Kobe Bryant: "A True Shooting Guard" … Or Was He?

By: Brunda Chouthoy, John Misailedes, Kiron Mishra, Craig Stanek, Samantha Stanley

Introduction

On April 13, 2016, Kobe Bryant played the final game of his storied 20-year NBA career for the Los Angeles Lakers. In an ending seemingly straight out of a Hollywood manuscript, he fittingly capped his farewell tour by scoring 13 unanswered points in the game's final two minutes as part of an overall 60-point effort to lead his team to victory after being down by 10 with only 2:36 to play. That effort was the culmination of a playing tenure that elevated him to 3rd place on the league's all-time scoring list. He was additionally recognized as an 18-time All-Star selection, 15-time All-NBA team player (including league MVP in 2008), and a 12-time All-Defensive team choice. His teams reached the NBA Finals seven times and won five titles.

To commemorate the end of an era, the *LA Times* produced an infographic that received a fair amount of publicity (see Appendix for the graphic). It displayed every one of the 30,697 total shots that he took in his career by location on the court with purple dots signifying shots made and gold dots representing misses (the Lakers' colors). The heading at the top of the page proclaimed him as "A True Shooting Guard", and much of the discussion around his retirement proclaimed him as one of the NBA's all-time greatest players, perhaps the second-best shooting guard ever—behind only Michael Jordan.

The data science web site Kaggle was able to obtain the detailed shot data behind that infographic and put together a competition (https://www.kaggle.com/c/kobe-bryant-shot-selection) designed for predicting whether Kobe made or missed a shot for 5,000 test cases (i.e. that key variable was removed from 5,000 records). So despite missing a bit more than 16% of the total data, which meant that our results will not align perfectly with his career statistics, we still felt that it is a representative sample with the potential to provide for some interesting visualizations. Our goal then is to complete exploratory and explanatory visualizations that disclose patterns and anomalies in the data. We will not be trying to predict the outcome of each shot, but rather trying to identify compelling ways to highlight Kobe's career from a purely analytical viewpoint.

Data Exploration

One of the primary reasons for selecting this data set was its inclusion of both temporal and geospatial aspects. Along the time dimension, there are actually several possibilities. We have the season that games occurred in, whether a game was during the regular season or that year's playoffs, the date of the game, the period each shot was taken, how many minutes remained in that period, and even how many seconds remained within each minute. As far as spatial dimensions, we have the latitude and longitude of each shot taken, and an x-y coordinate pair that describes the shot location in terms of a distance scale corresponding to the basketball court. We also have categorical shot-specific location data including: zone, where the court is divided into 6 areas; zone basic, which tells where within the zone the shot occurred; and zone range, a binned class of ranges of distances in feet. There is a continuous variable as well—shot distance, which provides the length of the shot in feet.

Before diving straight into trying to create visualizations, we first decided to throw the data into Excel and create some basic pivot tables to get a feel for the data. In most cases, we simply crossed a single field with the binary target variable from the Kaggle competition—whether the shot was made (represented by a value of 1) or missed (0). Although we looked at both the raw totals and distributions (in terms of percentage of

misses/makes), for the sake of brevity we only display the percentages here as they provide the basis for the key story lines.

As an example of this work, we show here a simple year-by-year look at Kobe's field goal percentage, supplemented with other information pulled from the web that may also be incorporated into our analysis:

Count of shot_id	shot_made_flag				Team	Playoffs	Key
season	0	1	Grand Total		Win Pct.	Result	Teammate
1996-97	57.70%	42.30%	100.00%		0.683	WC Semis	Shaq
1997-98	56.91%	43.09%	100.00%		0.744	WC Final	Shaq
1998-99	54.12%	45.88%	100.00%		0.620	WC Semis	Shaq
1999-00	53.96%	46.04%	100.00%		0.817	**Won Finals**	Shaq
2000-01	53.33%	46.67%	100.00%		0.683	**Won Finals**	Shaq
2001-02	54.16%	45.84%	100.00%		0.707	**Won Finals**	Shaq
2002-03	56.37%	43.63%	100.00%		0.610	WC Semis	Shaq
2003-04	56.67%	43.33%	100.00%		0.683	Lost Finals	Shaq
2004-05	56.34%	43.66%	100.00%		0.415		
2005-06	54.63%	45.37%	100.00%		0.549	WC 1st Round	
2006-07	54.21%	45.79%	100.00%		0.512	WC 1st Round	
2007-08	53.16%	46.84%	100.00%		0.695	Lost Finals	Pau Gasol
2008-09	53.21%	46.79%	100.00%		0.793	**Won Finals**	Pau Gasol
2009-10	54.63%	45.37%	100.00%		0.695	**Won Finals**	Pau Gasol
2010-11	55.36%	44.64%	100.00%		0.695	WC Semis	Pau Gasol
2011-12	57.42%	42.58%	100.00%		0.621	WC Semis	Pau Gasol
2012-13	54.22%	45.78%	100.00%		0.549	WC 1st Round	Pau Gasol
2013-14	59.32%	40.68%	100.00%		0.329		Pau Gasol
2014-15	62.39%	37.61%	100.00%		0.256		
2015-16	64.38%	35.62%	100.00%		0.207		
Grand Total	55.38%	44.62%	100.00%				

Other elements investigated in similar fashion included:

- A look to see how Kobe's shooting percentage varied by opponent over the course of his career
- Number of games played against each of the other teams in the league
- An examination of how his shooting percentage varied minute-by-minute over the course of an aggregated "game"
- A drill down into field goal percentage by seconds remaining in each period, particularly for the 4th quarter (and compared regular season versus postseason)
- Kobe's field goal percentage by the type of shot taken (Dunk, Layup, Jump Shot, etc.)
- His mix of shots by type and how that evolved over the course of his career (year-by-year)

Several of these tables can be found in the Appendix for reference. From them, we were able to develop some basic exploratory visualizations. For example, the year-by-year field goal percentage was initially displayed with the following vertical bar chart:

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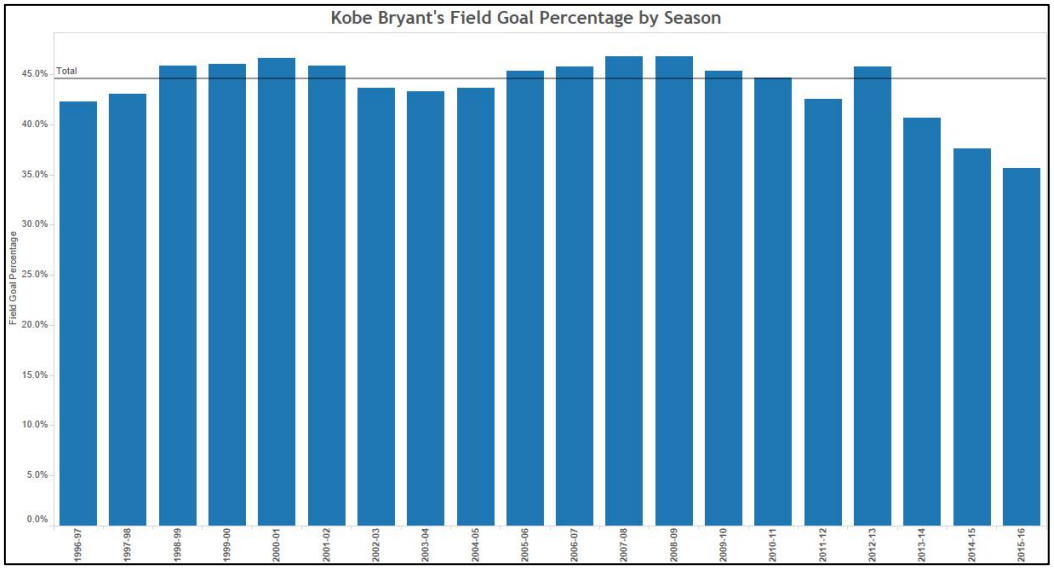


More of these initial exploratory visualizations can be found in the Appendix. From analysis of them, we were able to see how different elements fit together, and several story lines emerged.

