# Association Rule Mining in R

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## Contents

### Reading in the data

The *arules* package read data slightly differently than other packages. Specifically, it has its own `read.transactions` function that can be used to read in columns stored as transactions.

```
install.packages('arules', dependencies = TRUE)
library(arules)

bought = read.transactions('people_who_bought.txt',
                           format = 'basket',
                           sep = ',')
catalog = read.delim('product_catalog.tsv',
                     header = TRUE,
                     sep = '\t'
                     quote = '')
```

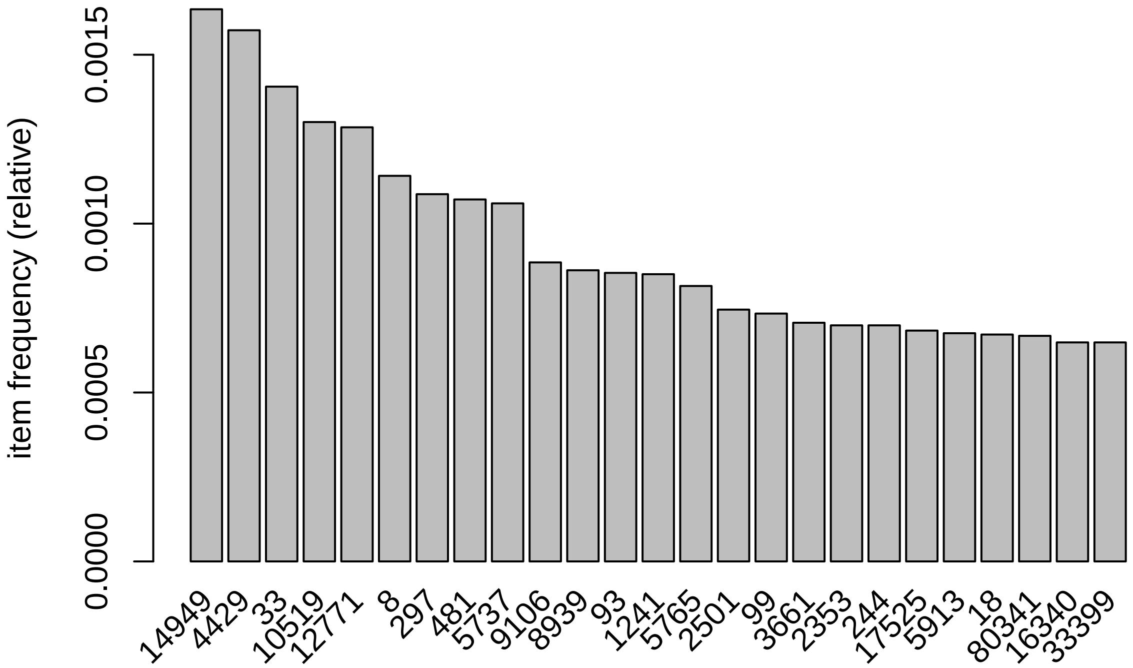
```
# attach the catalog data onto the item-sets
itemInfo(bought) = catalog

# view the itemsets
inspect(bought[1:5])
```

```
##   items
## 1 {0,
##    1,
##    2,
##    3,
##    4,
##    5}
## 2 {0,
##    1,
##    15,
##    2,
##    4,
##    5}
## 3 {0,
##    11,
##    12,
##    13,
##    14,
##    2}
## 4 {3,
##    63,
##    64,
##    65,
##    66,
##    67}
## 5 {16,
##    17,
##    18,
##    19,
##    4,
##    7}
```

```r
summary(bought)
```

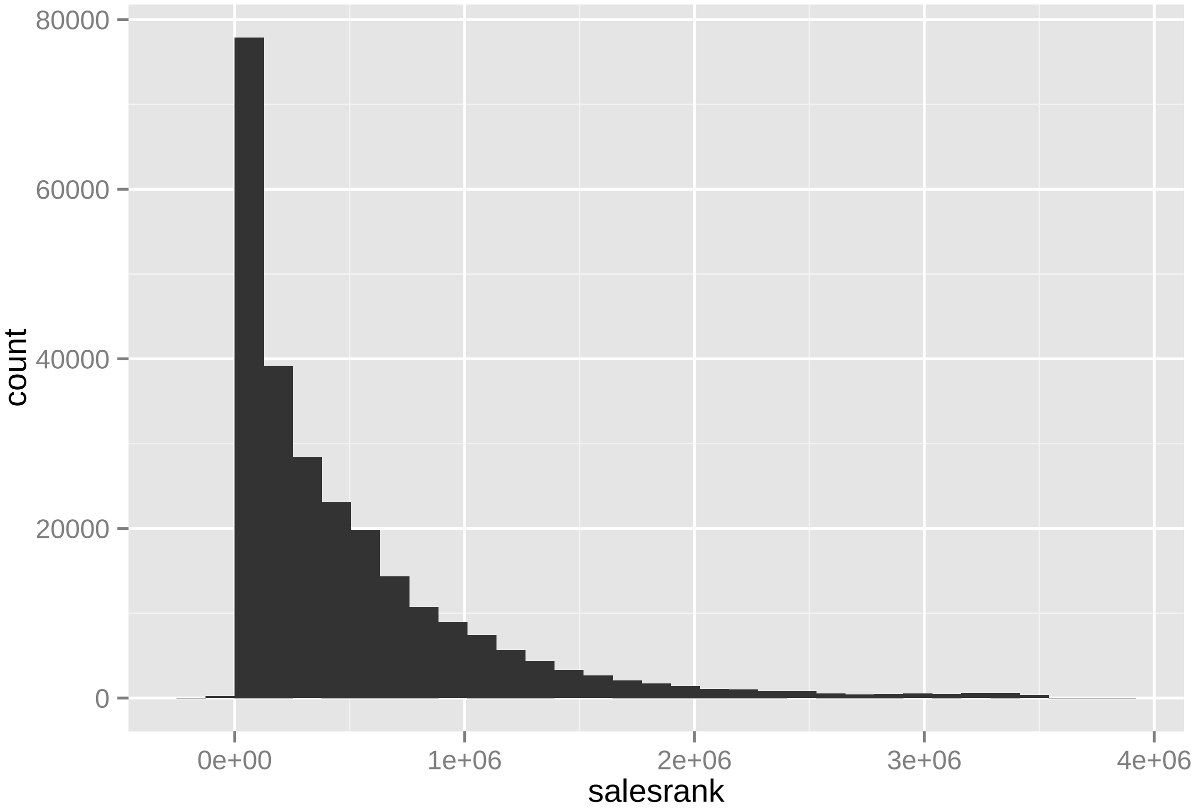
```
## transactions as itemMatrix in sparse format with
##  257570 rows (elements/itemsets/transactions) and
##  262111 columns (items) and a density of 2.210642e-05
##
## most frequent items:
##   14949    4429      33   10519   12771 (Other)
##     421     405     362     335     331 1490593
##
## element (itemset/transaction) length distribution:
## sizes
##      2      3      4      5      6
##   3803   5654   6557   7685 233871
##
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.000   6.000   6.000   5.794   6.000   6.000
##
## includes extended item information - examples:
##   labels avg_rating downloaded group reviews_count salesrank
## 1      0         NA         NA                    NA        NA
## 2      1          5          2  Book             2    396585
## 3     10          4          6  Book             6    220379
##                      title
## 1
## 2  Patterns of Preaching
## 3 The Edward Said Reader
```

```r
# plot the most frequent items
itemFrequencyPlot(bought, topN = 25)
```

