Detroit Tigers Baseball Analytics Questionnaire

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Packages

```r
library(readr)
library(ggplot2)
library(dplyr)
library(DescTools)
library(kableExtra)
```

Data

```r
df <- read_csv("~/Desktop/R-Projects/Baseball Analytics/Detroit Tigers Baseball Analytics/AnalyticsQues

head(df)

names(df)

# Check for NA values in each column
na_counts <- colSums(is.na(df))

# Identify columns with NA values
columns_with_na <- names(na_counts[na_counts > 0])

# Print the columns with NA values
print(columns_with_na)

# Replace NA values with column means
df <- df %>%
  mutate_all(funs(ifelse(is.na(.), mean(., na.rm = TRUE), .)))

# Print data frame
df
```

```r
game1 <- df %>% filter(GamePk == 1)
game2 <- df %>% filter(GamePk == 2)
```

GAME 1

```r
summary(game1)
```

```
##      PitchId          GamePk  PitcherHand        PitchCall
##  Min.   :  1.0   Min.   :1   Length:361        Length:361
##  1st Qu.:161.0   1st Qu.:1   Class :character   Class :character
```

1

```
##  Median :326.0   Median :1   Mode  :character   Mode  :character
##  Mean   :318.2   Mean   :1
##  3rd Qu.:474.0   3rd Qu.:1
##  Max.   :620.0   Max.   :1
##   PitchType          BatterId        PitcherId        BatterSide
##  Length:361       Min.   : 1.00   Min.   : 1.000   Length:361
##  Class :character 1st Qu.:14.00   1st Qu.: 1.000   Class :character
##  Mode  :character Median :20.00   Median : 6.000   Mode  :character
##                   Mean   :20.64   Mean   : 6.837
##                   3rd Qu.:29.00   3rd Qu.:11.000
##                   Max.   :36.00   Max.   :16.000
##     Inning          IsTop           Balls           Strikes
##  Min.   : 0.000  Min.   :0.000  Min.   :0.0000  Min.   :0.0000
##  1st Qu.: 3.000  1st Qu.:0.000  1st Qu.:0.0000  1st Qu.:0.0000
##  Median : 5.000  Median :0.000  Median :1.0000  Median :1.0000
##  Mean   : 5.305  Mean   :0.482  Mean   :0.9446  Mean   :0.8283
##  3rd Qu.: 8.000  3rd Qu.:1.000  3rd Qu.:2.0000  3rd Qu.:2.0000
##  Max.   :10.000  Max.   :1.000  Max.   :3.0000  Max.   :2.0000
##      Outs          PostBalls       PostStrikes       PostOuts
##  Min.   :0.0000  Min.   :0.000  Min.   :0.000   Min.   :0.000
##  1st Qu.:0.0000  1st Qu.:1.000  1st Qu.:1.000   1st Qu.:0.000
##  Median :1.0000  Median :1.000  Median :1.000   Median :1.000
##  Mean   :0.9224  Mean   :1.294  Mean   :1.202   Mean   :1.089
##  3rd Qu.:2.0000  3rd Qu.:2.000  3rd Qu.:2.000   3rd Qu.:2.000
##  Max.   :2.0000  Max.   :4.000  Max.   :3.000   Max.   :3.000
##   PitchNumber      AtBatNumber      AwayTeamID     VenueID     HomeTeamID
##  Min.   :0.000   Min.   : 1.00   Min.   :1   Min.   :1   Min.   :2
##  1st Qu.:1.000   1st Qu.:23.00   1st Qu.:1   1st Qu.:1   1st Qu.:2
##  Median :3.000   Median :42.00   Median :1   Median :1   Median :2
##  Mean   :2.828   Mean   :42.71   Mean   :1   Mean   :1   Mean   :2
##  3rd Qu.:4.000   3rd Qu.:63.00   3rd Qu.:1   3rd Qu.:1   3rd Qu.:2
##  Max.   :8.000   Max.   :86.00   Max.   :1   Max.   :1   Max.   :2
##  StrikeZoneTop   StrikeZoneBottom ReleaseExtension  ReleaseAngle
##  Min.   :3.040   Min.   :1.360    Min.   :5.462    Min.   :-4.5470
##  1st Qu.:3.320   1st Qu.:1.530    1st Qu.:6.087    1st Qu.:-1.9344
##  Median :3.390   Median :1.590    Median :6.299    Median :-1.1341
##  Mean   :3.413   Mean   :1.589    Mean   :6.280    Mean   :-1.0736
##  3rd Qu.:3.490   3rd Qu.:1.630    3rd Qu.:6.451    3rd Qu.:-0.4195
##  Max.   :4.000   Max.   :1.860    Max.   :7.374    Max.   : 2.8501
##  ReleaseSpinAxis  ReleasePositionX ReleasePositionY ReleasePositionZ
##  Min.   : 22.59   Min.   :-3.591   Min.   :53.13   Min.   :5.184
##  1st Qu.:133.91   1st Qu.:-3.268   1st Qu.:54.05   1st Qu.:5.466
##  Median :177.98   Median :-1.531   Median :54.20   Median :5.635
##  Mean   :183.27   Mean   :-0.822   Mean   :54.22   Mean   :5.672
##  3rd Qu.:224.02   3rd Qu.: 1.809   3rd Qu.:54.41   3rd Qu.:5.775
##  Max.   :329.70   Max.   : 3.028   Max.   :55.04   Max.   :6.513
##   ReleaseSpeed     ReleaseDirection ReleaseSpinRate TrajectoryHorizontalBreak
##  Min.   : 73.47   Min.   :-6.389   Min.   :1252   Min.   :-1.50081
##  1st Qu.: 85.93   1st Qu.:-3.785   1st Qu.:2270   1st Qu.:-0.60679
##  Median : 90.16   Median :-1.439   Median :2390   Median : 0.03341
##  Mean   : 89.85   Mean   :-1.021   Mean   :2314   Mean   :-0.03410
##  3rd Qu.: 94.12   3rd Qu.: 1.975   3rd Qu.:2485   3rd Qu.: 0.58418
##  Max.   :101.62   Max.   : 5.693   Max.   :3084   Max.   : 1.26686
##  TrajectoryVerticalBreakInduced TrajectoryZoneSpeed
```

```
##  Min.   :-0.8725               Min.   :69.13
##  1st Qu.: 0.1534               1st Qu.:79.49
##  Median : 0.4823               Median :83.09
##  Mean   : 0.4181               Mean   :82.55
##  3rd Qu.: 0.9474               3rd Qu.:86.30
##  Max.   : 1.5362               Max.   :92.12
##  TrajectoryVerticalApproachAngle TrajectoryPfxHorz   TrajectoryPfxVert
##  Min.   :-11.864                 Min.   :-0.807437  Min.   :-0.4832
##  1st Qu.: -7.713                 1st Qu.:-0.393620  1st Qu.: 0.1087
##  Median : -6.535                 Median :-0.020824  Median : 0.2847
##  Mean   : -6.644                 Mean   :-0.001425  Mean   : 0.2502
##  3rd Qu.: -5.450                 3rd Qu.: 0.342349  3rd Qu.: 0.5456
##  Max.   : -2.770                 Max.   : 0.860394  Max.   : 0.8931
##  TrajectoryEffectiveVelocity TrajectoryHorizontalApproachAngle
##  Min.   :74.27                Min.   :-7.002
##  1st Qu.:85.46                1st Qu.:-3.019
##  Median :89.30                Median :-1.339
##  Mean   :89.12                Mean   :-1.099
##  3rd Qu.:93.54                3rd Qu.: 1.044
##  Max.   :99.82                Max.   : 5.925
##  TrajectoryVerticalBreak TrajectoryLocationX TrajectoryLocationY
##  Min.   :-4.828          Min.   :-2.1307     Min.   :1.417
##  1st Qu.:-2.913          1st Qu.:-0.4135     1st Qu.:1.417
##  Median :-2.422          Median : 0.1792     Median :1.417
##  Mean   :-2.485          Mean   : 0.1598     Mean   :1.417
##  3rd Qu.:-1.659          3rd Qu.: 0.7377     3rd Qu.:1.417
##  Max.   :-1.040          Max.   : 1.9309     Max.   :1.417
##  TrajectoryLocationZ SpinVectorX       SpinVectorY       SpinVectorZ
##  Min.   :-0.5946     Min.   :-2203.9   Min.   :-2725.0   Min.   :-1996.0
##  1st Qu.: 1.6073     1st Qu.:-1471.4   1st Qu.:-1586.1   1st Qu.:-1296.2
##  Median : 2.2760     Median : -837.7   Median : -591.1   Median : -141.0
##  Mean   : 2.1975     Mean   : -720.8   Mean   : -221.8   Mean   : -103.1
##  3rd Qu.: 2.7946     3rd Qu.: -569.1   3rd Qu.: 1548.6   3rd Qu.: 1008.1
##  Max.   : 4.5413     Max.   : 2555.0   Max.   : 2368.4   Max.   : 1980.1
##   SpinFitError      TrajectoryZoneTime TrajectoryPolynomialX0
##  Min.   :0.08592   Min.   :0.3764     Min.   :-3.5659
##  1st Qu.:0.14050   1st Qu.:0.4031     1st Qu.:-3.2521
##  Median :0.16860   Median :0.4202     Median :-1.5444
##  Mean   :0.17718   Mean   :0.4240     Mean   :-0.8164
##  3rd Qu.:0.19746   3rd Qu.:0.4401     3rd Qu.: 1.8107
##  Max.   :0.52662   Max.   :0.5063     Max.   : 3.0293
##  TrajectoryPolynomialX1 TrajectoryPolynomialX2 TrajectoryPolynomialY0
##  Min.   :-13.458        Min.   :-9.8359        Min.   :54.13
##  1st Qu.: -4.422        1st Qu.:-4.5399        1st Qu.:54.13
##  Median :  3.340        Median :-0.2358        Median :54.13
##  Mean   :  2.387        Mean   :-0.1397        Mean   :54.13
##  3rd Qu.:  8.362        3rd Qu.: 3.4519        3rd Qu.:54.13
##  Max.   : 15.532        Max.   : 8.5311        Max.   :54.14
##  TrajectoryPolynomialY1 TrajectoryPolynomialY2 TrajectoryPolynomialZ0
##  Min.   :-145.5         Min.   : 7.701         Min.   :5.179
##  1st Qu.:-135.7         1st Qu.:10.184         1st Qu.:5.463
##  Median :-130.2         Median :11.456         Median :5.637
##  Mean   :-129.6         Mean   :11.299         Mean   :5.671
##  3rd Qu.:-124.2         3rd Qu.:12.271         3rd Qu.:5.769
```

```
## Max.   :-108.5        Max.   :15.232        Max.    :6.525
## TrajectoryPolynomialZ1 TrajectoryPolynomialZ2  TrajectoryX0
## Min.   :-10.7882       Min.    :-20.624       Min.    :-3.3665
## 1st Qu.: -4.4507       1st Qu.:-15.035        1st Qu.:-2.8931
## Median : -2.5871       Median :-13.175        Median :-1.4576
## Mean   : -2.5324       Mean    :-13.168       Mean    :-0.7424
## 3rd Qu.: -0.9129       3rd Qu.: -9.845        3rd Qu.: 1.6572
## Max.   :  5.5907       Max.    : -6.272       Max.    : 3.0040
##   TrajectoryX1     TrajectoryX2     TrajectoryV0      TrajectoryV1
## Min.   :50.00   Min.   :5.022   Min.   :-12.945   Min.    :-144.7
## 1st Qu.:50.00   1st Qu.:5.384   1st Qu.: -4.189   1st Qu.:-134.9
## Median :50.00   Median :5.537   Median :  3.297   Median :-129.4
## Mean   :50.00   Mean   :5.579   Mean   :  2.383   Mean    :-128.9
## 3rd Qu.:50.00   3rd Qu.:5.709   3rd Qu.:  8.287   3rd Qu.:-123.5
## Max.   :50.01   Max.   :6.445   Max.   : 14.954   Max.    :-107.8
##   TrajectoryV2       TrajectoryA0       TrajectoryA1     TrajectoryA2
## Min.   :-11.479   Min.    :-19.6718   Min.   :15.40   Min.    :-41.25
## 1st Qu.: -5.187   1st Qu.: -9.0797    1st Qu.:20.37   1st Qu.:-30.07
## Median : -3.416   Median : -0.4716    Median :22.91   Median :-26.35
## Mean   : -3.390   Mean    : -0.2794   Mean   :22.60   Mean    :-26.34
## 3rd Qu.: -1.824   3rd Qu.:  6.9037    3rd Qu.:24.54   3rd Qu.:-19.69
## Max.   :  4.214   Max.    : 17.0622   Max.   :30.46   Max.    :-12.54
```

```r
# Pitch counts
## Mean
mean(game1$ReleaseSpeed, na.rm = TRUE)
```

```
## [1] 89.84946
```

```r
## Total pitches
nrow(game1)
```

```
## [1] 361
```

```r
## Total strikes
called_strike_count1 <- sum(game1$PitchCall == "called_strike")
swinging_strike_count1 <- sum(game1$PitchCall == "swinging_strike")
strikeout_count1 <- sum(game1$PitchCall == "strikeout")
called_strike_count1+swinging_strike_count1+strikeout_count1
```

```
## [1] 85
```

```r
## Total ball
sum(game1$PitchCall == "ball")
```

```
## [1] 111
```

```r
# Pitch type
## Most common pitch type
pitch_count1 <- table(game1$PitchType)
names(pitch_count1)[which.max(pitch_count1)]
```

```
## [1] "FF"
```

```r
## Others pitch type
unique(game1$PitchType)
```

```
## [1] "CH"   "CU"   "SL"   "SI"   "NULL" "FF"   "FC"   "KC"
```

