

## Simulated VulfenSarah (Nunez) hits landed with first 50 Wolfey (Mazvidal) as a Testing Set

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This script was edited months afterwards to correct the regex error with the knee to body getting selected as a knee strike, so now the counts are accurate. Updated 2/11/2020.

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('Nunez-ML-Analysis-editedRegex.csv',
                  sep=',', header=TRUE,
                  na.strings=c('', 'NA'))

Wolfey <- read.csv('wolfey_addedFeatures.csv',
                  sep=',', header=TRUE, nrow=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)

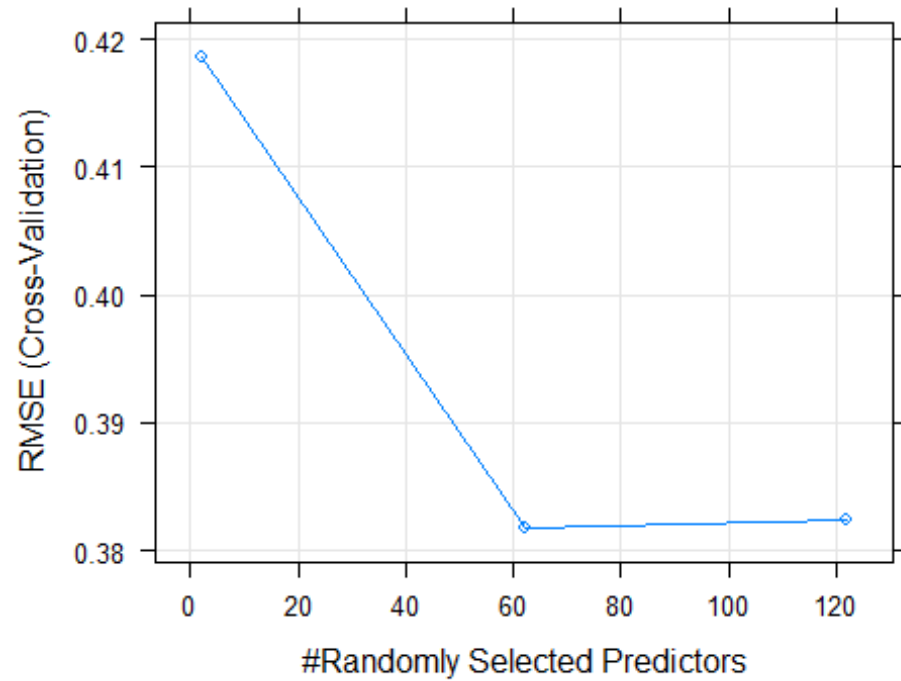
set.seed(189678345)

trainingSet <- Vulfen
testingSet <- Wolfey

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

##      user      system elapsed
##    30.69       0.20     32.56

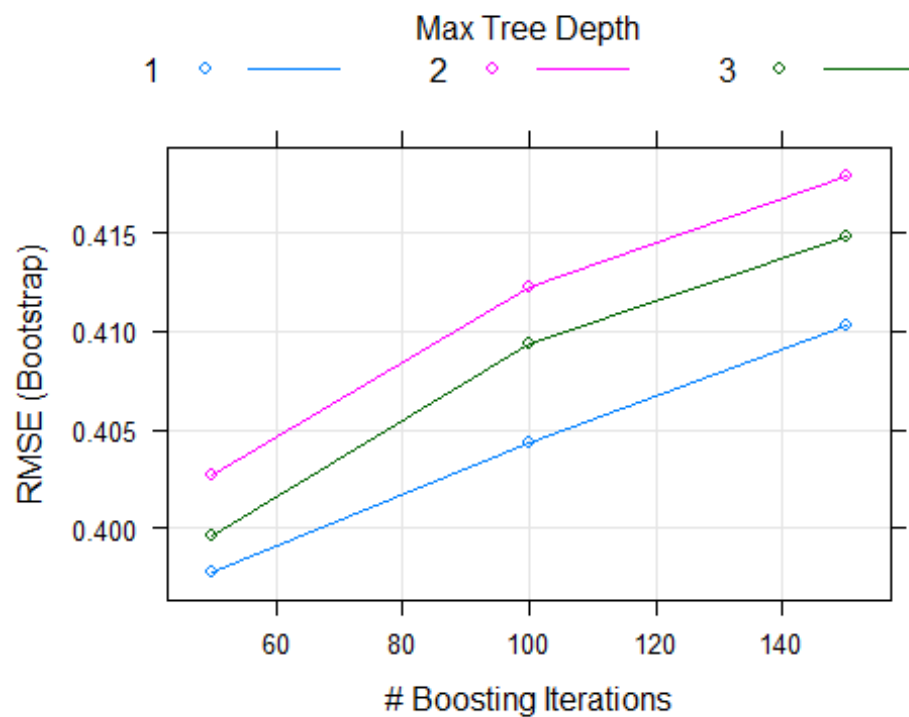
plot(rfMod)
```



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

```
##    user  system elapsed  
## 17.83   0.08   19.26
```

```
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      0      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] 0.74
```

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'),
```

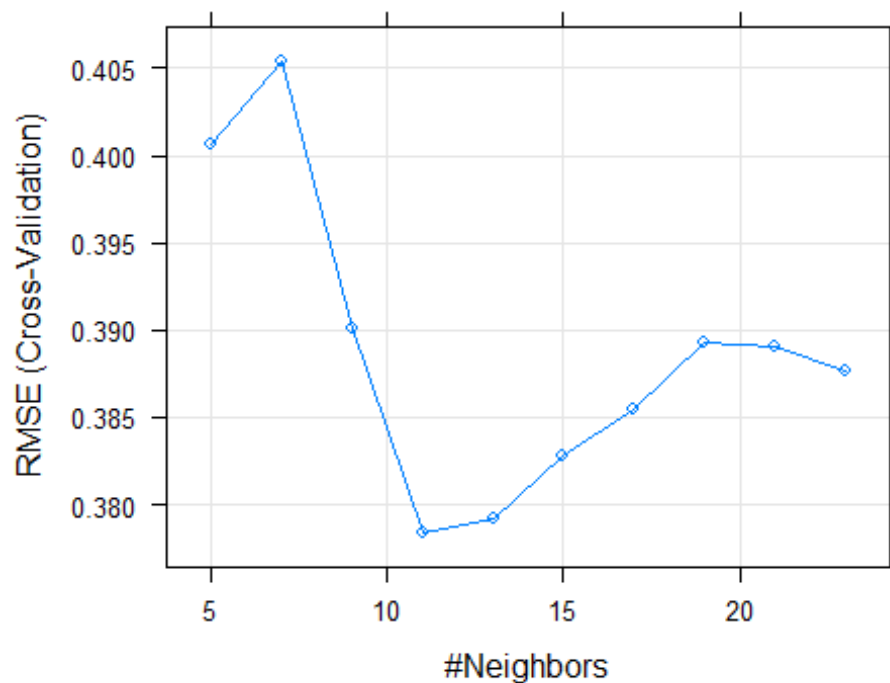
```

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

##    user  system elapsed
##    3.92    0.06    5.16

plot(knnMod)

```



From the above plot  $n=11$  seems to have the lowest Root mean Squared error.