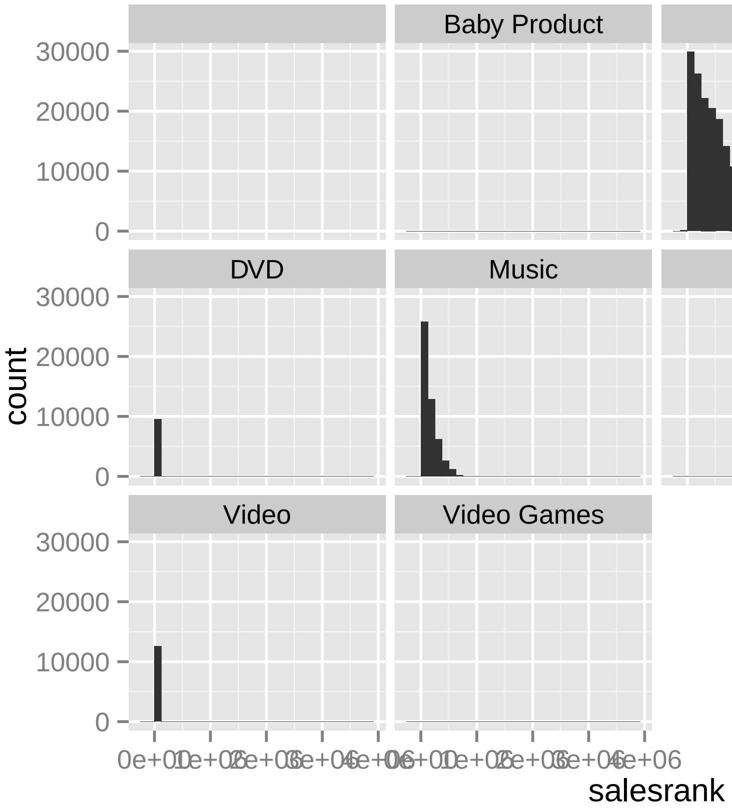


Let's explore the data a bit.

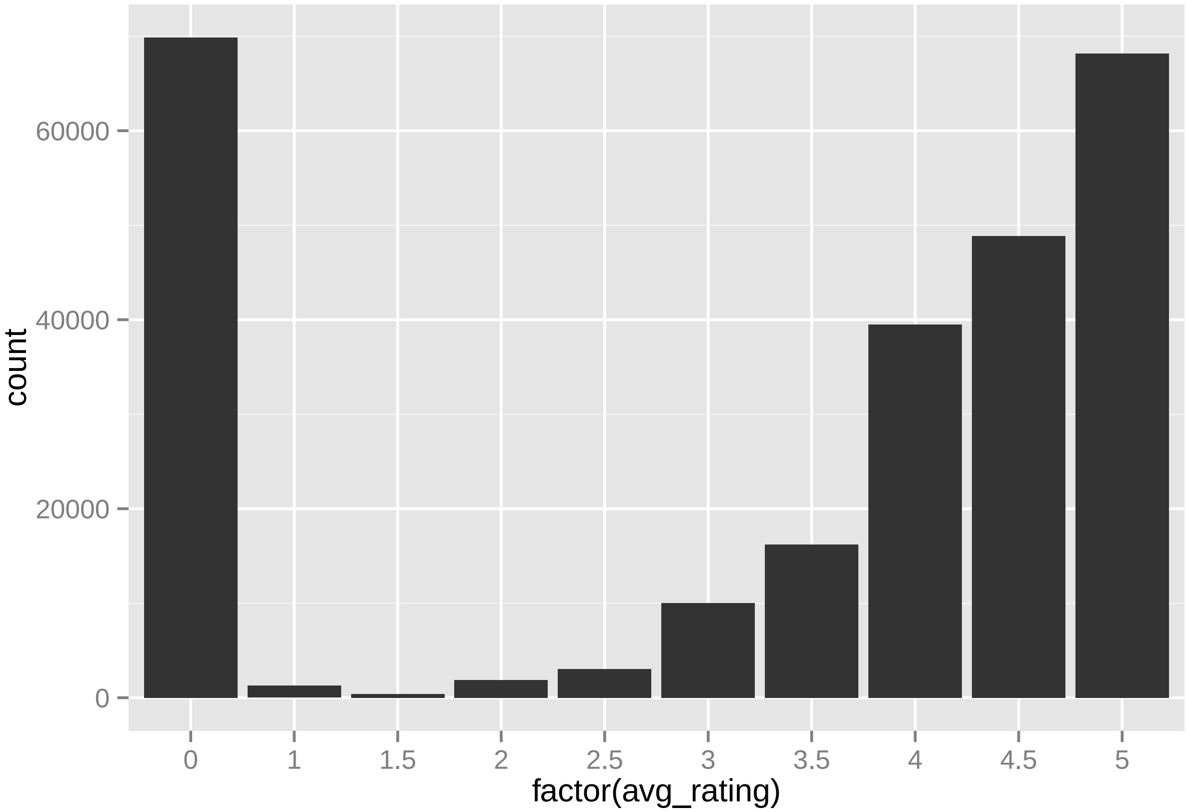
```
# what does the distribution of salesrank look like?
ggplot(catalog, aes(x = salesrank)) +
  geom_histogram()
```