Story Lines

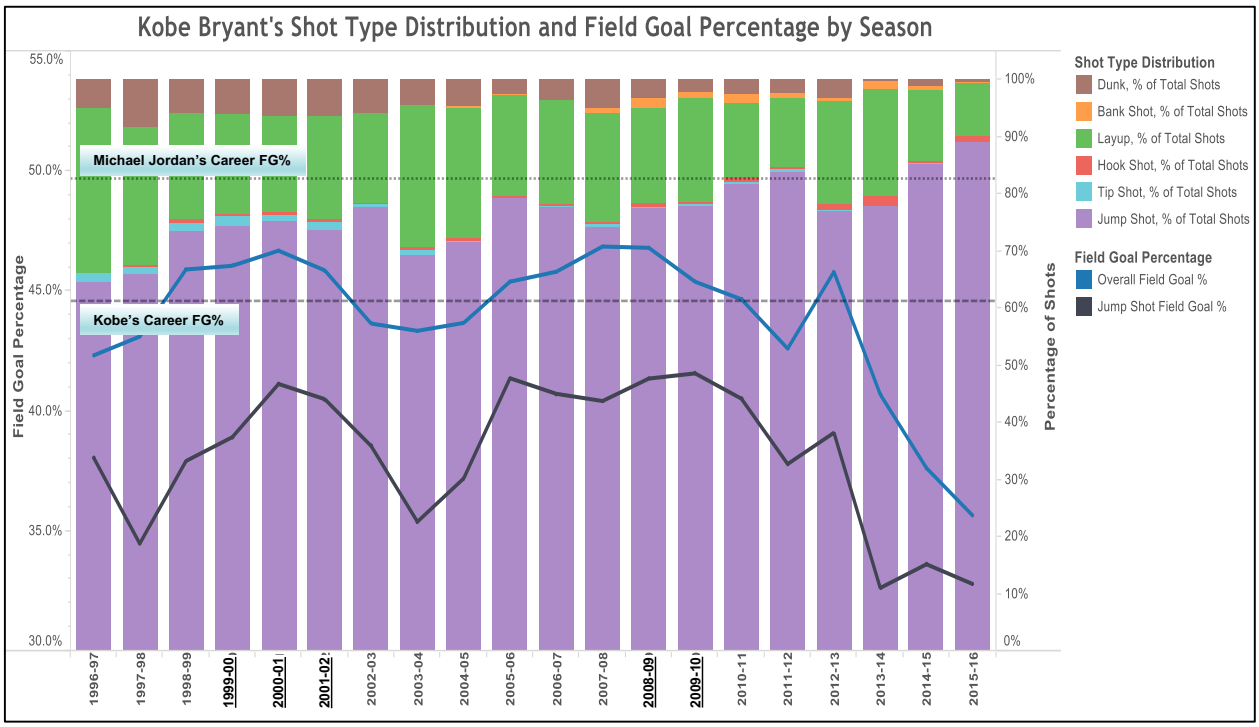
Story Line #1: Scoring Proficiency Based on Volume, not Necessarily Accuracy

Overall field goal percentage seemed like the natural place to start in order to provide a baseline for the rest of the visualizations. We also noticed that there appeared to be a good story showing that Kobe's overall field goal percentage for each season was largely a function of the types of shots he took and because of an increasingly heavy reliance on jump shots, specifically his ability (or inability) to make a relatively high percentage of those jumpers. Looking at the individual exploratory visualizations for overall field goal percentage by season, year-by-year jump shot field goal percentage, and the stacked vertical bar chart showing distribution of shots by type for each season, here is the story that emerged:

- Early in his career, Kobe's overall FG% got better as he improved his jump shot and used his athleticism to get a lot of dunks and layups … won 3 straight titles in 1999-00 thru 2001-02
- Then he went through a period where his jump shot shooting declined—bottoming out in 2003-04—and his overall shooting percentage suffered accordingly
- What appeared to be a renewed effort on his jump shot brought his overall field goal percentage to peak levels in 2007-08 and 2008-09 … which coincided with a return to the NBA Finals in both of those seasons as well as 2009-10 (won the latter two of those)
- But beginning after 2007-08, he became more and more reliant upon jump shots (note the decreasing presence of dunks and layups in his shot distribution), and his overall FG% began to drop again
- There was what appeared to be one last renewed effort in 2012-13 to get to the basket more often, but then he got injured in 2013-14 and was almost exclusively dependent on a failing jump shot for his final two seasons

The question was: how best to represent this story visually. One option was to leave each of the three basic visualizations separate, but that would make it very difficult to see how the overall field goal percentage was a function of the other two. To compile the analysis shown above, there was a constant flipping back and forth

among the individual graphs. So all of the information really needed to be on a single page. To accomplish this goal, a dual-axis chart seemed like the best option:



Several key design choices went into the construction of this visualization. For instance, the "Jump Shot" and "Dunk" bars were specifically placed at the two ends of the stacked vertical bar portion so that these types of shots had an even starting point for each season. Therefore it would be much easier to discern changes in their levels from one year to the next (you can generally see an overall trend of reduction of the size of the brown bars—dunks—and an increase in the size of the purple bars—jump shots). A suggestion was made to perhaps put the stacked vertical bar distribution portion separately below a line chart showing the field goal percentages (similar to how stock prices and volumes are often shown over time), but that meant reducing the size of the bars, which made it much more difficult to see the fluctuating trends in types of shots taken.

Another key element of the graph was the color choices. The variation in bar colors were set so that each one could be clearly differentiated from its adjoining one. The field goal percentage line colors were chosen so that they clearly stood out against the purple bars. In order to position those lines appropriately, the range for the field goal percentage y-axis was altered so that it did not go all the way down to zero. By doing so, year-to-year fluctuations were easier to see, and the two lines themselves had greater separation between them instead of almost being on top of one another.

A couple of reference lines were included to provide overall benchmarks. Kobe's career field goal percentage was represented as the darker dashed line so that each one of his individual seasons could easily be judged as above or below his overall average. And Michael Jordan's career field goal percentage, as indicated by the lighter dashed line, served as a reminder that not a single one of Kobe's seasons came even close to approaching Michael's career field goal percentage. Finally, the years that the Lakers won NBA titles were underlined to highlight their correlation to Kobe's performance by season.

