Package 'callback'

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Type Package

Title Computes Statistics from Discrimination Experimental Data

Version 0.1.3

Description In discrimination experiments candidates are sent on the same test (e.g. job, house rental) and one examines whether they receive the same outcome. The number of non negative answers are first examined in details looking for outcome differences. Then various statistics are computed. This package can also be used for analyzing the results from random experiments.

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 7.3.1

Imports stats, ggplot2

Suggests knitr, rmarkdown

BuildVignettes true

VignetteBuilder knitr

NeedsCompilation no

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Contents

address1 *Origin/Gender discrimination and strongly negative mediatic exposure (information technologist)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between December 2008 and January 2009. A candidate is defined by the variables ("gender","origin", "mediaexp"). The variable "reput" creates a sample separation.

- **offer:** add number
- **date:** date of the application
- **sentorder:** order in which the application was sent
- **callback:** TRUE if there was a non negative callback
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **origin:** all the candidates are French, the origin is suggested by the name, F = France, M = Morocco
- **gender:** Woman or Man
- **city:** candidate location
- **reput:** reputation of the city, P = privileged, U = Unprivileged
- **mediaexp:** strong negative mediatic exposure, Yes or No

Usage

```
data(address1)
```

Format

A data frame with 3684 rows and 11 variables

References

Duguet E., Gray D., L'Horty Y., Du Parquet L, Petit P., 2020. Labor market effects of urban riots: an experimental assessment. Papers in Regional Science, 99:787-806.

`callback` *Data formatting*

Description

Creates the data set used in the callback package.

Usage

```
callback(data, cluster, candid, callback, comp = "ref")
```

Arguments

`data`	A data frame.
`cluster`	A variable name, identifying the test (e.g., a job offer number).
`candid`	A list of factor names defining the candidates (e.g., gender, origin).
`callback`	A Boolean variable, equal to TRUE for non negative callbacks.
`comp`	An option, equal to "all" or "ref" (the default). "ref" give the comparisons with the reference candidate, and "all" the pairwise comparisons.

Value

A list with class 'callback' containing the formatted data set (`fds`), the averaged formatted data set (`afds`, for multiple tests), the list of the paired formatted data sets (`pfds`), the offer-level formatted data set (`ofds`), the names of the candidate variables (`candid`) and the name of the callback variable (`callback`).

`fds` contains the following variables:

- **cluster:** the cluster variable
- **candid:** the concatenation of the candidate variables
- **callback:** the callback variable

`afds` contains the following variables:

- **cluster:** the cluster variable
- **candid:** the concatenation of the candidate variables
- **callback:** the aggregated callback dummy

`pfds` data frames containing the following variables:

- **callback1:** TRUE if candidate 1 had a callback
- **callback2:** TRUE if candidate 2 had a callback
- **c00:** TRUE if neither candidate was called back
- **c10:** TRUE if candidate 1 was the only one called back
- **c01:** TRUE if candidate 2 was the only one called back

- **c11:** TRUE if both candidates were called back
- **callback:** TRUE if either candidate was called back
- **calldif:** callback difference

ofds contains variables corresponding to the candidates' codes and the following variables:

- **cluster:** the cluster variable
- **ncall:** the number of callback for the current offer

Author(s)

Emmanuel Duguet

Examples

```
data(inter1)
m <- callback(data=subset(origin1,reput=="U"),cluster="offer",candid="origin",
     callback="callback",comp = "ref")
str(m)
```

---

callback_comp *Creates the estimation data for a component model*

Description

Creates the estimation data for a component model

Usage

```
callback_comp(
  data = NULL,
  cluster = NULL,
  candid = NULL,
  callback = NULL,
  model = NULL
)
```

Arguments

data	a data frame.
cluster	A variable name, identifying the test (e.g., a job offer number).
candid	A list of factor names defining the candidates (e.g., gender, origin).
callback	A Boolean variable, equal to TRUE for non negative callbacks.
model	a list of string lists, defining the components of the model, in difference from the reference candidate.

Value

a list with class `callback_comp` containing:

- **aux_cand:** list of the candidates.
- **aux_model:** summary of the components model.
- **aux_boole:** Boole matrix of the components model.
- **aux_det:** determinant of `t(aux_boole)%*%aux_boole`.
- **aux_coef:** auxilliary parameters.
- **aux_vcov:** covariance matrix of the auxilliary parameters.
- **aux_cor:** correlation matrix of the auxilliary parameters.

Author(s)

Emmanuel Duguet

Examples

```
data(mobility1)
model <- list(c("license"),c("woman"),c("woman","license","inter"))
callback_comp(data = mobility1, cluster = "offer",
candid = c("gender","licenses"), callback = "callback",
model = model)
```

---

gender1 *Gender/Maternity discrimination (commercial and administrative jobs in the financial sector)*

Description

The data were collected in January-March 2002 by Pascale Petit for her PhD thesis (University of Paris I-Panthéon-Sorbonne, 2004). A candidate is defined by the variables ("gender","age","child").

