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Conjoint R package

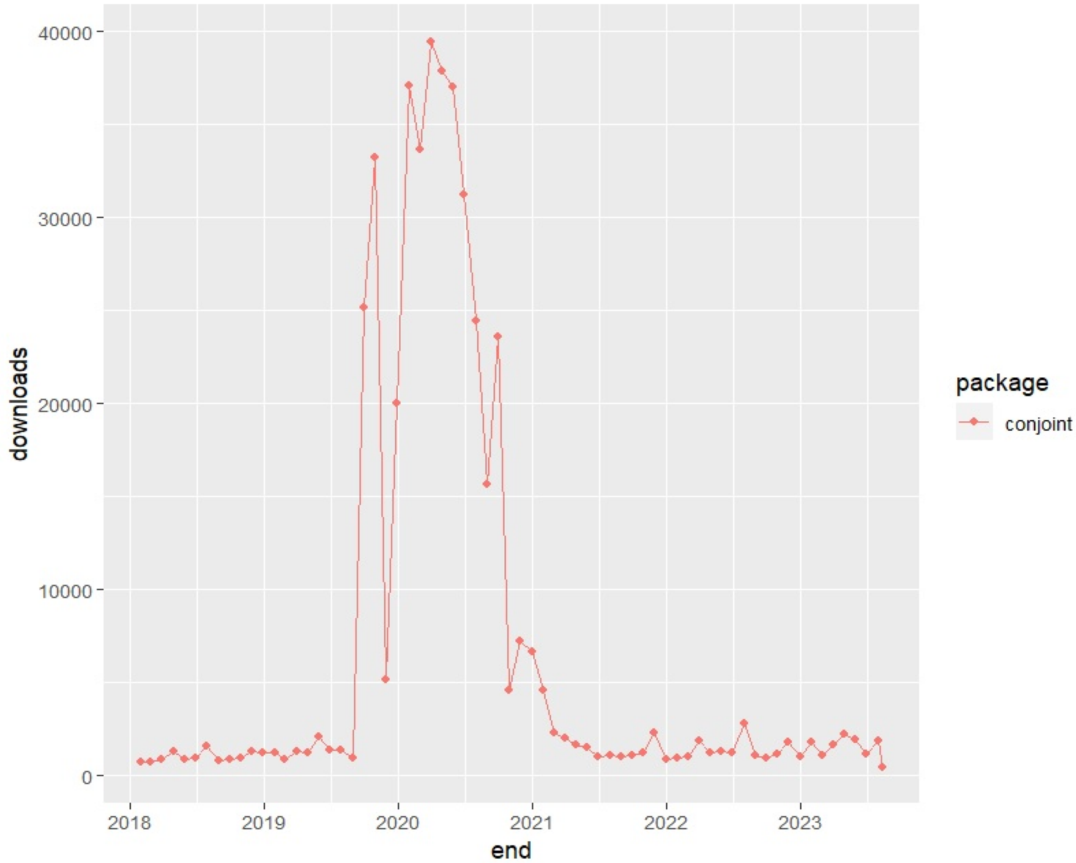
conjoint R[1] – statistical software package for GNU R program. It contains the implementation of the traditional conjoint analysis method. It is written in R programming language as the development (module) of popular statistical software in the form of GNU R program, it also works with programs dedicated to R environment, such as: RStudio and Microsoft R Application Network.

The conjoint R package covers the set of functions[2] facilitating stated preference analysis based on empirical data representing consumers' assessments of product or service profiles (the so-called total utilities, empirical utilities). Total utilities are subject to decomposition into the so-called part-worths utilities, which in further analysis are used to determine product or service importance, to define a product with optimal features, to separate segments of buyers with similar preferences, etc[3]. The decomposition is carried out based on the linear multiple regression model with dummy variables (lm function from stats R package [R Core Team 2018[4]]). The conjoint package allow as follows:

- estimation of conjoint analysis model parameters (part-worths utilities) in the cross-section of respondents (individual models) and the total sample (aggregated model),
- estimation of attributes' importance (features describing profiles of products or services),
- estimation of the theoretical usefulness of complete product or service profiles,
- estimation of simulation profiles as market share,
- segmentation of respondents. In addition, the package offers functions generating full and fractional (including orthogonal and effective) factorial design, necessary to prepare a proper questionnaire representing the tool for collecting data on respondents' stated preferences using the conjoint analysis method.

The conjoint package source code is published based on GNU GPL licence rules. Binary versions are available for Windows, Macintosh systems and Unix systems (including Linux as the natural environment for GNU R project).

Requirements



The correct functioning of conjoint package requires installing GNU R basic version and also additional packages (e.g. AlgDesign R package [Wheeler 2015[5]] and others), which starting from 3.3.2 version of GNU R are automatically downloaded and installed including the conjoint package. The package can be downloaded and installed from the website of CRAN R repository (https://CRAN.R-project.org/package=conjoint[1]) and the GitHub website (https://github.com/packagesR/conjoint). The total number of conjoint package installations (as at August 13, 2023) by the users of RStudio program exceeded 450 000 downloads (statistics does not cover the downloads by users of other R program versions, including primarily the original version of R environment). Fig. 1 shows the monthly number of conjoint R package downloads. The statistics were prepared based on dlstats R package [Yu 2017[6]] and presented using ggplot2 R package [Wickham et al. 2018[7]] (below the respective R code).

```
library("ggplot2")
library("dlstats")
x<-cran_stats("conjoint")
ggplot(x,aes(end,downloads,group=package,color=package))+geom_line() +
geom_point(aes(shape=package))+scale_x_date(date_breaks="1 year",date_labels="%Y")
```

History and versions

The first version of conjoint package on CRAN server was available on October 2, 2011. Since then the package has been gradually developed and adapted to current standards, including various hardware platforms. The package can be installed on a computer with a 32-bit or a 64-bit processor. The package functionality is identical in both cases, with the exception of fractional factorial designs. In 32-bit systems it is possible to obtain a different fractional factorial design than in the case of 64-bit systems (it results from the numerical determinants of the machine word length and its impact on the seed of the random number generator, which is used in the procedure of fractional factorial design generation). The presented examples were developed using 64-bit processors working under the control of Windows 10 operating system.

