Stat 345 Midterm Project Ben Ellingworth

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Timberwolves Shot Chart (Parts 1 and 3)

```
# Here are all the necessary packages needed to be loaded in to perform the task of creating a
# shot chart. Making sure all of these packages are loaded in order is essential. When
# downloading NBAstatR make sure to follow the exact code below to correctly get all the data
# loaded in. This part was tough but it ended up working out following what I did below.
#library(devtools)
#library(tidyverse)
#library(ggplot2)
#library(dplyr)
#devtools::install_github("abresler/nbastatR")
#library(nbastatR)
#library(hexbin)
#library(lubridate)
#library(gganimate)
#library(magick)
#library(formatR)

# The first step after everything is correctly loaded in is to change your
# "VROOM_CONNECTION_SIZE." When I first tried using the data from nbastatR I kept getting an
# error message and multiplying by 2 to my vroom size helped fix this issue. It may need to
# bigger depending on what you plan on working with but for this specific task this was the
# correct size that worked.
Sys.setenv("VROOM_CONNECTION_SIZE" = 131072 * 2)

#Loading in data and preparing it.
# The second step is to divide out the data that you want to create your shot charts from. For
# this specific example,  I specified the data to use (team_shots), the team I want
# (Timberwolves), as well as the seasons I wanted to use. You can tweak these variables as
# needed to get different kind of shot charts that you might want in the future. I would just
# make sure to check out the team_shots data to see what you can specify to work with, before
# plugging in different variables. Once I specified what season to use, I used the select
# function to clean the data up and select which columns I wanted to keep. This is important if
# any issues arise. Cleaning the data up allows for us to go back and try and fix the problem.
# All of the columns I needed for this shot chart were namePlayer, yearSeason,
# zoneRange,locationX, locationY, slugZone, typeShot, isShotAttempted, isShotMade,
# distanceShot.The rest were not needed so I made the judgment to not include them in our data.
# This code gives us a base to rely on for future modifications to achieve certain goals.
Tpups2022 <-teams_shots(teams = "Minnesota Timberwolves", seasons = 2022)%>%
   select(namePlayer, yearSeason, zoneRange,locationX, locationY, slugZone, typeShot,
   isShotAttempted, isShotMade, distanceShot)
```

```
## Warning: `funs()` was deprecated in dplyr 0.8.0.
## Please use a list of either functions or lambdas:
##
##   # Simple named list:
##   list(mean = mean, median = median)
##
##   # Auto named with `tibble::lst()`:
##   tibble::lst(mean, median)
##
##   # Using lambdas
##   list(~ mean(., trim = .2), ~ median(., na.rm = TRUE))
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was generated.
```

```
## Minnesota Timberwolves 2021-22 shot data
```

```
Tpups2012 <- teams_shots(teams = "Minnesota Timberwolves", seasons = 2012)%>%
   select(namePlayer, yearSeason, zoneRange,locationX, locationY, slugZone, typeShot,
   isShotAttempted, isShotMade, distanceShot)
```

```
## Minnesota Timberwolves 2011-12 shot data
```

```
Tpups2002 <- teams_shots(teams = "Minnesota Timberwolves", seasons = 2002)%>%
   select(namePlayer, yearSeason, zoneRange,locationX, locationY, slugZone, typeShot,
   isShotAttempted, isShotMade, distanceShot)
```

```
## Minnesota Timberwolves 2001-02 shot data
```

```
# Joining data in one place.
# Here we use the full join function to join the 3 separate years together. This will become
# very important once we need to facet our data and show all 3 years of shot chart data later. I
# used two separate calls to do this task. This allows us to only have to call one object for
# the shot chart and compare years.
Tpups <- full_join(Tpups2002,Tpups2012)
```

```
## Joining, by = c("namePlayer", "yearSeason", "zoneRange", "locationX",
## "locationY", "slugZone", "typeShot", "isShotAttempted", "isShotMade",
## "distanceShot")
```