- **offer:** add number
- **gender:** Woman or Man
- **age:** 25 or 37 years old
- **child:** number of children, 0 or 3
- **educ:** education, BAC = Baccalauréat = A-level, BTS = 2 years of vocational training after the A-level
- **qual:** qualification required by the offer, Administrative or Commercial
- **date:** January 2002, February 2002 or March 2002
- **cv:** CV template, A or B
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)

- **popp:** promotion opportunity, Yes or No
- **train:** training included, Yes or No
- **negow:** negotiable wage, Yes or No
- **incent:** wage depending on output, Yes or No
- **callback:** TRUE if there was a non negative callback

Usage

```
data(gender1)
```

Format

A data frame with 942 rows and 14 variables

References

Duguet E., Petit P., 2005. Hiring discrimination in the French financial sector: an econometric analysis on field experiment data. Annals of Economics and Statistics, 78: 79-102.

Petit P., 2007. The effects of age and family constraints on gender hiring discrimination: A field experiment in the French financial sector. Labor Economics, 14: 371-391.

`gender2` *Gender/Maternity discrimination (electricians)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between February and July 2015. A candidate is defined by the variables ("gender","educ").

- **offer:** add number
- **gender:** Woman or Man
- **age:** 23 or 24 years old
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **educ:** education, CAP = vocational training certificate before the A level, MAF = CAP + "One of the best French apprentice", OLY = CAP + participation to the Worldskills Competition
- **zip:** ZIP code
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **recgender:** gender of the recruiter
- **cv:** CV template, A or B
- **ansmode:** answering channel, email or ordinary mail ("omail")
- **sentorder:** order in which the application was sent
- **hours:** weekly work time
- **callback:** TRUE if there was a non negative callback
- **date:** between February and July 2015

Usage

```
data(gender2)
```

Format

A data frame with 564 rows and 15 variables

References

Duguet E., du Parquet L., Petit P. (2022). Extracting the discrimination components from the callback rates". TEPP Working Paper 2022-15.

Duguet, E., du Parquet, L. & Petit, P. (2022). Révéler les composantes de la discrimination à partir des taux de rappel. Revue française d'économie, XXXVII, 233-268.

---

gender3 *Gender/Maternity discrimination (masons)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between February and July 2015. A candidate is defined by the variables ("gender","educ").

- **offer:** add number
- **gender:** Woman or Man
- **age:** 23 or 24 years old
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **educ:** education, CAP = vocational training certificate before the A level, MAF = CAP + "One of the best French apprentice", OLY = CAP + participation to the Worldskills Competition
- **zip:** ZIP code
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **recgender:** gender of the recruiter
- **cv:** CV template, A or B
- **ansmode:** answering channel, email or ordinary mail ("omail")
- **sentorder:** order in which the application was sent
- **hours:** weekly work time
- **callback:** TRUE if there was a non negative callback
- **date:** between February and July 2015

Usage

```
data(gender3)
```

Format

A data frame with 532 rows and 15 variables

References

Duguet E., du Parquet L., Petit P. (2022). Extracting the discrimination components from the call-back rates". TEPP Working Paper 2022-15.

Duguet, E., du Parquet, L. & Petit, P. (2022). Révéler les composantes de la discrimination à partir des taux de rappel. Revue française d'économie, XXXVII, 233-268.

---

gender4 *Gender/Maternity discrimination (plumbers)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between February and July 2015. A candidate is defined by the variables ("gender","educ").

- **offer:** add number
- **gender:** Woman or Man
- **age:** 23 or 24 years old
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **educ:** education, CAP = vocational training certificate before the A level, MAF = CAP + "One of the best French apprentice", OLY = CAP + participation to the Worldskills Competition
- **zip:** ZIP code
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **recgender:** gender of the recruiter
- **cv:** CV template, A or B
- **ansmode:** answering channel, email or ordinary mail ("omail")
- **sentorder:** order in which the application was sent
- **hours:** weekly work time
- **callback:** TRUE if there was a non negative callback
- **date:** between February and July 2015

Usage

```
data(gender4)
```

Format

A data frame with 1152 rows and 15 variables

References

Duguet E., du Parquet L., Petit P. (2022). Extracting the discrimination components from the call-back rates". TEPP Working Paper 2022-15.

Duguet, E., du Parquet, L. & Petit, P. (2022). Révéler les composantes de la discrimination à partir des taux de rappel. Revue française d'économie, XXXVII, 233-268.

`g_difp` *Difference of proportions plot*

Description

Difference of proportions plot

Usage

```
g_difp(data = NULL, col = NULL, ...)
```

Arguments

`data`	A `callback_stat` object.
`col`	A list of three colors.
`...`	further arguments passed to or from other methods.

Value

A ggplot2 object

Author(s)

Emmanuel Duguet

Examples

```
data(labour1)
m <- callback(labour1,"offer","hist","callback","all")
s <- stat_mcr(m)
g_difp(s)
```

g_ecs *Exclusive callback shares plot*

Description

Exclusive callback shares plot

Usage

```
g_ecs(data = NULL, col = NULL, ...)
```

Arguments

data	a callback_stat object.
col	A list of four colors.
...	further arguments passed to or from other methods.

Value

A ggplot2 object

Author(s)

Emmanuel Duguet

Examples

```
data(labour1)
m <- callback(labour1,"offer","hist","callback","all")
s <- stat_ecs(m)
g_ecs(s)
```

g_mcr *Proportions' comparison plot*

Description

Proportions' comparison plot

Usage

```
g_mcr(data = NULL, col = NULL, ...)
```

Arguments

data	A callback_stat object.
col	A list of three colors.
...	further arguments passed to or from other methods.

