Launch Angle

Griffin Sanford

1/24/2022

My goal for this project is to analyze data from MLB games to see if the distance of a batted ball travels further based on the launch angle. I will be pulling the data from the MLB api using baseballr.

Start by pulling the game ids and the play by play data

```
  library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.6     v dplyr   1.0.7
## v tidyr   1.1.4     v stringr 1.4.0
## v readr   2.1.1     v forcats 0.5.1
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
  library(baseballr)
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
  get_game_pks_mlb("2021-05-21")
```

```
##    game_pk                              link gameType season             gameDate
## 1   634012 /api/v1.1/game/634012/feed/live        R   2021 2021-05-21T23:05:00Z
## 2   634054 /api/v1.1/game/634054/feed/live        R   2021 2021-05-21T23:05:00Z
## 3   634014 /api/v1.1/game/634014/feed/live        R   2021 2021-05-21T23:05:00Z
## 4   634015 /api/v1.1/game/634015/feed/live        R   2021 2021-05-21T23:10:00Z
## 5   634089 /api/v1.1/game/634089/feed/live        R   2021 2021-05-21T23:10:00Z
## 6   634027 /api/v1.1/game/634027/feed/live        R   2021 2021-05-21T23:10:00Z
## 7   634036 /api/v1.1/game/634036/feed/live        R   2021 2021-05-21T23:20:00Z
## 8   634078 /api/v1.1/game/634078/feed/live        R   2021 2021-05-21T23:37:00Z
## 9   634008 /api/v1.1/game/634008/feed/live        R   2021 2021-05-22T00:05:00Z
## 10  634088 /api/v1.1/game/634088/feed/live        R   2021 2021-05-22T00:10:00Z
## 11  634022 /api/v1.1/game/634022/feed/live        R   2021 2021-05-22T00:15:00Z
## 12  634016 /api/v1.1/game/634016/feed/live        R   2021 2021-05-22T00:40:00Z
## 13  634028 /api/v1.1/game/634028/feed/live        R   2021 2021-05-22T01:38:00Z
## 14  634013 /api/v1.1/game/634013/feed/live        R   2021 2021-05-22T01:45:00Z
## 15  634019 /api/v1.1/game/634019/feed/live        R   2021 2021-05-22T02:10:00Z
##    officialDate isTie gameNumber publicFacing doubleHeader gamedayType
## 1    2021-05-21 FALSE          1         TRUE            N           P
## 2    2021-05-21 FALSE          1         TRUE            N           P
## 3    2021-05-21 FALSE          1         TRUE            N           P
```

```
## 4    2021-05-21 FALSE          1         TRUE            N           P
## 5    2021-05-21 FALSE          1         TRUE            N           P
## 6    2021-05-21 FALSE          1         TRUE            N           P
## 7    2021-05-21 FALSE          1         TRUE            N           P
## 8    2021-05-21 FALSE          1         TRUE            N           E
## 9    2021-05-21 FALSE          1         TRUE            N           P
## 10   2021-05-21 FALSE          1         TRUE            N           P
## 11   2021-05-21 FALSE          1         TRUE            N           P
## 12   2021-05-21 FALSE          1         TRUE            N           P
## 13   2021-05-21 FALSE          1         TRUE            N           P
## 14   2021-05-21 FALSE          1         TRUE            N           P
## 15   2021-05-21 FALSE          1         TRUE            N           P
##    tiebreaker      calendarEventID seasonDisplay dayNight scheduledInnings
## 1           N 14-634012-2021-05-21          2021    night                9
## 2           N 14-634054-2021-05-21          2021    night                9
