

CS 6630 MAMBA MENTALITY
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The title Mamba Mentality comes from Kobe Bryant's autobiography, "The Mamba Mentality: How I Play."

Basic Information

Title: Mamba Mentality

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Github Link: <https://github.com/miholjcicmarko/DataVizProject>

Visualization Website Link: <https://miholjcicmarko.github.io/DataVizProject.io/>

Overview and Motivation

Kobe Bryant is an inspirational figure in the world of sports. His tragic death has led many sports writers and analysts to analyze his legendary 20 year career. Numerous visualizations on talk shows and social media have attempted to convey his legendary career. Most of these visualizations fall short of capturing interesting details of his career or overwhelm the viewer with the large amount of data that Bryant's career presents. We feel that we are capable of developing an interactive visualization that will convey more details about Bryant's career while maintaining visual appeal. Additionally, both group members are passionate basketball fans. Therefore, we look forward to exploring and visualizing the data collected over the course of a legendary NBA career. Another reason for choosing this project is the opportunity to work with a large dataset. Communicating complex data and large datasets is an important skill to have because data has become important in industry. We feel that managing and resolving the problems that may arise with visualizing over 50,000 data points is good practice for our future careers as data scientists.

The dataset allows for different types of visualizations. We can look at trends and distributions of shots over the course of a season or over the course of the entire career and where they occur across the court. The dataset can inform the viewer about which areas of the

court did Bryant shoot from the most and how did his shot tendencies change over time. Furthermore, the dataset allows Kobe to be compared to other players in the regular season and in the playoffs.

Another aspect that we wanted to capture in our visualization were the legendary game winners throughout Kobe Bryant's career. Bryant was defined as a clutch basketball player, and providing a central location for all of his famous shots will be appreciated by the average NBA basketball fan.

Related Work

Upon Bryant's tragic death, multiple data science competitions appeared on Kaggle. A large amount of the competitions revolved around analyzing and visualizing the data produced over the course of Bryant's career. The Los Angeles Times produced a visualization displaying the 30,000 shots that Bryant attempted throughout his career shown in Figure 1. The story-telling aspect of the Los Angeles Times visualizations highlighting important shots made in important games. In addition, the comparison of Bryant's different seasons was a nice visualization that we wanted to include in our visualization. Another inspiring visualization was discovered on Github. As shown in Figure 2, the visualization provided a shot chart for all the shots attempted during Bryant's career. This visualization provided a drop down menu where the user could choose which iconic game they wanted to observe.

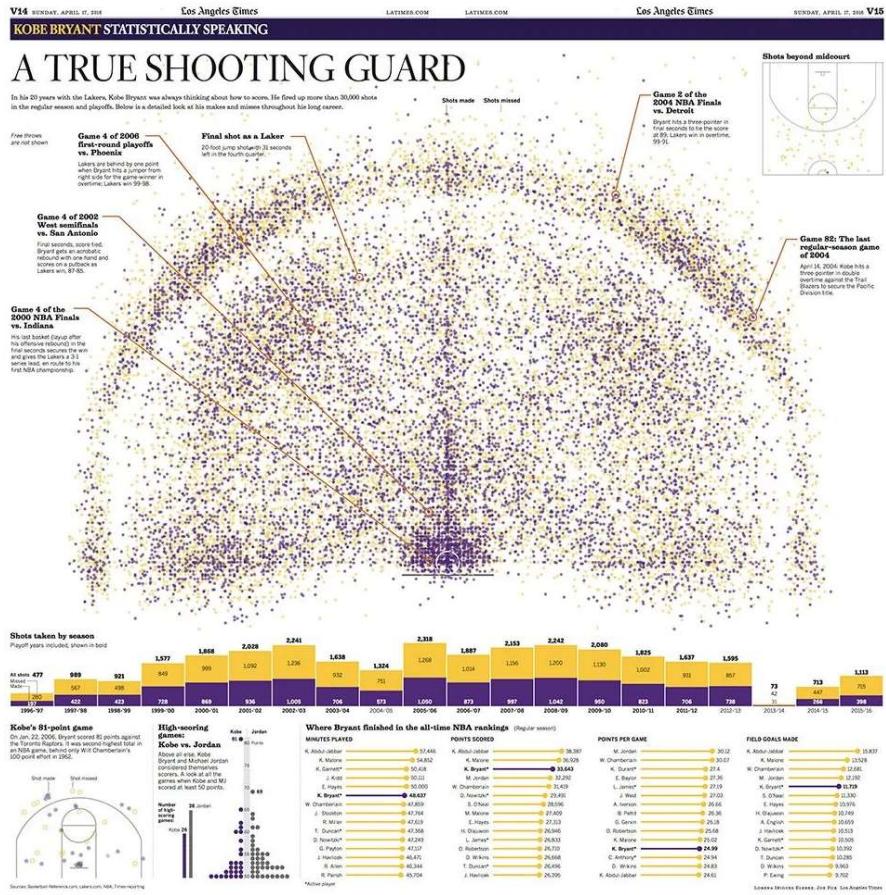


Figure 1: The Los Angeles Times visualization of Kobe Bryant's career. The link to the visualization (now broken) is: <https://graphics.latimes.com/kobe-every-shot-ever/>.

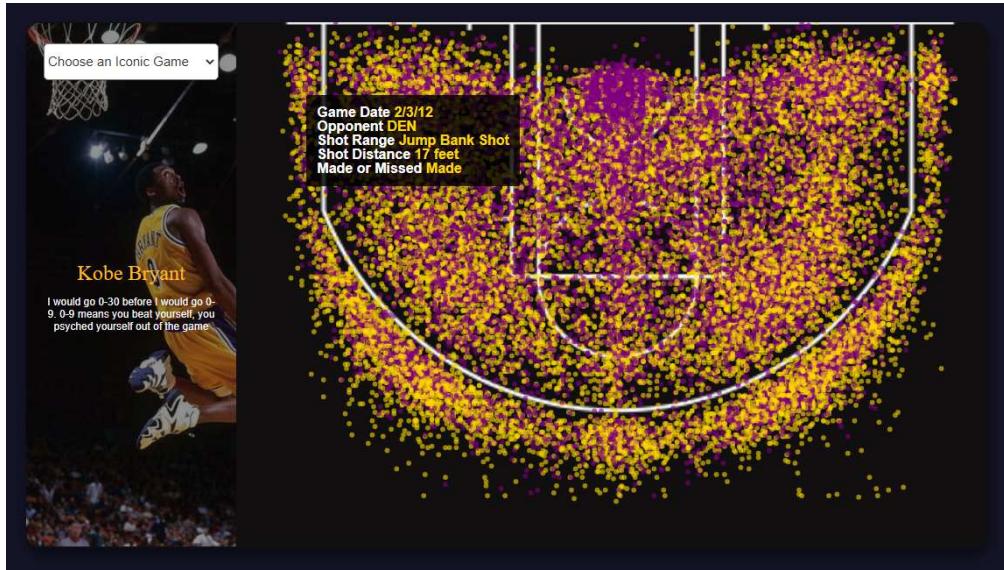


Figure 2: The visualization of Kobe Bryant's career found on Github. The link to the visualization is <https://github.com/derekchoe/kobe-chart>.

We were influenced by the “Call of Data,” visualization presented during class. This visualization provided a home page with a link to a page explaining the visualization. We liked the idea of providing the viewer with the option to learn about all of the aspects of our visualization prior to experimenting with it (Figure 3).

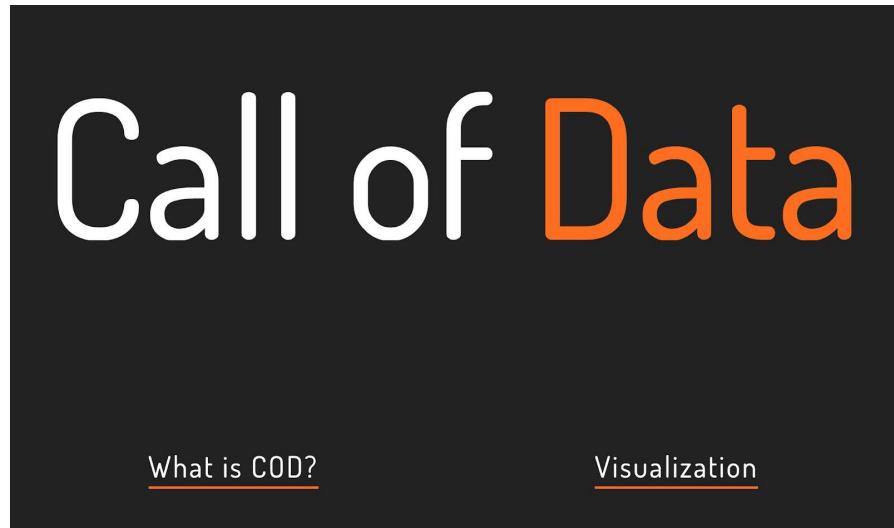


Figure 3: The Call of Data home page. The link to the visualization is <https://bisberg.me/dataviscourse-pr-call-of-data/>.

Questions

The primary questions that we are trying to answer with our visualization are:

- What are all of the significant shots that Bryant attempted and made over the course of his career?
- Which areas of the court did Bryant shoot from the most?
- Which parts of the court were the lowest percentage shot for Bryant?
- How did Kobe's shooting percentage and shot tendencies change over time?
- Where did buzzer beaters occur from?
- Did Kobe perform similarly in the playoffs and regular season?
- Were there particular seasons that he performed differently?
- How does Kobe compare to other players? Volume? Scoring?

Data Acquisition and Processing:

The data was collected from the `nba_api.stats`. We used the package, “shot chart detail.” This package provides a shot chart for various basketball players in the NBA. The package provides data for every regular season/playoff game that the selected player participated in. We utilized a loop to load in all of the data for Kobe Bryant for every year that he played in the NBA. The data has over 30,000 rows and 24 columns. Each row is a single shot attempt in Kobe Bryant’s career. The columns provide details about the shot, such as shot type, the opposing team name, the location of the shot on the court, whether the shot was made, etc. The link to the api is <https://pypi.org/project/nba-api/>.

The player ID and the seasons played were altered in order to access a different player’s career. We loaded in data for the following 2020 All Stars: Devin Booker, Anthony Davis, Luka Doncic, Giannis Antetokounmpo, James Harden, Kemba Walker, LeBron James, Kawhi Leonard, Pascal Siakam, and Trae Young. We added Stephen Curry into the dataset because we believed most NBA fans would be interested in comparing him to Kobe Bryant. The dataset for each player included all of the shots attempted in their entire career.