Value

A ggplot2 object

Author(s)

Emmanuel Duguet

Examples

```
data(labour1)
m <- callback(labour1,"offer","hist","callback","all")
s <- stat_mcr(m)
g_mcr(data = s)
```

---

g_raw *Raw callback rates plot*

Description

Raw callback rates plot

Usage

```
g_raw(data = NULL, col = NULL, ...)
```

Arguments

data	A callback_stat object.
col	A list of two colors.
...	further arguments passed to or from other methods.

Value

A ggplot2 object

Author(s)

Emmanuel Duguet

Examples

```
data(origin1)
m <- callback(labour1,"offer","hist","callback","all")
s <- stat_raw(m)
g_raw(s)
```

`g_tcs` *Total callback shares plot*

Description

Total callback shares plot

Usage

```
g_tcs(data = NULL, col = NULL, ...)
```

Arguments

`data`	a `callback_stat` object.
`col`	A list of three colors.
`...`	further arguments passed to or from other methods.

Value

A ggplot2 object

Author(s)

Emmanuel Duguet

Examples

```
data(labour1)
m <- callback(labour1,"offer","hist","callback","all")
s <- stat_tcs(m)
g_tcs(s)
```

`inter1` *Gender/Origin discrimination (software developer)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between February and April 2009. A candidate is defined by the variables ("gender","origin").

- **offer:** add number
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **gender:** Woman or Man
- **origin:** all candidates are French, the origin is suggested by the name. F = French, S = Senegal, M = Morocco, V = Vietnam
- **date:** date of the application
- **sentorder:** order in which the application was sent
- **callback:** TRUE if there was a non negative callback
- **ansorder:** order in which the answer was received when positive, 9 otherwise
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **paris:** job located inside Paris, Yes or No

Usage

```
data(inter1)
```

Format

A data frame with 2480 rows and 11 variables

References

Petit P., Duguet E., L'Horty Y., Du Parquet L., Sari F., 2013. Discrimination à l'embauche : les effets du genre et de l'origine se cumulent-ils systématiquement ? Economie et Statistique, 464-465-466: 141-153.

Duguet E., Du Parquet L, L'Horty Y., Petit P., 2015. New Evidence of Ethnic and Gender discriminations in the French Labor Market using experimental data: A ranking extension of responses from correspondence tests. Annals of Economics and Statistics, 117-118: 21-39.

is.calc *Computational compatibility*

Description

Computational compatibility

Usage

```
is.calc(x)
```

Arguments

x	A variable name

Value

A logical variable indicating whether the variable can be used for computations (TRUE) or not (FALSE).

Examples

```
data(origin1)
is.calc(origin1$cartime)
is.calc(origin1$callback)
is.calc(origin1$origin)
```

labour1 *Labour market history discrimination (accountants)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between February and April 2015. A candidate is defined by the variable "hist".

- **offer:** add number
- **date:** date of the application
- **sentorder:** order in which the application was sent
- **callback:** TRUE if there was a non negative callback
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **paris:** job located inside Paris, Yes or No
- **hist:** history in the labour market, LTC = Long term contract, LTU = Long term unemployment, STU = Short term unemployment, STC = Short term contract, PTC = Part time contract

Usage

```
data(labour1)
```

Format

A data frame with 1475 rows and 7 variables

References

Duguet E., Le Gall R., L'Horty Y., Petit P., 2018. How does labour market history influence the access to hiring interviews? International Journal of Manpower, 39(4), 519-533.

---

labour2 *Labour market history discrimination (sales assistant)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between January and April 2015. A candidate is defined by the variable "hist".

- **offer:** add number
- **date:** date of the application
- **sentorder:** order in which the application was sent
- **callback:** TRUE if there was a non negative callback
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **paris:** job located inside Paris, Yes or No
- **hist:** history in the labour market, LTC = Long term contract, LTU = Long term unemployment, STU = Short term unemployment, STC = Short term contract, PTC = Part time contract

Usage

```
data(labour2)
```

Format

A data frame with 1470 rows and 7 variables

References

Duguet E., Le Gall R., L'Horty Y., Petit P., 2018. How does labour market history influence the access to hiring interviews? International Journal of Manpower, 39(4), 519-533.

mobility1 *Gender discrimination and mobility (management controller)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between October 2008 and March 2009. A candidate is defined by the variables ("gender", "licenses").

- **offer:** add number
- **date:** date of the application
- **sentorder:** order in which the application was sent
- **callback:** TRUE if there was a non negative callback
- **ansorder:** order in which the answer was received when positive, 5 otherwise
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **gender:** Woman or Man
- **licenses:** both moto and car licenses, Yes or No
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **paris:** job located inside Paris, Yes or No
- **cv:** CV template, A or B

Usage

```
data(mobility1)
```

Format

A data frame with 1200 rows and 12 variables

References

Duguet E., du Parquet L., L'Horty Y., Petit P., 2018. Counterproductive hiring discrimination against women: evidence from a French correspondence test. International Journal of Manpower, 39(1): 37-50.

origin1 *Origin discrimination (accountants)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between September and November 2006. A candidate is defined by the variables ("nation","lnation", "fnation"). The variables "educ" and "reput" create sample separations.