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

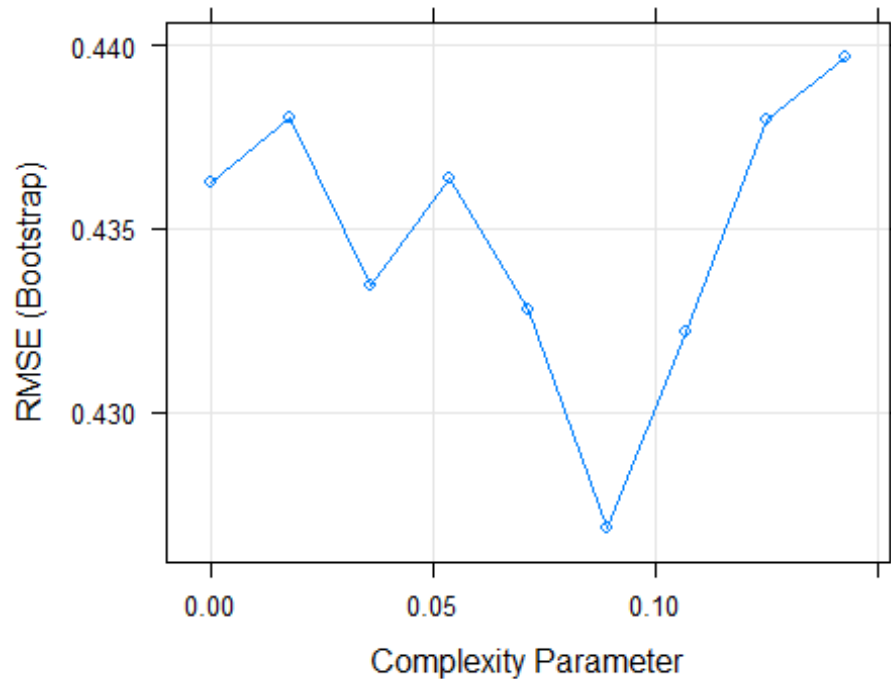
```

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

##    user  system elapsed
##    5.95    0.00    6.24

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
##   2.11    0.00    2.14

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      1      0      0      0
```

```
## 46      0      0      0      0
## 47      1      1      1      1
## 48      1      1      0      0
## 49      1      1      1      1
## 50      1      1      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] 0.74
## [1] 0.86
## [1] 0.58
## [1] 0.86
## [1] 0.62
```

From the above algorithm accuracies, GBM and Rpart scored the best with 86%, then random forest with 74%.

```
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      1      0      0      0
## 46      0      0      0      0      0      0
## 47      0      0      1      1      1      1
```

```
## 48      0      0      1      1      0      0
## 49      0      0      1      1      1      1
## 50      0      0      1      1      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      1      1      1
## 48            0      0      1      1      0      0
## 49            0      0      1      1      1      1
## 50            0      0      1      1      1      0
## results    0.74    0.86    0.58    0.86    0.62    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	1
## 48	0	0	1
## 49	1	0	1
## 50	0	0	1
## 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       1           2
## 17            0       0       0         0       1           1
## 24            1       0       1         0       1           1
## 32            0       0       1         0       1           1
## 47            0       0       1         1       1           1
## 49            0       0       1         1       1           1
## Accuracy    0.14       0     0.57     0.29     0.71           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       1           2     1
## 49
## 17        0       0       0         0       1           1     1
## 67
## 24        1       0       1         0       1           1     1
## 95
## 32        0       0       1         0       1           1     1
## 139
## 47        0       0       1         1       1           1     1

```

```

235
## 49      0      0      1      1      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 Cross1.X2 Kneel.X2 Elbow1.X2
Hook1.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
##      Jab1.X2 Kick1.X2 upper1.X2 takedown1.X2 hammer1.X2 Cross21.X2 Knee21.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	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						
## 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						

## 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
## 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
##	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
## 160                44                      1              0          13
##      cmTotHitsM.X1 TotLandsX1  Notes Cross1.X1 Knee1.X1 Elbow1.X1 Hook1.X1
## 46                30          2    Tate        0        0          0        0
## 160                22          2 Rousey        0        0          0        0
##      Jab1.X1 Kick1.X1 upper1.X1 takedown1.X1 hammer1.X1 Cross21.X1
Knee21.X1
## 46          1          0          0          0          0          1
0
## 160          1          0          0          0          0          1
0
##      Elbow21.X1 Hook21.X1 Jab21.X1 Kick21.X1 upper21.X1 takedown21.X1
## 46              0          0          0          0          0          0
## 160              0          0          0          0          0          0
##      hammer21.X1 Cross31.X1 Knee31.X1 Elbow31.X1 Hook31.X1 Jab31.X1
Kick31.X1
## 46              0          0          0          0          0          0
0
## 160              0          0          0          0          0          0
0
##      upper31.X1 takedown31.X1 hammer31.X1
## 46              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                44                      1              0          13
## 3                164                      1              2          10
## 4                44                      1              0          13
## 5                164                      1              2          10
## 6                44                      1              0          13
## 7                164                      1              2          10
## 8                44                      1              0          13
## 9                164                      1              2          10
## 10               44                      1              0          13
```



## 11	164	1	2	10
## 12	44	1	0	13
## 13	164	1	2	10
## 14	44	1	0	13
## 15	164	1	2	10
## 16	44	1	0	13
## 17	164	1	2	10
## 18	44	1	0	13
## 19	164	1	2	10
## 20	44	1	0	13
## 21	164	1	2	10
## 22	44	1	0	13
## 23	164	1	2	10
## 24	44	1	0	13
## 25	164	1	2	10
## 26	44	1	0	13
## 27	164	1	2	10
## 28	44	1	0	13
## 29	164	1	2	10
## 30	44	1	0	13
## 31	164	1	2	10
## 32	44	1	0	13
## 33	164	1	2	10
## 34	44	1	0	13
## 35	164	1	2	10
## 36	44	1	0	13
## 37	164	1	2	10
## 38	44	1	0	13
## 39	164	1	2	10
## 40	44	1	0	13
## 41	164	1	2	10
## 42	44	1	0	13
## 43	164	1	2	10
## 44	44	1	0	13
## 45	164	1	2	10
## 46	44	1	0	13
## 47	164	1	2	10
## 48	44	1	0	13
## 49	164	1	2	10
## 50	44	1	0	13
## 51	164	1	2	10
## 52	44	1	0	13
## 53	164	1	2	10
## 54	44	1	0	13

