

# Basketball Shot Percentages

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## ABSTRACT

**Keywords:** Data, basketball, standardized, heat, shot, visualization.

Data driven approaches in the realm of basketball to improve team performance are not centralized or standardized. With the use of shot charts and heat maps, teams can better understand their chemistry, efficiency and productivity. The visualizations provided show overlapping heat maps where certain players perform better than others. To better structure your team with the nuance of data, coaches and staff can utilize the visualizations to know what players perform better with certain teammates, against certain players/teams, in particular quarters of the game.

<https://github.com/DS4200-S22/final-project-basketball-shot-chart-visualization>

## 1 INTRODUCTION

Imagine a team that uses a centralized shot chart showcasing its players' abilities throughout the game. This team can utilize a visualization that allows coaches to compare their player's with each other, against the other teams, and showcase certain player's performances within a certain point of the game. This tool will centralize a coach's game plan and allow a more easy, efficient and simple approach to statistical basketball. The use does not end here however, providing a visualization that is easy to read and simple to use will also allow players who do not have time to scour the internet for statistics on themselves to simply click and view their efficiency on the court. This capability will prove to be essential as player's can see their area of improvement and also specialize themselves against certain teams/players. For example, if a shooting guard sees that when he plays the Golden State Warriors he is more effective from the left corner, when he plays that team he can focus on getting to that spot more to take a more effective shot. Basketball is a game about taking the best shot at any given time. The purpose of this visualization is to centralize these results for players and coaches to utilize to perfect their game.

## 2 RELATED WORK

1. <https://www.visualnoise.io/visualising-basketball-shots-the-basics/>
2. <https://www.clutejournals.com/index.php/IJMIS/article/view/8705>
3. <https://www.tandfonline.com/doi/10.1080/24748668.2009.11868464?scroll=top>
4. <https://www6.uniovi.es/hypvis/percept/visrules.htm>
5. <https://ieeexplore.ieee.org/abstract/document/7750529/authors#authors>

### 2.1 SOURCE 1

This source presented the league in general, in terms of mapping out shot frequencies with equally sized hexagons, shot frequency in NBA by distance, and also shot accuracy and value. One insight from this source is that it presents the dots by color (in terms of accuracy), and size (in terms of frequency).

### 2.2 SOURCE 2

The second source we found goes into detail on creating heat maps in visualizations. This source is perfect for our idea as a heatmap is one of the ideas we have for our main visualization.

### 2.3 SOURCE 3

This source talks about the relevance of different performance indicators in the sport of basketball that help distinguish winning and losing teams. This source helped come to a conclusion that our data and idea was indeed sufficient for what we wanted to achieve: creating a shooting visualization that could actually help coaches win games.

### 2.4 SOURCE 4

This source talks about the basics of creating data visualizations. When we say basics, we mean the rules and principles that go into creating solid visualizations, which will be very helpful as guidelines for us when we create ours.

### 2.5 SOURCE 5

This report focuses on individual basketball games using classic and novel methods to reveal how players perform together and as individuals.

### 3 USE CASE

For this visualization, we would essentially be creating a heat map, or a shot chart, of how players on different teams across the NBA are shooting from different spots from the floor this season. We would also group the visualizations, so it shows the shot chart per quarter. Along with this, we plan to add a small table that shows how a player shoots from 2 or 3 point distance based on their shot type. In this case, we would be looking at the shot types of a pull-up jump shot or a shot off of a catch and shoot. This visualization would allow the league's coaches to see where each player shoots best from the floor and what type of shot suits them best. With this, the coaches can tailor plays to get the ball in their players to be ready to shoot and for them to get to their hot spots. It would also let coaches see where players need to improve from and have them practice from those spots more. So, with this, not only will the coaches be able to show the players where their best spots to capitalize but it can also help improve weaknesses in location and shot type.

The key thing about showing the shot chart by quarter is to see how players shoot as the game goes on. As the game goes on, we expect players to shoot worse because they are getting tired. So, this could put an emphasis on coaches to push players to condition better. It would also allow coaches to see who shoots better later in the game and allow them to draw up plays for those players during the closing minutes which are very crucial. In addition, coaches and scouting staff would be able to use this data to find players from across the league that shoot well in accordance with their specific system.

### 4 DATA

<https://www.nba.com/stats/players/shooting/?Season=2021-22&SeasonType=Regular%20Season&DistanceRange=By%20Zone>, This link provides data on all shooting splits for all NBA players and it categorizes the shooting % by distance from the basket, and we can filter it by quarter which is key in our visualization. The data comes straight from the NBA itself which means the data will be accurate, unbiased, and updated as soon as games become final.

<https://www.nba.com/stats/players/shots-general/>, This link will be key for the other component of our visualization where we will provide a table on players shooting % based on their shot type and if it is from 2 or 3 point range. Just like the link above, this data is straight from the NBA so it is credible and it can also be filtered by quarter which means it will fit seamlessly with our data from the first link.

### 5 TASK ANALYSIS

Task ID #	Domain Task	Analyze Task (high-level)	Search Task (mid-level)	Analytic Task (low-level, "query")
1	NBA Coach: I want to make my gameplan as efficient as possible.	Consume → Discover	Explore	Identify
2	NBA Scout: I want to see what prospective players will fill the holes in my team's current gameplan.	Consume → Discover	Lookup	Lookup
3	NBA Player: I want to perfect the way I play and become efficient.	Consume → Discover	Explore	Identify
4	NBA Fan: I want to see how my favorite players perform on average.	Consume → Enjoy	Explore	Identify

#### 5.1 FINAL REVIEW

The primary consumer for this visualization will be NBA coaches. NBA coaches will find this visualization most useful as it will allow them to tailor their gameplan to their strengths and their opposing team's weaknesses more effectively than they have in the past. Giving coaches, scouts and players the ability to discover their strengths and weaknesses within the team and individual players' games is the focus in the development of this visualization.

### 6 IMPLEMENTATION PLAN

The tool we plan to create is going to be a shooting map on a half basketball court. Essentially, the map would show shooting percentage in different ranges across the court, with shading used to show hot spots and weak spots, by section, not location. We will also have data from multiple teams and data from all the quarters in the game. In addition, we will have a pop up table for each range including what type of shot was taken. According to one of our references about the creation of shot charts, sql can be used to create them. Other options include Tableau and Python.

## Final Visual Encodings

For our final product, we will end up with a half basketball court that will use shading and area to show how well different players from different teams (selected by drop down bars) shoot from different predefined areas on the court. We will also include a bar graph that will show the data presented in the court chart in a different method by quarter for the chosen player.

## Interactive Components

We will require brush/link components on the court shot chart as there will be a highlighting component as you hover over each section. The highlighting will be darker based on how well the player shoots from that area and in addition, if you click on it, it will bring up additional details about the player's shooting abilities from that area.