- **offer:** add number
- **date:** September 2006, October 2006 or November 2006
- **callback:** TRUE if there was a non negative callback
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **educ:** education, BAC = Baccalauréat = A-level, BTS = 2 years of vocational training after the A-level
- **cartime:** commuting time by car (minutes)
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **paris:** job located inside Paris, Yes or No
- **nation:** nationality, M = Moroccan, F = French
- **fnation:** first name sounding, M = Moroccan, F = French
- **lnation:** last name sounding, M = Moroccan, F = French
- **origin:** summary variable made from nation, lnation and fnation. Example: FMF = French nationality, Moroccan family name and French first name
- **city:** candidate location
- **reput:** reputation of the city, P = privileged, U = Unprivileged
- **cv:** CV template, A or B
- **natemp:** add obtained from the national employment agency (ANPE at the time of the test, France Travail today)
- **subsid:** the firm is a subsidiary of a large corporation, Yes or No
- **ansmode:** answering channel, email or ordinary mail for all the applications to the same add. M = email, P = postage prepaid envelope, R = Marianne stamp, C = Cubitus stamp (comics character)
- **email:** answered by email by all the candidates, 1 = yes, 0 = No

Usage

```
data(origin1)
```

Format

A data frame with 1097 rows and 20 variables

References

Duguet E., Leandri N., L'Horty Y., Petit P., 2010. Are young French jobseekers of ethnic immigrant origin discriminated against? A controlled experiment in the Paris area. Annals of Economics and Statistics, 99-100: 187-215.

---

origin2 *Origin discrimination (waiters)*

Description

The data were collected by the TEPP team (FR CNRS 2042) between September and November 2006. A candidate is defined by the variables ("nation","lnation", "fnation"). The variables "educ" and "reput" create sample separations.

- **offer:** add number
- **date:** September 2006, October 2006 or November 2006
- **callback:** TRUE if there was a non negative callback
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **educ:** education, BAC = Baccalauréat = A-level, BTS = 2 years of vocational training after the A-level
- **cartime:** commuting time by car (minutes)
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **paris:** job located inside Paris, Yes or No
- **nation:** nationality, M = Moroccan, F = French
- **fnation:** first name sounding, M = Moroccan, F = French
- **lnation:** last name sounding, M = Moroccan, F = French
- **origin:** summary variable made from nation, lnation and fnation. Example: FMF = French nationality, Moroccan family name and French first name
- **city:** candidate location
- **reput:** reputation of the city, P = privileged, U = Unprivileged
- **cv:** CV template, A or B
- **natemp:** add obtained from the national employment agency (ANPE at the time of the test, France Travail today)
- **subsid:** the firm is a subsidiary of a large corporation, Yes or No
- **ansmode:** answering channel, email or ordinary mail for all the applications to the same add. M = email, P = postage prepaid envelope, R = Marianne stamp, C = Cubitus stamp (comics character)
- **email:** answered by email by all the candidates, 1 = yes, 0 = No

Usage

```
data(origin2)
```

Format

A data frame with 936 rows and 20 variables

References

Petit P., Duguet E., L'Horty Y., 2015. Discrimination résidentielle et origine ethnique: une étude expérimentale sur les serveurs en Ile de France. Economie et Prevision, 206-207: 55-69.

---

plot.callback_stat *Plots for callback rates and shares*

Description

Plots for callback rates and shares

Usage

```
## S3 method for class 'callback_stat'
plot(x, col = NULL, dif = TRUE, ...)
```

Arguments

x	a callback_stat object.
col	A list of four colors.
dif	FALSE for the confidence intervals (the default), TRUE for the difference in proportions
...	further arguments passed to or from other methods.

Value

a ggplot2 object

Author(s)

Emmanuel Duguet

Examples

```
data(labour1)
m <- callback(labour1,"offer","hist","callback","all")
s <- stat_mcr(m)
plot(s)
```

print.callback *Prints the structure of the experiment*

Description

Computes the number of tests available for each pair of candidates

Usage

```
## S3 method for class 'callback'
print(x, ...)
```

Arguments

x	a stat_paired object.
...	further arguments passed to or from other methods.

Value

Printed output.

Examples

```
data(labour1)
x <- callback(data=labour1,cluster="offer",candid="hist",callback="callback",
comp = "all")
print(x)
```

print.callback_comp *Prints the structure of a component model*

Description

Prints the structure of a component model

Usage

```
## S3 method for class 'callback_comp'
print(x, ...)
```

Arguments

x	a list with class "callback_comp"
...	further arguments passed to or from other methods.

Value

Printed output.

Author(s)

Emmanuel Duguet

Examples

```
model <- list(c("license"),c("woman"),c("woman","license","inter"))
print(callback_comp(mobility1,"offer",c("gender","licenses"),"callback",model))
```

`print.callback_reg` *Prints the components of a component model*

Description

Prints the components of a component model

Usage

```
## S3 method for class 'callback_reg'
print(x, ...)
```

Arguments

`x`	a list with class `"callback_reg"`
`...`	further arguments passed to or from other methods.

Value

Printed output.

Author(s)

Emmanuel Duguet

Examples

```
model <- list(c("license"),c("woman"),c("woman","license","inter"))
z <- reg(callback_comp(mobility1,"offer",c("gender","licenses"),"callback",model))
print(z)
```

print.callback_stat *Prints the callback proportions analysis*

Description

Prints the statistics about the callback rates or shares.

Usage

```
## S3 method for class 'callback_stat'
print(x, digits = 3, ...)
```

Arguments

x	a callback_stat object.
digits	minimal number of significant digits.
...	further arguments passed to or from other methods.

Value

Printed output.