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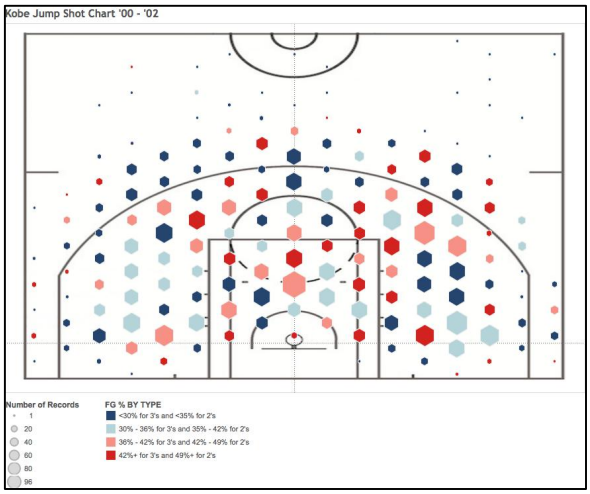
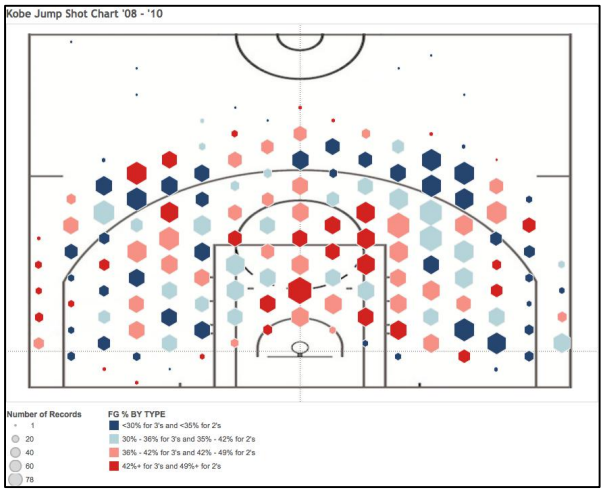
Story Line #2: Comparison of Eras via Jump Shot Heat Maps

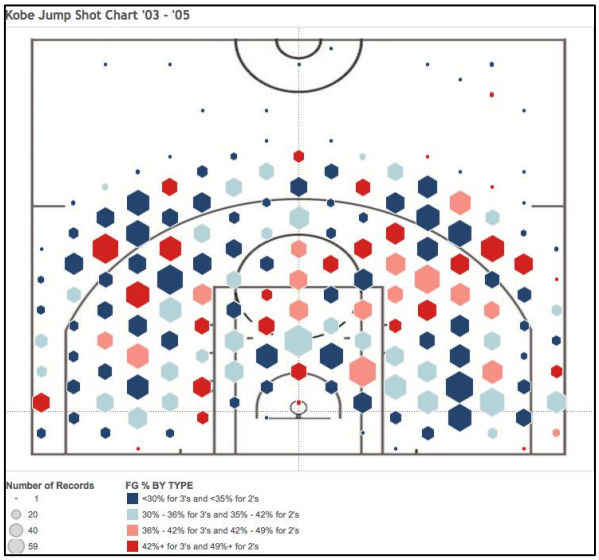
Inspired by the *LA Times* infographic and possessing coordinates specific to the location on the court for every one of Kobe's shots within our data set, we felt that it would be interesting to see if Kobe's shot selection and shooting proficiency from different areas evolved over time. So we created some heat maps in order to explore this story line. Specifically, we decided to focus on jump shots. The reason being, in our original exploratory analysis, we noticed that including layups, tip-ins, dunks, hook shots, etc., all skewed the data. It made Kobe look like a much better shooter. These are all shot types that are usually within 3 feet of the basket. As a result, you will see the hex representation for shots directly under the basket in our images appear quite small.

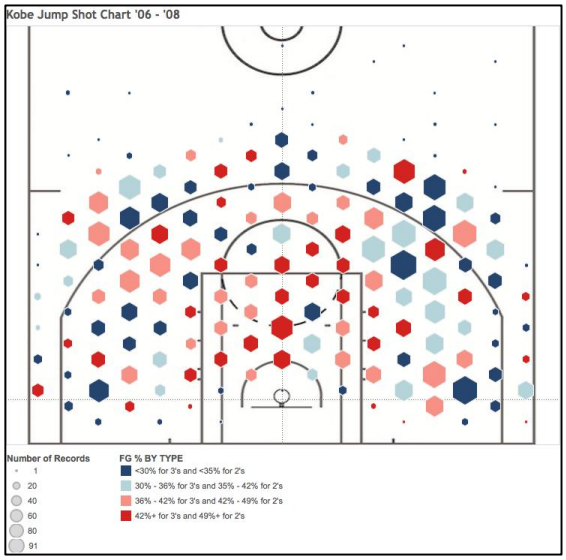
Looking at the jump shots through hex plots overlaid on a court and also coloring the hexes as a heat map by field goal percentage allowed for an easy comparison. It's clear to see how the shot taking and accuracy changed based on the seasons chosen. There were different scenarios for seasonal comparison. For example, there was a look at different seasons based on Championship appearances or based on the players on Kobe's team.





Certain star players can also have a bigger impact on a team. For example, Kobe's shot chart differs when he played the last 3 years with Shaq versus the 3 years immediately without him.



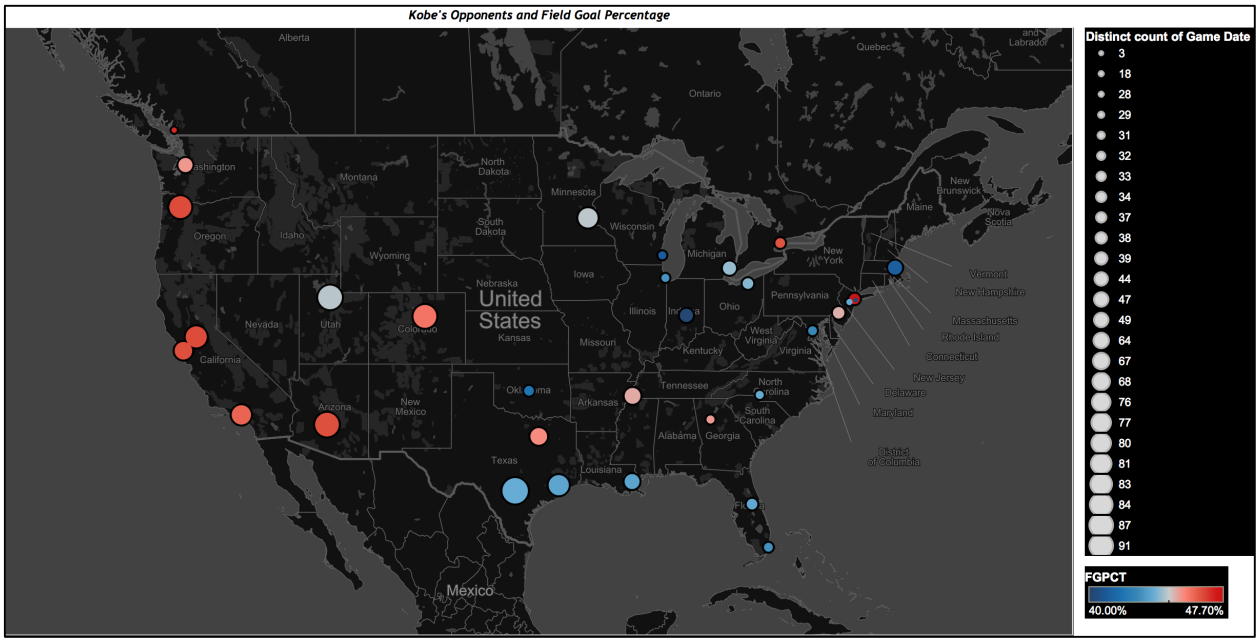


You can see in the images above that Kobe's shots are more accurate in the years after Shaq left. It's possible that in an effort to show himself as a #1 option, Kobe would throw up more ill-advised shots. His shot selection is clearly better after Shaq left.