## 3           N 14-634014-2021-05-21          2021    night                9
## 4           N 14-634015-2021-05-21          2021    night                9
## 5           N 14-634089-2021-05-21          2021    night                9
## 6           N 14-634027-2021-05-21          2021    night                9
## 7           N 14-634036-2021-05-21          2021    night                9
## 8           N 14-634078-2021-05-21          2021    night                9
## 9           N 14-634008-2021-05-21          2021    night                9
## 10          N 14-634088-2021-05-21          2021    night                9
## 11          N 14-634022-2021-05-21          2021    night                9
## 12          N 14-634016-2021-05-21          2021    night                9
## 13          N 14-634028-2021-05-21          2021    night                9
## 14          N 14-634013-2021-05-21          2021    night                9
## 15          N 14-634019-2021-05-21          2021    night                9
##    reverseHomeAwayStatus inningBreakLength gamesInSeries seriesGameNumber
## 1                  FALSE               120             3                1
## 2                  FALSE               120             3                1
## 3                  FALSE               120             3                1
## 4                  FALSE               120             3                1
## 5                  FALSE               120             3                1
## 6                  FALSE               120             3                1
## 7                  FALSE               120             4                2
## 8                  FALSE                NA             4                1
## 9                  FALSE               120             3                1
## 10                 FALSE               120             3                1
## 11                 FALSE               120             3                1
## 12                 FALSE               120             3                1
## 13                 FALSE               120             3                1
## 14                 FALSE               120             3                1
## 15                 FALSE               120             3                1
##    seriesDescription recordSource ifNecessary ifNecessaryDescription
## 1     Regular Season            S           N            Normal Game
## 2     Regular Season            S           N            Normal Game
## 3     Regular Season            S           N            Normal Game
## 4     Regular Season            S           N            Normal Game
## 5     Regular Season            S           N            Normal Game
## 6     Regular Season            S           N            Normal Game
## 7     Regular Season            S           N            Normal Game
## 8     Regular Season            S           N            Normal Game
## 9     Regular Season            S           N            Normal Game
```

```
