

# Package ‘SetMethods’

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**Title** Functions for Set-Theoretic Multi-Method Research and Advanced QCA

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## Description

Functions for performing set-theoretic multi-method research, QCA for clustered data, theory evaluation, Enhanced Standard Analysis, indirect calibration, radar visualisations. Additionally it includes data to replicate the examples in the books by Oana, I.E, C. Q. Schneider, and E. Thomann. Qualitative Comparative Analysis (QCA) using R: A Beginner's Guide. Cambridge University Press and C. Q. Schneider and C. Wagemann "Set Theoretic Methods for the Social Sciences", Cambridge University Press.

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SetMethods-package      *Functions for Set-Theoretic Multi-Method Research and Advanced QCA*

---

## Description

This initiated as a package companion to the book by C. Q. Schneider and C. Wagemann "Set-Theoretic Methods for the Social Sciences", Cambridge University Press. It has now grown to include functions for performing set-theoretic multi-method research (Schneider 2023, Schneider and Rohlfing 2013), QCA for clustered data (Garcia-Castro and Arino 2013), theory evaluation, Enhanced Standard Analysis, QCA Radar Charts, indirect calibration, robustness tests (Oana and Schneider - 2021) etc.. Additionally it includes data to replicate the examples in the book by Oana, I.E, C. Q. Schneider, and E. Thomann. Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge University Press and C. Q. Schneider and C. Wagemann "Set Theoretic Methods for the Social Sciences", 2021, Cambridge University Press.

## Details

Package: SetMethods  
Type: Package  
Version: 4.0  
Date: 2023-03-29  
License: GPL-2

The package contains functions to perform set-theoretic multi-method research, theory evaluation, QCA for clustered data, Enhanced Standard Analyses, indirect calibration, calculate parameters of fit and produce XY plots and QCA Radar Charts, perform robustness tests, etc.. Furthermore, it contains all the data used in the Schneider and Wagemann (2012) and Oana, Schneider, and Thomann (2021) books.

## Author(s)

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Maintainer: Ioana-Elena Oana <ioana.oana@eui.eu>

## References

Schneider, C. Q. (2023). Set-Theoretic Multi-Method Research: A Guide to Combining QCA and Case Studies. Cambridge: Cambridge University Press.

Oana, I.E., Schneider, C. Q., Thomann, E. (2021). Qualitative Comparative Analysis (QCA) using R: A Beginner's Guide. Cambridge: Cambridge University Press.

Oana, I.E., Schneider, C. Q. (2021). A Robustness Test Protocol for Applied QCA: Theory and R Software Application. Sociological Methods and Research. <https://doi.org/10.1177/00491241211036158>.

Oana, I.E., Schneider, C.Q. (2018) SetMethods: An Add-on R Package for Advanced QCA. The R Journal 10(1): 507-33.

Schneider, C. Q., Wagemann, C. (2012) Set-Theoretic Methods for the Social Sciences, Cambridge University Press: Cambridge

Schneider, C. Q., Rohlfing, I. (2013) Combining QCA and Process Tracing in Set-Theoretic Multi-Method Research. Sociological Methods Research 42(4): 559-597

Haesebrouck, T. (2015) Pitfalls in QCA's consistency measure. Journal of Comparative Politics 2:65-80.

Garcia-Castro, A., Arino, M. A.. (2013) A General Approach to Panel Data Set-Theoretic Research. COMPASS Working Paper 2013-76

---

ambig.cases

*Function for identifying cases with 0.5 fuzzy-set values.*

---

## Description

A function that identifies cases with 0.5 fuzzy-set values.

## Usage

```
ambig.cases(data)
```

## Arguments

data	A dataframe, a subset of a dataframe, or a vector (i.e. single column in a dataframe). If the function is provided with the dataframe it will return the name of the cases with 0.5 values together with their location in the dataframe. If the function is provided with a vector (i.e. a single column), it will return the position of the case having a 0.5 in that vector. The function should be used for calibrated data and will give an error if the data contains uncalibrated scores. However, if you have both calibrated and uncalibrated data in the same dataframe, it is possible to use the function only for the calibrated subset of that data.
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## Author(s)

Ioana-Elena Oana

## Examples

```
# Import your data. For example:  
  
data(SCHF)  
  
# Get cases with 0.5 in the entire dataframe:  
  
ambig.cases(SCHF)
```

```
# Get cases with 0.5 in the column "EMP" in the dataframe:  
ambig.cases(SCHF$EMP)  
  
# Get cases with 0.5 in the 7th column of the dataframe:  
ambig.cases(SCHF[,7])
```

---

BCMV

*Berg-Schlosser and Cronqvist (2005)*

---

### Description

The BCMV data frame has 18 rows and 5 variables

### Usage

```
data(BCMV)
```

### Format

A data frame with 18 observations on the following 5 variables.

GNP a numeric vector. Condition, Gross National Product/Capita (ca. 1930). 0 if below 500\$, 1 if between 550 and 850\$, 2 above 850\$.

URB a numeric vector. Condition, urbanization (population in towns with 20000 and more inhabitants); 0 if below 50 per cent; 1 if above.

LIT a numeric vector. Condition, literacy: 0 if below 75 per cent; 1 if above.

INDUS a numeric vector. Condition, Industrial Labour Force (incl. mining); 0 if below 30 per cent of active population; 1 if above.

DEMOC a numeric vector. Condition, stability of a democracy: 0 if not stable; 1 if stable.

### Details

The data are used by Berg-Schlosser and Cronqvist (2005) to demonstrate mvQCA. The original data are from Lipset (1963). Data are multi-value.

### References

Berg-Schlosser, D. and Cronqvist, L. (2005) "Macro-Quantitative vs. Macro-Qualitative Methods in the Social Sciences - An Example from Empirical Democratic Theory", *Historical Social Research* 30, pp. 154-175.

Lipset, Seymour M. (1963) *Political Man. The Social Bases of Politics*. Doubleday: New York.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

Schneider, C. Q., Wagemann, C., Quaranta, M. (2012) How To... Use Software for Set-Theoretic Analysis. Online Appendix to "Set-Theoretic Methods for the Social Sciences". Available at [www.cambridge.org/schneider-wagemann](http://www.cambridge.org/schneider-wagemann)

### Examples

```
data(BCMV)
```

---

cluster	<i>Diagnostic tool for clustered data.</i>
---------	--

---

### Description

Function returns pooled, within, and between consistencies for the relationship between two sets, for an object of class "qca", and for a Boolean expression.

### Usage

```
cluster(data=NULL, results, outcome,
        unit_id, cluster_id, sol = 1,
        necessity = FALSE, wicons = FALSE)
```

### Arguments

data	A data frame in the long format containing both a column with the unit names and a column with the cluster names. Column names should be in capital letters.
results	An object of class "qca". For performing cluster diagnostics of the sufficient solution for the negated outcome one must only use the <code>minimize()</code> result from the sufficiency analysis of the negated outcome. The argument results can also be a vector, a character string, or a boolean expression of the form e.g. "A*~B + ~B*C".
outcome	A character string with the name of the outcome in capital letters. When performing cluster diagnostics of the sufficient solution for the negated outcome one must only use the <code>minimize()</code> result from the sufficiency analysis of the negated outcome in the argument results. When performing cluster diagnostics for boolean expressions or vectors the negated outcome can be used by inserting a tilde in the outcome name in the argument outcome. The outcome can also be a vector.
unit_id	A character string with the name of the vector containing the units (e.g. countries).
cluster_id	A character string with the name of the vector containing the clustering units (e.g. years).
sol	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.

necessity	Logical. Perform the diagnostic for the relationship of necessity?
wicons	Logical. Should within consistencies and coverages be printed?

**Author(s)**

Ioana-Elena Oana

**References**

Garcia-Castro, Roberto, and Miguel A. Arino. 2016. "A General Approach to Panel Data Set-Theoretic Research." *Journal of Advances in Management Sciences & Information Systems* 2: 6376.

**See Also**

[minimize](#)

**Examples**

```
# Import your clustered data in the long format.
# For example:

data(SCHLF)

# Get the intermediate solution:

sol_yi <- minimize(SCHLF, outcome = "EXPORT",
                  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",
                  details = TRUE, show.cases = TRUE, dir.exp = c(0,0,0,0,0,0))

# Get pooled, within, and between consistencies for the intermediate solution:

cluster(SCHLF, sol_yi, "EXPORT", unit_id = "COUNTRY",
        cluster_id = "YEAR", sol = 1)

# or:

cluster(SCHLF, sol_yi, "EXPORT", unit_id = "COUNTRY",
        cluster_id = "YEAR", sol = "c1p1i1")

# Get pooled, within, and between consistencies for EMP as necessary for EXPORT:

cluster(SCHLF, results="EMP", outcome="EXPORT", unit_id = "COUNTRY",
        cluster_id = "YEAR", necessity=TRUE)

# or:

cluster(results=SCHLF$EMP, outcome=SCHLF$EXPORT, unit_id = SCHLF$COUNTRY,
        cluster_id = SCHLF$YEAR, necessity=TRUE)
```

```

# Get pooled, within, and between consistencies for ~EMP as necessary for EXPORT:

cluster(SCHLF, results=~EMP", outcome="EXPORT", unit_id = "COUNTRY",
        cluster_id = "YEAR", necessity=TRUE)
# or:

cluster(results=1-SCHLF$EMP, outcome=SCHLF$EXPORT, unit_id = SCHLF$COUNTRY,
        cluster_id = SCHLF$YEAR, necessity=TRUE)

# Get pooled, within, and between consistencies for EMP*~MA*STOCK as sufficient for EXPORT:

cluster(SCHLF, "EMP*~MA*STOCK", "EXPORT", unit_id = "COUNTRY",
        cluster_id = "YEAR")

# Get pooled, within, and between consistencies for EMP*MA + ~STOCK as sufficient for ~EXPORT:

cluster(SCHLF, "EMP*MA + ~STOCK", "~EXPORT", unit_id = "COUNTRY",
        cluster_id = "YEAR")

```

---

cluster.plot	<i>Function for plotting pooled, between, and within consistencies for a cluster diagnostics.</i>
--------------	---

---

## Description

Function for plotting pooled, between, and within consistencies for a cluster diagnostics. For a sufficient solution, the function returns plots for the entire solution and each sufficient term.