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```r
# Bar plot of the outcome distribution
pitch_call_counts1 <- as.data.frame(table(game1$PitchCall))
ggplot(pitch_call_counts1, aes(x = Var1, y = Freq)) +
  geom_bar(stat = "identity", fill = "skyblue") +
  geom_text(aes(label = Freq), vjust = -0.5, color = "black", size = 3) +
  labs(title = "Pitch Call Distribution (Game 1)", x = "Pitch Call", y = "Count") +
  theme_minimal()
```


Pitch Call Distribution (Game 1)
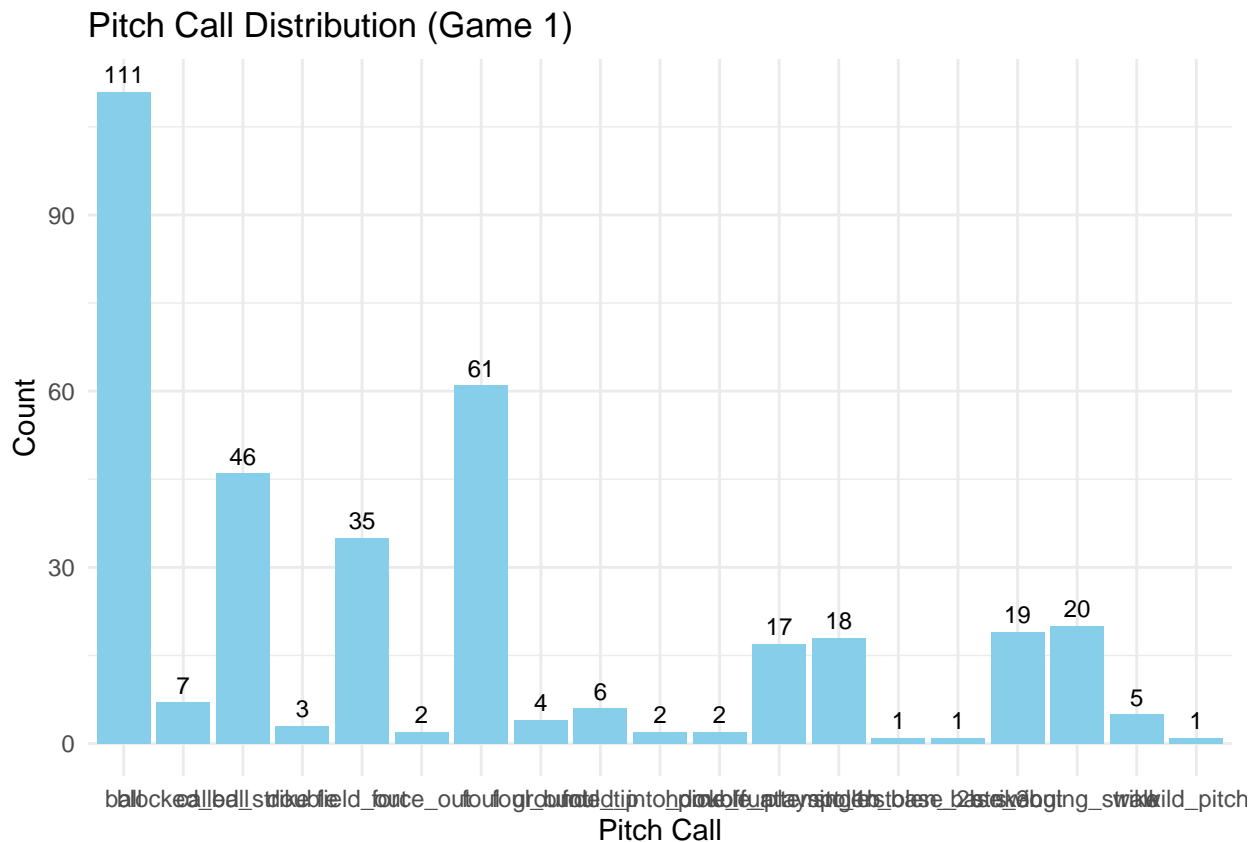
```r
# Plotting Histogram of Release Speed with Normal Curve
ggplot(game1, aes(x = ReleaseSpeed)) +
  geom_histogram(binwidth = 1, fill = 'blue', color = 'white', aes(y = ..density..)) +
  stat_function(fun = dnorm, args = list(mean = mean(game1$ReleaseSpeed), sd = sd(game1$ReleaseSpeed)),
                color = 'red', size = 1) +
  labs(title = 'Histogram of Release Speed with Normal Curve (Game 1)',
       x = 'Release Speed (mph)', y = 'Density') +
  theme_minimal()
```

```
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use `linewidth` instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
## Warning: The dot-dot notation (`..density..`) was deprecated in ggplot2 3.4.0.
## i Please use `after_stat(density)` instead.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

Histogram of Release Speed with Normal Curve (Game 1)
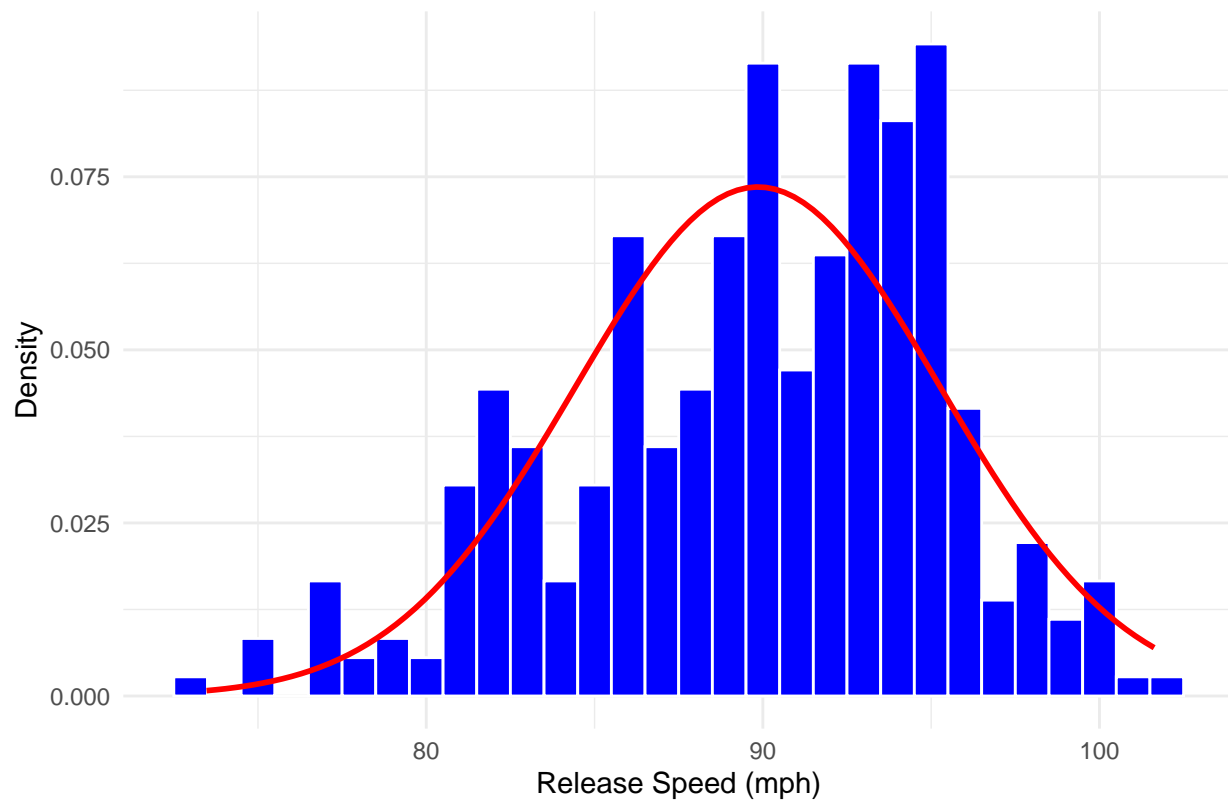

```
# Plotting Scatter Plot of Release Speed vs. Trajectory Effective Velocity
ggplot(game1, aes(x = ReleaseSpeed, y = TrajectoryEffectiveVelocity)) +
  geom_point(color = 'black') +
  labs(title = 'Scatter Plot of Release Speed vs. Trajectory Effective Velocity (Game 1)',
       x = 'Release Speed (mph)', y = 'Trajectory Effective Velocity') +
  theme_minimal()
```

