Simulated VulfenSarah hits landed with first 50 Wolfey as a Testing Set

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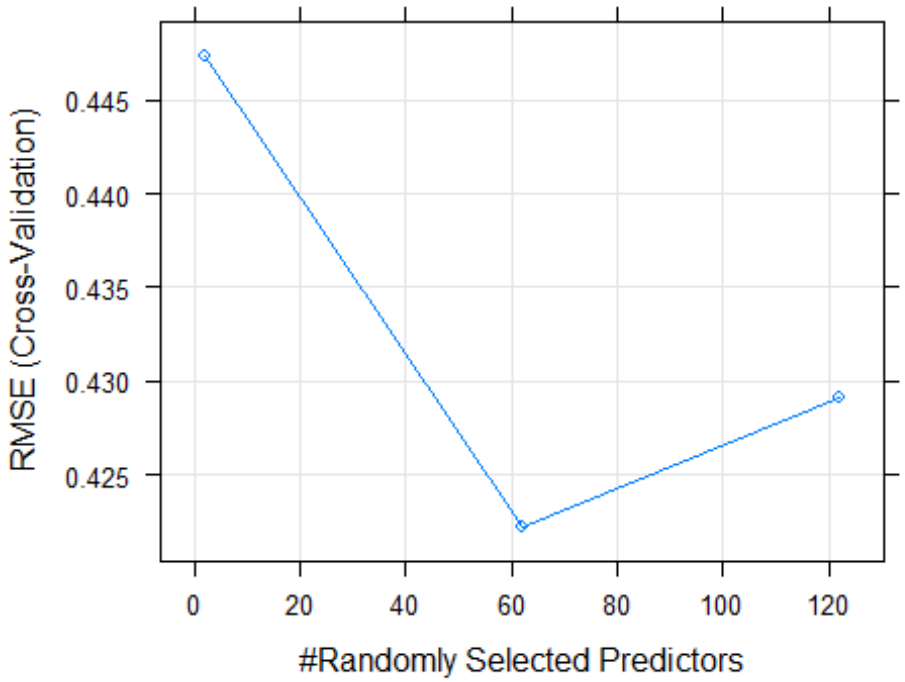
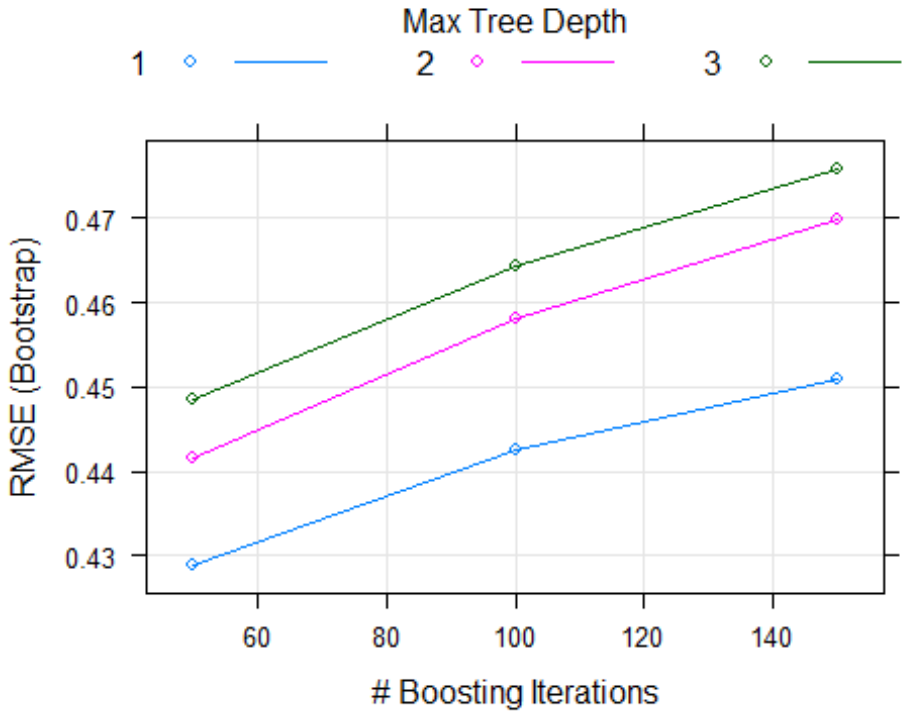
put in the first 50 samples of Wolfey as the testing set to see the

prediction accuracy of hits landed with VulfenSarah hits landed comparison

```
Vulfen1 <- read.csv('SarahWolfEaten_addedFeatures2.csv',
                        sep=',', header=TRUE,
                        na.strings=c('','NA'))

Wolfey <- read.csv('wolfey_addedFeatures.csv',
                        sep=',', header=TRUE, nrows=50,
                        na.strings=c('','NA'))

Wolfey <- Wolfey[,c(1:7,8:15,48:155)]#omit all X1 landed and x2 received
Vulfen <- Vulfen1[,c(1:7,8:15,48:155)]#omit all X1 landed and x2 received

library(caret)
library(randomForest)
library(MASS)
library(gbm)
library(dplyr)

set.seed(189678345)

trainingSet <- Vulfen
testingSet <- Wolfey

system.time(rfMod <- train(TotLandsX1~., method='rf', data=(trainingSet),
                           trControl=trainControl(method='cv'), number=5))

##    user  system elapsed
##   35.30    0.27   37.71

plot(rfMod)
```




```
system.time(gbmMod <- train(TotLandsX1~., method='gbm', data=trainingSet,
verbose=FALSE ))

##    user  system elapsed
##   17.60    0.13   18.79

plot(gbmMod)
```




```
predRF <- round(predict(rfMod, testingSet))
predGbm <- round(predict(gbmMod, testingSet))

predDF <- data.frame(predRF, predGbm, type=testingSet$TotLandsX1)
predDF
```

```
##    predRF predGbm type
## 1       0       0    0
## 2       0       0    1
## 3       0       0    0
## 4       0       0    0
## 5       0       0    0
## 6       0       0    0
## 7       0       0    0
## 8       0       0    0
## 9       0       0    0
## 10      0       0    0
## 11      0       0    0
## 12      0       0    2
## 13      0       0    0
## 14      0       0    0
## 15      0       0    0
## 16      0       0    0
## 17      0       0    1
## 18      0       0    0
## 19      0       0    0
## 20      0       0    0
```

```
## 21      0       0    0
## 22      1       0    0
## 23      0       0    0
## 24      1       0    1
## 25      0       0    0
## 26      1       0    0
## 27      0       0    0
## 28      1       0    0
## 29      0       0    0
## 30      1       0    0
## 31      1       0    0
## 32      0       0    1
## 33      0       0    0
## 34      0       0    0
## 35      0       0    0
## 36      1       0    0
## 37      0       0    0
## 38      0       0    0
## 39      1       0    0
## 40      1       0    0
## 41      0       0    0
## 42      0       0    0
## 43      0       0    0
## 44      0       0    0
## 45      0       0    0
## 46      0       0    0
## 47      0       0    1
## 48      0       0    0
## 49      0       0    1
## 50      0       0    0
```

Accuracy of the random forest algorithm:

```
sum <- sum(predRF==testingSet$TotLandsX1)
length <- length(testingSet$TotLandsX1)
accuracy_rfMod <- (sum/length)
accuracy_rfMod
```

```
## [1] 0.72
```

Accuracy of the Generalized Boosted Machines algorithm:

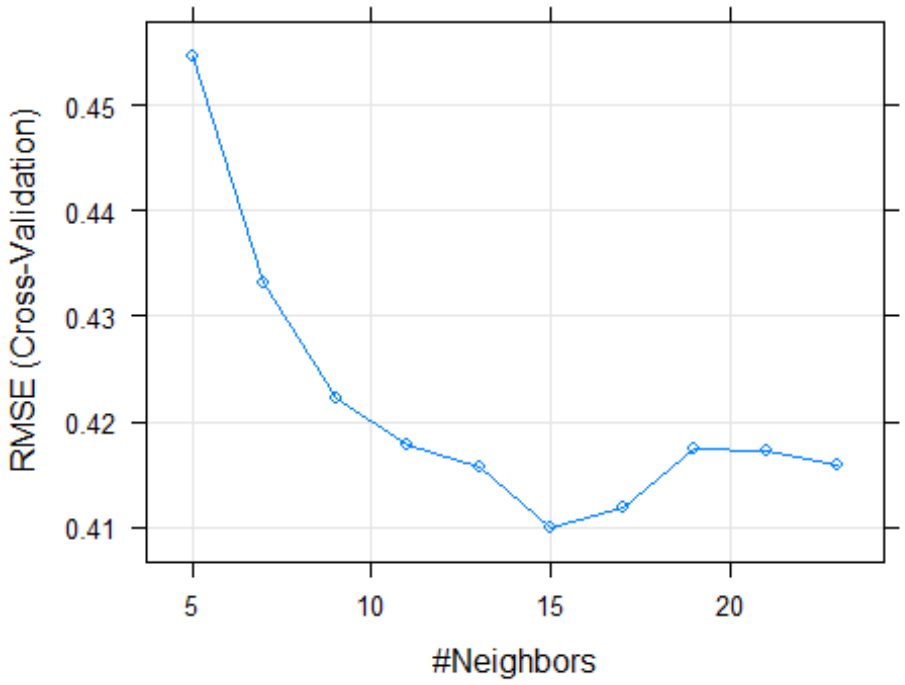
```
sum <- sum(predGbm==testingSet$TotLandsX1)
accuracy_Gbm <- (sum/length)
accuracy_Gbm
```

```
## [1] 0.86
```

Now, use the K-nearest neighbor or KNN algorithm.

```
system.time(knnMod <- train(TotLandsX1 ~ .,
                            method='knn', preProcess=c('center','scale'),
```

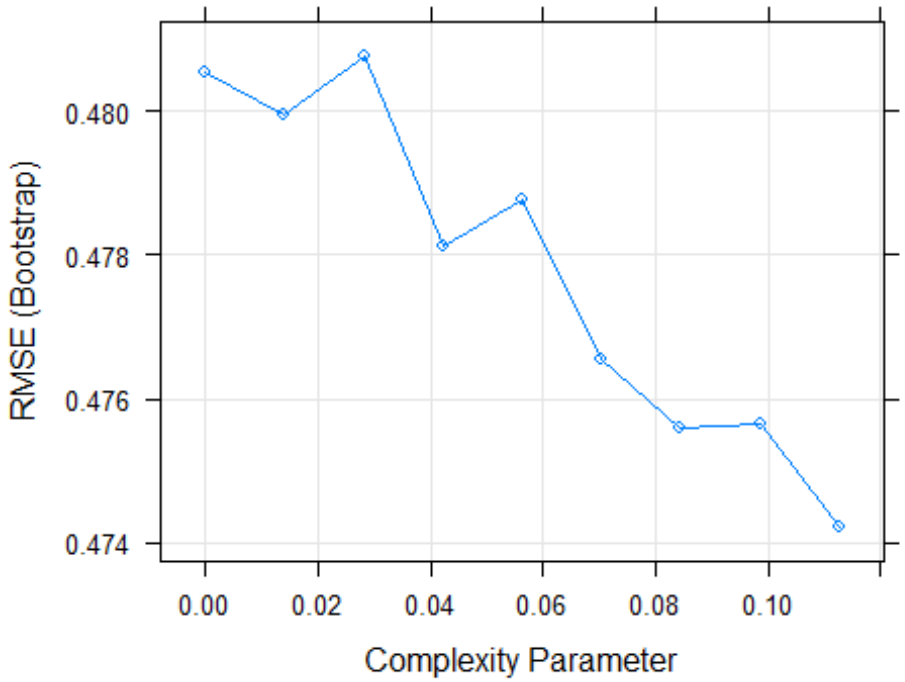
```
                                tuneLength=10,
trControl=trainControl(method='cv'), data=trainingSet))

##    user  system elapsed
##    3.11    0.01    4.31

plot(knnMod)
```



From the above plot n=15 seems to have the lowest Root mean Squared error.

Now, use the recursive partitioning Trees alogorithm, a type of decision trees methos.

```
system.time(rpartMod <- train(TotLandsX1~ ., method='rpart', tuneLength=9,
data=trainingSet))

##    user  system elapsed
##    5.99    0.04    6.62

plot(rpartMod)
```



Now, use the generalized linear machines algorithm that encompasses linear and logistic regression models.

```
system.time(glmMod <- train(TotLandsX1~ .,
                            method='glm', data=trainingSet))

##    user  system elapsed
##    2.16    0.03    2.29

predKNN <- round(predict(knnMod, testingSet))
predRPART <- round(predict(rpartMod, testingSet))
predGLM <- round(predict(glmMod, testingSet))

df3 <- cbind(predKNN, predRPART, predGLM,testingSet$TotLandsX1)
colnames(df3)[4] <- 'TrueValue'
head(df3);tail(df3)

##   predKNN predRPART predGLM TrueValue
## 1       0         0       0         0
## 2       0         0       0         1
## 3       0         0       0         0
## 4       0         0       0         0
## 5       0         0       0         0
## 6       0         0       0         0

##    predKNN predRPART predGLM TrueValue
## 45       0         0       0         0
```

```
## 46       0         0       0         0
## 47       1         0       1         1
## 48       0         0       0         0
## 49       1         0       1         1
## 50       1         0       1         0
```

The above output shows the predicted values for the KNN, Rpart, and GLM models as well as the actual or true value.

```
length=length(testingSet$TotLandsX1)

sumKNN <- sum(predKNN==testingSet$TotLandsX1)
sumRPart <- sum(predRPART==testingSet$TotLandsX1)
sumGLM <- sum(predGLM==testingSet$TotLandsX1)
```

The accuracy in prediction for Random Forest, GBM, KNN, Rpart, and GLM are (respectively):

```
accuracy_KNN <- sumKNN/length
accuracy_RPART <- sumRPart/length
accuracy_GLM <- sumGLM/length

accuracy_rfMod; accuracy_Gbm; accuracy_KNN; accuracy_RPART; accuracy_GLM

## [1] 0.72

## [1] 0.86

## [1] 0.68

## [1] 0.86

## [1] 0.66
```