## 10    Regular Season            S           N            Normal Game
## 11    Regular Season            S           N            Normal Game
## 12    Regular Season            S           N            Normal Game
## 13    Regular Season            S           N            Normal Game
## 14    Regular Season            S           N            Normal Game
## 15    Regular Season            S           N            Normal Game
##       description status.abstractGameState status.codedGameState
## 1            <NA>                   Final                     F
## 2            <NA>                   Final                     F
## 3            <NA>                   Final                     F
## 4            <NA>                   Final                     F
## 5            <NA>                   Final                     F
## 6            <NA>                   Final                     F
## 7            <NA>                   Final                     F
## 8  in Dunedin, FL                   Final                     F
## 9            <NA>                   Final                     F
## 10           <NA>                   Final                     F
## 11           <NA>                   Final                     F
## 12           <NA>                   Final                     F
## 13           <NA>                   Final                     F
## 14           <NA>                   Final                     F
## 15           <NA>                   Final                     F
##    status.detailedState status.statusCode status.startTimeTBD
## 1                 Final                F               FALSE
## 2                 Final                F               FALSE
## 3                 Final                F               FALSE
## 4                 Final                F               FALSE
## 5                 Final                F               FALSE
## 6                 Final                F               FALSE
## 7                 Final                F               FALSE
## 8                 Final                F               FALSE
## 9                 Final                F               FALSE
## 10                Final                F               FALSE
## 11                Final                F               FALSE
## 12                Final                F               FALSE
## 13                Final                F               FALSE
## 14                Final                F               FALSE
## 15                Final                F               FALSE
##    status.abstractGameCode teams.away.score teams.away.isWinner
## 1                        F                2               FALSE
## 2                        F               11                TRUE
## 3                        F                1               FALSE
## 4                        F               10                TRUE
## 5                        F                6                TRUE
## 6                        F                4               FALSE
## 7                        F                1               FALSE
## 8                        F                9                TRUE
## 9                        F                5               FALSE
## 10                       F                7                TRUE
## 11                       F               12                TRUE
## 12                       F                1               FALSE
## 13                       F                8                TRUE
## 14                       F                2                TRUE
## 15                       F                1               FALSE
```

```