Key to the construction of these visualizations were a lot of small manipulations. For example, the color range used has a great impact on the appearance of Kobe's shooting ability. At first, a scale from 0 to 100 was used with a good shooting percentage set at 50%. This made Kobe look like an absolutely awful shooter. However, setting the shooting percentage too low (at 40%) to account for 3-point shots made the visual appear homogeneous. It took some fine tweaking on the color scales to represent the distribution of field goal percentages (that were in line with the NBA averages). Not only was the scale important, but the colors themselves are quite important for a viewer. While the original visuals were a purple and gold color to mirror the colors of the Lakers, this scale doesn't help the viewer. Instead, a choice of a red and blue scale to represent "hot" and "cold" seemed like a better option—a relationship the viewer can imply from the image and is also familiar with from other scenarios in society.

Story Line #3: Go West, Young Man

In reviewing the exploratory data and visualization for Kobe's field goal percentages against opponents, a trend seemed to emerge. When we created a heat map based upon the latitude and longitude coordinates accompanying his shot data, it clearly stood out:



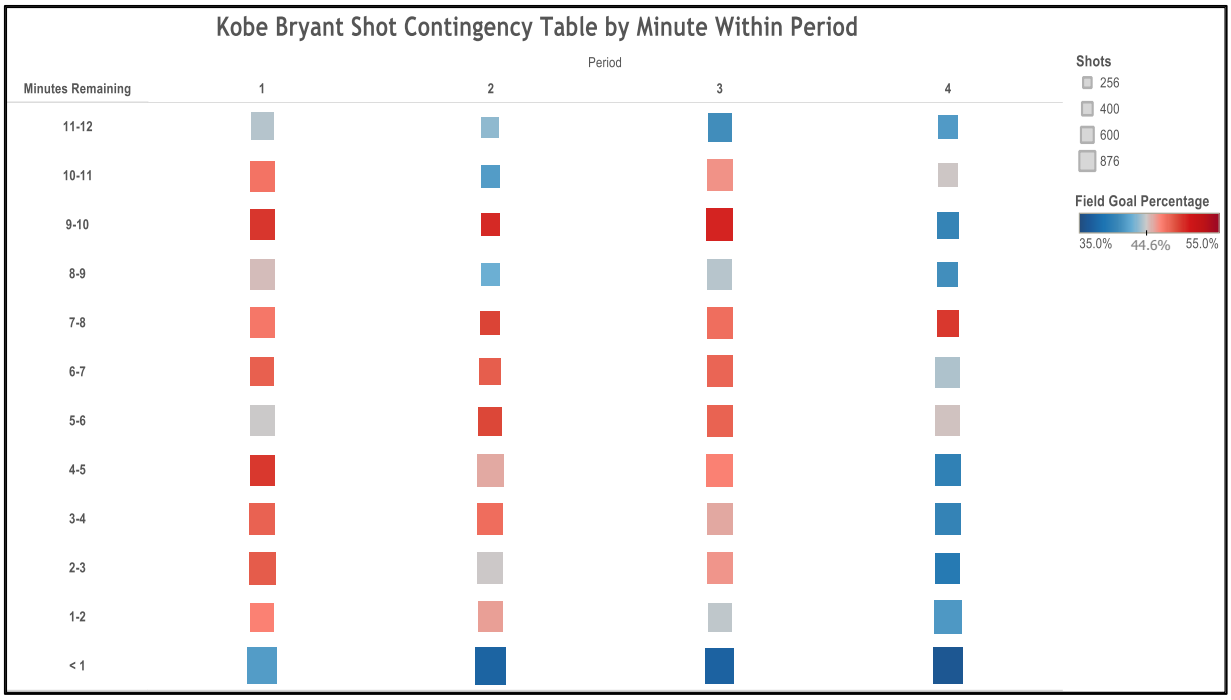
Notice the particular dominance of the red dots in the western half of the United States, corresponding to the cities of Western Conference teams against whom Kobe appeared to perform best. Add to this the fact that Kobe played his entire career for the Lakers and teams play opponents within their conference more often than teams from the other conference, as reflected by the size of the circles (the more games played against an opponent, the larger the circle for the corresponding city on the map).

So Kobe largely performed best against the teams that he played most often. Some of this dynamic may be explained by greater fatigue from longer travel when playing at Eastern Conference opponents, but it also likely

reflects conventional wisdom about the styles of the two conferences: western teams are known to play more of an open-court and up-tempo style while eastern squads generally rely on a more rugged, physical, defensive-minded approach. What makes our finding even more interesting is that Kobe was originally drafted by the Charlotte Hornets (an Eastern Conference team) and traded to the Lakers in a draft-day deal. Had he played for an eastern team rather than the Lakers, his shooting percentage numbers could have been far worse.

Story Line #4: Is it Fatigue, or Just Trying to do Too Much?

When we first examined Kobe's field goal percentage by quarter, we noticed that it was highest in the first (when he would be most fresh at the start of the game), next-best in the third (after halftime break), decent for the second, and by far the worst in the fourth (when who wins the game is often decided). To get an even more in-depth look, we decided to drill down within each period minute-by-minute and combine his shooting performance with number of shots taken to see if any trends emerged. In order to combine all of this information into a single visualization, we turned to the use of a contingency table:



This visualization evolved quite a bit before eventually settling upon this choice. Initially, it was a pure heat map based only on field goal percentage, and at first that seemed to tell a good story on its own. But some exploratory work to create a mosaic graph based on shots taken uncovered some further insights that blended well with the heat map. Since color representing field goal percentage could not be incorporated into the mosaic, the contingency table was used instead. Note that the divergent color pattern was chosen to be consistent with the rest of the visualizations (red signifying "hot", or higher field goal percentage, and blue representing "cold", or lower field goal percentage). The midpoint of the range was set to match Kobe's overall field goal percentage (44.6%). An initial breakdown of the final minute into a few different buckets of seconds remaining was judged to be too confusing, and a separate story line to investigate this aspect was developed instead.

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By breaking things out by minute and depicting shot totals by size of the square in the visual, we could now see that Kobe's greatest shot volumes were in the first and third periods. His shots taken were lower in the second and fourth quarters, especially in the first few minutes. This suggests a general pattern whereby he would rest in the early parts of those quarters. Then his shot totals start increasing, perhaps indicating that his standard playing pattern was to come back into the game a little before the middle of those periods, and his shooting percentage was much higher in those first few minutes after getting some rest.