Package functions

The current version of conjoint (1.41) package offers 16 functions, which allow for: model parameters estimation of conjoint analysis and respondents' segmentation (functions: caModel, caSegmentation), estimation of theoretical part-worths utilities and total utilities in the cross-section of respondents (functions: caPartUtilities, caTotalUtilities), estimation of attributes' importance and part-worths utilities of attributes' levels at an aggregated level (functions: caImportance, caUtilities), and also – within the framework of simulation analysis – market share estimations of simulation profiles (functions: caBTL, caLogit, caMaxUtility). The special purpose functions include the function converting the empirical preference data set (caRankToScore function) and the functions which allow obtaining the aggregate results of the selected measurements and simulations (functions: Conjoint, ShowAllSimulations and ShowAllUtilities). In addition, the package offers tools supporting the design of a questionnaire survey, i.e. the construction of appropriate factorial designs, in particular to reduce the complete set of profiles in the form of fractional designs (orthogonal and effective). For this purpose the conjoint R package uses functions of AlgDesign R package [Wheeler 2015[5]]. The application of AlgDesign package functions in conjoint package is carried out in the form of functions, which allow generating orthogonal and effective fractional factorial designs and their encoding using artificial variables (functions: caFactorialDesign, caEncodedDesign and caRecreatedDesign). In order to generate the appropriate factorial (full and fractional) design the data regarding the number of taken into account attributes (variables, features, factors) are sufficient and their levels (realizations, values, observations) as well as the names of attributes and levels. The detailed characteristics of all the available functions is provided in the official documentation[8] of conjoint R package and on other unofficial websites [9] [10] [11] [12] presenting the package application. The table presents the concise description of conjoint R package functions.

Generating factorial designs and data conversion
caFactorialDesign(data, type="null", cards=NA, seed=123) – the function determines the (full or fractional) factorial design with variable names and their levels
caEncodedDesign(design) – the function encodes the factorial design obtained using

caFactorialDesign function for the needs of conjoint module functioning
caRecreatedDesign(attr.names, lev.numbers, z, prof.numbers) – the function recreates the fractional factorial design based on profile numbers from the full factorial design
caRankToScore(y.rank) – the function transforms the empirical preference data measured on a rank scale into a data set in the form of point grades (on a positional scale)
Estimation of individual part-worths utilities and theoretical total utilities (in the cross-section of respondents)
caPartUtilities(y, x, z) – the function calculates the part-worths utility matrix of attribute levels in the cross-section of respondents (including an intercept)
caTotalUtilities(y, x) – the function calculates the theoretical total utilities matrix of profiles in the cross-section of respondents
Estimation of part-worths utilities of attributes' levels (at an aggregated level) and the attributes' importance level
caUtilities(y, x, z) – the function calculates part-worths utilities of attributes' levels at an aggregated level
caImportance(y, x) – the function calculates an average relative "importance" of all attributes (as %) at an aggregated level
Simulation analysis of market share
caBTL(sym, y, x) – the function estimates market shares of simulation profiles based on the BTL probability model (Bradley-Terry-Luce Model)
caLogit(sym, y, x) – the function estimates market shares of simulation profiles based on logit model
caMaxUtility(sym, y, x) – the function estimates market shares of simulation profiles based on the maximum utility model
Estimation of *conjoint analysis* model parameters and respondents' segmentation
caModel(y, x) – the function estimates *conjoint analysis* model parameters for an individual respondent
caSegmentation(y, x, c=2) – the function performs respondents' segmentation using k-means method
Main results of *conjoint analysis* and simulation analysis

Conjoint(y, x, z, y.type=”score”) – the function calculates basic results of *conjoint analysis* at an aggregated level	
ShowAllUtilities(y, x, z) – the function calculates all (part-worths and total) utilities available in the conjoint package	
ShowAllSimulations(sym, y, x) – the function estimates market shares of simulation profiles based on all simulation models available in the conjoint package	
Function arguments	
data	data describing the object of an experiment (product, service) – the set of attributes (factors) and their levels in the form of expand.grid function
type	optional parameter describing the type of generated factorial design (default type="null" – fractional design is generated with no specific criteria)
cards	optional parameter describing the number of generated profiles (default cards=NA – the number of profiles results from the type of generated factorial design)
seed	optional parameter describing the seed value of the random number generator (default seed=123)
design	factorial (fractional or full) experiment design
attr.names	vector representing names of attributes (factors)
lev.numbers	vector representing numbers of attributes’ (factors) levels
prof.numbers	vector representing numbers of reconstructed profiles
z	vector representing names of attributes’ (factors) levels
y.rank	matrix (or vector) of empirical preferences in the ranking form (the ranking data require transformation to rating data using caRankToScore function)
y	matrix (or vector) of empirical preferences (in the form of importance assessments on a rating or ranking scale)
x	matrix representing profiles (including names of attributes)
y.type	type of data about preferences – data in the form of profile importance assessments on a rating or ranking scale (default type is rating)
sym	matrix representing simulation profiles (including attributes’ names)

c	optional parameter specifying the number of segments (default c=2 – division into 2 segments)

Package datasets

In version 1.41 of the conjoint R package there are 9 datasets that allow the presentation of using of the package functions. In each of datasets there are exemplary data describing: respondents' preferences (in the form of a data matrix or data vector), fractional factorial experiment design (in the form of a data matrix) and the names of individual variables' levels (in the form of data vector). In some datasets there is also design representing simulation profiles (in the form of a data matrix) that allows analysis of the market share of (products or services) profiles that were not included in the experiment design. Detailed characteristics of all datasets are available in the official documentation[8] of the conjoint package. The table presents a short description and the content of selected datasets of conjoint R package.

Dataset name	Description	Content (with variables' names)
ice	Sample artificial data on a ranking scale (needs conversion) about preferences of ice-creams consumers. The product described by 4 attributes (with following attributes' levels): flavour (chocolate, vanilla, strawberry), price ($1.50, $2.00, $2.50), container (cone, cup), topping (yes, no).	ipref - matrix of preferences (6 respondents and 9 profiles), iprof - matrix of profiles (4 attributes and 9 profiles), ilevn - vector of names for the attributes' levels (10 levels).
tea	Sample data on a rating scale collected in 2007 about preferences of tea consumers. The product described by 4 attributes (with following attributes' levels): price (low, medium, high), variety (black, green, red), kind (bags, granulated, leafy), aroma (yes, no).	tprefm - matrix of preferences (100 respondents and 13 profiles), tpref - vector of preferences (length 1300), tprof - matrix of profiles (4 attributes and 13 profiles), tlevn - vector of names for the attributes' levels (11 levels), tsimp - matrix of simulation profiles (4 attributes and 4 profiles).
chocolate	Sample data on a rating scale collected in 2000 about preferences of chocolate consumers.	cprefm - matrix of preferences (87 respondents and 16

