

# Feature Engineering

## Feature Selection

### Feature Filtering

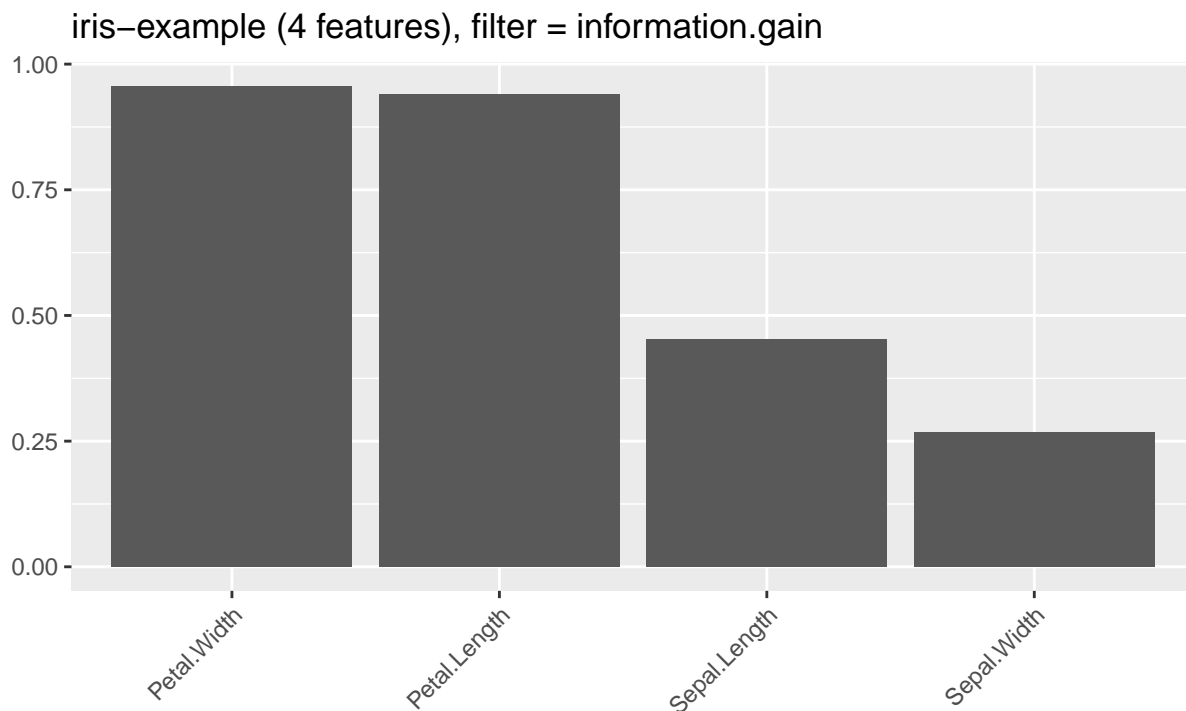
#### Classification

```
library(mlr)

## Loading required package: ParamHelpers
fv = generateFilterValuesData(iris.task, method = "information.gain")
print(fv)

## FilterValues:
## Task: iris-example
##      name      type information.gain
## 1 Sepal.Length numeric      0.4521286
## 2 Sepal.Width  numeric      0.2672750
## 3 Petal.Length numeric      0.9402853
## 4 Petal.Width  numeric      0.9554360

plotFilterValues(fv)
```



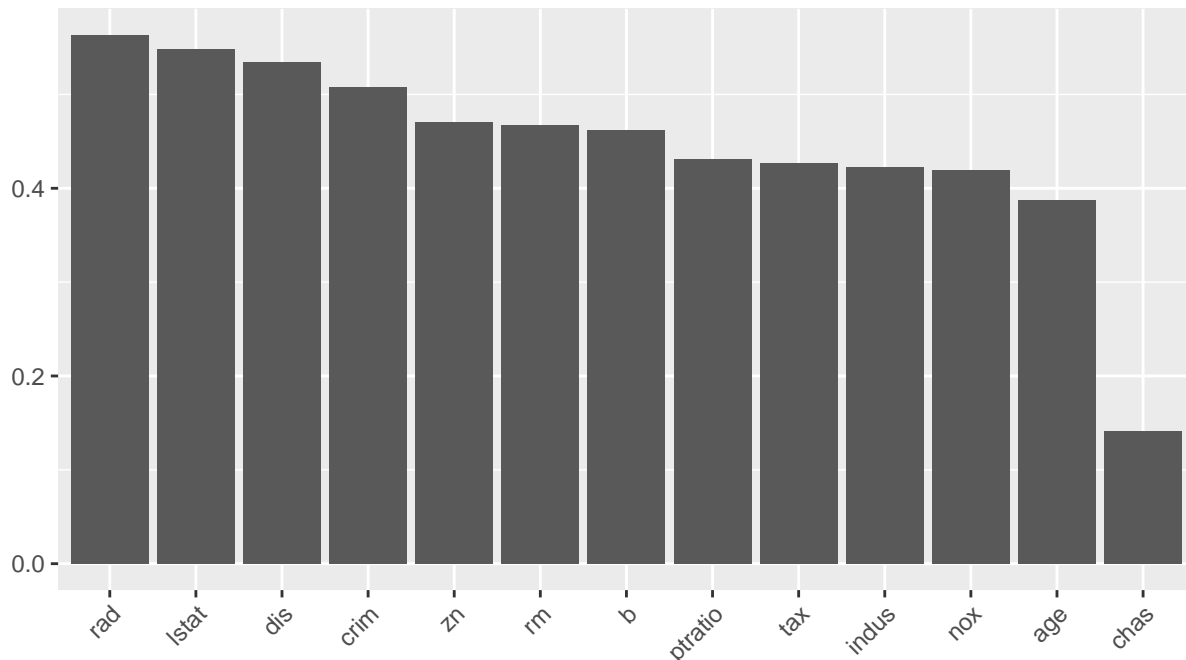
## Regression

```
fv = generateFilterValuesData(bh.task, method = "chi.squared")
print(fv)
```

```
## FilterValues:
## Task: BostonHousing-example
##   name    type chi.squared
## 1  crim numeric  0.5074870
## 2   zn  numeric  0.4706141
## 3 indus numeric  0.4221206
## 4  chas factor  0.1412928
## 5  nox numeric  0.4188065
## 6   rm numeric  0.4677489
## ... (13 rows, 3 cols)
```

```
plotFilterValues(fv)
```

BostonHousing-example (13 features), filter = chi.squared



## Available Methods

```
listFilterMethods()
```

```
##           id           package
## 1      anova.test         Rfast
## 2      carscore           care
## 3 cforest.importance     party
## 4      chi.squared       FSelector
## 5      gain.ratio        FSelector
## 6 information.gain       FSelector
## 7      kruskal.test
```

```

## 8         linear.correlation           Rfast
## 9                 mrmr                 mRMRe
## 10                oneR                 FSelector
## 11      permutation.importance
## 12      randomForest.importance      randomForest
## 13      randomForestSRC.rfsrc randomForestSRC
## 14 randomForestSRC.var.select randomForestSRC
## 15                rank.correlation           Rfast
## 16                  relief                 FSelector
## 17      symmetrical.uncertainty         FSelector
## 18      univariate.model.score
## 19                variance
##
##                               desc
## 1 ANOVA Test for binary and multiclass ...
## 2                               CAR scores
## 3 Permutation importance of random fore...
## 4 Chi-squared statistic of independence...
## 5 Entropy-based gain ratio between feat...
## 6 Entropy-based information gain betwee...
## 7 Kruskal Test for binary and multclas...
## 8 Pearson correlation between feature a...
## 9 Minimum redundancy, maximum relevance...
## 10                oneR association rule
## 11 Aggregated difference between feature...
## 12 Importance based on OOB-accuracy or n...
## 13 Importance of random forests fitted i...
## 14 Minimal depth of / variable hunting v...
## 15 Spearman's correlation between featur...
## 16                  RELIEF algorithm
## 17 Entropy-based symmetrical uncertainty...
## 18 Resamples an mlr learner for each inp...
## 19                A simple variance filter