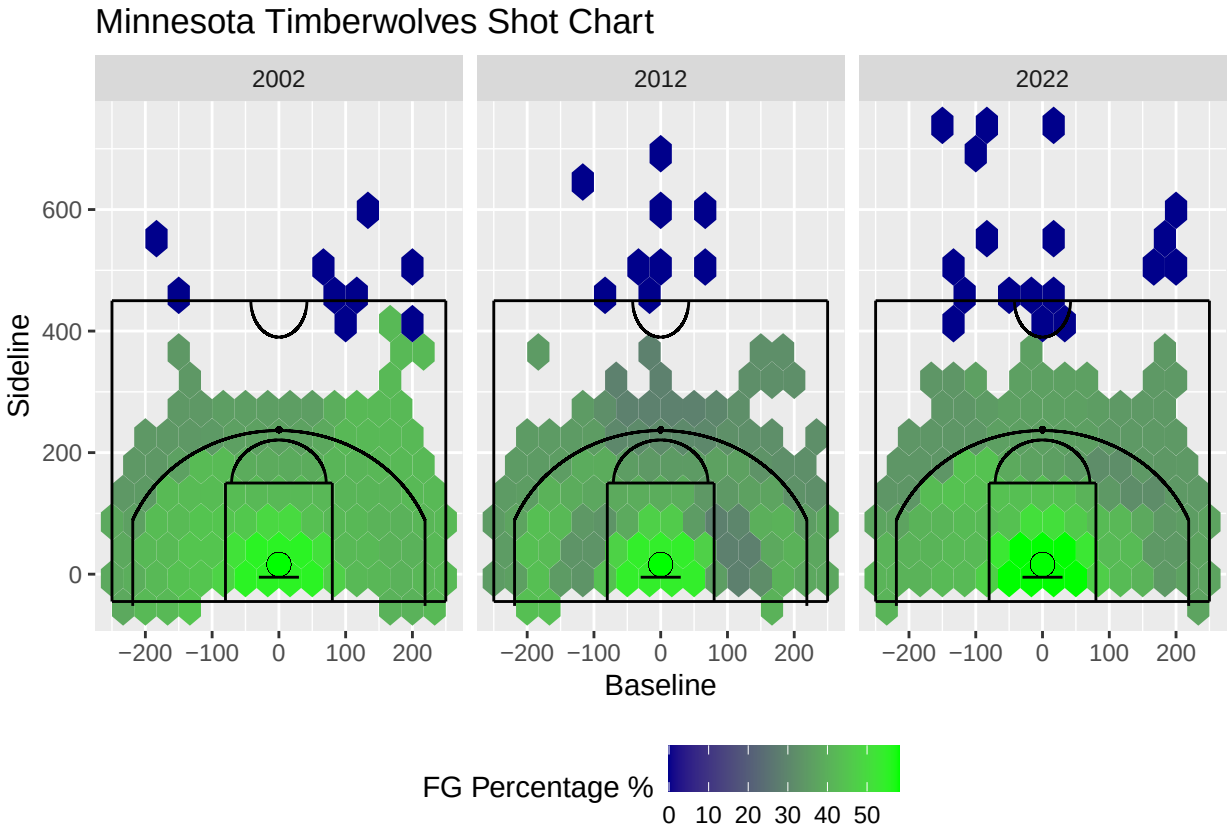
```
Tpups2 <- full_join(Tpups, Tpups2022)
```

```
## Joining, by = c("namePlayer", "yearSeason", "zoneRange", "locationX",
## "locationY", "slugZone", "typeShot", "isShotAttempted", "isShotMade",
## "distanceShot")
```

```
#Mutating Data
# Here is where we start to mutate the data and add an extra column based on our purpose for the
# shot chart. For this specific shot chart, I wanted to see the fg percentage from each zone on
# the floor to get a more accurate report of our 2022 season. So first, I took the data gathered
#from the step before and grouped it by yearSeason and zoneRange first to group shots in similar
# distances together from that specific year. Next, I grouped the new data by the zone of these
# shots using slugZone. This took shots of similar distance and groups them as either from the
# left wing, center, right wing, or either corner. Third, I separated the type of shot (2pt or
# 3pt) to help specify the close shots between long 2pt and short 3pt shots. Lastly, once
# everything is grouped with these 3 specific variables, I used the mutate function to create a
# column that gives the fg% from these specifically grouped zones. I did this by taking the sum
# of the isShotMade variable and dividing it by the isShotAttempted. This is basically a "mean"
# function that will show up later. Finally, once this is finished we can get to the final part
```

```
# of plotting the data. This gives us the main idea for our shot chart.
madeShot2 <- Tpups2 %>%
   group_by(yearSeason,zoneRange,slugZone,typeShot)%>%
mutate(fgPercentage = sum(isShotMade)/sum(isShotAttempted)*100)

#ggplot
# This is where we use the data, cleaned and manipulated above, to create our shot chart. First
# we must identify a name for it, then call ggplot() with our data we want to use inside. This
# gives us our blank canvas to add to it whatever we like. Notice I used the the data set we
# created with our new fg% in it (madeShot2). This is essential to get this project to work.
shotChart <- ggplot(madeShot2) +

   # Next I used stat_summary_hex to help bin the points into hexagons rather than geom_point.
   # Geom_point has too many points and is difficult to draw conclusions from, so binning the
   # points is essential. Here is where we define our x,y,z variable we want to use. These
   # variables are the inputs into the function. Our x and y variables are the respective
   #locations found in our data above, that plot the specific shots where they actually were on
   # the floor. The z however, is what we want our color to be based on. For this example,
   # wanted to see the difference in FG% at different parts of the court so I set the z to be =
   # to fgPercentage. The last part was specify what function we wanted to use for these points.
   # As mentioned before, the FG% is a mean function so I specified it in quotes and decided how
   # many bins we wanted to use.
   stat_summary_hex(aes(x = locationX, y = locationY, z = fgPercentage),fun = "mean",
   bins = 15)+

# Here is where we can decide the colors. Make sure to pick 2 colors that are opposite so the
# viewers can see the differences between areas. I chose green and blue because they are
# different and the Timberwolves colors.
scale_fill_gradient(high = "green", low = "darkblue", "FG Percentage %")+

# Here I used xlab and ylab to label the axis. I chose baseline and sideline because that will
# show the viewers where on the court is is. I also named the title the year to make the chart
# look better and give an easy reference for the viewers to look back at. I did this by a
# simple ggtitle() call.
   xlab("Baseline") +