	The product described by 5 attributes (with following attributes' levels): kind (milk, walnut, delicaties, dark), price (low, average, high), packing (paperback, hardback), weight (light, middle, heavy), calorie (little, much).	profiles), cpref - vector of preferences (length 1392), cprof - matrix of profiles (5 attributes and 16 profiles), clevn - vector of names for the attributes' levels (14 levels), csimp - matrix of simulation profiles (5 attributes and 4 profiles).
journey	Sample data on a rating scale collected in 2015/2016 about preferences of tourists. The product described by 4 attributes (with following attributes' levels): purpose (cognitive, vacation, health, business), form (organized, own), season (summer, winter), accommodation (1-2-3 star hotel, 4-5 star hotel, guesthouse, hostel).	jpref - matrix of preferences (306 respondents and 14 profiles), jprof - matrix of profiles (4 attributes and 14 profiles), jlevn - vector of names for the attributes' levels (12 levels), csimp - matrix of simulation profiles (4 attributes and 5 profiles).

```
> library(conjoint)
> data(tea)
> ls()
[1] "tlevn"  "tpref"  "tprefm" "tprof"  "tsimp"
> print(tprof)
   price variety kind aroma
1      3       1    1     1
2      1       2    1     1
3      2       2    2     1
4      2       1    3     1
5      3       3    3     1
6      2       1    1     2
7      3       2    1     2
8      2       3    1     2
9      3       1    2     2
10     1       3    2     2
11     1       1    3     2
12     2       2    3     2
13     3       2    3     2
> print(tsimp)
  price variety kind aroma
1     3       2    2     2
```

```
2     1      3    1     1
3     2      3    3     2
4     3      1    2     1
> print(tlevn)
      levels
1        low
2     medium
3       high
4      black
5      green
6        red
7       bags
8  granulated
9      leafy
10       yes
11        no
> tpref[1:78,]
 [1]  8  1  1  3  9  2  7  2  2  2  2  3  4  0 10  3  5  1  4  8  6  2  9  7  5  2  4 10  3
[37]  8  9  7  6  7  4  9  6  3  7  4  8  5  2 10  9  5  1  7  8  6 10  7 10  6  6  6 10  7 1
[73]  0  0  0  0  1  1
> head(tprefm)
  profil1 profil2 profil3 profil4 profil5 profil6 profil7 profil8 profil9 profil10 profil11 p
1       8       1       1       3       9       2       7       2       2        2        2
2       0      10       3       5       1       4       8       6       2        9        7
3       4      10       3       5       4       1       2       0       0        1        8
4       6       7       4       9       6       3       7       4       8        5        2
5       5       1       7       8       6      10       7      10       6        6        6
6      10       1       1       5       1       0       0       0       0        0        0
```

Practical applications of conjoint R package

Example 1. Consumer preference analysis of ice-creams based on the data collected on the rank scale

Research construction

Declaration of the research variables (including the relevant variable levels): flavour (chocolate, vanilla, strawberry), price ($1.50, $2.00, $2.50), container (cone, cup) and topping (yes, no):

```
> library(conjoint)
> experiment<-expand.grid(
+ flavor=c("chocolate","vanilla","strawberry"),
+ price=c("$1.50","$2.00","$2.50"),
```

```
+ container=c("cone","cup"),
+ topping=c("yes","no"))
```

Determining fractional, orthogonal factorial design with variable names and their levels for the needs of questionnaire construction:

```
> factdesign<-caFactorialDesign(data=experiment,type="orthogonal")
> print(factdesign)
       flavor price container topping
2     vanilla $1.50      cone     yes
6  strawberry $2.00      cone     yes
10  chocolate $1.50       cup     yes
13  chocolate $2.00       cup     yes
17    vanilla $2.50       cup     yes
18 strawberry $2.50       cup     yes
25  chocolate $2.50      cone      no
30 strawberry $1.50       cup      no
32    vanilla $2.00       cup      no
```

Encoding variable levels of the fractional design:

```
> prof=caEncodedDesign(design=factdesign)
> print(prof)
   flavor price container topping
2       2     1         1       1
6       3     2         1       1
10      1     1         2       1
13      1     2         2       1
17      2     3         2       1
18      3     3         2       1
25      1     3         1       2
30      3     1         2       2
32      2     2         2       2
```

Verification (using covariance and correlation matrix) of the fractional design quality:

```
> print(round(cov(prof),5))
          flavor price container topping
flavor      0.75  0.00      0.00    0.00
price       0.00  0.75      0.00    0.00
container   0.00  0.00      0.25    0.00
topping     0.00  0.00      0.00    0.25
> print(round(cor(prof),5))
          flavor price container topping
flavor         1     0         0       0
```

```
price          0     1         0       0
container      0     0         1       0
topping        0     0         0       1
> print(det(cor(prof)))
[1] 1
```

Data loading

Loading from external files: data on empirical preferences, research design, variable names and their levels

```
> pref=read.csv2("ice_preferences.csv", header=TRUE)
> profiles=read.csv2("ice_profiles.csv", header=TRUE)
> levelnames=read.csv2("ice_levels.csv", header=TRUE)
> print(pref)
  profile1 profile2 profile3 profile4 profile5 profile6 profile7 profile8 profile9
1        1        6        2        7        8        4        3        9        5
2        3        4        9        8        1        5        7        6        2
3        3        5        1        6        8        9        2        7        4
4        1        4        2        8        9        5        7        6        3
5        2        6        3        7        8        1        4        5        9
6        2        5        9        6        7        8        3        4        1
> print(profiles)
  flavour price container topping
1       2     1         1       1
2       3     2         1       1
3       1     1         2       1
4       1     2         2       1
5       2     3         2       1
6       3     3         2       1
7       1     3         1       2
8       3     1         2       2
9       2     2         2       2
> print(levelnames)
       levels
1   chocolate
2     vanilla
3  strawberry
4       $1.50
5       $2.00
6       $2.50
7        cone
8         cup
9         yes
10         no
```

Data files in comma-separated values (.csv format) to be downloaded: ice_preferences.csv, ice_profiles.csv, ice_levels.csv

