

# Package ‘FSelector’

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**Type** Package

**Title** Selecting Attributes

**Version** 0.33

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**BugReports** <https://github.com/larskotthoff/fselector/issues>

**URL** <https://github.com/larskotthoff/fselector>

**Description** Functions for selecting attributes from a given dataset. Attribute subset selection is the process of identifying and removing as much of the irrelevant and redundant information as possible.

**License** GPL-2

**Imports** digest, entropy, randomForest, RWeka

**Suggests** mlbench, rpart

**Encoding** UTF-8

**LazyLoad** yes

**NeedsCompilation** no

**Repository** CRAN

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FSelector-package	<i>Package for selecting attributes</i>
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## Description

Package containing functions for selecting attributes from a given dataset and a destination attribute.

## Details

Package:	FSelector
Type:	Package
Version:	0.31
Date:	2018-05-16
License:	GPL-2
LazyLoad:	yes

This package contains:

- -Algorithms for filtering attributes: cfs, chi.squared, information.gain, gain.ratio, symmetrical.uncertainty, linear.correlation, rank.correlation, oneR, relief, consistency, random.forest.importance
- -Algorithms for wrapping classifiers and search attribute subset space: best.first.search, backward.search, forward.search, hill.climbing.search
- -Algorithm for choosing a subset of attributes based on attributes' weights: cutoff.k, cutoff.k.percent, cutoff.biggest.diff
- -Algorithm for creating formulas: as.simple.formula

## Author(s)

Piotr Romanski  
 Maintainer: Lars Kotthoff <larsko@uwo.edu>

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as.simple.formula      *Converting to formulas*

---

**Description**

Converts character vector of attributes' names and destination attribute's name to a simple formula.

**Usage**

```
as.simple.formula(attributes, class)
```

**Arguments**

attributes	character vector of attributes' names
class	name of destination attribute

**Value**

A simple formula like "class ~ attr1 + attr2"

**Author(s)**

Piotr Romanski

**Examples**

```
data(iris)
result <- cfs(Species ~ ., iris)
f <- as.simple.formula(result, "Species")
```

---

best.first.search      *Best-first search*

---

**Description**

The algorithm for searching attribute subset space.

**Usage**

```
best.first.search(attributes, eval.fun, max.backtracks = 5)
```

**Arguments**

attributes	a character vector of all attributes to search in
eval.fun	a function taking as first parameter a character vector of all attributes and returning a numeric indicating how important a given subset is
max.backtracks	an integer indicating a maximum allowed number of backtracks, default is 5

## Details

The algorithm is similar to [forward.search](#) besides the fact that it chooses the best node from all already evaluated ones and evaluates it. The selection of the best node is repeated approximately `max.backtracks` times in case no better node found.

## Value

A character vector of selected attributes.

## Author(s)

Piotr Romanski

## See Also

[forward.search](#), [backward.search](#), [hill.climbing.search](#), [exhaustive.search](#)

## Examples

```
library(rpart)
data(iris)

evaluator <- function(subset) {
  #k-fold cross validation
  k <- 5
  splits <- runif(nrow(iris))
  results = sapply(1:k, function(i) {
    test.idx <- (splits >= (i - 1) / k) & (splits < i / k)
    train.idx <- !test.idx
    test <- iris[test.idx, , drop=FALSE]
    train <- iris[train.idx, , drop=FALSE]
    tree <- rpart(as.simple.formula(subset, "Species"), train)
    error.rate = sum(test$Species != predict(tree, test, type="c")) / nrow(test)
    return(1 - error.rate)
  })
  print(subset)
  print(mean(results))
  return(mean(results))
}

subset <- best.first.search(names(iris)[-5], evaluator)
f <- as.simple.formula(subset, "Species")
print(f)
```

---

`cfs`*CFS filter*

---

**Description**

The algorithm finds attribute subset using correlation and entropy measures for continuous and discrete data.

**Usage**

```
cfs(formula, data)
```

**Arguments**

formula	a symbolic description of a model
data	data to process

**Details**

The algorithm makes use of [best.first.search](#) for searching the attribute subset space.