## Usage

```

cluster.plot(cluster.res,
             labs = TRUE,
             size = 5,
             angle = 0,
             wicons = FALSE,
             wiconslabs = FALSE,
             wiconssize = 5,
             wiconsangle = 90)

```

## Arguments

cluster.res	An object of class "cluster.res". This is the result of a cluster diagnostics obtained with the cluster() function.
labs	Logical. Should labels for the clusters be printed?
size	Label font size for the clusters.
angle	Label rotation for the clusters.
wicons	Logical. Should within consistency plots be returned?



wiconslabs	Logical. Should labels for the units be printed?
wiconssize	Label font size for the units.
wiconsangle	Label rotation for the units.

### Author(s)

Ioana-Elena Oana

### References

Garcia-Castro, Roberto, and Miguel A. Arino. 2016. "A General Approach to Panel Data Set-Theoretic Research." *Journal of Advances in Management Sciences & Information Systems* 2: 6376.

### Examples

```
# Load the data:
data(PAYF)

# Create a sufficient solution using minimize:
PS <- minimize(data = PAYF,
               outcome = "HL",
               conditions = c("HE", "GG", "AH", "HI", "HW"),
               incl.cut = 0.9,
               n.cut = 2,
               include = "?",
               details = TRUE,
               show.cases = TRUE)

PS

# Perform cluster diagnostics:

CB <- cluster(data = PAYF,
              results = PS,
              outcome = "HL",
              unit_id = "COUNTRY",
              cluster_id = "REGION",
              necessity=FALSE,
              wicons = FALSE)

CB

# Plot pooled, between, and within consistencies:

cluster.plot(cluster.res = CB,
             labs = TRUE,
             size = 8,
             angle = 6,
             wicons = TRUE)
```

---

EMMF

*EMMFnegger (2011)*

---

### **Description**

The EMMF data frame has 19 rows and 8 sets

### **Usage**

```
data(EMMF)
```

### **Format**

A data frame with 19 observations on the following 8 sets.

country a factor with levels Australia Austria Belgium Canada Denmark Finland France  
Germany Ireland Italy Netherlands NewZealand Norway Portugal Spain Sweden Switzerland  
UK USA

s a numeric vector. Condition, state-society relationships.

c a numeric vector. Condition, non-market coordination.

l a numeric vector. Condition, strength of the labour movement.

r a numeric vector. Condition, religious denomination.

p a numeric vector. Condition, strenght of religious parties.

v a numeric vector. Condition, institutional veto points.

jsr a numeric vector. Outcome, job-security regulations.

### **Details**

Data are used by Emmenegger (2011) to analyze job-security regulations in Western democracies.  
The data are fuzzy-sets.

### **References**

Emmenegger, P. (2011) "Job-security regulations in Western democracies", *European Journal of Political Research* 50, pp. 336-364.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### **Examples**

```
data(EMMF)
```

---

esa

*Function that performs the Enhanced Standard Analysis.*

---

### Description

Function that performs the Enhanced Standard Analysis.

### Usage

```
esa(oldtt, nec_cond, untenable_LR, contrad_rows)
```

### Arguments

oldtt	A truthTable object.
nec_cond	A vector of character strings containing the necessary conditions. Conditions should be capitalized and negated conditions should be inserted with a "~". Unions of conditions are performed with a "+". Using this argument, logical remainder rows that contradict the statement of necessity will not be used in the analysis (i.e. OUT will be set to 0 in the truth table).
untenable_LR	A Boolean expression containing the untenable logical remainders. Conditions should be capitalized and negated conditions should be inserted with a "~". Intersections of conditions are performed with a "*". Using this argument, logical remainder rows containing the particular intersection specified will not be used in the analysis (i.e. OUT will be set to 0 in the truth table).
contrad_rows	A vector containing the names of the rows that are contradictory. Using this argument, all rows with the names specified (both logical remainders and rows containing empirical information) will not be used in the analysis (i.e. OUT will be set to 0 in the truth table).

### Value

It returns a new truth table in which all truth table rows are set to outcome value 0 that would otherwise present untenable assumptions.

### Author(s)

Ioana-Elena Oana

### References

Schneider, C. Q., Wagemann, C. 2012. Set-Theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis. Cambridge: Cambridge University Press, chapter 8.

### See Also

[minimize](#)

**Examples**

```

# Import your data. For example:

data(SCHF)

# Get the truth table for the presence of the outcome:

TT_y <- truthTable(SCHF, outcome = "EXPORT",
                   conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                   incl.cut = .9,
                   complete = TRUE,
                   PRI = TRUE,
                   sort.by = c("out", "incl", "n"))

# Exclude condition STOCK + MA and condition EMP as necessary for EXPORT
# Exclude all remainder rows containing the combination BARGAIN*~OCCUP
# Exclude the rows "19", "14", "46", "51" as contradictory:

newtt <- esa(oldtt = TT_y, nec_cond = c("STOCK+MA", "EMP"),
             untenable_LR = "BARGAIN*~OCCUP", contrad_rows = c("19", "14", "46", "51"))

# The truth table newly created can afterwards be used in further analyses

```

---

FakeCS

*Fake crisp-set data*


---

**Description**

The FakeCS data frame has 30 rows and 5 sets

**Usage**

```
data(FakeCS)
```

**Format**

A data frame with 30 observations on the following 5 sets.

- y a numeric vector. Outcome with 2 categories (crisp-set).
- j a numeric vector. Condition with 2 categories (crisp-set).
- z a numeric vector. Condition with 2 categories (crisp-set).
- w a numeric vector. Condition with 2 categories (crisp-set).
- k a numeric vector. Condition with 2 categories (crisp-set).

**Details**

The data frame has only exercise purposes to let the user learn how to perform crisp-set QCA in R.

**References**

Schneider, C. Q., Wagemann, C., Quaranta, M. (2012) How To... Use Software for Set-Theoretic Analysis. Online Appendix to "Set-Theoretic Methods for the Social Sciences". Available at [www.cambridge.org/schneider-wagemann](http://www.cambridge.org/schneider-wagemann).

Schneider, C. Q., Wagemann, C. (2012) Set-Theoretic Methods for the Social Sciences, Cambridge University Press: Cambridge.

**Examples**

```
data(FakeCS)
```

---

FakeMV

*Fake data for mvQCA*

---

**Description**

mvQCA data frame has 25 rows and 4 sets.

**Usage**

```
data(FakeMV)
```

**Format**

A data frame with 25 observations on the following 4 sets.

Y a numeric vector. Outcome with 2 categories (crisp).

A a numeric vector. Condition with 2 categories (crisp).

B a numeric vector. Condition with 3 categories (multi-value).

C a numeric vector. Condition with 3 categories (multi-value).

**Details**

The data frame has only exercise purposes to let the user learn how to perform mvQCA in R.

**References**

Schneider, C. Q., Wagemann, C., Quaranta, M. (2012) How To... Use Software for Set-Theoretic Analysis. Online Appendix to "Set-Theoretic Methods for the Social Sciences". Available at [www.cambridge.org/schneider-wagemann](http://www.cambridge.org/schneider-wagemann).

Schneider, C. Q., Wagemann, C. (2012) Set-Theoretic Methods for the Social Sciences, Cambridge University Press: Cambridge.

**Examples**

```
data(FakeMV)
```

---

FSR

*Freitag and Schlicht (2009)*

---

### **Description**

The FSR data frame has 16 rows and 8 sets

### **Usage**

```
data(FSR)
```

### **Format**

A data frame with 16 observations on the following 8 sets.

`integrated_comp_schools` a numeric vector. Condition, percentage of Pupils Enrolled in Integrated Comprehensive Schools,

`coop_comp_schools` a numeric vector. Condition, percentage of Pupils Enrolled in Cooperative Comprehensive Schools.

`full_day_schools` a numeric vector. Condition, percentage of Pupils Enrolled in All-Day Schools

`child_care` a numeric vector. Condition, ratio of Number of Child Care Facilities to Total Population between 0 and 6 Years (percent).

`pre_schools` a numeric vector. Condition, ratio of pupils Enrolled in Pre-School to Total 6-Year-Old Population (per cent)

`early_tracking` a numeric vector. Condition, onset of Tracking, Legal Regulation.

`outcome` a numeric vector. Outcome, high Degree of Social Inequality Cases in Education.

`indep_hauptschule` a numeric vector. Condition, autonomy of the Hauptschule.

### **Details**

Data are used by Freitag and Schlicht (2009) to analyze social inequality in education. The data are raw scores.

### **References**

Freitag, M, and Schlicht, R. (2009) "Educational Federalism in Germany: Foundations of Social Inequalities in Education", *Governance* 22(1), pp. 47-72.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### **Examples**

```
data(FSR)
```

---

indirectCalibration    *Function performing the indirect calibration*

---

**Description**

indirectCalibration is a function for the indirect calibration procedure as described by Ragin (2008). It uses a binomial or a beta regression for transforming raw scores into calibrated scores. In our opinion, using a fractional polynomial may not be appropriate to this case. In fact, we do not deal with proportions. This function requires the package `betareg`.

**Usage**

```
indirectCalibration(x, x_cal, binom = TRUE)
```

**Arguments**

<code>x</code>	vector of raw scores.
<code>x_cal</code>	vector of theoretically calibrated scores.
<code>binom</code>	logical. If indirect calibration has to be performed using binomial regression or beta regression. The default is TRUE, which means that binomial regression is used.

**Value**

It returns a vector of indirectly calibrated values.

**Author(s)**

Mario Quaranta

**References**

Ragin, C. C. (2008) *Redesigning Social Inquiry: Fuzzy Sets and Beyond*, The Chicago University Press: Chicago and London.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

**Examples**

```
# Generate fake data
set.seed(4)
x <- runif(20, 0, 1)

# Find quantiles
quant <- quantile(x, c(.2, .4, .5, .6, .8))

# Theoretical calibration
```

```
x_cal <- NA
x_cal[x <= quant[1]] <- 0
x_cal[x > quant[1] & x <= quant[2]] <- .2
x_cal[x > quant[2] & x <= quant[3]] <- .4
x_cal[x > quant[3] & x <= quant[4]] <- .6
x_cal[x > quant[4] & x <= quant[5]] <- .8
x_cal[x > quant[5]] <- 1
x_cal

# Indirect calibration (binomial)
a <- indirectCalibration(x, x_cal, binom = TRUE)

# Indirect calibration (beta regression)
b <- indirectCalibration(x, x_cal, binom = FALSE)

# Correlation
cor(a, b)

# Plot
plot(x, a); points(x, b, col = "red")
```

---

intersectExp

*Intersects two boolean expressions.*

---

## Description

Function that intersects two boolean expressions.