Consistent with the numbers overall by quarter, the first period is almost all red (again, reflecting that he was fresh to start the game), and the same can be said for the early part of the third quarter, perhaps needing a minute to get back into the flow after the halftime break. There is a whole lot of blue, however, in the fourth quarter. This suggests that Kobe was not a great clutch performer, either suffering from fatigue or perhaps trying to do too much on his own (note how his number of shots taken appears to grow larger as it got closer to the end of the game), or a combination of both. His shooting percentage for the last minute of each period was extremely poor, but that may just be a function of desperation shots to try to beat the buzzer in the last few seconds. But it deserves a closer look, particularly for the end of games…

Story Line #5: Was Kobe Really Clutch?

To be clutch or not to be clutch? In many professional sports, the concept of a clutch player is widespread. For those who don't know, a clutch player is someone who can perform under pressure or under the buzzer. In basketball, this moment often comes at the end of a game. Throughout his career, many people argued that Kobe Bryant was a horrible clutch player, some argued that he was the opposite, and others argued that he was a solid clutch player but fatigue often took over at the end of the 4^{th} period.

While there are many different measures of fatigue and interpretations of fatigue, in basketball, one's ability to make a jump shot might be a definition of this measure. After all, running up and down the court for almost four periods most likely affects a player's ability to jump and to maintain flawless shooting form, all things that make for a successful jump shot. Therefore, to examine whether Kobe was a good clutch player, we examined jump shots during the final seconds of regular season and post season games.

An interactive Tableau Dashboard was created for this story line to explore Kobe's end-of-game performance. The dashboard allows users to change the amount of seconds remaining in a game and then displays the shots on a virtual "court" while also displaying his corresponding shooting stats for that time period in a table to the side of the court. Being able to do this without having to switch between screens is extremely useful to an end user and during exploratory data analysis.

There were a few design elements that were key to making the visualization work. To help the data stand out, the court images were made to appear more transparent. In order to distinguish between shots made and missed, a color-coding scheme was implemented on the court consistent with the rest of the visuals—a red "x" signified a shot made while a blue one represented a missed attempt.

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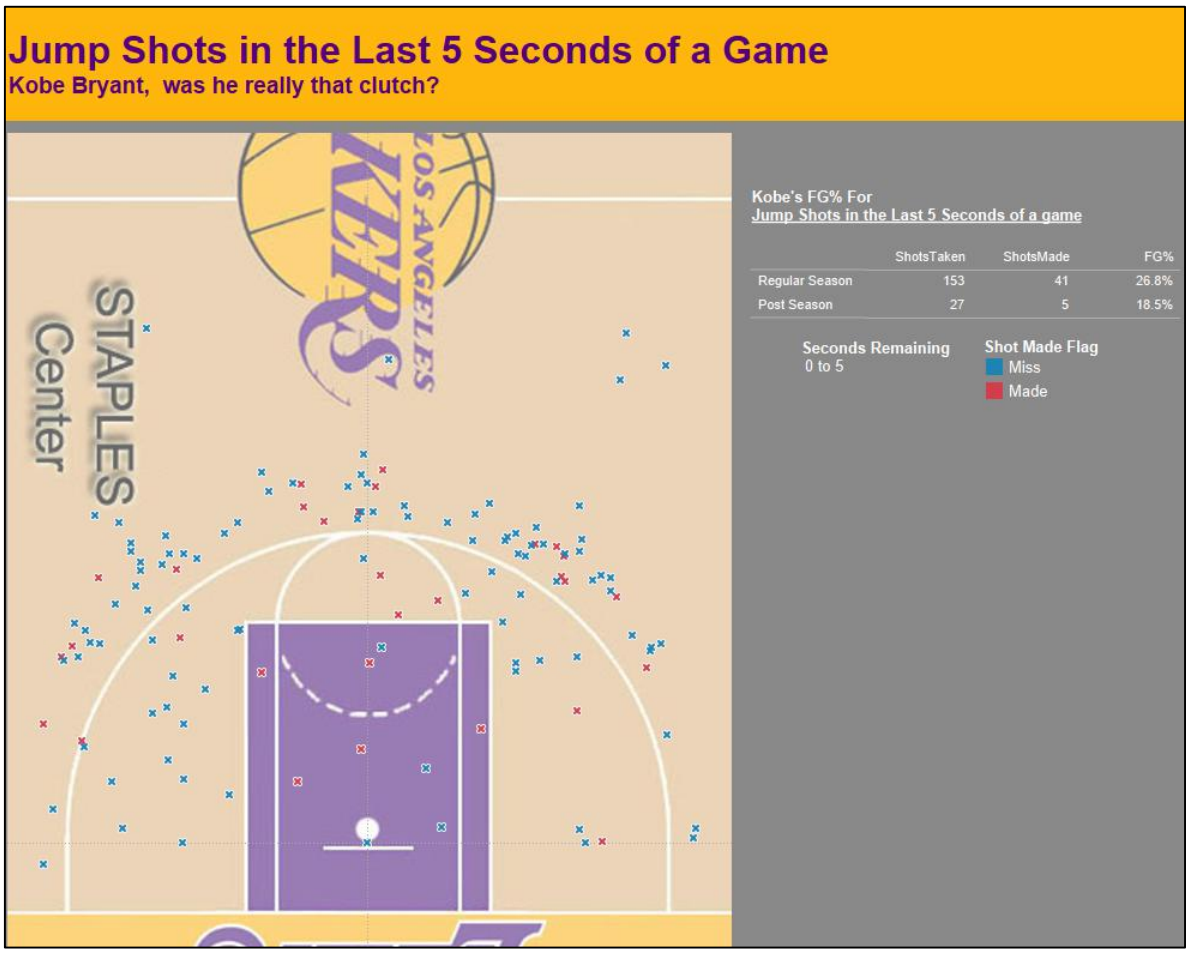
The following visualization represents a single selection from the dashboard, focusing on the last five seconds of a game to show there are far more blue symbols than red ones:



One of the elements included in the table of shooting stats was to break out regular season and post season games separately to see if there were any differences. While the sample size is much smaller, Kobe's performance in the last five seconds of post season games appears to be even worse than the already poor shooting percentage in those clutch regular season moments.

So, is Kobe really that bad in clutch situations? There is room for some debate. Undeniably, his consistently lower field goal percentage throughout the fourth quarter of games lends some support for making the assertion that he was not one of the game's clutch performers. Here is an instance where it would have been nice to have similar data available for some other players to provide a basis for comparison. However, the fact that Kobe's field goal percentage was low over the final minute of *every* quarter (and further analysis showed it was entirely a function of the final seconds of each quarter) suggests that there may be another aspect to the story. For quarters one through three, about half or even greater than half of his jump shots taken in the final 5 seconds were literally ones taken as the clock expired. Undoubtedly, many of these were desperation or forced jumpers simply trying to beat the buzzer, and it comes as little surprise that he would make a very low percentage of them. These literal buzzer-beaters comprised a smaller percentage of his fourth quarter jump shots with 5 seconds remaining or less (39%), but the same logic holds true. Still, with the game on the line and the clock ticking down, is Kobe the player you want with the ball in his hands? There seems to be plenty of evidence to suggest perhaps not.

