Practical Machine Learning

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Project Description

Using devices such as Jawbone Up, Nike FuelBand, and Fitbit it is now possible to collect a large amount of data about personal activity relatively inexpensively. One thing that people regularly do is quantify how much of a particular activity they do, but they rarely quantify how well they do it. In this project, the goal will be to use data from accelerometers on the belt, forearm, arm, and dumbell of 6 participants. They were asked to perform barbell lifts correctly and incorrectly in 5 different ways.

Project Objectives

The goal of the project is to predict the manner in which they did the exercise. The following report describes the model was built, how it is cross validation, the expected out of sample error is, and why the best fitting model was chosen.

Report

Loading Libraries

```
library(abind)
library(arm)
```

```
## Loading required package: MASS
```

```
## Loading required package: Matrix
```

```
## Loading required package: lme4
```

```
##
## arm (Version 1.9-1, built: 2016-8-21)
```

```
## Working directory is C:/Users/Ramiro/Documents/Personal/Coursera/Data Scienc
e/Machine Learning
```

```
library(caret)
```

```
## Loading required package: lattice
```

```
## Loading required package: ggplot2
```

```
library(kernlab)
```

```
##
## Attaching package: 'kernlab'
```

```
## The following object is masked from 'package:ggplot2':
##
##     alpha
```

```
library(klaR)
library(rattle)
```

```
## Rattle: A free graphical interface for data mining with R.
## Version 4.1.0 Copyright (c) 2006-2015 Togaware Pty Ltd.
## Type 'rattle()' to shake, rattle, and roll your data.
```

```
library(randomForest)
```

```
## randomForest 4.6-12
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:ggplot2':
##
##     margin
```

```
library(rpart)
library(knitr)
library(rpart.plot)
library(corrplot)
```

```
##
## Attaching package: 'corrplot'
```

```
## The following object is masked from 'package:arm':
##
##     corrplot
```

```
library(RColorBrewer)
```

Set Working Environment

Data Description and Importing

Six young health participants were asked to perform one set of 10 repetitions of the Unilateral Dumbbell Biceps Curl in five different fashions:

Class A - > exactly according to the specification Class B - > throwing the elbows to the front Class C - > lifting the dumbbell only halfway Class D - > lowering the dumbbell only halfway Class E - > throwing the hips to the front .

Class A corresponds to the specified execution of the exercise, while the other 4 classes correspond to common mistakes.

The exercises were performed by six male participants aged between 20-28 years, with little weight lifting experience.

All participants could easily simulate the mistakes in a safe and controlled manner by using a relatively light dumbbell (1.25kg)

```
# URL to get DataSets
UrlTrainData <- "http://d396qusza40orc.cloudfront.net/predmachlearn/pml-trainin
g.csv"
UrlTestData  <- "http://d396qusza40orc.cloudfront.net/predmachlearn/pml-testin
g.csv"

# Get DataSets
trainData <- read.csv(url(UrlTrainData))
testData  <- read.csv(url(UrlTestData))
```

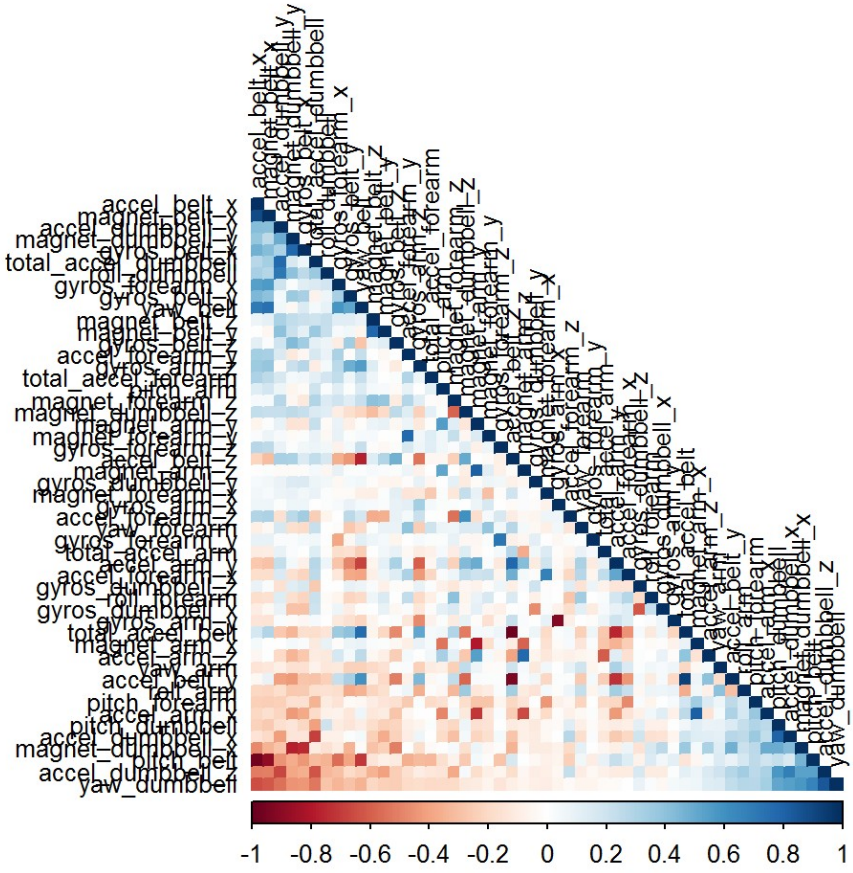
Prepare and Clean Data

```
# Create Partition
inTrain  <- createDataPartition(trainData$classe, p=0.8, list=FALSE)
TrainSet <- trainData[inTrain, ]
TestSet  <- trainData[-inTrain, ]

#Remove Variables with Near Zero Variance
helper <- nearZeroVar(TrainSet)
TrainSet <- TrainSet[, -helper]
TestSet  <- TestSet[, -helper]

#Remove Variables that are mostly NA
helper   <- sapply(TrainSet, function(x) mean(is.na(x))) > 0.90
TrainSet <- TrainSet[, helper==FALSE]
TestSet  <- TestSet[, helper==FALSE]

#Remove identification variables (columns 1 to 7)
TrainSet <- TrainSet[, -(1:7)]
TestSet  <- TestSet[, -(1:7)]
```

After cleaning process the number of variables for the analysis is 52.

Correlation Analisys

```
# Detect Correlation
corMatrix <- cor(TrainSet[, -52])
corrplot(corMatrix,
         order = "FPC",
         method = "color",
         type = "lower",
         tl.col = "black",
         tl.cex = 0.8)
```




```
corrAnal <- caret::findCorrelation(cor(TrainSet[, -52]), cutoff=0.8)
names(TrainSet)[corrAnal]
```

```
## [1] "accel_belt_z"     "accel_dumbbell_z" "accel_belt_y"
## [4] "accel_belt_x"     "pitch_belt"       "accel_dumbbell_x"
## [7] "accel_arm_x"      "magnet_arm_y"     "gyros_arm_x"
```

Variables above are highly correlated.