##    teams.away.splitSquad teams.away.seriesNumber teams.away.leagueRecord.wins
## 1                  FALSE                      15                           17
## 2                  FALSE                      15                           28
## 3                  FALSE                      15                           26
## 4                  FALSE                      16                           16
## 5                  FALSE                      14                           22
## 6                  FALSE                      15                           21
## 7                  FALSE                      15                           18
## 8                  FALSE                      15                           27
## 9                  FALSE                      15                           26
## 10                 FALSE                      15                           18
## 11                 FALSE                      15                           23
## 12                 FALSE                      15                           18
## 13                 FALSE                      15                           27
## 14                 FALSE                      15                           27
## 15                 FALSE                      15                           21
##    teams.away.leagueRecord.losses teams.away.leagueRecord.pct
## 1                              27                        .386
## 2                              18                        .609
## 3                              17                        .605
## 4                              28                        .364
## 5                              17                        .564
## 6                              23                        .477
## 7                              26                        .409
## 8                              19                        .587
## 9                              19                        .578
## 10                             26                        .409
## 11                             21                        .523
## 12                             28                        .391
## 13                             19                        .587
## 14                             18                        .600
## 15                             24                        .467
##    teams.away.team.id teams.away.team.name teams.away.team.link
## 1                 110    Baltimore Orioles    /api/v1/teams/110
## 2                 111       Boston Red Sox    /api/v1/teams/111
## 3                 145    Chicago White Sox    /api/v1/teams/145
## 4                 142      Minnesota Twins    /api/v1/teams/142
## 5                 121        New York Mets    /api/v1/teams/121
## 6                 158    Milwaukee Brewers    /api/v1/teams/158
## 7                 134   Pittsburgh Pirates    /api/v1/teams/134
## 8                 139       Tampa Bay Rays    /api/v1/teams/139
## 9                 117       Houston Astros    /api/v1/teams/117
## 10                116       Detroit Tigers    /api/v1/teams/116
## 11                112         Chicago Cubs    /api/v1/teams/112
## 12                109 Arizona Diamondbacks    /api/v1/teams/109
## 13                133    Oakland Athletics    /api/v1/teams/133
## 14                119  Los Angeles Dodgers    /api/v1/teams/119
## 15                136     Seattle Mariners    /api/v1/teams/136
##    teams.home.score teams.home.isWinner teams.home.splitSquad
## 1                 4                TRUE                FALSE
## 2                 3               FALSE                FALSE
## 3                 2                TRUE                FALSE
## 4                 0               FALSE                FALSE
## 5                 5               FALSE                FALSE
```