From the above algorithm accuracies, GBM and Rpart scored the best with 86%, then random forest with 72%.

```
predDF3 <- data.frame(predRF,predGbm,df3)
head(predDF3);tail(predDF3)

##   predRF predGbm predKNN predRPART predGLM TrueValue
## 1      0       0       0         0       0         0
## 2      0       0       0         0       0         1
## 3      0       0       0         0       0         0
## 4      0       0       0         0       0         0
## 5      0       0       0         0       0         0
## 6      0       0       0         0       0         0

##    predRF predGbm predKNN predRPART predGLM TrueValue
## 45      0       0       0         0       0         0
## 46      0       0       0         0       0         0
## 47      0       0       1         0       1         1
```

```
## 48      0       0       0         0       0         0
## 49      0       0       1         0       1         1
## 50      0       0       1         0       1         0

colnames(predDF3)

## [1] "predRF"    "predGbm"   "predKNN"   "predRPART" "predGLM"
"TrueValue"

results <- c(round(accuracy_rfMod,2),
             round(accuracy_Gbm,2),
             round(accuracy_KNN,2), round(accuracy_RPART,2),
             round(accuracy_GLM,2),
             round(100,2))

results <- as.factor(results)
results <- t(data.frame(results))
colnames(results) <- colnames(predDF3)
Results <- rbind(predDF3, results)
head(Results);tail(Results)

##   predRF predGbm predKNN predRPART predGLM TrueValue
## 1      0       0       0         0       0         0
## 2      0       0       0         0       0         1
## 3      0       0       0         0       0         0
## 4      0       0       0         0       0         0
## 5      0       0       0         0       0         0
## 6      0       0       0         0       0         0

##         predRF predGbm predKNN predRPART predGLM TrueValue
## 46           0       0       0         0       0         0
## 47           0       0       1         0       1         1
## 48           0       0       0         0       0         0
## 49           0       0       1         0       1         1
## 50           0       0       1         0       1         0
## results   0.72    0.86    0.68      0.86    0.66       100

best <- order(results, decreasing=TRUE)
bestResults <- Results[,best[1:3]]
bestResults

##         TrueValue predGbm predRPART
## 1               0       0         0
## 2               1       0         0
## 3               0       0         0
## 4               0       0         0
## 5               0       0         0
## 6               0       0         0
## 7               0       0         0
## 8               0       0         0
## 9               0       0         0
```

```
## 10              0       0         0
## 11              0       0         0
## 12              2       0         0
## 13              0       0         0
## 14              0       0         0
## 15              0       0         0
## 16              0       0         0
## 17              1       0         0
## 18              0       0         0
## 19              0       0         0
## 20              0       0         0
## 21              0       0         0
## 22              0       0         0
## 23              0       0         0
## 24              1       0         0
## 25              0       0         0
## 26              0       0         0
## 27              0       0         0
## 28              0       0         0
## 29              0       0         0
## 30              0       0         0
## 31              0       0         0
## 32              1       0         0
## 33              0       0         0
## 34              0       0         0
## 35              0       0         0
## 36              0       0         0
## 37              0       0         0
## 38              0       0         0
## 39              0       0         0
## 40              0       0         0
## 41              0       0         0
## 42              0       0         0
## 43              0       0         0
## 44              0       0         0
## 45              0       0         0
## 46              0       0         0
## 47              1       0         0
## 48              0       0         0
## 49              1       0         0
## 50              0       0         0
## results       100    0.86      0.86
```

```
library(dplyr)
BestPredictedHit <- subset(Results, Results$TrueValue == 1 |
Results$TrueValue ==2)
length=length(BestPredictedHit$TrueValue)

sumRF <- sum(BestPredictedHit$predRF==BestPredictedHit$TrueValue)
sumGbm <- sum(BestPredictedHit$predGbm==BestPredictedHit$TrueValue)
```

```
sumKNN <- sum(BestPredictedHit$predKNN==BestPredictedHit$TrueValue)
sumRPart <- sum(BestPredictedHit$predRPART==BestPredictedHit$TrueValue)
sumGLM <- sum(BestPredictedHit$predGLM==BestPredictedHit$TrueValue)

accuracy_RF <- round(sumRF/length,2)
accuracy_Gbm <- round(sumGbm/length,2)
accuracy_KNN <- round(sumKNN/length,2)
accuracy_RPART <- round(sumRPart/length,2)
accuracy_GLM <- round(sumGLM/length,2)
Truth <-
round(sum(BestPredictedHit$TrueValue==BestPredictedHit$TrueValue)/length,2)

HitAccuracy <- c(accuracy_RF,accuracy_Gbm,accuracy_KNN,accuracy_RPART,
                 accuracy_GLM,Truth)
HitAccuracy <- t(data.frame(as.factor(HitAccuracy)))
colnames(HitAccuracy) <- colnames(BestPredictedHit)
BestPredictedHit1 <- rbind(BestPredictedHit,HitAccuracy)
row.names(BestPredictedHit1)[8] <- 'Accuracy'
BestPredictedHit1
```

```
##          predRF predGbm predKNN predRPART predGLM TrueValue
## 2             0       0       0         0       0         1
## 12            0       0       0         0       0         2
## 17            0       0       0         0       0         1
## 24            1       0       1         0       1         1
## 32            0       0       0         0       1         1
## 47            0       0       1         0       1         1
## 49            0       0       1         0       1         1
## Accuracy   0.14       0    0.43         0    0.57         1
```

KNN and GLM were more accurate in guessing which simulations would produce a hit landed by VulfenSarah.

```
testHits <- testingSet[row.names(BestPredictedHit1)[1:7],]
Hits <-cbind(BestPredictedHit1[1:7,],testHits)
Hits
```

```
##    predRF predGbm predKNN predRPART predGLM TrueValue Round
SecondsIntoRound
## 2       0       0       0         0       0         1     1
4
## 12      0       0       0         0       0         2     1
49
## 17      0       0       0         0       0         1     1
67
## 24      1       0       1         0       1         1     1
95
## 32      0       0       0         0       1         1     1
139
## 47      0       0       1         0       1         1     1
```

```
235
## 49      0       0       1         0       1         1     1
245
##    lastAction SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
cmTotHitsM.X1
## 2           1                     3             0             1
0
## 12         48                     1             2             3
1
## 17         66                     1             2             4
3
## 24         94                     1             2             5
3
## 32        138                     1             2             6
7
## 47        234                     1             2             7
16
## 49        238                     7             2             8
17
##    TotLandsX1 TotMissedX1 TotReceivedX1 cmTotHitsR.X2 cmTotHitsL.X2
## 2           1           0             0             1             0
## 12          2           0             0             3             2
## 17          1           0             0             4             2
## 24          1           0             0             6             2
## 32          1           1             0             7             2
## 47          1           0             0             9             2
## 49          1           0             0            10             2
##    cmTotHitsM.X2 TotLandsX2 TotMissedX2 Crossl.X2 Kneel.X2 Elbowl.X2
Hookl.X2
## 2              0          0           0         0        0         0
0
## 12             0          0           0         0        0         0
0
## 17             0          0           0         0        0         0
0
## 24             0          0           0         0        0         0
0
## 32             1          0           0         0        0         0
0
## 47             5          0           0         0        0         0
0
## 49             5          0           0         0        0         0
0
##    Jabl.X2 Kickl.X2 upperl.X2 takedownl.X2 hammerl.X2 Cross2l.X2 Knee2l.X2
## 2        0        0         0            0          0          0         0
## 12       0        0         0            0          0          0         0
## 17       0        0         0            0          0          0         0
## 24       0        0         0            0          0          0         0
## 32       0        0         0            0          0          0         0
## 47       0        0         0            0          0          0         0
```

```
## 49       0        0         0            0          0          0         0
##    Elbow2l.X2 Hook2l.X2 Jab2l.X2 Kick2l.X2 upper2l.X2 takedown2l.X2
hammer2l.X2
## 2           0         0        0         0          0             0
0
## 12          0         0        0         0          0             0
0
## 17          0         0        0         0          0             0
0
## 24          0         0        0         0          0             0
0
## 32          0         0        0         0          0             0
0
## 47          0         0        0         0          0             0
0
## 49          0         0        0         0          0             0
0
##    Cross3l.X2 Knee3l.X2 Elbow3l.X2 Hook3l.X2 Jab3l.X2 Kick3l.X2 upper3l.X2
## 2           0         0          0         0        0         0          0
## 12          0         0          0         0        0         0          0
## 17          0         0          0         0        0         0          0
## 24          0         0          0         0        0         0          0
## 32          0         0          0         0        0         0          0
## 47          0         0          0         0        0         0          0
## 49          0         0          0         0        0         0          0
##    takedown3l.X2 hammer3l.X2 Crossm.X1 Kneem.X1 Elbowm.X1 Hookm.X1 Jabm.X1
## 2              0           0         0        0         0        0       0
## 12             0           0         0        0         0        0       0
## 17             0           0         0        0         0        0       0
## 24             0           0         0        0         0        0       0
## 32             0           0         0        0         0        0       0
## 47             0           0         0        0         0        0       0
## 49             0           0         0        0         0        0       0
##    Kickm.X1 upperm.X1 takedownm.X1 hammerm.X1 Cross2m.X1 Knee2m.X1
Elbow2m.X1
## 2         0         0            0          0          0         0
0
## 12        0         0            0          0          0         0
0
## 17        0         0            0          0          0         0
0
## 24        0         0            0          0          0         0
0
## 32        0         0            0          0          0         0
0
## 47        0         0            0          0          0         0
0
## 49        0         0            0          0          0         0
0
##    Hook2m.X1 Jab2m.X1 Kick2m.X1 upper2m.X1 takedown2m.X1 hammer2m.X1
```

```
Cross3m.X1
## 2          0        0         0          0             0           0
0
## 12         0        0         0          0             0           0
0
## 17         0        0         0          0             0           0
0
## 24         0        0         0          0             0           0
0
## 32         0        1         0          0             0           0
0
## 47         0        0         0          0             0           0
0
## 49         0        0         0          0             0           0
0
##    Knee3m.X1 Elbow3m.X1 Hook3m.X1 Jab3m.X1 Kick3m.X1 upper3m.X1
takedown3m.X1
## 2          0          0         0        0         0          0
0
## 12         0          0         0        0         0          0
0
## 17         0          0         0        0         0          0
0
## 24         0          0         0        0         0          0
0
## 32         0          0         0        0         0          0
0
## 47         0          0         0        0         0          0
0
## 49         0          0         0        0         0          0
0
##    hammer3m.X1 Crossm.X2 Kneem.X2 Elbowm.X2 Hookm.X2 Jabm.X2 Kickm.X2
upperm.X2
## 2            0         0        0         0        0       0        0
0
## 12           0         0        0         0        0       0        0
0
## 17           0         0        0         0        0       0        0
0
## 24           0         0        0         0        0       0        0
0
## 32           0         0        0         0        0       0        0
0
## 47           0         0        0         0        0       0        0
0
## 49           0         0        0         0        0       0        0
0
##    takedownm.X2 hammerm.X2 Cross2m.X2 Knee2m.X2 Elbow2m.X2 Hook2m.X2
Jab2m.X2
## 2             0          0          0         0          0         0
```

```
0
## 12            0          0          0         0          0         0
0
## 17            0          0          0         0          0         0
0
## 24            0          0          0         0          0         0
0
## 32            0          0          0         0          0         0
0
## 47            0          0          0         0          0         0
0
## 49            0          0          0         0          0         0
0
##    Kick2m.X2 upper2m.X2 takedown2m.X2 hammer2m.X2 Cross3m.X2 Knee3m.X2
## 2          0          0             0           0          0         0
## 12         0          0             0           0          0         0
## 17         0          0             0           0          0         0
## 24         0          0             0           0          0         0
## 32         0          0             0           0          0         0
## 47         0          0             0           0          0         0
## 49         0          0             0           0          0         0
##    Elbow3m.X2 Hook3m.X2 Jab3m.X2 Kick3m.X2 upper3m.X2 takedown3m.X2
hammer3m.X2
## 2           0         0        0         0          0             0
0
## 12          0         0        0         0          0             0
0
## 17          0         0        0         0          0             0
0
## 24          0         0        0         0          0             0
0
## 32          0         0        0         0          0             0
0
## 47          0         0        0         0          0             0
0
## 49          0         0        0         0          0             0
0
##    Crossr.X1 Kneer.X1 Elbowr.X1 Hookr.X1 Jabr.X1 Kickr.X1 upperr.X1
## 2          0        0         0        0       0        0         0
## 12         0        0         0        0       0        0         0
## 17         0        0         0        0       0        0         0
## 24         0        0         0        0       0        0         0
## 32         0        0         0        0       0        0         0
## 47         0        0         0        0       0        0         0
## 49         0        0         0        0       0        0         0
##    takedownr.X1 hammerr.X1 Cross2r.X1 Knee2r.X1 Elbow2r.X1 Hook2r.X1
Jab2r.X1
## 2             0          0          0         0          0         0
0
## 12            0          0          0         0          0         0
```

```
0
## 17            0          0          0         0          0         0
0
## 24            0          0          0         0          0         0
0
## 32            0          0          0         0          0         0
0
## 47            0          0          0         0          0         0
0
## 49            0          0          0         0          0         0
0
##    Kick2r.X1 upper2r.X1 takedown2r.X1 hammer2r.X1 Cross3r.X1 Knee3r.X1
## 2          0          0             0           0          0         0
## 12         0          0             0           0          0         0
## 17         0          0             0           0          0         0
## 24         0          0             0           0          0         0
## 32         0          0             0           0          0         0
## 47         0          0             0           0          0         0
## 49         0          0             0           0          0         0
##    Elbow3r.X1 Hook3r.X1 Jab3r.X1 Kick3r.X1 upper3r.X1 takedown3r.X1
hammer3r.X1
## 2           0         0        0         0          0             0
0
## 12          0         0        0         0          0             0
0
## 17          0         0        0         0          0             0
0
## 24          0         0        0         0          0             0
0
## 32          0         0        0         0          0             0
0
## 47          0         0        0         0          0             0
0
## 49          0         0        0         0          0             0
0
```

The above table shows the 7 simulations of another fighter in our trained model and the results of those hits that were landed in this testing set against the prediction of a hit landed with those algorithms for machine learning: random forest (rf), global boosted machines (gbm), k nearest neighbors (KNN), recursive partitioning and regression trees (rpart), generalized linear models (glm), and the true testing set value aiming to predict for hits landed.