**Value**

a character vector containing chosen attributes

**Author(s)**

Piotr Romanski

**See Also**

[best.first.search](#)

**Examples**

```
data(iris)

subset <- cfs(Species~., iris)
f <- as.simple.formula(subset, "Species")
print(f)
```

---

`chi.squared`*Chi-squared filter*

---

**Description**

The algorithm finds weights of discrete attributes basing on a chi-squared test.

**Usage**

```
chi.squared(formula, data)
```

**Arguments**

formula            a symbolic description of a model

data                a symbolic description of a model

**Details**

The result is equal to Cramer's V coefficient between source attributes and destination attribute.

**Value**

a data.frame containing the worth of attributes in the first column and their names as row names

**Author(s)**

Piotr Romanski

**Examples**

```
library(mlbench)
data(HouseVotes84)

weights <- chi.squared(Class~., HouseVotes84)
print(weights)
subset <- cutoff.k(weights, 5)
f <- as.simple.formula(subset, "Class")
print(f)
```

---

`consistency`*Consistency-based filter*

---

**Description**

The algorithm finds attribute subset using consistency measure for continuous and discrete data.

**Usage**

```
consistency(formula, data)
```

**Arguments**

formula	a symbolic description of a model
data	data to process

**Details**

The algorithm makes use of [best.first.search](#) for searching the attribute subset space.

**Value**

a character vector containing chosen attributes

**Author(s)**

Piotr Romanski

**See Also**

[best.first.search](#)

**Examples**

```
## Not run:
library(mlbench)
data(HouseVotes84)

subset <- consistency(Class~., HouseVotes84)
f <- as.simple.formula(subset, "Class")
print(f)

## End(Not run)
```

---

correlation

*Correlation filter*

---

### Description

The algorithm finds weights of continuous attributes basing on their correlation with continuous class attribute.

### Usage

```
linear.correlation(formula, data)
rank.correlation(formula, data)
```

### Arguments

formula	a symbolic description of a model
data	data to process

### Details

`linear.correlation` uses Pearson's correlation  
`rank.correlation` uses Spearman's correlation  
Rows with NA values are not taken into consideration.

### Value

a data.frame containing the worth of attributes in the first column and their names as row names

### Author(s)

Piotr Romanski

### Examples

```
library(mlbench)
data(BostonHousing)
d=BostonHousing[-4] # only numeric variables

weights <- linear.correlation(medv~., d)
print(weights)
subset <- cutoff.k(weights, 3)
f <- as.simple.formula(subset, "medv")
print(f)

weights <- rank.correlation(medv~., d)
print(weights)
subset <- cutoff.k(weights, 3)
f <- as.simple.formula(subset, "medv")
print(f)
```



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cutoff	<i>Cutoffs</i>
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## Description

The algorithms select a subset from a ranked attributes.

## Usage

```
cutoff.k(attrs, k)
cutoff.k.percent(attrs, k)
cutoff.biggest.diff(attrs)
```

## Arguments

attrs	a data.frame containing ranks for attributes in the first column and their names as row names
k	a positive integer in case of cutoff.k and a numeric between 0 and 1 in case of cutoff.k.percent

## Details

cutoff.k chooses k best attributes  
cutoff.k.percent chooses best k \* 100% of attributes  
cutoff.biggest.diff chooses a subset of attributes which are significantly better than other.

## Value

A character vector containing selected attributes.

## Author(s)

Piotr Romanski

## Examples

```
data(iris)

weights <- information.gain(Species~., iris)
print(weights)

subset <- cutoff.k(weights, 1)
f <- as.simple.formula(subset, "Species")
print(f)

subset <- cutoff.k.percent(weights, 0.75)
f <- as.simple.formula(subset, "Species")
print(f)
```

```
subset <- cutoff.biggest.diff(weights)
f <- as.simple.formula(subset, "Species")
print(f)
```

---

entropy.based

*Entropy-based filters*


---

### Description

The algorithms find weights of discrete attributes basing on their correlation with continous class attribute.

### Usage

```
information.gain(formula, data, unit)
gain.ratio(formula, data, unit)
symmetrical.uncertainty(formula, data, unit)
```

### Arguments

formula	A symbolic description of a model.
data	Data to process.
unit	Unit for computing entropy (passed to <a href="#">entropy</a> . Default is "log").