Scatter Plot of Release Speed vs. Trajectory Effective Velocity (Game 1)
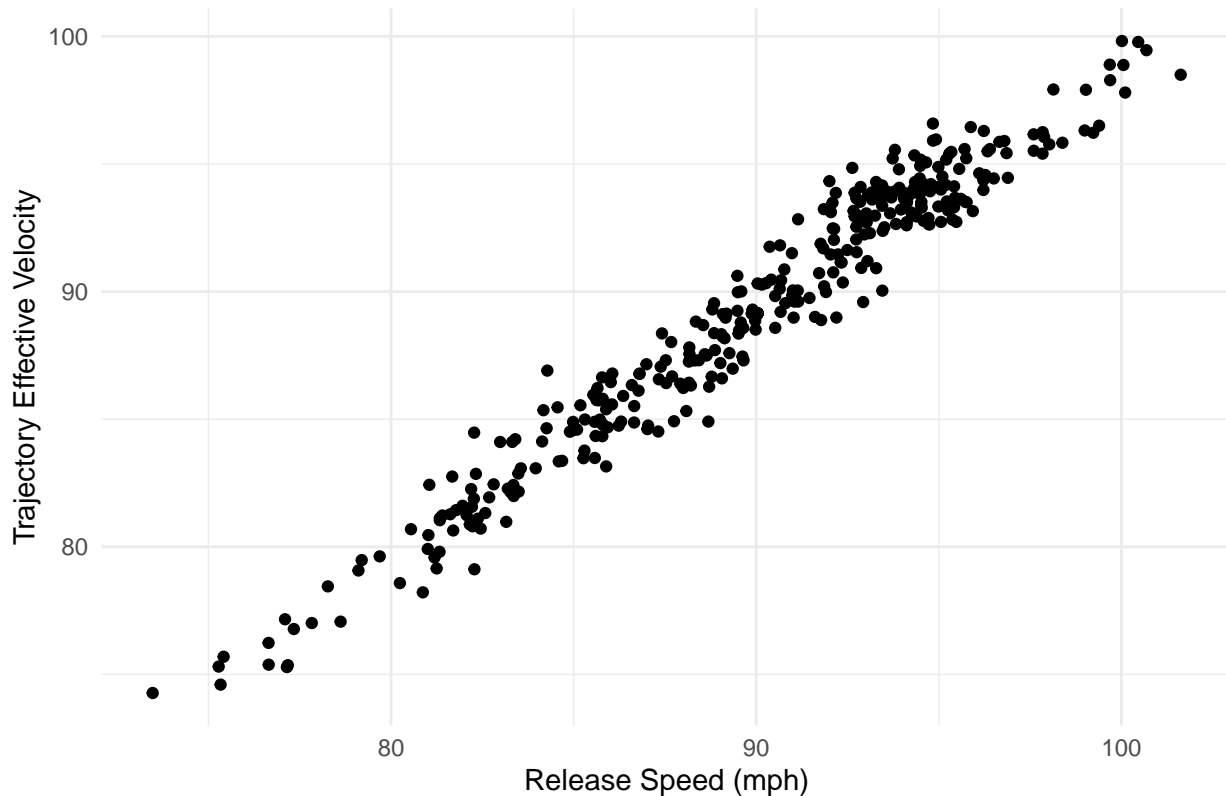
GAME 2

```r
summary(game2)
```

```
##     PitchId          GamePk  PitcherHand          PitchCall
##  Min.   :  4.0   Min.   :2   Length:259         Length:259
##  1st Qu.:149.0   1st Qu.:2   Class :character   Class :character
##  Median :292.0   Median :2   Mode  :character   Mode  :character
##  Mean   :299.7   Mean   :2
##  3rd Qu.:447.5   3rd Qu.:2
##  Max.   :619.0   Max.   :2
##   PitchType            BatterId        PitcherId        BatterSide
##  Length:259         Min.   : 1.00   Min.   : 1.00   Length:259
##  Class :character   1st Qu.: 8.00   1st Qu.: 1.00   Class :character
##  Mode  :character   Median :15.00   Median : 7.00   Mode  :character
##                     Mean   :16.27   Mean   : 6.12
##                     3rd Qu.:24.00   3rd Qu.: 9.00
##                     Max.   :37.00   Max.   :17.00
##     Inning           IsTop           Balls            Strikes
##  Min.   :1.000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:3.000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000
##  Median :5.000   Median :1.0000   Median :1.0000   Median :1.0000
##  Mean   :5.274   Mean   :0.5135   Mean   :0.8726   Mean   :0.7954
##  3rd Qu.:8.000   3rd Qu.:1.0000   3rd Qu.:2.0000   3rd Qu.:2.0000
##  Max.   :9.000   Max.   :1.0000   Max.   :3.0000   Max.   :2.0000
##      Outs          PostBalls       PostStrikes        PostOuts
```

```
##  Min.   :0.0000   Min.   :0.000   Min.   :0.000   Min.   :0.000
##  1st Qu.:0.0000   1st Qu.:0.000   1st Qu.:0.500   1st Qu.:0.000
##  Median :1.0000   Median :1.000   Median :1.000   Median :1.000
##  Mean   :0.9961   Mean   :1.232   Mean   :1.189   Mean   :1.205
##  3rd Qu.:2.0000   3rd Qu.:2.000   3rd Qu.:2.000   3rd Qu.:2.000
##  Max.   :2.0000   Max.   :4.000   Max.   :3.000   Max.   :3.000
##   PitchNumber      AtBatNumber     AwayTeamID   VenueID     HomeTeamID
##  Min.   : 0.000   Min.   : 1.0   Min.   :1   Min.   :2   Min.   :1
##  1st Qu.: 1.000   1st Qu.:19.0   1st Qu.:1   1st Qu.:2   1st Qu.:1
##  Median : 2.000   Median :39.0   Median :1   Median :2   Median :1
##  Mean   : 2.757   Mean   :37.1   Mean   :1   Mean   :2   Mean   :1
##  3rd Qu.: 4.000   3rd Qu.:55.0   3rd Qu.:1   3rd Qu.:2   3rd Qu.:1
##  Max.   :10.000   Max.   :73.0   Max.   :1   Max.   :2   Max.   :1
##  StrikeZoneTop    StrikeZoneBottom ReleaseExtension  ReleaseAngle
##  Min.   :2.760   Min.   :0.120   Min.   :5.701   Min.   :-4.228
##  1st Qu.:3.260   1st Qu.:1.480   1st Qu.:6.149   1st Qu.:-1.971
##  Median :3.320   Median :1.510   Median :6.365   Median :-1.213
##  Mean   :3.316   Mean   :1.505   Mean   :6.329   Mean   :-1.097
##  3rd Qu.:3.395   3rd Qu.:1.590   3rd Qu.:6.487   3rd Qu.:-0.232
##  Max.   :4.470   Max.   :1.720   Max.   :7.347   Max.   : 3.088
##  ReleaseSpinAxis  ReleasePositionX   ReleasePositionY ReleasePositionZ
##  Min.   : 24.78   Min.   :-3.4795   Min.   :53.26   Min.   :5.252
##  1st Qu.: 97.04   1st Qu.:-3.2381   1st Qu.:54.01   1st Qu.:5.573
##  Median :198.87   Median :-1.9220   Median :54.14   Median :5.678
##  Mean   :163.37   Mean   :-1.5073   Mean   :54.18   Mean   :5.723
##  3rd Qu.:220.26   3rd Qu.:-0.4806   3rd Qu.:54.35   3rd Qu.:5.817
##  Max.   :254.31   Max.   : 3.2682   Max.   :54.80   Max.   :6.571
##   ReleaseSpeed    ReleaseDirection   ReleaseSpinRate TrajectoryHorizontalBreak
##  Min.   :75.28   Min.   :-6.3974   Min.   :1178   Min.   :-1.6190
##  1st Qu.:86.28   1st Qu.:-3.9835   1st Qu.:2269   1st Qu.:-0.5117
##  Median :91.72   Median :-2.0853   Median :2412   Median : 0.2665
##  Mean   :90.30   Mean   :-2.0209   Mean   :2346   Mean   : 0.1543
##  3rd Qu.:95.14   3rd Qu.:-0.5511   3rd Qu.:2535   3rd Qu.: 0.9295
##  Max.   :98.79   Max.   : 3.9869   Max.   :2977   Max.   : 1.4446
##  TrajectoryVerticalBreakInduced TrajectoryZoneSpeed
##  Min.   :-1.3453                 Min.   :68.75
##  1st Qu.: 0.0495                 1st Qu.:78.67
##  Median : 0.6807                 Median :84.15
##  Mean   : 0.5774                 Mean   :81.99
##  3rd Qu.: 1.2824                 3rd Qu.:86.04
##  Max.   : 2.4804                 Max.   :90.25
##  TrajectoryVerticalApproachAngle TrajectoryPfxHorz TrajectoryPfxVert
##  Min.   :-12.223                 Min.   :-0.8872   Min.   :-0.75586
##  1st Qu.: -7.976                 1st Qu.:-0.5901   1st Qu.: 0.05423
##  Median : -6.172                 Median :-0.1615   Median : 0.41102
##  Mean   : -6.382                 Mean   :-0.1274   Mean   : 0.33916
##  3rd Qu.: -4.728                 3rd Qu.: 0.2667   3rd Qu.: 0.74199
##  Max.   : -2.345                 Max.   : 0.8906   Max.   : 1.00738
##  TrajectoryEffectiveVelocity TrajectoryHorizontalApproachAngle
##  Min.   :73.84               Min.   :-5.7483
##  1st Qu.:85.32               1st Qu.:-3.0600
##  Median :91.57               Median :-1.8531
##  Mean   :89.18               Mean   :-1.6745
##  3rd Qu.:93.96               3rd Qu.:-0.3453
```

```
## Max.   :98.35            Max.   : 3.9195
## TrajectoryVerticalBreak TrajectoryLocationX TrajectoryLocationY
## Min.   :-5.0170          Min.   :-2.2498     Min.   :1.417
## 1st Qu.:-3.0302          1st Qu.:-0.2719     1st Qu.:1.417
## Median :-2.0061          Median : 0.1674     Median :1.417
## Mean   :-2.3341          Mean   : 0.2061     Mean   :1.417
## 3rd Qu.:-1.2772          3rd Qu.: 0.7463     3rd Qu.:1.417
## Max.   :-0.8054          Max.   : 2.1214     Max.   :1.417
## TrajectoryLocationZ SpinVectorX       SpinVectorY       SpinVectorZ
## Min.   :-0.7778     Min.   :-2256.36  Min.   :-2560.3   Min.   :-1898.3
## 1st Qu.: 1.7171     1st Qu.:-1684.97  1st Qu.:-1906.0   1st Qu.:-1341.6
## Median : 2.2874     Median :-1113.20  Median :-1418.7   Median : -394.3
## Mean   : 2.3854     Mean   : -696.19  Mean   :-1105.7   Mean   : -193.9
## 3rd Qu.: 3.0176     3rd Qu.:  -66.62  3rd Qu.: -589.1   3rd Qu.:  937.1
## Max.   : 7.5690     Max.   : 2338.74  Max.   : 2311.4   Max.   : 2013.6
##  SpinFitError      TrajectoryZoneTime TrajectoryPolynomialX0
## Min.   :0.08949   Min.   :0.3815      Min.   :-3.463
## 1st Qu.:0.13405   1st Qu.:0.4014      1st Qu.:-3.218
## Median :0.16039   Median :0.4111      Median :-1.921
## Mean   :0.16753   Mean   :0.4242      Mean   :-1.502
## 3rd Qu.:0.19051   3rd Qu.:0.4413      3rd Qu.:-0.482
## Max.   :0.44662   Max.   :0.5078      Max.   : 3.268
## TrajectoryPolynomialX1 TrajectoryPolynomialX2 TrajectoryPolynomialY0
## Min.   :-9.646         Min.   :-9.806         Min.   :54.13
## 1st Qu.: 1.232         1st Qu.:-6.755         1st Qu.:54.13
## Median : 4.691         Median :-1.778         Median :54.13
## Mean   : 4.668         Mean   :-1.689         Mean   :54.13
## 3rd Qu.: 9.154         3rd Qu.: 2.665         3rd Qu.:54.13
## Max.   :14.528         Max.   : 7.776         Max.   :54.14
## TrajectoryPolynomialY1 TrajectoryPolynomialY2 TrajectoryPolynomialZ0
## Min.   :-144.3         Min.   : 9.477         Min.   :5.252
## 1st Qu.:-137.0         1st Qu.:11.718         1st Qu.:5.573
## Median :-133.9         Median :13.107         Median :5.675
## Mean   :-130.3         Mean   :13.020         Mean   :5.724
## 3rd Qu.:-124.3         3rd Qu.:14.383         3rd Qu.:5.818
## Max.   :-108.6         Max.   :16.074         Max.   :6.603
## TrajectoryPolynomialZ1 TrajectoryPolynomialZ2  TrajectoryX0      TrajectoryX1
## Min.   :-10.2459       Min.   :-22.308         Min.   :-3.243    Min.   :50.00
## 1st Qu.: -4.6687       1st Qu.:-15.579         1st Qu.:-2.913    1st Qu.:50.00
## Median : -2.9286       Median :-11.649         Median :-1.740    Median :50.00
## Mean   : -2.6634       Mean   :-12.052         Mean   :-1.357    Mean   :50.00
## 3rd Qu.: -0.5662       3rd Qu.: -7.595         3rd Qu.:-0.415    3rd Qu.:50.00
## Max.   :  6.3135       Max.   : -4.484         Max.   : 3.071    Max.   :50.01
##  TrajectoryX2    TrajectoryV0     TrajectoryV1     TrajectoryV2
## Min.   :5.137   Min.   :-9.261   Min.   :-143.4   Min.   :-10.568
## 1st Qu.:5.479   1st Qu.: 1.101   1st Qu.:-136.2   1st Qu.: -5.262
## Median :5.599   Median : 4.578   Median :-133.0   Median : -3.455
## Mean   :5.630   Mean   : 4.572   Mean   :-129.5   Mean   : -3.452
## 3rd Qu.:5.750   3rd Qu.: 8.898   3rd Qu.:-123.6   3rd Qu.: -1.526
## Max.   :6.446   Max.   :14.048   Max.   :-107.9   Max.   :  4.795
##  TrajectoryA0     TrajectoryA1     TrajectoryA2
## Min.   :-19.612  Min.   :18.95    Min.   :-44.616
## 1st Qu.:-13.510  1st Qu.:23.44    1st Qu.:-31.158
## Median : -3.556  Median :26.21    Median :-23.298
```

```
##  Mean    : -3.379   Mean    :26.04   Mean    :-24.104
##  3rd Qu.:  5.329   3rd Qu.:28.77   3rd Qu.:-15.190
##  Max.   : 15.551   Max.   :32.15   Max.   : -8.968
```

```r
## Pitch counts
# Mean
mean(game2$ReleaseSpeed, na.rm = TRUE)
```

```
## [1] 90.29512
```

```r
#Total pitches
nrow(game2)
```

```
## [1] 259
```

```r
# Total strikes
called_strike_count2 <- sum(game2$PitchCall == "called_strike")
swinging_strike_count2 <- sum(game2$PitchCall == "swinging_strike")
strikeout_count2 <- sum(game2$PitchCall == "strikeout")
called_strike_count2+swinging_strike_count2+strikeout_count2
```

```
## [1] 72
```

```r
# Total ball
sum(game2$PitchCall == "ball")
```

```
## [1] 77
```

```r
## Pitch type
# Most common pitch type
pitch_count2 <- table(game2$PitchType)
names(pitch_count2)[which.max(pitch_count2)]
```

```
## [1] "FF"
```

```r
# Others pitch type
unique(game2$PitchType)
```

```
## [1] "FF"   "CU"   "FC"   "SI"   "SL"   "CH"   "NULL" "KC"
```

```r
## Bar plot of the outcome distribution
pitch_call_counts2 <- as.data.frame(table(game2$PitchCall))
ggplot(pitch_call_counts2, aes(x = Var1, y = Freq)) +
  geom_bar(stat = "identity", fill = "skyblue") +
  geom_text(aes(label = Freq), vjust = -0.5, color = "black", size = 3) +
  labs(title = "Pitch Call Distribution (Game 2)", x = "Pitch Call", y = "Count") +
  theme_minimal()
```