```

## Embedded Feature Selection

### Classification

```

mod = train(makeLearner("classif.randomForest"), iris.task)
getFeatureImportance(mod)

```

```

## FeatureImportance:
## Task: iris-example
##
## Learner: classif.randomForest
## Measure: NA
## Contrast: NA
## Aggregation: function (x) x
## Replace: NA
## Number of Monte-Carlo iterations: NA
## Local: FALSE
##   Sepal.Length Sepal.Width Petal.Length Petal.Width
## 1      8.683067      2.253404      43.23414      45.09746

```

## Regression

```
mod = train(makeLearner("regr.randomForest"), bh.task)
getFeatureImportance(mod)
```

```
## FeatureImportance:
## Task: BostonHousing-example
##
## Learner: regr.randomForest
## Measure: NA
## Contrast: NA
## Aggregation: function (x) x
## Replace: NA
## Number of Monte-Carlo iterations: NA
## Local: FALSE
##      crim      zn      indus      chas      nox      rm      age      dis
## 1 2432.205 239.916 2619.305 267.4488 2646.835 12173.42 1165.539 2548.443
##      rad      tax ptratio      b      lstat
## 1 349.3764 1291.256 2836.213 781.4629 12661.58
```

## Feature Selection Wrapper

### Random Subsets Search

```
rdesc = makeResampleDesc("CV", iters = 10)
ctrl = makeFeatSelControlRandom(maxit = 10)
selectFeatures(learner = "regr.rpart", task = bh.task, resampling = rdesc, control = ctrl)
```

```
## [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 1111100001000 (6 bits)
## [FeatSel-y] 1: mse.test.mean=43.9; time: 0.0 min
## [FeatSel-x] 1: 0101011000111 (7 bits)
## [FeatSel-y] 1: mse.test.mean=23.3; time: 0.0 min
## [FeatSel-x] 1: 1100010111000 (6 bits)
## [FeatSel-y] 1: mse.test.mean=31.2; time: 0.0 min
## [FeatSel-x] 1: 1110000111000 (6 bits)
## [FeatSel-y] 1: mse.test.mean=50.5; time: 0.0 min
## [FeatSel-x] 1: 1101000001100 (5 bits)
## [FeatSel-y] 1: mse.test.mean=50.7; time: 0.0 min
## [FeatSel-x] 1: 1011110001001 (7 bits)
## [FeatSel-y] 1: mse.test.mean=23.5; time: 0.0 min
## [FeatSel-x] 1: 1101011111001 (9 bits)
```

```

## [FeatSel-y] 1: mse.test.mean=24.8; time: 0.0 min
## [FeatSel-x] 1: 0010011111010 (7 bits)
## [FeatSel-y] 1: mse.test.mean=28.7; time: 0.0 min
## [FeatSel-x] 1: 0001001011001 (5 bits)
## [FeatSel-y] 1: mse.test.mean=30.8; time: 0.0 min
## [FeatSel-x] 1: 1000011000100 (4 bits)
## [FeatSel-y] 1: mse.test.mean=28.2; time: 0.0 min
## [FeatSel] Result: znchasrmageptratiooblstat (7 bits)
## FeatSel result:
## Features (7): zn, chas, rm, age, ptratio, b, lstat
## mse.test.mean=23.3

```

### Sequential Forward Search

```

ctrl = makeFeatSelControlSequential(method = "sfs")
selectFeatures(learner = "regr.rpart", task = bh.task, resampling = rdsc, control = ctrl)

```

```

## [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlSequential
## Imputation value: Inf
## [FeatSel-x] 1: 0000000000000 (0 bits)
## [FeatSel-y] 1: mse.test.mean=84.9; time: 0.0 min
## [FeatSel-x] 2: 1000000000000 (1 bits)
## [FeatSel-y] 2: mse.test.mean=67.7; time: 0.0 min
## [FeatSel-x] 2: 0100000000000 (1 bits)
## [FeatSel-y] 2: mse.test.mean=67.6; time: 0.0 min
## [FeatSel-x] 2: 0010000000000 (1 bits)
## [FeatSel-y] 2: mse.test.mean=55.7; time: 0.0 min
## [FeatSel-x] 2: 0001000000000 (1 bits)
## [FeatSel-y] 2: mse.test.mean=82.9; time: 0.0 min
## [FeatSel-x] 2: 0000100000000 (1 bits)
## [FeatSel-y] 2: mse.test.mean= 47; time: 0.0 min
## [FeatSel-x] 2: 0000010000000 (1 bits)
## [FeatSel-y] 2: mse.test.mean=36.6; time: 0.0 min
## [FeatSel-x] 2: 0000001000000 (1 bits)
## [FeatSel-y] 2: mse.test.mean=75.4; time: 0.0 min
## [FeatSel-x] 2: 0000000100000 (1 bits)
## [FeatSel-y] 2: mse.test.mean= 79; time: 0.0 min