## Annotations

In order to create this visualization we first need to utilize the d3.js library. First we will create the heatmap utilizing an open source library for basketball heat maps. After which, we will create the bar graph which utilizes similar data. From this point on, something nice that we want to implement is the 3d shot chart. This is a hard task that will take time but it is the current goal. If this were to fail, we will resort to using a basic data table to display the data in real-time for users to look at.

## Summary

We collected our data from NBA advanced stats. Since it doesn't provide API on their website, we'll just utilize the data that we cleaned up using python to implement it. We will utilize Javascript and d3.js to create all our graphs and interactions.

## VISUALIZATION DESIGN

The final visualization will include three different views. One that shows the team's effective field goal percentage and another that compares wins to effective field goal percentage. Furthermore, another chart will show the team's shots on a basketball court, where hot spots (frequent hits) are denoted with red and cold spots (frequent misses) are denoted with blue. Anything in between will take on a color in between red and blue. The scatter plot will allow brushing to see the bar graph in clearer detail. Dots that are brushed will be linked to the bar graph. All three of these visualizations will help the end users look at their team's stats compared to NBA leader stats and figure out what they need to improve on using one centralized tool.

We believe that this design will successfully help us fulfill our aim for this visualization. By this we mean that our final dashboard will be useful to coaches and scouting systems across the NBA. The shot charts will allow coaches to understand which of their players shoot well from different areas of the court. They can use this data to design plays and put their players in positions to succeed. As for the scouts, they can use these charts to compare players on their team to others across the league and find potential matches.

## REFERENCES

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## 7 APPENDIX B: DATA EXPLORATION

The following will contain our findings as we initially explore the data we plan on using for our main visualizations.

### 7.1 DATA COLLECTION

#### Data Review

As we are mainly looking to do a shot chart heat map and a table showing shooting percentages, the data type would be attributes and the attribute type for the shooting stats would be quantitative. These would include field goals attempted, field goals made, and field goal percentage. For the shot chart, we plan on categorizing the shooting data by two categories, the team the player plays for and the quarter a certain shot was taken in. For these two categories the levels would be teams and quarters. Within these categories, we would also filter the shooting percentage based on how far from the basket the player shot the ball. The level for this category of data would be distance from the basket. For our secondary table that will complement our shot chart, we also need the quantitative data but we also plan to break the percentages down by the shot type, which would be the level for that category.

Since our project is based on individual players and their stats, we would have to pivot and give a snapshot of the league by looking at the overall shooting data and not break it down by player, distance from basket or quarter. We picked 5 teams to

analyze, the Knicks, Bulls, Warriors, Celtics, and Suns. We know we cannot draw a correlation but we find it interesting how the Warriors, Bulls, and Suns all are in the top 7 of total FG% in the league and also have the best records. The Celtics have a middle of the pack record and are in the middle range of FG% while the Knicks rank 28th out 30 in total field goal percentage at 43% and are one of the worst teams in the league. It was also interesting to see that these 5 teams, as well as most of the NBA, have each taken about 86-89 shots a game so it is not like one team is putting up more shots than another but better teams will just make more shots and that makes logical sense.

A potential issue that we have found with our data is:

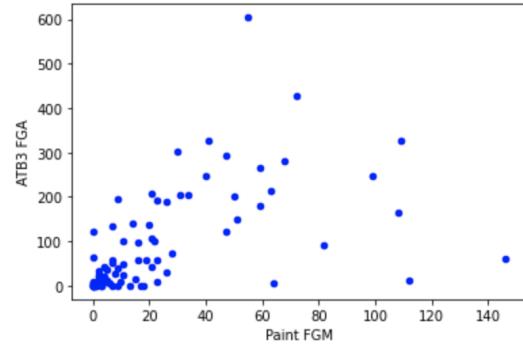
- Players who were on the team at one point, are still shown in the data
  - For the main user of our visualization being the coaches of the team, they only care about who is on the team currently. As the season goes on, players get traded and cut from the roster so there are moving pieces we have to take into account.
  - To solve this, we will simply find all players on the current roster and remove those who are no longer on the roster. Players who were sent down to do G-League will be kept as they are still part of the organization and could get called back up to the NBA.

## 7.2 PROCESSING AND DATA EXPLORATION

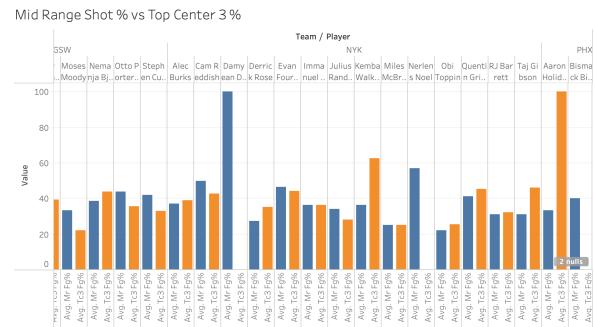
### Insights

We cleaned our data using python and were able to create columns of attempted shots, made shots, and percentage made from each respective area on the court. One thing that we found surprising is that shots attempted are very close among all the teams. Hence the reason, teams with higher shooting percentages have a higher ranking in the league. Another trend is that while different teams have different strategies and players, most of them take a balanced amount of shots between paint and three point (scatterplot). Our data does have a few flaws to it, even after cleaning it up. First, the age column does not have data for a large number of the players. If we decide to use that (undecided), we would have to add in a good bit of data. Second, There are a lot of players who do not have any data for certain areas of the court. This is not necessarily a bad thing, as it could just add to our analysis of who shoots more/better from where. However, the potential flaw comes from players with no data due to no play time. Some of our visualizations will look a little strange due to this, but workarounds are available such as hiding data or just removing unimportant players on the court from the data set.

### Screenshots

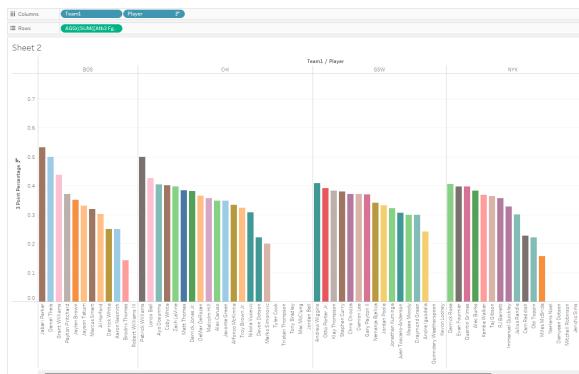


In this visualization the correlation between paint field goals made (x-axis) and three point field goals attempted (y-axis) are displayed. The interesting insights that can be derived from this data lie within its outliers. For example, the furthest right point shows a team that takes a lot of shots in the paint but barely any three pointers. This tells us about today's game and age, the heat maps that will be generated for certain teams will be very different to others based on specific players' playstyles, and this visualization describes it. You can also see a slight positive correlation in the leftmost region of the graph, this tells us that good teams are utilizing a spacious game plan with versatile players which will help in building the heatmaps. In this graph there are 0D points used as our marks and one color to represent the channel, since different colors are not needed.