## Pitch Call Distribution (Game 2)
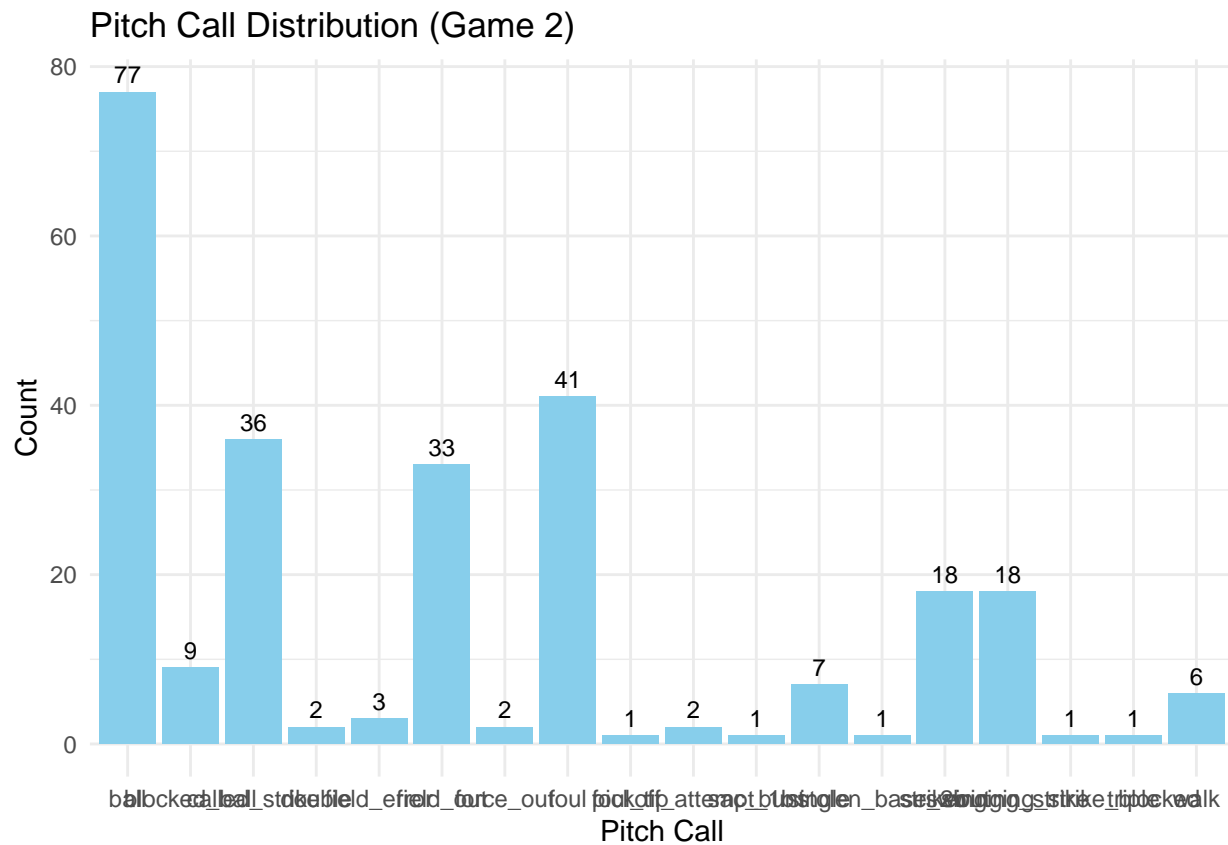

```
## Plotting Histogram of Release Speed with Normal Curve
ggplot(game2, aes(x = ReleaseSpeed)) +
  geom_histogram(binwidth = 1, fill = 'blue', color = 'white', aes(y = ..density..)) +
  stat_function(fun = dnorm, args = list(mean = mean(game2$ReleaseSpeed), sd = sd(game2$ReleaseSpeed)),
                color = 'red', size = 1) +
  labs(title = 'Histogram of Release Speed with Normal Curve (Game 2)',
       x = 'Release Speed (mph)', y = 'Density') +
  theme_minimal()
```

Histogram of Release Speed with Normal Curve (Game 2)
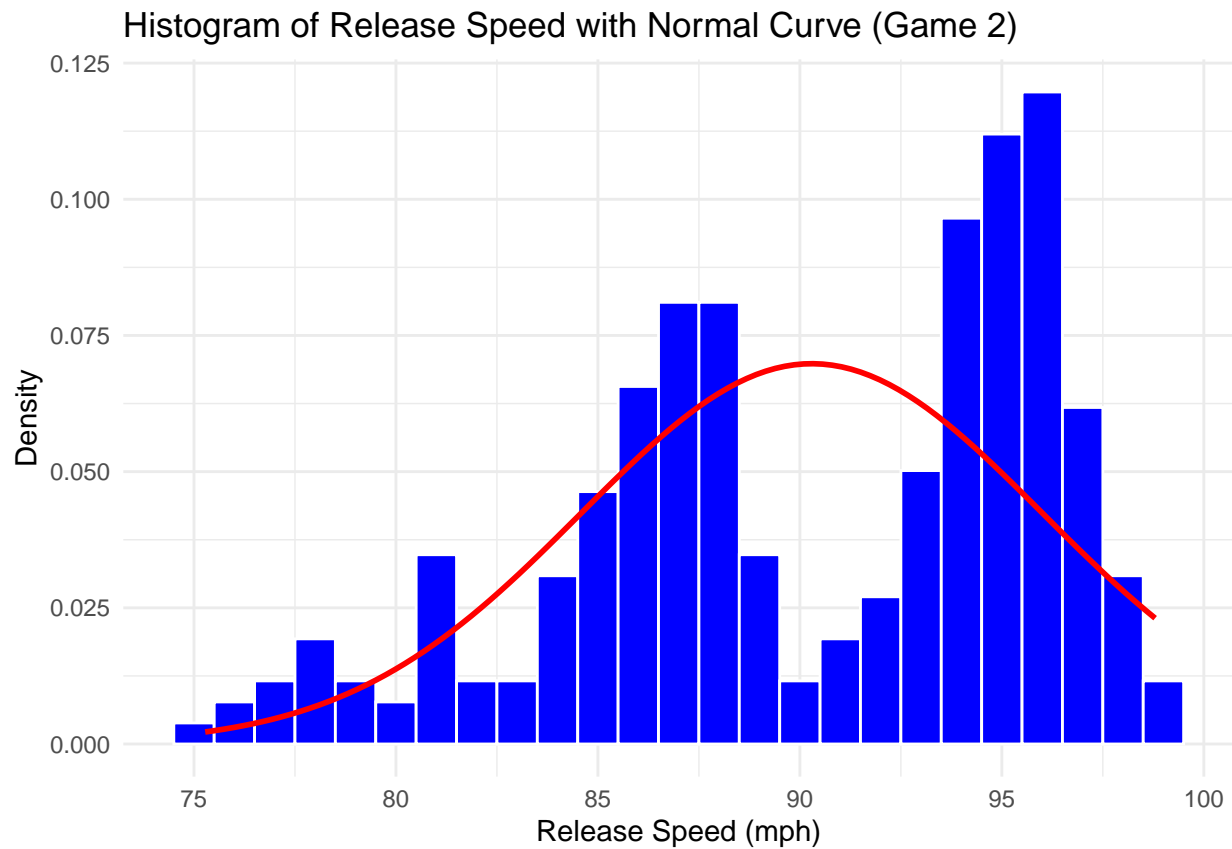

```
# Plotting Scatter Plot of Release Speed vs. Trajectory Effective Velocity
ggplot(game2, aes(x = ReleaseSpeed, y = TrajectoryEffectiveVelocity)) +
  geom_point(color = 'black') +
  labs(title = 'Scatter Plot of Release Speed vs. Trajectory Effective Velocity (Game 2)',
       x = 'Release Speed (mph)', y = 'Trajectory Effective Velocity') +
  theme_minimal()
```