Data clean up was required for this project. The importation of the data was performed using python. The data was imported from the api and we checked for null values in any of the data points. We added columns to track which season corresponds to each shot and to track if the shot occurred in the regular season or the playoffs. We placed the data into a dataframe and converted it to a csv file for each player.

In addition, we derived the shot percentage for each hexagon in the heatmap for the career as well as cumulative shot percentage for each hexagon dependent on the year being filtered for. The percentage derivation was implemented using JavaScript by cycling through the shots taken and counting the number of shots made and then dividing by the total shots. This calculation was performed for each bin of the heatmap and upon drawing and was thus reperformed after any filtering or change of player took place.

For the brushing aspect of the visualization, the percentage of shots made within the brush area was calculated, and the distributions needed for the additional visualizations were created using D3. Necessary calculations, such as aggregate field goal percentage and aggregate field goal percentage for each year within the selected regions, were calculated by first defining

which bins are within the region. These bins are then cycled through and the needed data is pulled from each shot within the bin. This implementation carries over to any region, number of bins, size of bins, or filters applied to the data.

Exploratory Data Analysis:

Our data was initially looked at using the scatter plot type visualizations that we had seen online. From these we were able to deduce whether a heatmap would be a useful visualization for this dataset. We realized that we could create plots for each individual year because each shot was associated with a specific season. This led us to include bar charts for each selected in the sub-visualizations.

Design Evolution:

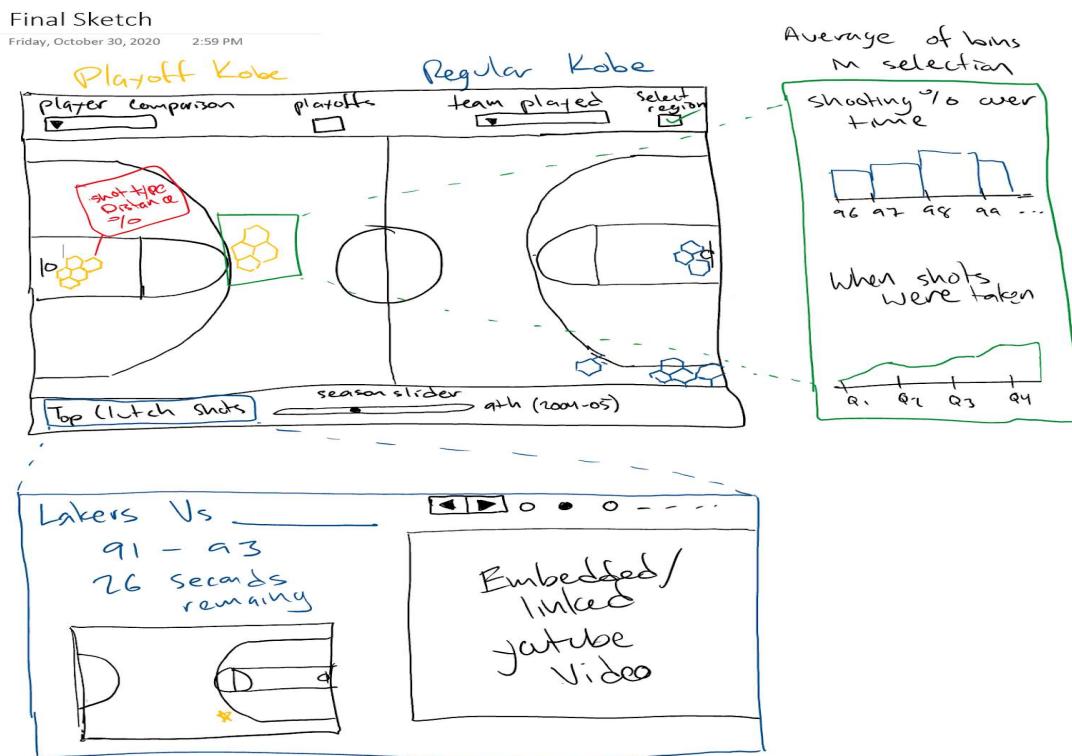


Figure 4: The final sketch we created as part of our design process prior to our project proposal. This is representative of our original aim as we began developing our visualization.

Incorporating additional labels for the season: When making the slider, we noticed that the NBA season includes two years. Therefore, we need to number the seasons. Additionally, the

dataset did not differentiate between shots attempted during the regular season and playoffs. As a result, we need to add data labels for the two different categories. These labels allowed us to filter the data correctly.

Separate Slider for the Opposing Player: Initially, we planned on having a single slider in the visualization. However, we have noticed that the players had different career lengths. This posed an issue when filtering the data for the different players. Therefore, we have decided to create a second slider below the first one when the player comparison option is chosen.



Figure 5: Comparison between the original and the current slider visualization. The color of the second slider matches the color of the heatmap on the right.

Improving Legibility of the Tooltip: As we finalized our visualization we noticed that our tooltip's text was difficult to read and was not formatted in the most useful way. We increased the size of the font, adjusted the positioning of the tooltip div so it could not be occluded by the pointer, and reformatted the order in which stats are presented to increase its efficacy.

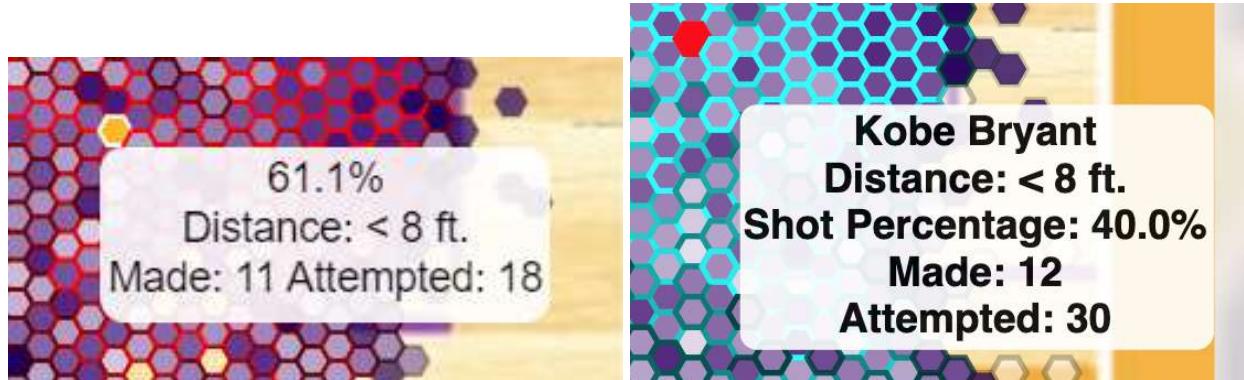


Figure 6: Original implementation of tooltip providing shot percentage, shot range, shots made, and attempted shots for the hovered hex (gold and white). The improved tooltip is on the left and shows the stats for the bin highlighted in solid red.

Altering the encoding strategy within the heatmap: In our proposal, we had no plan for representing the total number of shots taken from within a hex-tile. After implementing this we noticed that the decreasing opacity made it difficult to determine how the color/field goal percentage was changing across tiles (Figure 7).

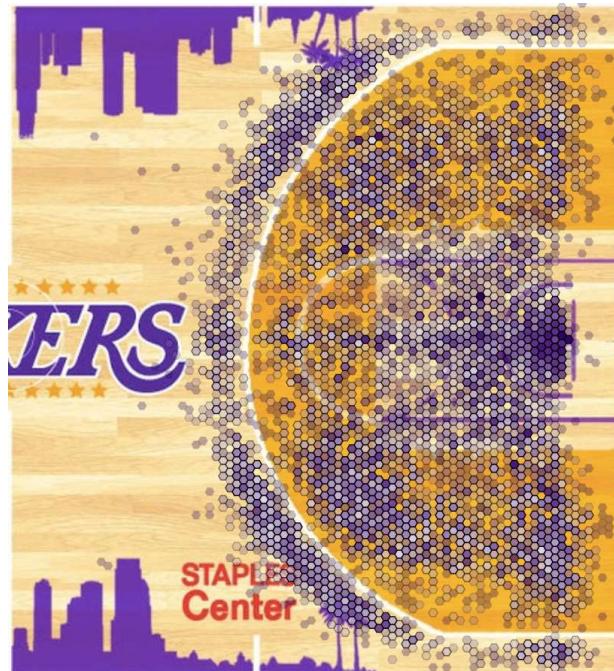


Figure 7: Original heatmap (shot data is over Kobe’s entire career) implementation using opacity as the encoding method for number of shots taken. While the areas of high traffic are relatively clear, it is difficult to compare shot percentage between these high frequency areas and lower frequency areas.

This led us to try encoding the shot attempt number through another method - stroke color saturation. This encoding saturates with increasing shot attempts and is clamped at a set number of shots (12 for the career heatmaps) so that areas with a high rate of shooting are distinct, while still allowing for more direct comparison between the fill of tiles. Lower opacity is still applied to tiles with only a singular shot taken so that they are not as impactful as other regions of 100% accuracy.