CrossValidation

Models Test: Random forest Neural Net

```
trainC <- trainControl(method = "cv",
                       verboseIter=TRUE)

#RandomForest
rf <- train(classe ~ ., data = TrainSet, method = "rf", trControl= trainC)
```

```
## + Fold01: mtry= 2
## - Fold01: mtry= 2
## + Fold01: mtry=26
## - Fold01: mtry=26
## + Fold01: mtry=51
## - Fold01: mtry=51
## + Fold02: mtry= 2
## - Fold02: mtry= 2
## + Fold02: mtry=26
## - Fold02: mtry=26
## + Fold02: mtry=51
## - Fold02: mtry=51
## + Fold03: mtry= 2
## - Fold03: mtry= 2
## + Fold03: mtry=26
## - Fold03: mtry=26
## + Fold03: mtry=51
## - Fold03: mtry=51
## + Fold04: mtry= 2
## - Fold04: mtry= 2
## + Fold04: mtry=26
## - Fold04: mtry=26
## + Fold04: mtry=51
## - Fold04: mtry=51
## + Fold05: mtry= 2
## - Fold05: mtry= 2
## + Fold05: mtry=26
## - Fold05: mtry=26
## + Fold05: mtry=51
## - Fold05: mtry=51
## + Fold06: mtry= 2
## - Fold06: mtry= 2
## + Fold06: mtry=26
## - Fold06: mtry=26
## + Fold06: mtry=51
## - Fold06: mtry=51
## + Fold07: mtry= 2
## - Fold07: mtry= 2
## + Fold07: mtry=26
## - Fold07: mtry=26
## + Fold07: mtry=51
## - Fold07: mtry=51
## + Fold08: mtry= 2
## - Fold08: mtry= 2
## + Fold08: mtry=26
## - Fold08: mtry=26
## + Fold08: mtry=51
## - Fold08: mtry=51
```

```
## + Fold09: mtry= 2
## - Fold09: mtry= 2
## + Fold09: mtry=26
## - Fold09: mtry=26
## + Fold09: mtry=51
## - Fold09: mtry=51
## + Fold10: mtry= 2
## - Fold10: mtry= 2
## + Fold10: mtry=26
## - Fold10: mtry=26
## + Fold10: mtry=51
## - Fold10: mtry=51
## Aggregating results
## Selecting tuning parameters
## Fitting mtry = 26 on full training set
```

```
#Support Vector Machine
svm <- train(classe ~ ., data = TrainSet, method = "svmRadial", trControl= trai
nC)
```

```
## + Fold01: sigma=0.01296, C=0.25
## - Fold01: sigma=0.01296, C=0.25
## + Fold01: sigma=0.01296, C=0.50
## - Fold01: sigma=0.01296, C=0.50
## + Fold01: sigma=0.01296, C=1.00
## - Fold01: sigma=0.01296, C=1.00
## + Fold02: sigma=0.01296, C=0.25
## - Fold02: sigma=0.01296, C=0.25
## + Fold02: sigma=0.01296, C=0.50
## - Fold02: sigma=0.01296, C=0.50
## + Fold02: sigma=0.01296, C=1.00
## - Fold02: sigma=0.01296, C=1.00
## + Fold03: sigma=0.01296, C=0.25
## - Fold03: sigma=0.01296, C=0.25
## + Fold03: sigma=0.01296, C=0.50
## - Fold03: sigma=0.01296, C=0.50
## + Fold03: sigma=0.01296, C=1.00
## - Fold03: sigma=0.01296, C=1.00
## + Fold04: sigma=0.01296, C=0.25
## - Fold04: sigma=0.01296, C=0.25
## + Fold04: sigma=0.01296, C=0.50
## - Fold04: sigma=0.01296, C=0.50
## + Fold04: sigma=0.01296, C=1.00
## - Fold04: sigma=0.01296, C=1.00
## + Fold05: sigma=0.01296, C=0.25
## - Fold05: sigma=0.01296, C=0.25
## + Fold05: sigma=0.01296, C=0.50
## - Fold05: sigma=0.01296, C=0.50
## + Fold05: sigma=0.01296, C=1.00
## - Fold05: sigma=0.01296, C=1.00
## + Fold06: sigma=0.01296, C=0.25
## - Fold06: sigma=0.01296, C=0.25
## + Fold06: sigma=0.01296, C=0.50
## - Fold06: sigma=0.01296, C=0.50
## + Fold06: sigma=0.01296, C=1.00
## - Fold06: sigma=0.01296, C=1.00
## + Fold07: sigma=0.01296, C=0.25
## - Fold07: sigma=0.01296, C=0.25
## + Fold07: sigma=0.01296, C=0.50
## - Fold07: sigma=0.01296, C=0.50
## + Fold07: sigma=0.01296, C=1.00
## - Fold07: sigma=0.01296, C=1.00
## + Fold08: sigma=0.01296, C=0.25
## - Fold08: sigma=0.01296, C=0.25
## + Fold08: sigma=0.01296, C=0.50
## - Fold08: sigma=0.01296, C=0.50
## + Fold08: sigma=0.01296, C=1.00
## - Fold08: sigma=0.01296, C=1.00
```

```
## + Fold09: sigma=0.01296, C=0.25
## - Fold09: sigma=0.01296, C=0.25
## + Fold09: sigma=0.01296, C=0.50
## - Fold09: sigma=0.01296, C=0.50
## + Fold09: sigma=0.01296, C=1.00
## - Fold09: sigma=0.01296, C=1.00
## + Fold10: sigma=0.01296, C=0.25
## - Fold10: sigma=0.01296, C=0.25
## + Fold10: sigma=0.01296, C=0.50
## - Fold10: sigma=0.01296, C=0.50
## + Fold10: sigma=0.01296, C=1.00
## - Fold10: sigma=0.01296, C=1.00
## Aggregating results
## Selecting tuning parameters
## Fitting sigma = 0.013, C = 1 on full training set
```

```
#Neural Net
NN <- train(classe ~ ., data = TrainSet, method = "nnet", verbose=FALSE, trCont
rol= trainC )
```

```
## Loading required package: nnet
```

```
## + Fold01: size=1, decay=0e+00
## # weights:  62
## initial  value 23520.728768
## iter  10 value 21953.426504
## iter  20 value 21452.471306
## iter  30 value 21303.567064
## iter  40 value 21167.424931
## iter  50 value 21164.751399
## iter  60 value 21026.145294
## iter  70 value 20787.883790
## iter  80 value 20598.749728
## iter  90 value 20527.517789
## iter 100 value 20512.245643
## final  value 20512.245643
## stopped after 100 iterations
## - Fold01: size=1, decay=0e+00
## + Fold01: size=3, decay=0e+00
## # weights:  176
## initial  value 25682.961493
## iter  10 value 22123.026113
## iter  20 value 21729.244284
## iter  30 value 20858.925425
## iter  40 value 20616.430989
## iter  50 value 20501.090377
## iter  60 value 20292.618419
## iter  70 value 20230.962573
## iter  80 value 20184.658125
## iter  90 value 20167.090641
## iter 100 value 20159.892581
## final  value 20159.892581
## stopped after 100 iterations
## - Fold01: size=3, decay=0e+00
## + Fold01: size=5, decay=0e+00
## # weights:  290
## initial  value 25752.539825
## iter  10 value 21233.216794
## iter  20 value 20939.251731
## iter  30 value 20623.949022
## iter  40 value 20038.821502
## iter  50 value 19628.460701
## iter  60 value 19570.687503
## iter  70 value 19434.310759
## iter  80 value 19399.290290
## iter  90 value 19144.335006
## iter 100 value 18894.510201
## final  value 18894.510201
## stopped after 100 iterations
## - Fold01: size=5, decay=0e+00
```

```
## + Fold01: size=1, decay=1e-01
## # weights:  62
## initial  value 23429.163122
## iter  10 value 22599.482148
## iter  20 value 22523.916032
## iter  30 value 22363.311101
## iter  40 value 22335.575796
## iter  50 value 22311.381377
## iter  60 value 22289.965940
## iter  70 value 22279.547906
## iter  80 value 22275.374855
## iter  90 value 22269.346486
## iter 100 value 22263.837595
## final  value 22263.837595
## stopped after 100 iterations
## - Fold01: size=1, decay=1e-01
## + Fold01: size=3, decay=1e-01
## # weights:  176
## initial  value 29349.094784
## iter  10 value 22827.795891
## iter  20 value 22467.404160
## iter  30 value 22395.328599
## iter  40 value 22265.749620
## iter  50 value 21953.009865
## iter  60 value 21697.493462
## iter  70 value 21432.212052
## iter  80 value 21377.670540
## iter  90 value 21290.504775
## iter 100 value 21236.506118
## final  value 21236.506118
## stopped after 100 iterations
## - Fold01: size=3, decay=1e-01
## + Fold01: size=5, decay=1e-01
## # weights:  290
## initial  value 25445.586616
## iter  10 value 20938.889044
## iter  20 value 20421.687584
## iter  30 value 20058.422108
## iter  40 value 19735.138379
## iter  50 value 19434.954847
## iter  60 value 19345.871172
## iter  70 value 19140.248015
## iter  80 value 19089.145197
## iter  90 value 19008.036379
## iter 100 value 18906.091209
## final  value 18906.091209
## stopped after 100 iterations
## - Fold01: size=5, decay=1e-01
## + Fold01: size=1, decay=1e-04
```

```
## # weights:  62
## initial  value 23139.664527
## iter  10 value 22094.448075
## iter  20 value 21205.214652
## iter  30 value 20861.001437
## iter  40 value 20802.635607
## iter  50 value 20669.602993
## iter  60 value 20638.586308
## iter  70 value 20564.754031
## iter  80 value 20540.054815
## iter  90 value 20534.592302
## iter 100 value 20533.510192
## final  value 20533.510192
## stopped after 100 iterations
## - Fold01: size=1, decay=1e-04
## + Fold01: size=3, decay=1e-04
## # weights:  176
## initial  value 26178.655547
## iter  10 value 22289.695892
## iter  20 value 22209.905991
## iter  30 value 22168.353800
## iter  40 value 22038.457580
## iter  50 value 21929.887964
## iter  60 value 21882.804687
## iter  70 value 21472.020890
## iter  80 value 20802.069462
## iter  90 value 20671.108730
## iter 100 value 20537.895792
## final  value 20537.895792
## stopped after 100 iterations
## - Fold01: size=3, decay=1e-04
## + Fold01: size=5, decay=1e-04
## # weights:  290
## initial  value 24525.276157
## iter  10 value 21563.079158
## iter  20 value 21172.235304
## iter  30 value 20972.664071
## iter  40 value 20554.411760
## iter  50 value 20042.055176
## iter  60 value 19895.770056
## iter  70 value 19819.549824
## iter  80 value 19757.237870
## iter  90 value 19629.251217
## iter 100 value 19480.495839
## final  value 19480.495839
## stopped after 100 iterations
## - Fold01: size=5, decay=1e-04
## + Fold02: size=1, decay=0e+00
## # weights:  62
```

```
## initial  value 23302.092947
## iter  10 value 22054.989456
## iter  20 value 21821.318040
## iter  30 value 21584.655116
## iter  40 value 21456.067762
## iter  50 value 21423.223925
## iter  60 value 21384.785855
## iter  70 value 21358.345760
## iter  80 value 21305.126682
## iter  90 value 21270.942919
## iter 100 value 21195.943003
## final  value 21195.943003
## stopped after 100 iterations
## - Fold02: size=1, decay=0e+00
## + Fold02: size=3, decay=0e+00
## # weights:  176
## initial  value 26614.140048
## iter  10 value 21251.608331
## iter  20 value 20988.117134
## iter  30 value 20753.626505
## iter  40 value 20651.933479
## iter  50 value 20596.579857
## iter  60 value 20551.326352
## iter  70 value 20404.385180
## iter  80 value 20390.141024
## iter  90 value 20228.613035
## iter 100 value 20115.373012
## final  value 20115.373012
## stopped after 100 iterations
## - Fold02: size=3, decay=0e+00
## + Fold02: size=5, decay=0e+00
## # weights:  290
## initial  value 26037.320171
## iter  10 value 21463.237921
## iter  20 value 20951.017248
## iter  30 value 20520.567798
## iter  40 value 20312.936117
## iter  50 value 20053.789585
## iter  60 value 19672.377934
## iter  70 value 19602.371847
## iter  80 value 19563.092947
## iter  90 value 19502.014360
## iter 100 value 19418.928750
## final  value 19418.928750
## stopped after 100 iterations
## - Fold02: size=5, decay=0e+00
## + Fold02: size=1, decay=1e-01
## # weights:  62
## initial  value 23220.879791
```