Change of data format about preferences from rank ordering (so-called ranking) into score importance assessments (so-called rating):

```
> preferences=caRankToScore(y.rank=pref)
> print(preferences)
  profile1 profile2 profile3 profile4 profile5 profile6 profile7 profile8 profile9
1        9        4        8        3        2        6        7        1        5
2        7        6        1        2        9        5        3        4        8
3        7        5        9        4        2        1        8        3        6
4        9        6        8        2        1        5        3        4        7
5        8        4        7        3        2        9        6        5        1
6        8        5        1        4        3        2        7        6        9
```

Measurement of preferences at the individual level (for selected respondents)

Conjoint analysis model estimation for the 1-st respondent:

```
> caModel(preferences[1,],profiles)

Call:
lm(formula = frml)

Residuals:
         1          2          3          4          5          6          7          8
 6.667e-01 -6.667e-01  1.500e+00 -1.500e+00 -2.833e+00  2.833e+00  2.591e-16 -2.167e+00  2.16

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)            5.2500     1.4633   3.588   0.0697 .
factor(x$flavour)1     1.0000     1.8509   0.540   0.6431
factor(x$flavour)2     0.3333     1.8509   0.180   0.8737
factor(x$price)1       1.0000     1.8509   0.540   0.6431
factor(x$price)2      -1.0000     1.8509  -0.540   0.6431
factor(x$container)1   1.2500     1.3882   0.900   0.4629
factor(x$topping)1     0.5000     1.3882   0.360   0.7532
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.926 on 2 degrees of freedom
Multiple R-squared:  0.4861,	Adjusted R-squared:  -1.056
F-statistic: 0.3153 on 6 and 2 DF,  p-value: 0.8851
```

Determining relative importance of variables (attributes) for the 1-st respondent:

```
> importance=caImportance(y=preferences[1,],x=profiles)
> print(importance)
[1] 29.79 25.53 31.91 12.77
```

Measurement of preferences at the aggregate level (in the cross-section of respondents)

Measurement of part-worths utilities:

```
> partutilities=caPartUtilities(y=preferences,x=profiles,z=levelnames)
> print(partutilities)
     intercept chocolate vanilla strawberry  $1.50  $2.00  $2.50 cone   cup   yes    no
[1,]     5.250     1.000   0.333     -1.333  1.000 -1.000  0.000 1.25 -1.25  0.50 -0.50
[2,]     5.083    -3.000   3.000      0.000 -1.000  0.333  0.667 0.25 -0.25  0.00  0.00
[3,]     5.583     2.000   0.000     -2.000  1.333  0.000 -1.333 1.25 -1.25 -0.50  0.50
[4,]     5.167    -0.667   0.667      0.000  2.000  0.000 -2.000 0.75 -0.75  0.25 -0.25
[5,]     5.000     0.333  -1.333      1.000  1.667 -2.333  0.667 0.75 -0.75  0.75 -0.75
[6,]     6.000    -1.000   1.667     -0.667  0.000  1.000 -1.000 1.25 -1.25 -1.75  1.75
```

Measurement of total utilities:

```
> totalutilities=caTotalUtilities(y=preferences,x=profiles)
> print(totalutilities)
      [,1]  [,2]  [,3]  [,4]  [,5]  [,6] [,7]  [,8]   [,9]
[1,] 8.333 4.667 6.500 4.500 4.833 3.167    7 3.167  2.833
[2,] 7.333 5.667 0.833 2.167 8.500 5.500    3 3.833  8.167
[3,] 7.667 4.333 7.167 5.833 2.500 0.500    8 4.167  4.833
[4,] 8.833 6.167 6.000 4.000 3.333 2.667    3 6.167  4.833
[5,] 6.833 5.167 7.000 3.000 4.333 6.667    6 6.167 -0.167
[6,] 7.167 5.833 2.000 3.000 3.667 1.333    7 5.833  9.167
```

Summary of the most important preference measurement results using the Conjoint function:

```
> Conjoint(y=preferences,x=profiles,z=levelnames)

Call:
lm(formula = frml)

Residuals:
    Min      1Q  Median      3Q     Max 
-3,9444 -1,6944  0,0833  1,3333  5,6944
```

```
Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)            5,3472     0,3747  14,269   <2e-16 ***
factor(x$flavour)1    -0,2222     0,4740  -0,469   0,6414
factor(x$flavour)2     0,7222     0,4740   1,524   0,1343
factor(x$price)1       0,8333     0,4740   1,758   0,0853 .
factor(x$price)2      -0,3333     0,4740  -0,703   0,4854
factor(x$container)1   0,9167     0,3555   2,578   0,0131 *
factor(x$topping)1    -0,1250     0,3555  -0,352   0,7267
---
Signif. codes:  0 ‘***’ 0,001 ‘**’ 0,01 ‘*’ 0,05 ‘.’ 0,1 ‘ ’ 1

Residual standard error: 2,463 on 47 degrees of freedom
Multiple R-squared:  0,2079,    Adjusted R-squared:  0,1068
F-statistic: 2,057 on 6 and 47 DF,  p-value: 0,07656

[1] "Part worths (utilities) of levels (model parameters for whole sample):"
       levnms    utls
1   intercept  5,3472
2   chocolate -0,2222
3     vanilla  0,7222
4  strawberry    -0,5
5       $1.50  0,8333
6       $2.00 -0,3333
7       $2.50    -0,5
8        cone  0,9167
9         cup -0,9167
10        yes  -0,125
11         no   0,125
[1] "Average importance of factors (attributes):"
[1] 35,13 31,39 20,43 13,05
[1] Sum of average importance:  100
[1] "Chart of average factors importance"
```