##	cmTotHitsM.X1	TotLandsX1	Notes	actionReaction	actionCounts
## 1	30	2	Tate	Cross1.X1	0
## 2	22	2	Rousey	Cross1.X1	0
## 3	30	2	Tate	Kneel.X1	0
## 4	22	2	Rousey	Kneel.X1	0
## 5	30	2	Tate	Elbow1.X1	0

## 6	22	2 Rousey	Elbow1.X1	0
## 7	30	2 Tate	Hook1.X1	0
## 8	22	2 Rousey	Hook1.X1	0
## 9	30	2 Tate	Jab1.X1	1
## 10	22	2 Rousey	Jab1.X1	1
## 11	30	2 Tate	Kick1.X1	0
## 12	22	2 Rousey	Kick1.X1	0
## 13	30	2 Tate	upper1.X1	0
## 14	22	2 Rousey	upper1.X1	0
## 15	30	2 Tate	takedown1.X1	0
## 16	22	2 Rousey	takedown1.X1	0
## 17	30	2 Tate	hammer1.X1	0
## 18	22	2 Rousey	hammer1.X1	0
## 19	30	2 Tate	Cross21.X1	1
## 20	22	2 Rousey	Cross21.X1	1
## 21	30	2 Tate	Knee21.X1	0
## 22	22	2 Rousey	Knee21.X1	0
## 23	30	2 Tate	Elbow21.X1	0
## 24	22	2 Rousey	Elbow21.X1	0
## 25	30	2 Tate	Hook21.X1	0
## 26	22	2 Rousey	Hook21.X1	0
## 27	30	2 Tate	Jab21.X1	0
## 28	22	2 Rousey	Jab21.X1	0
## 29	30	2 Tate	Kick21.X1	0
## 30	22	2 Rousey	Kick21.X1	0
## 31	30	2 Tate	upper21.X1	0
## 32	22	2 Rousey	upper21.X1	0
## 33	30	2 Tate	takedown21.X1	0
## 34	22	2 Rousey	takedown21.X1	0
## 35	30	2 Tate	hammer21.X1	0
## 36	22	2 Rousey	hammer21.X1	0
## 37	30	2 Tate	Cross31.X1	0
## 38	22	2 Rousey	Cross31.X1	0
## 39	30	2 Tate	Knee31.X1	0
## 40	22	2 Rousey	Knee31.X1	0
## 41	30	2 Tate	Elbow31.X1	0
## 42	22	2 Rousey	Elbow31.X1	0
## 43	30	2 Tate	Hook31.X1	0
## 44	22	2 Rousey	Hook31.X1	0
## 45	30	2 Tate	Jab31.X1	0
## 46	22	2 Rousey	Jab31.X1	0
## 47	30	2 Tate	Kick31.X1	0
## 48	22	2 Rousey	Kick31.X1	0
## 49	30	2 Tate	upper31.X1	0
## 50	22	2 Rousey	upper31.X1	0
## 51	30	2 Tate	takedown31.X1	0
## 52	22	2 Rousey	takedown31.X1	0
## 53	30	2 Tate	hammer31.X1	0
## 54	22	2 Rousey	hammer31.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
## 9	164	1	2	10
## 10	44	1	0	13
## 19	164	1	2	10
## 20	44	1	0	13

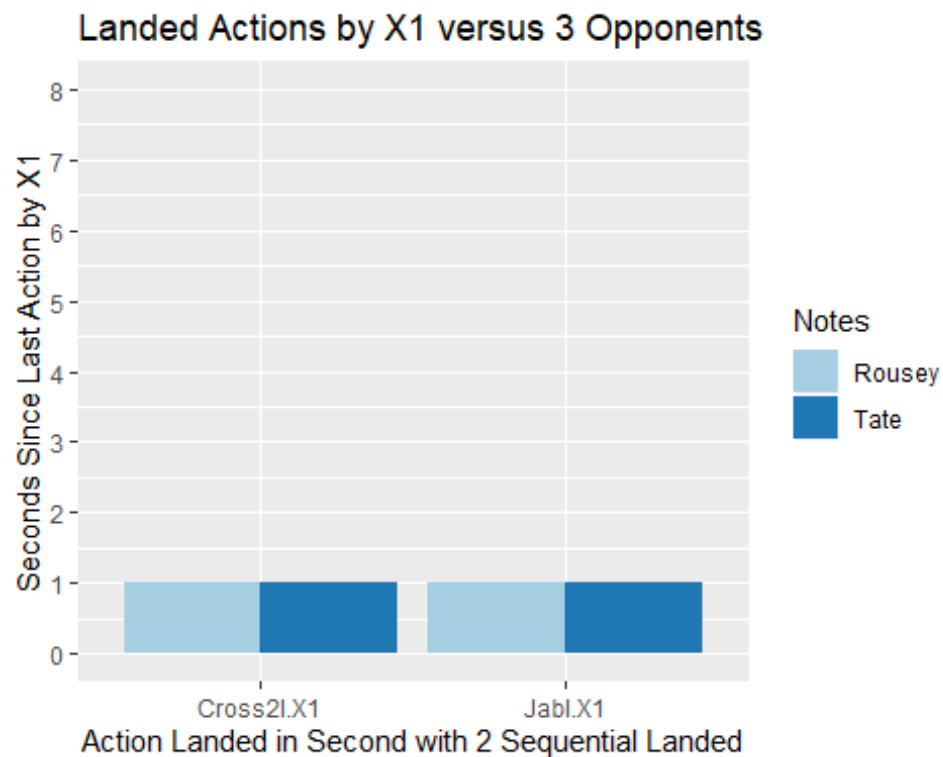
  

	cmTotHitsM.X1	TotLandsX1	Notes	actionReaction	actionCounts
## 9	30	2	Tate	Jabl.X1	1
## 10	22	2	Rousey	Jabl.X1	1
## 19	30	2	Tate	Cross2l.X1	1
## 20	22	2	Rousey	Cross2l.X1	1

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 shows that the combo used by Nunez was a jab and cross for the double hits landed on Rousey and Tate, but not on Pennington.