```
## iter  10 value 22070.671574
## iter  20 value 21842.036020
## iter  30 value 21798.043643
## iter  40 value 21744.833704
## iter  50 value 21636.406491
## iter  60 value 21605.123343
## iter  70 value 21576.928299
## iter  80 value 21515.315440
## iter  90 value 21349.487690
## iter 100 value 21305.257358
## final  value 21305.257358
## stopped after 100 iterations
## - Fold02: size=1, decay=1e-01
## + Fold02: size=3, decay=1e-01
## # weights:  176
## initial  value 27520.256403
## iter  10 value 22231.123999
## iter  20 value 21828.097481
## iter  30 value 21573.739351
## iter  40 value 21146.733846
## iter  50 value 20862.273621
## iter  60 value 20725.355817
## iter  70 value 20670.812286
## iter  80 value 20500.495932
## iter  90 value 20476.918090
## iter 100 value 20460.244741
## final  value 20460.244741
## stopped after 100 iterations
## - Fold02: size=3, decay=1e-01
## + Fold02: size=5, decay=1e-01
## # weights:  290
## initial  value 24921.025671
## iter  10 value 21202.216319
## iter  20 value 20814.453380
## iter  30 value 20444.251127
## iter  40 value 19603.049415
## iter  50 value 19211.197365
## iter  60 value 19068.283659
## iter  70 value 18965.313839
## iter  80 value 18755.872425
## iter  90 value 18658.293224
## iter 100 value 18632.971955
## final  value 18632.971955
## stopped after 100 iterations
## - Fold02: size=5, decay=1e-01
## + Fold02: size=1, decay=1e-04
## # weights:  62
## initial  value 24364.776484
## iter  10 value 22070.848951
```

```
## iter  20 value 21389.796129
## iter  30 value 21191.823823
## iter  40 value 21107.203344
## iter  50 value 20997.205658
## iter  60 value 20773.280735
## iter  70 value 20649.511853
## iter  80 value 20553.971588
## iter  90 value 20540.692420
## iter 100 value 20535.683320
## final  value 20535.683320
## stopped after 100 iterations
## - Fold02: size=1, decay=1e-04
## + Fold02: size=3, decay=1e-04
## # weights:  176
## initial  value 24782.733289
## iter  10 value 21649.348398
## iter  20 value 21338.446781
## iter  30 value 21071.852729
## iter  40 value 20866.152766
## iter  50 value 20586.006233
## iter  60 value 20425.909247
## iter  70 value 20393.250921
## iter  80 value 20242.499741
## iter  90 value 20197.488697
## iter 100 value 20041.827934
## final  value 20041.827934
## stopped after 100 iterations
## - Fold02: size=3, decay=1e-04
## + Fold02: size=5, decay=1e-04
## # weights:  290
## initial  value 26683.353538
## iter  10 value 22163.166914
## iter  20 value 21166.450714
## iter  30 value 20816.417652
## iter  40 value 20640.904884
## iter  50 value 20321.928570
## iter  60 value 20079.672771
## iter  70 value 19815.023072
## iter  80 value 19537.982937
## iter  90 value 19434.180690
## iter 100 value 19384.337190
## final  value 19384.337190
## stopped after 100 iterations
## - Fold02: size=5, decay=1e-04
## + Fold03: size=1, decay=0e+00
## # weights:  62
## initial  value 24552.159083
## iter  10 value 21953.898284
## iter  20 value 21897.494099
```

```
## iter  30 value 21520.939175
## iter  40 value 21354.575389
## iter  50 value 21236.488012
## iter  60 value 21206.969417
## iter  70 value 21151.779627
## iter  80 value 21129.834906
## iter  90 value 21059.882735
## iter 100 value 21053.576911
## final  value 21053.576911
## stopped after 100 iterations
## - Fold03: size=1, decay=0e+00
## + Fold03: size=3, decay=0e+00
## # weights:  176
## initial  value 23816.084093
## iter  10 value 21429.443628
## iter  20 value 21138.312285
## iter  30 value 20959.736217
## iter  40 value 20750.626966
## iter  50 value 20707.187979
## iter  60 value 20651.227095
## iter  70 value 20525.113204
## iter  80 value 20476.268917
## iter  90 value 20458.562350
## iter 100 value 20441.385605
## final  value 20441.385605
## stopped after 100 iterations
## - Fold03: size=3, decay=0e+00
## + Fold03: size=5, decay=0e+00
## # weights:  290
## initial  value 23902.930104
## iter  10 value 21619.866924
## iter  20 value 21332.577959
## iter  30 value 21108.445640
## iter  40 value 20821.240276
## iter  50 value 20481.684146
## iter  60 value 20326.025268
## iter  70 value 20114.855598
## iter  80 value 19942.141816
## iter  90 value 19826.211898
## iter 100 value 19466.992038
## final  value 19466.992038
## stopped after 100 iterations
## - Fold03: size=5, decay=0e+00
## + Fold03: size=1, decay=1e-01
## # weights:  62
## initial  value 24452.944620
## iter  10 value 21405.550652
## iter  20 value 21049.244198
## iter  30 value 20753.383659
```

```
## iter  40 value 20627.895658
## iter  50 value 20515.850147
## iter  60 value 20428.152103
## iter  70 value 20392.516578
## iter  80 value 20262.631049
## iter  90 value 20236.374594
## iter 100 value 20226.681664
## final  value 20226.681664
## stopped after 100 iterations
## - Fold03: size=1, decay=1e-01
## + Fold03: size=3, decay=1e-01
## # weights:  176
## initial  value 24526.480415
## iter  10 value 21464.551405
## iter  20 value 21348.965542
## iter  30 value 21285.821603
## iter  40 value 21089.970403
## iter  50 value 21026.808563
## iter  60 value 21009.574286
## iter  70 value 20999.537263
## iter  80 value 20989.922642
## iter  90 value 20977.711701
## iter 100 value 20943.025717
## final  value 20943.025717
## stopped after 100 iterations
## - Fold03: size=3, decay=1e-01
## + Fold03: size=5, decay=1e-01
## # weights:  290
## initial  value 27979.065055
## iter  10 value 21548.367539
## iter  20 value 21003.561930
## iter  30 value 20633.316011
## iter  40 value 20260.754102
## iter  50 value 19992.674523
## iter  60 value 19740.469215
## iter  70 value 19590.376611
## iter  80 value 19423.629859
## iter  90 value 19200.604504
## iter 100 value 19050.193848
## final  value 19050.193848
## stopped after 100 iterations
## - Fold03: size=5, decay=1e-01
## + Fold03: size=1, decay=1e-04
## # weights:  62
## initial  value 22762.960929
## iter  10 value 21563.164863
## iter  20 value 21074.458884
## iter  30 value 20753.597534
## iter  40 value 20716.936640
```

```
## iter  50 value 20650.757067
## iter  60 value 20515.996748
## iter  70 value 20449.339616
## iter  80 value 20426.334672
## iter  90 value 20400.525877
## iter 100 value 20345.747491
## final  value 20345.747491
## stopped after 100 iterations
## - Fold03: size=1, decay=1e-04
## + Fold03: size=3, decay=1e-04
## # weights:  176
## initial  value 27692.659014
## iter  10 value 23398.341456
## iter  20 value 22011.853865
## iter  30 value 21577.768757
## iter  40 value 21420.999378
## iter  50 value 21322.076308
## iter  60 value 21289.658820
## iter  70 value 21219.518697
## iter  80 value 21064.208467
## iter  90 value 20986.673411
## iter 100 value 20968.033731
## final  value 20968.033731
## stopped after 100 iterations
## - Fold03: size=3, decay=1e-04
## + Fold03: size=5, decay=1e-04
## # weights:  290
## initial  value 26565.288365
## iter  10 value 21053.926497
## iter  20 value 20493.387098
## iter  30 value 20192.503849
## iter  40 value 19874.052652
## iter  50 value 19698.262210
## iter  60 value 19293.144380
## iter  70 value 19176.729673
## iter  80 value 19109.826312
## iter  90 value 19044.456525
## iter 100 value 18970.552990
## final  value 18970.552990
## stopped after 100 iterations
## - Fold03: size=5, decay=1e-04
## + Fold04: size=1, decay=0e+00
## # weights:  62
## initial  value 24750.506742
## iter  10 value 22237.045640
## iter  20 value 22151.827033
## iter  30 value 22100.590715
## iter  40 value 22046.781644
## iter  50 value 22013.016756
```

```
## iter  60 value 22000.424352
## iter  70 value 21997.354256
## iter  80 value 21935.930737
## iter  90 value 21913.136154
## iter 100 value 21905.349244
## final  value 21905.349244
## stopped after 100 iterations
## - Fold04: size=1, decay=0e+00
## + Fold04: size=3, decay=0e+00
## # weights:  176
## initial  value 25880.145808
## iter  10 value 22461.163762
## iter  20 value 21483.010077
## iter  30 value 21071.048731
## iter  40 value 21008.086901
## iter  50 value 20790.614883
## iter  60 value 20726.804053
## iter  70 value 20535.350381
## iter  80 value 20447.331067
## iter  90 value 20314.154834
## iter 100 value 20177.472474
## final  value 20177.472474
## stopped after 100 iterations
## - Fold04: size=3, decay=0e+00
## + Fold04: size=5, decay=0e+00
## # weights:  290
## initial  value 25188.712380
## iter  10 value 21482.714366
## iter  20 value 20408.045489
## iter  30 value 20062.708347
## iter  40 value 20015.859474
## iter  50 value 19980.239314
## iter  60 value 19947.094791
## iter  70 value 19799.094159
## iter  80 value 19674.690014
## iter  90 value 19541.237199
## iter 100 value 19169.008568
## final  value 19169.008568
## stopped after 100 iterations
## - Fold04: size=5, decay=0e+00
## + Fold04: size=1, decay=1e-01
## # weights:  62
## initial  value 28050.335532
## iter  10 value 22362.370608
## iter  20 value 22284.564973
## iter  30 value 21851.716991
## iter  40 value 21334.785640
## iter  50 value 21227.233387
## iter  60 value 21008.467386
```

```