```

```
## [FeatSel-x] 2: 0000000010000 (1 bits)
## [FeatSel-y] 2: mse.test.mean=67.6; time: 0.0 min
## [FeatSel-x] 2: 0000000001000 (1 bits)
## [FeatSel-y] 2: mse.test.mean= 59; time: 0.0 min
## [FeatSel-x] 2: 0000000000100 (1 bits)
## [FeatSel-y] 2: mse.test.mean=59.8; time: 0.0 min
## [FeatSel-x] 2: 0000000000010 (1 bits)
## [FeatSel-y] 2: mse.test.mean=76.3; time: 0.0 min
## [FeatSel-x] 2: 0000000000001 (1 bits)
## [FeatSel-y] 2: mse.test.mean=30.4; time: 0.0 min
## [FeatSel-x] 3: 1000000000001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=28.6; time: 0.0 min
## [FeatSel-x] 3: 0100000000001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=30.6; time: 0.0 min
## [FeatSel-x] 3: 0010000000001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 3: 0001000000001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=30.4; time: 0.0 min
## [FeatSel-x] 3: 0000100000001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=26.7; time: 0.0 min
## [FeatSel-x] 3: 0000010000001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=24.2; time: 0.0 min
## [FeatSel-x] 3: 0000001000001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=30.1; time: 0.0 min
## [FeatSel-x] 3: 0000000100001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=27.6; time: 0.0 min
## [FeatSel-x] 3: 0000000010001 (2 bits)
## [FeatSel-y] 3: mse.test.mean= 31; time: 0.0 min
## [FeatSel-x] 3: 0000000001001 (2 bits)
## [FeatSel-y] 3: mse.test.mean=26.2; time: 0.0 min
## [FeatSel-x] 3: 0000000000101 (2 bits)
## [FeatSel-y] 3: mse.test.mean=25.6; time: 0.0 min
## [FeatSel-x] 3: 0000000000011 (2 bits)
## [FeatSel-y] 3: mse.test.mean=31.7; time: 0.0 min
## [FeatSel-x] 4: 1000010000001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=25.8; time: 0.0 min
```

```
## [FeatSel-x] 4: 0100010000001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=24.2; time: 0.0 min
## [FeatSel-x] 4: 0010010000001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=24.2; time: 0.0 min
## [FeatSel-x] 4: 0001010000001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=24.2; time: 0.0 min
## [FeatSel-x] 4: 0000110000001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=22.9; time: 0.0 min
## [FeatSel-x] 4: 0000011000001 (3 bits)
## [FeatSel-y] 4: mse.test.mean= 24; time: 0.0 min
## [FeatSel-x] 4: 0000010100001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=23.6; time: 0.0 min
## [FeatSel-x] 4: 0000010010001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=23.7; time: 0.0 min
## [FeatSel-x] 4: 0000010001001 (3 bits)
## [FeatSel-y] 4: mse.test.mean=23.9; time: 0.0 min
## [FeatSel-x] 4: 0000010000101 (3 bits)
## [FeatSel-y] 4: mse.test.mean=23.7; time: 0.0 min
## [FeatSel-x] 4: 0000010000011 (3 bits)
## [FeatSel-y] 4: mse.test.mean=25.1; time: 0.0 min
## [FeatSel-x] 5: 1000110000001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=24.8; time: 0.0 min
## [FeatSel-x] 5: 0100110000001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.9; time: 0.0 min
## [FeatSel-x] 5: 0010110000001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.3; time: 0.0 min
## [FeatSel-x] 5: 0001110000001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.9; time: 0.0 min
## [FeatSel-x] 5: 0000111000001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.3; time: 0.0 min
## [FeatSel-x] 5: 0000110100001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.3; time: 0.0 min
## [FeatSel-x] 5: 0000110010001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 5: 0000110001001 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.9; time: 0.0 min
```

```

## [FeatSel-x] 5: 0000110000101 (4 bits)
## [FeatSel-y] 5: mse.test.mean=22.9; time: 0.0 min
## [FeatSel-x] 5: 0000110000011 (4 bits)
## [FeatSel-y] 5: mse.test.mean=23.3; time: 0.0 min
## [FeatSel-x] 6: 1000110010001 (5 bits)
## [FeatSel-y] 6: mse.test.mean=24.8; time: 0.0 min
## [FeatSel-x] 6: 0100110010001 (5 bits)
## [FeatSel-y] 6: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 6: 0010110010001 (5 bits)
## [FeatSel-y] 6: mse.test.mean=22.3; time: 0.0 min
## [FeatSel-x] 6: 0001110010001 (5 bits)
## [FeatSel-y] 6: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 6: 0000111010001 (5 bits)
## [FeatSel-y] 6: mse.test.mean=22.3; time: 0.0 min
## [FeatSel-x] 6: 0000110110001 (5 bits)
## [FeatSel-y] 6: mse.test.mean=22.3; time: 0.0 min
## [FeatSel-x] 6: 0000110011001 (5 bits)
## [FeatSel-y] 6: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 6: 0000110010101 (5 bits)
## [FeatSel-y] 6: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 6: 0000110010011 (5 bits)
## [FeatSel-y] 6: mse.test.mean=23.3; time: 0.0 min
## [FeatSel] Result: noxrmradlstat (4 bits)
## FeatSel result:
## Features (4): nox, rm, rad, lstat
## mse.test.mean=22.2

```

## Sequential Backward Search

```

ctrl = makeFeatSelControlSequential(method = "sbs")
selectFeatures(learner = "regr.rpart", task = bh.task, resampling = rdesc, control = ctrl)

```

```

## [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlSequential
## Imputation value: Inf
## [FeatSel-x] 1: 1111111111111 (13 bits)
## [FeatSel-y] 1: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 2: 0111111111111 (12 bits)