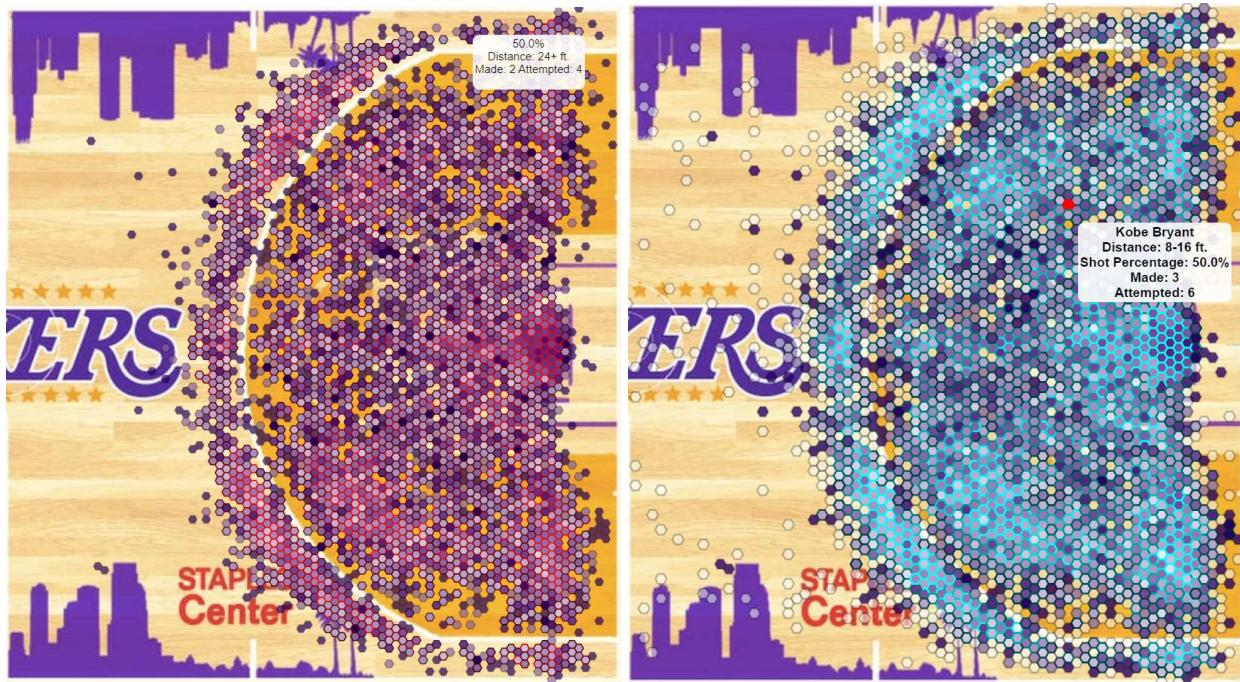


Figure 8: The second (left) and final (right) versions of the heatmap. Rather than using opacity as the encoding method for shot frequency, saturation of the stroke color is used. This allows visualization of distinct areas that are high frequency (near the hoop, near three point line, center, etc.,) while also allowing a more direct comparison of fill between hexes. We later decided that using a bright blue rather than red maintained contrast while being friendlier to some eyes, and also increased the hex size and stroke width to make the heatmap more legible.

Aggregate Statistics Vis Location: We originally planned on displaying the smaller visualizations generated upon brushing the heatmap adjacent to the court. However, to improve compatibility across display types and across visualization layouts, we decided to put these visualizations in a div similar to a tooltip that stays a certain distance from the selected region. This would allow us to increase the size of the court/heatmap and/or center it while there wouldn't have been room before. The div holding the sub visualizations now primarily resides in the center of the court and moves to avoid overlapping with the selected region (Figure 9-11).

Aggregate Sub-visualization Charts: Originally we considered displaying multiple visualizations for a single player after selection of a region, however, after meeting with another group during the peer feedback session we decided a single visualization type allowing for comparison between players would be better (Figure 11). We further refined this later on to convert into a tooltip style display of statistics when the data is filtered by year as a barchart with a single column was not useful (Figure 26).

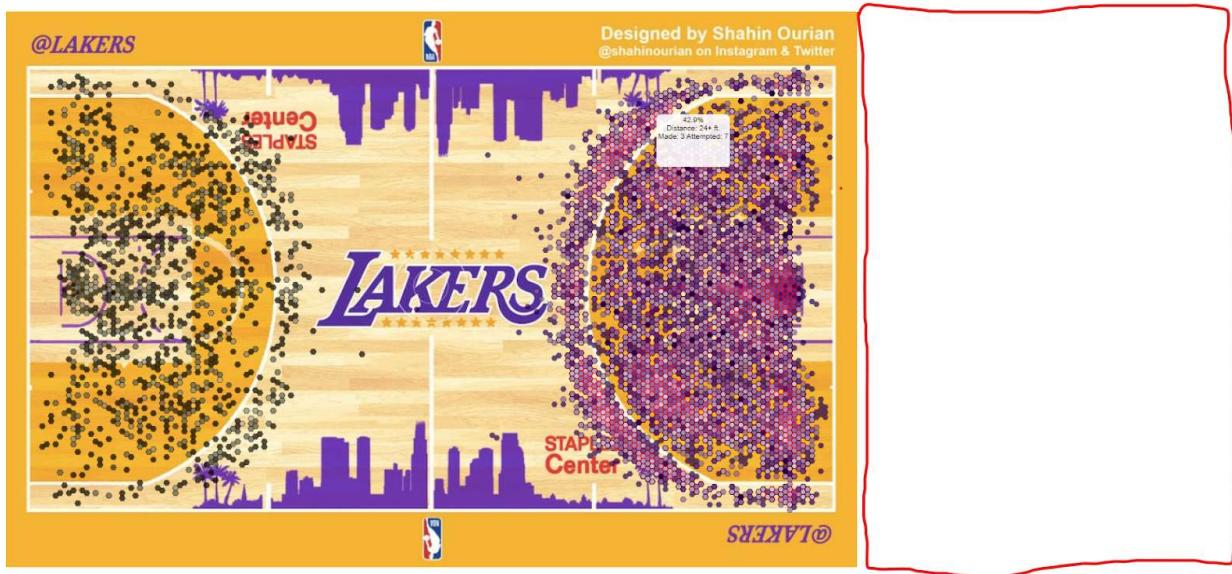


Figure 9: The planned location of the sub-visualizations in context of the full court visualization (boxed in red).

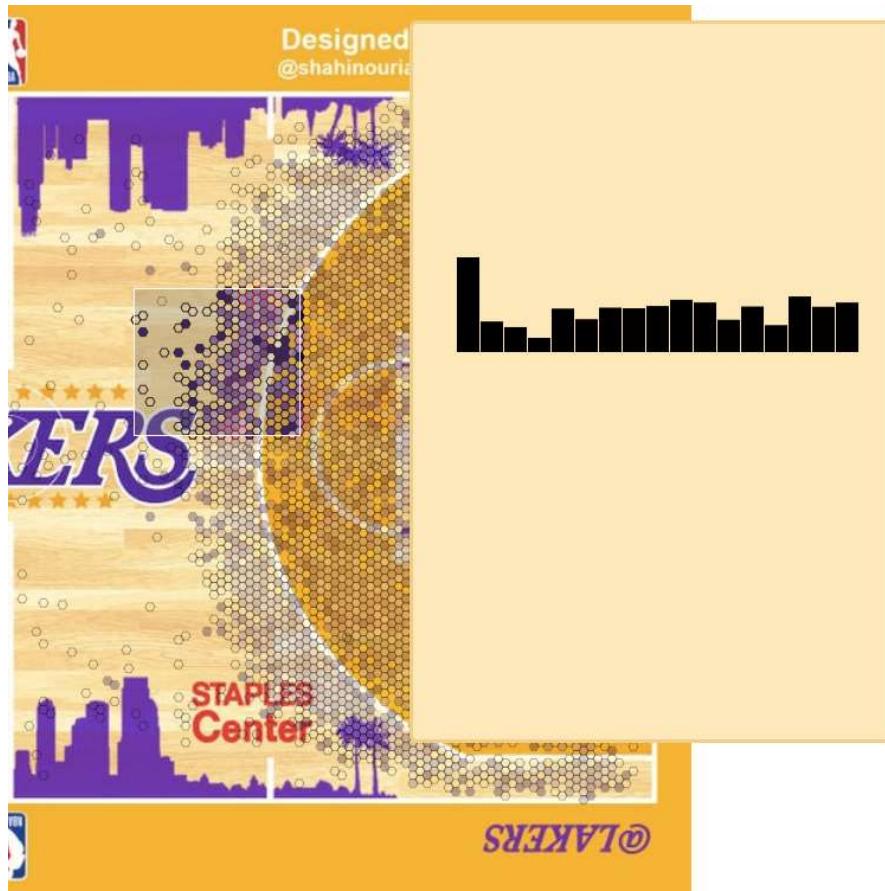


Figure 10: depiction of the second implemented location for the sub-visualizations - this is set to maintain a certain distance from the right edge of the selection. The early implementation of a sub-visualization shown is the field goal percentage in the selected region across the years.

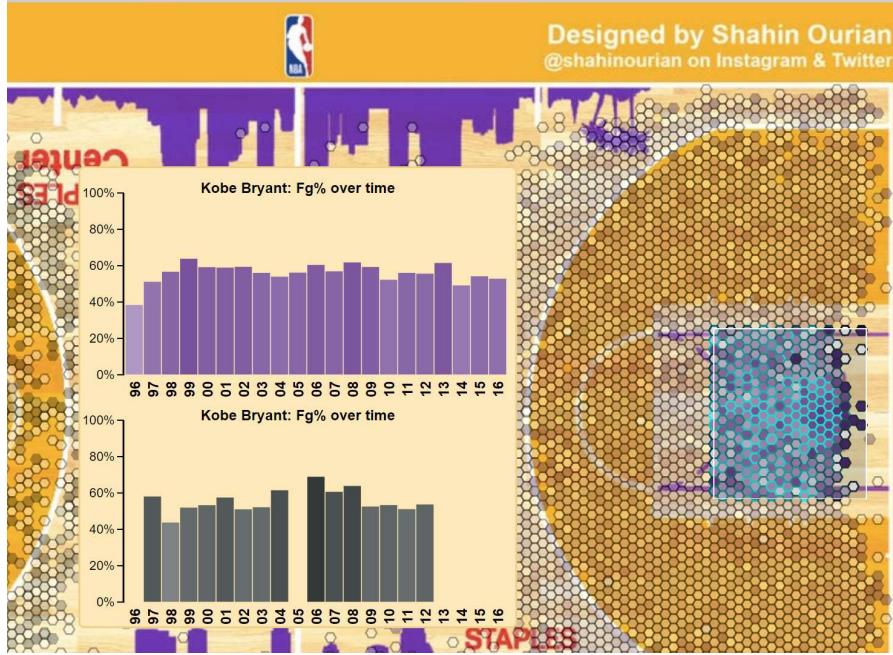


Figure 11: Final location of the sub-visualizations. It was decided that residing in the center of the court unless the selected region would overlap with the visualizations (at which point the div will be shifted to avoid overlap with the primary selection) would be the most useful location.

Exclusion of shots from beyond half court: Initially, we did not know that Kobe Bryant had attempted multiple shots beyond the half court mark. None of these $\frac{3}{4}$ court shots were successful shot attempts. As a result, we decided to hide bins from beyond half court except during brushing, at which point they are visible.