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

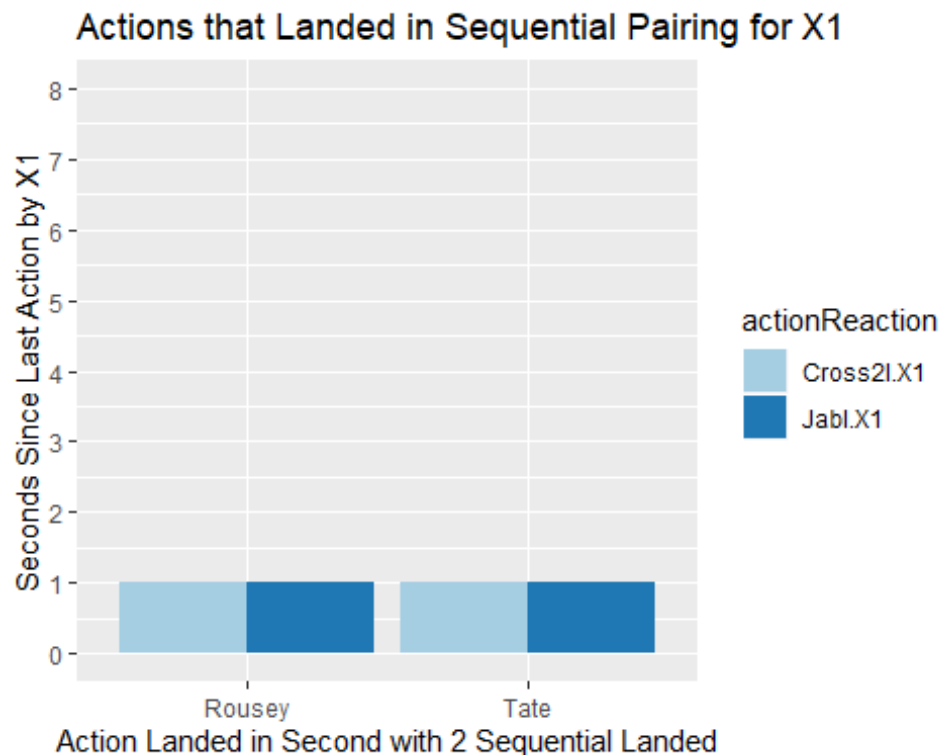
```
##      SecondsLastRoundAction TotLandsX1  Notes Crossl.X1 Kneel.X1 Elbowl.X1
## 46              1          2   Tate      0      0      0
## 160             1          2 Rousey      0      0      0
##      Hookl.X1 Jabl.X1 Kickl.X1 upperl.X1 takedownl.X1 hammerl.X1 Cross2l.X1
## 46          0      1      0      0      0      0      1
## 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
## 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
## 160          0      0      0      0      0      0
0
##      upper3l.X1 takedown3l.X1 hammer3l.X1
```

```
## 46          0          0          0
## 160         0          0          0

plot2plus <- x1_2plus_lands_counts # originally REGEX error
x1_2plus_lands_counts$Notes != 'Pennington')
plot2plus

##      SecondsIntoRound SecondsLastRoundAction cmTotHitsR.X1 cmTotHitsL.X1
## 9                164                1                2                10
## 10               44                1                0                13
## 19               164                1                2                10
## 20               44                1                0                13
##      cmTotHitsM.X1 TotLandsX1  Notes actionReaction actionCounts
## 9                 30         2   Tate      Jabl.X1             1
## 10                22         2 Rousey      Jabl.X1             1
## 19                 30         2   Tate      Cross2l.X1          1
## 20                 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	Cross1.X1	1
## 27	0	8	Rousey	Cross1.X1	1
## 32	0	10	Rousey	Cross1.X1	1
## 34	0	10	Rousey	Cross1.X1	1
## 165	0	6	Rousey	Jab1.X1	1
## 167	0	6	Rousey	Jab1.X1	1
## 170	0	7	Rousey	Jab1.X1	1
## 174	0	10	Rousey	Jab1.X1	1
## 179	0	10	Rousey	Jab1.X1	1
## 180	0	10	Rousey	Jab1.X1	1
## 341	0	3	Rousey	Cross21.X1	1
## 355	0	10	Rousey	Cross21.X1	1
## 359	0	10	Rousey	Cross21.X1	1
## 484	0	2	Rousey	Jab21.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.

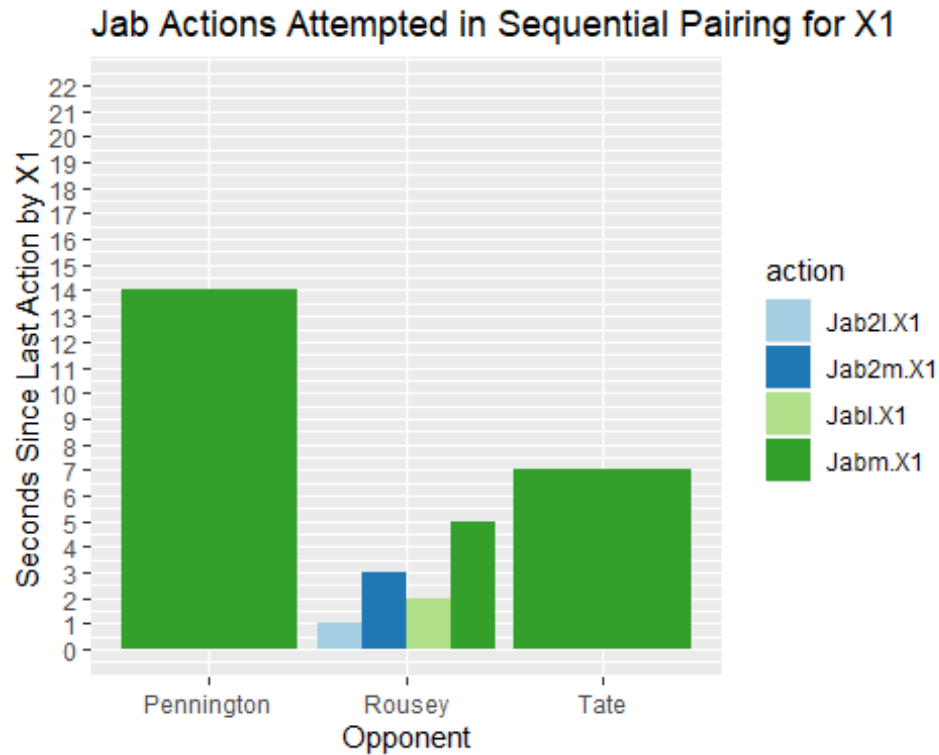
Lets look at the jabs only first then the cross only. We will look at the seconds since last action, the opponent as Notes, and cumulative hits missed and landed by X1. But not in the same bar chart because that is beyond the three dimension capability.