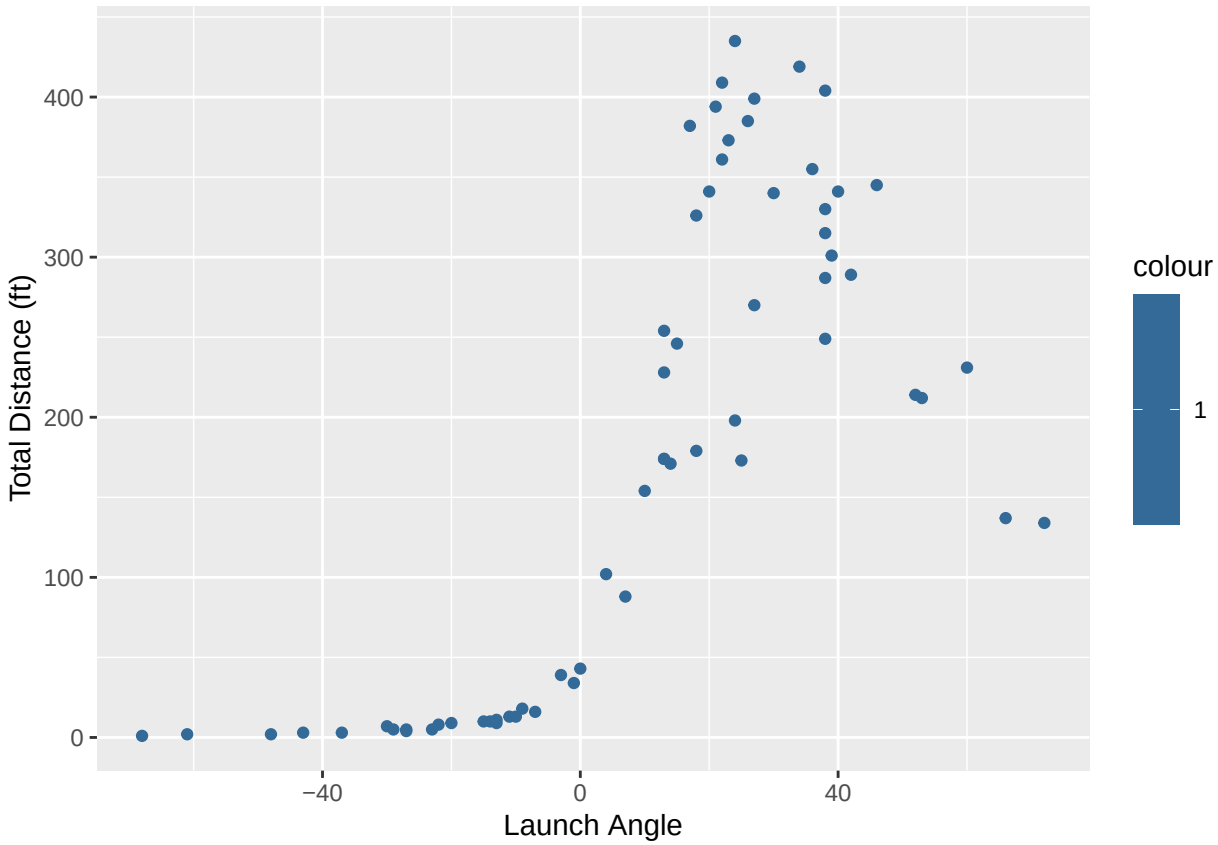
```
## 6                 9                TRUE                 FALSE
## 7                20                TRUE                 FALSE
## 8                 7               FALSE                 FALSE
## 9                 7                TRUE                 FALSE
## 10                5               FALSE                 FALSE
## 11                3               FALSE                 FALSE
## 12                7                TRUE                 FALSE
## 13                4               FALSE                 FALSE
## 14                1               FALSE                 FALSE
## 15               16                TRUE                 FALSE
##    teams.home.seriesNumber teams.home.leagueRecord.wins
## 1                       14                           18
## 2                       15                           22
## 3                       15                           26
## 4                       15                           23
## 5                       15                           20
## 6                       15                           20
## 7                       15                           21
## 8                       15                           23
## 9                       15                           20
## 10                      15                           20
## 11                      15                           25
## 12                      15                           16
## 13                      16                           19
## 14                      15                           28
## 15                      15                           28
##    teams.home.leagueRecord.losses teams.home.leagueRecord.pct
## 1                              23                        .439
## 2                              23                        .489
## 3                              19                        .578
## 4                              19                        .548
## 5                              25                        .444
## 6                              23                        .465
## 7                              24                        .467
## 8                              20                        .535
## 9                              27                        .426
## 10                             23                        .465
## 11                             19                        .568
## 12                             29                        .356
## 13                             26                        .422
## 14                             17                        .622
## 15                             17                        .622
##    teams.home.team.id  teams.home.team.name teams.home.team.link venue.id
## 1                 120  Washington Nationals    /api/v1/teams/120     3309
## 2                 143 Philadelphia Phillies    /api/v1/teams/143     2681
## 3                 147      New York Yankees    /api/v1/teams/147     3313
## 4                 114     Cleveland Indians    /api/v1/teams/114        5
## 5                 146         Miami Marlins    /api/v1/teams/146     4169
## 6                 113       Cincinnati Reds    /api/v1/teams/113     2602
## 7                 144        Atlanta Braves    /api/v1/teams/144     4705
## 8                 141     Toronto Blue Jays    /api/v1/teams/141     2536
## 9                 140         Texas Rangers    /api/v1/teams/140     5325
## 10                118    Kansas City Royals    /api/v1/teams/118        7
## 11                138   St. Louis Cardinals    /api/v1/teams/138     2889
```