```



```
## [FeatSel-y] 2: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 2: 101111111111 (12 bits)
## [FeatSel-y] 2: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 2: 110111111111 (12 bits)
## [FeatSel-y] 2: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 2: 111011111111 (12 bits)
## [FeatSel-y] 2: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 2: 111101111111 (12 bits)
## [FeatSel-y] 2: mse.test.mean= 23; time: 0.0 min
## [FeatSel-x] 2: 111110111111 (12 bits)
## [FeatSel-y] 2: mse.test.mean=29.5; time: 0.0 min
## [FeatSel-x] 2: 111111011111 (12 bits)
## [FeatSel-y] 2: mse.test.mean=23.3; time: 0.0 min
## [FeatSel-x] 2: 111111101111 (12 bits)
## [FeatSel-y] 2: mse.test.mean=24.2; time: 0.0 min
## [FeatSel-x] 2: 111111110111 (12 bits)
## [FeatSel-y] 2: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 2: 111111111011 (12 bits)
## [FeatSel-y] 2: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 2: 111111111101 (12 bits)
## [FeatSel-y] 2: mse.test.mean=22.7; time: 0.0 min
## [FeatSel-x] 2: 111111111110 (12 bits)
## [FeatSel-y] 2: mse.test.mean=27.9; time: 0.0 min
## [FeatSel-x] 3: 001111111111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 3: 010111111111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 3: 011011111111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 3: 011101111111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=22.6; time: 0.0 min
## [FeatSel-x] 3: 011110111111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=28.7; time: 0.0 min
## [FeatSel-x] 3: 011111011111 (11 bits)
```

```
## [FeatSel-y] 3: mse.test.mean=21.6; time: 0.0 min
## [FeatSel-x] 3: 011111101111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 3: 011111101111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 3: 011111110111 (11 bits)
## [FeatSel-y] 3: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 3: 011111111011 (11 bits)
## [FeatSel-y] 3: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 3: 011111111101 (11 bits)
## [FeatSel-y] 3: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 3: 011111111110 (11 bits)
## [FeatSel-y] 3: mse.test.mean=27.2; time: 0.0 min
## [FeatSel-x] 4: 001111111011 (10 bits)
## [FeatSel-y] 4: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 4: 010111111011 (10 bits)
## [FeatSel-y] 4: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 4: 011011111011 (10 bits)
## [FeatSel-y] 4: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 4: 011101111011 (10 bits)
## [FeatSel-y] 4: mse.test.mean=22.5; time: 0.0 min
## [FeatSel-x] 4: 011110111011 (10 bits)
## [FeatSel-y] 4: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 4: 011110111011 (10 bits)
## [FeatSel-y] 4: mse.test.mean=21.5; time: 0.0 min
## [FeatSel-x] 4: 011111011011 (10 bits)
## [FeatSel-y] 4: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 4: 011111101011 (10 bits)
## [FeatSel-y] 4: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 4: 011111110011 (10 bits)
## [FeatSel-y] 4: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 4: 011111111001 (10 bits)
## [FeatSel-y] 4: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 4: 011111111010 (10 bits)
## [FeatSel-y] 4: mse.test.mean=28.1; time: 0.0 min
## [FeatSel-x] 5: 0011111101011 (9 bits)
```

```
## [FeatSel-y] 5: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 5: 0101111101011 (9 bits)
## [FeatSel-y] 5: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 5: 0110111101011 (9 bits)
## [FeatSel-y] 5: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 5: 0111011101011 (9 bits)
## [FeatSel-y] 5: mse.test.mean=22.5; time: 0.0 min
## [FeatSel-x] 5: 0111101101011 (9 bits)
## [FeatSel-y] 5: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 5: 0111110101011 (9 bits)
## [FeatSel-y] 5: mse.test.mean=21.5; time: 0.0 min
## [FeatSel-x] 5: 0111111001011 (9 bits)
## [FeatSel-y] 5: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 5: 0111111100011 (9 bits)
## [FeatSel-y] 5: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 5: 0111111101001 (9 bits)
## [FeatSel-y] 5: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 5: 0111111101010 (9 bits)
## [FeatSel-y] 5: mse.test.mean= 28; time: 0.0 min
## [FeatSel-x] 6: 0011111100011 (8 bits)
## [FeatSel-y] 6: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 6: 0101111100011 (8 bits)
## [FeatSel-y] 6: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 6: 0110111100011 (8 bits)
## [FeatSel-y] 6: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 6: 0111011100011 (8 bits)
## [FeatSel-y] 6: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 6: 0111101100011 (8 bits)
## [FeatSel-y] 6: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 6: 0111110100011 (8 bits)
## [FeatSel-y] 6: mse.test.mean=21.5; time: 0.0 min
## [FeatSel-x] 6: 0111111000011 (8 bits)
## [FeatSel-y] 6: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 6: 0111111100001 (8 bits)
## [FeatSel-y] 6: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 6: 0111111100010 (8 bits)
```

```
## [FeatSel-y] 6: mse.test.mean= 28; time: 0.0 min
## [FeatSel-x] 7: 0001111100011 (7 bits)
## [FeatSel-y] 7: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 7: 0010111100011 (7 bits)
## [FeatSel-y] 7: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 7: 0011011100011 (7 bits)
## [FeatSel-y] 7: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 7: 0011101100011 (7 bits)
## [FeatSel-y] 7: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 7: 0011110100011 (7 bits)
## [FeatSel-y] 7: mse.test.mean=21.5; time: 0.0 min
## [FeatSel-x] 7: 0011111000011 (7 bits)
## [FeatSel-y] 7: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 7: 0011111100001 (7 bits)
## [FeatSel-y] 7: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 7: 0011111100010 (7 bits)
## [FeatSel-y] 7: mse.test.mean= 28; time: 0.0 min
## [FeatSel-x] 8: 0000111100011 (6 bits)
## [FeatSel-y] 8: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 8: 0001011100011 (6 bits)
## [FeatSel-y] 8: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 8: 0001101100011 (6 bits)
## [FeatSel-y] 8: mse.test.mean=27.4; time: 0.0 min
## [FeatSel-x] 8: 0001110100011 (6 bits)
## [FeatSel-y] 8: mse.test.mean=21.5; time: 0.0 min
## [FeatSel-x] 8: 0001111000011 (6 bits)
## [FeatSel-y] 8: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 8: 0001111100001 (6 bits)
## [FeatSel-y] 8: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 8: 0001111100010 (6 bits)
## [FeatSel-y] 8: mse.test.mean=27.3; time: 0.0 min
## [FeatSel-x] 9: 0000111100001 (5 bits)
## [FeatSel-y] 9: mse.test.mean= 21; time: 0.0 min
## [FeatSel-x] 9: 0001011100001 (5 bits)
## [FeatSel-y] 9: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 9: 0001101100001 (5 bits)
```

```

## [FeatSel-y] 9: mse.test.mean=27.4; time: 0.0 min
## [FeatSel-x] 9: 0001110100001 (5 bits)
## [FeatSel-y] 9: mse.test.mean=21.5; time: 0.0 min
## [FeatSel-x] 9: 0001111000001 (5 bits)
## [FeatSel-y] 9: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 9: 0001111100000 (5 bits)
## [FeatSel-y] 9: mse.test.mean=27.3; time: 0.0 min
## [FeatSel-x] 10: 0000011100001 (4 bits)
## [FeatSel-y] 10: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 10: 0000101100001 (4 bits)
## [FeatSel-y] 10: mse.test.mean=27.4; time: 0.0 min
## [FeatSel-x] 10: 0000110100001 (4 bits)
## [FeatSel-y] 10: mse.test.mean=21.5; time: 0.0 min
## [FeatSel-x] 10: 0000111000001 (4 bits)
## [FeatSel-y] 10: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 10: 0000111100000 (4 bits)
## [FeatSel-y] 10: mse.test.mean=27.3; time: 0.0 min
## [FeatSel] Result: noxrmagedislstat (5 bits)
## FeatSel result:
## Features (5): nox, rm, age, dis, lstat
## mse.test.mean= 21

```

## Genetic Algorithm Search

```

ctrl = makeFeatSelControlGA(maxit = 10)
selectFeatures(learner = "regr.rpart", task = bh.task, resampling = rdesc, control = ctrl)

## [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlGA
## Imputation value: Inf
## [FeatSel-x] 0: 0001011000111 (6 bits)
## [FeatSel-y] 0: mse.test.mean=21.6; time: 0.0 min
## [FeatSel-x] 0: 0001100111110 (7 bits)
## [FeatSel-y] 0: mse.test.mean=41.6; time: 0.0 min
## [FeatSel-x] 0: 1001001110110 (7 bits)
## [FeatSel-y] 0: mse.test.mean= 46; time: 0.0 min
## [FeatSel-x] 0: 1110001010101 (7 bits)
## [FeatSel-y] 0: mse.test.mean=28.3; time: 0.0 min