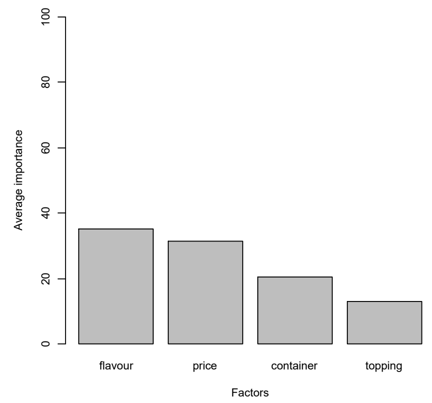


Fig. 2. The chart of variables (attributes) importance

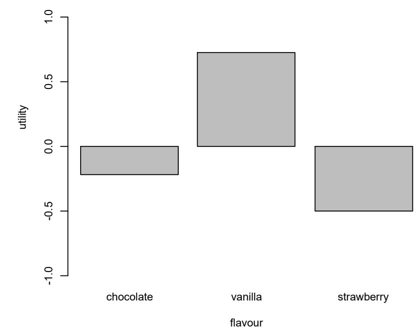


Fig. 3. The chart of preference levels of flavour variable

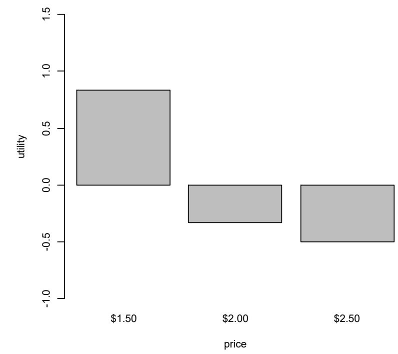


Fig. 4. The chart of preference levels of price variable

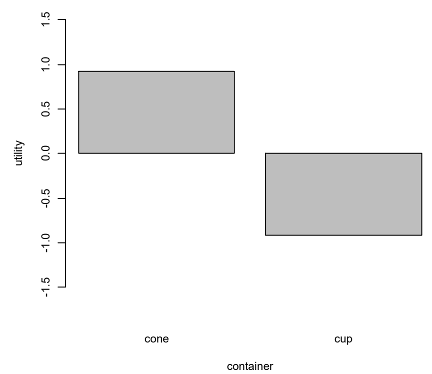


Fig. 5. The chart of preference levels of container variable

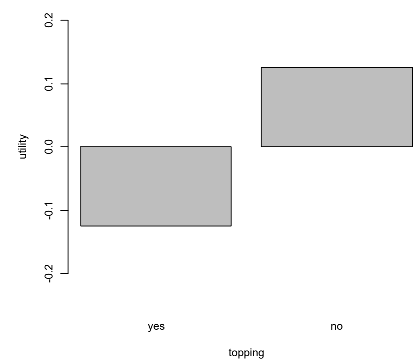


Fig. 6. The chart of preference levels of topping variable

Example 2. Tourists’ preference measurement based on the data collected in the form of grades on an interval scale

Research construction

Declaration of the research variables (including the relevant variable levels): purpose (cognitive, vacation, health, business), form (organized, own), season (summer, winter), accommodation (1-2-3 star hotel, 4-5 star hotel, guesthouse, hostel):

```
> library(conjoint)
> journey<-expand.grid(purpose=c("cognitive","vacation","health","business"),
+ form=c("own","organized"),
+ season=c("summer","winter"),
+ accommodation=c("1-2-3 star hotel","4-5 star hotel","guesthouse","hostel"))
```

Determining fractional factorial design with variable names and their levels for the needs of questionnaire construction:

```
> journeyfactdesign<-caFactorialDesign(data=journey,type="fractional")
> journeyfactdesign
     purpose      form season     accommodation
1  cognitive       own summer 1-2-3 star hotel
8   business organized summer 1-2-3 star hotel
10  vacation       own winter 1-2-3 star hotel
15    health organized winter 1-2-3 star hotel
19    health       own summer   4-5 star hotel
21 cognitive organized summer   4-5 star hotel
30  vacation organized winter   4-5 star hotel
34  vacation       own summer       guesthouse
39    health organized summer       guesthouse
41 cognitive       own winter       guesthouse
48  business organized winter       guesthouse
54  vacation organized summer           hostel
60  business       own winter           hostel
61 cognitive organized winter           hostel
```

Encoding variable levels of the fractional design:

```
> prof=caEncodedDesign(design=journeyfactdesign)
> prof
   purpose form season accommodation
1        1    1      1             1
8        4    2      1             1
10       2    1      2             1
15       3    2      2             1
19       3    1      1             2
21       1    2      1             2
30       2    2      2             2
34       2    1      1             3
39       3    2      1             3
```

```
41         1    1      2             3
48         4    2      2             3
54         2    2      1             4
60         4    1      2             4
61         1    2      2             4
```

Data loading

Loading from external files: data on empirical preferences, research design, variable names, their levels and simulation profiles

```
> preferences=read.csv2("journey_preferences.csv", header=TRUE)
> profiles=read.csv2("journey_profiles.csv", header=TRUE)
> levelnames=read.csv2("journey_levels.csv", header=TRUE)
> simulations=read.csv2("journey_simulations.csv", header=TRUE)
> print(head(preferences))
  profile01 profile02 profile03 profile04 profile05 profile06 profile07 profile08 profile09 p
1         0        10         0        10        10         8         4         5        10
2        10         0        10         3         7         9         2         7         4
3         8         2         6         9         7         9         0         1         8
4         8        10         1         6         3         0         3         1         8
5         3         4         8        10        10         1        10         4         9
6         5         1         8         3        10         0         9         5         3
> print(profiles)
   purpose form season accommodation
1        1    1      1             1
2        4    2      1             1
3        2    1      2             1
4        3    2      2             1
5        3    1      1             2
6        1    2      1             2
7        2    2      2             2
8        2    1      1             3
9        3    2      1             3
10       1    1      2             3
11       4    2      2             3
12       2    2      1             4
13       4    1      2             4
14       1    2      2             4
> print(levelnames)
          levels
1      cognitive
2       vacation
3         health
4       business
5      organized
6            own
```

```
7           summer
8           winter
9  1-2-3 star_hotel
10   4-5 star_hotel
11       guesthouse
12           hostel
> print(simulations)
  purpose form season accommodation
1       2    2      1             1
2       2    1      1             2
3       3    2      2             2
4       1    1      1             4
5       4    1      2             3
```

Data files in comma-separated values (.csv format) to be downloaded: journey_preferences.csv, journey_profiles.csv, journej_levels.csv, journey_simulations.csv

Measurement of preferences (at the individual and aggregated level)

Measurement of part-worths utilities (in the cross-section of respondents):

```
> partutilities=caPartUtilities(y=preferences,x=profiles,z=levelnames)
> print(head(partutilities))
     intercept cognitive vacation health business organized    own summer winter 1-2-3 star_h
[1,]     4.938    -0.937   -2.687  3.639   -0.014    -1.562  1.562  0.692 -0.692            0
[2,]     5.625     0.875    1.625 -0.827   -1.673     0.250 -0.250  1.058 -1.058            0
[3,]     4.187     2.563   -2.437  3.341   -3.466     0.063 -0.063  0.135 -0.135            2
[4,]     4.375     1.125   -2.125  0.788    0.212    -1.625  1.625  0.346 -0.346            1
[5,]     6.688    -2.187   -1.187  3.534   -0.159    -0.062  0.062 -2.385  2.385           -0
[6,]     5.500     0.250    1.000  0.202   -1.452     0.750 -0.750 -1.808  1.808           -1
```