```
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
Jab1.X1					
## 167	13	1	0	0	Rousey
Jab1.X1					
## 170	16	1	0	0	Rousey
Jab1.X1					
## 174	20	1	1	0	Rousey
Jab1.X1					
## 179	22	2	0	0	Rousey
Jab1.X1					
## 180	22	1	0	0	Rousey
Jab1.X1					
## 484	5	1	1	0	Rousey
Jab21.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')
```

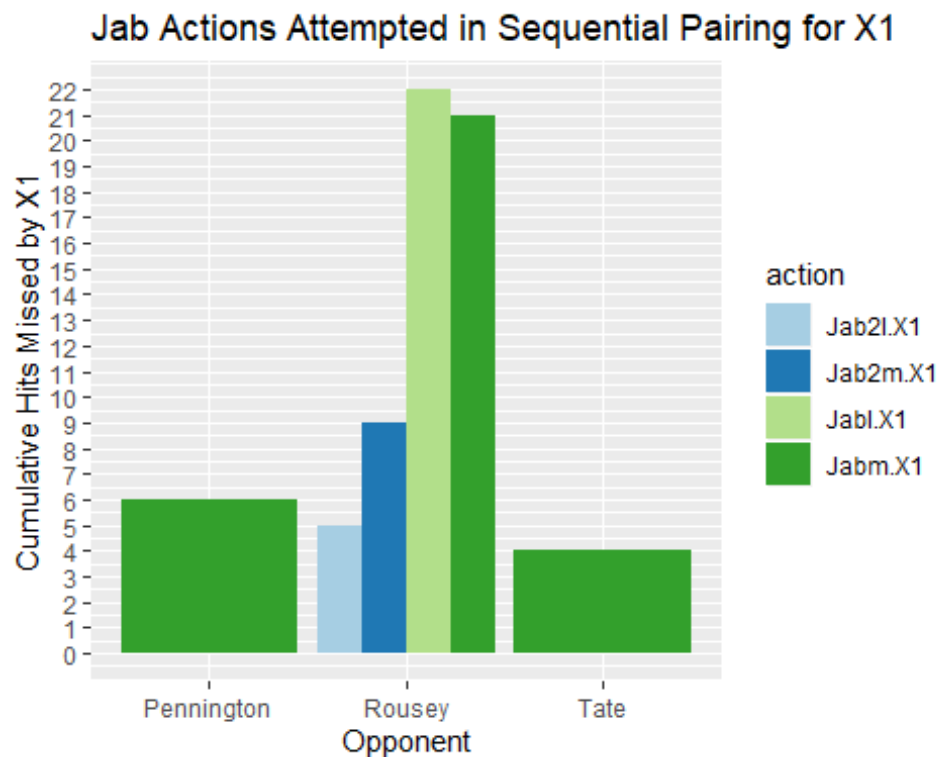


Take note that from the outcomes of these fights and after looking at the plot above, Pennington went to decision and lasted all five rounds of five minutes each and has more seconds between actions attempted by Nunez looking at the most landed hit and attempted hit by Nunez, the jab. The Rousey fight 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')
```

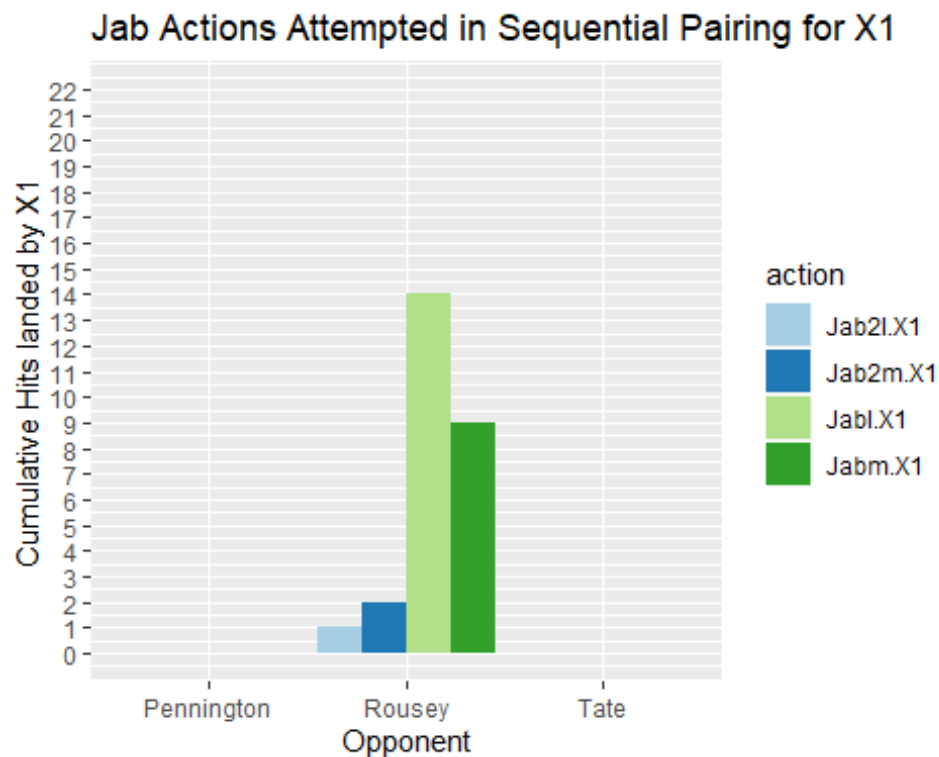


Nunez has more cumulative hits missed, which means she is taking more risks to get the fight over and done with when looking at her short lived fighting event with Rousey as you can see in the bar chart above.