```

```
## [FeatSel-x] 0: 1111110000000 (6 bits)
## [FeatSel-y] 0: mse.test.mean=27.7; time: 0.0 min
## [FeatSel-x] 0: 1101011011011 (9 bits)
## [FeatSel-y] 0: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 0: 1110111111001 (10 bits)
## [FeatSel-y] 0: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 0: 0011001011001 (6 bits)
## [FeatSel-y] 0: mse.test.mean=27.9; time: 0.0 min
## [FeatSel-x] 0: 0110100000011 (5 bits)
## [FeatSel-y] 0: mse.test.mean=26.8; time: 0.0 min
## [FeatSel-x] 0: 1000111001111 (8 bits)
## [FeatSel-y] 0: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 1: 1100011011010 (7 bits)
## [FeatSel-y] 1: mse.test.mean=29.4; time: 0.0 min
## [FeatSel-x] 1: 1111111000001 (8 bits)
## [FeatSel-y] 1: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 1: 1110110000000 (5 bits)
## [FeatSel-y] 1: mse.test.mean=27.7; time: 0.0 min
## [FeatSel-x] 1: 1001001110111 (8 bits)
## [FeatSel-y] 1: mse.test.mean=26.5; time: 0.0 min
## [FeatSel-x] 1: 0001000011010 (4 bits)
## [FeatSel-y] 1: mse.test.mean=56.2; time: 0.0 min
## [FeatSel-x] 2: 1111011000011 (8 bits)
## [FeatSel-y] 2: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 2: 1000111100101 (7 bits)
## [FeatSel-y] 2: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 2: 0111001010001 (6 bits)
## [FeatSel-y] 2: mse.test.mean=30.6; time: 0.0 min
## [FeatSel-x] 2: 1101011011011 (9 bits)
## [FeatSel-y] 2: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 2: 1111001110001 (8 bits)
## [FeatSel-y] 2: mse.test.mean=28.2; time: 0.0 min
## [FeatSel-x] 3: 1001011001111 (8 bits)
## [FeatSel-y] 3: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 3: 1000111011011 (8 bits)
## [FeatSel-y] 3: mse.test.mean= 22; time: 0.0 min
```

```
## [FeatSel-x] 3: 1000111101101 (8 bits)
## [FeatSel-y] 3: mse.test.mean=22.8; time: 0.0 min
## [FeatSel-x] 3: 0110111000001 (6 bits)
## [FeatSel-y] 3: mse.test.mean=21.2; time: 0.0 min
## [FeatSel-x] 3: 1101011011011 (9 bits)
## [FeatSel-y] 3: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 4: 1111011001001 (8 bits)
## [FeatSel-y] 4: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 4: 1011011000011 (7 bits)
## [FeatSel-y] 4: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 4: 1000111011001 (7 bits)
## [FeatSel-y] 4: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 4: 1101111011111 (11 bits)
## [FeatSel-y] 4: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 4: 0100111010001 (6 bits)
## [FeatSel-y] 4: mse.test.mean=21.4; time: 0.0 min
## [FeatSel-x] 5: 1001011011001 (7 bits)
## [FeatSel-y] 5: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 5: 1111011001011 (9 bits)
## [FeatSel-y] 5: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 5: 1111011011111 (11 bits)
## [FeatSel-y] 5: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 5: 1101111010011 (9 bits)
## [FeatSel-y] 5: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 5: 1001011011011 (8 bits)
## [FeatSel-y] 5: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 6: 0110011010001 (6 bits)
## [FeatSel-y] 6: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 6: 1011011000011 (7 bits)
## [FeatSel-y] 6: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 6: 1111011101001 (9 bits)
## [FeatSel-y] 6: mse.test.mean=22.7; time: 0.0 min
## [FeatSel-x] 6: 1011011000011 (7 bits)
## [FeatSel-y] 6: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 6: 1111011010001 (8 bits)
## [FeatSel-y] 6: mse.test.mean=21.8; time: 0.0 min
```

```
## [FeatSel-x] 7: 0101011010001 (6 bits)
## [FeatSel-y] 7: mse.test.mean=22.4; time: 0.0 min
## [FeatSel-x] 7: 0101011011011 (8 bits)
## [FeatSel-y] 7: mse.test.mean=21.9; time: 0.0 min
## [FeatSel-x] 7: 1101011010111 (9 bits)
## [FeatSel-y] 7: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 7: 1111011000001 (7 bits)
## [FeatSel-y] 7: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 7: 1001011000111 (7 bits)
## [FeatSel-y] 7: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 8: 1110111010001 (8 bits)
## [FeatSel-y] 8: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 8: 1111011000111 (9 bits)
## [FeatSel-y] 8: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 8: 1111011011011 (10 bits)
## [FeatSel-y] 8: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 8: 1111111011011 (11 bits)
## [FeatSel-y] 8: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 8: 0001010010010 (4 bits)
## [FeatSel-y] 8: mse.test.mean=32.6; time: 0.0 min
## [FeatSel-x] 9: 0011011000011 (6 bits)
## [FeatSel-y] 9: mse.test.mean=21.9; time: 0.0 min
## [FeatSel-x] 9: 0100000010011 (4 bits)
## [FeatSel-y] 9: mse.test.mean=31.3; time: 0.0 min
## [FeatSel-x] 9: 0100011001001 (5 bits)
## [FeatSel-y] 9: mse.test.mean=21.7; time: 0.0 min
## [FeatSel-x] 9: 1001111000001 (6 bits)
## [FeatSel-y] 9: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 9: 1101011000011 (7 bits)
## [FeatSel-y] 9: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 10: 0000111010010 (5 bits)
## [FeatSel-y] 10: mse.test.mean=28.7; time: 0.0 min
## [FeatSel-x] 10: 1001001011001 (6 bits)
## [FeatSel-y] 10: mse.test.mean=27.9; time: 0.0 min
## [FeatSel-x] 10: 0100010001011 (5 bits)
## [FeatSel-y] 10: mse.test.mean=22.6; time: 0.0 min
```



```

## [FeatSel-x] 10: 1001011001011 (7 bits)
## [FeatSel-y] 10: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 10: 1111011001101 (9 bits)
## [FeatSel-y] 10: mse.test.mean=21.8; time: 0.0 min
## [FeatSel] Result: znindusnoxrmagelstat (6 bits)

## FeatSel result:
## Features (6): zn, indus, nox, rm, age, lstat
## mse.test.mean=21.2

```

## Wrapper

```

ctrl = makeFeatSelControlRandom(maxit = 10)
lrn = makeFeatSelWrapper("regr.rpart", resampling = rdesc, control = ctrl)
resample(lrn, bh.task, rdesc)

```

```

## [Resample] cross-validation iter 1: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 1111010000011 (7 bits)
## [FeatSel-y] 1: mse.test.mean=24.1; time: 0.0 min
## [FeatSel-x] 1: 0000110010111 (6 bits)
## [FeatSel-y] 1: mse.test.mean=22.1; time: 0.0 min
## [FeatSel-x] 1: 1011001100111 (8 bits)
## [FeatSel-y] 1: mse.test.mean=26.2; time: 0.0 min
## [FeatSel-x] 1: 1101110010010 (7 bits)
## [FeatSel-y] 1: mse.test.mean=28.9; time: 0.0 min
## [FeatSel-x] 1: 0110010010000 (4 bits)
## [FeatSel-y] 1: mse.test.mean=33.8; time: 0.0 min
## [FeatSel-x] 1: 1101111011000 (8 bits)
## [FeatSel-y] 1: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 1: 0010010001110 (5 bits)
## [FeatSel-y] 1: mse.test.mean=32.4; time: 0.0 min
## [FeatSel-x] 1: 0001111000111 (7 bits)
## [FeatSel-y] 1: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 1: 1101101110111 (10 bits)
## [FeatSel-y] 1: mse.test.mean=27.2; time: 0.0 min
## [FeatSel-x] 1: 0110010110110 (7 bits)
## [FeatSel-y] 1: mse.test.mean= 30; time: 0.0 min
## [FeatSel] Result: noxrmradptratioblstat (6 bits)
## mse.test.mean= 15

## [Resample] cross-validation iter 2: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 0100000001001 (3 bits)
## [FeatSel-y] 1: mse.test.mean=29.7; time: 0.0 min
## [FeatSel-x] 1: 0000000110010 (3 bits)
## [FeatSel-y] 1: mse.test.mean=59.3; time: 0.0 min
## [FeatSel-x] 1: 0100110110101 (7 bits)
## [FeatSel-y] 1: mse.test.mean=23.2; time: 0.0 min
## [FeatSel-x] 1: 0000110110100 (5 bits)