Creating a homepage: We decided that a home page would be a nice introduction to our visualization. The visualization has a variety of different options for the viewer. We wanted to make sure that the viewer is aware of all the features of our visualizations. We believed that this would be best accomplished with a homepage that has a link to an “About,” page, where the user can watch a youtube video on how to utilize our visualization. Figure 12 displays the, “About,” page.

[Home](#) [Heatmap](#)

This project visualizes the data gathered over the course of Kobe Bryant's career and provides videos of some of his legendary moments. Upon opening the file, the user is introduced to the hexagonal heat map that describes taken by Kobe over the course of his entire career. The right half of the court is dedicated to the shots taken by Bryant during the regular season, while the left half of the court is dedicated to the shots taken by Bryant during the playoffs. The slider at the bottom of the page filters through the thirty year career of Kobe Bryant. The user has the option of hovering over each hexagon on the court to gather information of the shots attempted from that specific area of the court. Additionally, the user has the ability to select large regions of the court using a brush and compare them to the other side of the court.

The visualization offers a story mode to the user at the push of a button. In the story mode, the user can switch between videos all of Kobe's buzzer beaters.

Additionally, the visualization offers the ability to compare Kobe Bryant to other current players. The selection of players include the 2020 All Star Starters, Devin Booker, and Stephen Curry.

All of the code in this project has been completed by Jordan Hendriksen and Marko Miholjic. The videos shown in this visualization have been gathered from YouTube and are not owned by the creators of this visualization.



Figure 12: The About page. The photo depicts what viewers will see when they open the “About,” page. The embedded video is a demonstration of our visualization and can be viewed within the page, expanded to full screen, or used as a pathway to watching the video directly on YouTube.

Choosing the background picture for the home page: During Bryant's final NBA season, Nike created a sentimental commercial involving the Laker legend. The commercial honors Bryant's polarizing persona, and provides a visual of Bryant leaving the basketball court for the final time. The visual is displayed in Figure 13. We added links to the “About Page,” and the visualization in the form of buttons. The finished home page is displayed in Figure 14.



Figure 13: Photo of the Always Love the Hate commercial. The link to this photo is:
<https://www.stack.com/a/watch-kobe-bryant-reminds-us-to-always-love-the-hate-in-crazy-new-nike-commercial>.

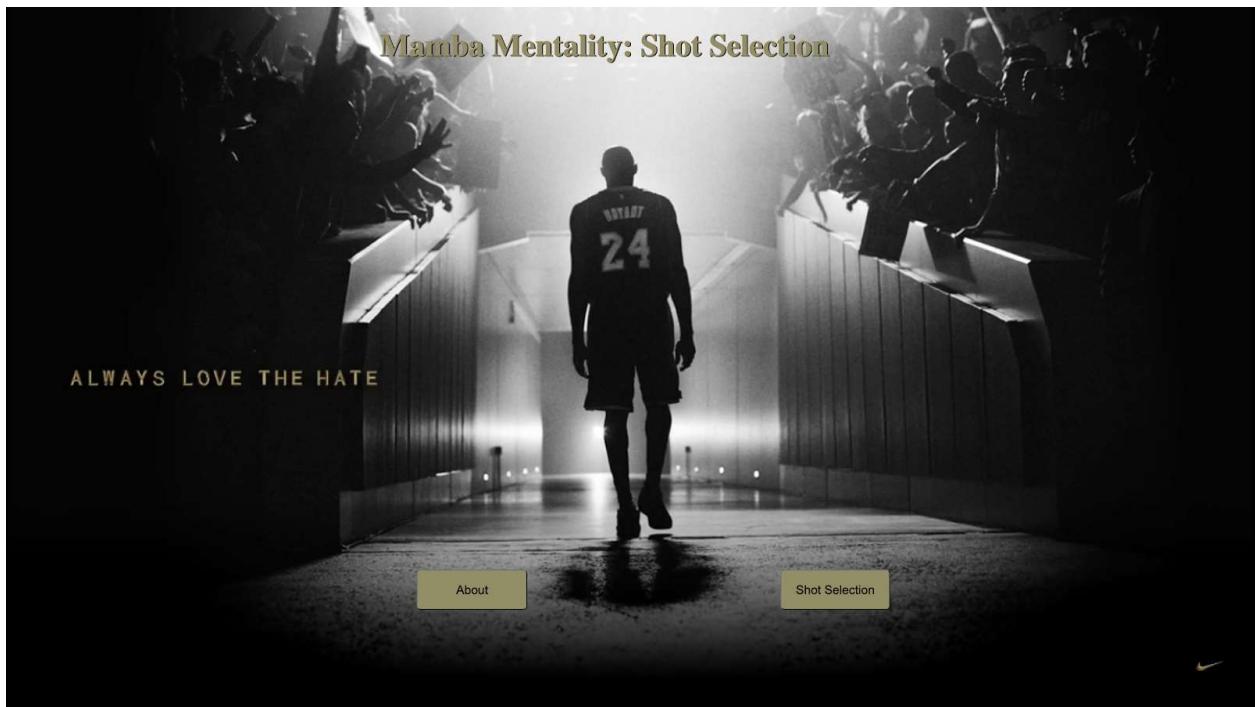


Figure 14: Photo of the Homepage. The buttons on the homepage provide links to the, “About,” page and the visualization.

Placing the youtube video inside a television icon: We felt that this would make the visualization more interesting. The previous version did not look visually appealing. The comparison between the original version and the updated version are shown in Figure 15.

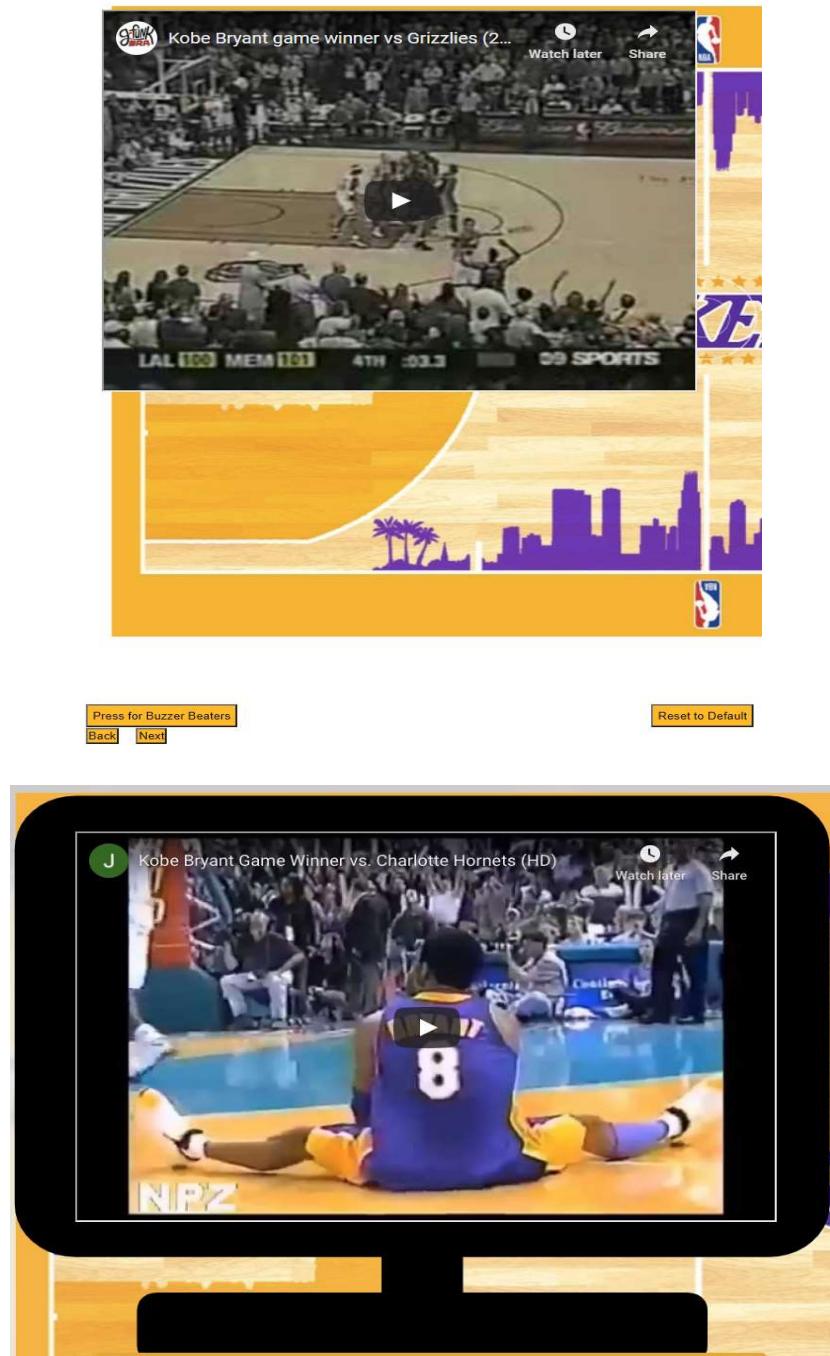


Figure 15: This figure displays the original version of the story mode and the updated version of the story mode. The updated version surrounds the embedded video with a television icon.

Placing a basketball icon: The original design utilized a star to indicate the location of Bryant's game winners. We felt that a basketball icon would be more fitting for the visualization.