---

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

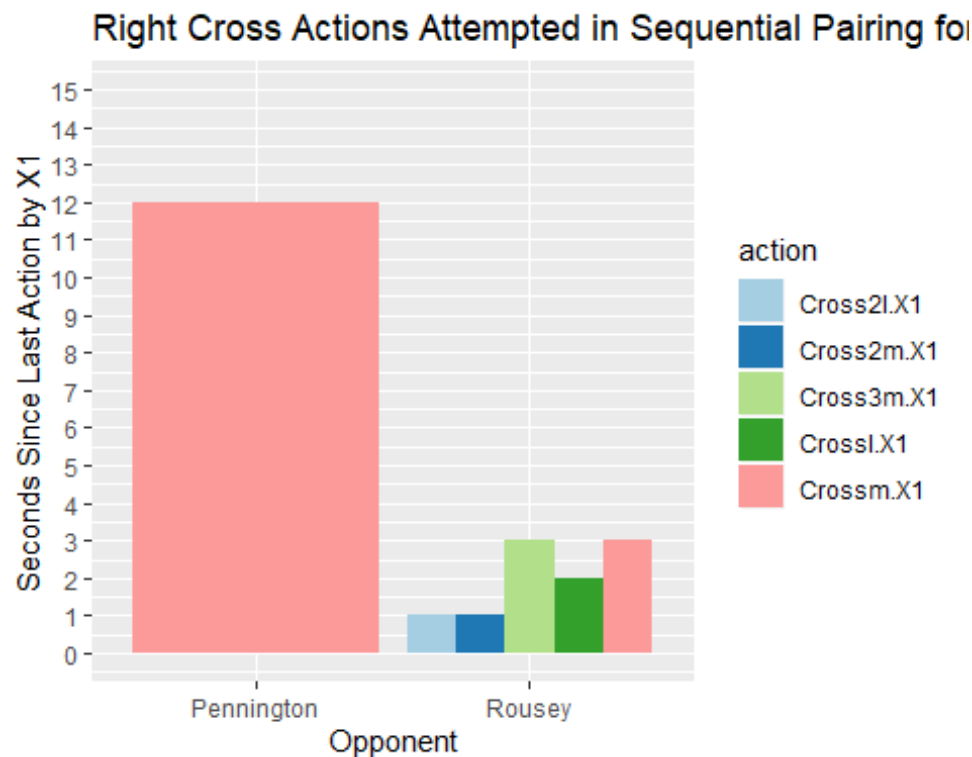


## 1005	41		1	0	10
## 1317	22		1	0	4
## 1318	23		1	0	4
## 1324	31		1	0	7
## 1326	35		1	0	8
## 1638	14		3	0	2
##	cmTotHitsM.X1	TotLandsX1	TotMissedX1	TotReceivedX1	Notes
action					
## 20	10	1	0	0	Rousey
Cross1.X1					
## 27	16	1	0	0	Rousey
Cross1.X1					
## 32	21	1	0	0	Rousey
Cross1.X1					
## 34	22	1	0	0	Rousey
Cross1.X1					
## 341	6	1	1	0	Rousey
Cross21.X1					
## 355	21	1	1	0	Rousey
Cross21.X1					
## 359	22	2	0	0	Rousey
Cross21.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.

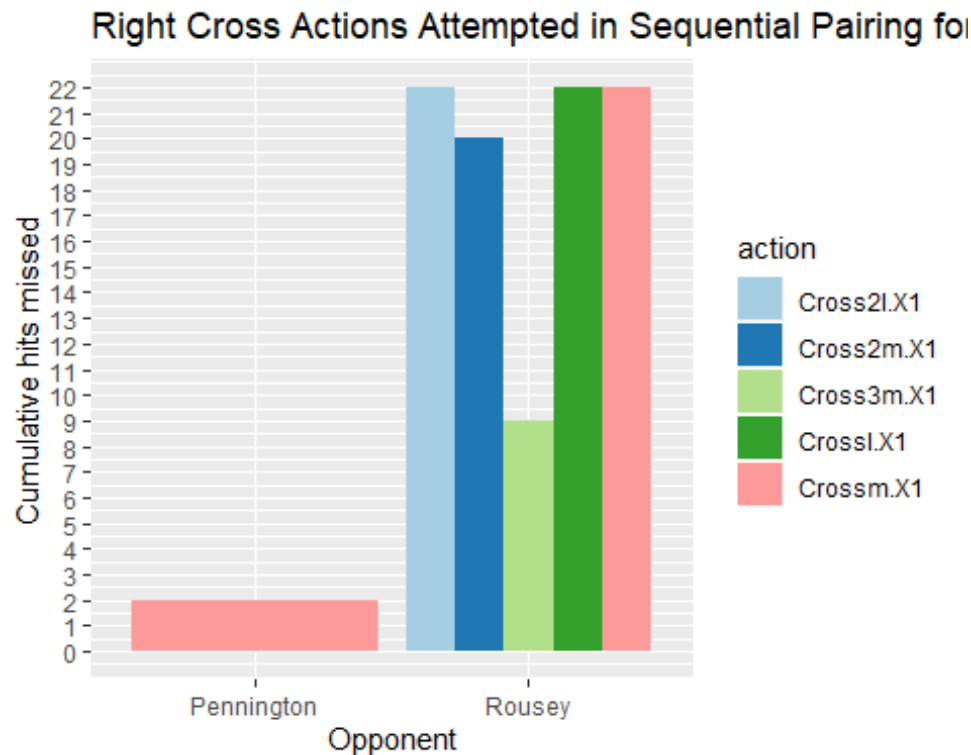
```
ggplot(data = cross, aes(x=Notes, y=SecondsLastRoundAction, fill=action)) +
  geom_bar(stat='identity', position=position_dodge()) +
  scale_y_continuous(breaks = seq(0, 15, by=1), limits=c(0,15)) +
  scale_fill_brewer(palette='Paired') +
  ggtitle('Right Cross Actions Attempted in Sequential Pairing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

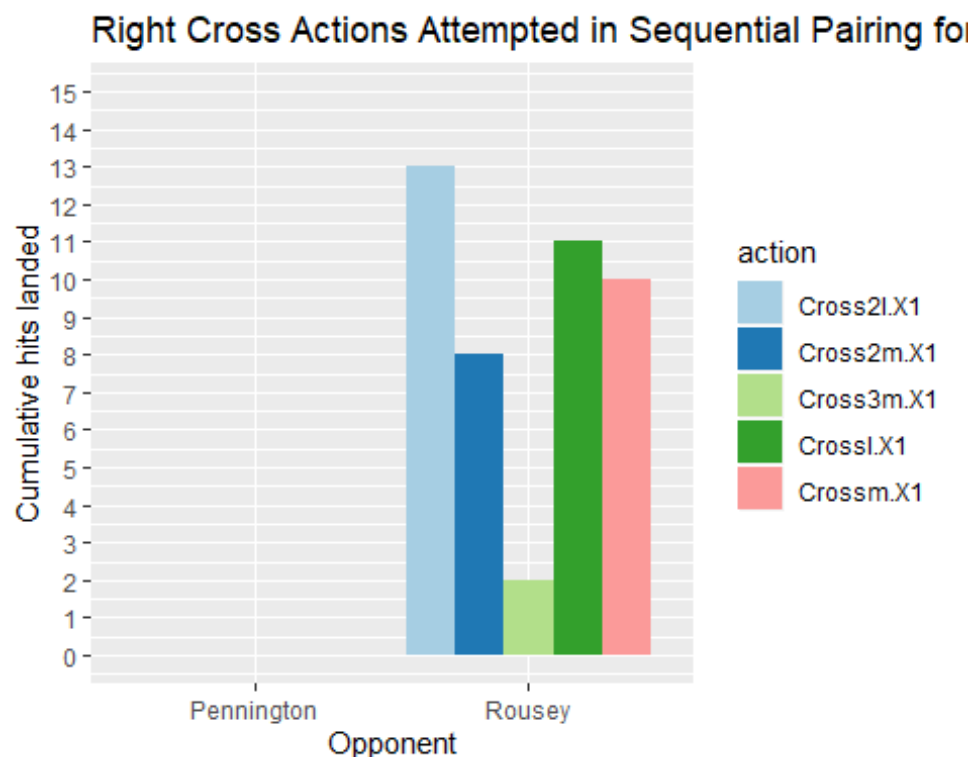
```
ggplot(data = cross, aes(x=Notes, y=cmTotHitsM.X1, fill=action)) +
  geom_bar(stat='identity', position=position_dodge()) +
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22)) +
  scale_fill_brewer(palette='Paired') +
  ggtitle('Right Cross Actions Attempted in Sequential Pairing for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