```

```

## [FeatSel-y] 1: mse.test.mean= 29; time: 0.0 min
## [FeatSel-x] 1: 0011001100010 (5 bits)
## [FeatSel-y] 1: mse.test.mean=53.9; time: 0.0 min
## [FeatSel-x] 1: 1011011001111 (9 bits)
## [FeatSel-y] 1: mse.test.mean=23.7; time: 0.0 min
## [FeatSel-x] 1: 0110000100100 (4 bits)
## [FeatSel-y] 1: mse.test.mean=45.7; time: 0.0 min
## [FeatSel-x] 1: 0000110101011 (6 bits)
## [FeatSel-y] 1: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 1: 1111110011111 (11 bits)
## [FeatSel-y] 1: mse.test.mean=23.2; time: 0.0 min
## [FeatSel-x] 1: 1001000000110 (4 bits)
## [FeatSel-y] 1: mse.test.mean=50.7; time: 0.0 min
## [FeatSel] Result: noxrmdistaxblstat (6 bits)
## mse.test.mean=23.7
## [Resample] cross-validation iter 3: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 1010110111111 (10 bits)
## [FeatSel-y] 1: mse.test.mean=22.1; time: 0.0 min
## [FeatSel-x] 1: 1001011011110 (8 bits)
## [FeatSel-y] 1: mse.test.mean=30.6; time: 0.0 min
## [FeatSel-x] 1: 1000110000011 (5 bits)
## [FeatSel-y] 1: mse.test.mean=21.6; time: 0.0 min
## [FeatSel-x] 1: 1010010111110 (8 bits)
## [FeatSel-y] 1: mse.test.mean=27.9; time: 0.0 min
## [FeatSel-x] 1: 1000011111001 (7 bits)
## [FeatSel-y] 1: mse.test.mean=21.1; time: 0.0 min
## [FeatSel-x] 1: 1010101110010 (7 bits)
## [FeatSel-y] 1: mse.test.mean=52.9; time: 0.0 min
## [FeatSel-x] 1: 0111100100111 (8 bits)
## [FeatSel-y] 1: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 1: 0010001110001 (5 bits)
## [FeatSel-y] 1: mse.test.mean=30.1; time: 0.0 min
## [FeatSel-x] 1: 0001000011111 (6 bits)
## [FeatSel-y] 1: mse.test.mean=27.2; time: 0.0 min
## [FeatSel-x] 1: 0101110110000 (6 bits)
## [FeatSel-y] 1: mse.test.mean=29.2; time: 0.0 min
## [FeatSel] Result: crimragedisradtaxlstat (7 bits)
## mse.test.mean=34.9
## [Resample] cross-validation iter 4: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 0110110100011 (7 bits)
## [FeatSel-y] 1: mse.test.mean=23.6; time: 0.0 min
## [FeatSel-x] 1: 0101010010001 (5 bits)
## [FeatSel-y] 1: mse.test.mean=23.4; time: 0.0 min
## [FeatSel-x] 1: 0110001100010 (5 bits)
## [FeatSel-y] 1: mse.test.mean=59.3; time: 0.0 min
## [FeatSel-x] 1: 1011011100000 (6 bits)
## [FeatSel-y] 1: mse.test.mean=31.3; time: 0.0 min
## [FeatSel-x] 1: 1001011110100 (7 bits)
## [FeatSel-y] 1: mse.test.mean=29.7; time: 0.0 min
## [FeatSel-x] 1: 0111111010000 (7 bits)

```

```

## [FeatSel-y] 1: mse.test.mean=29.6; time: 0.0 min
## [FeatSel-x] 1: 0111011011111 (10 bits)
## [FeatSel-y] 1: mse.test.mean=21.6; time: 0.0 min
## [FeatSel-x] 1: 0110001101101 (7 bits)
## [FeatSel-y] 1: mse.test.mean=26.1; time: 0.0 min
## [FeatSel-x] 1: 1000110100011 (6 bits)
## [FeatSel-y] 1: mse.test.mean= 24; time: 0.0 min
## [FeatSel-x] 1: 0111010000001 (5 bits)
## [FeatSel-y] 1: mse.test.mean=22.9; time: 0.0 min
## [FeatSel] Result: zninduschasrmageradtaxptrat... (10 bits)
## mse.test.mean=17.7
## [Resample] cross-validation iter 5: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 1110101101110 (9 bits)
## [FeatSel-y] 1: mse.test.mean=46.6; time: 0.0 min
## [FeatSel-x] 1: 0111001110011 (8 bits)
## [FeatSel-y] 1: mse.test.mean= 31; time: 0.0 min
## [FeatSel-x] 1: 1010011011101 (8 bits)
## [FeatSel-y] 1: mse.test.mean=22.6; time: 0.0 min
## [FeatSel-x] 1: 0111001011111 (9 bits)
## [FeatSel-y] 1: mse.test.mean=26.7; time: 0.0 min
## [FeatSel-x] 1: 0111000011100 (6 bits)
## [FeatSel-y] 1: mse.test.mean=51.7; time: 0.0 min
## [FeatSel-x] 1: 1110110001011 (8 bits)
## [FeatSel-y] 1: mse.test.mean=21.8; time: 0.0 min
## [FeatSel-x] 1: 0100100000011 (4 bits)
## [FeatSel-y] 1: mse.test.mean=28.8; time: 0.0 min
## [FeatSel-x] 1: 1010100101001 (6 bits)
## [FeatSel-y] 1: mse.test.mean=29.2; time: 0.0 min
## [FeatSel-x] 1: 1101100110101 (8 bits)
## [FeatSel-y] 1: mse.test.mean=28.7; time: 0.0 min
## [FeatSel-x] 1: 0000111011111 (8 bits)
## [FeatSel-y] 1: mse.test.mean=20.7; time: 0.0 min
## [FeatSel] Result: noxrmageradtaxptratioblstat (8 bits)
## mse.test.mean=23.1
## [Resample] cross-validation iter 6: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 0111100101101 (8 bits)
## [FeatSel-y] 1: mse.test.mean=27.5; time: 0.0 min
## [FeatSel-x] 1: 0110101100010 (6 bits)
## [FeatSel-y] 1: mse.test.mean=48.4; time: 0.0 min
## [FeatSel-x] 1: 0100000111101 (6 bits)
## [FeatSel-y] 1: mse.test.mean=27.9; time: 0.0 min
## [FeatSel-x] 1: 0111001111011 (9 bits)
## [FeatSel-y] 1: mse.test.mean=30.4; time: 0.0 min
## [FeatSel-x] 1: 1011000001100 (5 bits)
## [FeatSel-y] 1: mse.test.mean=47.1; time: 0.0 min
## [FeatSel-x] 1: 1110100011010 (7 bits)
## [FeatSel-y] 1: mse.test.mean=45.8; time: 0.0 min
## [FeatSel-x] 1: 0010001001001 (4 bits)
## [FeatSel-y] 1: mse.test.mean=28.3; time: 0.0 min
## [FeatSel-x] 1: 0011110111011 (9 bits)

```

```

## [FeatSel-y] 1: mse.test.mean=25.3; time: 0.0 min
## [FeatSel-x] 1: 0001000101000 (3 bits)
## [FeatSel-y] 1: mse.test.mean=57.6; time: 0.0 min
## [FeatSel-x] 1: 0011111101101 (9 bits)
## [FeatSel-y] 1: mse.test.mean=25.3; time: 0.0 min
## [FeatSel] Result: induschasnoxrmagedistaxpra... (9 bits)
## mse.test.mean=24.7
## [Resample] cross-validation iter 7: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 1001101111010 (8 bits)
## [FeatSel-y] 1: mse.test.mean=52.1; time: 0.0 min
## [FeatSel-x] 1: 1100100110000 (5 bits)
## [FeatSel-y] 1: mse.test.mean=43.6; time: 0.0 min
## [FeatSel-x] 1: 0011001110001 (6 bits)
## [FeatSel-y] 1: mse.test.mean=30.1; time: 0.0 min
## [FeatSel-x] 1: 1011110111110 (10 bits)
## [FeatSel-y] 1: mse.test.mean=24.4; time: 0.0 min
## [FeatSel-x] 1: 1110111101011 (10 bits)
## [FeatSel-y] 1: mse.test.mean=22.2; time: 0.0 min
## [FeatSel-x] 1: 0001010000001 (3 bits)
## [FeatSel-y] 1: mse.test.mean=22.9; time: 0.0 min
## [FeatSel-x] 1: 1000100110101 (6 bits)
## [FeatSel-y] 1: mse.test.mean=27.5; time: 0.0 min
## [FeatSel-x] 1: 0110011111100 (8 bits)
## [FeatSel-y] 1: mse.test.mean=26.6; time: 0.0 min
## [FeatSel-x] 1: 0010001110000 (4 bits)
## [FeatSel-y] 1: mse.test.mean=53.3; time: 0.0 min
## [FeatSel-x] 1: 1111100110010 (8 bits)
## [FeatSel-y] 1: mse.test.mean=46.5; time: 0.0 min
## [FeatSel] Result: crimznindusnoxrmagedistaxbl... (10 bits)
## mse.test.mean= 39
## [Resample] cross-validation iter 8: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 0110101010100 (6 bits)
## [FeatSel-y] 1: mse.test.mean=42.6; time: 0.0 min
## [FeatSel-x] 1: 1000100100111 (6 bits)
## [FeatSel-y] 1: mse.test.mean=28.2; time: 0.0 min
## [FeatSel-x] 1: 1011101111010 (9 bits)
## [FeatSel-y] 1: mse.test.mean=47.3; time: 0.0 min
## [FeatSel-x] 1: 1011101100010 (7 bits)
## [FeatSel-y] 1: mse.test.mean=56.6; time: 0.0 min
## [FeatSel-x] 1: 0101110101110 (8 bits)
## [FeatSel-y] 1: mse.test.mean=28.7; time: 0.0 min
## [FeatSel-x] 1: 1110000011010 (6 bits)
## [FeatSel-y] 1: mse.test.mean=50.2; time: 0.0 min
## [FeatSel-x] 1: 0010010100000 (3 bits)
## [FeatSel-y] 1: mse.test.mean=31.5; time: 0.0 min
## [FeatSel-x] 1: 0110110000111 (7 bits)
## [FeatSel-y] 1: mse.test.mean=21.9; time: 0.0 min
## [FeatSel-x] 1: 0010010001101 (5 bits)
## [FeatSel-y] 1: mse.test.mean= 22; time: 0.0 min
## [FeatSel-x] 1: 0110100011001 (6 bits)