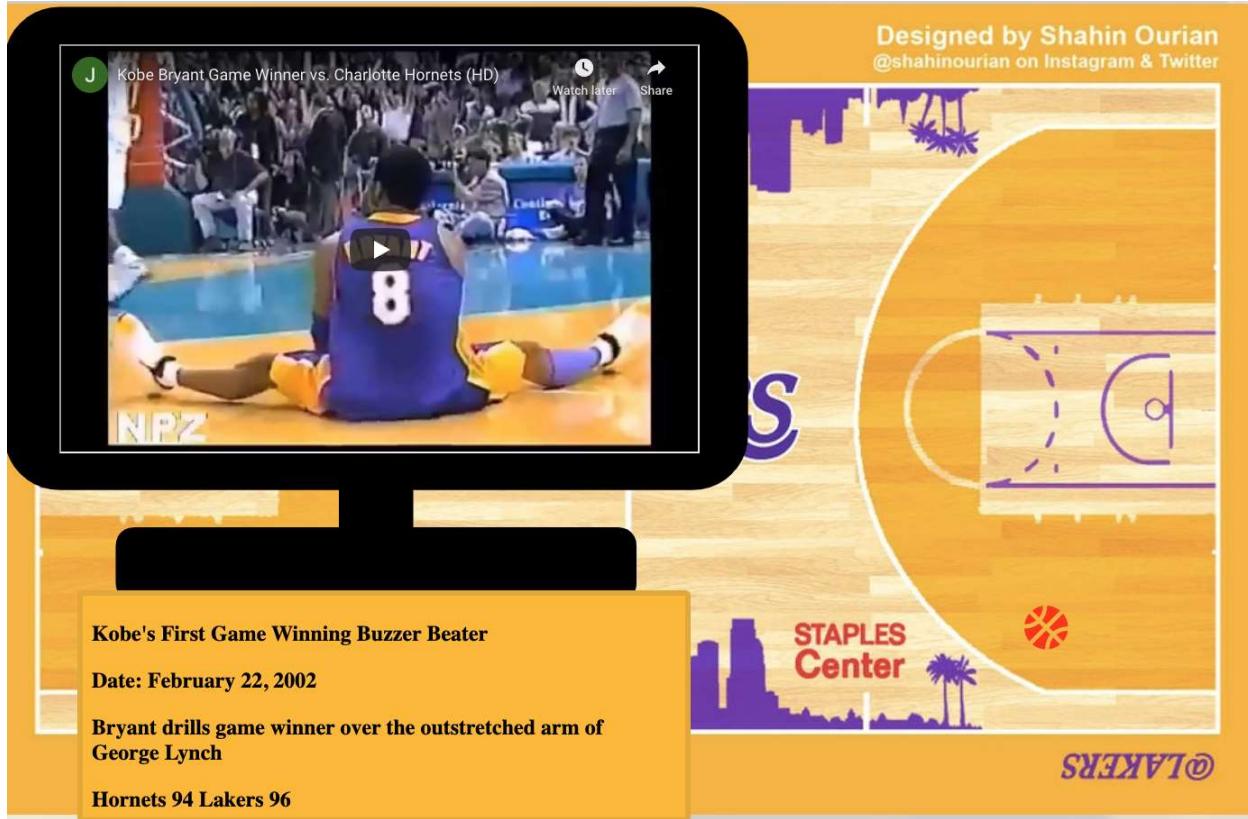


Figure 16: This figure displays the first buzzer beater shown in the story mode. The right half court contains an orange basketball icon that shows the location of Kobe's buzzer beater.

Altering the story mode: The original design incorporated all of the top clutch shots of Kobe Bryant's career. It was difficult to classify the meaning of, "clutch shot," because these shots can occur before the final moments of a basketball game. As a result, we chose game winning buzzer beaters because these shots are easy to define.

Placing a photo behind the visualization: The visualization had a lot of white space around it. Therefore, we felt that a background picture would help the visualization's appeal. As shown in Figure 14, the background picture displays Bryant's retired jerseys. We had to crop the photo to keep the focus on Bryant's jerseys. Additionally, we lowered the opacity of the photo to enable the elements around the heatmap to be seen. The original photo is shown in Figure 17.



Figure 17: A picture of Kobe Bryant's jerseys during Bryant's retirement ceremony. The link to the photo is: <https://www.nba.com/lakers/news/171218-kobe-bryant-jersey-retirement>

Addition of legends: The original design did not have legends. We felt that adding legends would help the viewer associate different colors with the metric being represented and allow their viewing to be informed. Without the legend, there is a larger chance that the viewer will misinterpret the data or not understand what is being represented.



Figure 18: A photo of the legends. The photo on the left was the legend used for the right half of the court, while the photo on the right was used for the left half of the court.

Implementation:

The heatmap is meant to display the distribution of shots throughout Kobe Bryant's career and his field goal percentages from different areas. This is accomplished through using a hexagonal heatmap that bins the shots by location and then uses color to encode the number of shots taken and the field goal percentage (Figure 8). The tool tip and brushing feature of the heatmap will display additional information about the shots Kobe took from within a hovered hexbin - this includes number of shots attempted, made, and the true field goal percentage (Figure 6). A slider will filter the data to show the shot distribution for specific years (Figure 21). The comparison drop down will allow current NBA players to compare with Kobe Bryant by drawing a heatmap of the same style on the other end of the court (Figure 23-27). The story mode presentation will display the buzzer beaters that Kobe Bryant made over the course of his career as embedded videos. These can be toggled through using a set of Next/Back buttons and in the future will include the context of the shot (Figure 28). Figures 22-28 show the different combinations of filtering and data presentation that can be generated through our visualization.



Figure 19: Current and final implementation of the player comparison dropdown above the left side heatmap.



Figure 20: Final implementation of tooltip providing the selected player, shot percentage, shot range, shots made, and attempted shots for the hovered hex (red). Font size and weight were increased to improve legibility.

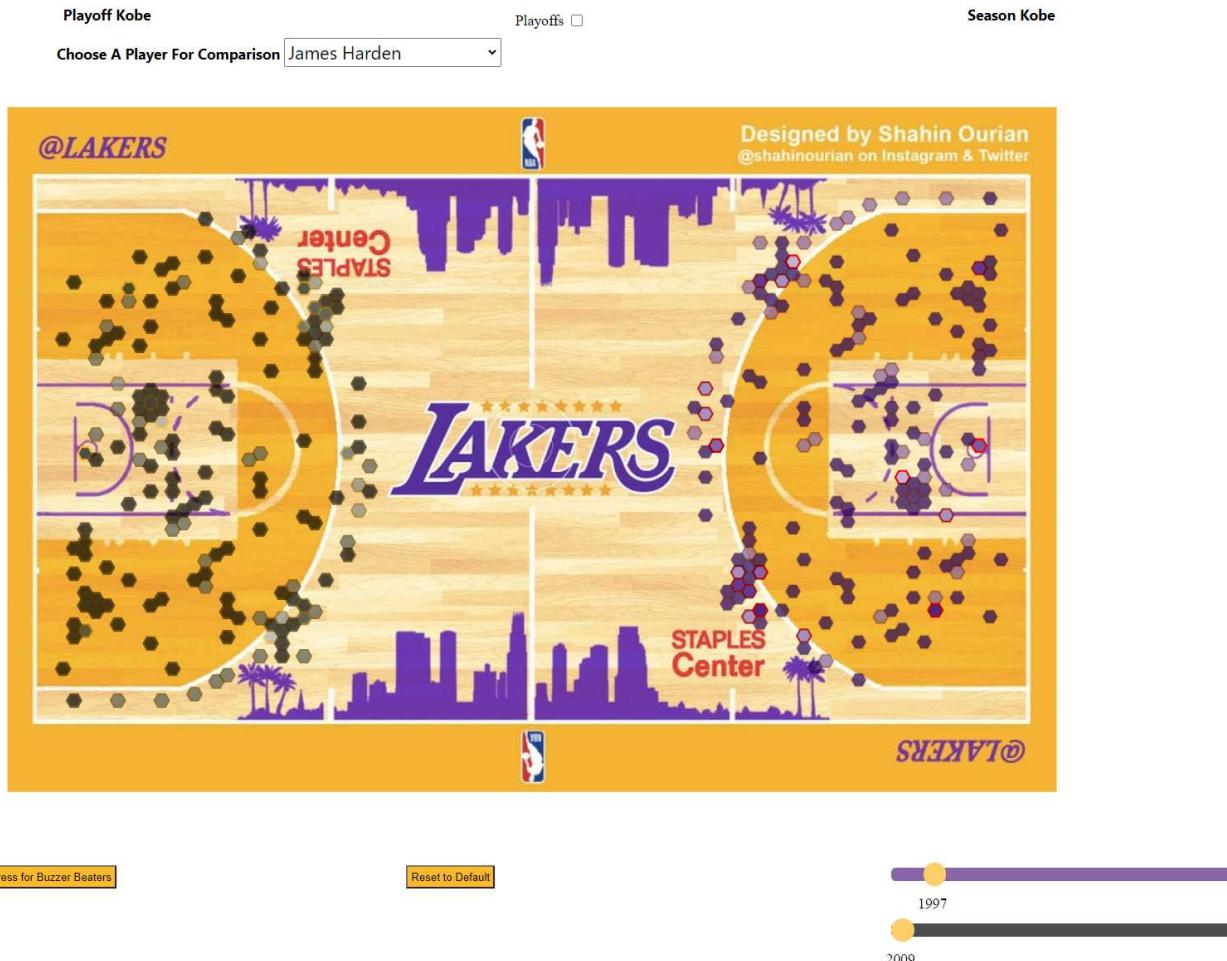


Figure 21: The original slider implementation for by year filtering and the resulting heatmaps for both players.

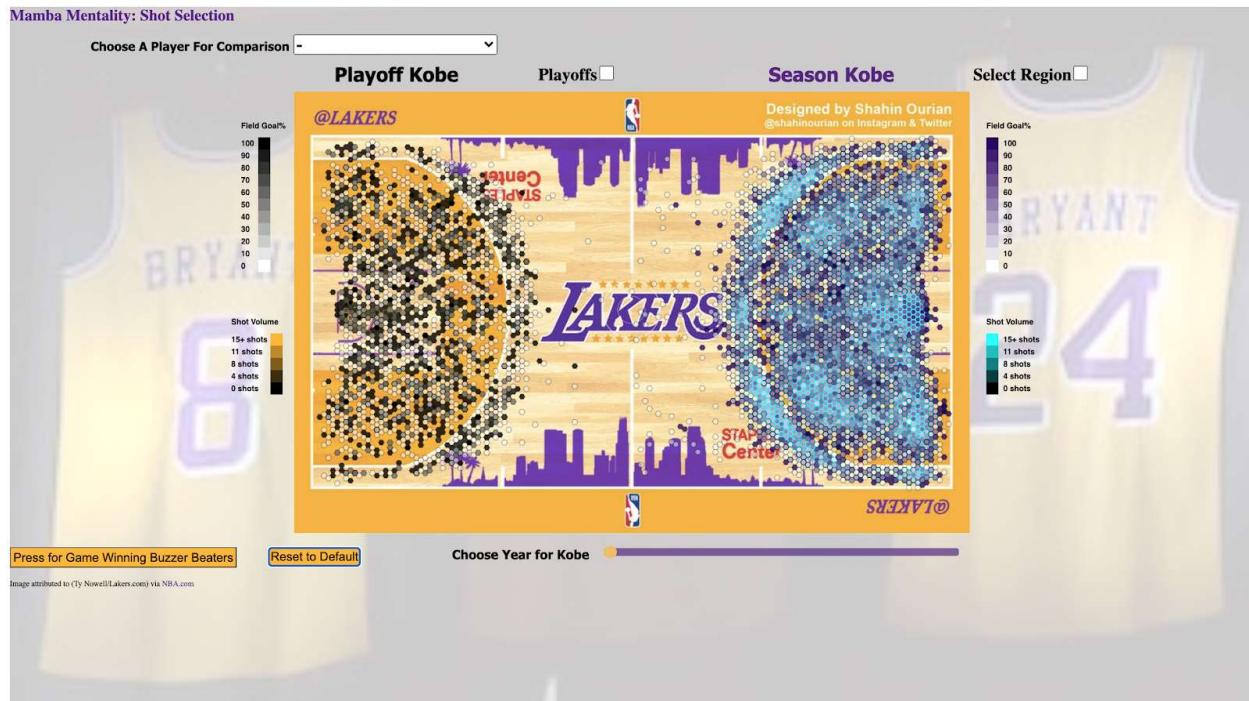


Figure 22: This is a image of the final visualization at the default screen.