   ylab("Sideline") +
   ggtitle("Minnesota Timberwolves Shot Chart")+

# Now is when I used the facet_wrap function to facet the different shot charts from the 3
# selected years above. I did this by choosing the yearSeason variable to seperate the data.
# This accomplished the goal. Lastly, I moved the legend position to the bottom of the charts
# to make it easier to read and allow the charts to be bigger on the screen.
   facet_wrap(~yearSeason)+
   theme(legend.position = "bottom")+

# Last was plotting the court to fit the actual dimensions of a NBA court. My method for
# attacking this problem was to put points at the main parts of the court and move my respective
# lines to fit them. For example, I left the 3pt dot as a reference. NbastatR uses a 1/10 foot
# ratio and an NBA 3pt shot is 23.75 feet away from the top of the key. So, I placed
# a point at (0, 237.5) and manipulated my numbers to move the 3pt arc to match with that
# point. The rest were lines that were straight and just needed to have either x or y set at
# the right spot. Looking up the dimensions of an NBA court and translating it to this graph
# was the toughest part.
```

```
   #3PT Line. I found the outline of the 3pt line on GitHub by Ed Kupfer and scaled it to fit
   # the graph of our shot chart. I did this by adding 41.75 and * by 9.95 at the end.
  geom_path(data=data.frame(x=c(-22,-22,-22000:(-1)/1000,1:22000/1000,22,22),
                            y=-c(47,47-169/12,41.75-sqrt(23.75^2-c(-22000:(-1)/1000,1:22000/1000)^2),
47-169/12,47)+41.75)*9.95,
aes(x=x, y=y))+
   #Half court line
   geom_path(data=data.frame(x=c(-250,250),y=c(450,450)), aes(x=x, y=y))+
   #Side lines
   geom_path(data=data.frame(x=c(-250,-250), y= c(-45,450)), aes(x=x, y=y))+
    geom_path(data=data.frame(x=c(250,250), y= c(-45,450)), aes(x=x, y=y))+
   # Baseline
   geom_path(data=data.frame(x=c(-250,250), y = c(-45,-45)), aes(x=x, y=y))+
   # Free Throw line and lane lines
      geom_path(data=data.frame(x=c(-80,80), y = c(150,150)), aes(x=x, y=y))+
    geom_path(data=data.frame(x=c(-80,-80), y = c(-45,150)), aes(x=x, y=y))+
   geom_path(data=data.frame(x=c(80,80), y = c(-45,150)), aes(x=x, y=y))+
   # Semi Circle at the half court line. This one needed a little scale of the x axis by
   # multiply by 7 and moving up along the y axis by adding 450.
   geom_path(data=data.frame(x=c(-6000:(-1)/1000,1:6000/1000)*7,
   y=-c(sqrt(6^2-c(-6000:(-1)/1000,1:6000/1000)^2)*10)+450),aes(x=x,y=y))+
   #Semi Circle above the free throw line. Multiplying by 11.811 from both the y and x axis gave
    # use the correct dimensions of the semi circle.
   geom_path(data=data.frame(x=c(-6000:(-1)/1000,1:6000/1000)*11.811,
                             y=c(sqrt(6^2-c(-6000:(-1)/1000,1:6000/1000)^2)*11.811)+150),aes(x=x,y=y))+
   geom_point(aes(0,237.5), size = 0.5)+

   # Placing two points and making them these sizes help give us the rim. I was not able to load
   # in an circle so I decided to place a smaller green dot above the black dot. This is fine
   # because all of the hexagons under these dots were green so there is not data lost. I placed
   # the backboard 40 from the baseline which was -45.
   geom_point(aes(0,16), size = 3.625, color = "black")+
      geom_point(aes(0,16), size = 3.3, color = "green")+
   geom_path(data=data.frame(x=c(-30,30), y = c(-5,-5)), aes(x=x, y=y))
shotChart
```