Aside, put aside the above, some time later as in months. What about looking at those instances where Vulfen lands 2 hits in one second and plotting this against the number of hits and seconds that passed? Lets do that.

```
library(tidyr)
```

Aside: This is the un-altered table, everything works as it should, the code to grab and extract each action is good. I originally thought there was a calculation problem, but the fields for X1's landed,missed, received actions were omitted in the beginning of this script. Carry on.

```
X1_2plus <- subset(Vulfen1, Vulfen1$TotLandsX1 > 1)
X1_2plus_lands_X1 <- X1_2plus[,c(2,4:8,20:47)]
X1_2plus_lands_X1
```

```
##     SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 46               164                     1             2            10
## 77               107                     5             0             3
## 93               157                     3             0             6
## 160               44                     1             0            13
##     cmTotHitsM.X1 TotLandsX1      Notes Crossl.X1 Kneel.X1 Elbowl.X1
Hookl.X1
## 46             30          2       Tate         0        0         0
0
## 77             21          2 Pennington         0        1         0
0
## 93             31          2 Pennington         0        1         0
0
## 160            22          2     Rousey         0        0         0
0
##     Jabl.X1 Kickl.X1 upperl.X1 takedownl.X1 hammerl.X1 Cross2l.X1
Knee2l.X1
## 46        1        0         0            0          0          1
0
## 77        0        1         0            0          0          0
0
## 93        0        1         0            0          0          0
0
## 160       1        0         0            0          0          1
0
##     Elbow2l.X1 Hook2l.X1 Jab2l.X1 Kick2l.X1 upper2l.X1 takedown2l.X1
## 46           0         0        0         0          0             0
## 77           0         0        0         0          0             0
## 93           0         0        0         0          0             0
## 160          0         0        0         0          0             0
##     hammer2l.X1 Cross3l.X1 Knee3l.X1 Elbow3l.X1 Hook3l.X1 Jab3l.X1
Kick3l.X1
## 46            0          0         0          0         0        0
0
## 77            0          0         0          0         0        0
0
## 93            0          0         0          0         0        0
0
## 160           0          0         0          0         0        0
```

```
0
##     upper3l.X1 takedown3l.X1 hammer3l.X1
## 46           0             0           0
## 77           0             0           0
## 93           0             0           0
## 160          0             0           0

x1_2plus_lands_tidy <- gather(X1_2plus_lands_X1, 'actionReaction',
'actionCounts', 8:34)
x1_2plus_lands_tidy

##     SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 1                164                      1             2            10
## 2                107                      5             0             3
## 3                157                      3             0             6
## 4                 44                      1             0            13
## 5                164                      1             2            10
## 6                107                      5             0             3
## 7                157                      3             0             6
## 8                 44                      1             0            13
## 9                164                      1             2            10
## 10               107                      5             0             3
## 11               157                      3             0             6
## 12                44                      1             0            13
## 13               164                      1             2            10
## 14               107                      5             0             3
## 15               157                      3             0             6
## 16                44                      1             0            13
## 17               164                      1             2            10
## 18               107                      5             0             3
## 19               157                      3             0             6
## 20                44                      1             0            13
## 21               164                      1             2            10
## 22               107                      5             0             3
## 23               157                      3             0             6
## 24                44                      1             0            13
## 25               164                      1             2            10
## 26               107                      5             0             3
## 27               157                      3             0             6
## 28                44                      1             0            13
## 29               164                      1             2            10
## 30               107                      5             0             3
## 31               157                      3             0             6
## 32                44                      1             0            13
## 33               164                      1             2            10
## 34               107                      5             0             3
## 35               157                      3             0             6
## 36                44                      1             0            13
## 37               164                      1             2            10
## 38               107                      5             0             3
```

```
## 39              157                3              0               6
## 40               44                1              0              13
## 41              164                1              2              10
## 42              107                5              0               3
## 43              157                3              0               6
## 44               44                1              0              13
## 45              164                1              2              10
## 46              107                5              0               3
## 47              157                3              0               6
## 48               44                1              0              13
## 49              164                1              2              10
## 50              107                5              0               3
## 51              157                3              0               6
## 52               44                1              0              13
## 53              164                1              2              10
## 54              107                5              0               3
## 55              157                3              0               6
## 56               44                1              0              13
## 57              164                1              2              10
## 58              107                5              0               3
## 59              157                3              0               6
## 60               44                1              0              13
## 61              164                1              2              10
## 62              107                5              0               3
## 63              157                3              0               6
## 64               44                1              0              13
## 65              164                1              2              10
## 66              107                5              0               3
## 67              157                3              0               6
## 68               44                1              0              13
## 69              164                1              2              10
## 70              107                5              0               3
## 71              157                3              0               6
## 72               44                1              0              13
## 73              164                1              2              10
## 74              107                5              0               3
## 75              157                3              0               6
## 76               44                1              0              13
## 77              164                1              2              10
## 78              107                5              0               3
## 79              157                3              0               6
## 80               44                1              0              13
## 81              164                1              2              10
## 82              107                5              0               3
## 83              157                3              0               6
## 84               44                1              0              13
## 85              164                1              2              10
## 86              107                5              0               3
## 87              157                3              0               6
## 88               44                1              0              13
```

```
## 89                164                      1             2            10
## 90                107                      5             0             3
## 91                157                      3             0             6
## 92                 44                      1             0            13
## 93                164                      1             2            10
## 94                107                      5             0             3
## 95                157                      3             0             6
## 96                 44                      1             0            13
## 97                164                      1             2            10
## 98                107                      5             0             3
## 99                157                      3             0             6
## 100                44                      1             0            13
## 101               164                      1             2            10
## 102               107                      5             0             3
## 103               157                      3             0             6
## 104                44                      1             0            13
## 105               164                      1             2            10
## 106               107                      5             0             3
## 107               157                      3             0             6
## 108                44                      1             0            13
##     cmTotHitsM.X1 TotLandsX1      Notes actionReaction actionCounts
## 1              30          2       Tate      Crossl.X1            0
## 2              21          2 Pennington      Crossl.X1            0
## 3              31          2 Pennington      Crossl.X1            0
## 4              22          2     Rousey      Crossl.X1            0
## 5              30          2       Tate       Kneel.X1            0
## 6              21          2 Pennington       Kneel.X1            1
## 7              31          2 Pennington       Kneel.X1            1
## 8              22          2     Rousey       Kneel.X1            0
## 9              30          2       Tate      Elbowl.X1            0
## 10             21          2 Pennington      Elbowl.X1            0
## 11             31          2 Pennington      Elbowl.X1            0
## 12             22          2     Rousey      Elbowl.X1            0
## 13             30          2       Tate       Hookl.X1            0
## 14             21          2 Pennington       Hookl.X1            0
## 15             31          2 Pennington       Hookl.X1            0
## 16             22          2     Rousey       Hookl.X1            0
## 17             30          2       Tate        Jabl.X1            1
## 18             21          2 Pennington        Jabl.X1            0
## 19             31          2 Pennington        Jabl.X1            0
## 20             22          2     Rousey        Jabl.X1            1
## 21             30          2       Tate       Kickl.X1            0
## 22             21          2 Pennington       Kickl.X1            1
## 23             31          2 Pennington       Kickl.X1            1
## 24             22          2     Rousey       Kickl.X1            0
## 25             30          2       Tate      upperl.X1            0
## 26             21          2 Pennington      upperl.X1            0
## 27             31          2 Pennington      upperl.X1            0
## 28             22          2     Rousey      upperl.X1            0
## 29             30          2       Tate   takedownl.X1            0
```

```
## 30             21          2 Pennington   takedownl.X1            0
## 31             31          2 Pennington   takedownl.X1            0
## 32             22          2     Rousey   takedownl.X1            0
## 33             30          2       Tate     hammerl.X1            0
## 34             21          2 Pennington     hammerl.X1            0
## 35             31          2 Pennington     hammerl.X1            0
## 36             22          2     Rousey     hammerl.X1            0
## 37             30          2       Tate     Cross2l.X1            1
## 38             21          2 Pennington     Cross2l.X1            0
## 39             31          2 Pennington     Cross2l.X1            0
## 40             22          2     Rousey     Cross2l.X1            1
## 41             30          2       Tate      Knee2l.X1            0
## 42             21          2 Pennington      Knee2l.X1            0
## 43             31          2 Pennington      Knee2l.X1            0
## 44             22          2     Rousey      Knee2l.X1            0
## 45             30          2       Tate     Elbow2l.X1            0
## 46             21          2 Pennington     Elbow2l.X1            0
## 47             31          2 Pennington     Elbow2l.X1            0
## 48             22          2     Rousey     Elbow2l.X1            0
## 49             30          2       Tate      Hook2l.X1            0
## 50             21          2 Pennington      Hook2l.X1            0
## 51             31          2 Pennington      Hook2l.X1            0
## 52             22          2     Rousey      Hook2l.X1            0
## 53             30          2       Tate       Jab2l.X1            0
## 54             21          2 Pennington       Jab2l.X1            0
## 55             31          2 Pennington       Jab2l.X1            0
## 56             22          2     Rousey       Jab2l.X1            0
## 57             30          2       Tate      Kick2l.X1            0
## 58             21          2 Pennington      Kick2l.X1            0
## 59             31          2 Pennington      Kick2l.X1            0
## 60             22          2     Rousey      Kick2l.X1            0
## 61             30          2       Tate     upper2l.X1            0
## 62             21          2 Pennington     upper2l.X1            0
## 63             31          2 Pennington     upper2l.X1            0
## 64             22          2     Rousey     upper2l.X1            0
## 65             30          2       Tate  takedown2l.X1            0
## 66             21          2 Pennington  takedown2l.X1            0
## 67             31          2 Pennington  takedown2l.X1            0
## 68             22          2     Rousey  takedown2l.X1            0
## 69             30          2       Tate    hammer2l.X1            0
## 70             21          2 Pennington    hammer2l.X1            0
## 71             31          2 Pennington    hammer2l.X1            0
## 72             22          2     Rousey    hammer2l.X1            0
## 73             30          2       Tate     Cross3l.X1            0
## 74             21          2 Pennington     Cross3l.X1            0
## 75             31          2 Pennington     Cross3l.X1            0
## 76             22          2     Rousey     Cross3l.X1            0
## 77             30          2       Tate      Knee3l.X1            0
## 78             21          2 Pennington      Knee3l.X1            0
## 79             31          2 Pennington      Knee3l.X1            0
```

```
## 80              22           2     Rousey      Knee3l.X1             0
## 81              30           2       Tate     Elbow3l.X1             0
## 82              21           2 Pennington     Elbow3l.X1             0
## 83              31           2 Pennington     Elbow3l.X1             0
## 84              22           2     Rousey     Elbow3l.X1             0
## 85              30           2       Tate      Hook3l.X1             0
## 86              21           2 Pennington      Hook3l.X1             0
## 87              31           2 Pennington      Hook3l.X1             0
## 88              22           2     Rousey      Hook3l.X1             0
## 89              30           2       Tate       Jab3l.X1             0
## 90              21           2 Pennington       Jab3l.X1             0
## 91              31           2 Pennington       Jab3l.X1             0
## 92              22           2     Rousey       Jab3l.X1             0
## 93              30           2       Tate      Kick3l.X1             0
## 94              21           2 Pennington      Kick3l.X1             0
## 95              31           2 Pennington      Kick3l.X1             0
## 96              22           2     Rousey      Kick3l.X1             0
## 97              30           2       Tate     upper3l.X1             0
## 98              21           2 Pennington     upper3l.X1             0
## 99              31           2 Pennington     upper3l.X1             0
## 100             22           2     Rousey     upper3l.X1             0
## 101             30           2       Tate  takedown3l.X1             0
## 102             21           2 Pennington  takedown3l.X1             0
## 103             31           2 Pennington  takedown3l.X1             0
## 104             22           2     Rousey  takedown3l.X1             0
## 105             30           2       Tate    hammer3l.X1             0
## 106             21           2 Pennington    hammer3l.X1             0
## 107             31           2 Pennington    hammer3l.X1             0
## 108             22           2     Rousey    hammer3l.X1             0
```

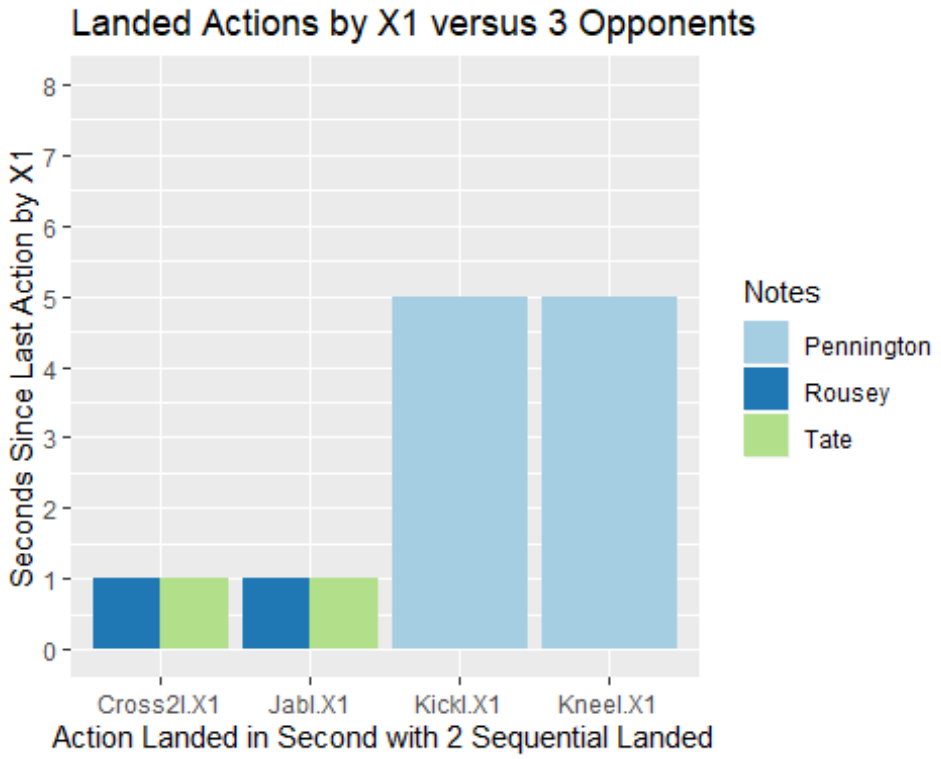
```
x1_2plus_lands_counts <- subset(x1_2plus_lands_tidy,
x1_2plus_lands_tidy$actionCounts > 0)
x1_2plus_lands_counts
```

```
##    SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 6               107                      5            0             3
## 7               157                      3            0             6
## 17              164                      1            2            10
## 20               44                      1            0            13
## 22              107                      5            0             3
## 23              157                      3            0             6
## 37              164                      1            2            10
## 40               44                      1            0            13
##    cmTotHitsM.X1 TotLandsX1      Notes actionReaction actionCounts
## 6             21          2 Pennington       Kneel.X1            1
## 7             31          2 Pennington       Kneel.X1            1
## 17            30          2       Tate        Jabl.X1            1
## 20            22          2     Rousey        Jabl.X1            1
## 22            21          2 Pennington       Kickl.X1            1
## 23            31          2 Pennington       Kickl.X1            1
```

```
## 37            30          2       Tate     Cross2l.X1            1
## 40            22          2     Rousey     Cross2l.X1            1
```