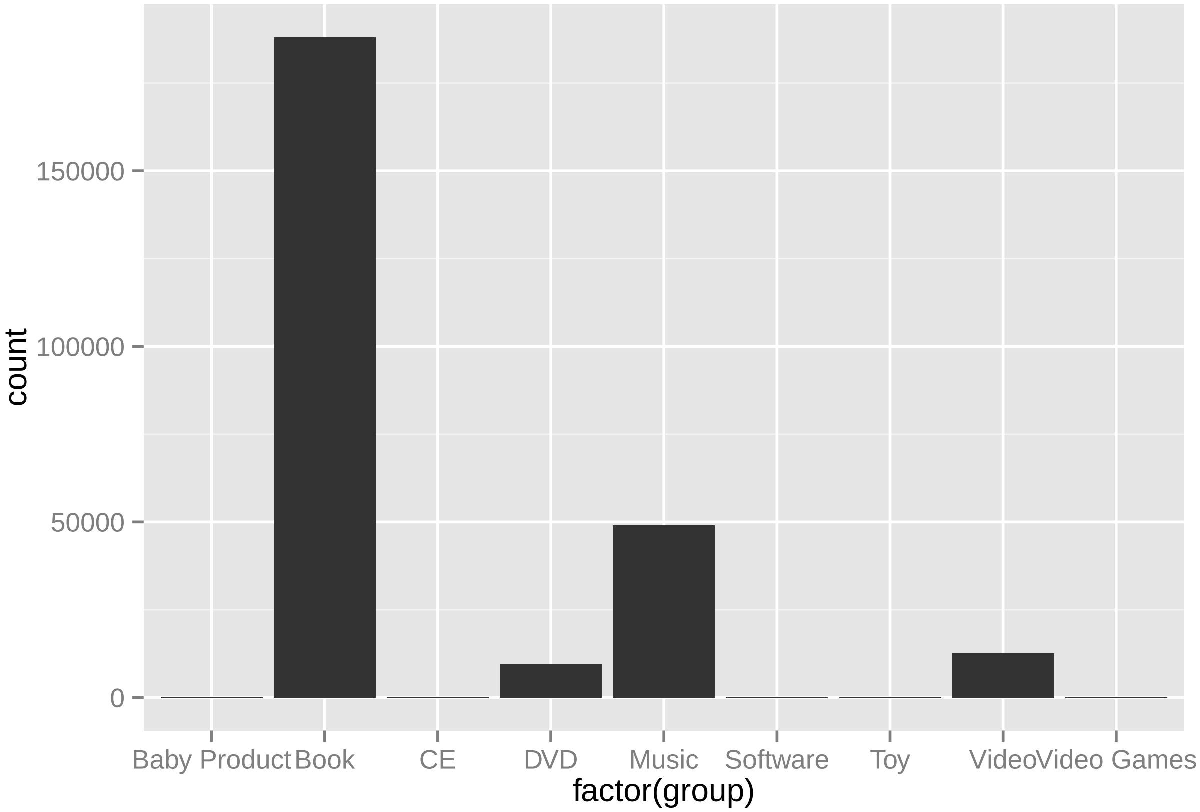
```r
# how about by product group?
ggplot(catalog, aes(x = salesrank)) +
  geom_histogram() +
  facet_wrap(~ group)
```



```r
# how about average rating?
ggplot(na.omit(catalog), aes(x = factor(avg_rating))) +
  geom_bar()
```



```
# how many items in each product group?
ggplot(na.omit(catalog), aes(x = factor(group))) +
  geom_bar()
```



### Creating rules

```
# run the apriori algorithm
rules = apriori(bought,
                parameter = list(sup = 0.0001, conf = 0.0001, target = 'rules'))
```

```
##
## Parameter specification:
##  confidence minval smax arem  aval originalSupport support minlen maxlen
##       1e-04    0.1    1 none FALSE            TRUE   1e-04      1     10
##  target   ext
##   rules FALSE
##
## Algorithmic control:
##  filter tree heap memopt load sort verbose
##     0.1 TRUE TRUE  FALSE TRUE    2    TRUE
##
## apriori - find association rules with the apriori algorithm
## version 4.21 (2004.05.09)        (c) 1996-2004   Christian Borgelt
## set item appearances ...[0 item(s)] done [0.00s].
## set transactions ...[262111 item(s), 257570 transaction(s)] done [0.41s].
## sorting and recoding items ... [2355 item(s)] done [0.03s].
## creating transaction tree ... done [0.04s].
## checking subsets of size 1 2 3 done [0.02s].
## writing ... [2601 rule(s)] done [0.01s].
## creating S4 object  ... done [0.08s].
```

```
# view the rules
inspect(head(rules))
```

```
##   lhs    rhs            support      confidence   lift
## 1 {}  => {26078}  0.0001048259 0.0001048259    1
## 2 {}  => {201419} 0.0001048259 0.0001048259    1
## 3 {}  => {50524}  0.0001009434 0.0001009434    1
## 4 {}  => {50451}  0.0001009434 0.0001009434    1
## 5 {}  => {165128} 0.0001009434 0.0001009434    1
## 6 {}  => {20169}  0.0001009434 0.0001009434    1
```

```
# sort the rules by lift
inspect(head(sort(rules, by = 'lift'), 10))
```

```
##    lhs         rhs           support confidence     lift
## 1  {127682} => {134413} 0.0001048259  0.7941176 4870.021
## 2  {134413} => {127682} 0.0001048259  0.6428571 4870.021
## 3  {35412}  => {35413}  0.0001087083  0.6086957 4611.228
## 4  {35413}  => {35412}  0.0001087083  0.8235294 4611.228
## 5  {55573}  => {55574}  0.0001009434  1.0000000 4518.772
## 6  {55574}  => {55573}  0.0001009434  0.4561404 4518.772
## 7  {44090}  => {33913}  0.0001475327  0.8636364 4277.823
## 8  {33913}  => {44090}  0.0001475327  0.7307692 4277.823
## 9  {66943}  => {37292}  0.0001397678  0.7826087 4113.807
## 10 {37292}  => {66943}  0.0001397678  0.7346939 4113.807
```

```
# aggregate the rules over the product type
group_rules = aggregate(rules, itemInfo(bought)$group)
inspect(group_rules)
```

```
##    lhs        rhs
## 1  {}      => {Book}
## 2  {}      => {Music}
## 3  {}      => {DVD}
## 4  {}      => {Video}
## 5  {}      => {}
## 6  {Music} => {Book}
## 7  {Book}  => {Music}
## 8  {Book}  => {Video}
## 9  {Video} => {Book}
## 10 {Video} => {Music}
## 11 {Music} => {Video}
## 12 {}      => {Video}
## 13 {Video} => {}
## 14 {DVD}   => {Book}
## 15 {Book}  => {DVD}
## 16 {Video} => {DVD}
## 17 {DVD}   => {Video}
## 18 {Music} => {DVD}
## 19 {DVD}   => {Music}
## 20 {}      => {DVD}
## 21 {DVD}   => {}
```

```
# quality
quality(rules) = cbind(quality(rules), coverage = coverage(rules))
```

However, it is clear that going through all the 5668 rules manually is not a viable option. We therefore will introduce different visualization techniques implemented in arulesViz. All implemented visualization techniques share the following interface.