Examples

```
data(labour1)
x <- callback(labour1, "offer", "hist", "callback", comp = "all")
print(stat_mcr(x))
```

print.stat_paired *Print the callback counts analysis*

Description

Computes the callback numbers for each candidate.

Usage

```
## S3 method for class 'stat_paired'
print(x, ...)
```

Arguments

x	a stat_paired object.
...	further arguments passed to or from other methods.

Value

Printed output.

Examples

```
data(labour1)
print(stat_paired(callback(labour1, "offer", "hist", "callback",
comp = "all")))
```

`reg` *Generic regression function*

Description

Generic regression function

Usage

```
reg(x, ...)
```

Arguments

`x`	A `callback_reg` object.
`...`	further arguments passed to or from other methods.

`reg.callback_comp` *Component model estimation*

Description

Component model estimation

Usage

```
## S3 method for class 'callback_comp'
reg(x, method = "fgls", ...)
```

Arguments

`x`	a `callback_comp` object.
`method`	estimation method, "ols" or "fgls" (the default).
`...`	further arguments passed to or from other methods.

Value

a list with class `callback_reg` containing `"config"` for the definition of the estimation method and `"reg"` for the estimation output.

The `"config"` data frame includes the following elements:

- **family:** "als" (for Asymptotic least squares).
- **method:** "ols" for Ordinary least square, or "fgls" for Feasible generalized least squares.
- **model:**a components model.

The list `"reg"` includes the following elements (when relevant):

- **estim:**a data frame with `c_names` for the component names, `coef`, the estimated coefficients, `std_coef`, the estimated standard errors, `student`the Student statistics for the equality of the coefficient to 0, `p_value`, the p-values of the asymptotic Student test.
- **cova:** the estimated covariance matrix of the estimator.
- **over_test:**a data frame with the output of the overidentification test (FGLS only). The statistic is given by `stat`, the degrees of freedom by `df` and the p-value by `p_value`.

References

Duguet E., Le Gall R., L'Horty Y., Petit P. (2018). How does the labour market history influence the access to hiring interviews? International Journal of Manpower, 39(4), 519-533, doi: 10.1108/IJM-09-2017-0231.

Examples

```
model <- list(c("license"),c("woman"),c("woman","license","inter"))
comp <- callback_comp(data = mobility1, cluster = "offer",
candid = c("gender","licenses"), callback = "callback", model = model)
reg(comp)
summary(reg(comp))
```

`reg_als` *Asymptotic least squares estimation*

Description

Asymptotic least squares estimation

Usage

```
reg_als(x, y, omega, ols = FALSE)
```

Arguments

x	the matrix of the right-hand variables (incl. the constant term when needed).
y	the vector of the left-hand variable.
omega	the covariance matrix of the disturbances.
ols	logical indicating whether to perform OLS (TRUE) or FGLS (FALSE). The default is FALSE.

Value

a list with class `reg_als` containing `"config"` for the definition of the estimation method and `"reg"` for the estimation output.

The `"config"` data frame includes the following elements:

- **family:** "als" (for Asymptotic least squares).
- **method:** "ols" for Ordinary least square, or "fgls" for Feasible generalized least squares.

The list `"reg"` includes the following elements (when relevant):

- **estim:**a data frame with `c_names` for the component names, `coef`, the estimated coefficients, `std_coef`, the estimated standard errors, `student`the Student statistics for the equality of the coefficient to 0, `p_value`, the p-values of the asymptotic Student test.
- **cova:** the estimated covariance matrix of the estimator.
- **over_test:**a data frame with the output of the overidentification test (FGLS only). The statistic is given by `stat`, the degrees of freedom by `df` and the p-value by `p_value`

References

Chamberlain, G. (1982). Multivariate regression models for panel data. Journal of econometrics, 18(1), 5-46. Gourieroux, C., Monfort, A., & Trognon, A. (1985). Moindres carrés asymptotiques. Annales de l'INSEE, 91-122. Kodde, D. A., Plam, F. C., & Pfann, G. A. (1990). Asymptotic least-squares estimation efficiency considerations and applications. Journal of Applied Econometrics, 5(3), 229-243.

Examples

```
model <- list(c("license"),c("woman"),c("woman","license","inter"))
comp <- callback_comp(mobility1,"offer",c("gender","licenses"),"callback",model)
    x <- comp$aux_boole
    y <- comp$aux_coef
omega <- comp$aux_vcov

str(reg_als(x,y,omega))
```

stat_colsums *Sums the numeric or logical columns in a data frame.*

Description

Sums the numeric or logical columns in a data frame.

Usage

```
stat_colsums(x)
```

Arguments

x	A data frame

Value

A data frame with the column sums, under their original names.

Examples

```
data(labour1)
s <- callback(labour1,"offer","hist","callback","all")
stat_colsums(s$pfds[["LTC vs STC"]])
```

stat_ecs *Exclusive callback shares*

Description

Computes the exclusive callback shares and their confidence intervals. The analysis is restricted to the tests with discrimination cases.

Usage

```
stat_ecs(x, method = "student", level = 0.95)
```

Arguments

x	a callback object.
method	estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for Student (the default).
level	the level of the confidence intervals (0.95 by default).

Value

A list with class `"callback_stat"` containing 4 components: specif, counts, props and stats

`specif`: A list containing

- **convention:** string "exclusive callback shares".
- **cid:** convention on 3 characters.
- **method:** the estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for "Student" (the default).
- **level:** the level of the confidence intervals (0.95 by default).
- **source:** the R stats function used to compute the statistics (binom.test, prop.test or t.test).
- **name:** the name of the statistic (Fisher, Pearson or Student).