Scatter Plot of Release Speed vs. Trajectory Effective Velocity (Game 2)
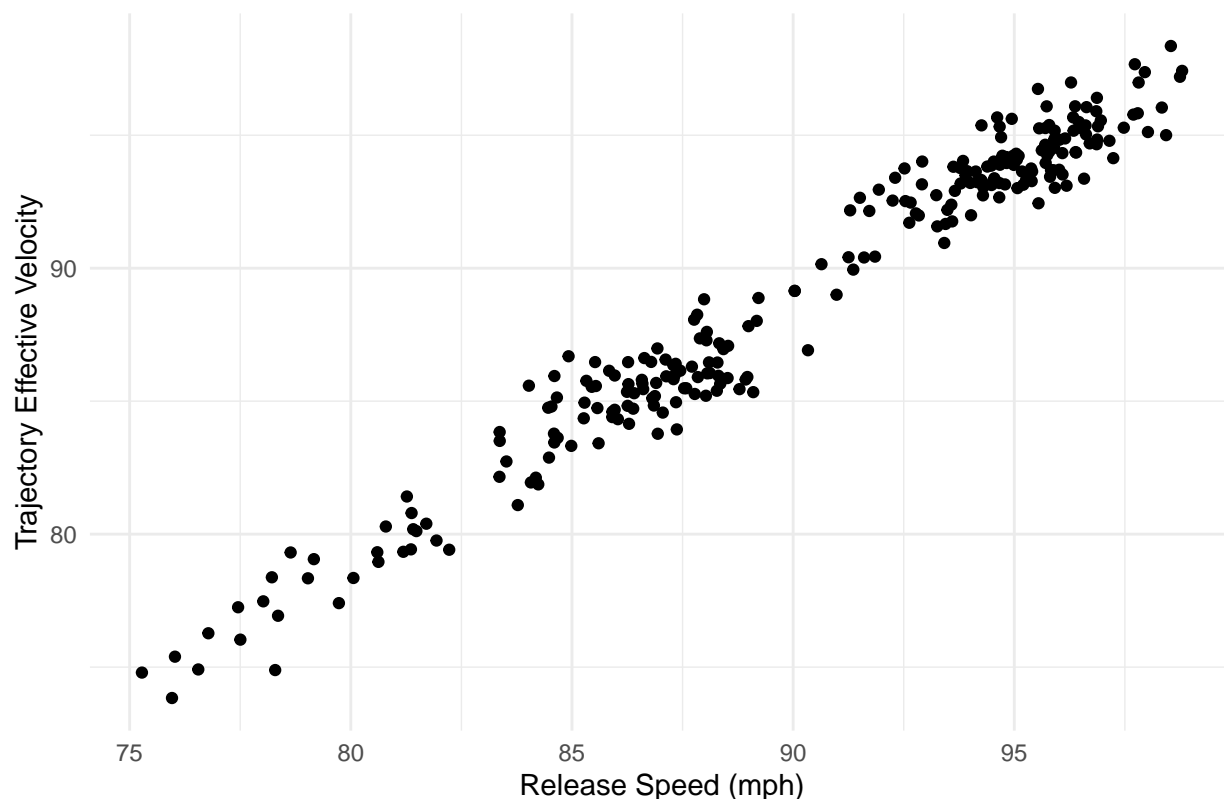
#Statistics summary Entire Data

```r
summary(df)
```

```
##     PitchId          GamePk      PitcherHand        PitchCall
##  Min.   :  1.0   Min.   :1.000   Length:620        Length:620
##  1st Qu.:155.8   1st Qu.:1.000   Class :character  Class :character
##  Median :310.5   Median :1.000   Mode  :character  Mode  :character
##  Mean   :310.5   Mean   :1.418
##  3rd Qu.:465.2   3rd Qu.:2.000
##  Max.   :620.0   Max.   :2.000
##   PitchType          BatterId        PitcherId        BatterSide
##  Length:620        Min.   : 1.00   Min.   : 1.000   Length:620
##  Class :character  1st Qu.:12.00   1st Qu.: 1.000   Class :character
##  Mode  :character  Median :19.00   Median : 7.000   Mode  :character
##                    Mean   :18.81   Mean   : 6.537
##                    3rd Qu.:27.25   3rd Qu.:11.000
##                    Max.   :37.00   Max.   :17.000
##     Inning           IsTop            Balls            Strikes
##  Min.   : 0.000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.: 3.000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000
##  Median : 5.000   Median :0.0000   Median :1.0000   Median :1.0000
##  Mean   : 5.292   Mean   :0.4952   Mean   :0.9145   Mean   :0.8145
##  3rd Qu.: 8.000   3rd Qu.:1.0000   3rd Qu.:2.0000   3rd Qu.:2.0000
##  Max.   :10.000   Max.   :1.0000   Max.   :3.0000   Max.   :2.0000
##      Outs           PostBalls        PostStrikes       PostOuts
##  Min.   :0.0000   Min.   :0.000   Min.   :0.000    Min.   :0.000
##  1st Qu.:0.0000   1st Qu.:0.000   1st Qu.:1.000    1st Qu.:0.000
```

```
##  Median :1.0000    Median :1.000    Median :1.000    Median :1.000
##  Mean   :0.9532    Mean   :1.268    Mean   :1.197    Mean   :1.137
##  3rd Qu.:2.0000    3rd Qu.:2.000    3rd Qu.:2.000    3rd Qu.:2.000
##  Max.   :2.0000    Max.   :4.000    Max.   :3.000    Max.   :3.000
##   PitchNumber      AtBatNumber      AwayTeamID     VenueID         HomeTeamID
##  Min.   : 0.000   Min.   : 1.00   Min.   :1    Min.   :1.000   Min.   :1.000
##  1st Qu.: 1.000   1st Qu.:21.00   1st Qu.:1    1st Qu.:1.000   1st Qu.:1.000
##  Median : 2.000   Median :41.00   Median :1    Median :1.000   Median :2.000
##  Mean   : 2.798   Mean   :40.37   Mean   :1    Mean   :1.418   Mean   :1.582
##  3rd Qu.: 4.000   3rd Qu.:60.00   3rd Qu.:1    3rd Qu.:2.000   3rd Qu.:2.000
##  Max.   :10.000   Max.   :86.00   Max.   :1    Max.   :2.000   Max.   :2.000
##  StrikeZoneTop    StrikeZoneBottom  ReleaseExtension  ReleaseAngle
##  Min.   :2.760   Min.   :0.120    Min.   :5.462    Min.   :-4.5470
##  1st Qu.:3.300   1st Qu.:1.510    1st Qu.:6.106    1st Qu.:-1.9558
##  Median :3.370   Median :1.560    Median :6.301    Median :-1.1785
##  Mean   :3.373   Mean   :1.554    Mean   :6.300    Mean   :-1.0835
##  3rd Qu.:3.470   3rd Qu.:1.600    3rd Qu.:6.471    3rd Qu.:-0.3468
##  Max.   :4.470   Max.   :1.860    Max.   :7.374    Max.   : 3.0876
##  ReleaseSpinAxis  ReleasePositionX ReleasePositionY ReleasePositionZ
##  Min.   : 22.59   Min.   :-3.591   Min.   :53.13   Min.   :5.184
##  1st Qu.:132.77   1st Qu.:-3.248   1st Qu.:54.03   1st Qu.:5.512
##  Median :193.02   Median :-1.703   Median :54.20   Median :5.655
##  Mean   :174.95   Mean   :-1.108   Mean   :54.20   Mean   :5.693
##  3rd Qu.:221.68   3rd Qu.: 1.193   3rd Qu.:54.39   3rd Qu.:5.794
##  Max.   :329.70   Max.   : 3.268   Max.   :55.04   Max.   :6.571
##   ReleaseSpeed     ReleaseDirection  ReleaseSpinRate TrajectoryHorizontalBreak
##  Min.   : 73.47   Min.   :-6.3974   Min.   :1178   Min.   :-1.61902
##  1st Qu.: 86.06   1st Qu.:-3.8736   1st Qu.:2269   1st Qu.:-0.55581
##  Median : 90.65   Median :-1.6518   Median :2398   Median : 0.04459
##  Mean   : 90.04   Mean   :-1.4389   Mean   :2328   Mean   : 0.04459
##  3rd Qu.: 94.55   3rd Qu.: 0.9567   3rd Qu.:2511   3rd Qu.: 0.76709
##  Max.   :101.62   Max.   : 5.6934   Max.   :3084   Max.   : 1.44462
##  TrajectoryVerticalBreakInduced TrajectoryZoneSpeed
##  Min.   :-1.34530               Min.   :68.75
##  1st Qu.: 0.08953               1st Qu.:79.15
##  Median : 0.50053               Median :83.35
##  Mean   : 0.48467               Mean   :82.32
##  3rd Qu.: 1.07454               3rd Qu.:86.17
##  Max.   : 2.48037               Max.   :92.12
##  TrajectoryVerticalApproachAngle TrajectoryPfxHorz  TrajectoryPfxVert
##  Min.   :-12.223                 Min.   :-0.88724   Min.   :-0.75586
##  1st Qu.: -7.768                 1st Qu.:-0.49875   1st Qu.: 0.07224
##  Median : -6.476                 Median :-0.05404   Median : 0.28964
##  Mean   : -6.535                 Mean   :-0.05404   Mean   : 0.28737
##  3rd Qu.: -5.211                 3rd Qu.: 0.31043   3rd Qu.: 0.62331
##  Max.   : -2.345                 Max.   : 0.89060   Max.   : 1.00738
##  TrajectoryEffectiveVelocity TrajectoryHorizontalApproachAngle
##  Min.   :73.84               Min.   :-7.0023
##  1st Qu.:85.35               1st Qu.:-3.0434
##  Median :89.79               Median :-1.6169
##  Mean   :89.15               Mean   :-1.3391
##  3rd Qu.:93.77               3rd Qu.: 0.4066
##  Max.   :99.82               Max.   : 5.9252
##  TrajectoryVerticalBreak TrajectoryLocationX TrajectoryLocationY
```

```
##  Min.   :-5.0170         Min.   :-2.2498     Min.   :1.417
##  1st Qu.:-2.9525         1st Qu.:-0.3270     1st Qu.:1.417
##  Median :-2.3739         Median : 0.1792     Median :1.417
##  Mean   :-2.4222         Mean   : 0.1792     Mean   :1.417
##  3rd Qu.:-1.5141         3rd Qu.: 0.7413     3rd Qu.:1.417
##  Max.   :-0.8054         Max.   : 2.1214     Max.   :1.417
##  TrajectoryLocationZ SpinVectorX        SpinVectorY        SpinVectorZ
##  Min.   :-0.7778     Min.   :-2256.4   Min.   :-2725.0   Min.   :-1996.0
##  1st Qu.: 1.6292     1st Qu.:-1603.6   1st Qu.:-1767.9   1st Qu.:-1308.6
##  Median : 2.2760     Median : -872.8   Median : -938.5   Median : -207.7
##  Mean   : 2.2760     Mean   : -710.5   Mean   : -591.1   Mean   : -141.0
##  3rd Qu.: 2.9157     3rd Qu.: -333.4   3rd Qu.:  562.0   3rd Qu.:  967.3
##  Max.   : 7.5690     Max.   : 2555.0   Max.   : 2368.4   Max.   : 2013.6
##   SpinFitError      TrajectoryZoneTime TrajectoryPolynomialX0
##  Min.   :0.08592   Min.   :0.3764     Min.   :-3.566
##  1st Qu.:0.13731   1st Qu.:0.4023     1st Qu.:-3.229
##  Median :0.16478   Median :0.4194     Median :-1.696
##  Mean   :0.17315   Mean   :0.4241     Mean   :-1.103
##  3rd Qu.:0.19459   3rd Qu.:0.4405     3rd Qu.: 1.191
##  Max.   :0.52662   Max.   :0.5078     Max.   : 3.268
##  TrajectoryPolynomialX1 TrajectoryPolynomialX2 TrajectoryPolynomialY0
##  Min.   :-13.458        Min.   :-9.8359        Min.   :54.13
##  1st Qu.: -2.008        1st Qu.:-5.5866        1st Qu.:54.13
##  Median :  3.814        Median :-0.6366        Median :54.13
##  Mean   :  3.340        Mean   :-0.7870        Mean   :54.13
##  3rd Qu.:  8.884        3rd Qu.: 3.0771        3rd Qu.:54.13
##  Max.   : 15.532        Max.   : 8.5311        Max.   :54.14
##  TrajectoryPolynomialY1 TrajectoryPolynomialY2 TrajectoryPolynomialZ0
##  Min.   :-145.5         Min.   : 7.701         Min.   :5.179
##  1st Qu.:-136.4         1st Qu.:10.746         1st Qu.:5.512
##  Median :-130.7         Median :12.018         Median :5.654
##  Mean   :-129.9         Mean   :12.018         Mean   :5.693
##  3rd Qu.:-124.3         3rd Qu.:13.285         3rd Qu.:5.792
##  Max.   :-108.5         Max.   :16.074         Max.   :6.603
##  TrajectoryPolynomialZ1 TrajectoryPolynomialZ2  TrajectoryX0
##  Min.   :-10.7882       Min.   :-22.308        Min.   :-3.3665
##  1st Qu.: -4.5003       1st Qu.:-15.399        1st Qu.:-2.9062
##  Median : -2.6685       Median :-12.740        Median :-1.5820
##  Mean   : -2.5871       Mean   :-12.702        Mean   :-0.9993
##  3rd Qu.: -0.7494       3rd Qu.: -8.927        3rd Qu.: 1.0965
##  Max.   :  6.3135       Max.   : -4.484        Max.   : 3.0706
##   TrajectoryX1    TrajectoryX2    TrajectoryV0      TrajectoryV1
##  Min.   :50.00   Min.   :5.022   Min.   :-12.945   Min.   :-144.7
##  1st Qu.:50.00   1st Qu.:5.422   1st Qu.: -2.099   1st Qu.:-135.6
##  Median :50.00   Median :5.570   Median : 3.817   Median :-130.0
##  Mean   :50.00   Mean   :5.600   Mean   : 3.297   Mean   :-129.1
##  3rd Qu.:50.00   3rd Qu.:5.736   3rd Qu.: 8.698   3rd Qu.:-123.6
##  Max.   :50.01   Max.   :6.446   Max.   : 14.954   Max.   :-107.8
##   TrajectoryV2      TrajectoryA0      TrajectoryA1      TrajectoryA2
##  Min.   :-11.479   Min.   :-19.672   Min.   :15.40   Min.   :-44.616
##  1st Qu.: -5.235   1st Qu.:-11.173   1st Qu.:21.49   1st Qu.:-30.799
##  Median : -3.427   Median : -1.273   Median :24.04   Median :-25.480
##  Mean   : -3.416   Mean   : -1.574   Mean   :24.04   Mean   :-25.403
##  3rd Qu.: -1.747   3rd Qu.:  6.154   3rd Qu.:26.57   3rd Qu.:-17.855
```

```
## Max.    : 4.795   Max.    : 17.062   Max.    :32.15   Max.    : -8.968
```

```r
# Calculate the mean
mean_release_speed <- mean(df$ReleaseSpeed, na.rm = TRUE)
mean_spin_rate <- mean(df$ReleaseSpinRate)
mean_release_ex <- mean(df$ReleaseExtension)

# Count occurrences in the PitchCall column
ball_count <- sum(df$PitchCall == "ball")
called_strike_count <- sum(df$PitchCall == "called_strike")
swinging_strike_count <- sum(df$PitchCall == "swinging_strike")
strikeout_count <- sum(df$PitchCall == "strikeout")
strike_count <- called_strike_count+swinging_strike_count+strikeout_count
home_run_count <- sum(df$PitchCall == "home_run")
walk_count <- sum(df$PitchCall == "walk")

# Histogram for Distribution of Release Speed
hist(df$ReleaseSpeed, main = "Distribution of Release Speed", xlab = "Release Speed", col = "lightblue"
```

