How Well Exercises Are Done

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The main goal for this report is to export how well exercises are being done. Model performance will be based on the accuracy statistics.

Initial Data Exploration

```
library(caret)
set.seed(1234)
#download.file("https://d396qusza40orc.cloudfront.net/predmachlearn/pml-training.csv"
,
#              destfile = "pml-training.csv")
#download.file("https://d396qusza40orc.cloudfront.net/predmachlearn/pml-testing.csv",
#              destfile = "pml-testing.csv")
pml_train_full <- read.csv("pml-training.csv")
#pml_test <- read.csv("pml-testing.csv")
dim(pml_train_full)
```

```
## [1] 19622   160
```

Because the number of columns and rows of the data, only half of the rows are used for the analysis to improve run time.

```
train_ind <- sample(1:dim(pml_train_full)[1], dim(pml_train_full)[1]/2, replace=F)
pml_train <- pml_train_full[train_ind, ]
pml_test <- pml_train_full[-train_ind, ]
dim(pml_train)
```

```
## [1] 9811  160
```

```
table(pml_train$classe)
```

```
##
##    A    B    C    D    E
## 2772 1951 1697 1596 1795
```

```
#str(pml_train)
```

Upon first inspection, many variables can be converted from string to numbers. However, given the amount of time available to do this analysis, all the non-numeric variables are simply removed. Furthermore, missing values are replaced with the median values.

```
numeric_var <- sapply(pml_train[, 1:160],is.numeric)
#sum(numeric_var)
numeric_var[1:7] <- FALSE
numeric_var[160] <- TRUE
pml_train <- pml_train[, numeric_var]
pml_test <- pml_test[, numeric_var]

mi <- preProcess(pml_train[, -120], method="medianImpute")
pml_train <- predict(mi, newdata=pml_train)
pml_test <- predict(mi, newdata=pml_test)
```

Model Training Data

Tree, random forest, and GBM were be used to predict classe. Afterward, another tree is built with the outputs of the previous 3 methods as inputs. Except for random forest, all the models are run with default options. For random forest, to shorten run time, only 100 trees were built.

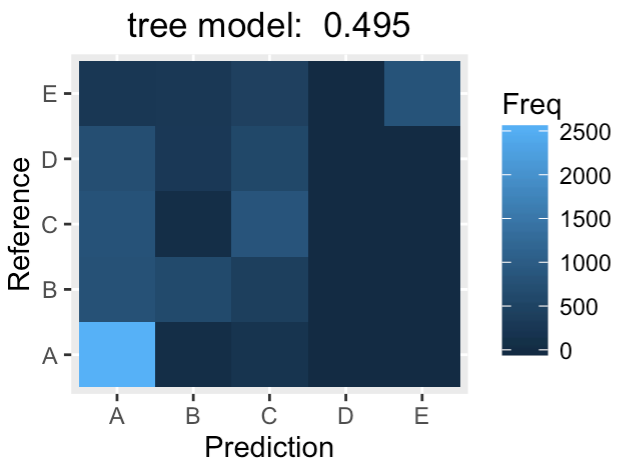
```
#gbm_fit <- train(classe ~ ., data=pml_train, method="gbm")
#rf_fit <- train(classe ~ ., data=pml_train, method="rf", ntree = 100)
#tree_fit <- train(classe ~ ., data=pml_train, method="rpart")
#save(gbm_fit, file="gbm_fit.RData")
#save(rf_fit, file="rf_fit.RData")
#save(tree_fit, file="tree_fit.RData")
load("gbm_fit.RData"); load("rf_fit.RData"); load("tree_fit.RData")
pml_train_comb <- data.frame(gbm_pred=gbm_fit$train$.outcome,
                             rf_pred=rf_fit$train$.outcome,
                             tree_pred=tree_fit$train$.outcome,
                             classe=pml_train$classe)
comb_tree_fit <- train(classe ~ ., data=pml_train_comb, method="rpart")

acc <-
rbind(confusionMatrix(pml_train_comb$gbm_pred, pml_train_comb$classe)$overall[1],
      confusionMatrix(pml_train_comb$rf_pred, pml_train_comb$classe)$overall[1],
      confusionMatrix(pml_train_comb$tree_pred, pml_train_comb$classe)$overall[1],
      confusionMatrix(comb_tree_fit$train$.outcome, pml_train_comb$classe)$overall[1]
)
acc
```

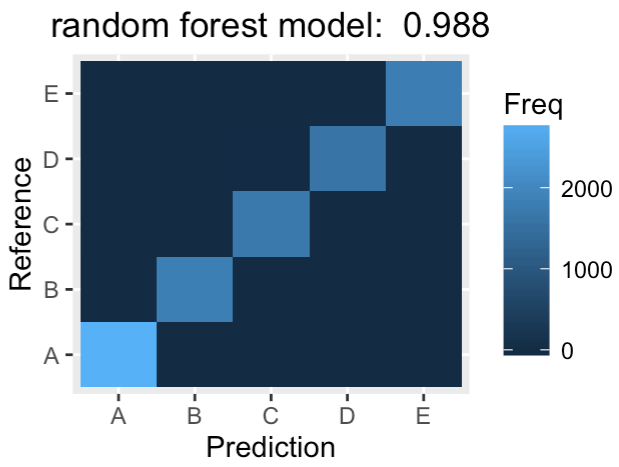
```
##      Accuracy
## [1,]        1
## [2,]        1
## [3,]        1
## [4,]        1
```