`counts`: a data frame with the callback counts.

- **tests:** number of tests.
- **callback:** number of tests with at least one callback for either candidate.
- **disc:** number of discrimination cases.
- **c00:** number of test without a callback.
- **c10:** number of tests with callbacks for candidate 1 only.
- **c01:** number of tests with callbacks for candidate 2 only.
- **c11:** number of tests with callbacks for both candidates.

`props`: A data frame containing the following proportions and their confidence intervals (when relevant)

- **inf_p_cand1:** 1st candidate exclusive callback share, lower bound.
- **p_cand1:** 1st candidate exclusive callback share.
- **sup_p_cand1:** 1st candidate exclusive callback share, upper bound.
- **inf_p_cand2:** 2nd candidate exclusive callback share, lower bound.
- **p_cand2:** 2nd candidate exclusive callback share.
- **sup_p_cand2:** 2nd candidate exclusive callback share, upper bound.
- **inf_cand_dif:** p_cand1-p_cand2, lower bound.
- **p_cand_dif:** exclusive callback share difference between the candidates.
- **sup_cand_dif:** p_cand1-p_cand2, upper bound.

`stats`: a data frame containing the statistics for testing the equality of proportions.

- **statistic:** the value of the test statistic.
- **p_stat:** the p-value of the test statistic.
- **c_stat:** the significance code of the test statistic.

Author(s)

Emmanuel Duguet

References

Clopper, C. J. & Pearson, E. S. (1934). The use of confidence or fiducial limits illustrated in the case of the binomial. Biometrika, 26, 404–413. doi:10.2307/2331986.

Student. (1908). The Probable Error of a Mean. Biometrika, 6(1), 1–25. doi:10.2307/2331554.

Wilson, E.B. (1927). Probable inference, the law of succession, and statistical inference. Journal of the American Statistical Association, 22, 209–212. doi:10.2307/2276774.

Examples

```
data(labour1)
x <- callback(data=labour1,cluster="offer",candid="hist",callback="callback")
str(stat_ecs(x))
```

`stat_mcr` *Matched callback rates*

Description

Computes the matched callback rates, their confidence intervals and performs the equality tests between the candidates.

Usage

```
stat_mcr(x, method = "student", level = 0.95)
```

Arguments

`x`	a `callback` object.
`method`	estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for Student (the default).
`level`	the level of the confidence intervals (0.95 by default).

Value

A list with class `"callback_stat"` containing 4 components: specif, counts, props and stats

`specif`: A list containing

- **convention:** string "matched callback rates".
- **cid:** convention on 3 characters.
- **method:** the estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for "Student" (the default).
- **level:** the level of the confidence intervals (0.95 by default).
- **source:** the R stats function used to compute the statistics (binom.test, prop.test or t.test).
- **name:** the name of the statistic (Fisher, Pearson or Student).

`counts`: a data frame with the callback counts.

- **tests:** number of tests.
- **callback:** number of tests with at least one callback for either candidate.
- **disc:** number of discrimination cases.
- **c00:** number of test without a callback.
- **c10:** number of tests with callbacks for candidate 1 only.
- **c01:** number of tests with callbacks for candidate 2 only.
- **c11:** number of tests with callbacks for both candidates.

`props`: A data frame containing the following proportions and their confidence intervals (when relevant)

- **inf_p_callback:** overall callback rate, lower bound.
- **p_callback:** overall callback rate.
- **sup_p_callback:** overall callback rate, upper bound.
- **inf_p_cand1:** 1st candidate callback rate, lower bound.
- **p_cand1:** 1st candidate callback rate.
- **sup_p_cand1:** 1st candidate callback rate, upper bound.
- **inf_p_cand2:** 2nd candidate callback rate, lower bound.
- **p_cand2:** 2nd candidate callback rate.
- **sup_p_cand2:** 2nd candidate callback rate, upper bound.
- **inf_cand_dif:** p_cand1-p_cand2, lower bound.
- **p_cand_dif:** callback proportion difference between the candidates.
- **sup_cand_dif:** p_cand1-p_cand2, upper bound.

`stats`: a data frame containing the statistics for testing the equality of proportions.

- **statistic:** the value of the test statistic.
- **p_stat:** the p-value of the test statistic.
- **c_stat:** the significance code of the test statistic.

Author(s)

Emmanuel Duguet

References

Clopper, C. J. & Pearson, E. S. (1934). The use of confidence or fiducial limits illustrated in the case of the binomial. Biometrika, 26, 404–413. doi:10.2307/2331986.

Student. (1908). The Probable Error of a Mean. Biometrika, 6(1), 1–25. doi:10.2307/2331554.

Wilson, E.B. (1927). Probable inference, the law of succession, and statistical inference. Journal of the American Statistical Association, 22, 209–212. doi:10.2307/2276774.

Examples

```
data(labour1)
x <- callback(data=labour1,cluster="offer",candid="hist",callback="callback")
str(stat_mcr(x))
```

`stat_paired` *Callback counts on paired data*

Description

Computes the callback count statistics from the paired data sets.

Usage

```
stat_paired(x)
```

Arguments

`x`	A `callback` object.

Value

A list with class `"stat_paired"` containing two data frames: counts and props.