The package *arulesViz* gives us lots of great visualization support.

```
plot(x,
     method = NULL,
     measure = "support",
     shading = "lift",
     interactive = FALSE,
     data,
     control = ...)
```

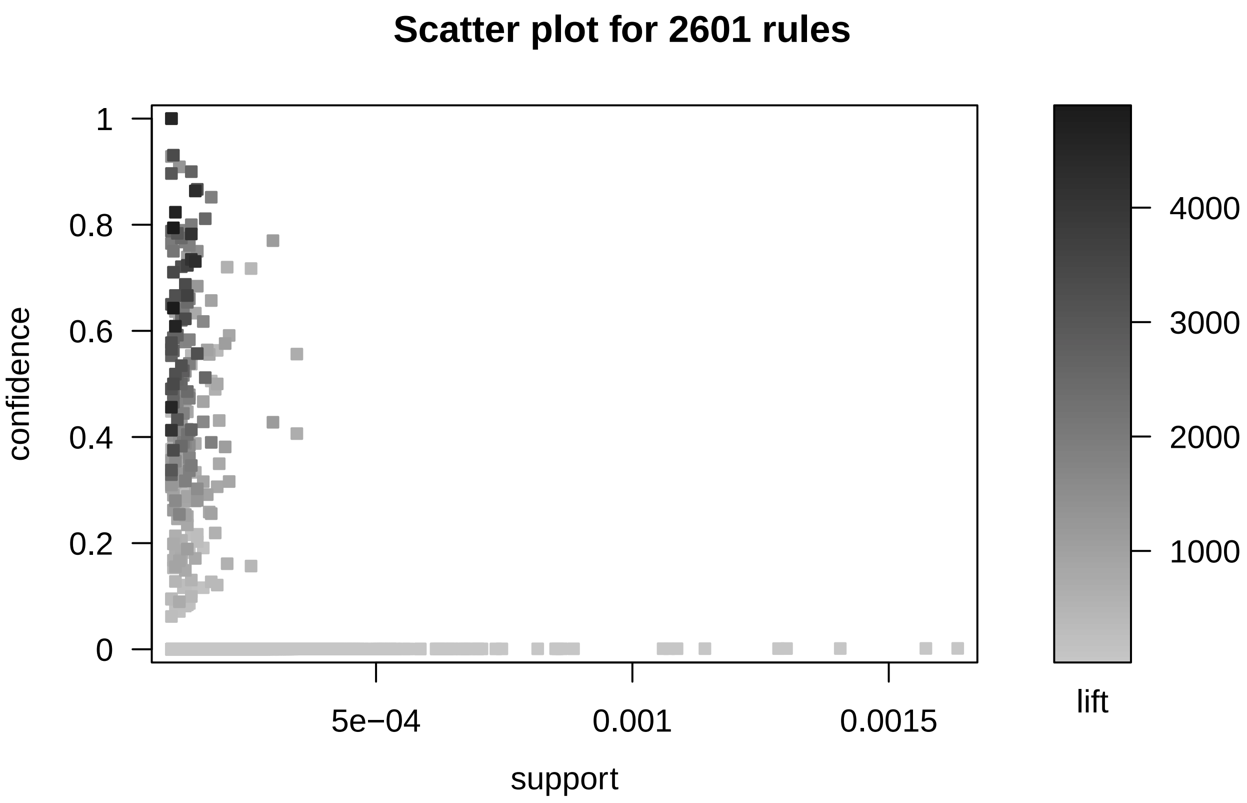
where:

- x is the set of rules to be visualized,
- method is the visualization method,
- measure and shading contain the interest measures used by the plot,
- interactive indicates if we want to interactively explore or just present the rules,
- data can contain the transaction data set used to mine the rules (only necessary for some methods)
- and control is a list with further control arguments to customize the plot.

A straight-forward visualization of association rules is to use a scatter plot with two interest measures on the axes. Such a presentation can be found already in an early paper by Bayardo, Jr. and Agrawal (1999) when they discuss sc-optimal rules. The default method for plot() for association rules in arulesViz is a scatter plot using support and confidence on the axes. In addition a third measure (default: lift) is used as the color (gray level) of the points. A color key is provided to the right of the plot.

```
install.packages('arulesViz', dependencies = TRUE)

# you might need to install Rgraphviz from this repository
source('http://bioconductor.org/biocLite.R')
biocLite('Rgraphviz')

library(arulesViz)
```

```
plot(rules)
```