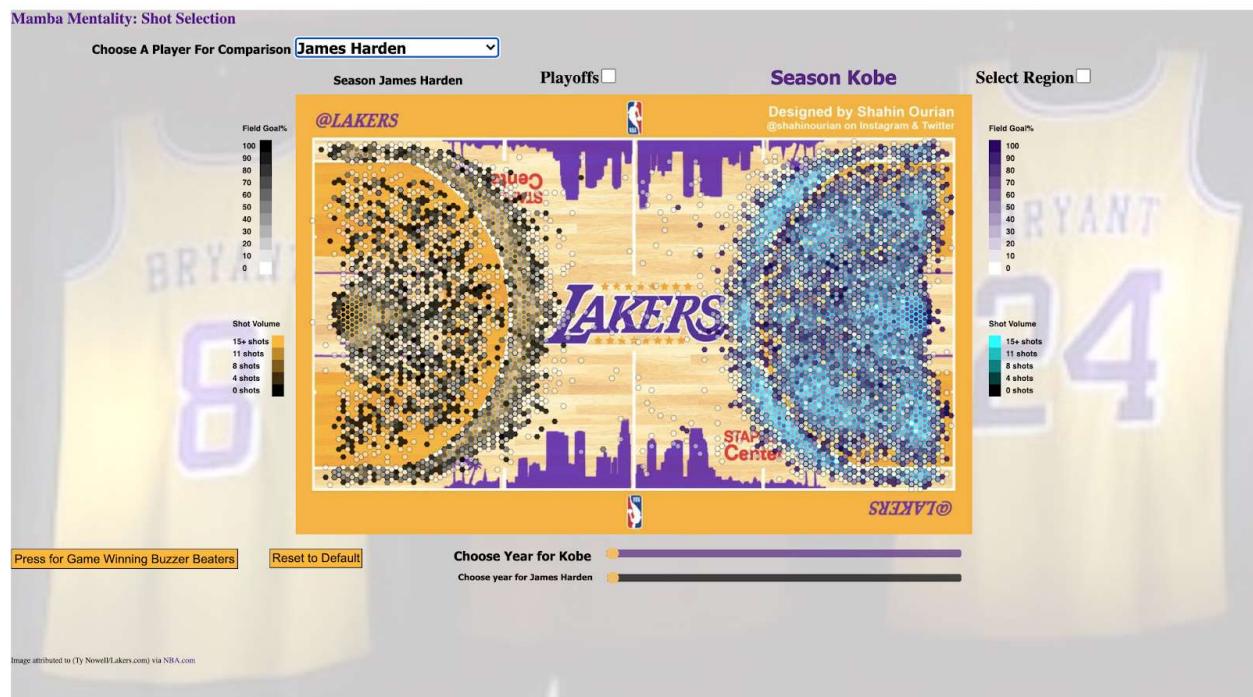


Figure 23: This figure displays the player comparison component of the visualization. The default setting is a comparison of all the regular season data for the two selected players. The

half court on the right will always be Kobe Bryant, while the half court on the left can be switched to any of the available players.

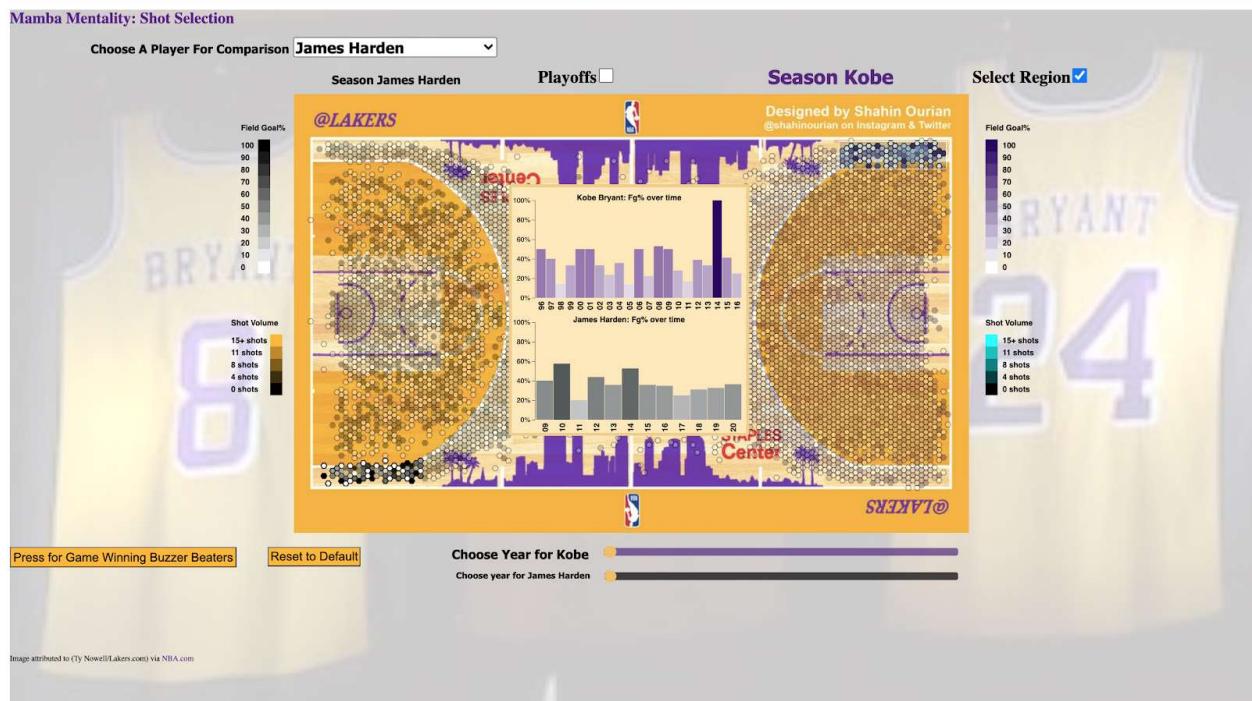


Figure 24: The figure displays the visualization when the player comparison and the select region button are selected. In this picture the user has selected the left corner of the basketball court. The selection is highlighted on both sides of the court, while a div presents statistics about the selected region for both players. The statistics include shot percentages for the selected region and display percentages for every season that the player has played in.

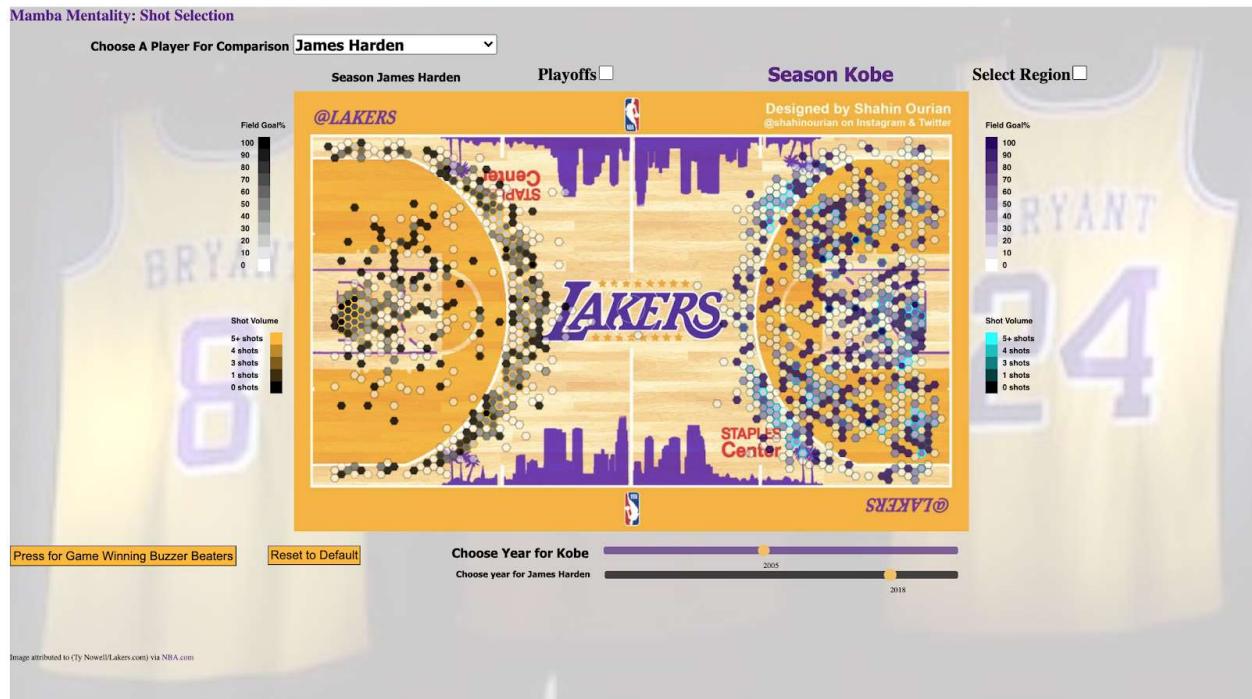


Figure 25: This figure displays the player comparison component of the visualization with a year filter applied. The sliders filter the data displayed on the heatmap. The data for Kobe Bryant includes the 2005 regular season, while the data for James Harden includes the 2018 season.