## iter  70 value 20890.804807
## iter  80 value 20839.795327
## iter  90 value 20796.106702
## iter 100 value 20683.778249
## final  value 20683.778249
## stopped after 100 iterations
## - Fold04: size=1, decay=1e-01
## + Fold04: size=3, decay=1e-01
## # weights:  176
## initial  value 25445.787061
## iter  10 value 22004.209555
## iter  20 value 21680.368966
## iter  30 value 21311.344821
## iter  40 value 20468.226985
## iter  50 value 20302.553332
## iter  60 value 20189.171055
## iter  70 value 20122.158619
## iter  80 value 20093.327666
## iter  90 value 20059.449970
## iter 100 value 20037.154021
## final  value 20037.154021
## stopped after 100 iterations
## - Fold04: size=3, decay=1e-01
## + Fold04: size=5, decay=1e-01
## # weights:  290
## initial  value 24913.052581
## iter  10 value 21414.977145
## iter  20 value 20479.809650
## iter  30 value 20069.313065
## iter  40 value 19978.635026
## iter  50 value 19911.835053
## iter  60 value 19855.147799
## iter  70 value 19812.174238
## iter  80 value 19770.576162
## iter  90 value 19728.530379
## iter 100 value 19674.696137
## final  value 19674.696137
## stopped after 100 iterations
## - Fold04: size=5, decay=1e-01
## + Fold04: size=1, decay=1e-04
## # weights:  62
## initial  value 23436.139475
## iter  10 value 22183.846689
## iter  20 value 21966.881072
## iter  30 value 21900.975896
## iter  40 value 21670.457527
## iter  50 value 21343.019230
## iter  60 value 21066.320612
## iter  70 value 20404.456352
```

```
## iter  80 value 20264.140960
## iter  90 value 20136.199565
## iter 100 value 20082.110633
## final  value 20082.110633
## stopped after 100 iterations
## - Fold04: size=1, decay=1e-04
## + Fold04: size=3, decay=1e-04
## # weights:  176
## initial  value 29302.495296
## iter  10 value 22750.573057
## iter  20 value 22421.748803
## iter  30 value 22349.292968
## iter  40 value 22337.585038
## iter  50 value 22329.850838
## iter  60 value 22323.499076
## iter  70 value 22319.185697
## iter  80 value 22317.690976
## iter  90 value 22317.681681
## iter 100 value 22294.954471
## final  value 22294.954471
## stopped after 100 iterations
## - Fold04: size=3, decay=1e-04
## + Fold04: size=5, decay=1e-04
## # weights:  290
## initial  value 23601.023152
## iter  10 value 21100.215757
## iter  20 value 20523.545178
## iter  30 value 20010.914289
## iter  40 value 19717.782603
## iter  50 value 19199.676257
## iter  60 value 19117.710426
## iter  70 value 19049.130668
## iter  80 value 18816.706101
## iter  90 value 18676.970795
## iter 100 value 18648.296342
## final  value 18648.296342
## stopped after 100 iterations
## - Fold04: size=5, decay=1e-04
## + Fold05: size=1, decay=0e+00
## # weights:  62
## initial  value 22735.169798
## iter  10 value 21427.690445
## iter  20 value 21108.501248
## iter  30 value 21002.026027
## iter  40 value 20779.109326
## iter  50 value 20580.695365
## iter  60 value 20526.826429
## iter  70 value 20509.411762
## iter  80 value 20469.702585
```

```
## iter  90 value 20432.957596
## iter 100 value 20405.220227
## final  value 20405.220227
## stopped after 100 iterations
## - Fold05: size=1, decay=0e+00
## + Fold05: size=3, decay=0e+00
## # weights:  176
## initial  value 24543.818972
## iter  10 value 21927.362969
## iter  20 value 21581.246296
## iter  30 value 21498.955495
## iter  40 value 21413.881411
## iter  50 value 21208.533328
## iter  60 value 20950.041272
## iter  70 value 20641.687026
## iter  80 value 20409.658966
## iter  90 value 19906.701927
## iter 100 value 19698.822037
## final  value 19698.822037
## stopped after 100 iterations
## - Fold05: size=3, decay=0e+00
## + Fold05: size=5, decay=0e+00
## # weights:  290
## initial  value 26673.505880
## iter  10 value 21197.896902
## iter  20 value 20733.359653
## iter  30 value 20536.690894
## iter  40 value 20465.147543
## iter  50 value 20205.096690
## iter  60 value 19956.101493
## iter  70 value 19797.677848
## iter  80 value 19641.911317
## iter  90 value 19354.451388
## iter 100 value 19090.811013
## final  value 19090.811013
## stopped after 100 iterations
## - Fold05: size=5, decay=0e+00
## + Fold05: size=1, decay=1e-01
## # weights:  62
## initial  value 25008.903917
## iter  10 value 22321.447021
## iter  20 value 22265.463282
## iter  30 value 22192.166001
## iter  40 value 22174.800452
## iter  50 value 22159.748246
## iter  60 value 22149.772968
## iter  70 value 22140.631899
## iter  80 value 22109.138620
## iter  90 value 22094.948690
```

```
## iter 100 value 22089.486363
## final  value 22089.486363
## stopped after 100 iterations
## - Fold05: size=1, decay=1e-01
## + Fold05: size=3, decay=1e-01
## # weights:  176
## initial  value 24591.208911
## iter  10 value 22299.843338
## iter  20 value 21826.574642
## iter  30 value 21182.754894
## iter  40 value 21018.796608
## iter  50 value 20960.645211
## iter  60 value 20880.564977
## iter  70 value 20789.656547
## iter  80 value 20572.573784
## iter  90 value 20523.608186
## iter 100 value 20494.225800
## final  value 20494.225800
## stopped after 100 iterations
## - Fold05: size=3, decay=1e-01
## + Fold05: size=5, decay=1e-01
## # weights:  290
## initial  value 23268.440995
## iter  10 value 21411.764904
## iter  20 value 21119.666823
## iter  30 value 20335.608382
## iter  40 value 19893.460663
## iter  50 value 19604.394207
## iter  60 value 19517.341884
## iter  70 value 19460.797811
## iter  80 value 19430.376980
## iter  90 value 19405.188001
## iter 100 value 19324.862990
## final  value 19324.862990
## stopped after 100 iterations
## - Fold05: size=5, decay=1e-01
## + Fold05: size=1, decay=1e-04
## # weights:  62
## initial  value 24019.672170
## iter  10 value 22254.484922
## iter  20 value 22227.656061
## iter  30 value 22046.817500
## iter  40 value 21730.989975
## iter  50 value 21442.068149
## iter  60 value 21103.516196
## iter  70 value 20845.985276
## iter  80 value 20771.933770
## iter  90 value 20728.015080
## iter 100 value 20698.747399
```

```
## final  value 20698.747399
## stopped after 100 iterations
## - Fold05: size=1, decay=1e-04
## + Fold05: size=3, decay=1e-04
## # weights:  176
## initial  value 22886.248320
## iter  10 value 21483.513052
## iter  20 value 21035.219998
## iter  30 value 20950.404735
## iter  40 value 20841.536857
## iter  50 value 20724.790244
## iter  60 value 20511.701063
## iter  70 value 20449.374108
## iter  80 value 20129.946264
## iter  90 value 19945.200096
## iter 100 value 19451.947884
## final  value 19451.947884
## stopped after 100 iterations
## - Fold05: size=3, decay=1e-04
## + Fold05: size=5, decay=1e-04
## # weights:  290
## initial  value 27499.503028
## iter  10 value 21644.392497
## iter  20 value 20946.693012
## iter  30 value 20564.885135
## iter  40 value 20321.943196
## iter  50 value 19570.646297
## iter  60 value 19395.148198
## iter  70 value 19160.363901
## iter  80 value 18932.299142
## iter  90 value 18812.404881
## iter 100 value 18778.364416
## final  value 18778.364416
## stopped after 100 iterations
## - Fold05: size=5, decay=1e-04
## + Fold06: size=1, decay=0e+00
## # weights:  62
## initial  value 24817.523142
## iter  10 value 22436.325434
## iter  20 value 22327.432319
## iter  30 value 22291.900249
## iter  40 value 22176.375006
## iter  50 value 22133.565657
## iter  60 value 22082.994674
## iter  70 value 22037.366993
## iter  80 value 22033.914206
## iter  90 value 22018.423263
## iter 100 value 21989.591877
## final  value 21989.591877
```

```
## stopped after 100 iterations
## - Fold06: size=1, decay=0e+00
## + Fold06: size=3, decay=0e+00
## # weights:  176
## initial  value 24187.390666
## iter  10 value 21489.754398
## iter  20 value 21111.581904
## iter  30 value 21070.754913
## iter  40 value 20907.296337
## iter  50 value 20769.403496
## iter  60 value 20568.974579
## iter  70 value 20505.886395
## iter  80 value 20372.644687
## iter  90 value 20225.547990
## iter 100 value 19986.883776
## final  value 19986.883776
## stopped after 100 iterations
## - Fold06: size=3, decay=0e+00
## + Fold06: size=5, decay=0e+00
## # weights:  290
## initial  value 23929.437898
## iter  10 value 20864.606778
## iter  20 value 20446.363739
## iter  30 value 20286.759959
## iter  40 value 20154.118852
## iter  50 value 20034.342003
## iter  60 value 19963.681235
## iter  70 value 19801.757105
## iter  80 value 19622.118694
## iter  90 value 19333.919406
## iter 100 value 19221.251545
## final  value 19221.251545
## stopped after 100 iterations
## - Fold06: size=5, decay=0e+00
## + Fold06: size=1, decay=1e-01
## # weights:  62
## initial  value 23473.599426
## iter  10 value 21748.590438
## iter  20 value 21527.111120
## iter  30 value 21490.532659
## iter  40 value 21468.443489
## iter  50 value 21439.420699
## iter  60 value 21415.775292
## iter  70 value 21404.890134
## iter  80 value 21398.991960
## iter  90 value 21395.917447
## iter 100 value 21391.648762
## final  value 21391.648762
## stopped after 100 iterations
```

```
## - Fold06: size=1, decay=1e-01
## + Fold06: size=3, decay=1e-01
## # weights:  176
## initial  value 24248.525240
## iter  10 value 21398.162003
## iter  20 value 20777.730656
## iter  30 value 20544.032249
## iter  40 value 20493.036455
## iter  50 value 20403.569155
## iter  60 value 20359.465329
## iter  70 value 20309.829566
## iter  80 value 20271.668210
## iter  90 value 20258.053571
## iter 100 value 20232.580216
## final  value 20232.580216
## stopped after 100 iterations
## - Fold06: size=3, decay=1e-01
## + Fold06: size=5, decay=1e-01
## # weights:  290
## initial  value 23416.178659
## iter  10 value 21126.767427
## iter  20 value 20532.264641
## iter  30 value 20205.639915
## iter  40 value 19992.441879
## iter  50 value 19905.495467
## iter  60 value 19626.103174
## iter  70 value 19578.615345
## iter  80 value 19438.513084
## iter  90 value 19233.495911
## iter 100 value 19135.907828
## final  value 19135.907828
## stopped after 100 iterations
## - Fold06: size=5, decay=1e-01
## + Fold06: size=1, decay=1e-04
## # weights:  62
## initial  value 24035.453995
## iter  10 value 22264.598515
## iter  20 value 21910.136003
## iter  30 value 21812.474161
## iter  40 value 21775.338203
## iter  50 value 21706.814495
## iter  60 value 21660.910953
## iter  70 value 21639.209499
## iter  80 value 21635.866362
## iter  90 value 21631.235463
## iter 100 value 21592.606352
## final  value 21592.606352
## stopped after 100 iterations
## - Fold06: size=1, decay=1e-04
```

