shuffling' refers to the a random sampling of a variable without replacement e.g. [A, B, C] becoming [B, A, C] but not [A, A, B]. Shuffling will preserve top level metrics (e.g. mean, median, mode) but removes ordinal properties i.e. correlations and auto-correlations

Fields

limit minimum vector length to be shuffled. If vector to be transformed has length < limit, the data is replaced with NAs

starwars

Starwars characters

Description

The original data, from SWAPI, the Star Wars API, <https://swapi.py4e.com/>, has been revised to reflect additional research into gender and sex determinations of characters. NB: taken from dplyr

Usage

starwars

Format

A tibble with 87 rows and 14 variables:

name Name of the character

height Height (cm)

mass Weight (kg)

hair_color,skin_color,eye_color Hair, skin, and eye colors

birth_year Year born (BBY = Before Battle of Yavin)

sex The biological sex of the character, namely male, female, hermaphroditic, or none (as in the case for Droids).

gender The gender role or gender identity of the character as determined by their personality or the way they were programmed (as in the case for Droids).

homeworld Name of homeworld

species Name of species

films List of films the character appeared in

vehicles List of vehicles the character has piloted

starships List of starships the character has piloted

Examples

starwars

white_noise	<i>Function factory to apply white noise to a vector</i>
-------------	--

Description

Function factory to apply white noise to a vector

Usage

```
white_noise(sd = 0.1)
```

Arguments

sd the standard deviation of noise to apply.

Value

a function

Examples

```
f <- white_noise(1)
f(1:10)
```

Index

* API

- [add_blur](#), 3
- [add_encrypt](#), 4
- [add_group](#), 5
- [add_numeric_blur](#), 6
- [add_perturb](#), 6
- [add_pseudonymize](#), 7
- [add_shuffle](#), 8

* datasets

- [ShiftsWorked](#), 18
- [starwars](#), 20

- [adaptive_noise](#), 2
- [adaptive_noise\(\)](#), 7
- [add_blur](#), 3
- [add_encrypt](#), 4
- [add_group](#), 5
- [add_group\(\)](#), 9
- [add_numeric_blur](#), 6
- [add_perturb](#), 6
- [add_pseudonymize](#), 7
- [add_shuffle](#), 8
- [add_ungroup \(add_group\)](#), 5
- [apply_deident](#), 9
- [apply_to_data_frame](#), 10

- [BaseDeident](#), 10
- [Blurer](#), 11

- [category_blur](#), 12
- [category_blur\(\)](#), 3
- [create_deident](#), 12

- [deident](#), 13
- [deident_job_from_folder](#), 14
- [dplyr::group_by\(\)](#), 5
- [Drop](#), 14

- [Encrypter](#), 14

- [from_yaml](#), 15

- [GroupedShuffler](#), 16

- [lognorm_noise](#), 16
- [lognorm_noise\(\)](#), 7

- [NumericBlurer](#), 17

- [Perturber](#), 17
- [Pseudonymizer](#), 18

- [ShiftsWorked](#), 18
- [Shuffler](#), 19
- [starwars](#), 20

- [white_noise](#), 21
- [white_noise\(\)](#), 7