## Usage

```
intersectExp(expression1, expression2)
```

## Arguments

expression1	A boolean expression. Conditions should be capitalized and negated conditions should be inserted with a "~". Unions of conditions are performed with a "+", while intersections are performed with a "*".
expression2	A boolean expression. Conditions should be capitalized and negated conditions should be inserted with a "~". Unions of conditions are performed with a "+", while intersections are performed with a "*".

## Value

It returns the boolean expression representing the intersection of the two inputted expressions.

## Author(s)

Ioana-Elena Oana



**Examples**

```
intersectExp("~EMP*MA", "MA+~STOCK*OCCUP")  
intersectExp("~A*B + C*~D", "A*B+~D")
```

---

JOBF

*Fake fuzzy-set job motivation data.*

---

**Description**

Fake fuzzy-set job motivation data used for Chapter 3 of the Oana et al. (forthcoming) book.

**Usage**

```
data(JOBF)
```

**Format**

A data frame with 17 observations on the following 3 variables.

HS Condition: High salary

FS Condition: Flexible schedule

LS Condition: Lenient supervisor

LJS Condition: Low job security

PP Condition: High promotion potential

HM Outcome: High motivation

FSorLS Condition:

**References**

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
data(JOBF)
```

---

KAF

*Koenig-Archibugi (2004)*

---

### **Description**

The KAF data frame has 13 rows and 5 sets

### **Usage**

```
data(KAF)
```

### **Format**

A data frame with 13 observations on the following 5 sets.

`supranat` a numeric vector. Government support for supranational CFSP.

`identmass` a numeric vector. European identity of the general public.

`conform` a numeric vector. Policy conformity.

`region` a numeric vector. Regional governance.

`capab` a numeric vector. Material capabilities.

### **Details**

Data are used by Koenig-Archibugi (2004) to analyze government preferences for institutional change in EU foreign and security policy. Data are fuzzy-sets.

### **References**

Koenig-Archibugi, M. (2004) "Explaining Government Preferences for Institutional Change in EU Foreign and Security Policy", *International Organization* 58, pp.137-174.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### **Examples**

```
data(KAF)
```

---

LIPC

*Lipset (1959), crisp-set*

---

### **Description**

The LIPC data frame has 18 rows and 6 sets

### **Usage**

```
data(LIPC)
```

### **Format**

A data frame with 18 observations on the following 6 sets.

DEVELOPED a numeric vector. Condition, economically developed country.

URBAN a numeric vector. Condition, urbanized countries.

LITERATE a numeric vector. Condition, countries with high literacy rate.

INDUSTRIAL a numeric vector. Condition, Industrialized countries.

GOVSTAB a numeric vector. Condition, politically stable countries.

SURVIVED a numeric vector. Outcome, survival of democracy during the inter-war period.

### **Details**

Data used by Ragin (2009) to illustrates the variants of QCA. Originally by Lipset (1959). Data are crisp-sets.

### **References**

Lipset, S. M. (1959) "Some Social Requisites of Democracy: Economic Development and Political Legitimacy", *American Political Science Review* 53, pp. 69-105.

Ragin, C. C. (2009) "Qualitative Comparative Analysis. Using Fuzzy Sets (fsQCA)." In Rihoux, B., and Ragin, C. C. (eds.) *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*. Thousand Oaks, CA and London: Sage, pp. 87-121.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### **Examples**

```
data(LIPC)
```

---

LIPF

*Lipset (1959), fuzzy-set*

---

### Description

The LIPF data frame has 18 rows and 6 sets

### Usage

```
data(LIPF)
```

### Format

A data frame with 18 observations on the following 6 sets.

SURVIVED a numeric vector. Outcome, survival of democracy during the inter-war period.

DEVELOPED a numeric vector. Condition, economically developed countries.

URBAN a numeric vector. Condition, urbanized countries.

LITERATE a numeric vector. Condition, countries with high literacy rate.

INDUSTRIAL a numeric vector. Condition, industrialized countries.

STABLE a numeric vector. Condition, politically stable countries.

### Details

Data used by Ragin (2009) to illustrates the variants of QCA. Originally by Lipset (1959). Data are fuzzy-sets.

### References

Lipset, S. M. (1959) "Some Social Requisites of Democracy: Economic Development and Political Legitimacy", *American Political Science Review* 53, pp. 69-105.

Ragin, C. C. (2009) "Qualitative Comparative Analysis. Using Fuzzy Sets (fsQCA)." In Rihoux, B., and Ragin, C. C. (eds.) *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*. Thousand Oaks, CA and London: Sage, pp. 87-121.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### Examples

```
data(LIPF)
```

---

LIPR

*Lipset (1959), raw data*

---

### Description

The LIPR data frame has 18 rows and 6 variables

### Usage

```
data(LIPR)
```

### Format

A data frame with 18 observations on the following 6 variables.

SURVIVED a numeric vector. Outcome, survival of democracy during the inter-war period.

DEVELOPED a numeric vector. Condition, level of economic development.

URBAN a numeric vector. Condition, level of urbanization.

LITERATE a numeric vector. Condition, level of literacy.

INDUSTRIAL a numeric vector. Condition, level of industrialization.

UNSTABLE a numeric vector. Condition, politically stable countries.

### Details

Data used by Ragin (2009) to illustrates the variants of QCA. Originally by Lipset (1959). Data are raw-scores.

### References

Lipset, S. M. (1959) "Some Social Requisites of Democracy: Economic Development and Political Legitimacy", *American Political Science Review* 53, pp. 69-105.

Ragin, C. C. (2009) "Qualitative Comparative Analysis. Using Fuzzy Sets (fsQCA)." In Rihoux, B., and Ragin, C. C. (eds.) *Configurational Comparative Methods. Qualitative Comparative Analysis (QCA) and Related Techniques*. Thousand Oaks, CA and London: Sage, pp. 87-121.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### Examples

```
data(LIPR)
```

---

LR.intersect	<i>Function for identifying contradictory simplifying assumptions or easy counterfactuals.</i>
--------------	--

---

### Description

A function for identifying contradictory simplifying assumptions or easy counterfactuals by intersecting the SAs or ECs of two solutions.

### Usage

```
LR.intersect(results1, results2, sol1 = 1, sol2 = 1)
```

### Arguments

results1	An object of class "qca". It can be a parsimonious or an intermediate solution for an outcome or its negation obtained via <code>minimize()</code> .
results2	An object of class "qca". It can be a parsimonious or an intermediate solution for an outcome or its negation obtained via <code>minimize()</code> .
sol1	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.
sol2	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.

### Author(s)

Ioana-Elena Oana

### See Also

[minimize](#)

### Examples

```
# Import your data. For example:

data(SCHF)

# Get the parsimonious solution:

sol_yp <- minimize(SCHF, outcome = "EXPORT",
```

```

conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
incl.cut = .9,
include = "?",
details = TRUE, show.cases = TRUE)

# Get the parsimonious solution for the absence of the outcome:

sol_nyp <- minimize(SCHF, outcome = "EXPORT", neg.out = TRUE,
conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
incl.cut = .9,
include = "?",
details = TRUE, show.cases = TRUE)

# Get the contradictory simplifying assumptions:

LR.intersect(sol_yp, sol_nyp)

```

---

negateExp	<i>Negates a boolean expression.</i>
-----------	--------------------------------------

---

### Description

Function that negates a boolean expression.

### Usage

```
negateExp(expression)
```

### Arguments

expression	A boolean expression. Conditions should be capitalized and negated conditions should be inserted with a "~". Unions of conditions are performed with a "+", while intersections are performed with a "*".
------------	---

### Value

It returns a negated boolean expression.

### Author(s)

Ioana-Elena Oana

### Examples

```

negateExp("~EMP*MA")
negateExp("~A*B + C*~D")

```

---

PAYF

*Paykani et al. (2018)*

---

### **Description**

The PAYF data frame has 131 rows and 9 sets. The data is calibrated into fuzzy sets.

### **Usage**

```
data(PAYF)
```

### **Format**

A data frame with 131 observations on the following 9 sets.

COUNTRY Country

REGION Region the country belongs to.

HE Condition: healthy education system

GG Condition: good governance

AH Condition: affluent health system

HI Condition: high income inequality

HW Condition: high wealth

HL Outcome: high life expectancy

LL Negated Outcome: low life expectancy

### **References**

Paykani, Toktam, Rafiey, Hassan, and Sajjadi, Homeira. 2018. A fuzzy set qualitative comparative analysis of 131 countries: which configuration of the structural conditions can explain health better? *International journal for equity in health*, 17(1), 10.

### **Examples**

```
data(PAYF)
```



---

PAYR

*Paykani et al. (2018)*

---

### **Description**

The PAYR data frame has 131 rows and 9 variables. The data is raw, uncalibrated.

### **Usage**

```
data(PAYR)
```

### **Format**

A data frame with 131 observations on the following 9 sets.

COUNTRY Country

REGION Region the country belongs to.

LIFEX Life expectancy, raw data.

EDUC Education, raw data.

GOV Governance, raw data.

HEAL Health system, raw data.

INCEQ Income inequality, raw data.

WEAL Wealth, raw data.

### **References**

Paykani, Toktam, Rafiey, Hassan, and Sajjadi, Homeira. 2018. A fuzzy set qualitative comparative analysis of 131 countries: which configuration of the structural conditions can explain health better? *International journal for equity in health*, 17(1), 10.

### **Examples**

```
data(PAYR)
```

---

PENF

*Pennings (2003)*

---

### **Description**

The PENF data frame has 45 rows and 5 sets

### **Usage**

```
data(PENF)
```

### **Format**

A data frame with 45 observations on the following 5 sets.

K a numeric vector. Outcome, constitutional control.

C a numeric vector. Condition, consensus democracy.

P a numeric vector. Condition, presidentialism.

N a numeric vector. Condition, new democracy.

R a numeric vector. Condition, rigid constitution.

### **Details**

Data used by Pennings (2009) to explain constitutional control. Data are fuzzy-sets.

### **References**

Pennings, P. (2009) "Beyond Dichotomous Explanations: Explaining Constitutional control of the Executive with Fuzzy-sets", *European Journal of Political Research* 42, pp. 541-567.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### **Examples**