Measurement of total utilities (in the cross-section of respondents):

```
> totalutilities=caTotalUtilities(y=preferences,x=profiles)
> print(head(totalutilities))
      [,1]  [,2]  [,3]   [,4]  [,5]  [,6]  [,7]  [,8]   [,9] [,10]  [,11] [,12]  [,13] [,14]
[1,] 3.192 7.240 0.058  9.510 9.346 7.894 4.760 1.692 11.144 2.058  6.106 2.490  0.654 2.856
[2,] 7.933 4.885 6.567  3.615 5.654 6.856 5.490 7.683  4.731 4.817  1.769 9.260  4.346 6.394
[3,] 9.010 2.856 3.740  9.394 7.692 6.788 1.519 1.260  6.913 5.990 -0.163 0.481 -0.692 5.212
[4,] 6.096 8.433 2.154  8.317 0.923 4.510 0.567 1.596  7.760 4.154  6.490 4.683  3.077 7.240
[5,] 1.615 3.769 7.385 12.231 8.808 3.212 8.981 3.115  7.962 6.885  9.038 2.519  8.192 6.288
[6,] 3.442 0.240 7.808  5.510 5.846 4.394 8.760 6.942  4.644 9.808  6.606 2.490  5.154 5.356
```

Determining the relative importance of features (for the respondent No.306):

```
> importance=caImportance(y=preferences[306,],x=profiles)
> print(importance)
[1] 41.97 18.11 13.37 26.56
```

Summary of the most important preference measurement results using the Conjoint function (for the respondent No. 306):

```
> Conjoint(preferences[306,],profiles,levelnames)

Call:
lm(formula = frml)

Residuals:
        1         2         3         4         5         6         7         8         9
 2,192308 -2,009615  2,557692 -2,740385  0,346154 -0,355769  0,009615 -3,307692  2,394231 -1,

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)                4,9375     0,8685   5,685  0,00235 **
factor(x$purpose)1         1,3125     1,4003   0,937  0,39165
factor(x$purpose)2        -0,4375     1,4003  -0,312  0,76733
factor(x$purpose)3         1,7356     1,6158   1,074  0,33184
factor(x$form)1            0,9375     0,8685   1,080  0,32966
factor(x$season)1         -0,6923     0,8617  -0,803  0,45823
factor(x$accommodation)1   1,3125     1,4003   0,937  0,39165
factor(x$accommodation)2   0,7356     1,6158   0,455  0,66802
factor(x$accommodation)3  -1,4375     1,4003  -1,027  0,35171
---
Signif. codes:  0 ‘***’ 0,001 ‘**’ 0,01 ‘*’ 0,05 ‘.’ 0,1 ‘ ’ 1

Residual standard error: 3,107 on 5 degrees of freedom
Multiple R-squared:  0,6034,    Adjusted R-squared:  -0,0311
F-statistic: 0,951 on 8 and 5 DF,  p-value: 0,549

[1] "Part worths (utilities) of levels (model parameters for whole sample):"
            levnms    utls
1        intercept  4,9375
2        cognitive  1,3125
3         vacation -0,4375
4           health  1,7356
5         business -2,6106
6        organized  0,9375
7              own -0,9375
8           summer -0,6923
9           winter  0,6923
```

```
10 1-2-3 star_hotel  1,3125
11   4-5 star_hotel  0,7356
12        guesthouse -1,4375
13            hostel -0,6106
[1] "Average importance of factors (attributes):"
[1] 41,97 18,11 13,37 26,56
[1] Sum of average importance:  100,01
[1] "Chart of average factors importance"
```

Summary of the most important preference measurement results using the Conjoint function (in the cross-section of respondents):

```
> Conjoint(y=preferences,x=profiles,z=levelnames)

Call:
lm(formula = frml)

Residuals:
    Min      1Q  Median      3Q     Max 
-5,4460 -3,0144 -0,0949  2,7758  5,9051 

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)    
(Intercept)               4,979371   0,052578  94,704  < 2e-16 ***
factor(x$purpose)1        0,139093   0,084780   1,641   0,1009    
factor(x$purpose)2        0,146446   0,084780   1,727   0,0842 .  
factor(x$purpose)3        0,437924   0,097823   4,477 7,78e-06 ***
factor(x$form)1          -0,070057   0,052578  -1,332   0,1828    
factor(x$season)1        -0,094834   0,052172  -1,818   0,0692 .  
factor(x$accommodation)1 -0,136234   0,084780  -1,607   0,1081    
factor(x$accommodation)2 -0,028171   0,097823  -0,288   0,7734    
factor(x$accommodation)3  0,005923   0,084780   0,070   0,9443    
---
Signif. codes:  0 ‘***’ 0,001 ‘**’ 0,01 ‘*’ 0,05 ‘.’ 0,1 ‘ ’ 1

Residual standard error: 3,291 on 4275 degrees of freedom
Multiple R-squared:  0,01474,	Adjusted R-squared:  0,0129 
F-statistic: 7,994 on 8 and 4275 DF,  p-value: 9,444e-11

[1] "Part worths (utilities) of levels (model parameters for whole sample):"
             levnms    utls
1         intercept  4,9794
2         cognitive  0,1391
3          vacation  0,1464
4            health  0,4379
5          business -0,7235
6         organized -0,0701
```

```
7               own  0,0701
8            summer -0,0948
9            winter  0,0948
10 1-2-3 star_hotel -0,1362
11   4-5 star_hotel -0,0282
12       guesthouse  0,0059
13           hostel  0,1585
[1] "Average importance of factors (attributes):"
[1] 38,62 13,30 13,97 34,11
[1] Sum of average importance:  100
[1] "Chart of average factors importance"
```