`counts`: a data frame with the callback counts.

- **tests:** number of tests.
- **callback:** number of tests with at least one callback for either candidate.
- **callback1:** number of callbacks for candidate 1.
- **callback2:** number of callbacks for candidate 2.
- **calldif:** difference in callback numbers.
- **disc:** number of discrimination cases.
- **c00:** number of test without a callback.
- **c10:** number of tests with callbacks for candidate 1 only.
- **c01:** number of tests with callbacks for candidate 2 only.
- **c11:** number of tests with callbacks for both candidates.

`props`: a data frame with the following variables.

- **p_callback:** callback/tests.
- **p_cand1:** callback1/tests.
- **p_cand2:** callback2/tests.
- **p_c00:** c00/tests.
- **p_c10:** c10/tests.
- **p_c01:** c01/tests.
- **p_c11:** c11/tests.
- **p_cand_dif:** calldif/tests.

Author(s)

Emmanuel Duguet

Examples

```
data(labour2)
x <- callback(data=labour2,cluster="offer",candid="hist",callback="callback")
stat_paired(x)
```

---

stat_raw *Unmatched callback rates*

Description

Number and proportion of callbacks for all the candidates.

Usage

```
stat_raw(x, method = "student", level = 0.95)
```

Arguments

x	A callback object.
method	estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for Student (the default).
level	A number, containing the level of the confidence intervals (0.95 by default).

Value

A callback_stat object with 2 components: specif and props.

specif: A list containing

- **convention:** string "raw callback rates".
- **cid:** convention on 3 characters.
- **method:** the estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for "Student" (the default).
- **level:** the level of the confidence intervals (0.95 by default).
- **source:** the R stats function used to compute the statistics (binom.test, prop.test or t.test).
- **name:** the name of the statistic (Fisher, Pearson or Student).

props: a data frame containing the following variables.

- **tests:** number of tests
- **callback:** number of callbacks
- **inf_p_callback:** callback rate lower bound
- **p_callback:** callback rate
- **sup_p_callback:** callback rate upper bound

Author(s)

Emmanuel Duguet

References

Clopper, C. J. & Pearson, E. S. (1934). The use of confidence or fiducial limits illustrated in the case of the binomial. Biometrika, 26, 404–413. doi:10.2307/2331986.

Wilson, E.B. (1927). Probable inference, the law of succession, and statistical inference. Journal of the American Statistical Association, 22, 209–212. doi:10.2307/2276774.

Examples

```
data(labour2)
x <- callback(data=labour2,cluster="offer",candid="hist",callback="callback")
str(stat_raw(x))
```

`stat_signif` *Significance code of a p-value*

Description

Significance code of a p-value

Usage

```
stat_signif(p)
```

Arguments

p	A number between 0 and 1

Value

A character string

Examples

```
stat_signif(0.045)
```

`stat_tcs` *Total callback shares*

Description

Computes the callback shares and their confidence intervals. The analysis is restricted to the tests with at least one callback. It is the definition used in Riach and Rich (2006).

Usage

```
stat_tcs(x, method = "student", level = 0.95)
```

Arguments

`x`	a `callback` object.
`method`	estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for Student (the default).
`level`	the level of the confidence intervals (0.95 by default).

Value

A list with class `"callback_stat"` containing 4 components: specif, counts, props and stats

`specif`: A list containing

- **convention:** string "total callback shares".
- **cid:** convention on 3 characters.
- **method:** the estimation method, "cp" for Clopper-Pearson, "wilson" for Wilson and "student" for "Student" (the default).
- **level:** the level of the confidence intervals (0.95 by default).
- **source:** the R stats function used to compute the statistics (binom.test, prop.test or t.test).
- **name:** the name of the statistic (Fisher, Pearson or Student).

`counts`: a data frame with the callback counts.

- **tests:** number of tests.
- **callback:** number of tests with at least one callback for either candidate.
- **disc:** number of discrimination cases.
- **c00:** number of test without a callback.
- **c10:** number of tests with callbacks for candidate 1 only.
- **c01:** number of tests with callbacks for candidate 2 only.
- **c11:** number of tests with callbacks for both candidates.

`props`: A data frame containing the following proportions and their confidence intervals (when relevant)

- **inf_p_cand1:** 1st candidate total callback share, lower bound.
- **p_cand1:** 1st candidate total callback share.
- **sup_p_cand1:** 1st candidate total callback share, upper bound.
- **inf_p_cand2:** 2nd candidate total callback share, lower bound.
- **p_cand2:** 2nd candidate total callback share.
- **sup_p_cand2:** 2nd candidate total callback share, upper bound.
- **inf_p_equal:** equal treatment total callback share, lower bound.
- **p_equal:** equal treatment total callback share.
- **sup_p_equal:** equal treatment total callback share, upper bound.
- **inf_cand_dif:** p_cand1-p_cand2, lower bound.
- **p_cand_dif:** total callback share difference between the candidates.
- **sup_cand_dif:** p_cand1-p_cand2, upper bound.

`stats`: a data frame containing the statistics for testing the equality of proportions.

- **statistic:** the value of the test statistic.
- **p_stat:** the p-value of the test statistic.
- **c_stat:** the significance code of the test statistic.

Author(s)

Emmanuel Duguet

References

Clopper, C. J. & Pearson, E. S. (1934). The use of confidence or fiducial limits illustrated in the case of the binomial. Biometrika, 26, 404–413. doi:10.2307/2331986.