Now, for plotting the actions that were landed for those observations or seconds that had more than one sequence of actions land by X1.

```
library(ggplot2)

ggplot(data = x1_2plus_lands_counts, aes(x=actionReaction,
y=SecondsLastRoundAction, fill=Notes)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 8, by=1), limits=c(0,8))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Landed Actions by X1 versus 3 Opponents')+
  ylab('Seconds Since Last Action by X1')+
  xlab('Action Landed in Second with 2 Sequential Landed')
```



The above bar chart isn't really showing a lot that explains better than the table, X1_2plus_lands_X1.

```
X1_2plus_lands_X1[,c(2,6,7:34)]

##     SecondsLastRoundAction TotLandsX1      Notes Crossl.X1 Kneel.X1
Elbowl.X1
## 46                       1          2       Tate         0        0
```

```
0
## 77                      5          2 Pennington         0        1
0
## 93                      3          2 Pennington         0        1
0
## 160                     1          2     Rousey         0        0
0
##     Hookl.X1 Jabl.X1 Kickl.X1 upperl.X1 takedownl.X1 hammerl.X1 Cross2l.X1
## 46         0       1        0         0            0          0          1
## 77         0       0        1         0            0          0          0
## 93         0       0        1         0            0          0          0
## 160        0       1        0         0            0          0          1
##     Knee2l.X1 Elbow2l.X1 Hook2l.X1 Jab2l.X1 Kick2l.X1 upper2l.X1
takedown2l.X1
## 46          0          0         0        0         0          0
0
## 77          0          0         0        0         0          0
0
## 93          0          0         0        0         0          0
0
## 160         0          0         0        0         0          0
0
##     hammer2l.X1 Cross3l.X1 Knee3l.X1 Elbow3l.X1 Hook3l.X1 Jab3l.X1
Kick3l.X1
## 46            0          0         0          0         0        0
0
## 77            0          0         0          0         0        0
0
## 93            0          0         0          0         0        0
0
## 160           0          0         0          0         0        0
0
##     upper3l.X1 takedown3l.X1 hammer3l.X1
## 46           0             0           0
## 77           0             0           0
## 93           0             0           0
## 160          0             0           0
```

Looking at the above table, all the sequential actions are in the first sequence. The initial code has to be examined to determine why two actions are in one instance and the first sequence only. The jab and then the cross are fine for sequence 1 then sequence 2, but the knee and kick both in sequence 1 has to be examined to find the error in the Pennington rounds.

```
Vulfen1[c(77,93),]

##    Round SecondsIntoRound lastAction SecondsLastRoundAction cmTotHitsR.X1
## 77     1              107        102                      5             0
```

```
## 93     1              157        154                       3             0
##    cmTotHitsL.X1 cmTotHitsM.X1 TotLandsX1 TotMissedX1 TotReceivedX1
## 77             3            21          2           2             0
## 93             6            31          2           0             0
##    cmTotHitsR.X2 cmTotHitsL.X2 cmTotHitsM.X2 TotLandsX2 TotMissedX2
## 77             3             0             6          0           0
## 93             6             0            13          0           0
##    TotReceivedX2 Time
## 77             2 3:12
## 93             2 2:22
##                                             FighterActionReactions.X1
## 77 lands R mt kick to low L back of knee, misses L jab, misses R cross
## 93                               lands R mt kick to low L back of knee
##              FightersActionsReactions.X2      Notes Crossl.X1 Kneel.X1
## 77 blocks L jab, ducks back from R cross Pennington         0        1
## 93                                  <NA> Pennington         0        1
##    Elbowl.X1 Hookl.X1 Jabl.X1 Kickl.X1 upperl.X1 takedownl.X1 hammerl.X1
## 77         0        0       0        1         0            0          0
## 93         0        0       0        1         0            0          0
##    Cross2l.X1 Knee2l.X1 Elbow2l.X1 Hook2l.X1 Jab2l.X1 Kick2l.X1 upper2l.X1
## 77          0         0          0         0        0         0          0
## 93          0         0          0         0        0         0          0
##    takedown2l.X1 hammer2l.X1 Cross3l.X1 Knee3l.X1 Elbow3l.X1 Hook3l.X1
Jab3l.X1
## 77             0           0          0         0          0         0
0
## 93             0           0          0         0          0         0
0
##    Kick3l.X1 upper3l.X1 takedown3l.X1 hammer3l.X1 Crossl.X2 Kneel.X2
Elbowl.X2
## 77         0          0             0           0         0        0
0
## 93         0          0             0           0         0        0
0
##    Hookl.X2 Jabl.X2 Kickl.X2 upperl.X2 takedownl.X2 hammerl.X2 Cross2l.X2
## 77        0       0        0         0            0          0          0
## 93        0       0        0         0            0          0          0
##    Knee2l.X2 Elbow2l.X2 Hook2l.X2 Jab2l.X2 Kick2l.X2 upper2l.X2
takedown2l.X2
## 77         0          0         0        0         0          0
0
## 93         0          0         0        0         0          0
0
##    hammer2l.X2 Cross3l.X2 Knee3l.X2 Elbow3l.X2 Hook3l.X2 Jab3l.X2
Kick3l.X2
## 77           0          0         0          0         0        0
0
## 93           0          0         0          0         0        0
0
##    upper3l.X2 takedown3l.X2 hammer3l.X2 Crossm.X1 Kneem.X1 Elbowm.X1
```

```
Hookm.X1
## 77          0             0           0         0        0         0
0
## 93          0             0           0         0        0         0
0
##    Jabm.X1 Kickm.X1 upperm.X1 takedownm.X1 hammerm.X1 Cross2m.X1 Knee2m.X1
## 77       0        0         0            0          0          0         0
## 93       0        0         0            0          0          0         0
##    Elbow2m.X1 Hook2m.X1 Jab2m.X1 Kick2m.X1 upper2m.X1 takedown2m.X1
hammer2m.X1
## 77          0         0        1         0          0             0
0
## 93          0         0        0         0          0             0
0
##    Cross3m.X1 Knee3m.X1 Elbow3m.X1 Hook3m.X1 Jab3m.X1 Kick3m.X1 upper3m.X1
## 77          1         0          0         0        0         0          0
## 93          0         0          0         0        0         0          0
##    takedown3m.X1 hammer3m.X1 Crossm.X2 Kneem.X2 Elbowm.X2 Hookm.X2 Jabm.X2
## 77             0           0         0        0         0        0       0
## 93             0           0         0        0         0        0       0
##    Kickm.X2 upperm.X2 takedownm.X2 hammerm.X2 Cross2m.X2 Knee2m.X2
Elbow2m.X2
## 77        0         0            0          0          0         0
0
## 93        0         0            0          0          0         0
0
##    Hook2m.X2 Jab2m.X2 Kick2m.X2 upper2m.X2 takedown2m.X2 hammer2m.X2
Cross3m.X2
## 77         0        0         0          0             0           0
0
## 93         0        0         0          0             0           0
0
##    Knee3m.X2 Elbow3m.X2 Hook3m.X2 Jab3m.X2 Kick3m.X2 upper3m.X2
takedown3m.X2
## 77         0          0         0        0         0          0
0
## 93         0          0         0        0         0          0
0
##    hammer3m.X2 Crossr.X1 Kneer.X1 Elbowr.X1 Hookr.X1 Jabr.X1 Kickr.X1
upperr.X1
## 77           0         0        0         0        0       0        0
0
## 93           0         0        0         0        0       0        0
0
##    takedownr.X1 hammerr.X1 Cross2r.X1 Knee2r.X1 Elbow2r.X1 Hook2r.X1
Jab2r.X1
## 77            0          0          0         0          0         0
0
## 93            0          0          0         0          0         0
0
```

```
##    Kick2r.X1 upper2r.X1 takedown2r.X1 hammer2r.X1 Cross3r.X1 Knee3r.X1
## 77         0          0             0           0          0         0
## 93         0          0             0           0          0         0
##    Elbow3r.X1 Hook3r.X1 Jab3r.X1 Kick3r.X1 upper3r.X1 takedown3r.X1
hammer3r.X1
## 77          0         0        0         0          0             0
0
## 93          0         0        0         0          0             0
0
##    Crossr.X2 Kneer.X2 Elbowr.X2 Hookr.X2 Jabr.X2 Kickr.X2 upperr.X2
## 77         0        1         0        0       0        1         0
## 93         0        1         0        0       0        1         0
##    takedownr.X2 hammerr.X2 Cross2r.X2 Knee2r.X2 Elbow2r.X2 Hook2r.X2
Jab2r.X2
## 77            0          0          0         0          0         0
0
## 93            0          0          0         0          0         0
0
##    Kick2r.X2 upper2r.X2 takedown2r.X2 hammer2r.X2 Cross3r.X2 Knee3r.X2
## 77         0          0             0           0          0         0
## 93         0          0             0           0          0         0
##    Elbow3r.X2 Hook3r.X2 Jab3r.X2 Kick3r.X2 upper3r.X2 takedown3r.X2
hammer3r.X2
## 77          0         0        0         0          0             0
0
## 93          0         0        0         0          0             0
0
```

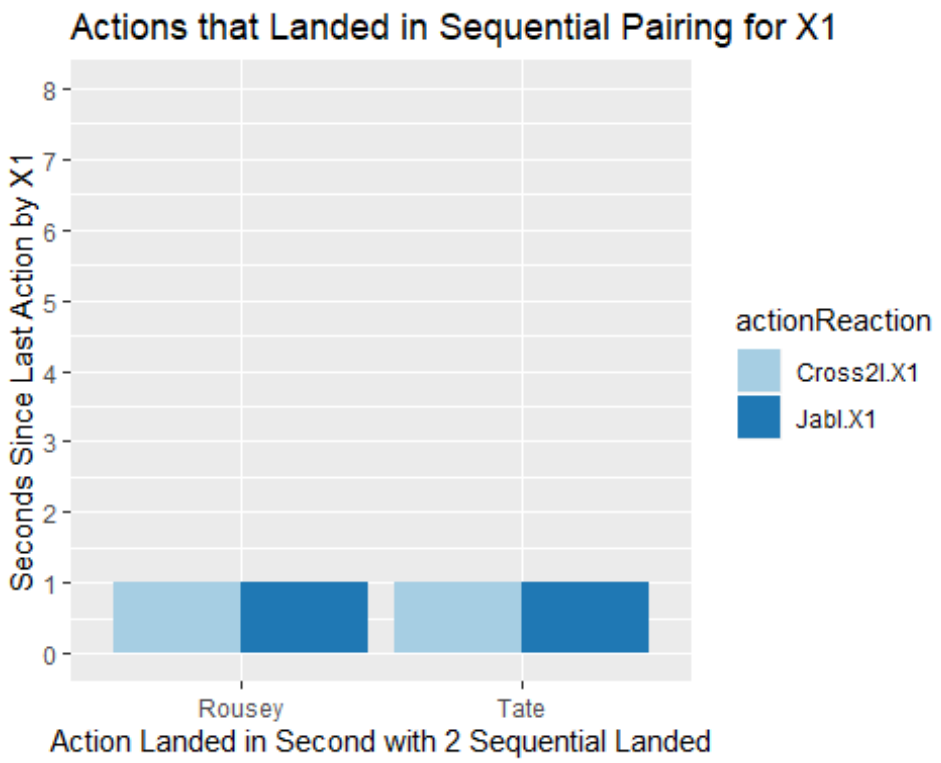
Looking at the above, this instance actually is only one hit landed, the way the regex was used in grabbing the actions, it selected the 'land.*knee' when it was a description of body location. In further action and reaction commentary the body location of hit could be omitted or change the knee strike column name of action to 'kneeStrike' to solve this problem.

We will omit the Pennington entries for now and plot the results.

```
plot2plus <- subset(x1_2plus_lands_counts, x1_2plus_lands_counts$Notes !=
'Pennington')
plot2plus
```

```
##    SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 17              164                      1            2           10
## 20               44                      1            0           13
## 37              164                      1            2           10
## 40               44                      1            0           13
##    cmTotHitsM.X1 TotLandsX1  Notes actionReaction actionCounts
## 17            30          2   Tate        Jabl.X1            1
## 20            22          2 Rousey        Jabl.X1            1
## 37            30          2   Tate     Cross2l.X1            1
## 40            22          2 Rousey     Cross2l.X1            1
```

```
ggplot(data = plot2plus, aes(x=Notes, y=SecondsLastRoundAction,
fill=actionReaction)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 8, by=1), limits=c(0,8))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Actions that Landed in Sequential Pairing for X1')+
  ylab('Seconds Since Last Action by X1')+
  xlab('Action Landed in Second with 2 Sequential Landed')
```



Keep in mind the opponents for this data collection were Pennington, Rousey, and Tate against Nunez (Vulfen) but that the only second observations with more than one hit landed by Nunez were the observations with Rousey or Tate, and each of these rounds were less than two minutes out of a five minute first round with Nunez. The combo favored for quick knockouts or technical knockouts by Nunez is the jab and cross (or strong right hand punch to face). We could rearrange the visual to show the cumulative hits missed with all three opponents for the first minute to see if Nunez gives it away that she plans on fighting all five of the five minute rounds or wants to damage the opponent.