```
## + Fold06: size=3, decay=1e-04
## # weights:  176
## initial  value 24099.669014
## iter  10 value 21788.036024
## iter  20 value 20996.641534
## iter  30 value 20420.810204
## iter  40 value 20330.084047
## iter  50 value 20076.654806
## iter  60 value 19964.206905
## iter  70 value 19950.245605
## iter  80 value 19930.565598
## iter  90 value 19898.056754
## iter 100 value 19888.368223
## final  value 19888.368223
## stopped after 100 iterations
## - Fold06: size=3, decay=1e-04
## + Fold06: size=5, decay=1e-04
## # weights:  290
## initial  value 25251.273074
## iter  10 value 21808.196366
## iter  20 value 20808.626724
## iter  30 value 20485.432577
## iter  40 value 20235.861285
## iter  50 value 20030.142318
## iter  60 value 19877.292785
## iter  70 value 19696.368128
## iter  80 value 19419.983652
## iter  90 value 19318.540010
## iter 100 value 19095.666435
## final  value 19095.666435
## stopped after 100 iterations
## - Fold06: size=5, decay=1e-04
## + Fold07: size=1, decay=0e+00
## # weights:  62
## initial  value 22911.780204
## iter  10 value 21672.412801
## iter  20 value 21315.446966
## iter  30 value 21171.645524
## iter  40 value 21050.651405
## iter  50 value 21014.958867
## iter  60 value 20986.712425
## iter  70 value 20956.308364
## iter  80 value 20873.045215
## iter  90 value 20833.470774
## iter 100 value 20816.426195
## final  value 20816.426195
## stopped after 100 iterations
## - Fold07: size=1, decay=0e+00
## + Fold07: size=3, decay=0e+00
```

```
## # weights:  176
## initial  value 25471.133119
## iter  10 value 21961.408323
## iter  20 value 21757.216112
## iter  30 value 21595.059195
## iter  40 value 21456.372773
## iter  50 value 21380.549240
## iter  60 value 21165.639304
## iter  70 value 21140.956170
## iter  80 value 21136.920228
## iter  90 value 21133.544369
## iter 100 value 21103.566753
## final  value 21103.566753
## stopped after 100 iterations
## - Fold07: size=3, decay=0e+00
## + Fold07: size=5, decay=0e+00
## # weights:  290
## initial  value 27037.660877
## iter  10 value 21493.305241
## iter  20 value 20895.548837
## iter  30 value 20500.222675
## iter  40 value 20220.323383
## iter  50 value 20151.680811
## iter  60 value 20017.904197
## iter  70 value 19505.607127
## iter  80 value 19368.489542
## iter  90 value 19294.809179
## iter 100 value 19191.877877
## final  value 19191.877877
## stopped after 100 iterations
## - Fold07: size=5, decay=0e+00
## + Fold07: size=1, decay=1e-01
## # weights:  62
## initial  value 26553.745731
## iter  10 value 22479.693167
## iter  20 value 22330.111537
## iter  30 value 22162.439507
## iter  40 value 22037.454990
## iter  50 value 21926.692802
## iter  60 value 21146.328448
## iter  70 value 20847.764643
## iter  80 value 20754.773574
## iter  90 value 20741.929212
## iter 100 value 20536.883444
## final  value 20536.883444
## stopped after 100 iterations
## - Fold07: size=1, decay=1e-01
## + Fold07: size=3, decay=1e-01
## # weights:  176
```

```
## initial  value 23936.493619
## iter  10 value 21735.489446
## iter  20 value 20848.429514
## iter  30 value 20418.139566
## iter  40 value 20137.952514
## iter  50 value 20047.972915
## iter  60 value 19952.694336
## iter  70 value 19883.159657
## iter  80 value 19777.988867
## iter  90 value 19609.944891
## iter 100 value 19550.073586
## final  value 19550.073586
## stopped after 100 iterations
## - Fold07: size=3, decay=1e-01
## + Fold07: size=5, decay=1e-01
## # weights:  290
## initial  value 30508.124155
## iter  10 value 21868.965238
## iter  20 value 20989.529502
## iter  30 value 20704.357563
## iter  40 value 20336.667663
## iter  50 value 20126.459966
## iter  60 value 19689.082170
## iter  70 value 19546.992914
## iter  80 value 19394.229614
## iter  90 value 19322.430492
## iter 100 value 19185.363340
## final  value 19185.363340
## stopped after 100 iterations
## - Fold07: size=5, decay=1e-01
## + Fold07: size=1, decay=1e-04
## # weights:  62
## initial  value 24554.785238
## iter  10 value 22224.847213
## iter  20 value 21801.087892
## iter  30 value 21434.636554
## iter  40 value 21364.527395
## iter  50 value 21274.305715
## iter  60 value 21253.537955
## iter  70 value 21240.657749
## iter  80 value 21171.514043
## iter  90 value 21169.973694
## iter 100 value 21158.562075
## final  value 21158.562075
## stopped after 100 iterations
## - Fold07: size=1, decay=1e-04
## + Fold07: size=3, decay=1e-04
## # weights:  176
## initial  value 23343.637038
```

```
## iter  10 value 21764.042235
## iter  20 value 21506.260198
## iter  30 value 21255.378033
## iter  40 value 20979.632161
## iter  50 value 20738.786451
## iter  60 value 20636.901718
## iter  70 value 20560.822385
## iter  80 value 20528.580723
## iter  90 value 20451.114796
## iter 100 value 20407.244059
## final  value 20407.244059
## stopped after 100 iterations
## - Fold07: size=3, decay=1e-04
## + Fold07: size=5, decay=1e-04
## # weights:  290
## initial  value 23497.594242
## iter  10 value 20517.014164
## iter  20 value 20210.615033
## iter  30 value 19959.688470
## iter  40 value 19751.871340
## iter  50 value 19574.708122
## iter  60 value 19295.293893
## iter  70 value 19188.793785
## iter  80 value 19130.664252
## iter  90 value 19004.795943
## iter 100 value 18905.614574
## final  value 18905.614574
## stopped after 100 iterations
## - Fold07: size=5, decay=1e-04
## + Fold08: size=1, decay=0e+00
## # weights:  62
## initial  value 25374.854523
## iter  10 value 22057.024104
## iter  20 value 21623.831355
## iter  30 value 21398.852687
## iter  40 value 21227.331835
## iter  50 value 21127.680311
## iter  60 value 21119.426347
## iter  70 value 21065.124975
## iter  80 value 21047.971352
## iter  90 value 21041.403457
## iter 100 value 20980.403050
## final  value 20980.403050
## stopped after 100 iterations
## - Fold08: size=1, decay=0e+00
## + Fold08: size=3, decay=0e+00
## # weights:  176
## initial  value 22870.548899
## iter  10 value 20767.522448
```

```
## iter  20 value 20245.866188
## iter  30 value 20038.674171
## iter  40 value 19825.277169
## iter  50 value 19672.712277
## iter  60 value 19643.306591
## iter  70 value 19611.677737
## iter  80 value 19559.877200
## iter  90 value 19493.465895
## iter 100 value 19185.791840
## final  value 19185.791840
## stopped after 100 iterations
## - Fold08: size=3, decay=0e+00
## + Fold08: size=5, decay=0e+00
## # weights:  290
## initial  value 31624.436767
## iter  10 value 22146.243111
## iter  20 value 21921.879865
## iter  30 value 21205.788385
## iter  40 value 21163.489835
## iter  50 value 21111.648241
## iter  60 value 20694.357033
## iter  70 value 20526.245776
## iter  80 value 20433.604504
## iter  90 value 20290.461180
## iter 100 value 20179.518318
## final  value 20179.518318
## stopped after 100 iterations
## - Fold08: size=5, decay=0e+00
## + Fold08: size=1, decay=1e-01
## # weights:  62
## initial  value 22840.329883
## iter  10 value 22340.209948
## iter  20 value 22334.520585
## iter  30 value 22319.526062
## iter  40 value 22314.618969
## iter  50 value 22309.632658
## iter  60 value 22298.394887
## iter  70 value 22266.181725
## iter  80 value 22169.242565
## iter  90 value 21825.077913
## iter 100 value 21626.182191
## final  value 21626.182191
## stopped after 100 iterations
## - Fold08: size=1, decay=1e-01
## + Fold08: size=3, decay=1e-01
## # weights:  176
## initial  value 23107.950596
## iter  10 value 21068.457623
## iter  20 value 20906.938354
```

```
## iter  30 value 20820.317237
## iter  40 value 20591.394223
## iter  50 value 20298.122411
## iter  60 value 19972.847446
## iter  70 value 19847.943707
## iter  80 value 19819.730011
## iter  90 value 19729.776601
## iter 100 value 19510.623257
## final  value 19510.623257
## stopped after 100 iterations
## - Fold08: size=3, decay=1e-01
## + Fold08: size=5, decay=1e-01
## # weights:  290
## initial  value 23611.060687
## iter  10 value 21119.394160
## iter  20 value 20778.607017
## iter  30 value 20507.148591
## iter  40 value 20237.894564
## iter  50 value 20107.924500
## iter  60 value 20059.294031
## iter  70 value 20030.662354
## iter  80 value 19919.073709
## iter  90 value 19806.767246
## iter 100 value 19567.786968
## final  value 19567.786968
## stopped after 100 iterations
## - Fold08: size=5, decay=1e-01
## + Fold08: size=1, decay=1e-04
## # weights:  62
## initial  value 23588.399462
## iter  10 value 22367.592202
## iter  20 value 22317.663191
## iter  30 value 22184.684834
## iter  40 value 21955.676937
## iter  50 value 21925.686631
## iter  60 value 21901.784839
## iter  70 value 21880.300555
## iter  80 value 21845.036254
## iter  90 value 21824.374118
## iter 100 value 21804.869228
## final  value 21804.869228
## stopped after 100 iterations
## - Fold08: size=1, decay=1e-04
## + Fold08: size=3, decay=1e-04
## # weights:  176
## initial  value 24855.318810
## iter  10 value 21944.458908
## iter  20 value 21218.158120
## iter  30 value 21126.639061
```

```