This visualization shows us a comparison between center mid range field goal percent completion and top center three point percent completion from our total game stats csv. For visual encoding, we used area marks and color, tilt, and size channels to create a barchart. We felt this was the best way to show a side by side comparison of the two stats per player, and to also have players stand out amongst their peers. The pattern that we are beginning to see with this data is that most teams/players are fairly similar in these shooting categories. What it also shows is those players that stand out in one of the two categories with a much higher shooting percent. This is exactly what we want to be

identifying as coaches can use this data to feed players who are stronger in these areas the ball more.



This visualization shows the 3 point percentage of each player each time from our “Total Game Stats” data set. In order to calculate the average 3-point percentage for each player each time, the “Above the Break Percentage (ABT)” and “Total Corner Three (TCT) Percentage” amount made was divided by the amount attempted:

$$((\text{SUM}([\text{Atb3 Fgm}]) + \text{SUM}([\text{Tc3 Fgm}])) / (\text{SUM}([\text{Tc3 Fga}]) + \text{SUM}([\text{Atb3 Fga}])))$$

This was done because the ABT did not account for corner threes, so by adding those two components together the 3 point percentage for all parts of the court was visualized. For visual encoding area marks and color, size channels, and tilt were used to create a barchart. This was the best visualization for this data because it allows users to see which individual player had the highest 3 point percentage and how they compare with other teams. Teams 3 point percentages can also be compared with one another as well. According to our visualization, There is a general pattern that most players have a 3 point percentage 30-40%. By being able to visualize the breakdown of how players are performing in each team in terms of 3-points, coaches can maximize players who have higher 3 point percentages in their strategies. Opposing teams can also draw up plays to minimize the risk of players that have high 3 point percentages.

### 7.3 DATA SNIPPET

#### Glossary

- RA = Restricted Area
- Paint = In the paint (not including RA)
- MR = Mid Range
- RC3 = Right corner 3
- LC3 = Left Corner 3
- TC3 = Total Corner 3
- ATB3 = above the break 3 (3s not including corner)
- FGM = Field Goals Made
- FGA = Field Goals Attempted
- FG% = Field Goal Percent

Player	Team	RA	RA FGA	RA FG%	Paint	Paint FGA	Paint FG%	MR	MR FGA	MR FG%	LC3	LC3 FGA	LC3 FG%	RC3	RC3 FGA	RC3 FG%	TC3	TC3 FGA	TC3 FG%	ATB3	ATB3 FGA	ATB3 FG%	
3 Derrick Rose	NYK	46.0	79.0	58.2	28.0	63.0	44.4	11.0	40.0	27.5	3.0	7.0	42.9	3.0	10.0	30.0	6.0	17.0	35.3	31.0	74.0	41.9	
78 Javale McGee	PHX	155.0	222.0	69.8	64.0	108.0	59.3	7.0	17.0	41.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	7.0	28.6
83 Mikal Bridges	PHX	134.0	162.0	82.7	82.0	148.0	55.4	29.0	73.0	38.4	20.0	59.3	33.9	32.0	79.0	40.5	52.0	138.0	37.7	30.0	91.0	33.0	
64 Stephen Curry	GSW	109.0	184.0	59.2	56.0	117.0	47.0	48.0	114.0	42.1	13.0	35.0	37.1	10.0	35.0	28.6	23.0	70.0	32.9	233.0	604.0	38.6	
32 Darrion Lee	GSW	51.0	64.0	79.7	16.0	38.0	42.1	15.0	51.0	29.4	15.0	35.0	42.9	6.0	24.0	25.0	21.0	59.0	35.6	37.0	97.0	381.1	

## 8 APPENDIX C: INTERVIEW

### 8.1 END USER PERSONAS

End user persona is an NBA coach. Yes I have used visualizations before, though not extensively. These visualizations mostly come in the form of drawing up plays and setting up my team for success on the court. This proposed visualization would take us one step further by allowing us to see exactly who is best at shooting from different areas of the court. This will allow us to put the correct players in the correct areas of the court. This visualization will extend to other teams in the NBA, so we will also be able to use it for scouting purposes by identifying talent across the league that fits into our team. Currently, we use our extensive system of scouts to identify players that would be a good fit for our team. This system already includes statistical analysis, but is not displayed in a concise and easy manner, which this visualization will excel at. This visualization will make our lives easier by allowing us to simply click and change teams and players to have access to a great pool of shooting data in an instant. It's about making the process simpler and more efficient so that we can identify the talent and players on our team that excel in different areas and scenarios quickly.

### 8.2 INTERVIEW SCRIPT

1. What is your role in this organization? Why are you asking for these tools?
  - a. Follow up: Is this something you would mainly be looking at or someone else?
2. What specific utilities would you like to see in the visualization?
  - a. Follow-Up: Could you prioritize these in terms of needs vs. wants?
3. Is the visualization specifically inward looking at your organization?
4. Would you like this visualization to expand outwards beyond just your organization into the rest of the league?
  - a. Would you want anything different in a visualization for the rest of the league?
5. Are there any visualization tools you guys are currently using?
  - a. Follow-up: What sort of utility do your current visualization tools provide? Why are you looking for something different?

6. What kind of visualization would you like to see?  
Player suggestion model?

### 8.3 INTERVIEW NOTES

1. Their role in this organization is coach. They make all the decisions for the team and have final say in recruitment matters.
  - a. This visualization will be looked at by multiple people in the coaching and scouting department, but the coach will have final say in all matters.
2. They would like to see shooting statistics across all different areas of court. Would like to include all players on a team and several other teams across the NBA for reference/scouting.
3. They would like the visualization to be both inward and outward looking.
4. It'll be advantageous if the coaches can see their opponents shooting percentages in different areas, as they can come up with specific defensive strategies. Also for scouting/recruiting purposes.
5. Yes. NBA teamed up with a company called STATS to install 6 cameras per basketball arena to track player and referee movements at 25 frames per second to get the most analytical data for teams and the NBA to analyze. The tool allows coaches to adjust offensive and defensive strategies in real time
6. Since the NBA already has advanced data visualization tools, there really isn't too much more we can add on. If we can attach a device to the player, and display the player's physical condition in real time, it'll be helpful for substitution purposes.

### 8.4 INTERVIEW RESULTS

**Q1: What is your role in this organization? Why are you asking for these tools?**

- Follow up: Is this something you would mainly be looking at or someone else?

Paraphrased A1: My role in the organization is the head coach and as the head coach I need to know the best way to utilize my players. This visualization is something that all coaches and even cots in the organization will look at but, as the head coach I will be looking at the most since I am leading my staff.