Why don't we do that and put some skills to use.

```
oneMinute <- subset(Vulfen1, (Vulfen1$SecondsIntoRound < 60) &
(Vulfen1$TotLandsX1 > 0 | (Vulfen1$TotMissedX1 > 0)))
dim(oneMinute)

## [1]  36 182
```

```
head(colnames(oneMinute),20)
```

```
##  [1] "Round"                          "SecondsIntoRound"
##  [3] "lastAction"                     "SecondsLastRoundAction"
##  [5] "cmTotHitsR.X1"                  "cmTotHitsL.X1"
##  [7] "cmTotHitsM.X1"                  "TotLandsX1"
##  [9] "TotMissedX1"                    "TotReceivedX1"
## [11] "cmTotHitsR.X2"                  "cmTotHitsL.X2"
## [13] "cmTotHitsM.X2"                  "TotLandsX2"
## [15] "TotMissedX2"                    "TotReceivedX2"
## [17] "Time"                           "FighterActionReactions.X1"
## [19] "FightersActionsReactions.X2"    "Notes"
```

Lets use the SecondsIntoRound, SecondsLastRoundAction, cmTotHits columns for X1, TotLandsX1, and cumulative actions of X2 as well as the Notes which is the opponent name, and also the sequential action columns.

```
Minute <- oneMinute[,c(2,4:13,20:182)]
Minute_tidy <- gather(Minute, 'action','actionCount',13:174)
Minute_tidy1 <- subset(Minute_tidy, Minute_tidy$actionCount > 0)
Minute_tidy1
```

```
##      SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 20                 18                      2             0             3
## 27                 30                      1             0             7
## 32                 39                      1             0            10
## 34                 43                      2             0            11
## 165                22                      1             0             4
## 167                24                      1             0             5
## 170                29                      2             0             6
## 174                35                      1             0             8
## 179                44                      1             0            13
## 180                45                      1             0            14
## 341                11                      1             0             2
## 355                36                      1             0             9
## 359                44                      1             0            13
## 484                10                      1             0             1
## 1951               34                     12             0             0
## 1957                6                      1             0             0
## 1958                8                      2             0             0
## 1960               10                      1             0             1
## 1962               14                      3             0             2
## 1968               25                      1             0             5
## 1969               27                      2             0             5
## 1977               41                      1             0            10
## 2089               16                      3             0             0
## 2092               55                      7             0             0
## 2099               59                     14             0             0
## 2100                5                      5             0             0
## 2105               11                      1             0             2
## 2110               23                      1             0             4
```

```
## 2116               31                    1             0             7
## 2119               36                    1             0             9
## 2126               18                    2             0             0
## 2127               38                    1             0             0
## 2129               59                    4             0             0
## 2130               22                   22             0             0
## 2132               37                    3             0             0
## 2133               40                    3             0             0
## 2134               45                    5             0             0
## 2139                9                    1             0             0
## 2143               16                    2             0             2
## 2189               34                    3             0             7
## 2289               22                    1             0             4
## 2290               23                    1             0             4
## 2296               31                    1             0             7
## 2298               35                    1             0             8
## 2430               14                    3             0             2
## 2508               25                    1             0             5
## 2610               14                    3             0             2
## 2932               10                    1             0             1
## 2943               30                    1             0             7
## 3073                6                    1             0             0
## 3086               29                    2             0             6
## 3090               35                    1             0             8
## 3113               11                    1             0             2
## 3116               18                    2             0             3
## 3404               18                    2             0             3
## 3412               31                    1             0             7
## 4880               18                    2             0             3
## 4887               30                    1             0             7
## 4892               39                    1             0            10
## 4894               43                    2             0            11
## 5025               22                    1             0             4
## 5027               24                    1             0             5
## 5030               29                    2             0             6
## 5034               35                    1             0             8
## 5039               44                    1             0            13
## 5040               45                    1             0            14
## 5201               11                    1             0             2
## 5215               36                    1             0             9
## 5219               44                    1             0            13
## 5344               10                    1             0             1
##      cmTotHitsM.X1 TotLandsX1 TotMissedX1 TotReceivedX1 cmTotHitsR.X2
## 20              10          1           0             0             3
## 27              16          1           0             0             7
## 32              21          1           0             0            10
## 34              22          1           0             0            11
## 165             11          1           1             0             4
## 167             13          1           0             0             5
## 170             16          1           0             0             6
```

```
## 174              20           1            1            0             8
## 179              22           2            0            0            13
## 180              22           1            0            0            14
## 341               6           1            1            0             2
## 355              21           1            1            0             9
## 359              22           2            0            0            13
## 484               5           1            1            0             1
## 1951              2           0            1            0             0
## 1957              2           0            1            0             0
## 1958              3           0            1            0             0
## 1960              5           1            1            0             1
## 1962              9           0            3            0             2
## 1968             15           0            2            0             5
## 1969             16           0            1            0             5
## 1977             22           0            1            0            10
## 2089              1           0            1            0             0
## 2092              4           0            1            0             0
## 2099              6           0            1            0             0
## 2100              1           0            1            0             0
## 2105              6           1            1            0             2
## 2110             13           0            2            0             4
## 2116             18           0            2            0             7
## 2119             21           1            1            0             9
## 2126              2           0            1            0             0
## 2127              3           0            1            0             0
## 2129              5           0            1            0             0
## 2130              1           0            1            0             0
## 2132              3           0            1            0             0
## 2133              4           0            1            0             0
## 2134              5           0            1            0             0
## 2139              4           0            1            0             0
## 2143             10           0            1            0             2
## 2189             19           0            1            0             7
## 2289             11           1            1            0             4
## 2290             13           0            2            0             4
## 2296             18           0            2            0             7
## 2298             20           1            1            0             8
## 2430              9           0            3            0             2
## 2508             15           0            2            0             5
## 2610              9           0            3            0             2
## 2932              5           1            1            0             1
## 2943             16           1            0            0             7
## 3073              2           0            1            0             0
## 3086             16           1            0            0             6
## 3090             20           1            1            0             8
## 3113              6           1            1            0             2
## 3116             10           1            0            0             3
## 3404             10           1            0            0             3
## 3412             18           0            2            0             7
## 4880             10           1            0            0             3
```

```
## 4887            16          1           0            0             7
## 4892            21          1           0            0            10
## 4894            22          1           0            0            11
## 5025            11          1           1            0             4
## 5027            13          1           0            0             5
## 5030            16          1           0            0             6
## 5034            20          1           1            0             8
## 5039            22          2           0            0            13
## 5040            22          1           0            0            14
## 5201             6          1           1            0             2
## 5215            21          1           1            0             9
## 5219            22          2           0            0            13
## 5344             5          1           1            0             1
##      cmTotHitsL.X2 cmTotHitsM.X2      Notes     action actionCount
## 20               0             5     Rousey  Crossl.X1           1
## 27               0             8     Rousey  Crossl.X1           1
## 32               0            10     Rousey  Crossl.X1           1
## 34               0            10     Rousey  Crossl.X1           1
## 165              0             6     Rousey    Jabl.X1           1
## 167              0             6     Rousey    Jabl.X1           1
## 170              0             7     Rousey    Jabl.X1           1
## 174              0            10     Rousey    Jabl.X1           1
## 179              0            10     Rousey    Jabl.X1           1
## 180              0            10     Rousey    Jabl.X1           1
## 341              0             3     Rousey Cross2l.X1           1
## 355              0            10     Rousey Cross2l.X1           1
## 359              0            10     Rousey Cross2l.X1           1
## 484              0             2     Rousey   Jab2l.X1           1
## 1951             0             0 Pennington  Crossm.X1           1
## 1957             0             1     Rousey  Crossm.X1           1
## 1958             0             1     Rousey  Crossm.X1           1
## 1960             0             2     Rousey  Crossm.X1           1
## 1962             0             3     Rousey  Crossm.X1           1
## 1968             0             6     Rousey  Crossm.X1           1
## 1969             0             6     Rousey  Crossm.X1           1
## 1977             0            10     Rousey  Crossm.X1           1
## 2089             0             2       Tate    Jabm.X1           1
## 2092             0             5       Tate    Jabm.X1           1
## 2099             0             0 Pennington    Jabm.X1           1
## 2100             0             0     Rousey    Jabm.X1           1
## 2105             0             3     Rousey    Jabm.X1           1
## 2110             0             6     Rousey    Jabm.X1           1
## 2116             0             9     Rousey    Jabm.X1           1
## 2119             0            10     Rousey    Jabm.X1           1
## 2126             0             2       Tate   Kickm.X1           1
## 2127             0             3       Tate   Kickm.X1           1
## 2129             0             5       Tate   Kickm.X1           1
## 2130             0             0 Pennington   Kickm.X1           1
## 2132             0             0 Pennington   Kickm.X1           1
## 2133             0             0 Pennington   Kickm.X1           1
```

```
## 2134             0              0 Pennington   Kickm.X1           1
## 2139             0              1     Rousey   Kickm.X1           1
## 2143             0              3     Rousey   Kickm.X1           1
## 2189             0              9     Rousey  upperm.X1           1
## 2289             0              6     Rousey Cross2m.X1           1
## 2290             0              6     Rousey Cross2m.X1           1
## 2296             0              9     Rousey Cross2m.X1           1
## 2298             0             10     Rousey Cross2m.X1           1
## 2430             0              3     Rousey   Jab2m.X1           1
## 2508             0              6     Rousey upper2m.X1           1
## 2610             0              3     Rousey Cross3m.X1           1
## 2932             0              2     Rousey  Crossm.X2           1
## 2943             0              8     Rousey  Crossm.X2           1
## 3073             0              1     Rousey    Jabm.X2           1
## 3086             0              7     Rousey    Jabm.X2           1
## 3090             0             10     Rousey    Jabm.X2           1
## 3113             0              3     Rousey   Kickm.X2           1
## 3116             0              5     Rousey   Kickm.X2           1
## 3404             0              5     Rousey   Jab2m.X2           1
## 3412             0              9     Rousey   Jab2m.X2           1
## 4880             0              5     Rousey  Crossr.X2           1
## 4887             0              8     Rousey  Crossr.X2           1
## 4892             0             10     Rousey  Crossr.X2           1
## 4894             0             10     Rousey  Crossr.X2           1
## 5025             0              6     Rousey    Jabr.X2           1
## 5027             0              6     Rousey    Jabr.X2           1
## 5030             0              7     Rousey    Jabr.X2           1
## 5034             0             10     Rousey    Jabr.X2           1
## 5039             0             10     Rousey    Jabr.X2           1
## 5040             0             10     Rousey    Jabr.X2           1
## 5201             0              3     Rousey Cross2r.X2           1
## 5215             0             10     Rousey Cross2r.X2           1
## 5219             0             10     Rousey Cross2r.X2           1
## 5344             0              2     Rousey   Jab2r.X2           1
```

We have a subset of data above that is when an action as an attempt was made by either X1 or X2 for observations less than one minute into the round. The opponent name is in the Notes column. Cumulative hits landed and missed for both are available as well as the seconds that have passed since the last action in the round.

Lets look at the action to group by it using dplyr and get a count of the action that is attempted most by X1 only. This means we should remove the X2 actions.Remove any field with 'X2' in the name as it won't be needed for now.

```
library(dplyr)

X2actions <- grep('X2', colnames(Minute))
Minute2 <- Minute[,-(X2actions)]

minute2_tidy <- gather(Minute2, 'action','actionCount',10:90)
```

```
minute2_tidy1 <- subset(minute2_tidy, minute2_tidy$actionCount > 0)

actionsGrouped <- minute2_tidy1 %>% group_by(action) %>% count()
mostAction <- actionsGrouped[order(actionsGrouped$n,decreasing=TRUE),]
mostAction
```

```
## # A tibble: 12 x 2
## # Groups:   action [12]
##    action         n
##    <chr>      <int>
##  1 Kickm.X1       9
##  2 Crossm.X1      8
##  3 Jabm.X1        8
##  4 Jabl.X1        6
##  5 Cross2m.X1     4
##  6 Crossl.X1      4
##  7 Cross2l.X1     3
##  8 Cross3m.X1     1
##  9 Jab2l.X1       1
## 10 Jab2m.X1       1
## 11 upper2m.X1     1
## 12 upperm.X1      1
```

We can see the most attempted action is the kick but missed, then the cross that is missed, then the jab missed. But following those attempted actions that were missed, the most landed action by X1 is the jab, then the cross in the 2nd sequence or combo order. But the Cross is also a first attempted action. The landed hits most taken by X1 are the jab and cross from these samples.

Lets look at the jabs only first then the cross only. We will look at the seconds since last action, the opponent as Notes, and cumulative hits missed and landed by X1. But not in the same bar chart because that is beyond the three dimension capability.