## iter  40 value 21020.895910
## iter  50 value 20893.110206
## iter  60 value 20829.071367
## iter  70 value 20765.725859
## iter  80 value 20710.900951
## iter  90 value 20687.130838
## iter 100 value 20670.238904
## final  value 20670.238904
## stopped after 100 iterations
## - Fold08: size=3, decay=1e-04
## + Fold08: size=5, decay=1e-04
## # weights:  290
## initial  value 29009.707427
## iter  10 value 21509.925090
## iter  20 value 21214.866158
## iter  30 value 21021.029870
## iter  40 value 20640.038612
## iter  50 value 20514.841397
## iter  60 value 20471.156457
## iter  70 value 20119.426790
## iter  80 value 19726.768837
## iter  90 value 19482.678626
## iter 100 value 19267.746472
## final  value 19267.746472
## stopped after 100 iterations
## - Fold08: size=5, decay=1e-04
## + Fold09: size=1, decay=0e+00
## # weights:  62
## initial  value 23359.000085
## iter  10 value 22160.875587
## iter  20 value 22044.193360
## iter  30 value 21958.195485
## iter  40 value 21943.240335
## iter  50 value 21918.276434
## iter  60 value 21902.135509
## iter  70 value 21895.479541
## iter  80 value 21894.380682
## iter  90 value 21887.288341
## iter 100 value 21886.623355
## final  value 21886.623355
## stopped after 100 iterations
## - Fold09: size=1, decay=0e+00
## + Fold09: size=3, decay=0e+00
## # weights:  176
## initial  value 28166.623842
## iter  10 value 22297.504980
## iter  20 value 22151.952972
## iter  30 value 21908.118690
## iter  40 value 21424.436079
```

```
## iter  50 value 21196.751986
## iter  60 value 20889.744280
## iter  70 value 20755.659454
## iter  80 value 20666.791327
## iter  90 value 20496.091846
## iter 100 value 20385.346680
## final  value 20385.346680
## stopped after 100 iterations
## - Fold09: size=3, decay=0e+00
## + Fold09: size=5, decay=0e+00
## # weights:  290
## initial  value 26274.828273
## iter  10 value 21792.518845
## iter  20 value 21495.066198
## iter  30 value 21380.237357
## iter  40 value 21123.377769
## iter  50 value 20040.665104
## iter  60 value 19713.300776
## iter  70 value 19551.120068
## iter  80 value 19426.697997
## iter  90 value 19252.632678
## iter 100 value 19166.451338
## final  value 19166.451338
## stopped after 100 iterations
## - Fold09: size=5, decay=0e+00
## + Fold09: size=1, decay=1e-01
## # weights:  62
## initial  value 23232.097189
## iter  10 value 21642.484954
## iter  20 value 21564.558971
## iter  30 value 21552.264647
## iter  40 value 21487.750400
## iter  50 value 21455.255403
## iter  60 value 21402.192276
## iter  70 value 21260.535228
## iter  80 value 21243.245917
## iter  90 value 21140.750904
## iter 100 value 21081.065657
## final  value 21081.065657
## stopped after 100 iterations
## - Fold09: size=1, decay=1e-01
## + Fold09: size=3, decay=1e-01
## # weights:  176
## initial  value 25610.209179
## iter  10 value 22062.074467
## iter  20 value 21494.443949
## iter  30 value 21003.737399
## iter  40 value 20893.763976
## iter  50 value 20756.899251
```

```
## iter  60 value 20643.506512
## iter  70 value 20601.856831
## iter  80 value 20582.291162
## iter  90 value 20559.514791
## iter 100 value 20533.960160
## final  value 20533.960160
## stopped after 100 iterations
## - Fold09: size=3, decay=1e-01
## + Fold09: size=5, decay=1e-01
## # weights:  290
## initial  value 26520.900370
## iter  10 value 22132.173851
## iter  20 value 22054.940102
## iter  30 value 21907.362705
## iter  40 value 21875.328133
## iter  50 value 21727.439744
## iter  60 value 21257.573180
## iter  70 value 21087.395154
## iter  80 value 21034.282635
## iter  90 value 20977.580489
## iter 100 value 20847.098951
## final  value 20847.098951
## stopped after 100 iterations
## - Fold09: size=5, decay=1e-01
## + Fold09: size=1, decay=1e-04
## # weights:  62
## initial  value 24652.987455
## iter  10 value 21439.777171
## iter  20 value 21209.009064
## iter  30 value 21116.557000
## iter  40 value 21075.085871
## iter  50 value 21026.575001
## iter  60 value 20965.441685
## iter  70 value 20465.206843
## iter  80 value 19898.993929
## iter  90 value 19665.298724
## iter 100 value 19573.371006
## final  value 19573.371006
## stopped after 100 iterations
## - Fold09: size=1, decay=1e-04
## + Fold09: size=3, decay=1e-04
## # weights:  176
## initial  value 23772.438268
## iter  10 value 21155.703977
## iter  20 value 20765.665477
## iter  30 value 20456.124049
## iter  40 value 20222.223694
## iter  50 value 20104.010397
## iter  60 value 19864.764054
```

```
## iter  70 value 19732.750202
## iter  80 value 19589.164633
## iter  90 value 19526.530600
## iter 100 value 19414.316612
## final  value 19414.316612
## stopped after 100 iterations
## - Fold09: size=3, decay=1e-04
## + Fold09: size=5, decay=1e-04
## # weights:  290
## initial  value 25991.626169
## iter  10 value 21334.923487
## iter  20 value 20977.405667
## iter  30 value 20679.206242
## iter  40 value 20299.033111
## iter  50 value 19804.819297
## iter  60 value 19468.307294
## iter  70 value 19171.446480
## iter  80 value 18772.099612
## iter  90 value 18373.808612
## iter 100 value 18146.114415
## final  value 18146.114415
## stopped after 100 iterations
## - Fold09: size=5, decay=1e-04
## + Fold10: size=1, decay=0e+00
## # weights:  62
## initial  value 23153.628556
## iter  10 value 22233.634860
## iter  20 value 21988.773065
## iter  30 value 21854.040742
## iter  40 value 21817.583894
## iter  50 value 21685.333384
## iter  60 value 21637.647633
## iter  70 value 21633.284307
## iter  80 value 21620.602774
## iter  90 value 21490.610532
## iter 100 value 21229.929618
## final  value 21229.929618
## stopped after 100 iterations
## - Fold10: size=1, decay=0e+00
## + Fold10: size=3, decay=0e+00
## # weights:  176
## initial  value 25389.257219
## iter  10 value 20978.499362
## iter  20 value 20521.471518
## iter  30 value 20352.673173
## iter  40 value 20321.568146
## iter  50 value 20223.062138
## iter  60 value 20075.139374
## iter  70 value 20036.714889
```

```
## iter  80 value 19882.545927
## iter  90 value 19829.057816
## iter 100 value 19784.705939
## final  value 19784.705939
## stopped after 100 iterations
## - Fold10: size=3, decay=0e+00
## + Fold10: size=5, decay=0e+00
## # weights:  290
## initial  value 29437.217506
## iter  10 value 22730.901003
## iter  20 value 21223.352813
## iter  30 value 21035.749117
## iter  40 value 20971.374186
## iter  50 value 20758.518445
## iter  60 value 20585.661490
## iter  70 value 20493.101360
## iter  80 value 20469.570650
## iter  90 value 20433.956971
## iter 100 value 20418.806744
## final  value 20418.806744
## stopped after 100 iterations
## - Fold10: size=5, decay=0e+00
## + Fold10: size=1, decay=1e-01
## # weights:  62
## initial  value 24122.268355
## iter  10 value 22263.225129
## iter  20 value 22152.235165
## iter  30 value 22052.238736
## iter  40 value 21953.559908
## iter  50 value 21882.982668
## iter  60 value 21760.199013
## iter  70 value 21711.215730
## iter  80 value 21633.904436
## iter  90 value 21610.246725
## iter 100 value 21322.824002
## final  value 21322.824002
## stopped after 100 iterations
## - Fold10: size=1, decay=1e-01
## + Fold10: size=3, decay=1e-01
## # weights:  176
## initial  value 23263.522468
## iter  10 value 21333.478314
## iter  20 value 20904.305060
## iter  30 value 20833.595773
## iter  40 value 20728.954677
## iter  50 value 20631.877288
## iter  60 value 20335.880191
## iter  70 value 20150.051718
## iter  80 value 19986.348678
```

```
## iter  90 value 19885.494874
## iter 100 value 19824.608998
## final  value 19824.608998
## stopped after 100 iterations
## - Fold10: size=3, decay=1e-01
## + Fold10: size=5, decay=1e-01
## # weights:  290
## initial  value 24341.760525
## iter  10 value 20942.466705
## iter  20 value 20427.091239
## iter  30 value 19948.082807
## iter  40 value 19575.017942
## iter  50 value 19419.731633
## iter  60 value 19263.659560
## iter  70 value 18757.228842
## iter  80 value 18700.665774
## iter  90 value 18653.456523
## iter 100 value 18516.518304
## final  value 18516.518304
## stopped after 100 iterations
## - Fold10: size=5, decay=1e-01
## + Fold10: size=1, decay=1e-04
## # weights:  62
## initial  value 26995.013770
## iter  10 value 22811.554308
## iter  20 value 22344.612083
## iter  30 value 21897.459454
## iter  40 value 21762.075533
## iter  50 value 21358.293419
## iter  60 value 21343.609206
## iter  70 value 21235.738841
## iter  80 value 21100.288253
## iter  90 value 20929.474697
## iter 100 value 20848.675855
## final  value 20848.675855
## stopped after 100 iterations
## - Fold10: size=1, decay=1e-04
## + Fold10: size=3, decay=1e-04
## # weights:  176
## initial  value 25122.628797
## iter  10 value 22114.112831
## iter  20 value 22027.049369
## iter  30 value 21987.026560
## iter  40 value 21774.867044
## iter  50 value 21599.318106
## iter  60 value 21308.833211
## iter  70 value 21066.112418
## iter  80 value 20787.810477
## iter  90 value 20637.797960
```

```
## iter 100 value 20589.404379
## final  value 20589.404379
## stopped after 100 iterations
## - Fold10: size=3, decay=1e-04
## + Fold10: size=5, decay=1e-04
## # weights:  290
## initial  value 27058.983699
## iter  10 value 21886.548735
## iter  20 value 21364.009855
## iter  30 value 21008.943677
## iter  40 value 20729.397874
## iter  50 value 20259.538771
## iter  60 value 20065.522506
## iter  70 value 19519.556146
## iter  80 value 19010.357955
## iter  90 value 18723.335482
## iter 100 value 18401.267909
## final  value 18401.267909
## stopped after 100 iterations
## - Fold10: size=5, decay=1e-04
## Aggregating results
## Selecting tuning parameters
## Fitting size = 5, decay = 1e-04 on full training set
## # weights:  290
## initial  value 27394.303208
## iter  10 value 23761.933034
## iter  20 value 23214.625692
## iter  30 value 22848.154355
## iter  40 value 22264.676518
## iter  50 value 21650.373318
## iter  60 value 21499.051652
## iter  70 value 21360.811941
## iter  80 value 21313.584713
## iter  90 value 21258.941434
## iter 100 value 21156.104328
## final  value 21156.104328
## stopped after 100 iterations
```

```
#Bayes Generalized Linear model
#bayesglm <- train(classe ~ ., data = TrainSet, method = "bayesglm", trControl
= trainC)
#Logit Boosted model
#logitboost <- train(classe ~ ., data = TrainSet, method = "LogitBoost", trCont
rol= trainC)
```