Distribution of Release Speed
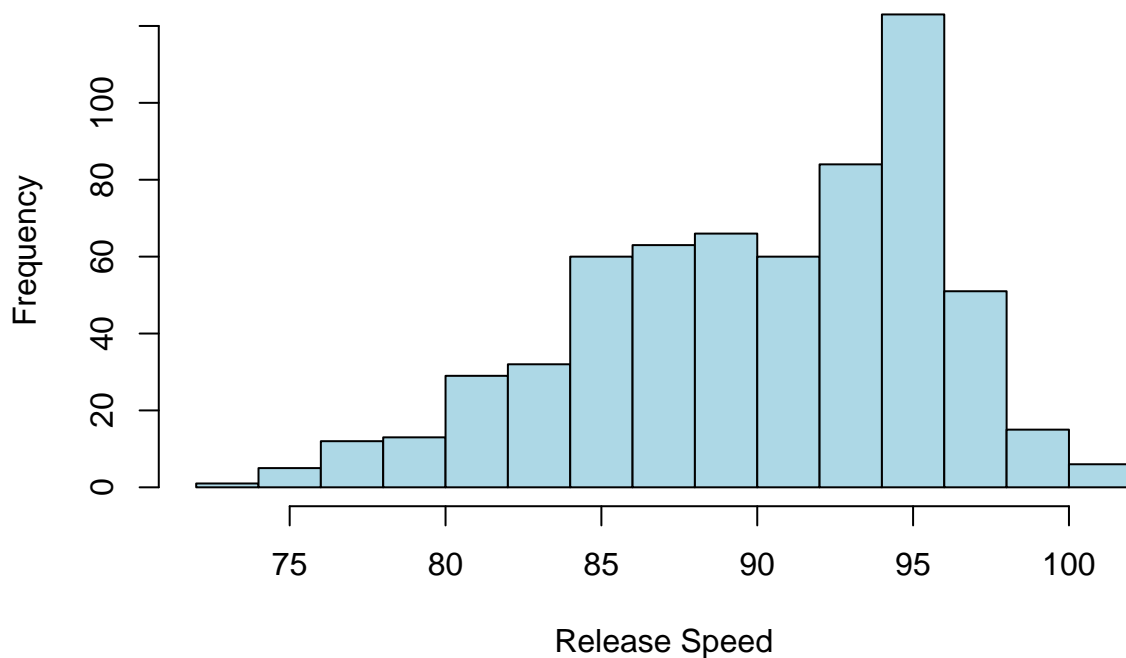

```r
# Display the result
cat("The distribution of release speed shows a left skewed distribution (negative skew), meaning the mo
```

```
## The distribution of release speed shows a left skewed distribution (negative skew), meaning the mode
```

```r
cat("The mean release speed across all pitches is: ", mean_release_speed, "\n")
```

```
## The mean release speed across all pitches is:  90.03563
```

```r
cat("The mean spin rate of all pitches is: ", mean_spin_rate, "\n")
```

```
## The mean spin rate of all pitches is:  2327.666
```

```
cat("The mean release extension of all pitches is: ", mean_release_ex, "\n")
```

The mean release extension of all pitches is: 6.300363

```
cat(ball_count, "were ball", "\n")
```

188 were ball

```
cat(strike_count, "were strike", "\n")
```

157 were strike

```
cat(home_run_count, "resulted in home runs", "\n")
```

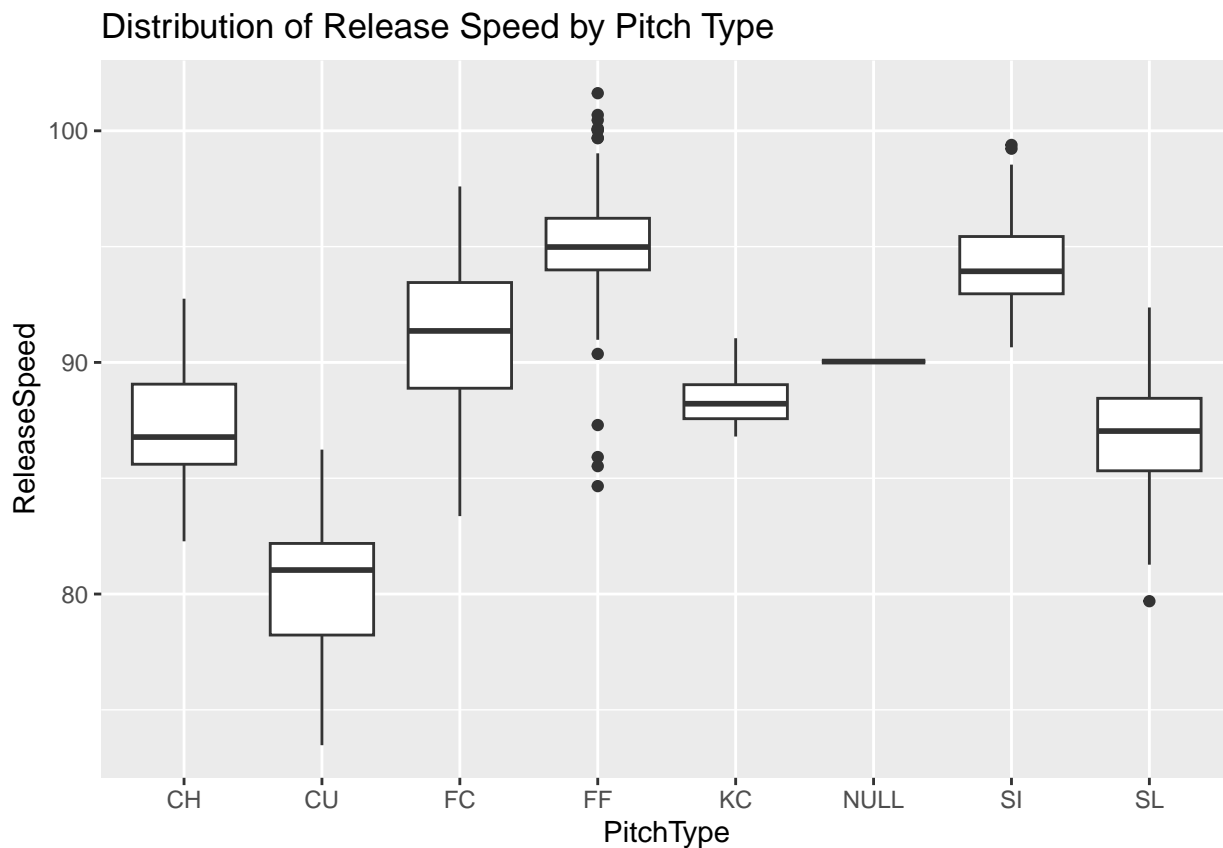## 2 resulted in home runs

```
cat(walk_count, "were walk", "\n")
```

11 were walk

Pitcher Summary Entire Data

```
# Create relevant visualizations
ggplot(df, aes(x = PitchType, y = ReleaseSpeed)) +
  geom_boxplot() +
  labs(title = "Distribution of Release Speed by Pitch Type")
```
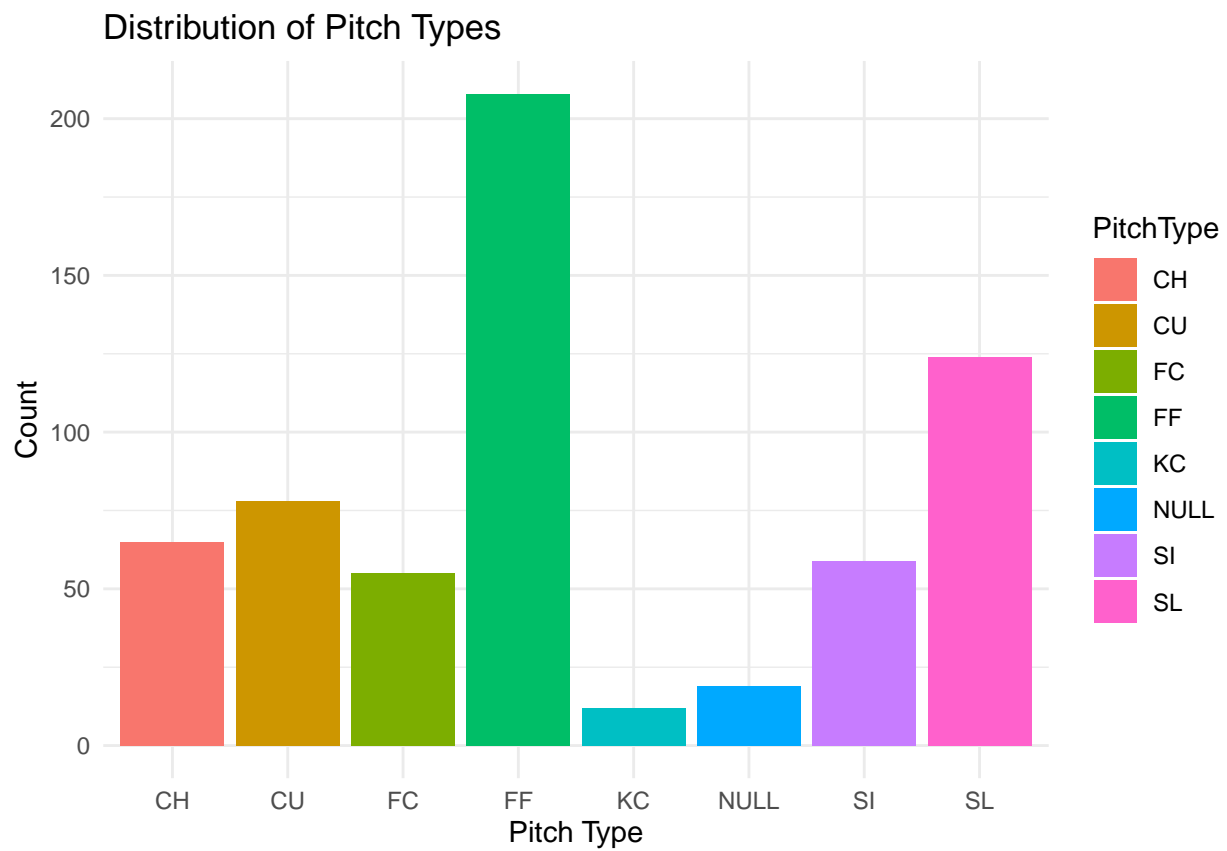