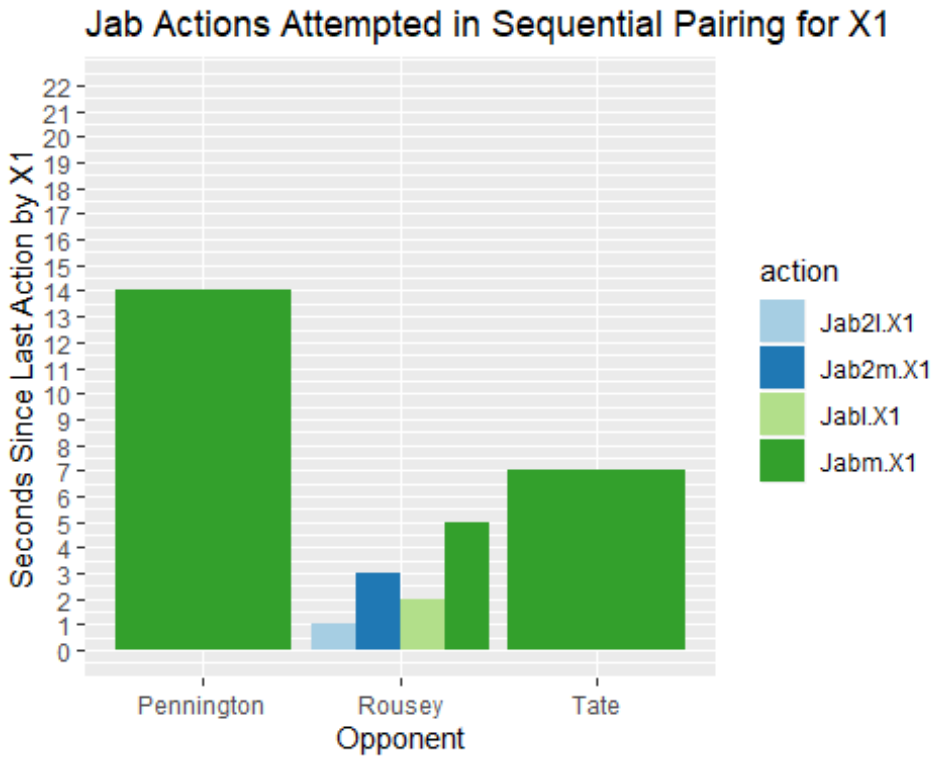
```
jab <- minute2_tidy1[grep('Jab', minute2_tidy1$action),]
jab
```

```
##      SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 165                22                      1            0             4
## 167                24                      1            0             5
## 170                29                      2            0             6
## 174                35                      1            0             8
## 179                44                      1            0            13
## 180                45                      1            0            14
## 484                10                      1            0             1
## 1117               16                      3            0             0
## 1120               55                      7            0             0
## 1127               59                     14            0             0
## 1128                5                      5            0             0
## 1133               11                      1            0             2
```

```
## 1138               23                    1            0            4
## 1144               31                    1            0            7
## 1147               36                    1            0            9
## 1458               14                    3            0            2
##      cmTotHitsM.X1 TotLandsX1 TotMissedX1 TotReceivedX1      Notes
action
## 165             11          1           1             0     Rousey
Jabl.X1
## 167             13          1           0             0     Rousey
Jabl.X1
## 170             16          1           0             0     Rousey
Jabl.X1
## 174             20          1           1             0     Rousey
Jabl.X1
## 179             22          2           0             0     Rousey
Jabl.X1
## 180             22          1           0             0     Rousey
Jabl.X1
## 484              5          1           1             0     Rousey
Jab2l.X1
## 1117             1          0           1             0       Tate
Jabm.X1
## 1120             4          0           1             0       Tate
Jabm.X1
## 1127             6          0           1             0 Pennington
Jabm.X1
## 1128             1          0           1             0     Rousey
Jabm.X1
## 1133             6          1           1             0     Rousey
Jabm.X1
## 1138            13          0           2             0     Rousey
Jabm.X1
## 1144            18          0           2             0     Rousey
Jabm.X1
## 1147            21          1           1             0     Rousey
Jabm.X1
## 1458             9          0           3             0     Rousey
Jab2m.X1
##      actionCount
## 165            1
## 167            1
## 170            1
## 174            1
## 179            1
## 180            1
## 484            1
## 1117           1
## 1120           1
## 1127           1
## 1128           1
```

```
## 1133           1
## 1138           1
## 1144           1
## 1147           1
## 1458           1
```

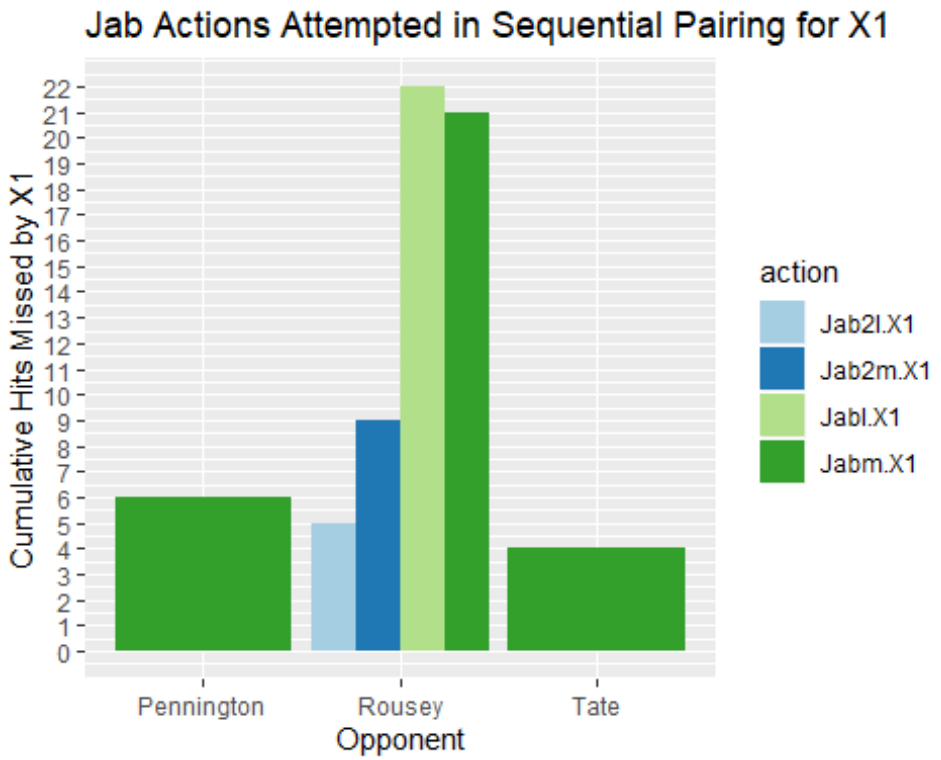
```
ggplot(data = jab, aes(x=Notes, y=SecondsLastRoundAction, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Jab Actions Attempted in Sequential Pairing for X1')+
  ylab('Seconds Since Last Action by X1')+
  xlab('Opponent')
```



Take note that from the outcomes of these fights and after looking at the plot above, Pennington went to decision and lasted all five rounds of five minutes each and has more seconds between actions attempted by Nunez looking at the most landed hit and attempted hit by Nunez, the jab. The Rousey fight had less seconds between actions attempted by Nunez and lasted under one minute with an outcome of technical knockout. The Tate fight is in the middle and lasted under five minutes of the first round.

Next, the jabs attempted and missed by Nunez on opponents for cumulative hits missed for Nunez at the time she makes the attempted hit with her most used strike landed, the jab.

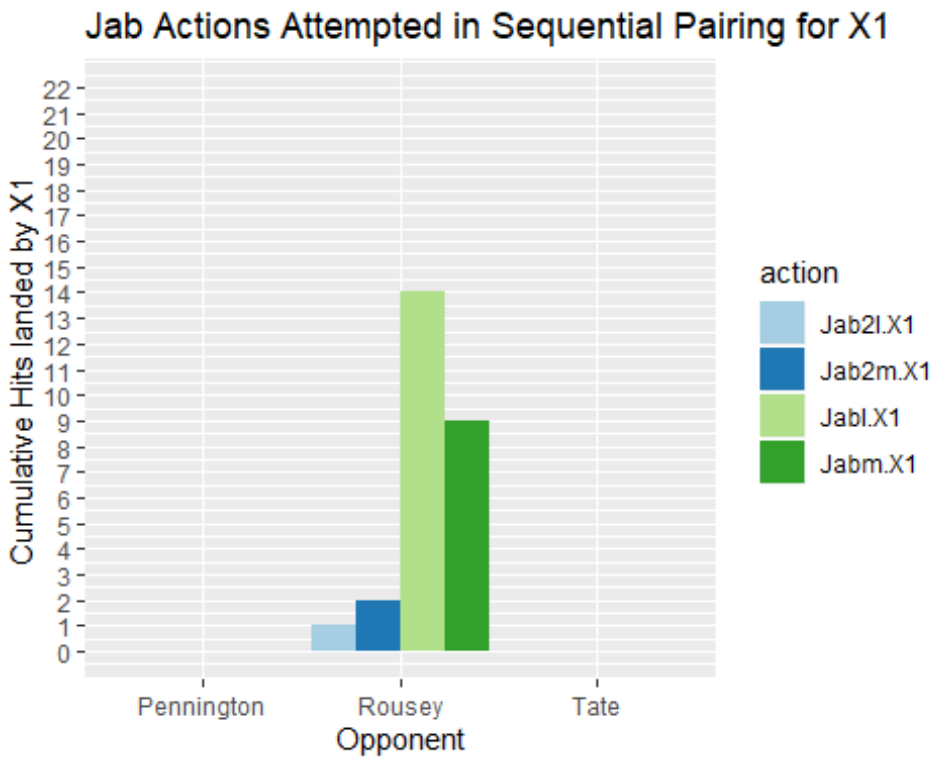
```
ggplot(data = jab, aes(x=Notes, y=cmTotHitsM.X1, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Jab Actions Attempted in Sequential Pairing for X1')+
  ylab('Cumulative Hits Missed by X1')+
  xlab('Opponent')
```



Nunez has more cumulative hits missed, which means she is taking more risks to get the fight over and done with when looking at her short lived fighting event with Rousey as you can see in the bar chart above.

Now, for the cumulative hits landed by Nunez against her opponent at each sequential second that she attempt a strike against her opponent.

```
ggplot(data = jab, aes(x=Notes, y=cmTotHitsL.X1, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Jab Actions Attempted in Sequential Pairing for X1')+
  ylab('Cumulative Hits landed by X1')+
  xlab('Opponent')
```



As we can see from the plot above, for the first minute of her fight with the three opponents, she has made more attempted hits that landed by way of the jab against Rousey, having had 14 cumulative jabs landed on Rousey in under one minute.

Now lets look at the power strike, Nunez's cross, on her opponent, which is her 2nd most attempted strike against her opponent.

```
cross <- minute2_tidy1[grep('Cross', minute2_tidy1$action),]
cross
```

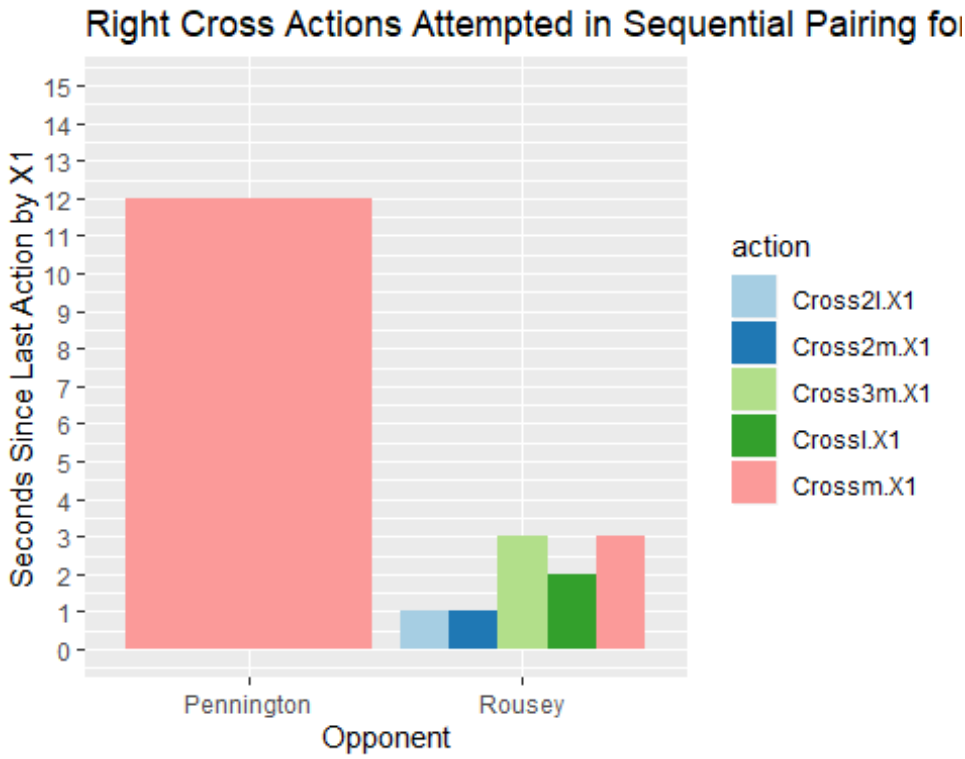
```
##      SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 20                 18                      2             0             3
## 27                 30                      1             0             7
## 32                 39                      1             0            10
## 34                 43                      2             0            11
## 341                11                      1             0             2
## 355                36                      1             0             9
## 359                44                      1             0            13
## 979                34                     12             0             0
## 985                 6                      1             0             0
## 986                 8                      2             0             0
## 988                10                      1             0             1
## 990                14                      3             0             2
## 996                25                      1             0             5
## 997                27                      2             0             5
```

```
## 1005               41                      1             0            10
## 1317               22                      1             0             4
## 1318               23                      1             0             4
## 1324               31                      1             0             7
## 1326               35                      1             0             8
## 1638               14                      3             0             2
##      cmTotHitsM.X1 TotLandsX1 TotMissedX1 TotReceivedX1      Notes
action
## 20              10          1           0             0     Rousey
Crossl.X1
## 27              16          1           0             0     Rousey
Crossl.X1
## 32              21          1           0             0     Rousey
Crossl.X1
## 34              22          1           0             0     Rousey
Crossl.X1
## 341              6          1           1             0     Rousey
Cross2l.X1
## 355             21          1           1             0     Rousey
Cross2l.X1
## 359             22          2           0             0     Rousey
Cross2l.X1
## 979              2          0           1             0 Pennington
Crossm.X1
## 985              2          0           1             0     Rousey
Crossm.X1
## 986              3          0           1             0     Rousey
Crossm.X1
## 988              5          1           1             0     Rousey
Crossm.X1
## 990              9          0           3             0     Rousey
Crossm.X1
## 996             15          0           2             0     Rousey
Crossm.X1
## 997             16          0           1             0     Rousey
Crossm.X1
## 1005            22          0           1             0     Rousey
Crossm.X1
## 1317            11          1           1             0     Rousey
Cross2m.X1
## 1318            13          0           2             0     Rousey
Cross2m.X1
## 1324            18          0           2             0     Rousey
Cross2m.X1
## 1326            20          1           1             0     Rousey
Cross2m.X1
## 1638             9          0           3             0     Rousey
Cross3m.X1
##      actionCount
## 20             1
```

```
## 27              1
## 32              1
## 34              1
## 341             1
## 355             1
## 359             1
## 979             1
## 985             1
## 986             1
## 988             1
## 990             1
## 996             1
## 997             1
## 1005            1
## 1317            1
## 1318            1
## 1324            1
## 1326            1
## 1638            1
```

The above table shows the cross actions attempted by X1.