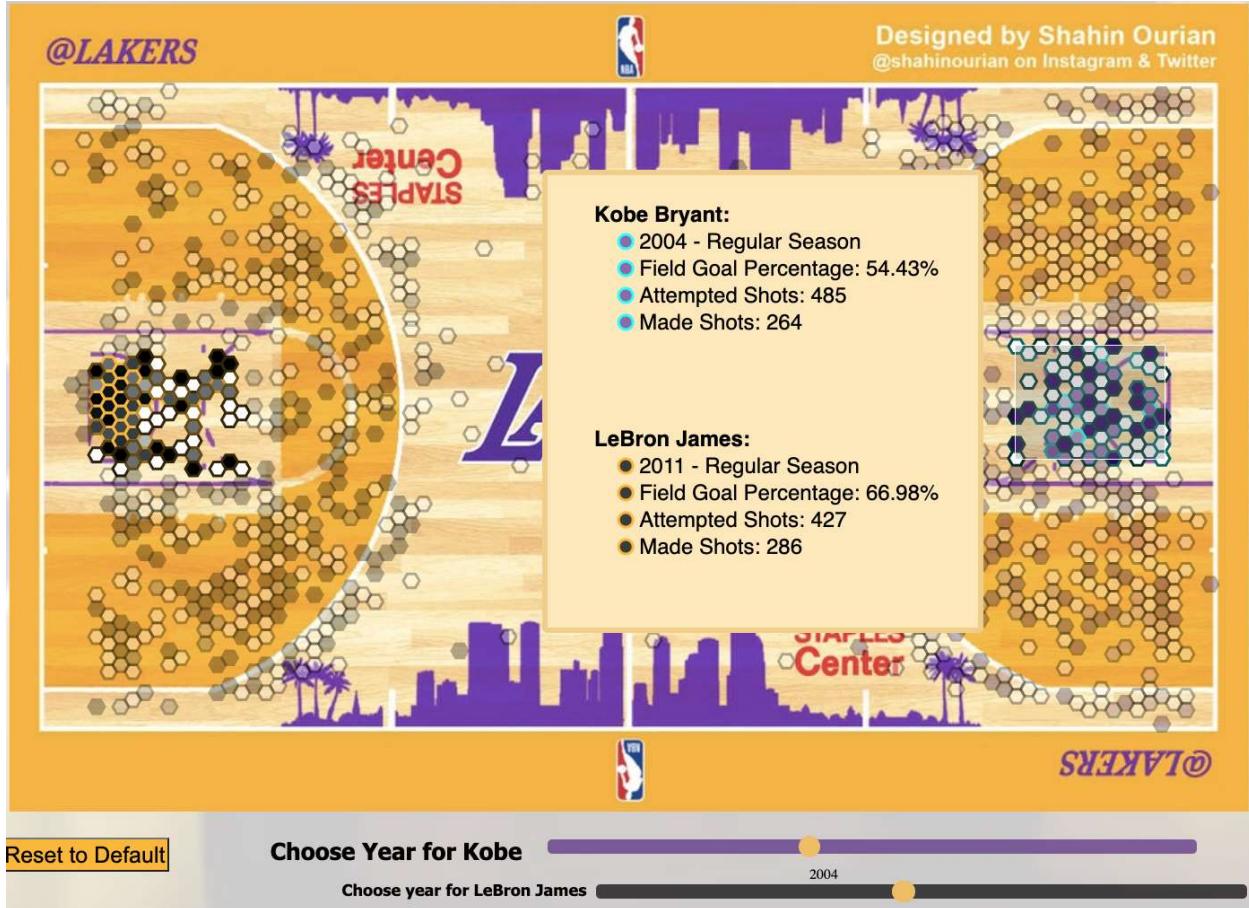


Figure 26: This figure displays the visualization when the player comparison and the select region button are selected with a year filter applied. The sliders filter Kobe’s data to display 2004 regular season data, and James’ data to display 2018 regular season data. In this picture the user has selected the left corner of the basketball court. The selection is highlighted on both sides of the court, while a div presents statistics about the selected region for both players. The bullet points next to the statistics are colored following the color scales used for the respective heatmaps, with stroke color based off average shot volume per game from that region and fill based off the field goal percentage from that region.

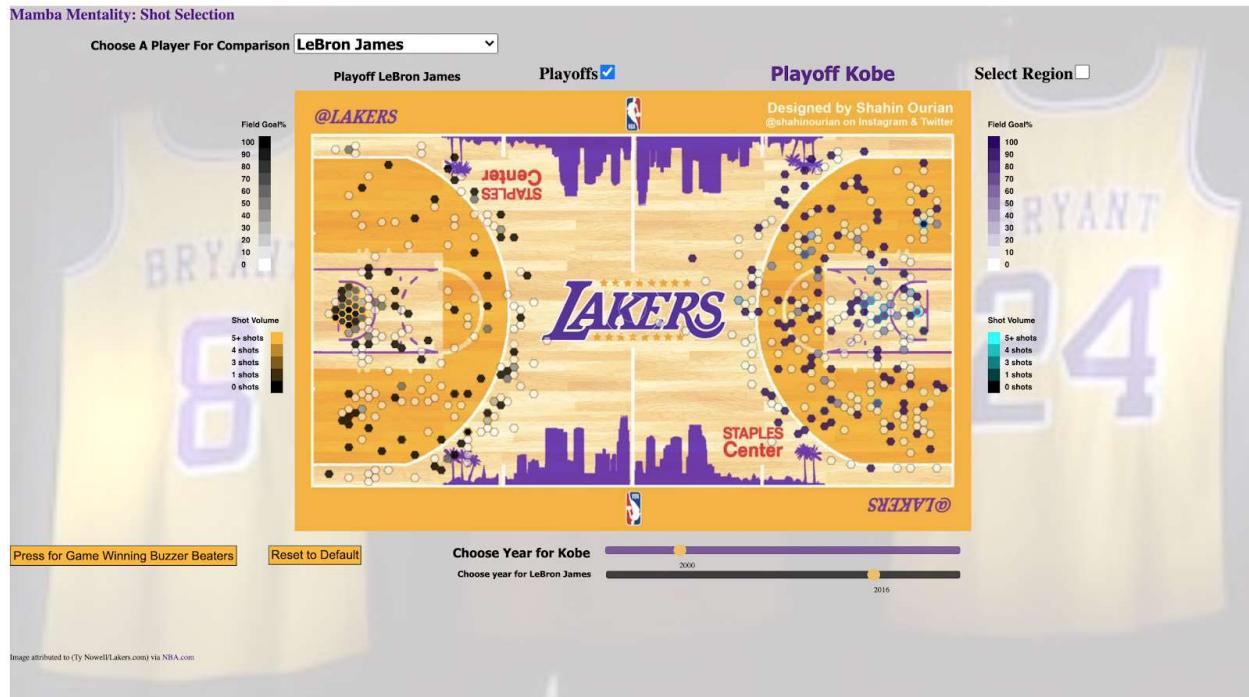


Figure 27: This figure displays the playoff player comparison component of the visualization. The sliders filter the data on the heatmap. The data for Kobe Bryant includes the 2000 playoffs, while the data for Lebron James includes the 2016 playoffs.



Figure 28: This figure displays the final buzzer beater of the story mode in the visualization. The div below the embedded video provides information about the game and the game winning shot.

The basketball icon on the right side of the court indicates the location of the game winner. The circles underneath the “Press for Game Winning Buzzer Beaters,” button indicates that this shot is the final buzzer beater. Pushing the, “next,” and, “back,” buttons will change the buzzer beater shown and the “reset to default,” button should remove the overlay.

Evaluation:

Our visualization gives insight into how Kobe Bryant has changed throughout his career. We noticed that early in his career, Bryant did not attempt many shot attempts from the beyond the 3 point line. As Bryant gets older, a larger distribution of jump shots are attempted from beyond the three point line. We noticed the large disparity in the number of 3 point attempts when comparing Kobe's earlier years with the shot distributions of players of 2020. The visualization shows how basketball has changed in the past twenty years. We were also able to see, when selecting different regions with high frequency, that in the first few years of his career Kobe's field goal percentage increased fairly linearly followed by a relative plateau across the rest of his career (Figure 29). This pattern was also seen in some of the other players such as James Harden and in Stephen Curry's 3-point shot. While his shot selection prefered the right side of the court (Figure 30), the story mode shows that Kobe did not favor a direction when shooting game winners. Bryant moves to his right for three of his buzzer beaters and moves to his left for four of his buzzer beaters.

Some questions are only provided mediocre answers by our visualization, such as: What are all of the significant shots that Bryant attempted and made over the course of his career? The visualization does display all of Kobe's game winning buzzer beaters. These buzzer beaters make up a solid amount of Kobe's significant shots. However, there are a number of significant Kobe shots that did not occur as the buzzer sounded, but that are significant to Kobe's legacy.

On the other hand, the storytelling of Kobe's game winning buzzer beaters shows the viewer where on the basketball court did Bryant make those crucial shots. The embedded videos show the viewer the magnitude of Kobe's great moments that the shot chart cannot show.

The implemented heatmaps do a great job of showing the viewer the areas of the court where Kobe shot from the most, the parts of the court where the percentage was lowest, and how Kobe's shooting tendencies and percentages changed over time. The heatmap and the various

filters that can be applied to the heatmap allow the user to determine the trends in Bryant's career and identify the areas of the court where Bryant performed the best and the worst.

The visualization answers the question: How does Kobe compare to other players? The player comparison that the visualization allows the user to perform displays Kobe's shot distributions next to the shot distributions of other players. The user can visually compare the two players' heatmaps and deduce conclusions from the comparisons.

Our original design evolved as we developed and altered ideas with the resulting visualization working well and being something we are proud of. The final design is much more colorful than the original visualization sketch. We were able to complete all of the aspects that we decided were necessary for the final visualization, as well as some features originally deemed as nice-to-haves. The visualization provides the casual NBA fan with the ability to compare Kobe with other NBA players in a detailed manner without any issues and further compare them on a region-region and year-year basis if they would like to.

When developing our visualization we faced several challenges, the largest of which was the difference in resolution and aspect ratio between the group members monitors and potentially any users monitor. What looked good and worked well on one member's monitor would often be offset on the other member's monitor, resulting in divs and elements being misaligned (Figure 31). This can be resolved by zooming out within the browser, but prior to final release settings were implemented that seemed to fix this issue on the monitors used by both group members.