Distribution of Release Speed by Pitch Type

```
# Create a barplot for the distribution of pitch types
ggplot(df, aes(x = PitchType, fill = PitchType)) +
```

```
geom_bar() +
labs(title = "Distribution of Pitch Types", x = "Pitch Type", y = "Count") +
theme_minimal()
```

Distribution of Pitch Types


```
# Create a boxplot for the release speed of pitches by pitch type
ggplot(df, aes(x = PitchType, y = ReleaseSpeed, fill = PitchType)) +
  geom_boxplot() +
  labs(title = "Release Speed of Pitches by Pitch Type", x = "Pitch Type", y = "Release Speed") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

Release Speed of Pitches by Pitch Type
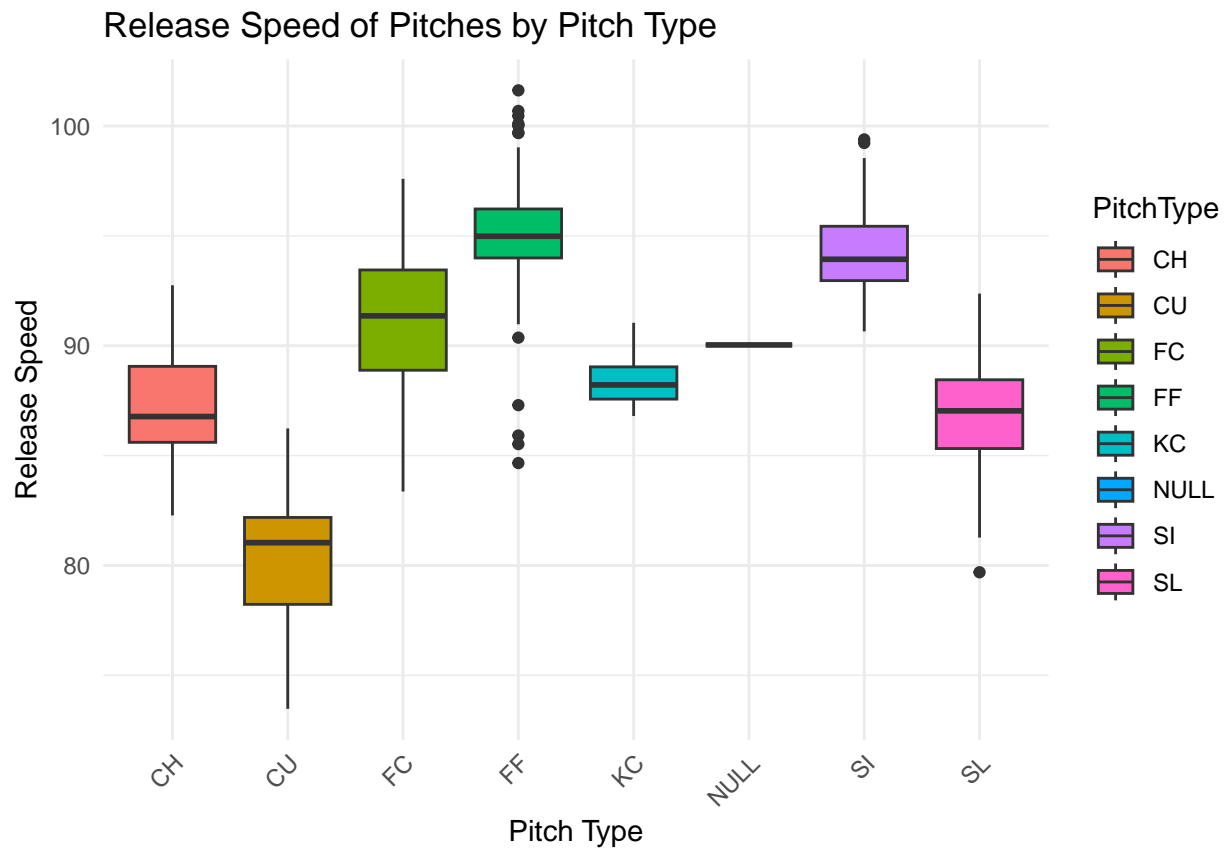

```r
# Create a boxplot for the release spin rate of pitches by pitch type
ggplot(df, aes(x = PitchType, y = ReleaseSpinRate, fill = PitchType)) +
  geom_boxplot() +
  labs(title = "Release Spin Rate of Pitches by Pitch Type", x = "Pitch Type", y = "Release Spin Rate")
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

Release Spin Rate of Pitches by Pitch Type
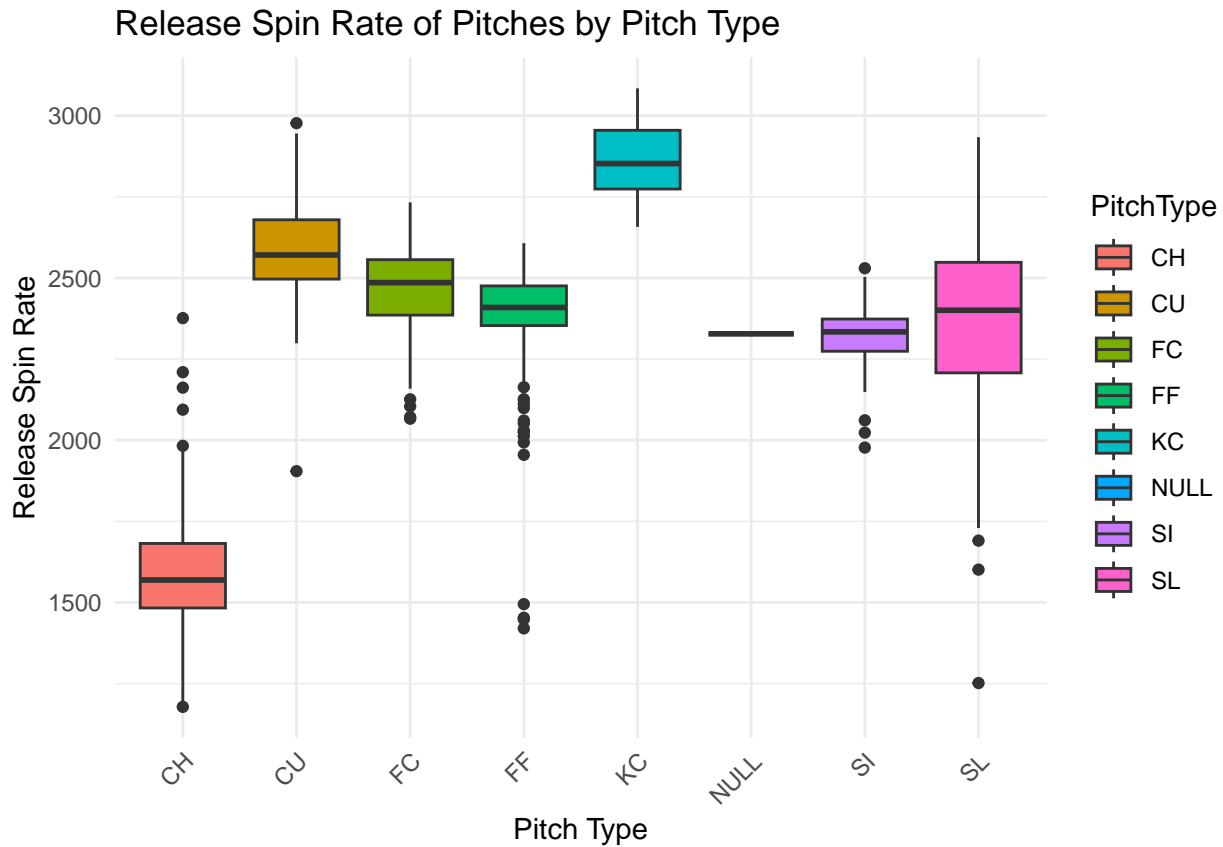

```r
# Summary statistics
summary_pitcher_stats <- df %>%
  group_by(PitcherId) %>%
  summarise(
    Mean_Ball = mean(Balls),
    Mean_Strikes = mean(Strikes),
    Mean_Out = mean(Outs),
    Mean_ReleaseSpeed = mean(ReleaseSpeed),
    Mean_ReleaseSpinRate = mean(ReleaseSpinRate),
    Mean_ReleaseExtension = mean(ReleaseExtension)
  )

# Create a summary table
summary_pitcher_table <- kable(summary_pitcher_stats, caption = "Summary Pitcher Statistics") %>%
  kable_styling()

# Save the plots (modify file names as needed)
ggsave("release_speed_comparison.png", width = 10, height = 6, units = "in")

# Print the summary table
summary_pitcher_table
```

Table 1: Summary Pitcher Statistics

PitcherId	Mean_Ball	Mean_Strikes	Mean_Out	Mean_ReleaseSpeed	Mean_ReleaseSpinRate	Mean_ReleaseE
1	0.8706468	0.9651741	0.7910448	89.50582	2276.936	

|					
2	0.4000000	1.1000000	0.6000000	92.37436	2554.850
3	0.9166667	0.8750000	1.0833333	91.73336	2444.402
4	1.0714286	0.4285714	1.2857143	89.22846	1988.102
5	1.2758621	0.9310345	1.1034483	88.70211	2486.144
6	0.9130435	0.7391304	0.8260870	92.01822	2486.730
7	0.7272727	0.6233766	0.9610390	89.36570	2511.627
8	1.1000000	0.0000000	0.9000000	95.29270	2339.023
9	1.1818182	1.0909091	0.9090909	90.65236	2420.207
10	0.8823529	0.2941176	1.1764706	90.85074	1992.116
11	0.9090909	0.7474747	0.7979798	88.52318	2295.784
12	0.6500000	0.8000000	1.3500000	93.19173	2029.835
13	1.2000000	1.0000000	0.8000000	91.65556	2402.090
14	0.9375000	0.5000000	1.5000000	91.28141	2330.769
15	1.2352941	1.1176471	1.1176471	92.85018	2183.166
16	1.2727273	1.0909091	2.0000000	88.41122	2384.342
17	0.9333333	0.5333333	1.6666667	92.08367	2380.503

Batter Summary Entire Data

```r
# Create a barplot for the count of pitches by batter side
ggplot(df, aes(x = BatterSide, fill = BatterSide)) +
  geom_bar() +
  labs(title = "Count of Pitches by Batter Side", x = "Batter Side", y = "Count") +
  theme_minimal()
```