```

```

## [FeatSel-y] 1: mse.test.mean=29.4; time: 0.0 min
## [FeatSel] Result: znindusnoxrmptratioblstat (7 bits)
## mse.test.mean=16.3
## [Resample] cross-validation iter 9: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 0100011110111 (8 bits)
## [FeatSel-y] 1: mse.test.mean=22.6; time: 0.0 min
## [FeatSel-x] 1: 0110111111011 (10 bits)
## [FeatSel-y] 1: mse.test.mean=22.6; time: 0.0 min
## [FeatSel-x] 1: 1111010001110 (8 bits)
## [FeatSel-y] 1: mse.test.mean=30.1; time: 0.0 min
## [FeatSel-x] 1: 0100100010010 (4 bits)
## [FeatSel-y] 1: mse.test.mean=47.1; time: 0.0 min
## [FeatSel-x] 1: 1111100100111 (9 bits)
## [FeatSel-y] 1: mse.test.mean=31.3; time: 0.0 min
## [FeatSel-x] 1: 0111101110100 (8 bits)
## [FeatSel-y] 1: mse.test.mean=53.3; time: 0.0 min
## [FeatSel-x] 1: 1000100101011 (6 bits)
## [FeatSel-y] 1: mse.test.mean=28.3; time: 0.0 min
## [FeatSel-x] 1: 0011001111101 (8 bits)
## [FeatSel-y] 1: mse.test.mean=28.8; time: 0.0 min
## [FeatSel-x] 1: 0000111111110 (8 bits)
## [FeatSel-y] 1: mse.test.mean=28.9; time: 0.0 min
## [FeatSel-x] 1: 0000111100111 (7 bits)
## [FeatSel-y] 1: mse.test.mean=22.6; time: 0.0 min
## [FeatSel] Result: znrmagedisradpdratioblstat (8 bits)
## mse.test.mean=16.2
## [Resample] cross-validation iter 10: [FeatSel] Started selecting features for learner 'regr.rpart'
## With control class: FeatSelControlRandom
## Imputation value: Inf
## [FeatSel-x] 1: 1101111110010 (9 bits)
## [FeatSel-y] 1: mse.test.mean=27.8; time: 0.0 min
## [FeatSel-x] 1: 1001111010101 (8 bits)
## [FeatSel-y] 1: mse.test.mean=23.1; time: 0.0 min
## [FeatSel-x] 1: 0010011001001 (5 bits)
## [FeatSel-y] 1: mse.test.mean=23.5; time: 0.0 min
## [FeatSel-x] 1: 0011101010001 (6 bits)
## [FeatSel-y] 1: mse.test.mean=27.7; time: 0.0 min
## [FeatSel-x] 1: 1101101010010 (7 bits)
## [FeatSel-y] 1: mse.test.mean=53.5; time: 0.0 min
## [FeatSel-x] 1: 1011001100111 (8 bits)
## [FeatSel-y] 1: mse.test.mean=27.6; time: 0.0 min
## [FeatSel-x] 1: 1100010111101 (8 bits)
## [FeatSel-y] 1: mse.test.mean=23.1; time: 0.0 min
## [FeatSel-x] 1: 1111111010011 (10 bits)
## [FeatSel-y] 1: mse.test.mean=23.1; time: 0.0 min
## [FeatSel-x] 1: 1011001011111 (9 bits)
## [FeatSel-y] 1: mse.test.mean= 26; time: 0.0 min
## [FeatSel-x] 1: 1011000010111 (7 bits)
## [FeatSel-y] 1: mse.test.mean= 26; time: 0.0 min
## [FeatSel] Result: crimchasnoxrmageradpdratiol... (8 bits)
## mse.test.mean=18.4
## [Resample] Aggr. Result: mse.test.mean=22.9

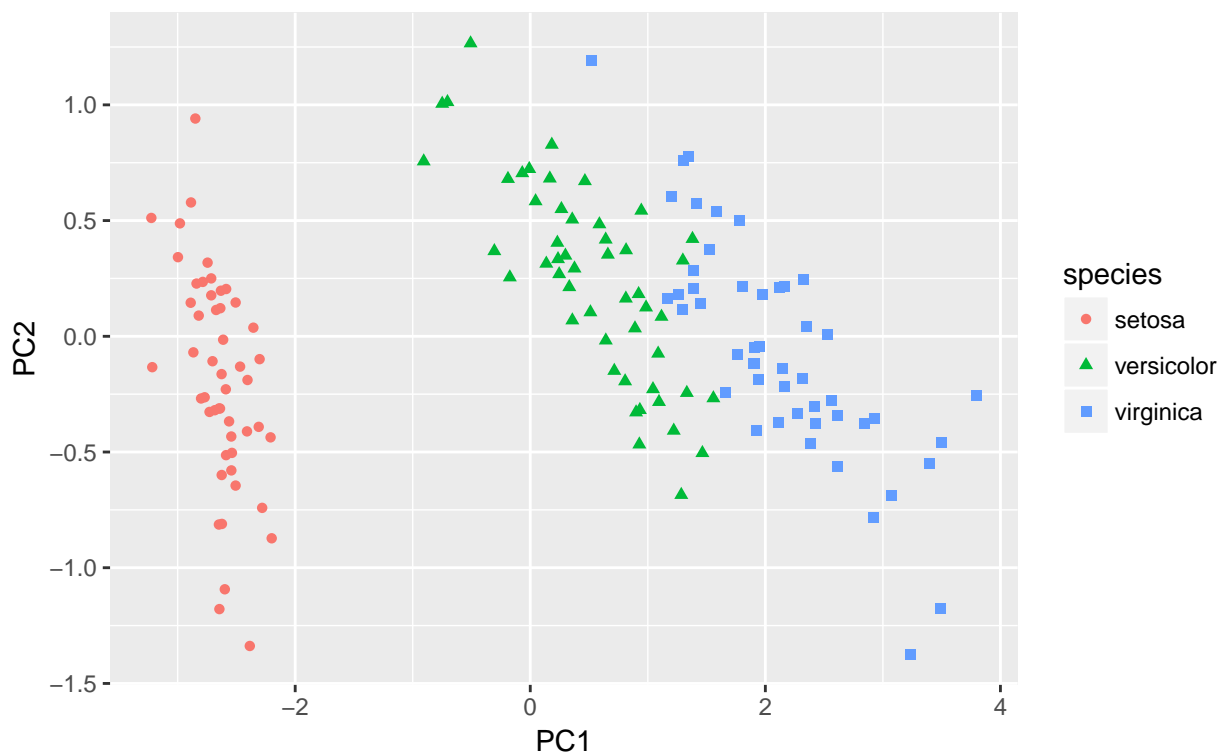
```

```
## Resample Result
## Task: BostonHousing-example
## Learner: regr.rpart.featsel
## Aggr perf: mse.test.mean=22.9
## Runtime: 11.8094
```