### Details

information.gain is

$$H(Class) + H(Attribute) - H(Class, Attribute)$$

.

gain.ratio is

$$\frac{H(Class) + H(Attribute) - H(Class, Attribute)}{H(Attribute)}$$

symmetrical.uncertainty is

$$2 \frac{H(Class) + H(Attribute) - H(Class, Attribute)}{H(Attribute) + H(Class)}$$

### Value

a data.frame containing the worth of attributes in the first column and their names as row names

### Author(s)

Piotr Romanski, Lars Kotthoff

**Examples**

```

data(iris)

weights <- information.gain(Species~., iris)
print(weights)
subset <- cutoff.k(weights, 2)
f <- as.simple.formula(subset, "Species")
print(f)

weights <- information.gain(Species~., iris, unit = "log2")
print(weights)

weights <- gain.ratio(Species~., iris)
print(weights)
subset <- cutoff.k(weights, 2)
f <- as.simple.formula(subset, "Species")
print(f)

weights <- symmetrical.uncertainty(Species~., iris)
print(weights)
subset <- cutoff.biggest.diff(weights)
f <- as.simple.formula(subset, "Species")
print(f)

```

---

exhaustive.search	<i>Exhaustive search</i>
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**Description**

The algorithm for searching attribute subset space.

**Usage**

```
exhaustive.search(attributes, eval.fun)
```

**Arguments**

attributes	a character vector of all attributes to search in
eval.fun	a function taking as first parameter a character vector of all attributes and returning a numeric indicating how important a given subset is

**Details**

The algorithm searches the whole attribute subset space in breadth-first order.

**Value**

A character vector of selected attributes.

**Author(s)**

Piotr Romanski

**See Also**[forward.search](#), [backward.search](#), [best.first.search](#), [hill.climbing.search](#)**Examples**

```
library(rpart)
data(iris)

evaluator <- function(subset) {
  #k-fold cross validation
  k <- 5
  splits <- runif(nrow(iris))
  results = sapply(1:k, function(i) {
    test.idx <- (splits >= (i - 1) / k) & (splits < i / k)
    train.idx <- !test.idx
    test <- iris[test.idx, , drop=FALSE]
    train <- iris[train.idx, , drop=FALSE]
    tree <- rpart(as.simple.formula(subset, "Species"), train)
    error.rate = sum(test$Species != predict(tree, test, type="c")) / nrow(test)
    return(1 - error.rate)
  })
  print(subset)
  print(mean(results))
  return(mean(results))
}

subset <- exhaustive.search(names(iris)[-5], evaluator)
f <- as.simple.formula(subset, "Species")
print(f)
```

---

`greedy.search`*Greedy search*

---

**Description**

The algorithms for searching attribute subset space.

**Usage**

```
backward.search(attributes, eval.fun)
forward.search(attributes, eval.fun)
```

**Arguments**

<code>attributes</code>	a character vector of all attributes to search in
<code>eval.fun</code>	a function taking as first parameter a character vector of all attributes and returning a numeric indicating how important a given subset is

**Details**

These algorithms implement greedy search. At first, the algorithms expand starting node, evaluate its children and choose the best one which becomes a new starting node. This process goes only in one direction. `forward.search` starts from an empty and `backward.search` from a full set of attributes.

**Value**

A character vector of selected attributes.

**Author(s)**

Piotr Romanski

**See Also**

[best.first.search](#), [hill.climbing.search](#), [exhaustive.search](#)

**Examples**

```
library(rpart)
data(iris)

evaluator <- function(subset) {
  #k-fold cross validation
  k <- 5
  splits <- runif(nrow(iris))
  results = sapply(1:k, function(i) {
    test.idx <- (splits >= (i - 1) / k) & (splits < i / k)
    train.idx <- !test.idx
    test <- iris[test.idx, , drop=FALSE]
    train <- iris[train.idx, , drop=FALSE]
    tree <- rpart(as.simple.formula(subset, "Species"), train)
    error.rate = sum(test$Species != predict(tree, test, type="c")) / nrow(test)
    return(1 - error.rate)
  })
  print(subset)
  print(mean(results))
  return(mean(results))
}

subset <- forward.search(names(iris)[-5], evaluator)
f <- as.simple.formula(subset, "Species")
print(f)
```

---

hill.climbing.search *Hill climbing search*

---

### Description

The algorithm for searching attribute subset space.