```
## 12                115      Colorado Rockies    /api/v1/teams/115       19
## 13                108    Los Angeles Angels    /api/v1/teams/108        1
## 14                137  San Francisco Giants    /api/v1/teams/137     2395
## 15                135      San Diego Padres    /api/v1/teams/135     2680
##                  venue.name          venue.link                content.link
## 1            Nationals Park /api/v1/venues/3309 /api/v1/game/634012/content
## 2         Citizens Bank Park /api/v1/venues/2681 /api/v1/game/634054/content
## 3            Yankee Stadium /api/v1/venues/3313 /api/v1/game/634014/content
## 4         Progressive Field    /api/v1/venues/5 /api/v1/game/634015/content
## 5            loanDepot park /api/v1/venues/4169 /api/v1/game/634089/content
## 6  Great American Ball Park /api/v1/venues/2602 /api/v1/game/634027/content
## 7               Truist Park /api/v1/venues/4705 /api/v1/game/634036/content
## 8               TD Ballpark /api/v1/venues/2536 /api/v1/game/634078/content
## 9          Globe Life Field /api/v1/venues/5325 /api/v1/game/634008/content
## 10         Kauffman Stadium    /api/v1/venues/7 /api/v1/game/634088/content
## 11            Busch Stadium /api/v1/venues/2889 /api/v1/game/634022/content
## 12              Coors Field   /api/v1/venues/19 /api/v1/game/634016/content
## 13            Angel Stadium    /api/v1/venues/1 /api/v1/game/634028/content
## 14              Oracle Park /api/v1/venues/2395 /api/v1/game/634013/content
## 15               Petco Park /api/v1/venues/2680 /api/v1/game/634019/content
```

```
pbpData <- get_pbp_mlb(game_pk = 634036)
```

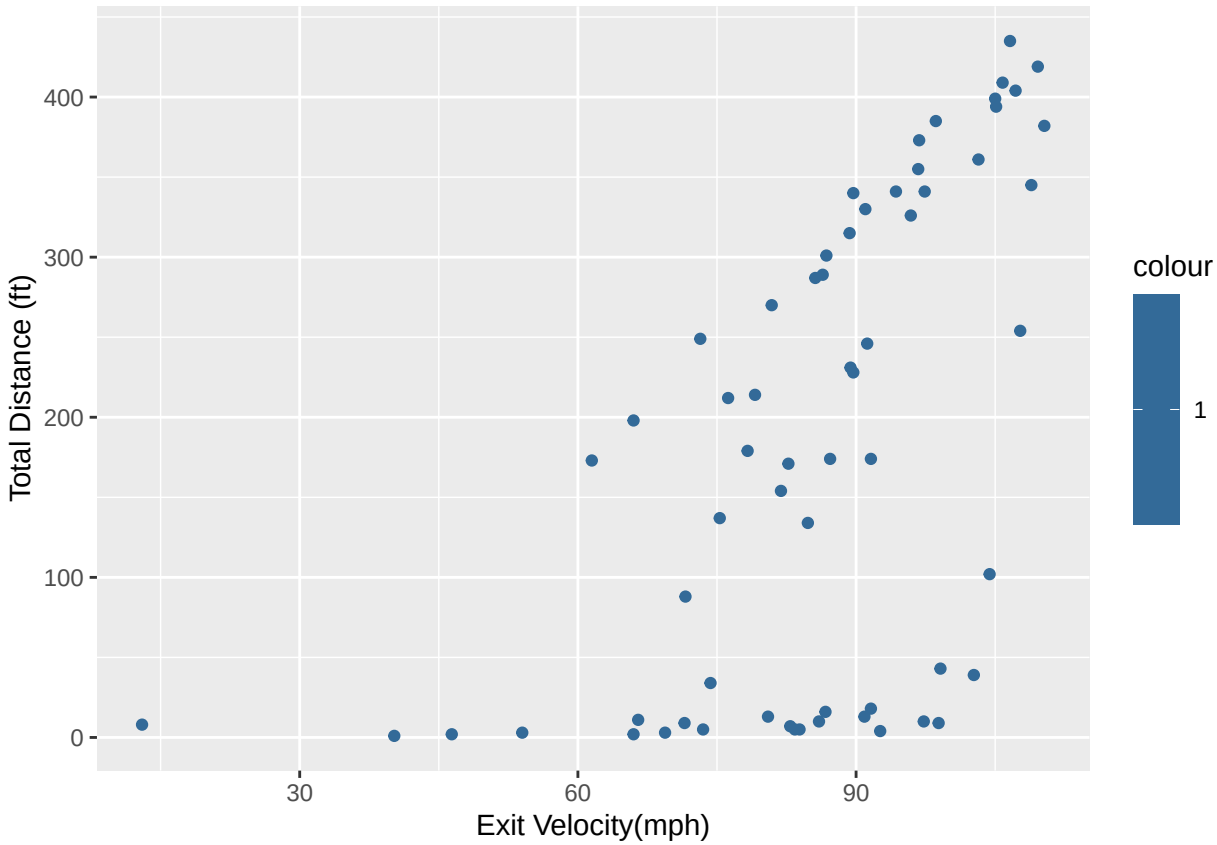
The two coloums I am looking for to plot are hitData.launchAngle and hitData.totalDistance. These will show the distance of each batted ball relative to the launch angle. I am hoping to see a peek at the most efficient launch angle.

```
ggplot(data = pbpData, aes(x=hitData.launchAngle, y = hitData.totalDistance)) + geom_point(aes(color=
xlab("Launch Angle") + ylab("Total Distance (ft)")
```



There seems to be a pattern here as the batted balls are trending upward until about 25-30°, after they start to travel at a shorter distance. I want to make sure that this pattern is as a result of the launch angle and not the exit velocity. To check this I will make a similar graph but replace launch angle with exit velocity.

```
ggplot(data = pbpData, aes(x=hitData.launchSpeed, y = hitData.totalDistance)) + geom_point(aes(color=
xlab("Exit Velocity(mph)") + ylab("Total Distance (ft)")
```



This graph shows that the harder the ball is hit the better chance it has to travel a further distance. These two graphs show that both launch angle, and exit velocity are important to how far a batted ball will travel. They also show that launch angle is much more important as none of the balls hit at the peek launch angle traveled less than 250ft. On the other hand many balls hit above 90mph didn't even break 50ft.