**Q2: What specific utilities would you like to see in the visualization?**

- Follow-Up: Could you prioritize these in terms of needs vs. wants?

Paraphrased A2: We really want to see how our players shoot from certain spots on the floor. Something we would look to see is the shooting percentages per quarter on the shot chart. If possible, we want to also see how our players compare to the rest of the players in the league to see how good they truly are from certain spots on the floor.

**Q3: Is the visualization specifically inward looking at your organization?**

Paraphrased A3: Yes this visualization is something that would be looking at our team only as well as guys who are currently on two-way contracts in the G-League in case we call those guys up. Any player who is traded or released from the team can be removed from the visualization.

**Q4: Would you like this visualization to expand outwards beyond just your organization into the rest of the league?**

- Follow-Up: Would you want anything different in a visualization for the rest of the league?

Paraphrased A4: If that is a possibility then yes, we would love a visualization for the rest of the league. A visuzalton like that would help us scout other teams so we know how to defend certain players. It would also allow us to target certain players in a trade if we want to prioritize a spot on the floor such as corner 3's. The visualization could have the same exact properties as the one for our team and that would be fine.

**Q5: Are there any visualization tools you guys are currently using?**

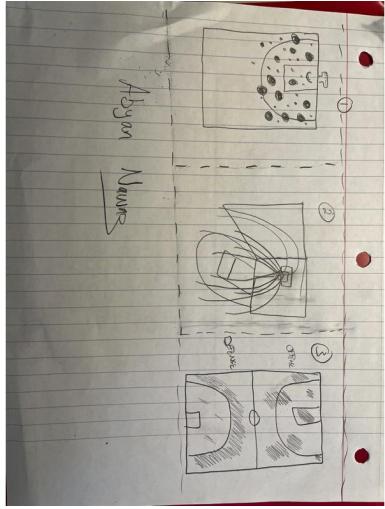
- Follow-Up: What sort of utility do your current visualization tools provide? Why are you looking for something different?

Paraphrased A5: Yes we do currently use a variety of different visualization tools, however none currently meet this need we are looking for. We have a ton of statistical analysis from a company called STATS that the entire NBA has teamed up with. These tools allow us to adjust our teams performance in terms of offensive and defensive structure in real time. We are looking for something that can provide a more player based analysis. We also want to be able to look across the league on top of looking at our own players because we want to add scouting/recruitment to this idea.

**Q6: What kind of visualization would you like to see?  
Player suggestion model?**

Paraphrased A6: At the end of the day we will leave the visualization details up to the experts as that is what we are hiring you for. However, we would like the model to include, at a minimum, analysis of all players on our team and in addition, analysis of players on teams across the league.

## 8 APPENDIX D: Design Sketches

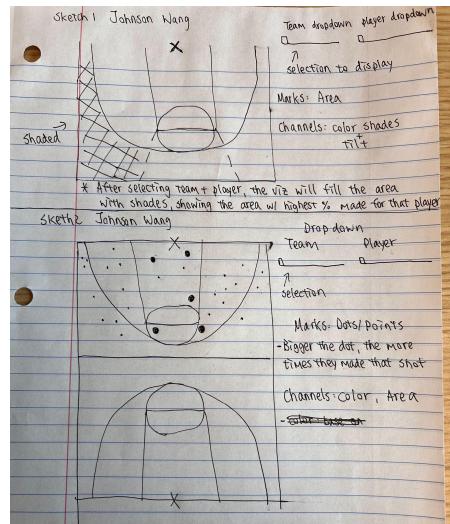


1 Abyan Nawaz. This visualization utilizes points/dots and color to visualize a player's effectiveness at certain spots on the court. This visualization makes sense since it is directly placed on the basketball court which is applicable to real life. Furthermore, this visualization will encapsulate the tasks required from tasks 1-4.

**Favorite:** 2 Abyan Nawaz. This visualization is a 3D depiction of a player's shots on the court. This uses color to show which spot on the court the player is more effective at. The statistic used for this will be EFG% from the respective spot on the court. Each line that goes towards the basket represents a sector on the court, and the color of that line will be red if the player is outstanding from that sector and blue if he is terrible. This visualization will solve all 4 tasks needed.

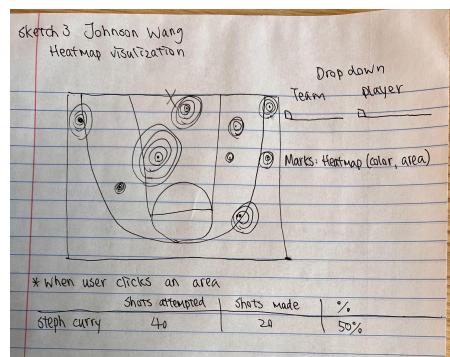
3 Abyan Nawaz. This visualization extends on the first one, basically, the first half shows a player's offensive efficiency by highlighting certain parts of the court using different colors and then on the other half, it shows also using color, how a player performs defensively. In this sketch you can see that the player performs well outside the 3-point line offensively and only defends well outside the 3-point line.

Being able to conceive these conclusions is how this visualization will cover tasks 1-4.



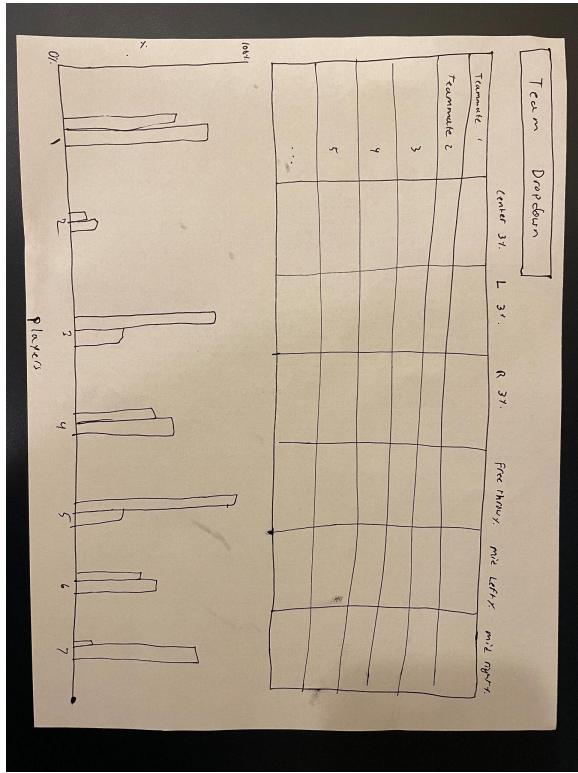
1 Johnson Wang. The first sketch allows coaches to look at how each player shoots from each area in a quick glance. For example, the highest percentage area will be shaded red, and the lowest percentage area will be shaded blue. The mark for this sketch is area, and the channels are color shades and tilt.