Accuracy Results

```
allModels <- c("Random Forest", "SVM","Neural Net")
Accuracy <- c(max(rf$results$Accuracy),
        max(svm$results$Accuracy),
        max(NN$results$Accuracy)
        )

Kappa <- c(max(rf$results$Kappa),
        max(svm$results$Kappa),
        max(NN$results$Kappa)
        )

results <- cbind(allModels,Accuracy,Kappa)

knitr::kable(results)
```

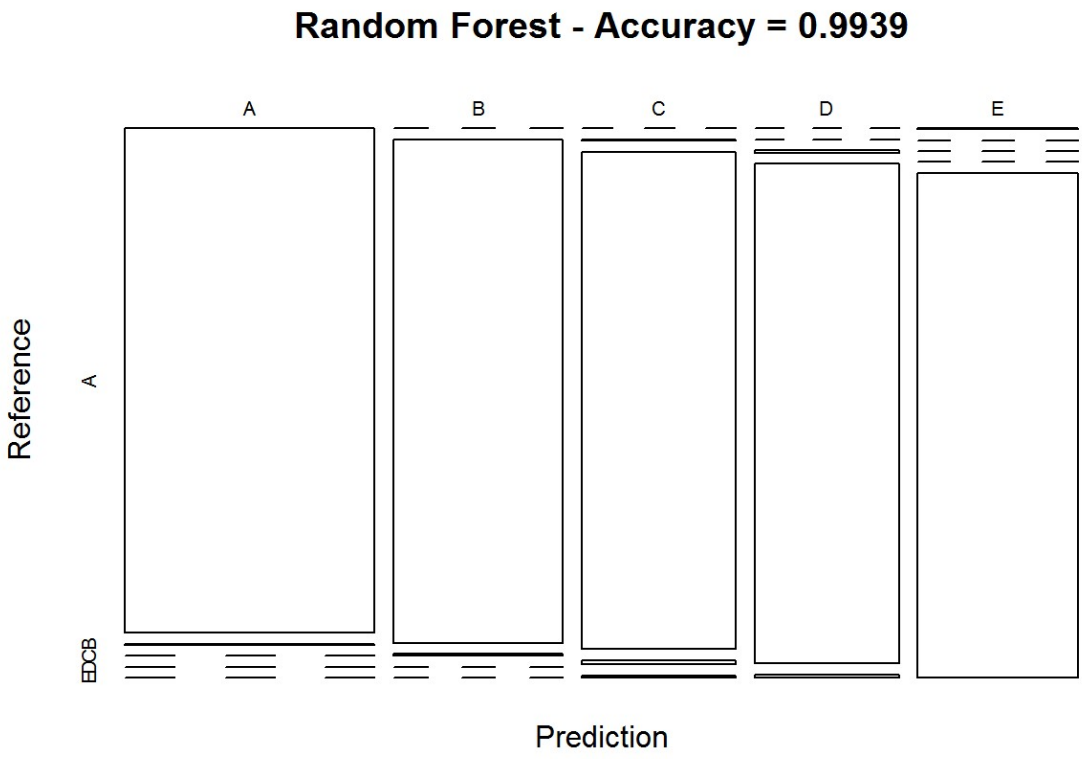
allModels	Accuracy	Kappa
Random Forest	0.992802140575815	0.99089440296581
SVM	0.931590916691407	0.913311437190184
Neural Net	0.42466519384376	0.270821941935932
Random forest pr	ovides the best resu	lt. That is the model to predict for the test Set