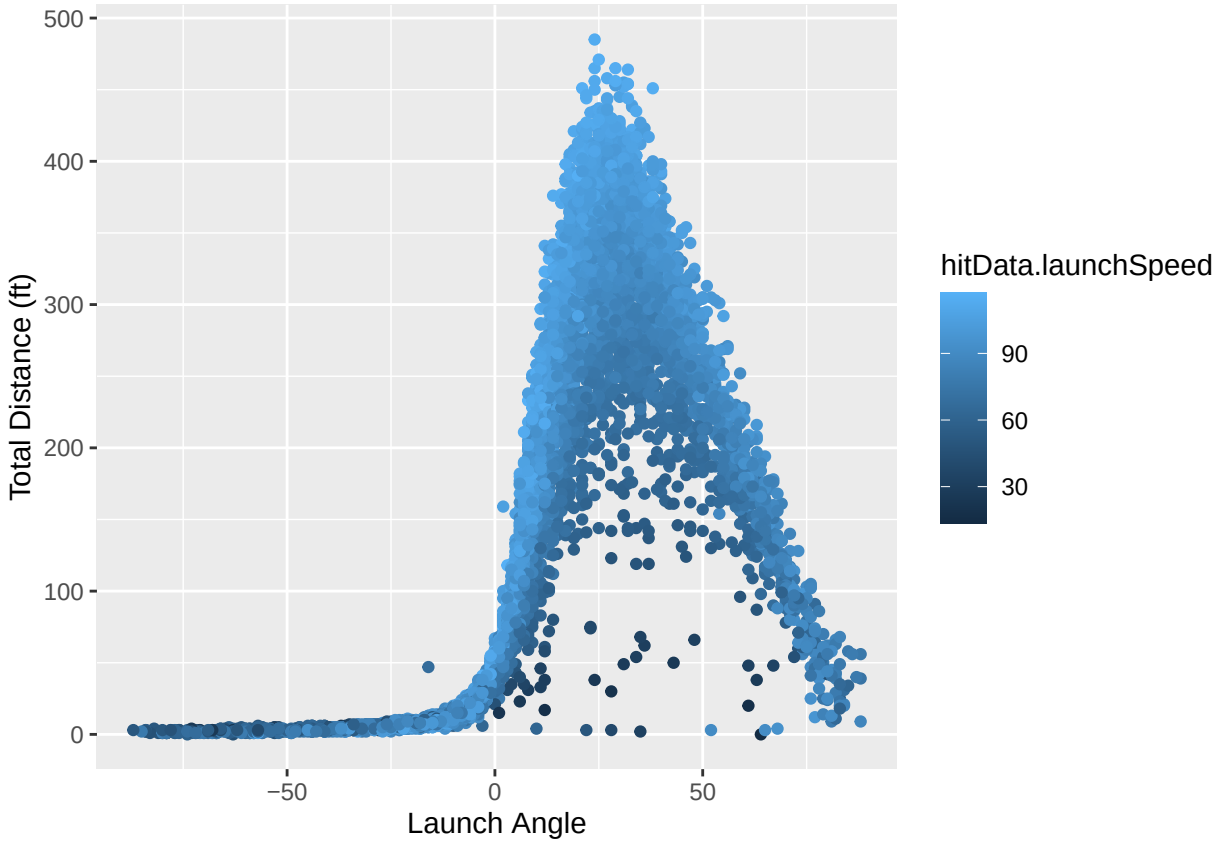
This data is only taken from a single game. I want to scale up the data to a whole month of MLB games to see if my analysis is still true. To do this I will need to make a data frame and fill it with multiple games ids in order to pull all the play by play data from a single month.

```
start = as.Date("2021-04-01")
end = as.Date("2021-04-10")
theDate = as.Date(start)
tempDF <- data.frame()
neededCols <- c("hitData.launchAngle", "hitData.totalDistance", "hitData.launchSpeed")
hitData <- data.frame(matrix(ncol = 3, nrow = 0))
colnames(hitData) <- c("hitData.launchAngle", "hitData.totalDistance", "hitData.launchSpeed")
allGamePK <- c(matrix(ncol = 1, nrow = 0))

while (theDate <= end){
  tempDF <- data.frame(get_game_pks_mlb(theDate))
  temp = tempDF[, (names(tempDF)%in% 'game_pk')]
  allGamePK <- append(allGamePK, temp)
  theDate <- theDate + 1
}

for(i in 1:length(allGamePK)) {
  temp <- data.frame(get_pbp_mlb(game_pk = allGamePK[i]))
  temp = temp[, (names(temp)%in% neededCols)]
```

```
  hitData <- rbind(hitData, temp)