2 Johnson Wang. The second sketch shows how many shots they took in the exact position, which is displayed in dots. The larger the dot means the more shots they took. This can be used for defensive and offensive purposes. Coaches can see where the player performs the best. From a defensive perspective, they could also deploy players to double team on a good player in their best area. The mark for this sketch is dot, and the channel is area.

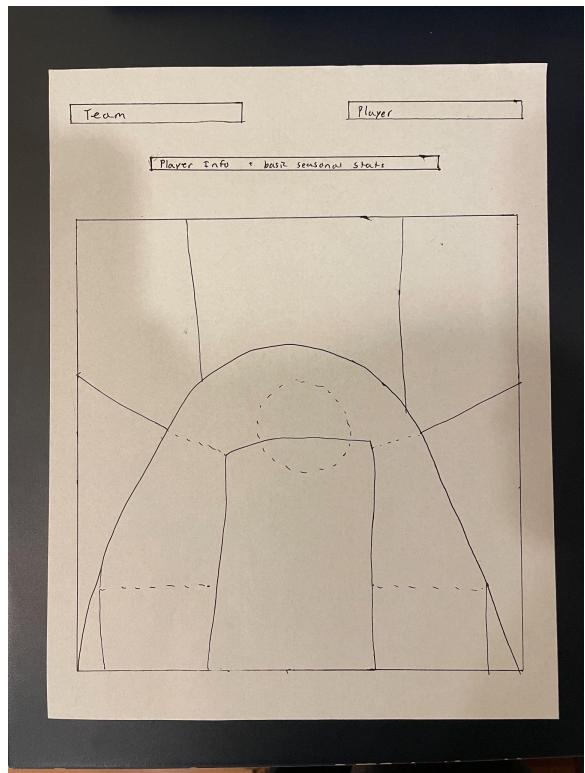


3. Johnson Wang. This visualization took a cluster approach to average out the made shots into a heatmap presentation. The area where the player shoots best will be red hot. Smaller circles mean less shots, while large circles mean more shots. Below the heatmap, there is also a quick

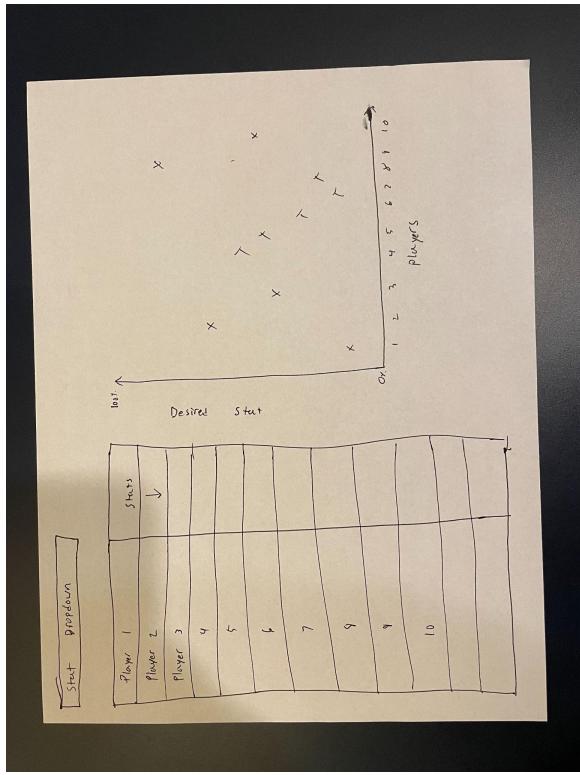
summary of how the selected player performs in that area of heatmap.



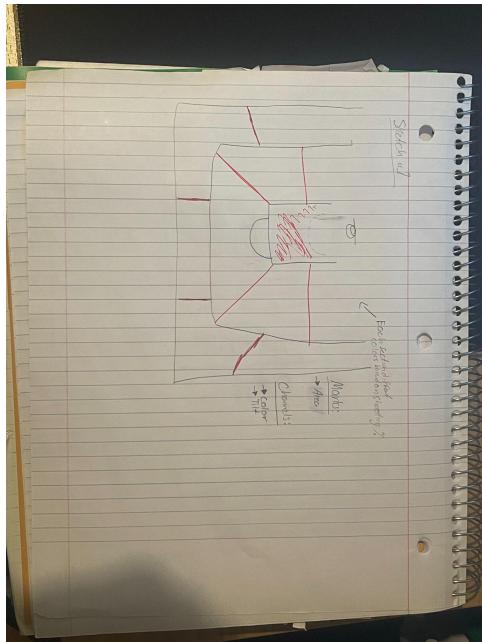
Matt Vieira drew this sketch. This sketch will be primarily used by coaches as they look inwards at their own team. It will show their entire team and many stats per player. This will help the coaches get a whole look at their players and understand better who shoots well from where. In addition, the coaches will have a bar chart below that will be malleable so that you can add how ever many stats you select to it, adding to the comparative factor. This sketch uses areas, position, and shape to relay the message of who shoots well from different positions on the court.



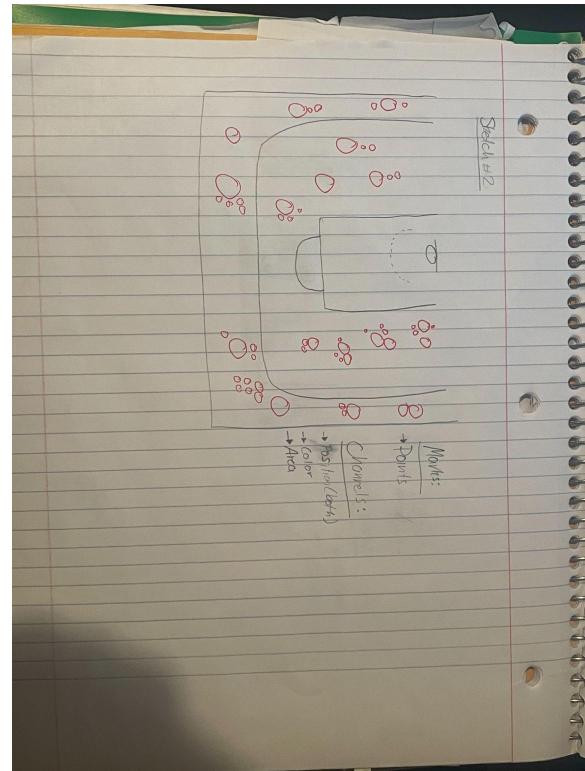
**Favorite:** Matt Vieira drew this sketch. This sketch will be used by fans as they take a look at what players across the league shoot well from different positions on the court. Alternatively, this could also be used by coaches and scouts as they look outwards across the league or at their own team. It uses area, shape and color to get a message across as to who shoots well from different areas of the court. A darker color as you hover over an area represents better shooting percentage and at the same time pops up an in depth stat analysis for that player on that area of the court.