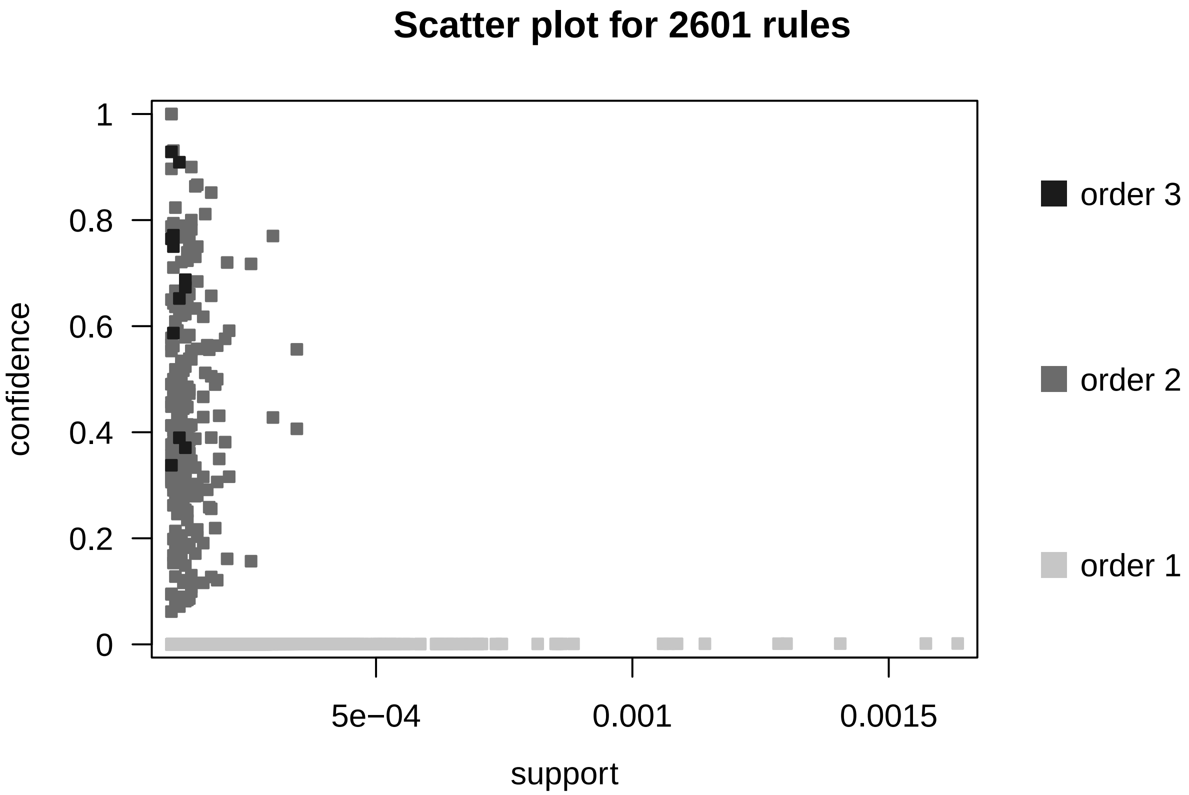
```r
head(quality(rules))
```

```
##        support   confidence lift coverage
## 1 0.0001048259 0.0001048259    1        1
## 2 0.0001048259 0.0001048259    1        1
## 3 0.0001009434 0.0001009434    1        1
## 4 0.0001009434 0.0001009434    1        1
## 5 0.0001009434 0.0001009434    1        1
## 6 0.0001009434 0.0001009434    1        1
```

```r
# there's also an interactive mode
# plot(rules, interactive = TRUE)
```

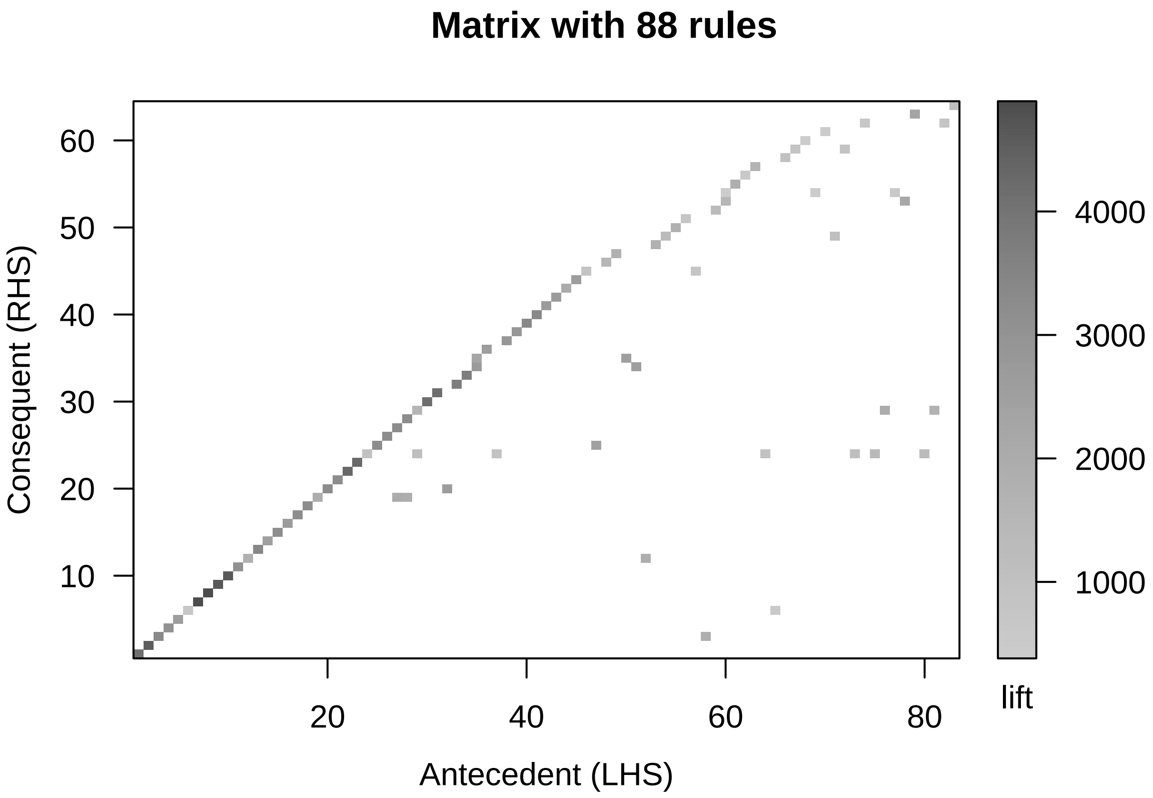
a special version of a scatter plot called Two- key plot. Here support and confidence are used for the x and y-axes and the color of the points is used to indicate "order," i.e., the number of items contained in the rule. Two-key plots can be produced using the unified interface by:

```r
plot(rules, shading = 'order')
```