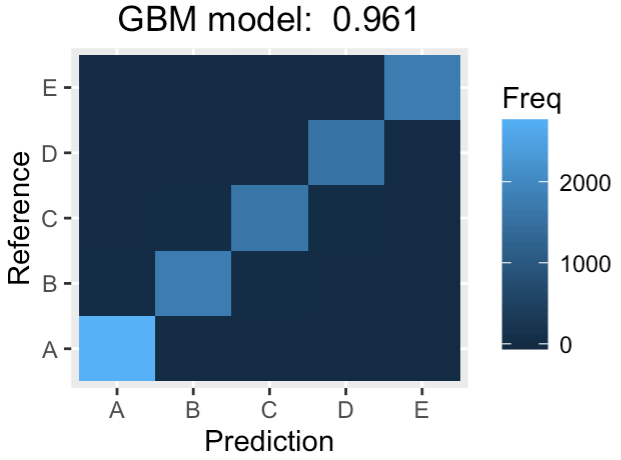
Examine Accuracy on Test Data

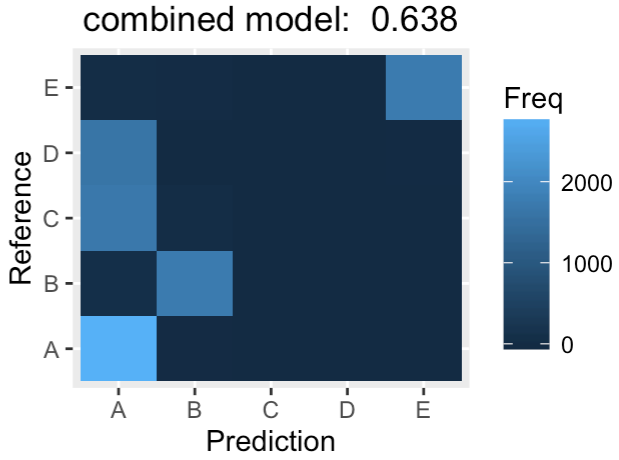
The test data were scored with the 4 models. Afterward, the heat maps and their accuracy statistics are plotted.

```
gbm_pred <- predict(gbm_fit, newdata=pml_test)
rf_pred <- predict(rf_fit, newdata=pml_test)
tree_pred <- predict(tree_fit, newdata=pml_test)
pml_test_comb <- data.frame(gbm_pred=gbm_pred,
                            rf_pred=rf_pred,
                            tree_pred=tree_pred,
                            classe=pml_test$classe)
comb_tree_pred <- predict(comb_tree_fit, newdata=pml_test_comb)

gbm_test_accuracy <- confusionMatrix(gbm_pred, pml_test$classe)$overall[1]
rf_test_accuracy <- confusionMatrix(rf_pred, pml_test$classe)$overall[1]
tree_test_accuracy <- confusionMatrix(tree_pred, pml_test$classe)$overall[1]
combine_test_accuracy <- confusionMatrix(comb_tree_pred, pml_test$classe)$overall[1]

tree_table <- confusionMatrix(tree_pred, pml_test$classe)$table
rf_table <- confusionMatrix(rf_pred, pml_test$classe)$table
gbm_table <- confusionMatrix(gbm_pred, pml_test$classe)$table
comb_table <- confusionMatrix(comb_tree_pred, pml_test$classe)$table

library(grid)
library(gridExtra)
g1 <- ggplot(data.frame(tree_table))
g1 <- g1 + geom_tile(aes(x=Prediction, y=Reference, fill=Freq))
g1 <- g1 + ggtitle(paste("tree model: ", round(tree_test_accuracy, 3)))

g2 <- ggplot(data.frame(rf_table))
g2 <- g2 + geom_tile(aes(x=Prediction, y=Reference, fill=Freq))
g2 <- g2 + ggtitle(paste("random forest model: ", round(rf_test_accuracy, 3)))

g3 <- ggplot(data.frame(gbm_table))
g3 <- g3 + geom_tile(aes(x=Prediction, y=Reference, fill=Freq))
g3 <- g3 + ggtitle(paste("GBM model: ", round(gbm_test_accuracy, 3)))

g4 <- ggplot(data.frame(comb_table))
g4 <- g4 + geom_tile(aes(x=Prediction, y=Reference, fill=Freq))
g4 <- g4 + ggtitle(paste("combined model: ", round(combine_test_accuracy, 3)))

grid.arrange(g1, g2, g3, g4, ncol = 2, nrow=2)
```









Conclusion

The random forest model happened to have the highest accuracy statistics in the test sample. Therefore, it will be selected as the final model.