Matt Vieira drew this sketch. This sketch will be for scouts as they look across the league for talent. You will be able to select a specific stat from the dropdown and it will pull up the top 10 players for that stat across the league as well as a scatter plot showing where their percentages are against each other. This visualization uses points and position.

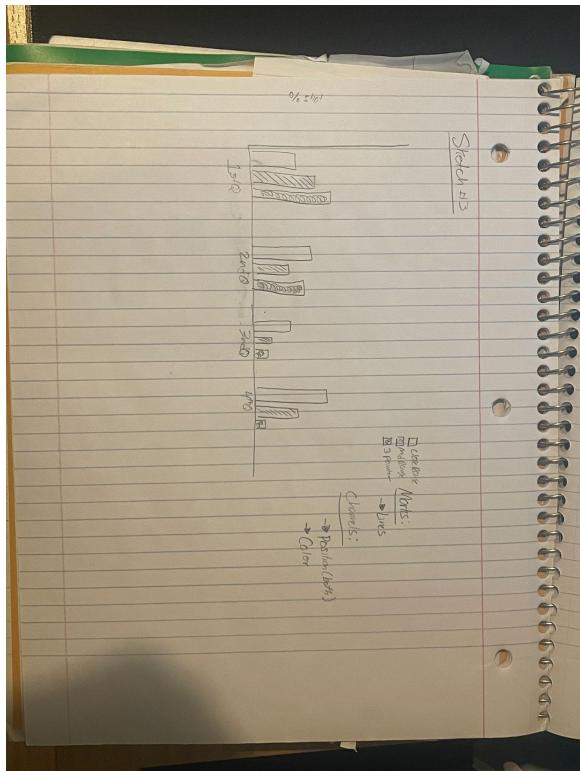


Sketched by Amaan Bhojani. In this sketch using the mark of area allows us to segment the basketball court to analyze how a player shoots from each area. To segment it we would need the channel of tilt. The channel of color would also be used here to fill in each area on the court. The colors would be green, yellow, and red with green obviously representing a good shooting percentage from that area, yellow meaning average, and red meaning bad. Since all our tasks in the task table go in hand, this visualization addresses all of them. A coach can see where his player shoots best, a player can see where on the floor he needs to work on, a scout can see where a player performs well and can see if it's a fit for his team, and a fan can see this and see how their player performs on average. However, this chart would need to be changed by quarter for a more indepth view and the volume of shots would not be displayed but can be added as a zoom function in a coordinated view.

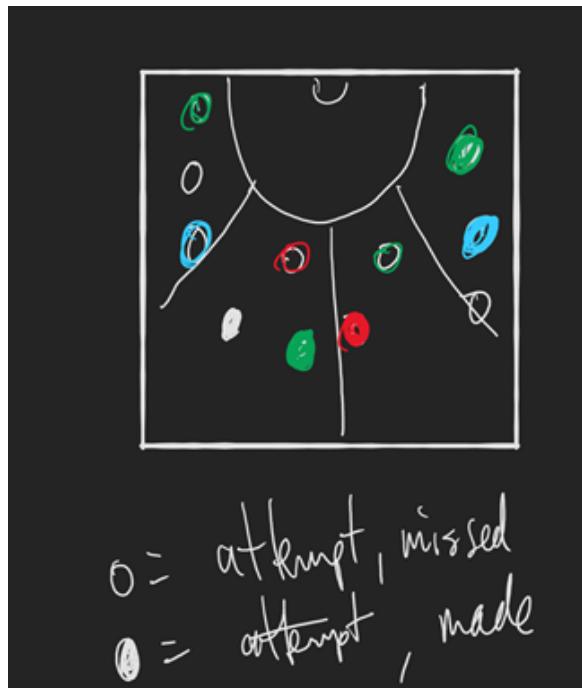


Sketched by Amaan Bhojani. In this sketch we see the mark of points on the court to not only show how well a player shoots from a spot but also the amount of shots they take. We see this by using the channels of area with the bigger a circle is, the more shots a player took. The channel of position is also used here to show us where the player is shooting from the court. Color is also a channel used here to once again show how well a player shot from that area.

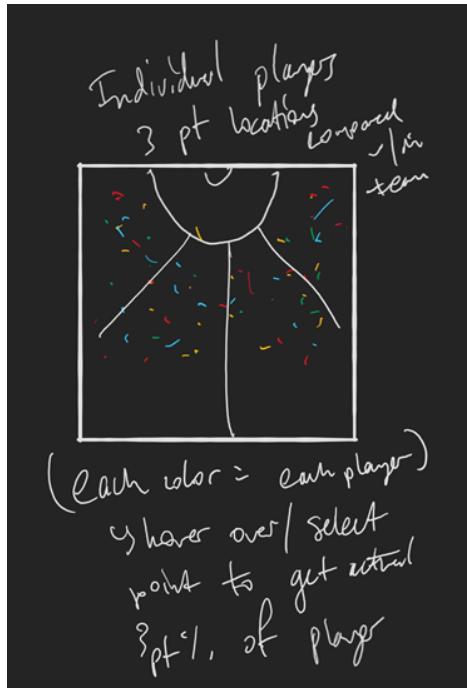
using the same scale as in sketch 1. Just like sketch 1, this sketch would also address all tasks on the task table since you can see how well a player shot from a certain position. However this is not broken down by quarter so that would be a feature that would need to be added to toggle quarters and dynamically change the visualization.



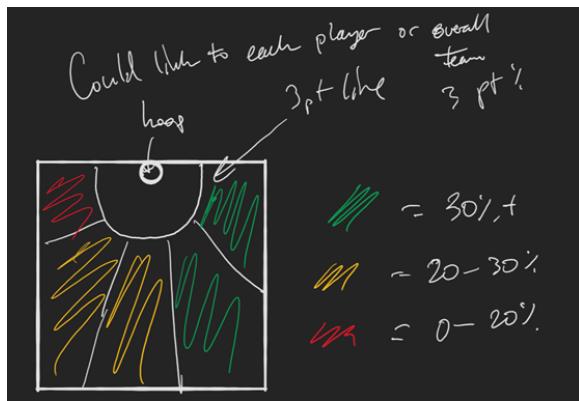
**Favorite:** Sketched by Amaan Bhojani. In this sketch, a different approach was used and the mark of lines were utilized to make a bar graph to show how well a player shot based on the height of the bar. The channel of position is used because not only does the height of the bar matter, but as you move along the x-axis it would tell you how the player shot for a specific quarter. The channel of color is also used here to show what type of shot a certain bar represents. The flaw with this sketch is that it does not give the location on the basketball floor. It gives more of a general overview of a player so it mainly satisfies the needs of a fan who wants to see how a player performs on average and a scout who may want to add an element of scoring to his team such as trying to acquire a player who shoots well from close range and from 3. Coaches and players would need a more indepth view to satisfy their task on the task table of creating a game plan and becoming more efficient.