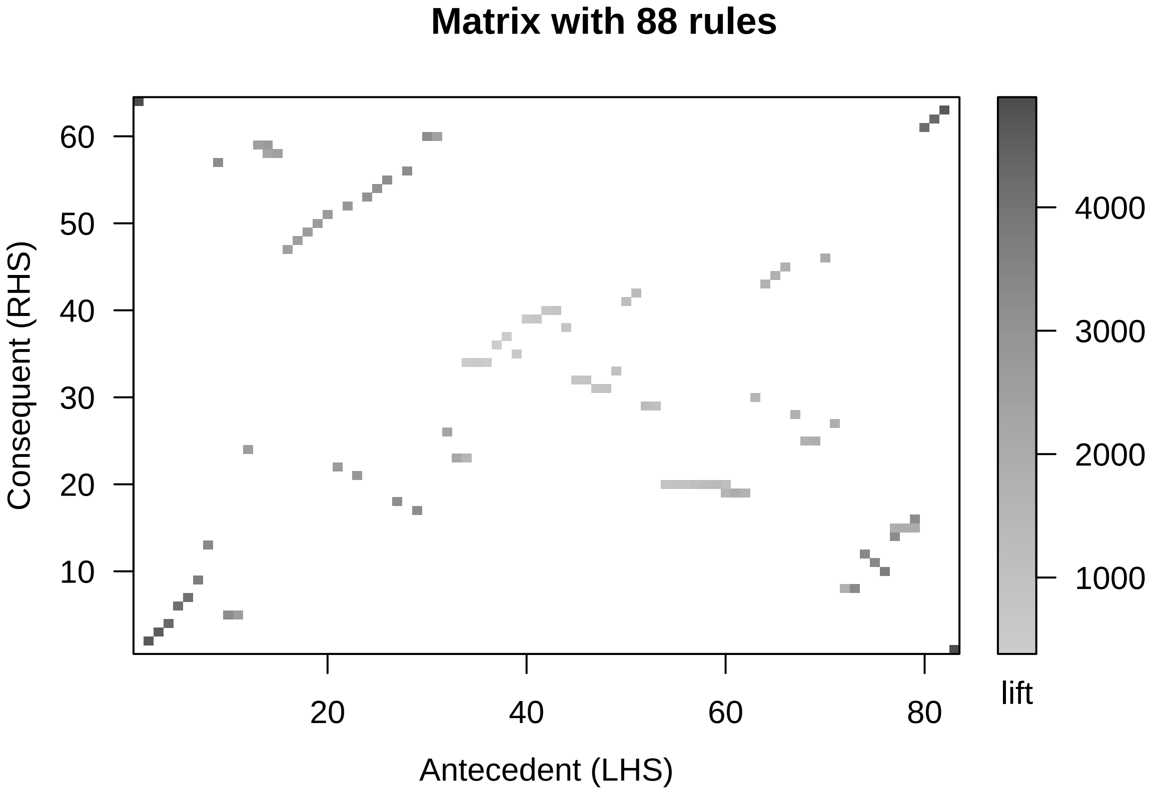
```
subrules = rules[quality(rules)$confidence > 0.5]
plot(subrules,
     method = 'matrix',
     measure = 'lift')
```

```
## Itemsets in Antecedent (LHS)
##  [1] "{83518}"     "{55573}"     "{58186}"     "{11039}"     "{12185}"
##  [6] "{16337}"     "{127682}"    "{134413}"    "{35413}"     "{35412}"
## [11] "{62848}"     "{82910}"     "{60540}"     "{7509}"      "{102492}"
## [16] "{43544}"     "{367}"       "{368}"       "{10709}"     "{12863}"
## [21] "{12862}"     "{44090}"     "{33913}"     "{250}"       "{85650}"
## [26] "{78197}"     "{9256}"      "{9334}"      "{251}"       "{66943}"
## [31] "{37292}"     "{7142}"      "{8551}"      "{8517}"      "{60311}"
## [36] "{91418}"     "{15944}"     "{63772}"     "{56317}"     "{8057}"
## [41] "{17160}"     "{47171}"     "{47170}"     "{95278}"     "{1498}"
## [46] "{13998}"     "{85648}"     "{6488}"      "{10897}"     "{60310}"
## [51] "{60312}"     "{95149}"     "{23146}"     "{9405}"      "{9864}"
## [56] "{4573}"      "{13997}"     "{43659}"     "{10419}"     "{94}"
## [61] "{6428}"      "{1673}"      "{4257}"      "{252}"       "{16338}"
## [66] "{20899}"     "{5915}"      "{4697}"      "{95}"        "{22073}"
## [71] "{9404}"      "{1439}"      "{241}"       "{1964}"      "{241,251}"
## [76] "{244,251}"   "{94,95}"     "{33,94}"     "{33,95}"     "{241,252}"
## [81] "{244,252}"   "{1964,2563}" "{1241,2563}"
## Itemsets in Consequent (RHS)
##  [1] "{83519}"  "{55574}"  "{58184}"  "{7447}"   "{7459}"   "{10519}"
##  [7] "{134413}" "{127682}" "{35412}"  "{35413}"  "{60468}"  "{82909}"
## [13] "{60561}"  "{7604}"   "{77634}"  "{43543}"  "{368}"    "{367}"
## [19] "{9332}"   "{12862}"  "{12863}"  "{33913}"  "{44090}"  "{244}"
## [25] "{78197}"  "{85650}"  "{9334}"   "{9256}"   "{241}"    "{37292}"
## [31] "{66943}"  "{8517}"   "{8551}"   "{60310}"  "{60312}"  "{83718}"
## [37] "{56317}"  "{63772}"  "{17160}"  "{8057}"   "{47170}"  "{47171}"
## [43] "{69483}"  "{1499}"   "{8939}"   "{1825}"   "{5936}"   "{36122}"
## [49] "{7153}"   "{5966}"   "{3661}"   "{3247}"   "{95}"     "{33}"
## [55] "{6427}"   "{481}"    "{4259}"   "{15934}"  "{5913}"   "{4429}"
## [61] "{14949}"  "{1241}"   "{94}"     "{1964}"
```