One improvement that could be made is the addition of tooltips to the sub visualizations. Occasionally, the user can select a combination of filters that results in one year having a percentage of 100 percent for a specific region. This result is misleading because the selected player attempted and made one shot from that area. The viewer does not know how many shots were taken from the region when the region selection is active on the players career heatmap. A tooltip incorporated into the sub visualization, similar to the one used on the heatmap, would provide additional information and help clarify when outliers are occurring.

Another improvement that could be made to this visualization is to provide a larger pool of players to select from. The current visualization does not include every NBA player. A larger pool of players might attract more NBA fans to this visualization and might increase the amount of time the view spends on this visualization.

Finally, the addition of several more sub-visualizations, such as a frequency distribution below the heat map showing the shot volume at different distances or a distribution showing when during games shots were most frequently taken. These would provide additional information to the user and would also help to characterize the overall shot selection characteristics of Kobe and the players he is being compared to.

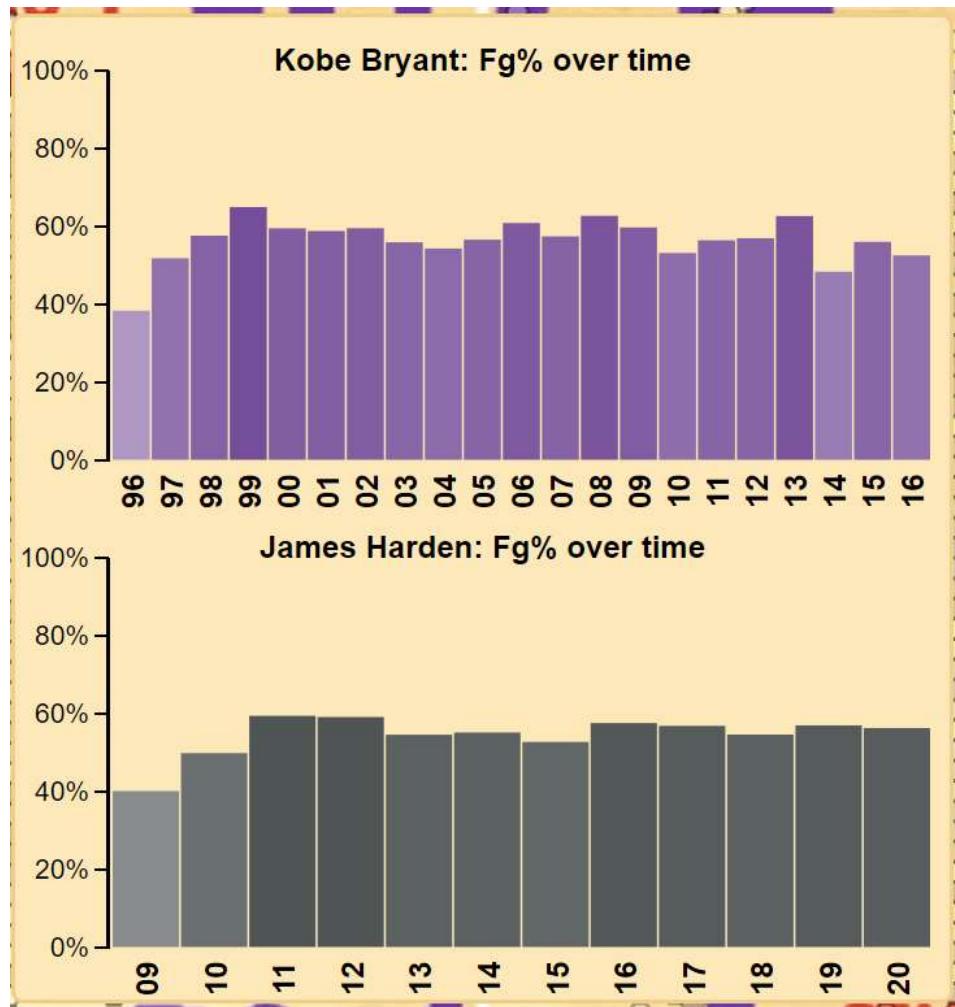


Figure 29: Demonstration showing how Kobe's and Harden's field goal percentage changed over the years in the paint. Interestingly both showed the same pattern of a linear increase for their first few years followed by a small decline and plateau.

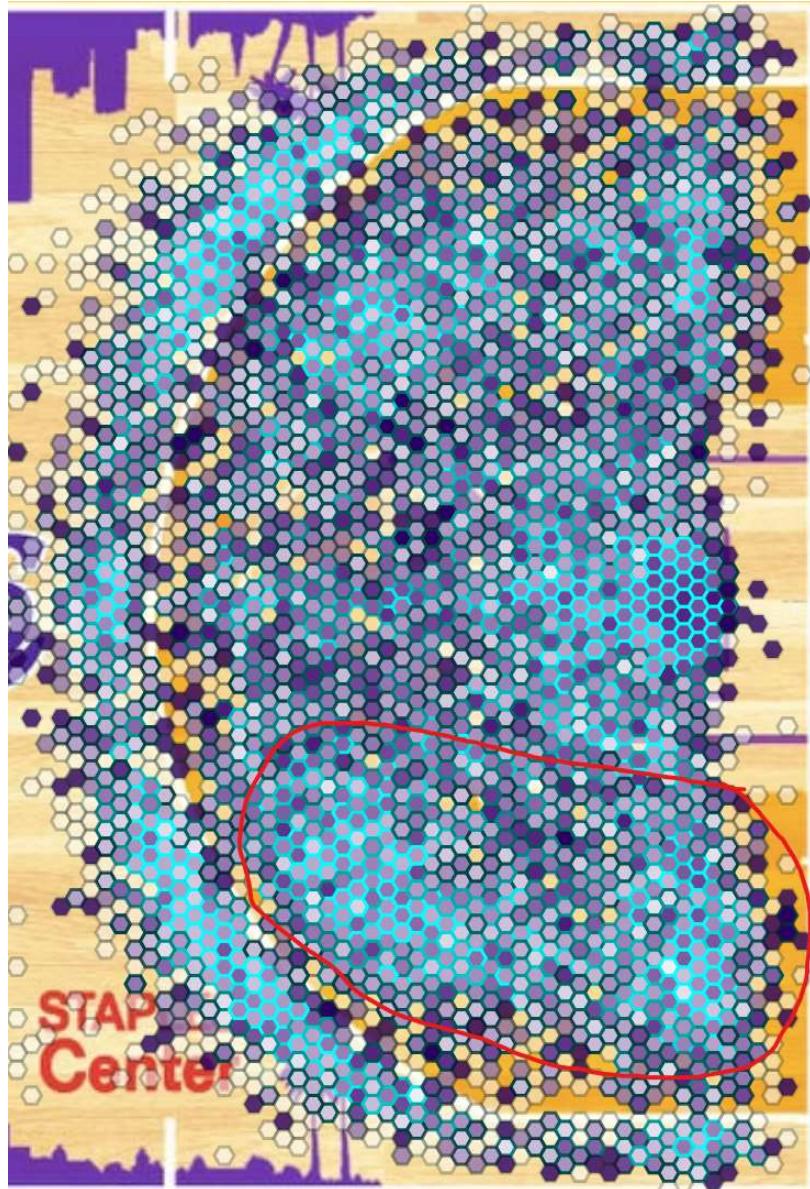


Figure 30: Kobe Bryant's career shot heatmap. While shooting between sides of the court was relatively even for 3-point shots, midrange shots showed a preference towards the right side of the court. Significantly more of the hexes within the region circled in red have a bright blue border when compared to the same location on the other side of the court.

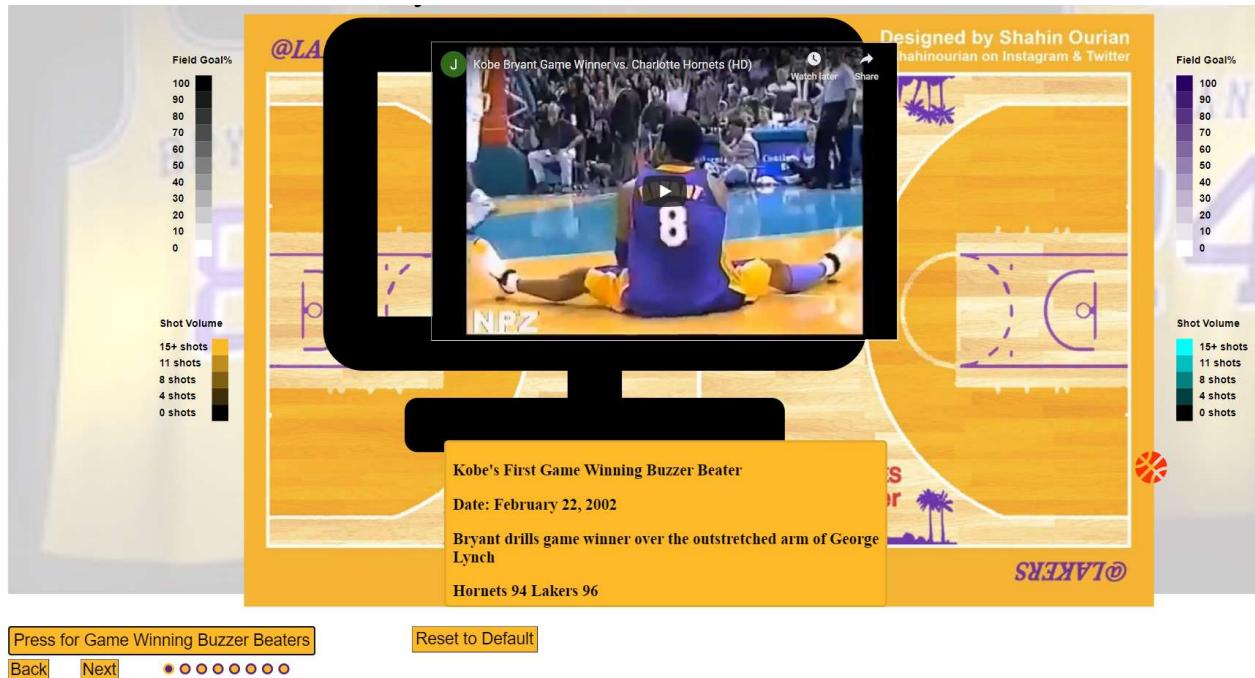


Figure 31: An example of the offset that can occur prior to zooming on some resolutions/aspect ratios.