Riach, P. A., & Rich, J. (2006). An experimental investigation of sexual discrimination in hiring in the English labor market. The BE Journal of Economic Analysis & Policy, 6(2),

Student. (1908). The Probable Error of a Mean. Biometrika, 6(1), 1–25. doi:10.2307/2331554.

Wilson, E.B. (1927). Probable inference, the law of succession, and statistical inference. Journal of the American Statistical Association, 22, 209–212. doi:10.2307/2276774.

Examples

```
data(labour1)
x <- callback(data=labour1,cluster="offer",candid="hist",callback="callback")
str(stat_tcs(x))
```

summary.callback_reg *Prints the regression table of a component model*

Description

Prints the regression table of a component model

Usage

```
## S3 method for class 'callback_reg'
summary(object, ...)
```

Arguments

object	a list with class "callback_reg".
...	further arguments passed to or from other methods.

Value

Printed output.

Author(s)

Emmanuel Duguet

Examples

```
model <- list(c("license"),c("woman"),c("woman","license","inter"))
comp <- callback_comp(data = mobility1, cluster = "offer",
candid = c("gender","licenses"), callback = "callback", model = model)
z <- reg(comp)
summary(z)
```

train1 *Training profile impact (plumbers)*

Description

The data were collected by the TEPP team (FR CNRS 2042) in 2011. A candidate is defined by the variables "fname","lname","educ" and "educ_qual" (giving 10 possible cases).

- **offer:** add number
- **fname:** first name (forename)
- **lname:** last name (family name, surname)

- **age:** between 21 and 24 years old
- **coop:** TRUE if the candidate got the diploma in co-op.
- **educ:** education, CAP = vocational training certificate before the A level, BAC = A-level, CAP+BAC = both diploma, None = Failed at CAP exam
- **educ_qual:** Failed = no diploma, GRETA = in-service training, Diploma = standard case, MAF = "One of the best French apprentices"
- **esp:** email service provider
- **cvq:** qualification indcated on the CV (heating or sanitary plumbing)
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **negow:** negotiable wage, TRUE or FALSE
- **hours:** weekly work time
- **woffer:** wage offer (in Euros)
- **jobzip:** job location in the Paris area
- **recgender:** gender of the recruiter
- **date:** sending date
- **ansmode:** answering channel, email or ordinary mail ("omail")
- **sentorder:** order in which the application was sent
- **callback:** TRUE if there was a non negative callback
- **cdate:** callback date
- **chour:** callback hour
- **ansorder:** order in which the answer was received when positive, missing otherwise

Usage

```
data(train1)
```

Format

A data frame with 2167 rows and 22 variables

References

Fremigacci F., L'Horty Y., du Parquet L., Petit P. (2013).L'accès à l'emploi après un CAP ou un baccalauréat professionnel: une évaluation expérimentale dans deux secteurs d'activité. Revue d'économie politique, Vol. 123, No. 3, pp. 353-375. https://www.jstor.org/stable/43860017.

`train2` *Training profile impact (waiters)*

Description

The data were collected by the TEPP team (FR CNRS 2042) in 2011. A candidate is defined by the variables "fname","lname","educ" and "educ_qual" (giving 10 possible cases).

- **offer:** add number
- **fname:** first name (forename)
- **lname:** last name (family name, surname)
- **age:** between 21 and 24 years old
- **coop:** TRUE if the candidate obtained the diploma in co-op.
- **adsrc:** Ad sources (ANPE, the national employment agency, "L'hôtel- lerie-Restauration" journal, other)
- **educ:** education, CAP = vocational training certificate before the A level, BAC = A-level, CAP+BAC = both diploma, None = Failed at CAP exam
- **educ_qual:** Failed = no diploma, GRETA = in-service training, Diploma = standard case, MAF = "One of the best French apprentices"
- **esp:** email service provider
- **jobtype:** job qualification required in the ad
- **hcrtype:** type of restaurant
- **chain:** TRUE if the restaurant belongs to a chain
- **hstars:** number of stars, for the hotels
- **quality:** TRUE if the restaurant has a quality label (Michelin, Bottin Gourmand, Gault et Millau, etc.)
- **cont:** length of labour contract, STC = short term contract (<=1 year), LTC = long term contract (>1 year with no ending date)
- **hours:** weekly work time
- **english:** TRUE if some knowledge of English is required
- **photo:** TRUE if a photograph is required (none is sent by our candidates)
- **negow:** negotiable wage, TRUE or FALSE
- **woffer:** wage offer (in Euros)
- **jobzip:** job location in the Paris area
- **recgender:** gender of the recruiter
- **date:** application sending date
- **ansmode:** answering channel, email or ordinary mail ("omail")
- **sentorder:** order in which the application was sent
- **callback:** TRUE if there was a non negative callback
- **cdate:** callback date
- **chour:** callback hour
- **ansorder:** order in which the answer was received when positive, missing otherwise

Usage

```
data(train2)
```

Format

A data frame with 3552 rows and 29 variables

References

Fremigacci F., L'Horty Y., du Parquet L., Petit P. (2013).L'accès à l'emploi après un CAP ou un baccalauréat professionnel: une évaluation expérimentale dans deux secteurs d'activité. Revue d'économie politique, Vol. 123, No. 3, pp. 353-375. https://www.jstor.org/stable/43860017.

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