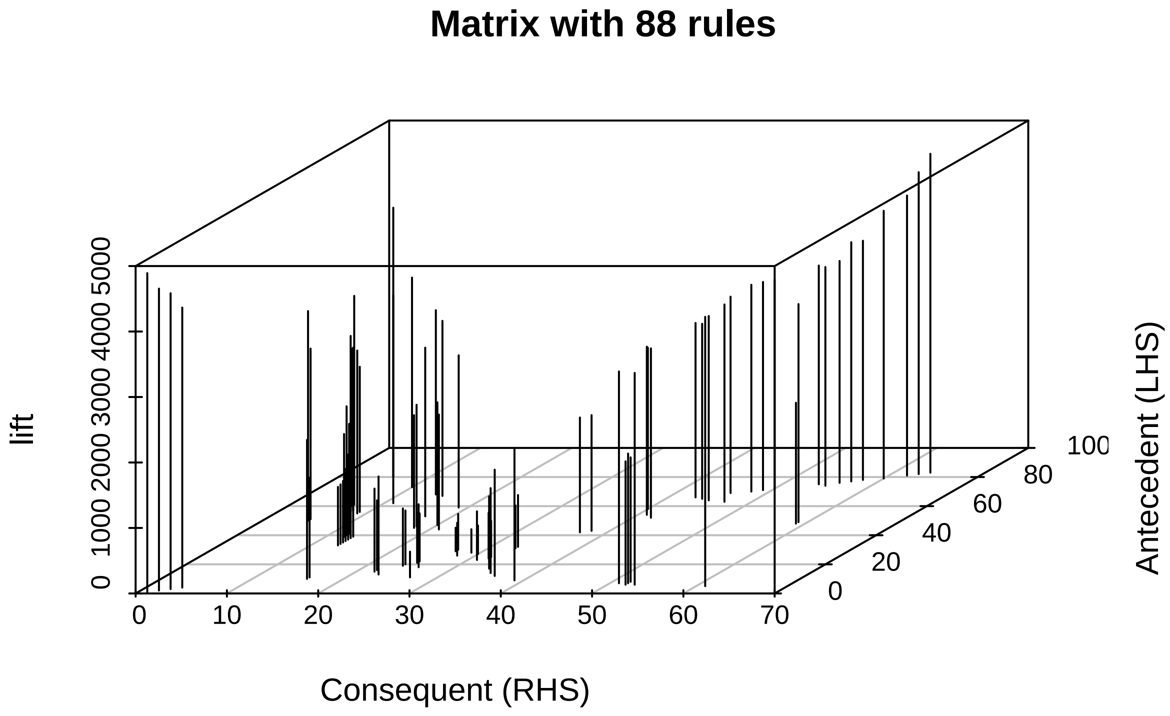
```r
# reorder based on
plot(subrules,
     method = 'matrix',
     measure = 'lift',
     control = list(reorder = TRUE))
```

```
## Itemsets in Antecedent (LHS)
##  [1] "{134413}"    "{35413}"     "{55573}"     "{44090}"     "{66943}"
##  [6] "{83518}"     "{8517}"      "{17160}"     "{12862}"     "{12863}"
## [11] "{7142}"      "{1498}"      "{60312}"     "{60311}"     "{60310}"
## [16] "{7509}"      "{12185}"     "{91418}"     "{43544}"     "{47170}"
## [21] "{47171}"     "{56317}"     "{63772}"     "{11039}"     "{62848}"
## [26] "{102492}"    "{368}"       "{367}"       "{78197}"     "{85650}"
## [31] "{85648}"     "{33,95}"     "{33,94}"     "{94}"        "{94,95}"
## [36] "{95}"        "{4697}"      "{22073}"     "{1673}"      "{16338}"
## [41] "{16337}"     "{1964}"      "{1964,2563}" "{4573}"      "{13997}"
## [46] "{13998}"     "{5915}"      "{1439}"      "{20899}"     "{1241,2563}"
## [51] "{10419}"     "{9405}"      "{9404}"      "{15944}"     "{250}"
## [56] "{252}"       "{241}"       "{241,252}"   "{241,251}"   "{251}"
## [61] "{244,251}"   "{244,252}"   "{6488}"      "{4257}"      "{10897}"
## [66] "{9864}"       "{23146}"      "{82910}"      "{95149}"      "{95278}"
## [71] "{6428}"       "{43659}"      "{58186}"      "{8057}"       "{60540}"
## [76] "{8551}"       "{9334}"       "{10709}"      "{9256}"       "{37292}"
## [81] "{33913}"      "{35412}"      "{127682}"
## Itemsets in Consequent (RHS)
##  [1] "{134413}" "{35412}"  "{55574}"  "{33913}"  "{12862}"  "{37292}"
##  [7] "{83519}"  "{58184}"  "{8551}"   "{8517}"   "{60561}"  "{17160}"
## [13] "{8057}"   "{9256}"   "{9332}"   "{9334}"   "{85650}"  "{367}"
## [19] "{241}"    "{244}"    "{56317}"  "{47170}"  "{95}"     "{1499}"
## [25] "{82909}"  "{94}"     "{6427}"   "{36122}"  "{7153}"   "{1825}"
## [31] "{5913}"   "{8939}"   "{15934}"  "{33}"     "{481}"    "{4429}"
## [37] "{14949}"  "{3661}"   "{10519}"  "{1241}"   "{1964}"   "{3247}"
## [43] "{4259}"   "{5936}"   "{5966}"   "{69483}"  "{7604}"   "{7459}"
## [49] "{83718}"  "{43543}"  "{47171}"  "{63772}"  "{7447}"   "{60468}"
## [55] "{77634}"  "{368}"    "{12863}"  "{60312}"  "{60310}"  "{78197}"
## [61] "{66943}"  "{44090}"  "{35413}"  "{127682}"
```

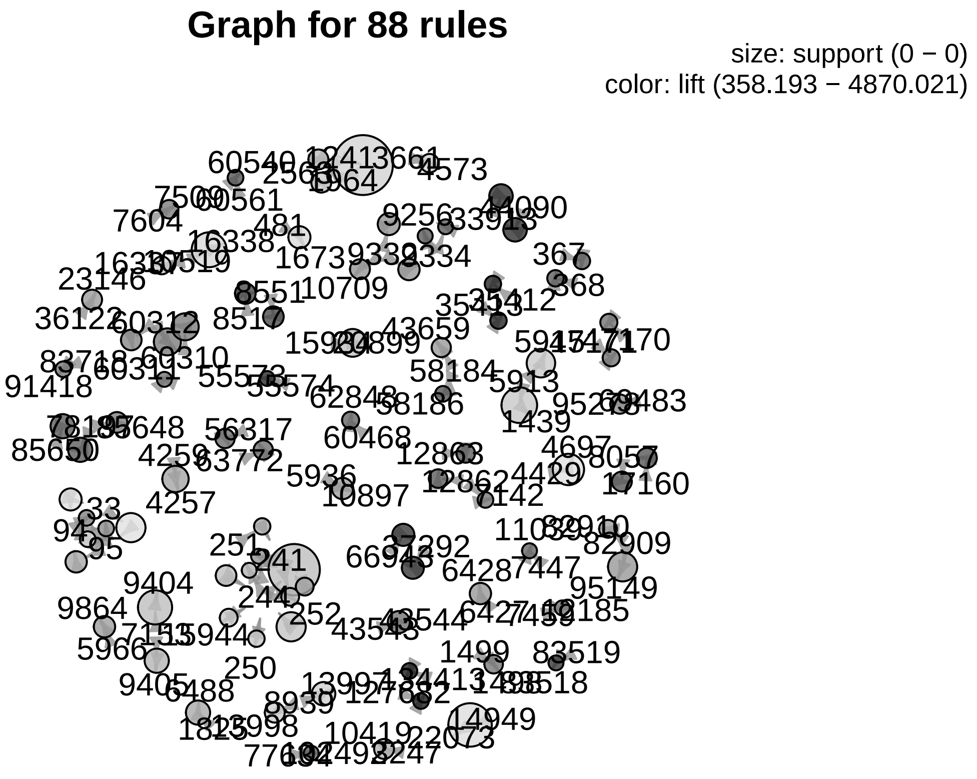


```
plot(subrules,
     method = 'matrix3D',
     measure = 'lift',
     control = list(reorder = TRUE))
```