Sketched by Sunny Kang. Open and closed circles were chosen to be the marks for this visualization to clearly mark the locations where players attempted a shot (open circle) and missed, as well as attempting a shot and making it in (filled in circle). Lines were used to represent the different sectors of a basketball court so that different shooting locations can be visualized. The positions/channels of the circles used both horizontal and vertical positioning to correspond to physical locations on the basketball court. Different colors were used for each circle to represent different players. The size of the circles remained consistent across all circles so that users would not mistakenly think that bigger circles represented some different statistic between shooters. The use case/task of this visualization is to allow the user to select a certain circle to have the player name, team, and 3 pt% shown as a hoverbox which would allow NBA coaches to make an efficient gameplan.



Sketched by Sunny Kang. Dots were used as the marks of this visualization to allow users to easily identify the locations of the 3 pt's made across all individual players from their basketball games in the past. Lines were also used to create a diagram of the basketball court. The channels of this visualization are different colors to represent different players, and the different positions to represent the different locations in which the player shot the ball. This visualization would be useful for task 2 of the task list in which NBA Scouts can visualize the locations of which a player shoots a 3 pt and their percentages.



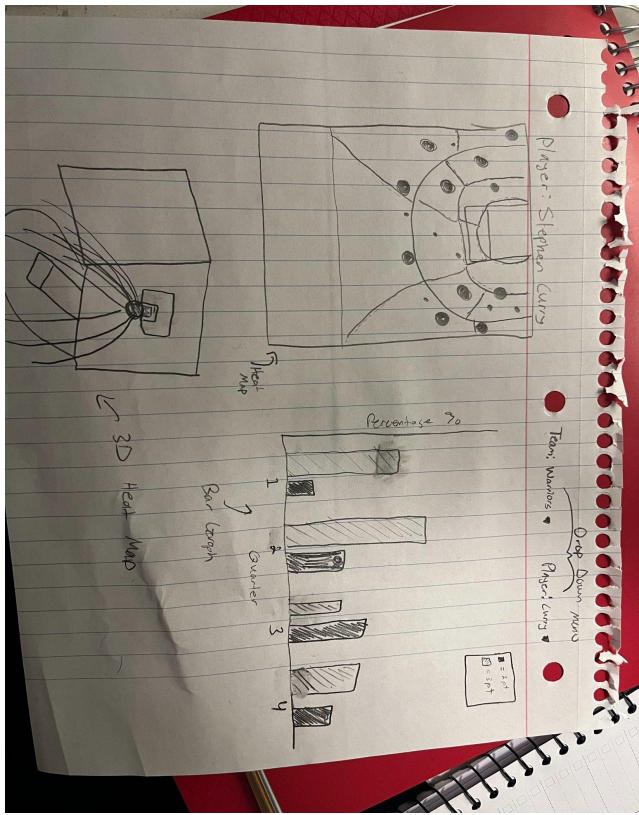
Sketched by Sunny Kang. This visualization uses areas to represent different locations of the basketball court where a player's shooting percentage is visualized. Different colors (channels) were used to represent the different percentages in which a player makes a shot in a given location. This fulfills the task of visualizing the shot percentage of a player on a basketball court. This visualization can even be expanded upon in which a whole team's shooting

percentages in each location can be visualized. A NBA Fan could potentially hover their cursor over each area and have a hoverbox that presents the top 5 shooters information (name, position, shooting percentage).

We decided to select these favorites based on the way they handle the tasks at hand. All three of the visualizations will handle tasks 1-4 in an elegant way. The first favorite splits the basketball court into sections, where each section is denoted by a color based on the player's effectiveness in that region. These sections will also showcase the areas in which player's are effective, which will help each user complete their desired domain task. We chose this sketch because it is easy on the eyes and simple for someone who is uneducated on the topic of basketball to understand.

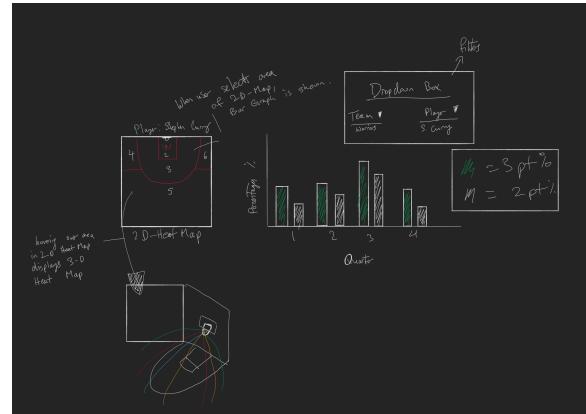
Furthermore, another favorite we have selected is the showing of a bar graph in relation to the first favorite, the basketball court heat map. This bar graph will show the player's different shots per quarter and the percentage at which they executed. This graph utilizes lines and the height of bars to show the shooter's efficiency. In conjunction with the first heat map, brushing and linking can be utilized to highlight the player's spots on the court, and then see which quarter they are usually in when shooting from a certain spot on the floor. We chose this because it shows the end user more specific data about their player.

The third favorite we chose is a 3d graph, essentially showing the heat map in 3D. This allows for a more interactive experience for the user and a more realistic visualization. The end users want this tool to be as realistic as possible due to its obvious implications to winning basketball games. All three of these sketches together form the final sketch of our visualization.



This sketch has three different graphs. The first, a basketball heat map utilizing colors to show where a player is most effective on different sections of the court (denoted by lines separating the court). The next is a bar graph which can be used in conjunction with the heatmap to brush and link. The brushing will allow the user to select certain points from the heatmap to highlight them in the bar graph. This graph utilizes lines to show the player's effectiveness throughout each quarter for two point shots and three point shots. The third and final graph is a more realistic and immersive implementation of the first heatmap. It will allow the user to drag and move the graph to view the player's shots. All three of these visualizations will tackle every task needed (1-4). These graphs will allow the end users to explore their data in new and exciting ways which will help them succeed in their respective crafts.

## 9 APPENDIX E: Digital Sketch



We believe that our visualization will be very easy to interact with. When coaches see the 2D heat chart, they will not only see the color on a section representing how a player is shooting but, they can highlight a section and it will show specific numbers of how a player is shooting from that spot. Coaches, and players can then see the number of shots a player took from that area and can truly determine if their performance is worth building a game plan around and if a player should keep shooting from that spot. Scouts will be able to see if a player is performing well at a certain location and if their team may want to acquire that player if they need help in that area.

Players and fans will enjoy the brushing and linking feature that shows them how they are shooting per quarter. If someone brushes over either the 2D or 3D heatmap at a certain section, those bars in the bar graph will be linked. The bars are organized by type of shot so each section on the court will have its own bar. Players can use this to see how they are performing per quarter to see where they can improve. Fans can use this as a fun feature to see their favorite players' performance. The entire visualization will have a team and player filter so all the graphs and charts will change upon selecting a new player which makes the visualization easier to read rather than having all team data at once. We have also kept all our tasks.