}
```

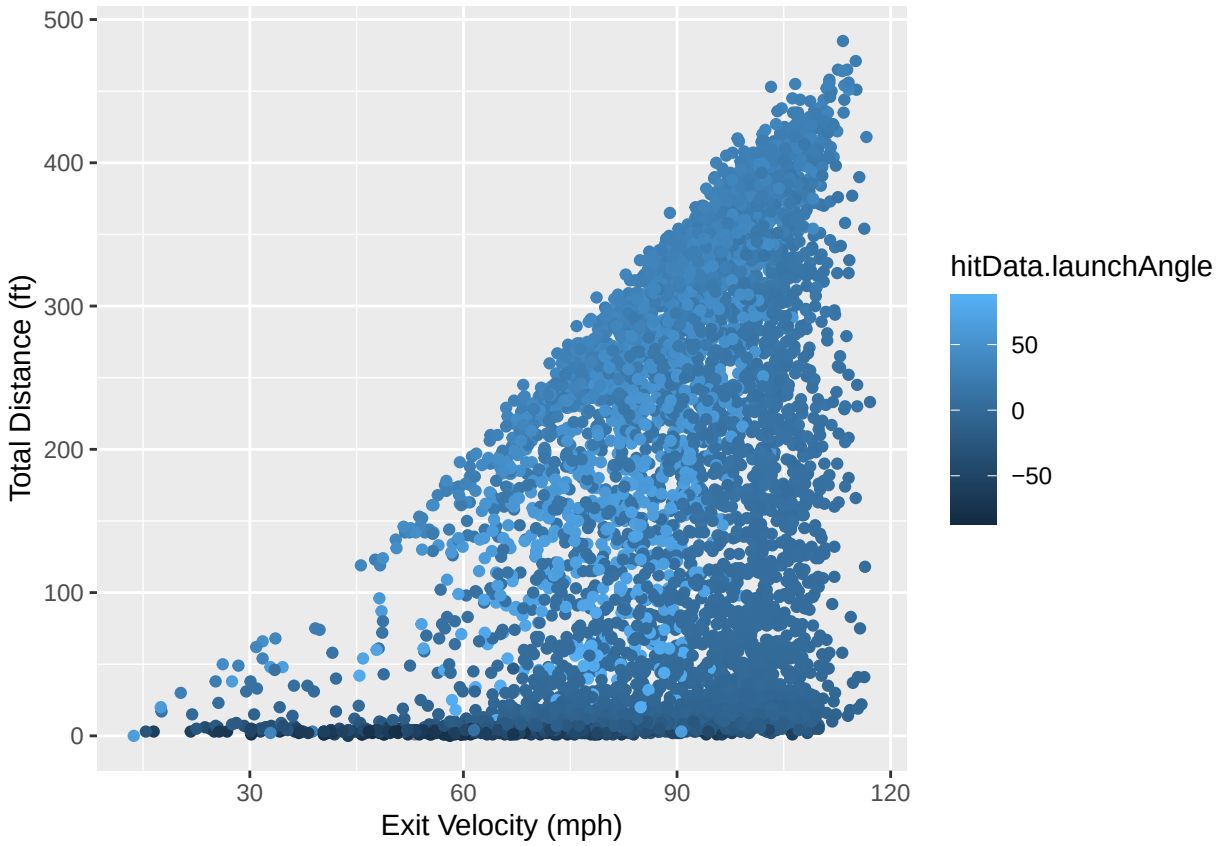
Now that I have collected all the data from a months worth of games I will graph the data in the same style. I am adding adding the exit velocity to the color of the plots see the effect of lauch angle and speed together.

```
  ggplot(data = hitData, aes(x=hitData.launchAngle, y = hitData.totalDistance)) + geom_point(aes(color=
  xlab("Launch Angle") + ylab("Total Distance (ft)")
```



I would also like to swithc launch angle and exit velocity to see what that chart will look like.

```
  ggplot(data = hitData, aes(x=hitData.launchSpeed, y = hitData.totalDistance)) + geom_point(aes(color=
  xlab("Exit Velocity (mph)") + ylab("Total Distance (ft)")
```



Now that there is more data points to look at it is very clear that the launch angle of the ball is the most important factor in hitting a ball as far as possible. The velocity is also a factor in distance but is alot more hit and miss. This is because the ball can be hit 100mph off the bat but if its launch angle is straight into the ground it's not going very far.