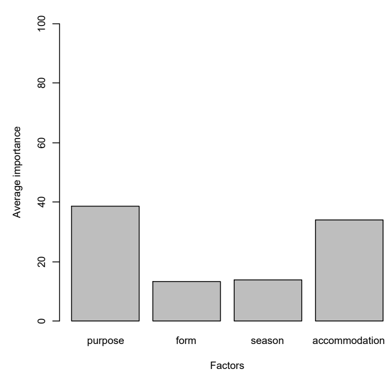


Fig. 7. The chart of variables (attributes) importance

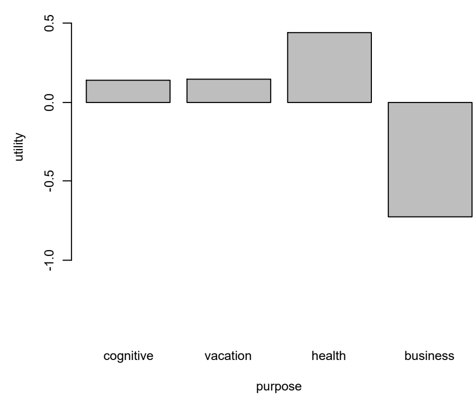


Fig. 8. The chart of preference levels of purpose variable

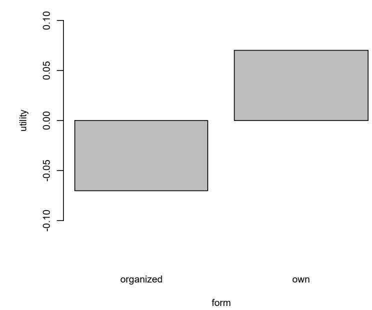


Fig. 9. The chart of preference levels of form variable

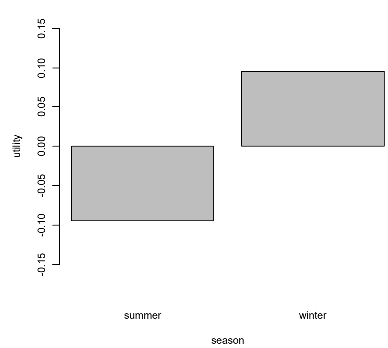


Fig. 10. The chart of preference levels of season

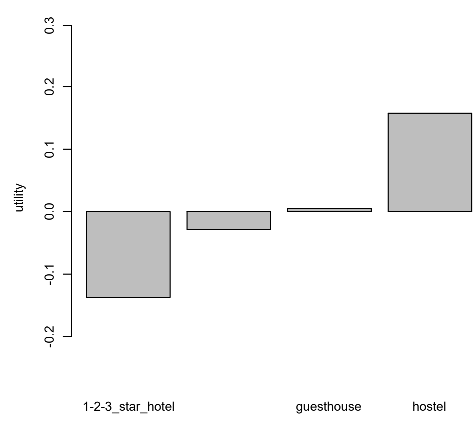


Fig. 11. The chart of preference levels of accommodation variable

variable	

Segmentation of respondents

Segmentation using k-means method - the default division into 2 segments:

```
> segments<-caSegmentation(preferences,profiles)
> print(segments$seg)
K-means clustering with 2 clusters of sizes 149, 157

Cluster means:
      [,1]     [,2]     [,3]    [,4]     [,5]     [,6]     [,7]     [,8]     [,9]    [,10]
1 6.025658 3.686060 5.200852 5.08743 4.808973 5.088503 4.263604 4.948477 4.835148 6.630383 4.
2 3.670554 4.482898 4.837408 5.78621 5.618357 5.043720 6.210573 4.984248 5.933051 3.743459 4.

Clustering vector:
  [1] 2 2 1 1 2 1 1 1 2 1 2 1 2 1 1 2 1 1 1 2 1 1 2 1 2 2 1 2 1 2 1 2 1 1 1 1 2 1 1 1 1 1 2 2
 [74] 1 2 1 1 2 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 1 2 1 2 2 2 2 1 1 2 2 2 2 1 2 2 2 2 2 1 1 2 2
[147] 2 2 2 2 2 2 1 2 2 1 1 1 2 1 2 2 2 1 2 2 2 2 1 2 1 2 1 2 2 1 2 1 2 2 2 2 2 1 2 2 2 2 2 2
[220] 1 2 2 2 2 2 2 1 2 1 1 2 1 1 1 2 2 2 1 1 1 2 1 1 1 2 2 1 1 1 1 2 2 2 1 1 2 2 1 2 1 2 1 2
[293] 2 1 1 1 1 2 2 1 1 2 1 1 1 1

Within cluster sum of squares by cluster:
[1] 12885.85 11758.15
 (between_SS / total_SS =  10.6%)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss" "betweenss"
```

Segmentation using k-means method – division into 3 segments:

```
> segments<-caSegmentation(preferences,profiles,c=3)
> print(segments$seg)
K-means clustering with 3 clusters of sizes 104, 97, 105

Cluster means:
      [,1]     [,2]     [,3]     [,4]     [,5]     [,6]     [,7]     [,8]     [,9]    [,10]
1 5.263000 3.860952 4.155269 7.124625 7.068404 4.630298 3.522462 3.895212 6.864673 5.561519 4
2 5.602402 3.695979 6.044505 3.409691 3.393330 5.303907 5.746031 6.161680 3.526845 6.583165 4
3 3.650619 4.695133 4.913667 5.664390 5.089067 5.276390 6.539390 4.924429 5.675200 3.416048 4

Clustering vector:
  [1] 1 3 1 1 1 2 2 2 2 1 3 1 1 2 2 3 1 1 2 1 1 2 1 2 3 3 2 2 1 3 2 3 2 2 2 2 3 2 1 2 2 1 2 3
 [74] 2 1 1 1 1 3 3 3 3 3 3 3 1 3 2 2 1 3 3 3 3 1 3 2 3 3 3 3 2 2 3 3 2 3 1 3 3 3 1 2 2 2 3 3
```

```
[147] 1 1 3 3 1 3 2 2 1 2 1 2 3 1 3 3 1 2 1 3 3 3 1 3 2 3 1 3 3 1 3 2 2 1 3 1 3 2 3 3 3 3 2 3
[220] 2 3 3 3 3 3 2 2 2 2 1 2 2 2 1 1 1 3 2 1 1 3 1 1 2 3 3 1 2 1 1 1 1 1 1 2 3 1 1 3 2 2 1 1
[293] 3 2 1 2 2 3 3 2 1 3 1 2 1 1

Within cluster sum of squares by cluster:
[1] 8321.434 7030.496 7021.380
 (between_SS / total_SS =  18.9%)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss" "betweenss"
```