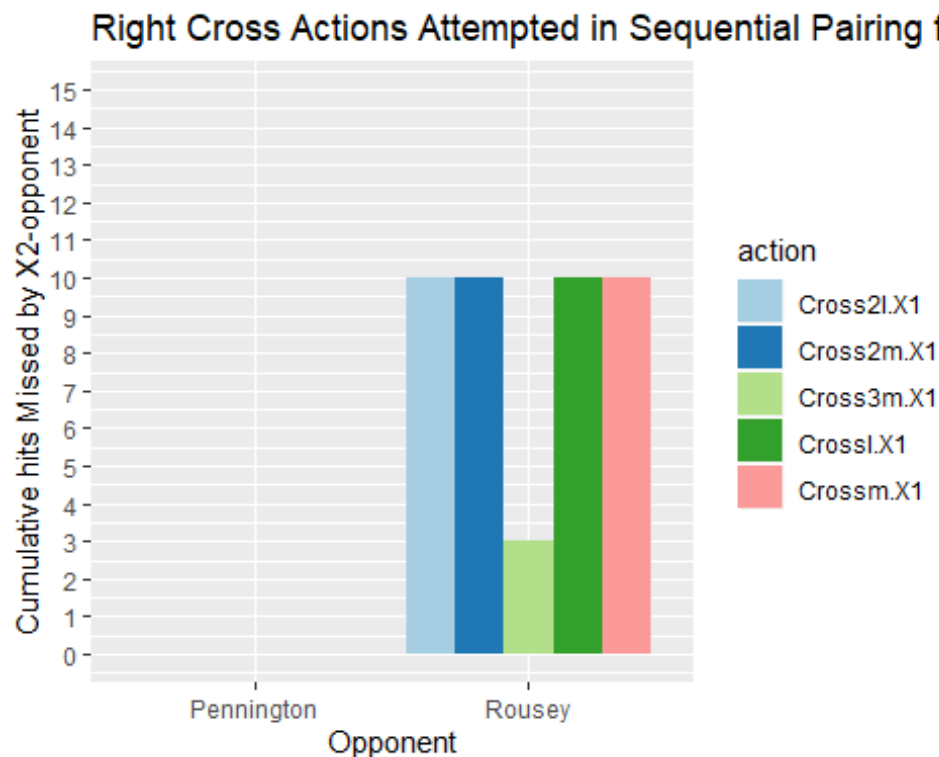
```
cross1 <- minute3_tidy1[grep('Cross', minute3_tidy1$action),]
cross1
```

##	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	Cross1.X1	1
## 27	0	8	Rousey	Cross1.X1	1
## 32	0	10	Rousey	Cross1.X1	1
## 34	0	10	Rousey	Cross1.X1	1
## 341	0	3	Rousey	Cross21.X1	1
## 355	0	10	Rousey	Cross21.X1	1
## 359	0	10	Rousey	Cross21.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