## 10 APPENDIX F: Usability Testing

### 10.1 PREPARATION

This visualization tool is used for coaches and other NBA connoisseurs to measure every team's performance throughout the season in relation to the famous, 4 factors of basketball. This tool will show each team and their factors on separate charts, but, they will be able to highlight specific points in one chart to link and see that team's appearance in the other charts. This is an immersive and

simple tool for visualizing important statistics in the basketball world. One task that can be completed is scanning the first scatter plot showing the relationship between EFG% and Games Won, to link to a stat such as 3 point field goal percentages. Another task that the user can complete is linking the bar charts together to see what team has a higher free throw percentage in comparison to its overall field goal percentage. The final task that can be completed is hovering over certain data points to see what team you are looking at. These three tasks create this fully immersive visualization tool.

## 10.2 RESULTS

The participants of the usability test enjoyed our visualization. They appreciated the data driven approach and multiple graphs. An issue that was noticed was that the brushing and linking seemed to be off by a little bit. You could brush over an empty spot on the graph and it would link to the other graph, this is because it is only registering one graph's cx and cy values. Another issue realized is the bar graphs are not registering in the linking process. These both are easy fixes and can be solved with some simple code fixes. The participants liked the tool overall, but those issues definitely hindered the overall experience. The participants went through the linking of the scatter plots for EFG% and Games won, this went well except for the fact that the brushing seems to be off a little bit. The other task to link the bar graphs was not completed yet but it will be done soon, the participants liked the idea of it. The hovering over data points task is also in progress but the participants mentioned this is a necessity. There is definitely a need to change design, in our digital sketch we have a much harder time designing visualization.

After the usability test, we are deciding to pivot our project into a more simple form of data visualization. It is much more feasible to finish on time if we use simple graphs instead of creating graphs that show no information and cannot have proper interactions. To modify we plan to create simple bar graphs and scatter plots that show different stats for NBA teams throughout the season. The end users will now be executives of NBA teams to see how their team stacks up against others. For example, you might want to model your team after another team who has done much better in certain aspects of the game. Creating more graphs with brushing and linking will be the end goal for this visualization.

### **GROUP PURPOSE**

The group formed on the basis of our passion for basketball and data sciences. The purpose for our project is to create a centralized source of data that NBA players, coaches and fans can use to maximize their efficiency on the court.

### **GROUP GOALS**

The goal for our group is to overperform and create the most quality visualization possible. We are collectively aiming for an A in the class and the project itself as this is the mark of perfection. We want to create a working visualization that is appealing to the eyes and popular.

### **GROUP MEMBER ROLES/RESPONSIBILITIES**

We will strive for an equal participation throughout the whole project. However to specify, Abyan and Amaan will be focusing more on the data aspect and incorporating that part of the project while Johnson and Matt will focus more on the tendencies of code and making it as legible and clean as possible.

### **GROUND RULES**

Our group will meet 1-2 times a week after our classes. We prefer to not specify a time as we all have extracurriculars that work on volatile schedules as well classes. However, we will plan to meet after 5pm, 1-2 days a week. We will all agree to carry an equal load in the project and ensure that we can get the best grade possible. Discussions will be conducted through iMessage group chats, and then over zoom if it requires a more in depth discussion. We will make decisions by compromising. If there is a dissenting decision we will communicate and collaborate on the basis of compromise. We will hold each other accountable by realizing that we do not want to be the one that ruins our grade. We expect equal participation and collaboration throughout the whole project.

### **POTENTIAL BARRIERS AND COPING STRATEGIES**

The biggest barrier that we can foresee is timing. To work around this we will meet once or twice a week if we can and then assign tasks for each to complete by the end of that week. None of us have experienced group issues besides laziness, but this is not a foreseeable problem for this group.

### **Have we all been abiding by our guidelines?**

We have all been abiding by our group guidelines and following the rules we set out. As a whole, we get

along very well and have not had any problems working together. The group works seamlessly every time we meet and we couldn't be happier with each other.

### **Do we feel comfortable with group roles?**

From our multiple discussions on this topic, each role that has been set has been fulfilled with much enthusiasm. Every time we meet we have a brief conversation discussing the roles and what we can do to support each other if someone is struggling or needs help in their role. Overall, the roles have been a rough guideline as everyone is more than happy to fill in wherever needed, which is part of why our group is working so well.

### **Are there any problems you need to troubleshoot, and if so how can you address them?**

At this point, we have no large problems in terms of the group. However, in terms of the project itself, we have had a few different ideas as to where we should put our final efforts and what we should focus on. I believe through discussion we can easily remedy this and figure out the final direction of the group.

### **Each group member should write one positive thing they have seen other group members contribute to the project.**

#### **Abyan**

- Johnson - Abyan always made sure to communicate clearly what needs to be done even when he can't attend the group meeting.
- Amaan - Abyan always gets our group together and makes sure we meet on time to complete our tasks.
- Sunny - Amazing leadership and communication skills. Always thinking one step ahead in getting everything done on time and thoroughly.
- Matt - Agree with sunny, Abyan has great communication and leadership skills. He works diligently to ensure we all are on task.

#### **Johnson**

- Amaan - Johnson has been very effective in getting his work done. He is the first to present ideas and gets the ball rolling.
- Abyan - Johnson does his work efficiently and correctly, very reliable.
- Sunny - Absolute team player. Always shows up to do his part of the work and is amazing at it.

- Matt - Johnson is a one man army, he does it all. Anything that needs to be done he steps up and slots in.

#### **Matt**

- Amaan - Matt stays on top of his work to make sure everything that needs to get done gets done with 100% effort.
- Johnson - Matt would always come up with creative ideas, and provide valuable feedback during our discussions
- Abyan - Same as Johnson, Matt is always attending meetings and completing work that needs to be done.
- Sunny - Super reliable and gets a lot of work done with no hesitation.

#### **Sunny**

- Amaan - Sunny always is ready to help with whatever is needed, he will always help out if someone needs help.
- Johnson - Sunny joined the team late, but he quickly caught up and got things done effectively.
- Abyam - Sunny immersed himself seamlessly and contributes just as much as everyone else, always getting the work done.
- Matt - Sunny is great at sharing the workload and always asking everyone if they need help with anything.

#### **Amaan**

- Johnson - Amaan is very helpful in organizing meetings, making our meetings very productive and effective.
- Abyan - Amaan spearheads the overall process, providing new ideas, working after hours and ensuring that our project is not the bare minimum.
- Sunny - Exactly what we need in a successful project group: reliable, excellent communication, and useful insight.
- Matt - Amaan is the one who came up with the idea for this project. Without him we wouldn't have this project to start with.