Prediction for the Test Set

```
#Before using the actual Test we will predict with the test portion of the trai
ning SeT
rfPrediction <- predict(rf, TestSet)
confMatRandForest <- confusionMatrix(rfPrediction, TestSet$classe)
confMatRandForest
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    A    B    C    D    E
##          A 1115    2    0    0    0
##          B    0  755    3    0    0
##          C    0    2  678    6    3
##          D    0    0    3  637    4
##          E    1    0    0    0  714
##
## Overall Statistics
##
##                Accuracy : 0.9939
##                  95% CI : (0.9909, 0.9961)
##     No Information Rate : 0.2845
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.9923
##  Mcnemar's Test P-Value : NA
##
## Statistics by Class:
##
##                      Class: A Class: B Class: C Class: D Class: E
## Sensitivity            0.9991   0.9947   0.9912   0.9907   0.9903
## Specificity            0.9993   0.9991   0.9966   0.9979   0.9997
## Pos Pred Value         0.9982   0.9960   0.9840   0.9891   0.9986
## Neg Pred Value         0.9996   0.9987   0.9981   0.9982   0.9978
## Prevalence             0.2845   0.1935   0.1744   0.1639   0.1838
## Detection Rate         0.2842   0.1925   0.1728   0.1624   0.1820
## Detection Prevalence   0.2847   0.1932   0.1756   0.1642   0.1823
## Balanced Accuracy      0.9992   0.9969   0.9939   0.9943   0.9950
```

```
# plot Results
plot(confMatRandForest$table, col = confMatRandForest$byClass,
     main = paste("Random Forest - Accuracy =",
                  round(confMatRandForest$overall['Accuracy'], 4)))
```



Now that we see that accuracy is very good lets predict for the real TEST

Conclusions

The random forest model provides an outstanding accuracy in this case.