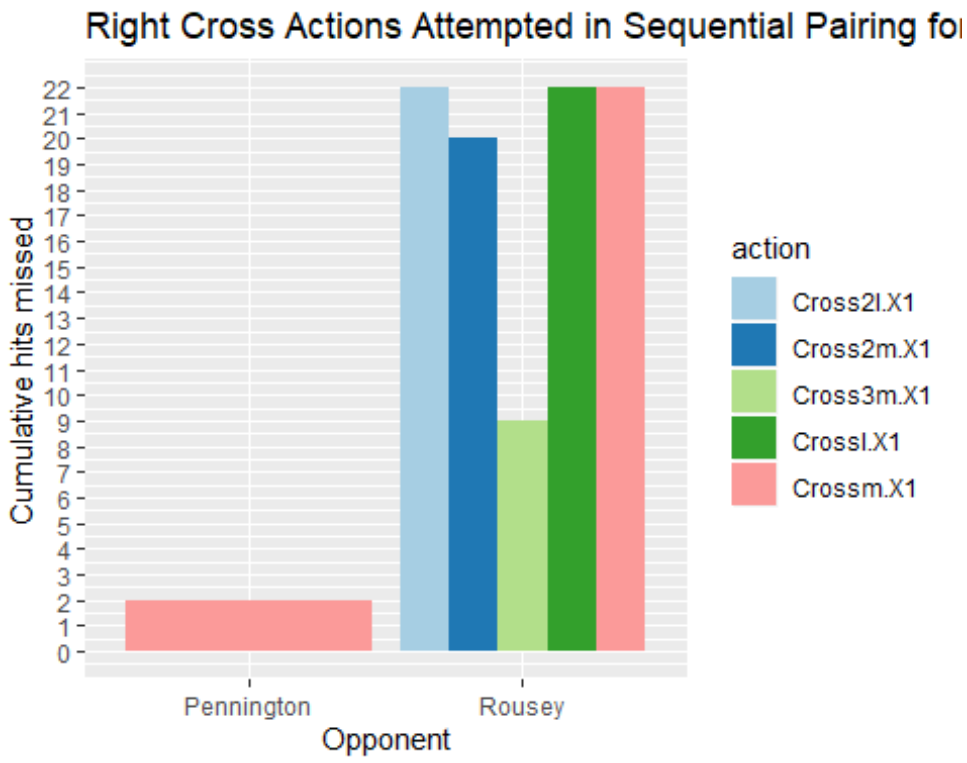
```
ggplot(data = cross, aes(x=Notes, y=SecondsLastRoundAction, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 15, by=1), limits=c(0,15))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Right Cross Actions Attempted in Sequential Pairing for X1')+
  ylab('Seconds Since Last Action by X1')+
  xlab('Opponent')
```



The above bar chart shows that Tate is not in the list of opponents she attempted to hit with her right cross, but Rousey got all attempts in the 1st, 2nd, and 3rd sequences of at least one of the one-second observations under one minute of the first round. The seconds since the last action by Nunez were more frequent in the first round than with Pennington at 12 seconds since last action.

Now, look at the cumulative hits missed for x1-Nunez and cross attempts on her opponents.

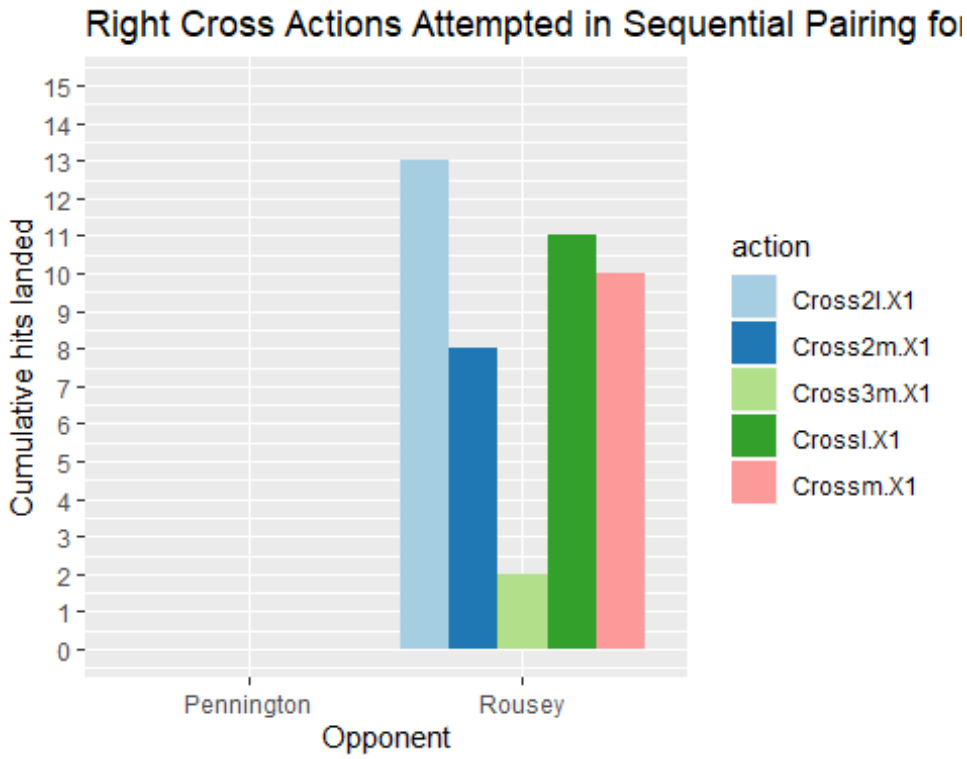
```
ggplot(data = cross, aes(x=Notes, y=cmTotHitsM.X1, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Right Cross Actions Attempted in Sequential Pairing for X1')+
  ylab('Cumulative hits missed')+
  xlab('Opponent')
```



Looking at the bar chart above for the amount of hits missed up to the point that X1 attempts a right cross on her opponent, Rousey has a much larger number of hits missed than Pennington.

Now, look at the cumulative hits landed for X1's right cross on her opponents during the first minute of the first round.

```
ggplot(data = cross, aes(x=Notes, y=cmTotHitsL.X1, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 15, by=1), limits=c(0,15))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Right Cross Actions Attempted in Sequential Pairing for X1')+
  ylab('Cumulative hits landed')+
  xlab('Opponent')
```



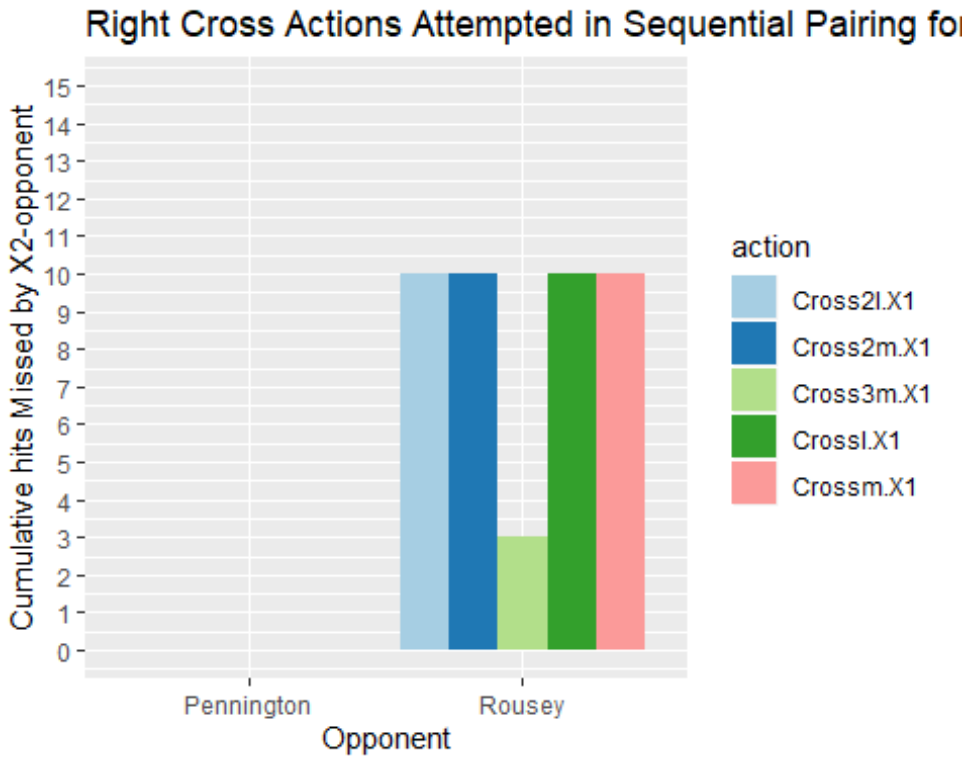
As we can see from the above bar chart, X1 had more right cross strikes against Rousey in the 2nd sequence of a combo and first sequence. But even the 3rd sequence had a hit when she had 2 hits landed. The fact that it is higher for her when using it as the 2nd strike of a combo when she had 13 hits landed, and as the first of a combo when she had 11 hits landed, shows she wanted to win, and most likely wasn't deterred by her opponent. To assert that last assumption, we would have to look at the cumulative hits missed and/or landed by her opponent to confirm X1 wasn't deterred when making her selection of strikes to take down her opponent.

```
X2actions <- grep('X2', colnames(Minute))
X2act <- X2actions[4:84]
Minute3 <- Minute[,-(X2act)]

minute3_tidy <- gather(Minute3, 'action','actionCount',13:93)

minute3_tidy1 <- subset(minute3_tidy, minute3_tidy$actionCount > 0)

cross1 <- minute3_tidy1[grep('Cross', minute3_tidy1$action),]
cross1

##      SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 20                 18                      2            0             3
## 27                 30                      1            0             7
## 32                 39                      1            0            10
## 34                 43                      2            0            11
## 341                11                      1            0             2
```

```
## 355                36                     1             0             9
## 359                44                     1             0            13
## 979                34                    12             0             0
## 985                 6                     1             0             0
## 986                 8                     2             0             0
## 988                10                     1             0             1
## 990                14                     3             0             2
## 996                25                     1             0             5
## 997                27                     2             0             5
## 1005               41                     1             0            10
## 1317               22                     1             0             4
## 1318               23                     1             0             4
## 1324               31                     1             0             7
## 1326               35                     1             0             8
## 1638               14                     3             0             2
##      cmTotHitsM.X1 TotLandsX1 TotMissedX1 TotReceivedX1 cmTotHitsR.X2
## 20              10          1           0             0             3
## 27              16          1           0             0             7
## 32              21          1           0             0            10
## 34              22          1           0             0            11
## 341              6          1           1             0             2
## 355             21          1           1             0             9
## 359             22          2           0             0            13
## 979              2          0           1             0             0
## 985              2          0           1             0             0
## 986              3          0           1             0             0
## 988              5          1           1             0             1
## 990              9          0           3             0             2
## 996             15          0           2             0             5
## 997             16          0           1             0             5
## 1005            22          0           1             0            10
## 1317            11          1           1             0             4
## 1318            13          0           2             0             4
## 1324            18          0           2             0             7
## 1326            20          1           1             0             8
## 1638             9          0           3             0             2
##      cmTotHitsL.X2 cmTotHitsM.X2      Notes     action actionCount
## 20               0             5     Rousey  Crossl.X1           1
## 27               0             8     Rousey  Crossl.X1           1
## 32               0            10     Rousey  Crossl.X1           1
## 34               0            10     Rousey  Crossl.X1           1
## 341              0             3     Rousey Cross2l.X1           1
## 355              0            10     Rousey Cross2l.X1           1
## 359              0            10     Rousey Cross2l.X1           1
## 979              0             0 Pennington  Crossm.X1           1
## 985              0             1     Rousey  Crossm.X1           1
## 986              0             1     Rousey  Crossm.X1           1
## 988              0             2     Rousey  Crossm.X1           1
## 990              0             3     Rousey  Crossm.X1           1
## 996              0             6     Rousey  Crossm.X1           1
```

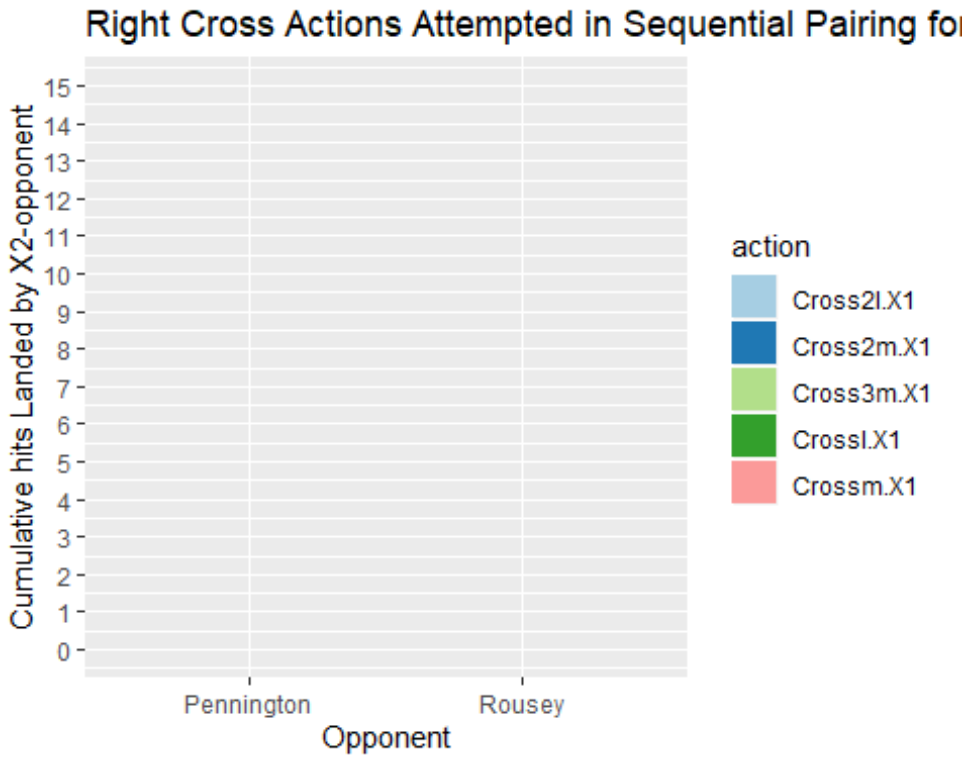
```
## 997              0              6     Rousey  Crossm.X1           1
## 1005             0             10     Rousey  Crossm.X1           1
## 1317             0              6     Rousey Cross2m.X1           1
## 1318             0              6     Rousey Cross2m.X1           1
## 1324             0              9     Rousey Cross2m.X1           1
## 1326             0             10     Rousey Cross2m.X1           1
## 1638             0              3     Rousey Cross3m.X1           1
```

```
ggplot(data = cross1, aes(x=Notes, y=cmTotHitsM.X2, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 15, by=1), limits=c(0,15))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Right Cross Actions Attempted in Sequential Pairing for X1')+
  ylab('Cumulative hits Missed by X2-opponent')+
  xlab('Opponent')
```



The above chart shows that Rousey as X2 had up to 10 hits cumulatively missed at the moment that Nunez or X1 attempted a right cross in every three sequence of an observational second in the round 1 of this fight event.

```
ggplot(data = cross1, aes(x=Notes, y=cmTotHitsL.X2, fill=action)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 15, by=1), limits=c(0,15))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Right Cross Actions Attempted in Sequential Pairing for X1')+
  ylab('Cumulative hits Landed by X2-opponent')+
  xlab('Opponent')
```



The above bar chart shows that The cumulative hits landed by the opponent or X2 were zero for the actions attempted by Nunez using her 2nd most attempted strike, the right cross.