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Conclusion

Putting all the story lines together, what do we have?

- An overall field goal percentage that was decent but well below the benchmark of the player almost unanimously considered the game's all-time best shooting guard (same position as Kobe), Michael Jordan, and was heavily reliant upon his athletic ability to get to the basket for dunks and layups
- A jump shot that was largely inconsistent over the course of Kobe's career with an overall field goal percentage below 40%; by comparison, Steph Curry's field goal percentage for this past season was 50.4%, and over half of his shots were 3-pointers!
- By playing his entire career for the Lakers, Kobe benefitted from a favorable schedule in which the majority of his games were against Western Conference teams, whose more open-court and up-tempo style was better suited to Kobe's game
- A clear drop-off in field goal percentage during the fourth quarter of games, suggesting he was not a great clutch player
- Further evidence to back this up by an examination of the final seconds of games—both regular season and playoffs—that displayed far many more misses than makes

Now, you don't become the NBA's third-leading scorer of all-time without possessing above-average ability. But a deep examination of the data through the visualizations we have presented challenges the notion that Kobe Bryant "defines" the position of shooting guard.

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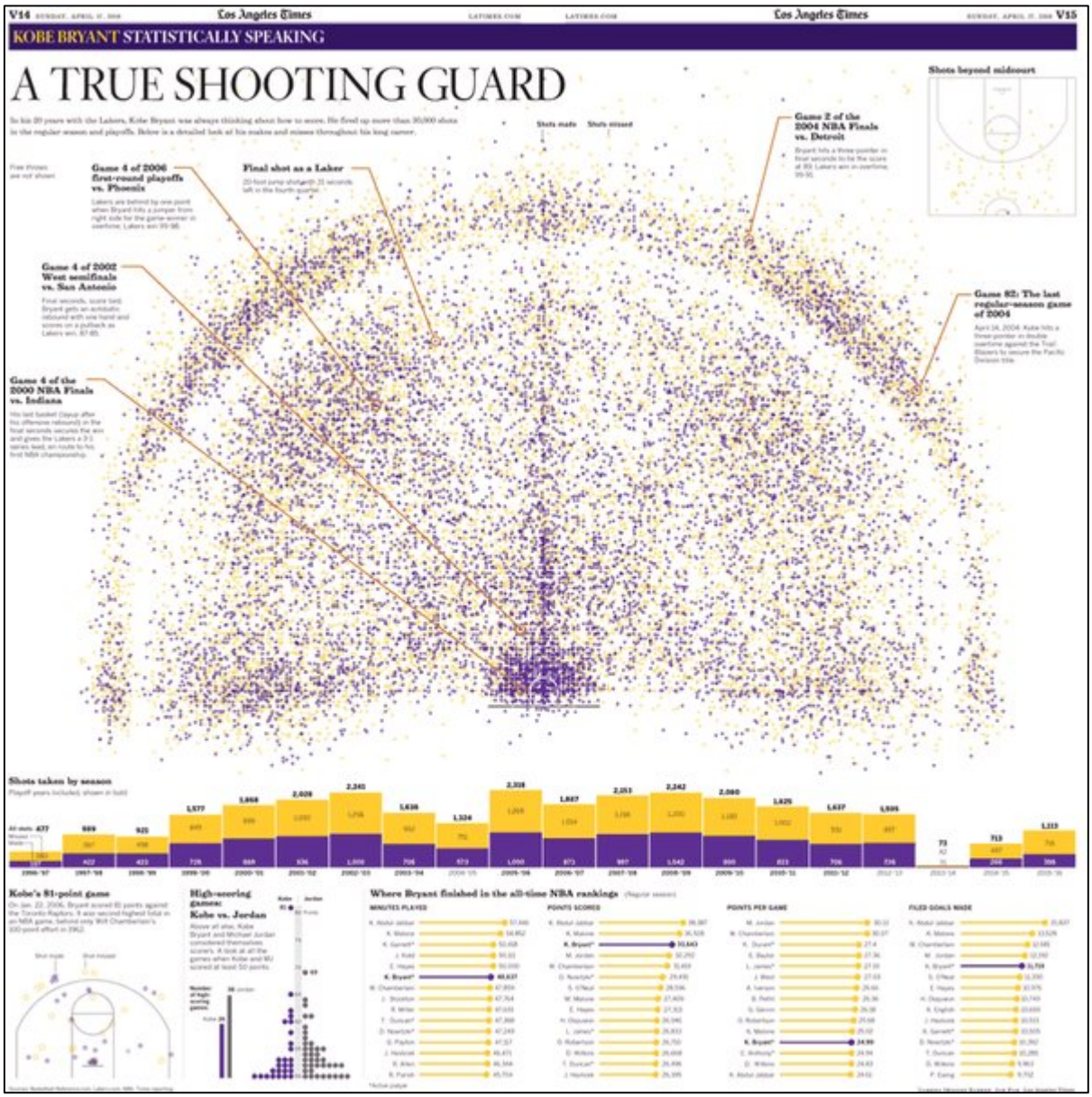
APPENDIX

Here is the LA Times infographic that at least initially helped to inspire this project:



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Exploratory Tables

A look to see how Kobe's shooting percentage varied by opponent over the course of his career:

		SORT	
Count of shot_id	shot_made_flag		
opponent	0	1	Grand Total
NYK	52.30%	47.70%	100.00%
VAN	52.94%	47.06%	100.00%
SAC	53.47%	46.53%	100.00%
POR	53.48%	46.52%	100.00%
GSW	53.54%	46.46%	100.00%
PHX	53.55%	46.45%	100.00%
TOR	53.60%	46.40%	100.00%
LAC	53.91%	46.09%	100.00%
DEN	54.22%	45.78%	100.00%
DAL	54.60%	45.40%	100.00%
SEA	54.76%	45.24%	100.00%
ATL	54.79%	45.21%	100.00%
NOH	54.95%	45.05%	100.00%
MEM	54.99%	45.01%	100.00%
PHI	55.06%	44.94%	100.00%
MIN	55.54%	44.46%	100.00%
UTA	55.57%	44.43%	100.00%
DET	55.88%	44.12%	100.00%
CLE	56.03%	43.97%	100.00%
SAS	56.35%	43.65%	100.00%
NJN	56.40%	43.60%	100.00%
CHA	56.40%	43.60%	100.00%
ORL	56.46%	43.54%	100.00%
HOU	56.54%	43.46%	100.00%
CHI	56.98%	43.02%	100.00%
MIA	57.06%	42.94%	100.00%
WAS	57.29%	42.71%	100.00%
OKC	58.11%	41.89%	100.00%
BOS	58.88%	41.12%	100.00%
MIL	58.97%	41.03%	100.00%
NOP	59.23%	40.77%	100.00%
IND	59.90%	40.10%	100.00%
BKN	60.00%	40.00%	100.00%
Grand Total	55.38%	44.62%	100.00%

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We can also examine how his shooting percentage varied minute-by-minute over the course of an aggregated "game":