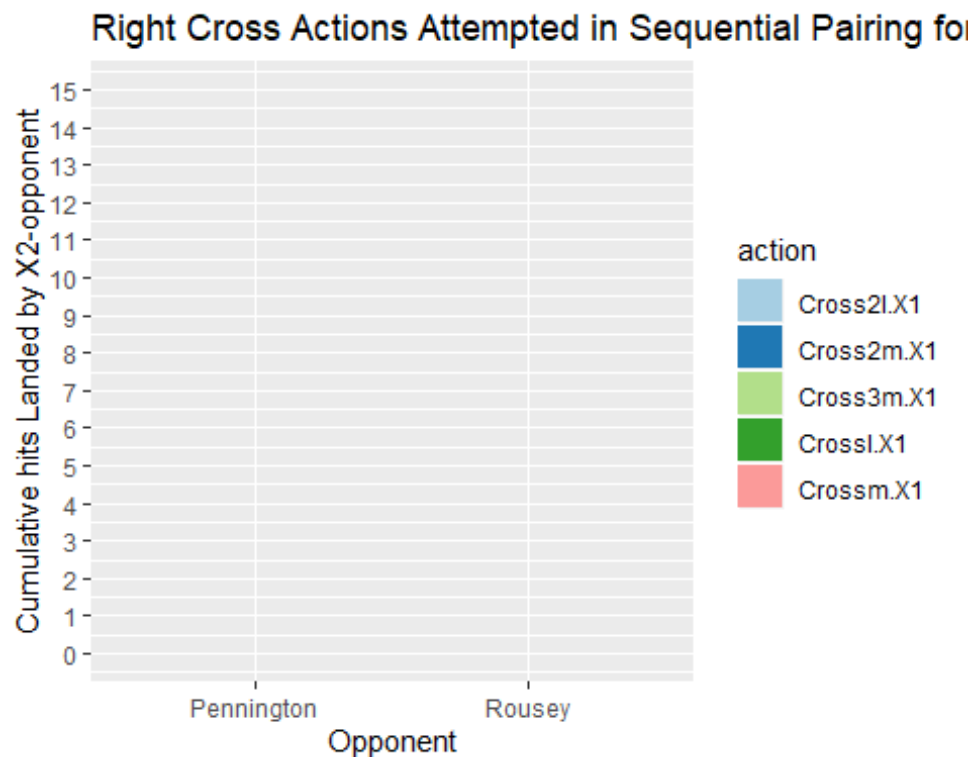
```
## 997          0          6    Rousey  Crossm.X1          1
## 1005         0         10    Rousey  Crossm.X1          1
## 1317         0          6    Rousey Cross2m.X1          1
## 1318         0          6    Rousey Cross2m.X1          1
## 1324         0          9    Rousey Cross2m.X1   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

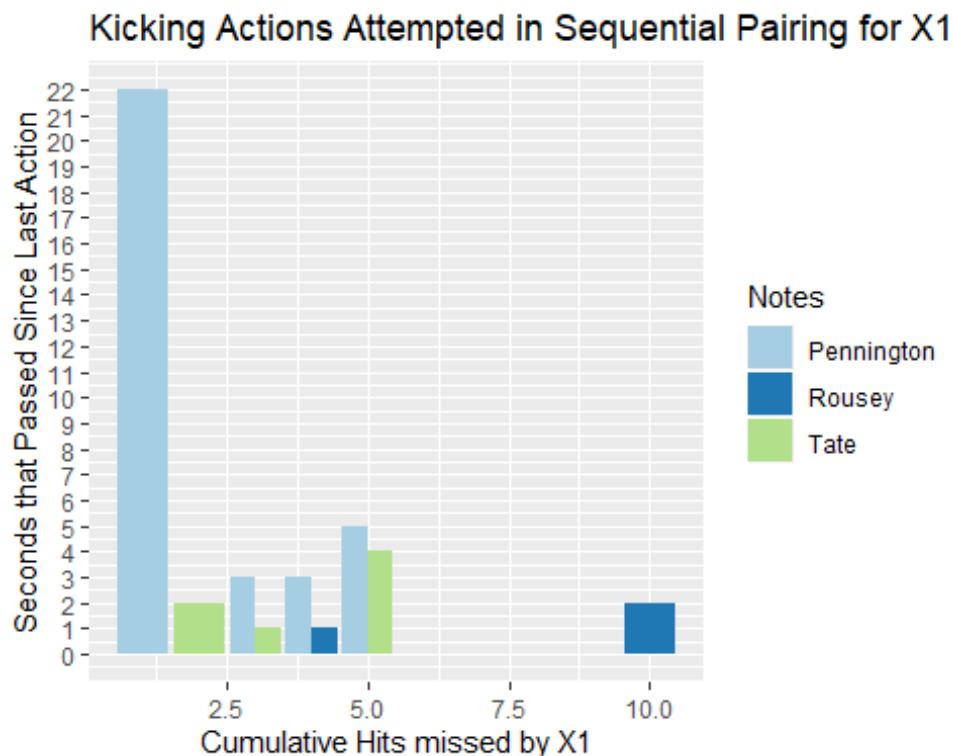
  

##	cmTotHitsM.X1	TotLandsX1	TotMissedX1	TotReceivedX1	cmTotHitsR.X2
## 1154	2	0	1	0	0



## 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

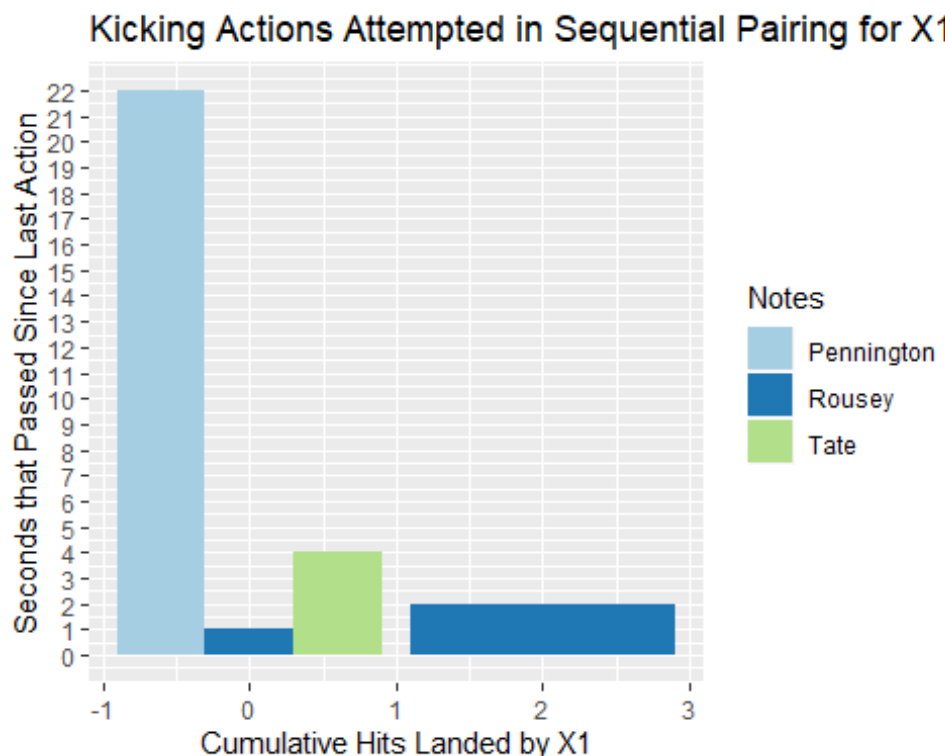
```
ggplot(data = kick, aes(x=cmTotHitsM.X1, y=SecondsLastRoundAction,
fill=Notes)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Kicking Actions Attempted in Sequential Pairing 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.

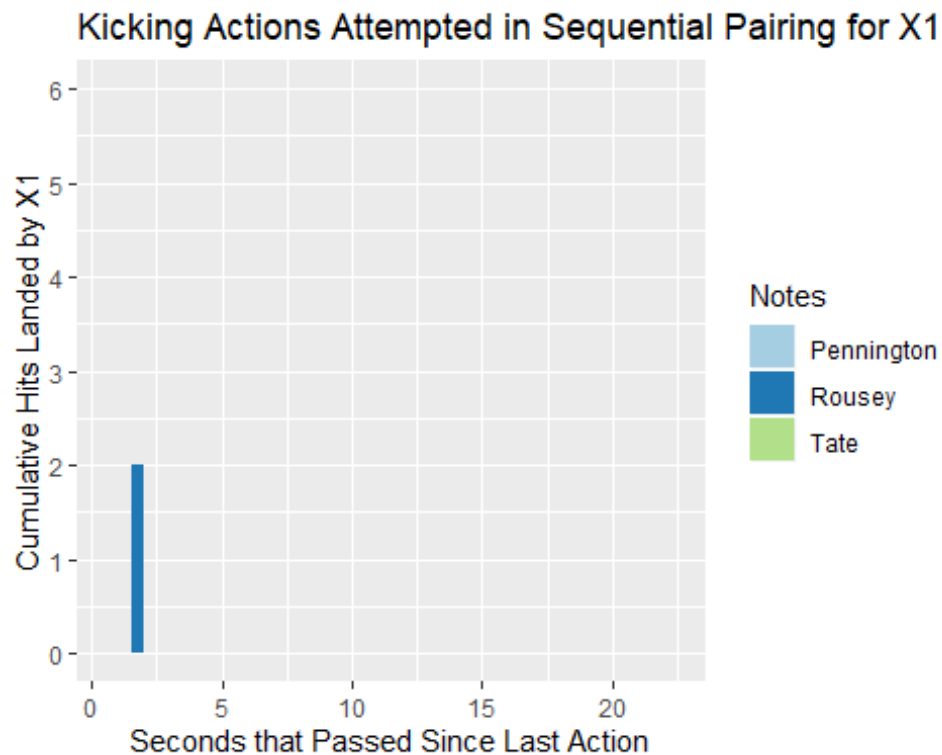
```
ggplot(data = kick, aes(x=cmTotHitsL.X1, y=SecondsLastRoundAction,
fill=Notes)) +
  geom_bar(stat='identity', position=position_dodge())+
  scale_y_continuous(breaks = seq(0, 22, by=1), limits=c(0,22))+
  scale_fill_brewer(palette='Paired') +
  ggtitle('Kicking Actions Attempted in Sequential Pairing 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 discrete, 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 neighbor, 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.