## Principal Component Analysis

```
library(ggplot2)

pca = prcomp(iris[, -5])
ggplot(cbind(as.data.frame(pca$x), species = iris$Species), aes(PC1, PC2)) +
  geom_point(aes(colour = species, shape = species))
```



## As Preprocessing Step

```
lrn = makeLearner("regr.lm")
resample(lrn, bh.task, rdesc)
```

```
## [Resample] cross-validation iter 1: mse.test.mean=48.7
## [Resample] cross-validation iter 2: mse.test.mean=20.1
## [Resample] cross-validation iter 3: mse.test.mean=20.4
## [Resample] cross-validation iter 4: mse.test.mean=18.5
## [Resample] cross-validation iter 5: mse.test.mean=25.2
## [Resample] cross-validation iter 6: mse.test.mean=22.2
## [Resample] cross-validation iter 7: mse.test.mean=17.1
## [Resample] cross-validation iter 8: mse.test.mean=21.4
```

```

## [Resample] cross-validation iter 9: mse.test.mean=23.2
## [Resample] cross-validation iter 10: mse.test.mean=21.4
## [Resample] Aggr. Result: mse.test.mean=23.8

## Resample Result
## Task: BostonHousing-example
## Learner: regr.lm
## Aggr perf: mse.test.mean=23.8
## Runtime: 0.116692

lrn = makePreprocWrapperCaret(learner = lrn, ppc.pca = TRUE, ppc.n.comp = 2)
resample(lrn, bh.task, rdesc)

## [Resample] cross-validation iter 1: mse.test.mean=20.9
## [Resample] cross-validation iter 2: mse.test.mean=19.3
## [Resample] cross-validation iter 3: mse.test.mean=13.7
## [Resample] cross-validation iter 4: mse.test.mean=35.4
## [Resample] cross-validation iter 5: mse.test.mean= 25
## [Resample] cross-validation iter 6: mse.test.mean=24.8
## [Resample] cross-validation iter 7: mse.test.mean=41.8
## [Resample] cross-validation iter 8: mse.test.mean=26.5
## [Resample] cross-validation iter 9: mse.test.mean= 31
## [Resample] cross-validation iter 10: mse.test.mean=23.7
## [Resample] Aggr. Result: mse.test.mean=26.2

## Resample Result
## Task: BostonHousing-example
## Learner: regr.lm.preproc
## Aggr perf: mse.test.mean=26.2
## Runtime: 1.46324

```

## Feature Expansion

```

lrn = makeLearner("classif.rpart", maxdepth = 1)
resample(lrn, iris.task, rdesc)

## [Resample] cross-validation iter 1: mmce.test.mean= 0.2
## [Resample] cross-validation iter 2: mmce.test.mean=0.333
## [Resample] cross-validation iter 3: mmce.test.mean= 0.4
## [Resample] cross-validation iter 4: mmce.test.mean=0.467
## [Resample] cross-validation iter 5: mmce.test.mean=0.467
## [Resample] cross-validation iter 6: mmce.test.mean=0.333
## [Resample] cross-validation iter 7: mmce.test.mean=0.533
## [Resample] cross-validation iter 8: mmce.test.mean= 0.4
## [Resample] cross-validation iter 9: mmce.test.mean= 0.6
## [Resample] cross-validation iter 10: mmce.test.mean=0.333
## [Resample] Aggr. Result: mmce.test.mean=0.407

## Resample Result
## Task: iris-example
## Learner: classif.rpart
## Aggr perf: mmce.test.mean=0.407
## Runtime: 0.130676

```

```
head(iris)
```

```
## Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1 5.1 3.5 1.4 0.2 setosa
## 2 4.9 3.0 1.4 0.2 setosa
## 3 4.7 3.2 1.3 0.2 setosa
## 4 4.6 3.1 1.5 0.2 setosa
## 5 5.0 3.6 1.4 0.2 setosa
## 6 5.4 3.9 1.7 0.4 setosa
```

```
d = as.data.frame(do.call(poly, c(lapply(1:4, function(x) iris[,x]), degree = 2, raw = TRUE)))
head(d)
```

```
## 1.0.0.0 2.0.0.0 0.1.0.0 1.1.0.0 0.2.0.0 0.0.1.0 1.0.1.0 0.1.1.0 0.0.2.0
## 1 5.1 26.01 3.5 17.85 12.25 1.4 7.14 4.90 1.96
## 2 4.9 24.01 3.0 14.70 9.00 1.4 6.86 4.20 1.96
## 3 4.7 22.09 3.2 15.04 10.24 1.3 6.11 4.16 1.69
## 4 4.6 21.16 3.1 14.26 9.61 1.5 6.90 4.65 2.25
## 5 5.0 25.00 3.6 18.00 12.96 1.4 7.00 5.04 1.96
## 6 5.4 29.16 3.9 21.06 15.21 1.7 9.18 6.63 2.89
## 0.0.0.1 1.0.0.1 0.1.0.1 0.0.1.1 0.0.0.2
## 1 0.2 1.02 0.70 0.28 0.04
## 2 0.2 0.98 0.60 0.28 0.04
## 3 0.2 0.94 0.64 0.26 0.04
## 4 0.2 0.92 0.62 0.30 0.04
## 5 0.2 1.00 0.72 0.28 0.04
## 6 0.4 2.16 1.56 0.68 0.16
```

```
colnames(d) = paste0("X", colnames(d))
task = makeClassifTask(data = cbind(d, Species = iris$Species), target = "Species")
resample(lrn, task, rdesc)
```

```
## [Resample] cross-validation iter 1: mmce.test.mean=0.467
## [Resample] cross-validation iter 2: mmce.test.mean= 0.4
## [Resample] cross-validation iter 3: mmce.test.mean= 0.4
## [Resample] cross-validation iter 4: mmce.test.mean= 0.4
## [Resample] cross-validation iter 5: mmce.test.mean= 0.4
## [Resample] cross-validation iter 6: mmce.test.mean=0.333
## [Resample] cross-validation iter 7: mmce.test.mean=0.267
## [Resample] cross-validation iter 8: mmce.test.mean=0.333
## [Resample] cross-validation iter 9: mmce.test.mean= 0.6
## [Resample] cross-validation iter 10: mmce.test.mean= 0.4
## [Resample] Aggr. Result: mmce.test.mean= 0.4
```

```
## Resample Result
## Task: cbind(d, Species = iris$Species)
## Learner: classif.rpart
## Aggr perf: mmce.test.mean= 0.4
## Runtime: 0.120742
```