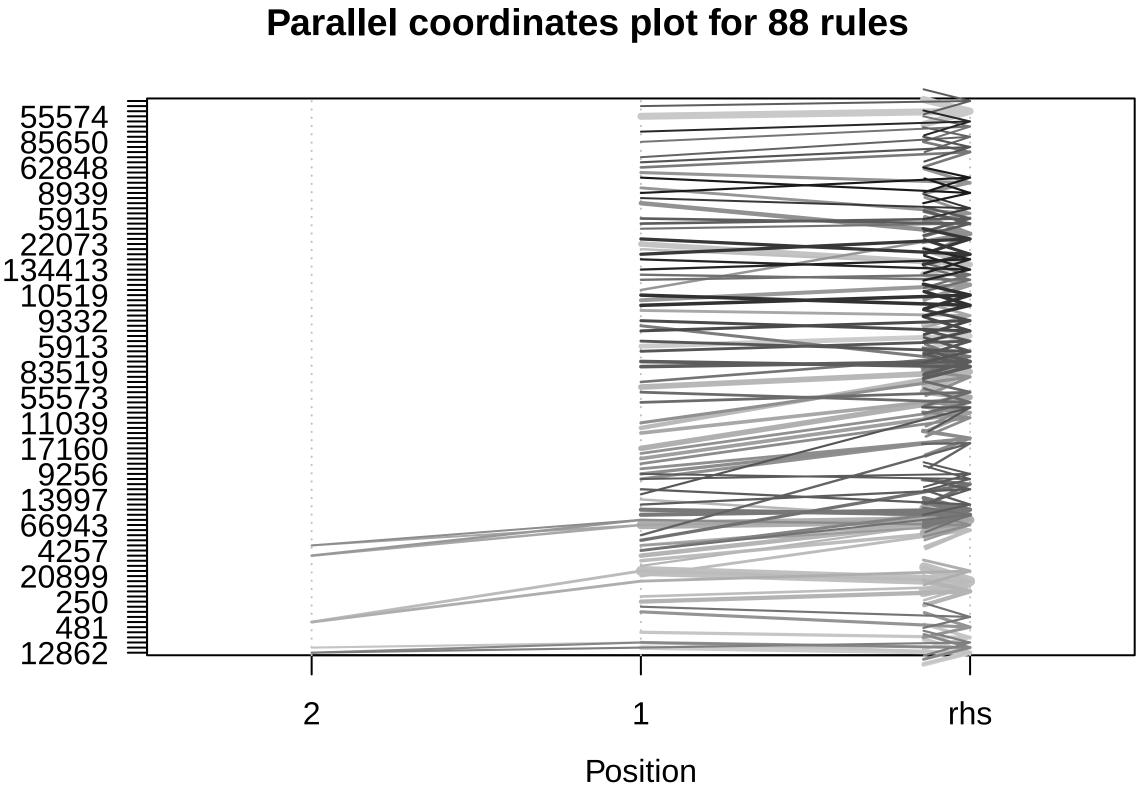
```
## Itemsets in Antecedent (LHS)
##  [1] "{134413}"     "{35412}"      "{55573}"      "{33913}"      "{37292}"
##  [6] "{9334}"       "{9256}"       "{10709}"      "{95278}"      "{33,94}"
## [11] "{94}"         "{4257}"       "{6488}"       "{10419}"      "{9405}"
## [16] "{9404}"       "{1241,2563}" "{20899}"      "{1439}"       "{5915}"
## [21] "{13998}"      "{13997}"      "{4573}"       "{16337}"      "{16338}"
## [26] "{1673}"      "{22073}"     "{4697}"      "{95}"        "{94,95}"
## [31] "{1964}"      "{1964,2563}" "{15944}"     "{250}"       "{252}"
## [36] "{241}"       "{241,252}"   "{241,251}"   "{251}"       "{244,251}"
## [41] "{244,252}"   "{10897}"     "{9864}"      "{23146}"     "{82910}"
## [46] "{95149}"     "{6428}"      "{43659}"     "{58186}"     "{12863}"
## [51] "{7142}"      "{91418}"     "{1498}"      "{12185}"     "{60310}"
## [56] "{60311}"     "{60312}"     "{7509}"      "{33,95}"     "{85648}"
## [61] "{85650}"     "{367}"       "{62848}"     "{63772}"     "{47171}"
## [66] "{43544}"     "{47170}"     "{56317}"     "{11039}"     "{102492}"
## [71] "{368}"       "{78197}"     "{12862}"     "{17160}"     "{8057}"
## [76] "{60540}"     "{8551}"      "{8517}"      "{83518}"     "{66943}"
## [81] "{44090}"     "{35413}"     "{127682}"
## Itemsets in Consequent (RHS)
##  [1] "{127682}" "{35413}"  "{55574}"  "{44090}"  "{12862}"  "{37292}"
##  [7] "{78197}"  "{60310}"  "{60312}"  "{12863}"  "{368}"    "{241}"
## [13] "{244}"    "{63772}"  "{47171}"  "{95}"     "{1499}"   "{82909}"
## [19] "{94}"     "{6427}"   "{36122}"  "{7153}"   "{1825}"   "{5913}"
## [25] "{8939}"   "{15934}"  "{33}"     "{481}"    "{4429}"   "{14949}"
## [31] "{3661}"   "{10519}"  "{1241}"   "{1964}"   "{3247}"   "{4259}"
## [37] "{5936}"   "{5966}"   "{69483}"  "{7604}"   "{7459}"   "{83718}"
## [43] "{43543}"  "{47170}"  "{56317}"  "{7447}"   "{60468}"  "{77634}"
## [49] "{367}"    "{85650}"  "{9334}"   "{9332}"   "{9256}"   "{17160}"
## [55] "{8057}"   "{60561}"  "{8517}"   "{8551}"   "{58184}"  "{83519}"
## [61] "{66943}"  "{33913}"  "{35412}"  "{134413}"
```



```
# plot a graph
plot(subrules, method = 'graph')
```



```
# parallel coordinates plot
plot(subrules, method = 'paracoord', control = list(reorder = TRUE))
```


Parallel coordinates plot for 88 rules
rhs
Position