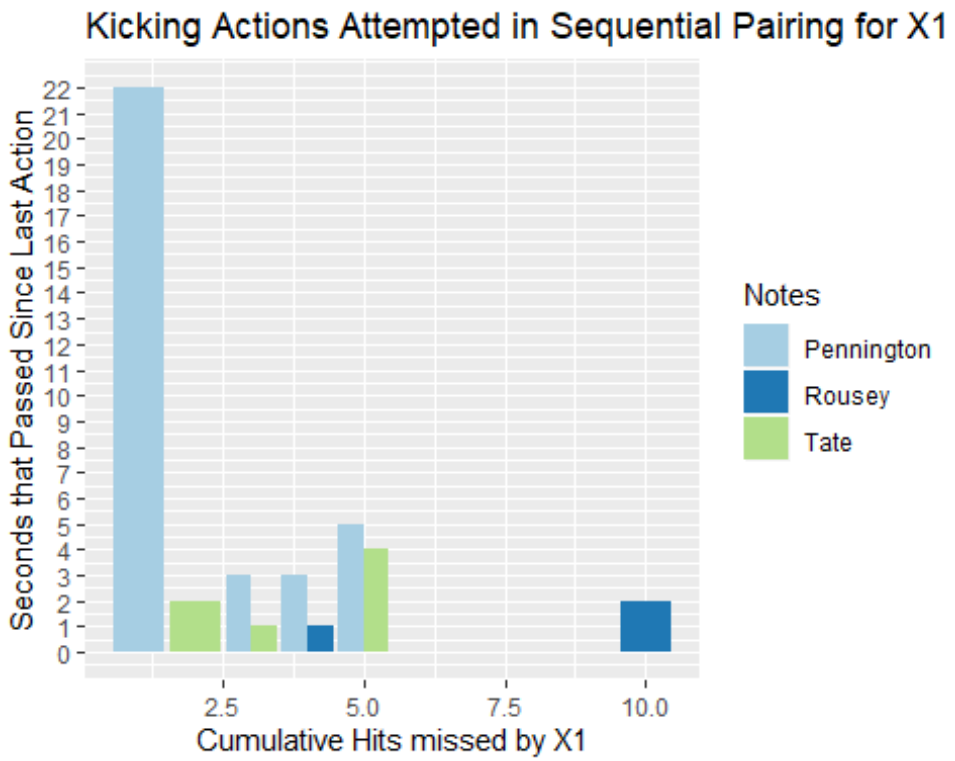
Now, for more curiosity and in answering some questions about the kick, which is Nunez's most attempted strike against her opponent in under one minute for these three opponents' first round fight with said fighter. She didn't land any kicks, but when the fight is just sizing up or opening up the opponent, she used the front kick at times or the muay thai kick to disable the opponent's anchor or leverage against her.

```
kick <- minute3_tidy1[grep('Kick', minute3_tidy1$action),]
kick
```

```
##      SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 1154               18                      2             0             0
## 1155               38                      1             0             0
## 1157               59                      4             0             0
## 1158               22                     22             0             0
## 1160               37                      3             0             0
## 1161               40                      3             0             0
## 1162               45                      5             0             0
## 1167                9                      1             0             0
## 1171               16                      2             0             2
##      cmTotHitsM.X1 TotLandsX1 TotMissedX1 TotReceivedX1 cmTotHitsR.X2
## 1154             2          0           1              0             0
```

```
## 1155              3           0           1              0              0
## 1157              5           0           1              0              0
## 1158              1           0           1              0              0
## 1160              3           0           1              0              0
## 1161              4           0           1              0              0
## 1162              5           0           1              0              0
## 1167              4           0           1              0              0
## 1171             10           0           1              0              2
##      cmTotHitsL.X2 cmTotHitsM.X2      Notes   action actionCount
## 1154             0             2       Tate Kickm.X1           1
## 1155             0             3       Tate Kickm.X1           1
## 1157             0             5       Tate Kickm.X1           1
## 1158             0             0 Pennington Kickm.X1           1
## 1160             0             0 Pennington Kickm.X1           1
## 1161             0             0 Pennington Kickm.X1           1
## 1162             0             0 Pennington Kickm.X1           1
## 1167             0             1     Rousey Kickm.X1           1
## 1171             0             3     Rousey Kickm.X1           1
```

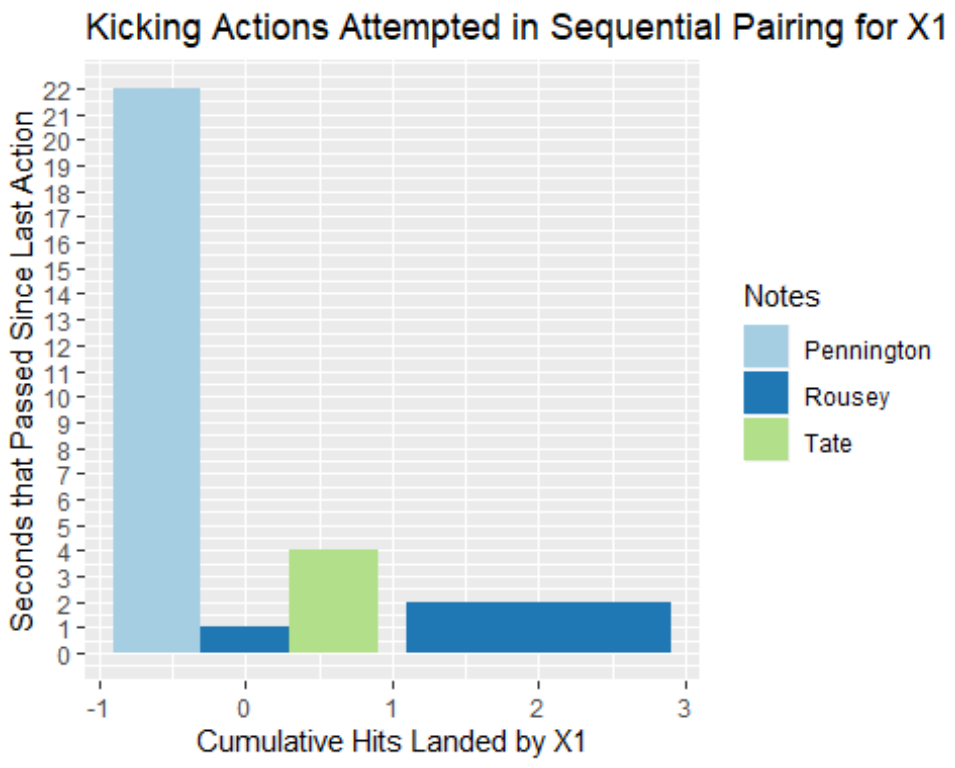
```
ggplot(data = kick, aes(x=cmTotHitsM.X1, y=SecondsLastRoundAction,
fill=Notes)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Kicking Actions Attempted in Sequential Pairing for X1')+
  xlab('Cumulative Hits missed by X1')+
  ylab('Seconds that Passed Since Last Action')
```



The above bar chart is a different arrangement, but shows that the time since last action and cumulative hits missed up to the point that X1-Nunez attempt a kick, and all kicks in the first minute were missed, against her opponent. We can see that after 22 seconds she made a kicking attempt with Pennington, and made more kick attempts against Pennington that lasted the whole event of 5-five minute rounds and a win for Nunez through a decision by the judges. Her attempts to kick Rousey in under a minute are actually less than Pennington and Tate. I recall that Rousey didn't shake Nunez's hand before the fight, and this could mean it was a grudge fight where Nunez looks to knock out her opponent with her upper body strikes than her lower body strikes.

To confirm her upper body strikes are X1's go to in ending a fight early, look at her cumulative hits landed in comparison to the seconds that passed since the last attempted action by X1.

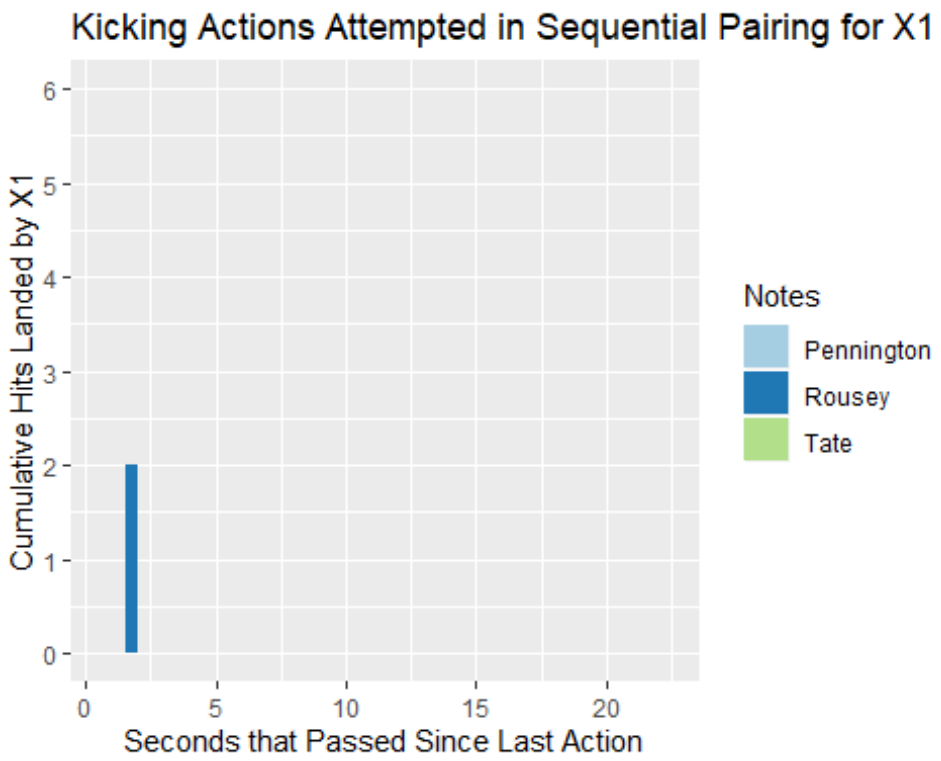
```
ggplot(data = kick, aes(x=cmTotHitsL.X1, y=SecondsLastRoundAction,
fill=Notes)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Kicking Actions Attempted in Sequential Pairing for X1')+
  xlab('Cumulative Hits Landed by X1')+
  ylab('Seconds that Passed Since Last Action')
```



The above bar chart isn't making sense as it shows negative values for cumulative hits landed by X1. And the values are discreet, so the bars should be exactly on an integer of the x-axis but as we see above are not.

Here is a better chart by switching the x and y labels.

```
ggplot(data = kick, aes(y=cmTotHitsL.X1, x=SecondsLastRoundAction,
fill=Notes)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 6, by=1), limits=c(0,6))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Kicking Actions Attempted in Sequential Pairing for X1')+
  ylab('Cumulative Hits Landed by X1')+
  xlab('Seconds that Passed Since Last Action')
```



Lets look at the data table and see if Rousey is the only one receiving attempted kicks.

```
kick2 <- kick[,c(2,4,12:14)]
kick2
```

```
##      SecondsLastRoundAction cmTotHitsL.X1      Notes   action actionCount
## 1154                      2             0       Tate Kickm.X1           1
## 1155                      1             0       Tate Kickm.X1           1
## 1157                      4             0       Tate Kickm.X1           1
## 1158                     22             0 Pennington Kickm.X1           1
## 1160                      3             0 Pennington Kickm.X1           1
## 1161                      3             0 Pennington Kickm.X1           1
## 1162                      5             0 Pennington Kickm.X1           1
## 1167                      1             0     Rousey Kickm.X1           1
## 1171                      2             2     Rousey Kickm.X1           1
```

By looking at the chart above, only Rousey was the opponent that received any hits that landed when Nunez attempted a kick as a strike. Nunez made kick attempts at the other two opponents, but she hadn't landed any hits by the time she attempted to kick those other opponents. Nunez, did however miss a number of strikes attempted on her other opponents when attempting a kick.

This was an interesting analysis of the fighter Nunez, than also compared results from Mazvidal earlier using machine learning models: random forest, recursive partitioning trees or decision trees, generalized linear models like liner and logistic regression, k-nearest neighber, and generalized boosted machines also a tree algorithm. The best predictors were the tree algorithms in using the samples of Mazvidal as the testing set for Nunez's model built only on her sampled second observations in her first round. The comparison with the best algorithm scored 86% meaning Mazvidal is 86% similar in fighting style to Nunez.

The other comparisons were for analyzing and using visualizations to understand Nunez's method in fighting. She uses more jabs and crosses, and leaves more seconds between actions of fights she wants to play out for longer as in with Pennington. If she wants to end the fight early or uses a grudge fight method, her style changes, hits become more frequent, and this is based on the attempted hits her opponent makes towards her, as Rousey made more attempts that coincidentally missed, while the seconds between fight actions on the part of Nunez on Rousey were much smaller.

If we were to use this understanding and see how her next opponent acts or behaves towards Nunez and other factors before the fight, we could determine how long the fight is predicted to last, but this was only the first round of three fights, when she has fought many fights and had many fights last more than one round. Measuring her exhaustion as a new feature, if the fight is a grudge fight as another feature, if the opponent is a dominating or aggressive bat out of the cave type as another feature, and so on.