```
data(PENF)
```

---

pimdata	<i>Function to extract prime implicants table from object of class "qca"</i>
---------	--

---

### Description

A function that displays each case's set membership scores in each sufficient term, the solution formula, and the outcome from an object of class "qca".

### Usage

```
pimdata(results, outcome, sol = 1, ...)
```

### Arguments

results	An object of class "qca". For performing pimdata of the sufficient solution for the negated outcome one must only use the <code>minimize()</code> result from the sufficiency analysis of the negated outcome.
outcome	A character string with the name of the outcome in capital letters. When performing pimdata of the sufficient solution for the negated outcome one must only use the <code>minimize()</code> result from the sufficiency analysis of the negated outcome in the argument <code>results</code> . Changing the name in the argument <code>outcome</code> or using a tilde is not necessary.
sol	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.
...	Deprecated arguments ( <code>neg.out</code> , <code>use.tilde</code> )

### Value

A table with set memberships.

solution_formula	The solution formula.
out	Membership in the outcome.

### Author(s)

Ioana-Elena Oana and Juraj Medzihorsky

### See Also

[minimize](#) [pimplot](#)

**Examples**

```

# Import your data. For example:

data(SCHF)

# Get the parsimonious solution:

sol_yp <- minimize(SCHF, outcome = "EXPORT",
                  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",
                  details = TRUE, show.cases = TRUE)

# Get the intermediate solution:

sol_yi <- minimize(SCHF, outcome = "EXPORT",
                  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",
                  details = TRUE, show.cases = TRUE, dir.exp = c(0,0,0,0,0,0))

# Get the prime implicants table for the parsimonious solution:

pimdata(results = sol_yp, outcome = "EXPORT")

# Get the prime implicants table for the first intermediate solution:

pimdata(results = sol_yi, outcome = "EXPORT", sol = 1)

```

---

pimplot

*Prime implicants, truth table rows, and necessity plots.*


---

**Description**

A function that displays XY plots for each sufficient term and the solution formula plotted against the outcome from an object of class "qca" (obtained by using the `minimize` function in package QCA). The function can also plot truth table rows against the outcome. Additionally, the function can plot results obtained from necessity analyses using an object of class "sS" (obtained by using the `superSubset` function in package QCA).

**Usage**

```

pimplot(data = NULL,
        results,
        outcome,
        incl.tt=NULL,

```

```

tthrows= c(),
necessity=FALSE,
sol=1,
all_labels=FALSE,
markers = TRUE,
labcol="black",
jitter = FALSE,
font = "sans",
fontface = "italic",
fontsize = 3,
crisp = FALSE,
consH = FALSE,
...)
```

### Arguments

data	For analyses of sufficiency, providing a dataframe is not necessary. For analyses of necessity on objects of class "sS, you need to provide a dataframe with the name of the outcome and of the conditions in capital letters.
results	An object of class "qca" when necessity is FALSE. An object of class "sS" when necessity is TRUE. For performing pimplot of the sufficient solution for the negated outcome one must use the minimize() result from the sufficiency analysis of the negated outcome.
outcome	A character string with the name of the outcome in capital letters. When performing pimplot of the sufficient solution for the negated outcome one must only use the minimize() result from the sufficiency analysis of the negated outcome in the argument results. Changing the name in the argument outcome or using a tilde is not necessary, but recommended.
incl.tt	A numerical vector of length 1 specifying the row consistency threshold above which it should plot truth table rows. By default it is NULL and the function will produce plots using "qca" or "sS" objects. If a numerical value is specified, then it automatically only plots truth table rows above that consistency value. N.B. This argument cannot be used simultaneously with the tthrows argument.
tthrows	A vector of character strings specifying the names of the truth table rows to be printed. By default this vector is empty and the function will produce plots using "qca" or "sS" objects. If a value is specified, then it automatically only plots those particular truth table rows. N.B. This argument cannot be used simultaneously with the incl.tt argument.
necessity	logical. It indicates if the output should be for the results of sufficiency or necessity analyses. By default, FALSE, the function works with an object of class "qca" obtained from the minimize function in package QCA. When it set to TRUE the function returns plots for an object of class "sS" obtained from the superSubset function in package QCA.
sol	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.

<code>all_labels</code>	Logical. Print ALL case labels?
<code>markers</code>	Logical. Print deviant consistency cases with different markers?
<code>labcol</code>	Color of the labels.
<code>jitter</code>	Logical. Should labels not overlap?
<code>font</code>	Font of the labels. Accepts "sans", "serif", and "mono" fonts.
<code>fontface</code>	Fontface of the labels. Accepts "plain", "bold", "italic", "bold.italic".
<code>fontsize</code>	Fontsize of the labels.
<code>crisp</code>	Logical. Should the function return a two-by-two table for crisp sets?
<code>consH</code>	Logical. Should Haesebrouck's consistency be printed?
<code>...</code>	Other non essential arguments.

**Value**

XY plots.

**Author(s)**

Ioana-Elena Oana

**References**

- Haesebrouck, T. (2015) Pitfalls in QCA's consistency measure. *Journal of Comparative Politics* 2:65-80.
- Schneider, C. Q., Rohlfing, I. 2013. Combining QCA and Process Tracing in Set-Theoretic Multi-Method Research. *Sociological Methods Research* 42(4): 559-597

**See Also**

[minimize pimdata](#)

**Examples**

```
# Import your data. For example:

data(SCHF)

# Get the parsimonious solution:

sol_yp <- minimize(SCHF, outcome = "EXPORT",
                  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",
                  details = TRUE, show.cases = TRUE)

# Plot the prime implicants of the parsimonious solution:

pimplot(data = SCHF, results = sol_yp, outcome = "EXPORT")
```

```
# Plot a two-by-two table:

pimplot(data = SCHF, results = sol_yp, outcome = "EXPORT", crisp = TRUE)

# Plot all truth table rows with a consistency higher than 0.95:

pimplot(data=SCHF, results = sol_yp, incl.tt=0.97, outcome = "EXPORT", sol = 1)

# Plot truth table row "60":

pimplot(data=SCHF, results = sol_yp, tthrows =c("60"),
        outcome = "EXPORT", sol = 1)

# For plotting results of necessity analyses using superSubset,
# the first step is to obtain an "sS" object:

SUPSUB <- superSubset(SCHF, outcome="EXPORT",
                    conditions = c("EMP","BARGAIN","UNI","OCCUP","STOCK", "MA"),
                    relation = "necessity", incl.cut = 0.996)

SUPSUB

# This can be imputed as result and necessity should be set to \code{TRUE}:

pimplot(data = SCHF, results = SUPSUB, outcome = "EXPORT", necessity = TRUE)
```

---

property.cube

*Function producing a 3D scatter plot.*

---

## Description

A function for visualizing 3D property spaces as a 3D scatter plot using the scatterplot3d package.

## Usage

```
property.cube(data, labs = FALSE,
             main = "3D Property Space",
             xlab=NULL,
             ylab=NULL,
             zlab=NULL,
             highlight.3d=TRUE,
             dot.cex=0.5,
             dot.col="black",
             dot.srt=15,
             dot.pos=3,
             dot.offset = 1)
```

**Arguments**

<code>data</code>	A dataframe with 3 conditions.
<code>labs</code>	Logical. Should the case names be printed? If set to TRUE, it will automatically print the rownames of the dataframe given.
<code>main</code>	an overall title for the plot. The default is "3D Property Space"
<code>xlab</code>	a title for the x-axis. The default is the name of the first column in the dataframe.
<code>ylab</code>	a title for the y-axis. The default is the name of the third column in the dataframe.
<code>zlab</code>	a title for the z-axis. The default is the name of the second column in the dataframe.
<code>highlight.3d</code>	Logical. Should dots be colored differently according to their position in the property space?
<code>dot.cex</code>	size of the case labels
<code>dot.col</code>	color of the case labels
<code>dot.srt</code>	rotation of the case labels
<code>dot.pos</code>	position of the case labels (1-below, 2-left, 3-above, 4-right)
<code>dot.offset</code>	distance of text label from the dot

**Value**

It returns an enhanced 3d scatter plot using the `scatterplot3d` package.

**Author(s)**

Ioana-Elena Oana

**Examples**

```
# Load the Schneider data:
data(SCHF)

# Create a property space for conditions "EMP", "BARGAIN", and outcome "EXPORT":
property.cube(SCHF[,c("EMP", "BARGAIN", "EXPORT")])

# Create a property space for conditions 1,2, and 3 in the data together with case labels:
property.cube(SCHF[,1:3], labs=TRUE)
```



QCAfit

*Function calculating the parameters of fit***Description**

QCAfit is a function calculating parameters of fit useful in QCA and fsQCA that are consistency, coverage, PRI, Haesebrouck's consistency, RoN and PRODUCT. It works with both single and multiple conditions.

**Usage**

```
QCAfit(x, y, cond.lab = NULL, necessity = TRUE, neg.out = FALSE,
       product = FALSE, sol=1, tthrows= c(), consH = FALSE)
```

**Arguments**

x	A vector containing the values of a condition, a matrix with more than one conditions, or an object of class "qca" when necessity is FALSE and when outcome is specified as a character string.
y	A vector containing the values of the output or a character string when y is of class "qca".
cond.lab	When inserting a dataframe or a matrix with more than one condition and column names, the function automatically prints the names of the conditions tested. When inputting a vector, hence a single condition (i.e. a single column in a dataframe, the name of the condition tested should be inserted in this option .)
necessity	logical. It indicates if the output should be for sufficient or necessary condition(s). By default, FALSE, the function returns a table of parameters of fit for sufficient condition(s) (Consistency, Coverage, PRI, Haesebrouck's Consistency, and optionally Product). When it set to TRUE the function returns a table of parameters of fit for necessary condition(s) (Consistency, Coverage, Relevance of Necessity).
neg.out	logical. It indicates if the parameters of fit should be computed for the positive or the negative outcome. By default, FALSE, the function returns parameters of fit for the positive outcome .
product	logical. It indicates whether the parameter of fit PRODUCT should be shown. This stands for the product between the consistency sufficiency parameter and the PRI parameter.
sol	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.
tthrows	A vector specifying the names of the truth table rows for which the function reports parameters of fit. For using this option y must be a "qca" object.
consH	Logical. Print also the Haesebrouck's consistency among the parameters of fit?

**Value**

It returns a matrix containing the parameters of fit for each condition.

**Author(s)**

Mario Quaranta and Ioana-Elena Oana

**References**

Haesebrouck, T. (2015) Pitfalls in QCA's consistency measure. *Journal of Comparative Politics* 2:65-80.

Ragin, C. C. 2006. *Set Relations in Social Research: Evaluating Their Consistency and Coverage*. *Political Analysis* 14(3): 291-310.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

**See Also**

[minimize](#)

**Examples**