Commentary on the results

Need One More 3pt Shooter

- With the game evolving and playing styles changing, it is essential to have guys who can space the floor. With the success rate we are having getting to the rim, adding one or two more >35% 3PT shooters will help open lanes for our team to continue to getting to the rim as well as fit the pace of play needed in today's NBA game. As we look at the different shot charts between 2012 and 2022, we are a much better all around shooting team from inside the arc, but can see little improvement from the three point line. We are not lacking from behind the arc, but I believe adding one more player who has a high 3PT percentage can help us take the final step we need to contending.

Stay Away From the Top of the Key/Deep Mid-Range Shots

- The 2022 shot chart shows we are shooting some of our worst percentages from the top of the key and left-side mid-range jump shots. The worst shot in basketball is the long two and eliminating these shots by either stepping out to the 3pt line or attacking to get closer to the rim will be beneficial. As a team, we are shooting better from the left corner 3pt line than slightly inside the arc at that area. By stepping out as well, we are gaining one extra point from each shot for attempting the three. Lastly, both inside and outside the arc from the top of the key are some of our worst shooting percentages. Staying away from contested shots in these areas may help the offense become more efficient and overall shoot better.

Balanced Scoring Wins Games

- I mentioned early adding one more 3PT specialist would help, but also adding veterans who can score on all 3 levels would be beneficial as well. Part of what made that 2002 team very good was having a good mixture of players who could do whatever they were asked. As we see from the shot charts, they were very well balanced at all spots on the floor. They didn't have one glaring weakness that teams could exploit as the year went on. When one option was taken, they were able to find ways to produce.

This year we have taken a step in the right direction, but getting a player or two who aren't great at just one aspect of the game, but are very competent in all aspects, I believe would help benefit the team. Our shot chart shows we have some gaps to fill. We could use someone who is great from the left side of the court. Having the perfect mixture of specialists and all-around players is essential to trying to contend for a title.

Keep Attacking

- The strength of the Timberwolves this year is their age and athleticism. We are more athletic than most teams we play and shoot very well from 2PT. It was expected that our best FG percentage would be near the hoop, but we still need to emphasize attacking the rim and not settling. Especially for players like Anthony Edwards, he is at his best when he's going downhill and getting to the rim. Even getting a foot or two inside the lane has shown to be very successful this year. It doesn't have to be a layup or a dunk. The 2022 chart shows how effective we can be as a team if we can attack and get in the lane. Unlike deep mid-range shots, we are shooting a much better percentage barely inside the lane so we should not look to abandon these shots. A layup every possession is unrealistic but incorporating more free throw line and elbow shots in our offense could help make us more efficient.

Attack the Right Side of the Court

- As a team overall, we are shooting a much better percentage from the right side of the court than from the left. The shot chart shows just how big of difference there is between sides. With this data we can slightly tweak the way we play to try and benefit our offense. Adding a couple sets to get shooters open on the right side of the court, or just instilling in the players minds to attack the right side as the shot clock runs down, can have a huge impact. Obviously, these players shouldn't be changing the entire way they play and stray away from open looks from the left side, but incorporating small tweaks to situations can help pay dividends in the long run.