Count of shot_id		shot_made_flag		
period	minutes_remaining	0	1	Grand Total
1	11	55.84%	44.16%	100.00%
	10	52.68%	47.32%	100.00%
	9	50.27%	49.73%	100.00%
	8	55.02%	44.98%	100.00%
	7	52.85%	47.15%	100.00%
	6	51.89%	48.11%	100.00%
	5	55.39%	44.61%	100.00%
	4	50.36%	49.64%	100.00%
	3	51.98%	48.02%	100.00%
	2	51.71%	48.29%	100.00%
	1	53.27%	46.73%	100.00%
	0	58.44%	41.56%	100.00%
1 Total		53.43%	46.57%	100.00%
2	11	56.64%	43.36%	100.00%
	10	58.42%	41.58%	100.00%
	9	49.83%	50.17%	100.00%
	8	57.38%	42.62%	100.00%
	7	50.77%	49.23%	100.00%
	6	51.81%	48.19%	100.00%
	5	50.89%	49.11%	100.00%
	4	54.44%	45.56%	100.00%
	3	52.42%	47.58%	100.00%
	2	55.35%	44.65%	100.00%
	1	54.15%	45.85%	100.00%
	0	62.90%	37.10%	100.00%
2 Total		55.12%	44.88%	100.00%
3	11	59.27%	40.73%	100.00%
	10	53.78%	46.22%	100.00%
	9	49.61%	50.39%	100.00%
	8	55.82%	44.18%	100.00%
	7	52.45%	47.55%	100.00%
	6	52.09%	47.91%	100.00%
	5	51.99%	48.01%	100.00%
	4	53.25%	46.75%	100.00%
	3	54.42%	45.58%	100.00%
	2	53.86%	46.14%	100.00%
	1	55.65%	44.35%	100.00%
	0	63.01%	36.99%	100.00%
3 Total		54.66%	45.34%	100.00%
4	11	58.54%	41.46%	100.00%
	10	55.29%	44.71%	100.00%
	9	59.95%	40.05%	100.00%
	8	59.23%	40.77%	100.00%
	7	50.36%	49.64%	100.00%
	6	56.01%	43.99%	100.00%
	5	55.18%	44.82%	100.00%
	4	60.28%	39.72%	100.00%
	3	60.03%	39.97%	100.00%
	2	60.97%	39.03%	100.00%
	1	58.65%	41.35%	100.00%
	0	64.03%	35.97%	100.00%
4 Total		58.63%	41.37%	100.00%
Overtime Total		55.52%	44.48%	100.00%
Grand Total		55.38%	44.62%	100.00%

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Kobe's field goal percentage varied considerably by the type of shot taken:

		SORT	
Count of shot_id	shot_made_flag		
combined_shot_type	0	1	Grand Total
Dunk	7.20%	92.80%	100.00%
Bank Shot	20.83%	79.17%	100.00%
Layup	43.49%	56.51%	100.00%
Hook Shot	46.46%	53.54%	100.00%
Jump Shot	60.89%	39.11%	100.00%
Tip Shot	65.13%	34.87%	100.00%
Grand Total	55.38%	44.62%	100.00%

Then it becomes important to see how the mix of his shots evolved over the course of his career:

Count of shot_id	combined_shot_type						
season	Bank Shot	Dunk	Hook Shot	Jump Shot	Layup	Tip Shot	Grand Total
1996-97	0.00%	4.82%	0.00%	63.31%	30.40%	1.47%	100.00%
1997-98	0.00%	8.39%	0.51%	65.62%	24.27%	1.21%	100.00%
1998-99	0.00%	6.84%	0.76%	72.42%	18.78%	1.19%	100.00%
1999-00	0.00%	6.21%	0.51%	74.13%	17.31%	1.84%	100.00%
2000-01	0.00%	6.48%	0.32%	75.11%	17.13%	0.96%	100.00%
2001-02	0.00%	5.92%	0.44%	73.77%	18.54%	1.33%	100.00%
2002-03	0.00%	6.07%	0.18%	77.64%	15.44%	0.67%	100.00%
2003-04	0.00%	4.52%	0.55%	69.17%	24.97%	0.79%	100.00%
2004-05	0.15%	4.53%	0.91%	71.53%	22.73%	0.15%	100.00%
2005-06	0.04%	2.85%	0.13%	79.29%	17.47%	0.22%	100.00%
2006-07	0.00%	3.71%	0.16%	77.27%	18.65%	0.21%	100.00%
2007-08	0.93%	4.83%	0.51%	74.18%	19.14%	0.42%	100.00%
2008-09	1.61%	3.26%	0.45%	77.65%	16.90%	0.13%	100.00%
2009-10	1.20%	2.21%	0.67%	77.93%	17.74%	0.24%	100.00%
2010-11	1.53%	2.30%	0.66%	81.75%	13.32%	0.44%	100.00%
2011-12	0.92%	2.50%	0.49%	83.45%	12.22%	0.43%	100.00%
2012-13	0.38%	3.33%	1.00%	76.27%	18.58%	0.44%	100.00%
2013-14	1.37%	1.37%	1.37%	79.45%	16.44%	0.00%	100.00%
2014-15	0.56%	0.98%	0.28%	84.85%	13.04%	0.28%	100.00%
2015-16	0.27%	0.45%	1.17%	88.77%	9.34%	0.00%	100.00%
Grand Total	0.46%	4.19%	0.50%	76.51%	17.75%	0.60%	100.00%