```
# Generate fake data
set.seed(1234)

a <- runif(100, 0, 1)
b <- runif(100, 0, 1)
c <- runif(100, 0, 1)
y <- runif(100, 0, 1)

# Only one condition, for necessity
QCAfit(a, y, cond.lab = "A")

# With three conditions and their negation, for necessity
QCAfit(cbind(a, b, c), y)

# Only one condition, for sufficiency
QCAfit(a, y, cond.lab = "A", necessity = FALSE)

# With three conditions, their negation and negated output, for necessity
QCAfit(cbind(a, b, c), y, neg.out = TRUE)

# Load the Schneider data:
data(SCHF)

# Get parameters of fit for condition EMP as necessary for outcome EXPORT:
QCAfit(SCHF$EMP, SCHF$EXPORT, cond.lab = "EMP")

# Get parameters of fit for condition ~EMP as necessary for outcome ~EXPORT:
```

```

QCAfit(1-SCHF$EMP, SCHF$EXPORT, neg.out=TRUE, cond.lab = "~EMP")

# Get parameters of fit for all conditions and their negation as necessary for outcome EXPORT:

QCAfit(SCHF[,1:6], SCHF$EXPORT)

# Obtain the parsimonious solution for outcome "EXPORT":

sol_yp <- minimize(SCHF, outcome = "EXPORT",
                  conditions = c("EMP","BARGAIN","UNI","OCCUP","STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",
                  details = TRUE, show.cases = TRUE)

# Get parameters of fit for the parsimonious solution:

QCAfit(x = sol_yp, y = "EXPORT", necessity = FALSE)

# Get parameters of fit for truth table rows 2,8, and 10:

QCAfit(x = sol_yp, y = "EXPORT", tthrows=c("2","8","10"), necessity = FALSE)

```

---

QCAradar

*Function for displaying a radar chart.*


---

## Description

Function displays a radar chart for an object of class "qca" or for a boolean expression.

## Usage

```
QCAradar(results, outcome= NULL, fit= FALSE, sol = 1)
```

## Arguments

results	An object of class "qca". For performing radar charts of the sufficient solution for the negated outcome one must only use the <code>minimize()</code> result from the sufficiency analysis of the negated outcome. The argument results can also be a boolean expression of the form e.g. "A*~B + ~B*C".
outcome	A character string with the name of the outcome in capital letters when results is of type 'qca'. When performing radar charts of the sufficient solution for the negated outcome one must only use the <code>minimize()</code> result from the sufficiency analysis of the negated outcome in the argument results. Changing the name in the argument outcome or using a tilde is not necessary.
fit	Logical. Print parameters of fit when results is of type 'qca'

`sol` A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.

### Author(s)

Ioana-Elena Oana

### References

Maerz, F. Seraphine. 2017. "Pathways of Authoritarian Persistence." Paper presented at the CEU Annual Doctoral Conference

### See Also

[minimize](#)

### Examples

```
# Import data.
# For example:

data(SCHF)

# Get the intermediate solution:

sol_yi <- minimize(SCHF, outcome = "EXPORT",
                  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",
                  details = TRUE, show.cases = TRUE, dir.exp = c(0,0,0,0,0,0))

# Display radar chart for the intermediate solution:

QCAradar(results = sol_yi, outcome = "EXPORT", fit=TRUE, sol = 1)

# Show a radar chart for the following boolean expression "A + ~B*Z*~C"

QCAradar(results = "A + ~B*Z*~C")
```

---

rob.calibrange

*Function for identifying the calibration threshold ranges for a condition within which the Boolean formula for the solution does not change.*

---

## Description

Function for identifying the calibration threshold ranges for a condition within which the Boolean formula for the solution does not change. The function gradually increases and, then, decreases each of the three (0, 0.5, 1) calibration thresholds of a condition by the value specified in the step argument and checks whether the solution formula changes. The function performs this iteration for the number of times specified in the max.runs argument. If the solution formula does not change given the number of runs specified, it will return an NA, meaning that it could not find a limit to the range.

## Usage

```
rob.calibrange(raw.data,
  calib.data,
  test.cond.raw,
  test.cond.calib,
  test.thresholds,
  type = "fuzzy",
  step = 1,
  max.runs = 20,
  outcome,
  conditions,
  incl.cut = 1,
  n.cut = 1,
  include = "",
  ...)
```

## Arguments

raw.data	A data frame containing the raw data used to test the calibration thresholds for the chosen condition.
calib.data	A data frame containing the calibrated data for the sufficient solution.
test.cond.raw	A character string specifying the name of the condition in the RAW dataset for which to test the calibration ranges.
test.cond.calib	A character string specifying the name of the condition in the CALIBRATED dataset for which to test the calibration ranges.
test.thresholds	The initial qualitative anchors used for calibrating the chosen condition.
type	The calibration type, "fuzzy" is the default, but it can also be changed to "crisp".
step	The value to be gradually added and subtracted from the threshold tested.
max.runs	The maximum number of times the step value gets gradually added and subtracted.
outcome	A character string with the name of the outcome in capital letters. For the negated outcome a tilde "~" should be used. This had the same usage as the outcome argument in the minimize function.

conditions	A vector of character strings containing the names of the conditions. This had the same usage as the conditions argument in the minimize function.
incl.cut	The raw consistency threshold for the truth table rows.
n.cut	The frequency threshold for the truth table rows.
include	A vector of other output values (for example "?" for logical remainders) to include in the minimization. This had the same usage as the include argument in the minimize function.
...	Other options that the minimize function in the QCA package accepts. Check them out using ?minimize.

### Author(s)

Ioana-Elena Oana

### References

Oana, Ioana-Elena, and Carsten Q. Schneider. 2020. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

### Examples

```
# Load the calibrated data:
data(LIPF)

# Load the raw data:
data(LIPR)

# Get calibration ranges for condition DEVELOPED:

rob.calibrange(
  raw.data = LIPR,
  calib.data = LIPF,
  test.cond.raw = "DEVELOPED",
  test.cond.calib = "DEVELOPED",
  test.thresholds = c(400, 550, 900),
  step = 500,
  max.runs = 2,
  outcome = "SURVIVED",
  conditions = c("URBAN", "LITERATE", "INDUSTRIAL", "STABLE"),
  incl.cut = 0.8,
  n.cut = 1,
  include = "?"
)
```

---

rob.cases	<i>Function for identifying cases in the intersections between an initial solution and test solutions.</i>
-----------	--

---

**Description**

Function for identifying cases between the various intersections between an initial solution and test solutions. The function also returns case ratio parameters.

**Usage**

```
rob.cases(test_sol,  
          initial_sol,  
          outcome)
```

**Arguments**

test_sol	The different alternative solutions created with minimize() and placed in a list using list().
initial_sol	The initial solution created with minimize().
outcome	A character string containing the name of the outcome.

**Author(s)**

Ioana-Elena Oana

**References**

Oana, Ioana-Elena, and Carsten Q. Schneider. 2020. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
## Not run:  
# Load the data:  
data(PAYF)  
  
# Store the name of the conditions in one vector:  
conds <- c("HE", "GG", "AH", "HI", "HW")  
  
# Create several solutions:  
  
# The initial solution  
IS <- minimize(data = PAYF,  
              outcome = "HL",  
              conditions = conds,
```

```
        incl.cut = 0.87,
        n.cut = 2,
        include = "?",
        details = TRUE,
        show.cases = TRUE)

# altering consistency
TS1 <- minimize(data = PAYF,
               outcome = "HL",
               conditions = conds,
               incl.cut = 0.7,
               n.cut = 2,
               include = "?",
               details = TRUE, show.cases = TRUE)

#altering n.cut
TS2 <- minimize(data = PAYF,
               outcome = "HL",
               conditions = conds,
               incl.cut = 0.87,
               n.cut = 1,
               include = "?",
               details = TRUE, show.cases = TRUE)

# Create the test set in a list:
TS <- list(TS1, TS2)

# Looking at cases against the test set:

rob.cases(test_sol = TS,
          initial_sol = IS,
          outcome = "HL")

## End(Not run)
```

---

rob.corefit

*Function returning parameters of fit for the robust core of different alternative sufficient solutions.*

---

### Description

Function returning parameters of fit for the robust core between an initial solution and various alternative test solutions.

### Usage

```
rob.corefit(test_sol,
            initial_sol,
            outcome)
```



**Arguments**

test_sol	The different alternative solutions created with minimize() and placed in a list using list().
initial_sol	The initial solution created with minimize().
outcome	A character string containing the name of the outcome.