Count of Pitches by Batter Side
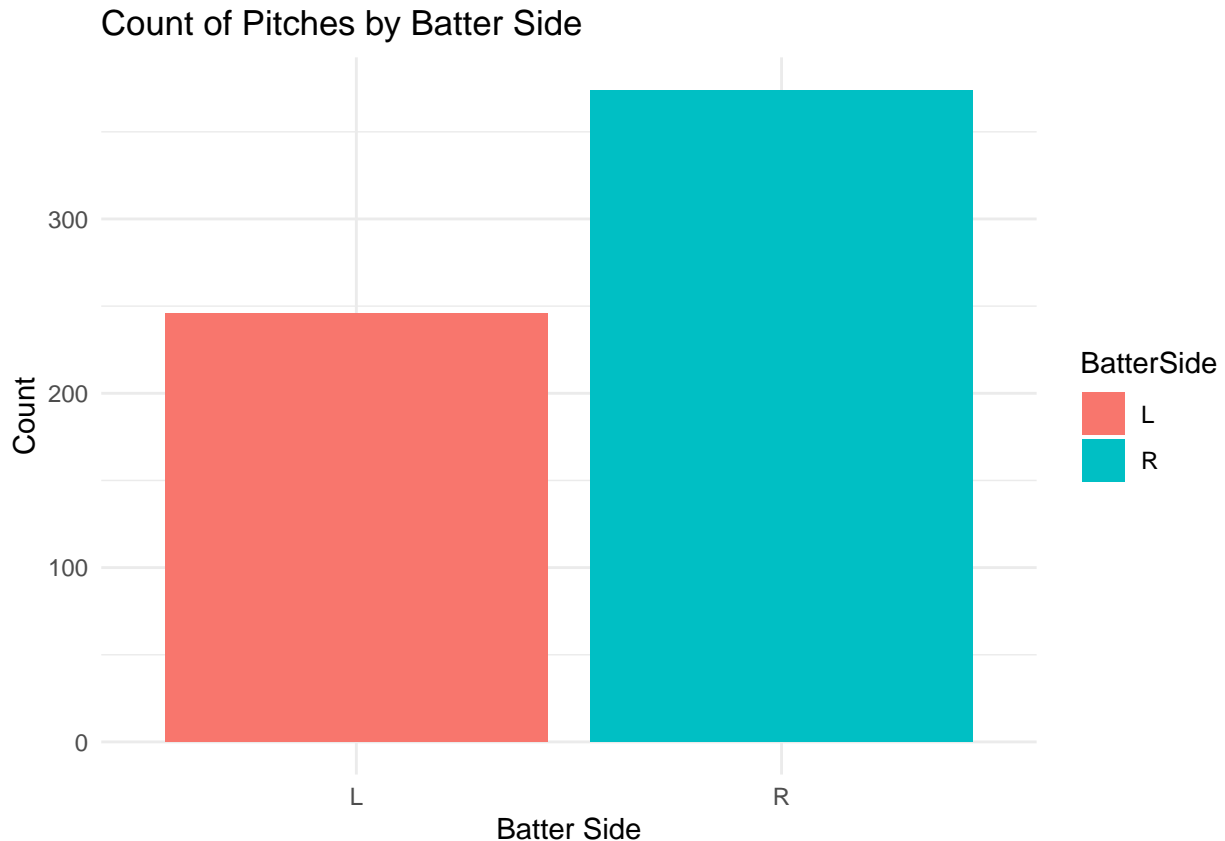
```r
# Create a boxplot for the Trajectory Effective Velocity of pitches by pitch type
ggplot(df, aes(x = PitchType, y = TrajectoryEffectiveVelocity,
               fill = PitchType)) +
  geom_boxplot() +
  labs(title = "Trajectory Effective Velocity of Pitches by Pitch Type", x = "Pitch Type",
       y = "Trajectory Effective Velocity") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```


Trajectory Effective Velocity of Pitches by Pitch Type
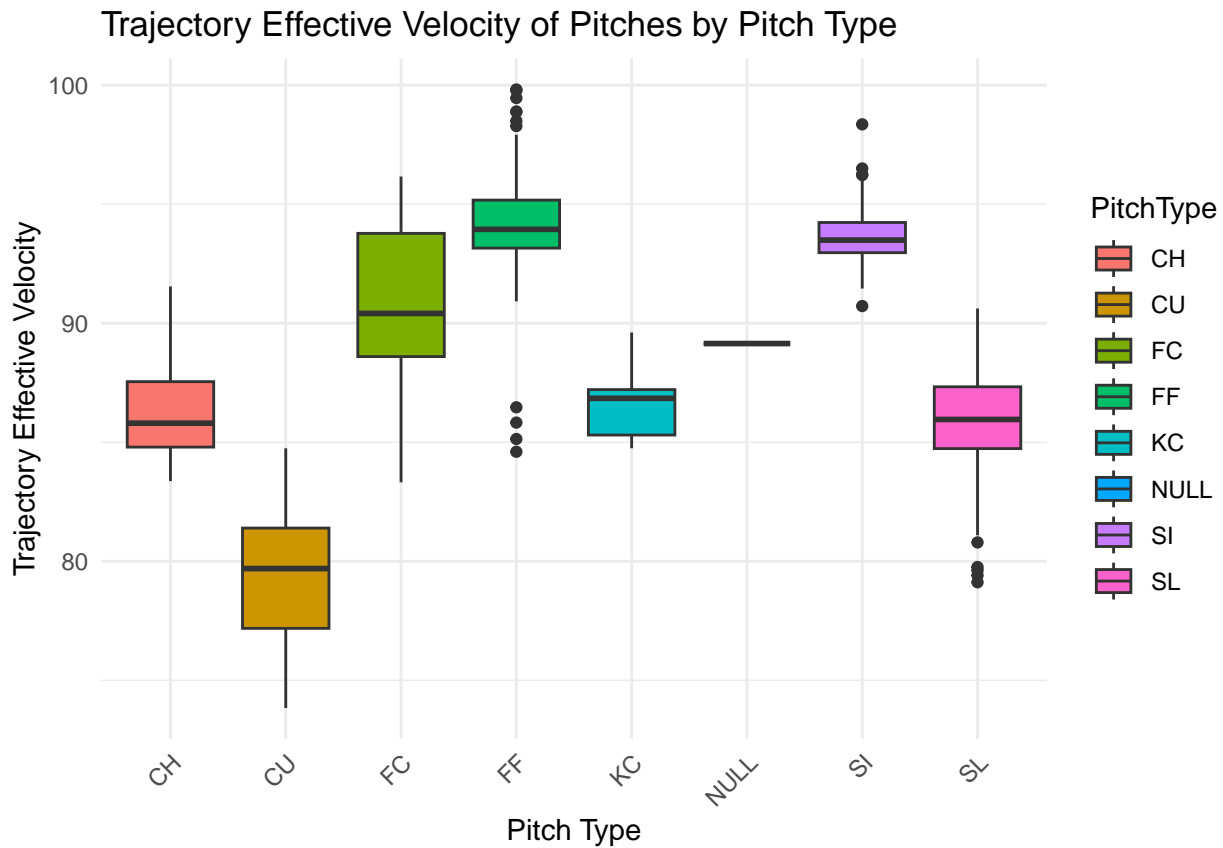
```r
# Create a boxplot for the Trajectory Zone Speed of pitches by pitch type
ggplot(df, aes(x = PitchType, y = TrajectoryZoneSpeed,
               fill = PitchType)) +
  geom_boxplot() +
  labs(title = "Trajectory Zone Speed of Pitches by Pitch Type", x = "Pitch Type", y = "Trajectory Zone
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

Trajectory Zone Speed of Pitches by Pitch Type
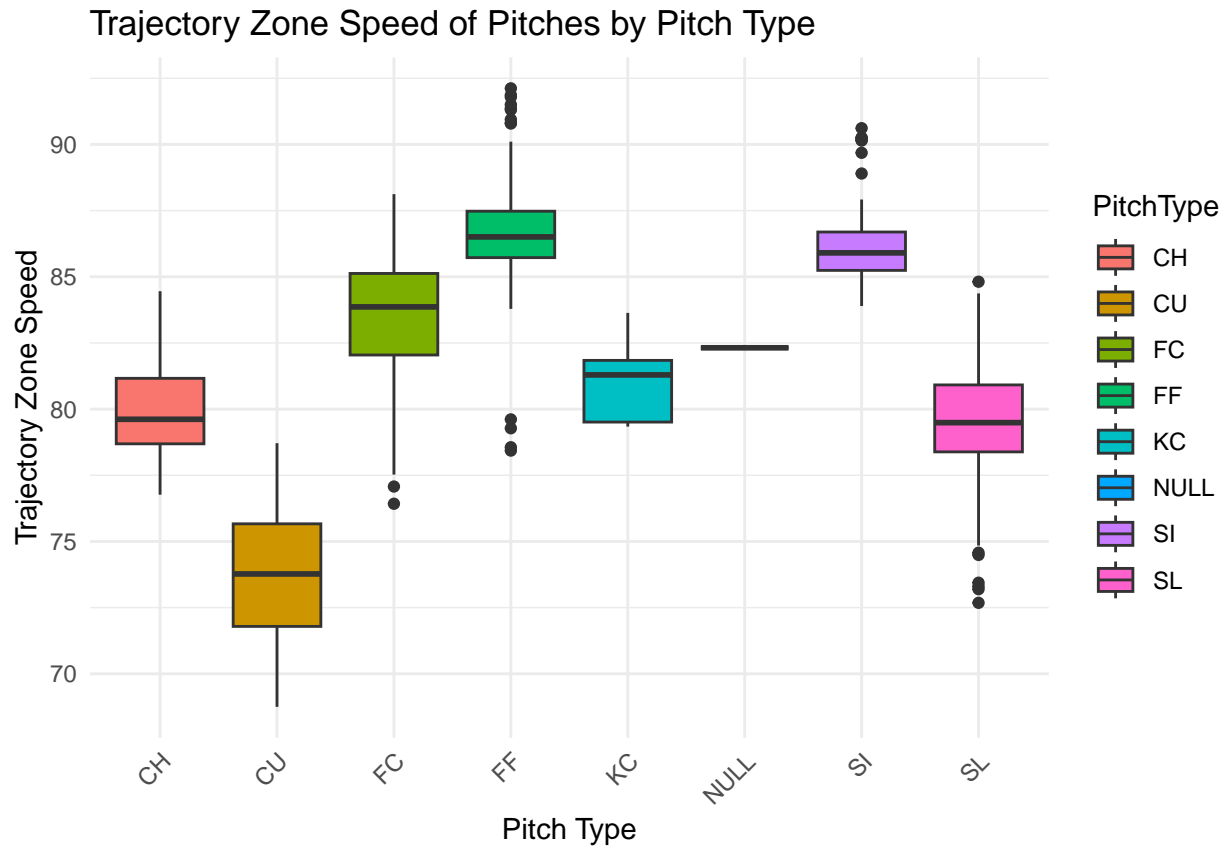

```r
summary_batter_stats <- df %>%
  group_by(BatterId) %>%
  summarise(
    Mean_TrajectoryZoneSpeed = mean(TrajectoryZoneSpeed),
    Mean_TrajectoryEffectiveVelocity = mean(TrajectoryEffectiveVelocity)
  )

summary_batter_stats <- kable(summary_batter_stats, caption = "Summary Batter Statistics") %>%
  kable_styling()

# Save the plots (modify file names as needed)
ggsave("release_trajectory_comparison.png", width = 10, height = 6, units = "in")

summary_batter_stats
```

Table 2: Summary Batter Statistics

BatterId	Mean_TrajectoryZoneSpeed	Mean_TrajectoryEffectiveVelocity
1	84.37528	91.40534
2	82.96011	90.31686
3	86.78590	95.37677
4	82.28921	89.11864
5	83.87188	91.13990
6	82.68636	89.66914
7	81.74407	87.78747
8	81.73485	88.53084

9	84.04871	92.25570
10	82.02454	90.05714
11	82.60492	89.30994
12	81.52256	88.49771
13	81.02702	87.97370
14	80.87893	87.18229
15	79.82739	86.17929
16	83.66094	90.46632
17	83.73537	90.37626
18	80.89638	87.75315
19	81.61178	88.55348
20	83.45926	90.21734
21	82.55778	89.67338
22	84.34940	90.51465
23	81.51533	87.50348
24	82.47227	89.79064
25	79.68303	86.27275
26	81.80888	88.98001
27	79.16028	85.26504
28	81.90347	88.38100
29	84.89380	91.74497
30	82.90026	89.20472
31	83.10081	90.03721
32	84.19870	92.44889
33	82.71315	89.38731
34	83.31560	90.49285
35	80.92431	86.51511
36	82.90766	89.05261
37	79.37103	85.48798