### Usage

```
hill.climbing.search(attributes, eval.fun)
```

### Arguments

attributes	a character vector of all attributes to search in
eval.fun	a function taking as first parameter a character vector of all attributes and returning a numeric indicating how important a given subset is

### Details

The algorithm starts with a random attribute set. Then it evaluates all its neighbours and chooses the best one. It might be susceptible to local maximum.

### Value

A character vector of selected attributes.

### Author(s)

Piotr Romanski

### See Also

[forward.search](#), [backward.search](#), [best.first.search](#), [exhaustive.search](#)

### Examples

```
library(rpart)
data(iris)

evaluator <- function(subset) {
  #k-fold cross validation
  k <- 5
  splits <- runif(nrow(iris))
  results = sapply(1:k, function(i) {
    test.idx <- (splits >= (i - 1) / k) & (splits < i / k)
    train.idx <- !test.idx
    test <- iris[test.idx, , drop=FALSE]
```

```
    train <- iris[train.idx, , drop=FALSE]
    tree <- rpart(as.simple.formula(subset, "Species"), train)
    error.rate = sum(test$Species != predict(tree, test, type="c")) / nrow(test)
    return(1 - error.rate)
  })
  print(subset)
  print(mean(results))
  return(mean(results))
}

subset <- hill.climbing.search(names(iris)[-5], evaluator)
f <- as.simple.formula(subset, "Species")
print(f)
```

---

oneR

*OneR algorithm*

---

## Description

The algorithms find weights of discrete attributes basing on very simple association rules involving only one attribute in condition part.

## Usage

```
oneR(formula, data)
```

## Arguments

formula	a symbolic description of a model
data	data to process

## Details

The algorithm uses OneR classifier to find out the attributes' weights. For each attribute it creates a simple rule based only on that attribute and then calculates its error rate.

## Value

a data.frame containing the worth of attributes in the first column and their names as row names

## Author(s)

Piotr Romanski

## Examples

```
library(mlbench)
data(HouseVotes84)

weights <- oneR(Class~., HouseVotes84)
print(weights)
subset <- cutoff.k(weights, 5)
f <- as.simple.formula(subset, "Class")
print(f)
```

---

random.forest.importance

*RandomForest filter*

---

## Description

The algorithm finds weights of attributes using RandomForest algorithm.

## Usage

```
random.forest.importance(formula, data, importance.type = 1)
```

## Arguments

formula	a symbolic description of a model
data	data to process
importance.type	either 1 or 2, specifying the type of importance measure (1=mean decrease in accuracy, 2=mean decrease in node impurity)

## Details

This is a wrapper for [importance](#).

## Value

a data.frame containing the worth of attributes in the first column and their names as row names

## Author(s)

Piotr Romanski



**Examples**

```
library(mlbench)
data(HouseVotes84)

weights <- random.forest.importance(Class~, HouseVotes84, importance.type = 1)
print(weights)
subset <- cutoff.k(weights, 5)
f <- as.simple.formula(subset, "Class")
print(f)
```

---

relief	<i>RReliefF filter</i>
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---

**Description**

The algorithm finds weights of continuous and discrete attributes basing on a distance between instances.

**Usage**

```
relief(formula, data, neighbours.count = 5, sample.size = 10)
```

**Arguments**

formula	a symbolic description of a model
data	data to process
neighbours.count	number of neighbours to find for every sampled instance
sample.size	number of instances to sample

**Details**

The algorithm samples instances and finds their nearest hits and misses. Considering that result, it evaluates weights of attributes.

**Value**

a data.frame containing the worth of attributes in the first column and their names as row names

**Author(s)**

Piotr Romanski

**References**

- -Igor Kononenko: Estimating Attributes: Analysis and Extensions of RELIEF. In: European Conference on Machine Learning, 171-182, 1994.
- -Marko Robnik-Sikonja, Igor Kononenko: An adaptation of Relief for attribute estimation in regression. In: Fourteenth International Conference on Machine Learning, 296-304, 1997.

**Examples**

```
data(iris)

weights <- relief(Species~., iris, neighbours.count = 5, sample.size = 20)
print(weights)
subset <- cutoff.k(weights, 2)
f <- as.simple.formula(subset, "Species")
print(f)
```

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