**Author(s)**

Ioana-Elena Oana

**References**

Oana, Ioana-Elena, and Carsten Q. Schneider. 2020. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
# Load the data:
data(PAYF)

# Store the name of the conditions in one vector:
conds <- c("HE", "GG", "AH", "HI", "HW")

# Create several solutions:

# The initial solution
IS <- minimize(data = PAYF,
               outcome = "HL",
               conditions = conds,
               incl.cut = 0.87,
               n.cut = 2,
               include = "?",
               details = TRUE,
               show.cases = TRUE)

# altering consistency
TS1 <- minimize(data = PAYF,
                outcome = "HL",
                conditions = conds,
                incl.cut = 0.7,
                n.cut = 2,
                include = "?",
                details = TRUE, show.cases = TRUE)

#altering n.cut
TS2 <- minimize(data = PAYF,
                outcome = "HL",
                conditions = conds,
```

```

        incl.cut = 0.87,
        n.cut = 1,
        include = "?",
        details = TRUE, show.cases = TRUE)

# Create the test set in a list:
TS <- list(TS1, TS2)

# Calculate robustness parameters, i.e. the ratio of the parameters
# of fit for the core vis-a-vis for the initial solution:

CF <- rob.corefit(test_sol = TS,
                 initial_sol = IS,
                 outcome = "HL")
CF

```

---

rob.fit

---

*Function returning robustness parameters of fit.*


---

### Description

Function returning robustness parameters of fit of the intersections between an initial sufficient solution and various alternative test solutions.

### Usage

```
rob.fit(test_sol,
        initial_sol,
        outcome)
```

### Arguments

test_sol	The different alternative solutions created with minimize() and placed in a list using list().
initial_sol	The initial solution created with minimize().
outcome	A character string containing the name of the outcome.

### Author(s)

Ioana-Elena Oana

### References

Oana, Ioana-Elena, and Carsten Q. Schneider. 2020. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
# Load the data:
data(PAYF)

# Store the name of the conditions in one vector:
conds <- c("HE", "GG", "AH", "HI", "HW")

# Create several solutions:

# The initial solution
IS <- minimize(data = PAYF,
               outcome = "HL",
               conditions = conds,
               incl.cut = 0.87,
               n.cut = 2,
               include = "?",
               details = TRUE,
               show.cases = TRUE)

# altering consistency
TS1 <- minimize(data = PAYF,
                outcome = "HL",
                conditions = conds,
                incl.cut = 0.7,
                n.cut = 2,
                include = "?",
                details = TRUE, show.cases = TRUE)

#altering n.cut
TS2 <- minimize(data = PAYF,
                outcome = "HL",
                conditions = conds,
                incl.cut = 0.87,
                n.cut = 1,
                include = "?",
                details = TRUE, show.cases = TRUE)

# Create the test set in a list:
TS <- list(TS1, TS2)

# Calculate robustness parameters, i.e. the ratio of the parameters
# of fit for the core vis-a-vis for the initial solution:

RF <- rob.fit(test_sol = TS,
              initial_sol = IS,
              outcome = "HL")

RF
```

---

**rob.inclrange**

*Function for identifying the raw consistency threshold range within which the Boolean formula for the solution does not change.*

---

## Description

Function for identifying the raw consistency threshold range for a truth table within which the Boolean formula for the solution does not change. The function gradually increases and, then, decreases an initial selected threshold by the value specified in the step argument and checks whether the solution formula changes for finding the lower and upper ranges for the raw consistency threshold. The function performs this iteration for the number of times specified in the max.runs argument. If the solution formula does not change given the number of runs specified, it will return an NA, meaning that it could not find a limit to the range.

## Usage

```
rob.inclrange(data,
  step = 0.1,
  max.runs = 20,
  outcome,
  conditions,
  incl.cut = 1,
  n.cut = 1,
  include = "",
  ...)
```

## Arguments

data	A data frame containing the calibrated data for the sufficient solution.
step	The value to be gradually added and subtracted from the threshold tested.
max.runs	The maximum number of times the step value gets gradually added and subtracted.
outcome	A character string with the name of the outcome in capital letters. For the negated outcome a tilde "~" should be used. This had the same usage as the outcome argument in the minimize function.
conditions	A vector of character strings containing the names of the conditions. This had the same usage as the conditions argument in the minimize function.
incl.cut	The raw consistency threshold for the truth table rows.
n.cut	The frequency threshold for the truth table rows.
include	A vector of other output values (for example "?" for logical remainders) to include in the minimization. This had the same usage as the include argument in the minimize function.
...	Other options that the minimize function in the QCA package accepts. Check them out using ?minimize.

## Author(s)

Ioana-Elena Oana

## References

Oana, Ioana-Elena, and Carsten Q. Schneider. 2020. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

## Examples

```
# Load the calibrated data:
data(PAYF)

# Check raw consistency ranges:

rob.inclrange(
  data = PAYF,
  step = 0.01,
  max.runs = 10,
  outcome = "HL",
  conditions = c("HE", "GG", "AH", "HI", "HW"),
  incl.cut = 0.87,
  n.cut = 2,
  include = "?"
)
```

---

rob.ncutrange

*Function for identifying the frequency threshold range within which the Boolean formula for the solution does not change.*

---

## Description

Function for identifying the frequency threshold range for a truth table within which the Boolean formula for the solution does not change. The function gradually increases and, then, decreases an initial selected threshold by the value specified in the step argument and checks whether the solution formula changes for finding the lower and upper ranges for the frequency threshold. The function performs this iteration for the number of times specified in the max.runs argument. If the solution formula does not change given the number of runs specified, it will return an NA, meaning that it could not find a limit to the range.

## Usage

```
rob.ncutrange(data,
  step = 1,
  max.runs = 20,
  outcome,
  conditions,
  incl.cut = 1,
  n.cut = 1,
  include = "",
  ...)
```

**Arguments**

data	A data frame containing the calibrated data for the sufficient solution.
step	The value to be gradually added and subtracted from the threshold tested.
max.runs	The maximum number of times the step value gets gradually added and subtracted.
outcome	A character string with the name of the outcome in capital letters. For the negated outcome a tilde "~" should be used. This had the same usage as the outcome argument in the minimize function.
conditions	A vector of character strings containing the names of the conditions. This had the same usage as the conditions argument in the minimize function.
incl.cut	The raw consistency threshold for the truth table rows.
n.cut	The frequency threshold for the truth table rows.
include	A vector of other output values (for example "?" for logical remainders) to include in the minimization. This had the same usage as the include argument in the minimize function.
...	Other options that the minimize function in the QCA package accepts. Check them out using ?minimize.

**Author(s)**

Ioana-Elena Oana

**References**

Oana, Ioana-Elena, and Carsten Q. Schneider. 2020. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
# Load the calibrated data:
data(PAYF)

# Check frequency ranges:
rob.ncutrange(
  data = PAYF,
  step = 1,
  max.runs = 10,
  outcome = "HL",
  conditions = c("HE", "GG", "AH", "HI", "HW"),
  incl.cut = 0.87,
  n.cut = 2,
  include = "?"
)
```

---

rob.singletest	<i>Function returning robustness parameters for each single test solution in TS.</i>
----------------	--

---

### Description

Function returning robustness parameters for each single test solution in TS. The function returns the set-coincidence and RC\_Rank between each alternative solution and the initial solution.

### Usage

```
rob.singletest(test_sol,  
              initial_sol,  
              outcome)
```

### Arguments

test_sol	The different alternative solutions created with minimize() and placed in a list using list().
initial_sol	The initial solution created with minimize().
outcome	A character string containing the name of the outcome.

### Author(s)

Ioana-Elena Oana

### References

Oana, Ioana-Elena, and Carsten Q. Schneider. 2021. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (2021). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

### Examples

```
# Load the data:  
data(PAYF)  
  
# Store the name of the conditions in one vector:  
conds <- c("HE", "GG", "AH", "HI", "HW")  
  
# Create several solutions:  
  
# The initial solution  
IS <- minimize(data = PAYF,  
              outcome = "HL",  
              conditions = conds,  
              incl.cut = 0.87,
```

```

        n.cut = 2,
        include = "?",
        details = TRUE,
        show.cases = TRUE)

# altering consistency
TS1 <- minimize(data = PAYF,
               outcome = "HL",
               conditions = conds,
               incl.cut = 0.7,
               n.cut = 2,
               include = "?",
               details = TRUE, show.cases = TRUE)

#altering n.cut
TS2 <- minimize(data = PAYF,
               outcome = "HL",
               conditions = conds,
               incl.cut = 0.87,
               n.cut = 1,
               include = "?",
               details = TRUE, show.cases = TRUE)

# Create the test set in a list:
TS <- list(TS1, TS2)

# Calculate robustness parameters, i.e. the ratio of the parameters
# of fit for the core vis-a-vis for the initial solution:

RST <- rob.singletest(test_sol = TS,
                     initial_sol = IS,
                     outcome = "HL")

RST

```

---

rob.xyplot

*Function for plotting an initial solution against the test set.*


---

### Description

Function for plotting an initial solution against the test set.

### Usage

```

rob.xyplot(test_sol,
           initial_sol,
           outcome,
           all_labels = FALSE,
           jitter = TRUE,
           fontsize = 3,
           labs = TRUE,
           area_lab = TRUE)

```



**Arguments**

test_sol	The different alternative solutions created with minimize() and placed in a list using list().
initial_sol	The initial solution created with minimize().
outcome	A character string containing the name of the outcome.
all_labels	Logical. Should all the case labels be printed? If FALSE, only shaky and possible cases are printed.
jitter	Logical. Should case labels be jitter so as not to overlap?
fontsize	The size of the font for case labels.
labs	Logical. Should case labels be printed?
area_lab	Logical. Should labels for each area with regard to minTS/maxTS be printed?

**Author(s)**

Ioana-Elena Oana

**References**

Oana, Ioana-Elena, and Carsten Q. Schneider. 2020. Robustness tests in QCA: A fit-oriented and case-oriented perspective using R. Unpublished Manuscript.

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
# Load the data:
data(PAYF)

# Store the name of the conditions in one vector:
conds <- c("HE", "GG", "AH", "HI", "HW")

# Create several solutions:

# The initial solution
IS <- minimize(data = PAYF,
               outcome = "HL",
               conditions = conds,
               incl.cut = 0.87,
               n.cut = 2,
               include = "?",
               details = TRUE,
               show.cases = TRUE)

# altering consistency
TS1 <- minimize(data = PAYF,
                outcome = "HL",
                conditions = conds,
                incl.cut = 0.7,
```

```
n.cut = 2,
include = "?",
details = TRUE, show.cases = TRUE)

#altering n.cut
TS2 <- minimize(data = PAYF,
  outcome = "HL",
  conditions = conds,
  incl.cut = 0.87,
  n.cut = 1,
  include = "?",
  details = TRUE, show.cases = TRUE)

# Create the test set in a list:
TS <- list(TS1, TS2)

# Plotting the initial solution against the test set:

rob.xyplot(test_sol = TS,
  initial_sol = IS,
  outcome = "HL",
  fontsize = 2.5,
  jitter=TRUE)
```

---

SAMF

*Samford (2010)*

---

## Description

The SAMF data frame has 61 rows and 4 sets

## Usage

```
data(SAMF)
```

## Format

A data frame with 61 observations on the following 4 sets.

Y a numeric vector. Outcome, trade liberalization.

G a numeric vector. Condition, lack of weak growth.

H a numeric vector. Condition, lack of hyper-inflation

HorG a numeric vector. Condition, H or G.

## Details

Data are used by Samford (2010) to analyze rapid trade liberalization in Latin America. Data are fuzzy-sets.

**References**

Samford, S. (2010) "Averting 'Disruption and Reversal': Reassessing the Logic of Rapid Trade Reform in Latin America", *Politics and Policy* 38(3), pp. 373-407.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

**Examples**

```
data(SAMF)
```

---

SC

*Selbst, practicing the truth table algorithm data*

---

**Description**

The SC data frame has 130 rows and 4 sets

**Usage**

```
data(SC)
```

**Format**

A data frame with 130 observations on the following 4 sets.