Visualization of the division into 3 segments:

```
> summary(segments)
     Length Class  Mode
segm    9   kmeans list
util 4284   -none- numeric
sclu  306   -none- numeric

> require(fpc)
> plotcluster(segments$util,segments$sclu)

> require(fpc)
> require(broom)
> require(ggplot2)
> dcf<-discrcoord(segments$util,segments$sclu)
> assignments<-augment(segments$segm,dcf$proj[,1:2])
> ggplot(assignments)+geom_point(aes(x=X1,y=X2,color= .cluster))+labs(color="Cluster Assignme
```

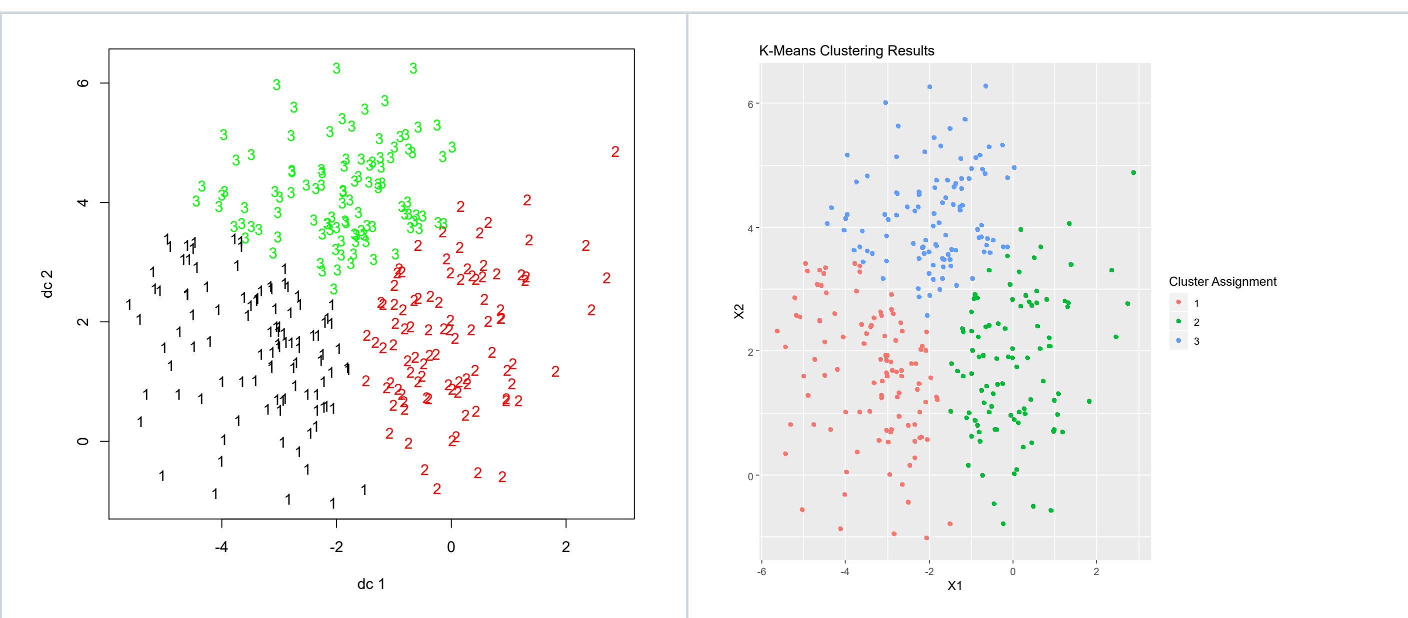


Fig. 9. Division into 3 segments (using plotcluster function of fpc R package [Hennig 2018[13]])	Fig. 10. Division into 3 segments (using ggplot function of ggplot2 R package [Wickham et al. 2018[7]])

Market share analysis of simulation profiles

Market share analysis of simulation profiles using maximum utility model, BTL probability model (Bradley-Terry-Luce Model) and logit model:

```
> ShowAllSimulations(sym=simulations,y=preferences,x=profiles)
  TotalUtility MaxUtility BTLmodel LogitModel
1         4,96      20,26    19,31      17,51
2         4,93      11,44    20,01      15,72
3         5,55      31,05    22,32      29,02
4         5,11      24,84    20,77      23,07
5         4,29      12,42    17,59      14,68
```

References

[1] Andrzej Bąk; Tomasz Bartłomowicz (2018-07-26). "conjoint: An Implementation of Conjoint Analysis Method". Retrieved 2018-07-26.

[2] Andrzej Bąk; Tomasz Bartłomowicz (2012). "Conjoint Analysis Method and Its Implementation in conjoint R Package". In Józef Pociecha; Reinhold Decker. Data analysis methods and its applications (PDF). Warszawa: C.H.Beck. pp. 239–248. ISBN 978-83-255-3458-5.

[3] Eugeniusz Gatnar; Marek Walesiak (2009). Statystyczna analiza danych z wykorzystaniem programu R. Warszawa: Wydawnictwo Naukowe PWN. ISBN 978-83-01-15661-9.

[4] R Core Team and contributors worldwide (2018-07-08). "stats: The R Stats Package". Retrieved 2018-07-07.

[5] Bob Wheeler (2014-10-15). "AlgDesign: Algorithmic Experimental Design". Retrieved 2018-06-30.

[6] Guangchuang Yu (2017-08-07). "dlstats: Download Stats of R Packages". Retrieved 2018-07-07.

[7] Hadley Wickham, Winston Chang, Lionel Henry, Thomas Lin Pedersen, Kohske Takahashi, Claus Wilke, Kara Woo (2018-07-03). "ggplot2: Create Elegant Data Visualisations Using the Grammar of Graphics". Retrieved 2018-07-07.

[8] Andrzej Bąk, Tomasz Bartłomowicz (2018-07-26). "Package 'conjoint' – manual" (PDF). Retrieved 2018-07-26.

[9] Jinsuh Lee (2016-11-05). "Conjoint Analysis on R". Retrieved 2018-07-07.

[10] Markus Burkhardt (2018-01-28). "R-Stutorials – 24 Conjoint-Analyse". Retrieved 2018-07-07.

[11] Martin Müller (2018-04-01). "Market Research Using Conjoint Analysis In R". Retrieved 2018-07-07.

[12] Holly Jones (2015). "Conjoint Analysis & Segmentation". Retrieved 2018-07-07.
[13] Christian Hennig (2018-01-13). "fpc: Flexible Procedures for Clustering". Retrieved 2018-07-07.

See also

Conjoint R manual on Wikipedia.pl (Polish). Retrieved 2018-07-07.

Clone this wiki locally

```
https://github.com/packagesR/conjoint.wiki.git
```