A a numeric vector. Condition, crisp-set.

B a numeric vector. Condition, crisp-set.

C a numeric vector. Condition, crisp-set.

Y a numeric vector. Condition, crisp-set.

**Details**

The authors of the data are Carsten Schnieder and Claudius Wagemann. The data are used in the on-line appendix of "Set-Theoretic Methods for the Social Sciences" to practice the truth table algorithm. Data are crisp-sets.

**References**

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

Schneider, C. Q., Wagemann, C., Quaranta, M. (2012) How To... Use Software for Set-Theoretic Analysis. Online Appendix to "Set-Theoretic Methods for the Social Sciences". Available at [www.cambridge.org/schneider-wagemann](http://www.cambridge.org/schneider-wagemann)

**Examples**

```
data(SC)
```

---

SCHF

*Schneider et. al. (2010)*

---

### **Description**

The SCHF data frame has 76 observations and 7 sets

### **Usage**

```
data(SCHF)
```

### **Format**

A data frame with 76 observations on the following 7 sets.

EMP a numeric vector. Condition, employment protection.

BARGAIN a numeric vector. Condition, collective bargaining.

UNI a numeric vector. Condition, university training.

OCCUP a numeric vector. Condition, occupational training.

STOCK a numeric vector. Condition, stock market size.

MA a numeric vector. Condition, mergers and acquisitions.

EXPORT a numeric vector. Outcome, export performance in high-tech industries.

### **Details**

Data used by Schneider et. al. (2010) to explain capitalist variety and export performance in high-tech industries. Data are fuzzy-sets.

### **References**

Schneider, M. R., Schulze-Bentrop, C., Paunescu, M. (2010) "Mapping the institutional capital of high-tech firms: A fuzzy-set analysis of capitalist variety and export performance", *Journal of International Business Studies* 41, pp. 246-266.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

### **Examples**

```
data(SCHF)
```

---

SCHLF

*Schneider et. al. (2010)*

---

**Description**

The SCHLF data frame has 76 observations and 9 variables.

**Usage**

```
data(SCHLF)
```

**Format**

A data frame with 76 observations on the following 9 variables.

EMP a numeric vector. Condition, employment protection.

BARGAIN a numeric vector. Condition, collective bargaining.

UNI a numeric vector. Condition, university training.

OCCUP a numeric vector. Condition, occupational training.

STOCK a numeric vector. Condition, stock market size.

MA a numeric vector. Condition, mergers and acquisitions.

EXPORT a numeric vector. Outcome, export performance in high-tech industries.

COUNTRY a string vector. Name of the country in which the observation was made.

YEAR a numeric vector. Year in which the observation was made.

**Details**

Data used by Schneider et. al. (2010) to explain capitalist variety and export performance in high-tech industries. Data is saved in the long format and the first 7 variables are fuzzy-sets.

**References**

Schneider, M. R., Schulze-Bentrop, C., Paunescu, M. (2010) "Mapping the institutional capital of high-tech firms: A fuzzy-set analysis of capitalist variety and export performance", *Journal of International Business Studies* 41, pp. 246:266;

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

**Examples**

```
data(SCHLF)
```

---

SDC

*Selbst, disappearing necessary condition data*

---

### **Description**

The SDC data frame has 98 rows and 4 sets

### **Usage**

```
data(SDC)
```

### **Format**

A data frame with 98 observations on the following 4 sets.

A a numeric vector. Condition, crisp-set.

B a numeric vector. Condition, crisp-set.

C a numeric vector. Condition, crisp-set.

Y a numeric vector. Outcome, crisp-set.

### **Details**

The authors of the data are Carsten Schnieder and Claudius Wagemann. The data are used in the on-line appendix of "Set-Theoretic Methods for the Social Sciences" to show the disappearance of a necessary condition. Data are crisp-sets.

### **References**

Schneider, C. Q., Wagemann, C. (2012) Set-Theoretic Methods for the Social Sciences, Cambridge University Press: Cambridge.

Schneider, C. Q., Wagemann, C., Quaranta, M. (2012) How To... Use Software for Set-Theoretic Analysis. Online Appendix to "Set-Theoretic Methods for the Social Sciences". Available at [www.cambridge.org/schneider-wagemann](http://www.cambridge.org/schneider-wagemann)

### **Examples**

```
data(SDC)
```

---

`skew.check`*Function for checking how skewed sets are.*

---

### Description

A function that identifies how skewed sets are by returning the number and percentage of cases with higher than 0.5 fuzzy-set values. The function can also return histograms of the calibrated sets.

### Usage

```
skew.check(data, hist = FALSE, main = NULL)
```

### Arguments

<code>data</code>	A dataframe, a subset of a dataframe, or a vector (i.e. single column in a dataframe). The function should be used for calibrated data and will give an error if the data contains uncalibrated scores. However, if you have both calibrated and uncalibrated data in the same dataframe, it is possible to use the function only for the calibrated subset of that data.
<code>hist</code>	Logical. Should the function also return histograms of the sets?
<code>main</code>	Title for the plot. When provided with a dataframe, the function automatically assigns the column name to the plot.

### Author(s)

Ioana-Elena Oana

### Examples

```
# Import your data. For example:
data(SCHF)

# Check skewness for the entire dataframe:
skew.check(SCHF)

# Check skewness for the column "EMP" in the dataframe:
skew.check(SCHF$EMP)

# Check skewness for the 5th column of the dataframe:
skew.check(SCHF[,5])
```

---

smmr

---

*Function for performing set-theoretic multi-method research.*


---

### Description

A function that selects best available cases for single case studies and best pairs of matching cases for comparative case studies.

### Usage

```
smmr(results, outcome, sol = 1, match = NULL,
      cases = NULL, max_pairs = 5, term = 1, nec.cond = NULL, necessity = FALSE, ...)
```

### Arguments

results	An object of class "qca".
outcome	A character string with the name of the outcome. If the negated outcome is analyzed, one can also write for example outcome = "~Y", however this is unnecessary as the values in the outcome will be taken from the appropriate minimized solution.
sol	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.
match	Logical. Should comparative SMMR be used?
cases	A numerical vector indicating the type of cases to be returned. For single case studies for SUFFICIENCY: 1 = typical cases, 2 = typical cases for each focal conjunct in a sufficient term, 3 = deviant consistency, 4 = deviant coverage, 5 = individually irrelevant, 6 = all of the above; For comparative case studies for SUFFICIENCY: 1 = Typical-Typical for each focal conjunct in a sufficient term, 2 = Typical-IIR for each focal conjunct in a sufficient term, 3 = Typical-Dev.Cons., 4 = Dev.Cov.-IIR; 5 = Typical-Typical for each term; 6 = Typical-IIR for each term; 7 = all of the above; For single case studies for NECESSITY: 1 = typical cases, 2 = deviant consistency, 3 = deviant relevance,



	4 = all of the above; For comparative case studies for NECESSITY: 1 = Typical-Deviant Relevance , 2 = Typical-Deviant Consistency, 3 = Typical-IIR, 4 = Typical-Typical, 5 = all of the above;
max_pairs	Maximum number of pairs to extract.
term	A numeric vector where the first number indicates the number of the term according to the order in the "qca" object.
nec.cond	A character vector specifying the necessity results obtained. This could be of the form "A", "A+B", or "A*B", making sure no spaces are left between the name of the conditions and the Boolean operator. Notice that nec.cond can also be specified for sufficiency results in single SMMR typical cases for each focal conjunct in a sufficient term, and for comparative SMMR in typical-typical and typical-iir comparisons for each focal conjunct. Note that in the later case only expressions of the forms "A" or "A+B" are accepted. If dealing with a necessary condition of the form "A*B", each of the individual conditions should be entered separately when performing analyses of sufficiency.
necessity	Logical. Should SMMR results for necessity be shown?
...	Deprecated arguments (neg.out, use.tilde)

**Author(s)**

Ioana-Elena Oana

**References**

Schneider, C. Q., Rohlfing, I. 2013. Combining QCA and Process Tracing in Set-Theoretic Multi-Method Research. *Sociological Methods and Research* 42(4): 559-97

**See Also**[minimize](#)**Examples**

```
# Import your data. For example:

data(SCHF)

## SUFFICIENCY SMMR examples:

# Get the parsimonious solution:

sol_yp <- minimize(SCHF, outcome = "EXPORT",
                  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",
```

```

        details = TRUE, show.cases = TRUE)

# Get typical cases for each focal conjunct in the third term of the parsimonious solution:

smmr(results = sol_yp, outcome = "EXPORT", match=FALSE, cases=2, term = 3)

# Get typical cases for each focal conjunct in the third term of the parsimonious solution
# and specifying STOCK as a necessary condition:

smmr(results = sol_yp, outcome = "EXPORT",
      match=FALSE, cases=2, term = 3, nec.cond="STOCK")

# Get matching typical-typical cases for the second term of the parsimonious solution:

smmr(results = sol_yp, outcome = "EXPORT", match=TRUE, cases=1, term = 2)

# Get matching typical-DCN cases:

smmr(results = sol_yp, outcome = "EXPORT", match=TRUE, cases=3)

## NECESSITY SMMR examples:

# Imagine you found condition "STOCK + MA" is necessary for outcome "EXPORT".

# Get typical cases for each disjunct of the necessary condition:

smmr(results = sol_yp, outcome = "EXPORT", match=FALSE, cases=1,
      nec.cond = "STOCK+MA", necessity = TRUE)

# Get typical - deviant relevance cases for each disjunct of the necessary condition:

smmr(results = sol_yp, outcome = "EXPORT", match=TRUE, cases=1,
      nec.cond = "STOCK+MA", necessity = TRUE)

```

---

stargazerSol

*Function for exporting a sufficient solution from minimize in latex, html, or text format.*

---

## Description

Function for exporting a sufficient solution from minimize in latex, html, or text format.

## Usage

```

stargazerSol(results,
             outcome,
             sol = 1,
             show.cases = FALSE,

```

```

type = "latex",
title = "",
out = NULL,
digits = 3)

```

### Arguments

results	An object of class "qca": a sufficient solution obtained with the minimize function.
outcome	A character string with the name of the outcome in capital letters. When performing pimplot of the sufficient solution for the negated outcome one must only use the minimize() result from the sufficiency analysis of the negated outcome in the argument results. Changing the name in the argument outcome or using a tilde is not necessary, but recommended.
sol	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.
show.cases	Logical. Should the names of cases be printed?
type	character string that specifies what type of output the command should produce. The possible values are "latex" (default), "html", "text".
title	title for the table.
out	name of the file to be saved containing the extension (e.g. "mysol.tex", "mysol.txt")
digits	To how many digits should the parameters of fit be rounded up.

### Author(s)

Ioana-Elena Oana

### References

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

### Examples

```

# Import your data. For example:

data(SCHF)

# Get the parsimonious solution:

sol_yp <- minimize(SCHF, outcome = "EXPORT",
                  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                  incl.cut = .9,
                  include = "?",

```

```

        details = TRUE, show.cases = TRUE)

# Print in latex format:

stargazerSol(sol_yp, "EXPORT")

```

---

stargazerTT	<i>Function for exporting a sufficient solution from minimize in latex, html, or text format.</i>
-------------	---

---

### Description

Function for exporting a sufficient solution from minimize in latex, html, or text format.

### Usage

```

stargazerTT(truthtable,
            show.cases = FALSE,
            type = "latex",
            title = "",
            out = NULL,
            digits = 3)

```

### Arguments

truthtable	A truth table obtained with the truthTable function.
show.cases	Logical. Should the names of cases be printed?
type	character string that specifies what type of output the command should produce. The possible values are "latex" (default), "html", "text".
title	title for the table.
out	name of the file to be saved containing the extension (e.g. "mysol.tex", "mysol.txt")
digits	To how many digits should the parameters of fit be rounded up.

### Author(s)

Ioana-Elena Oana

### References

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
# Import your data. For example:

data(SCHF)

# Get the truth table:

mytt <- truthTable(SCHF, outcome = "EXPORT",
                   conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
                   incl.cut = .9, complete = TRUE)

# Export as latex:
stargazerTT(mytt)

# Export as text:
stargazerTT(mytt, type = "text")
```

---

STUF

*Fake fuzzy-set student data.*

---

**Description**

Fake fuzzy-set football practice data used for Chapter 4 of the Oana et al. (forthcoming) book.

**Usage**

```
data(STUF)
```

**Format**

A data frame with 17 observations on the following 3 variables. Conditions for arriving in time for football practice.

- A Condition: Live close by
- B Condition: Arrive by bike
- C Condition: Come from punctual familie
- D Condition: Are seasoned players
- E Condition: Goalkeepers
- Y Outcome: Arrive on time for football practice

**References**

Oana, Ioana-Elena, Carsten Q. Schneider, and Eva Thomann (forthcoming). Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction. Cambridge: Cambridge University Press.

**Examples**

```
data(STUF)
```



**Arguments**

theory	A character string specifying the theory. Unions of conditions are performed with a "+", while intersections are performed with a "*". Conditions should be capitalized and negated conditions should be inserted with a "~".
empirics	An object of class 'qca'. When performing analyses for the negated outcome, just use the results from the <code>minimize()</code> function for the negation of the outcome.
outcome	A character string with the name of the outcome. When performing analyses of the sufficient solution for the negated outcome one must only use the <code>minimize()</code> result from the sufficiency analysis of the negated outcome in the argument <code>empirics</code> . Changing the name in the argument <code>outcome</code> or using a tilde is not necessary.
sol	A vector where the first number indicates the number of the conservative or parsimonious solution according to the order in the "qca" object. For more complicated structures of model ambiguity, the intermediate solution can also be specified by using a character string of the form "c1p3i2" where c = conservative solution, p = parsimonious solution and i = intermediate solution.
print.data	Logical. Print also the membership of cases in all the intersections between theory and empirics?
print.fit	Logical. Print also the parameters of fit for the intersections between theory and empirics?
consH	Logical. Print also the Haesebrouck's consistency among the parameters of fit?
...	Deprecated arguments (use.tilde).

**Author(s)**

Ioana-Elena Oana

**References**

- Ragin, C. C. 1987. *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*. Berkeley: University of California Press, pp. 118-121
- Schneider, C. Q., Wagemann, C. 2012. *Set-Theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis*. Cambridge: Cambridge University Press, chapter 11.3

**See Also**

[minimize](#)

**Examples**

```
## Not run:
# Import your data. For example:

data(SCHF)

# Get the intermediate solution:
```

```

sol_yi <- minimize(SCHF, outcome = "EXPORT",
  conditions = c("EMP", "BARGAIN", "UNI", "OCCUP", "STOCK", "MA"),
  incl.cut = .9,
  include = "?",
  details = TRUE, show.cases = TRUE, dir.exp = c(0,0,0,0,0,0))

# Specify the theory. Let's assume the theory says that the
# absence of EMP and the presence of MA is sufficient for EXPORT:

t<-"~EMP*MA"

# Perform theory evaluation (get only the names of the cases and the Boolean intersections):

TH <- theory.evaluation(theory = t, empirics = sol_yi, outcome = "EXPORT", sol = 1,
  print.data=FALSE, print.fit=FALSE)

TH

# Get only the case names:

TH$cases

# Or only the parameters of fit:

TH$fit
## End(Not run)

```

---

 THOF

*Thomann (2015)*


---

## Description

The THOF data frame has 76 rows and 7 sets. The study analyses how European Union (EU) member states adapt EU directives to domestic contexts during transposition and asks how and why fully compliant countries 'customize' EU directives.

## Usage

```
data(THOF)
```

## Format

A data frame with 76 observations on the following 7 sets.

RESP Cond.: Responsive regulatory mode

SAL Cond.: Salient issue



RES Cond.: Domestic resistance  
 VPO Cond.: Many veto points  
 VPL Cond.: Many veto players  
 COERC Cond.: Coercive interventionist style  
 CUSTOM Outcome: Extensive customization

### Details

Data used by Thomann (2015) to explain customization. Data are fuzzy-sets.

### References

Thomann, E. 2015. Customizing Europe: Transposition as bottom-up implementation. *Journal of European Public Policy* 22(10): 1368-1387.

### Examples

```
data(THOF)
```

---

VISIC

*Vis (2009), crisp set data*

---

### Description

The VISIC data frame has 25 rows and 4 sets

### Usage

```
data(VISIC)
```

### Format

A data frame with 25 observations on the following 4 sets.

P a numeric vector. Condition, weak political positions, with parties in government expecting losses at the next election.

S a numeric vector. Condition, deteriorating economic situation.

R a numeric vector. Condition, government dominated by parties from the right of the political spectrum.

U a numeric vector. Outcome, unpopular reform.

### Details

Data are used by Vis (2009) to analyze the pursuit of unpopular reforms by governments. Data are crisp-sets.

**References**

Vis, B. (2009) "Government and Unpopular Social Policy Reforms: Biting the Bullet or Steering Clear?", *European Journal of Political Research* 48, pp. 31-57.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

**Examples**

```
data(VISC)
```

---

VISF

*Vis (2009), fuzzy set data*

---

**Description**

The VISF data frame has 25 rows and 4 sets

**Usage**

```
data(VISF)
```

**Format**

A data frame with 25 observations on the following 4 sets.

p a numeric vector. Condition, weak political positions, with parties in government expecting losses at the next election.

s a numeric vector. Condition, deteriorating economic situation.

r a numeric vector. Condition, government dominated by parties from the right of the political spectrum.

u a numeric vector. Outcome, unpopular reform.

**Details**

Data are used by Vis (2009) to analyze the pursuit of unpopular reforms by governments. Data are fuzzy-sets.

**References**

Vis, B. (2009) "Government and Unpopular Social Policy Reforms: Biting the Bullet or Steering Clear?", *European Journal of Political Research* 48, pp. 31-57.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge University Press: Cambridge.

**Examples**

```
data(VISF)
```

xy.plot

*Function producing enhanced XY plots***Description**

xy.plot produces XY plots and provides values for consistency, Haesebrouck's consistency, coverage, RoN, PRI. Several graphic parameters can be decided by the user.

**Usage**

```
xy.plot(x, y, data,
        labcol = "black",
        main = "XY plot",
        ylab = "Outcome",
        xlab = "Condition",
        necessity = FALSE,
        jitter = FALSE,
        font = "sans",
        fontface = "italic",
        fontsize = 3,
        labs = rownames(data),
        crisp = FALSE,
        shape = 19,
        consH = FALSE,
        ...)
```

**Arguments**

x	vector containing the condition.
y	vector containing the outcome.
data	The dataset used
labcol	color of the dots.
main	an overall title for the plot. The default is "XY plot". See ?title.
ylab	a title for the y-axis. The default is "Outcome". See ?title.
xlab	a title for the x-axis. The default is "Condition". See ?title.
necessity	logical. Indicates if the parameters of fit are calculated for a sufficient or necessary condition. The default is FALSE, therefore it calculates the parameters of fit for sufficiency. To get the parameters of fit for necessary conditions set necessity as TRUE.
jitter	Logical. Should labels be jitter to not overlap?
font	Font of the labels. Accepts "sans", "serif", and "mono" fonts.
fontface	Fontface of the labels. Accepts "plain", "bold", "italic", "bold.italic".
fontsize	Fontsize of the labels.

labs	the vector of case labels. The default is the rownames of the dataset.
crisp	Logical. Should a two-by-two table for crisp sets be returned?
shape	The shape for the markers.
consH	Logical. Should Haesebrouck's consistency be printed?
...	Other internal arguments. Do not specify!

**Value**

It returns an enhanced XY plot.

**Author(s)**

Mario Quaranta and Ioana-Elena Oana.

**References**

Haesebrouck, T. (2015) Pitfalls in QCA's consistency measure. *Journal of Comparative Politics* 2:65-80.

Ragin, C. C. (2008) *Redesigning Social Inquiry: Fuzzy Sets and Beyond*. The Chicago University Press: Chicago and London.

Schneider, C. Q., Wagemann, C. (2012) *Set-Theoretic Methods for the Social Sciences*, Cambridge Univeristy Press: Cambridge.

**Examples**

```
# Load the Schneider data:

data(SCHF)

# Plot of condition EMP as necessary for outcome EXPORT with case labels
# and names for the plot and axes:

xy.plot("EMP", "EXPORT", data=SCHF, necessity = TRUE,
        main = "EMP as necessary for EXPORT", ylab = "EXPORT", xlab = "EMP")
```

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