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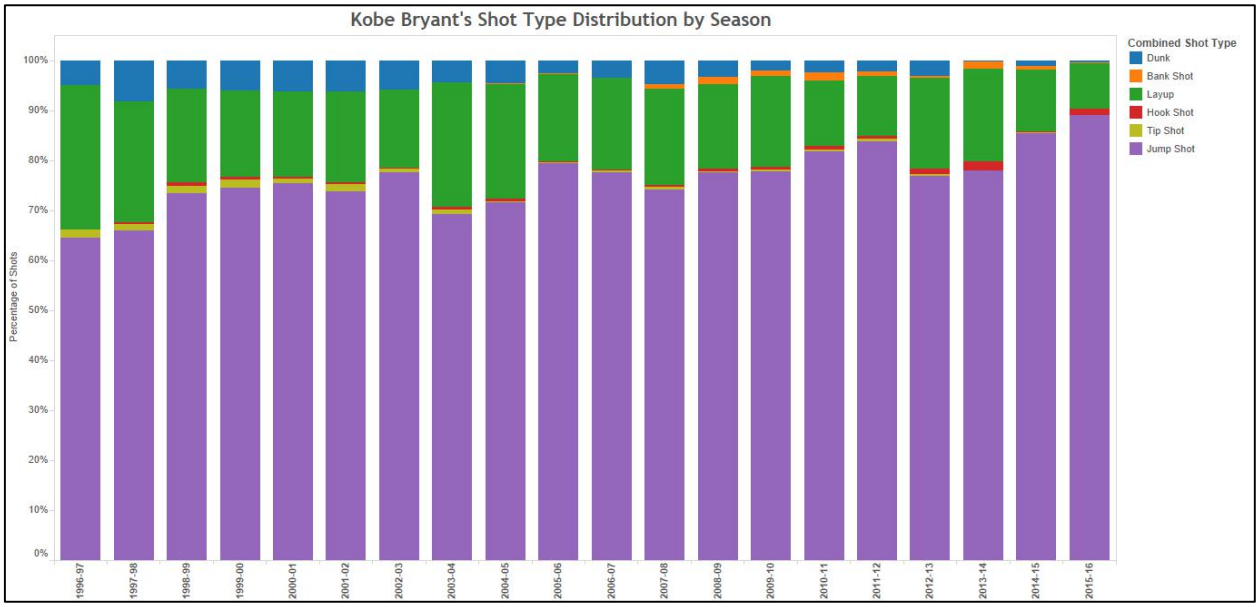
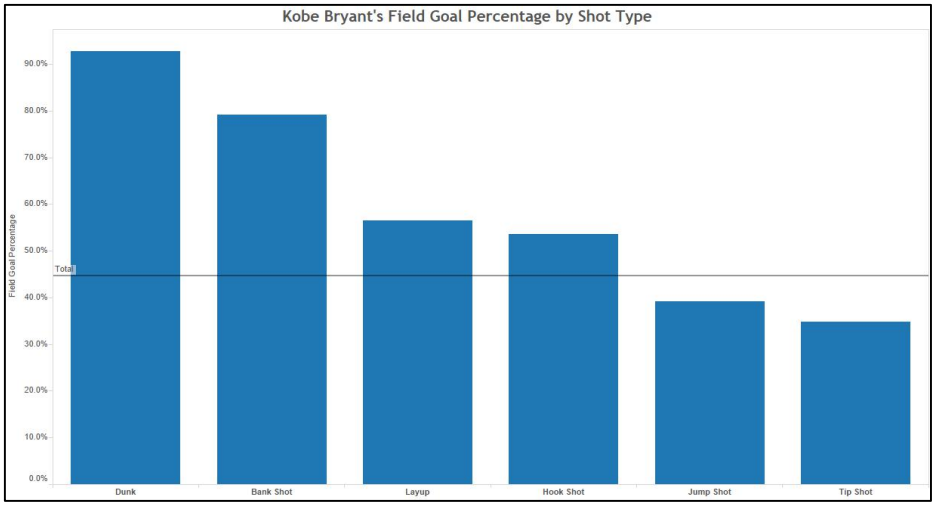
Exploratory Visualizations

Kobe's mix of shots by type for each season seemed to lend itself perfectly to a stacked vertical bar chart:



Kobe's field goal percentage by different shot types:



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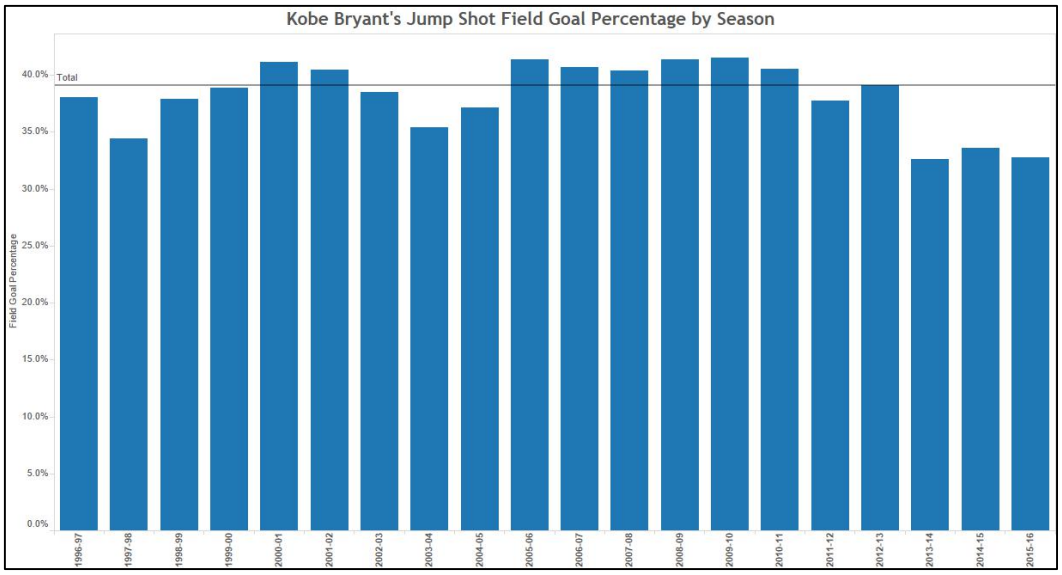
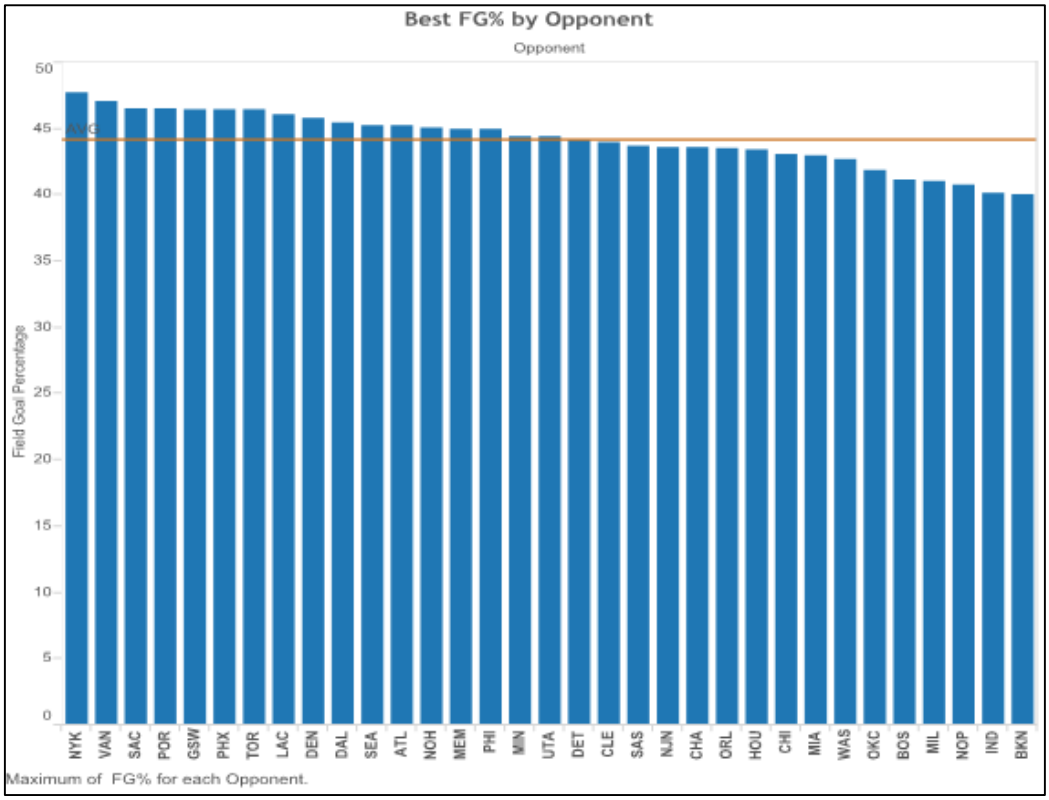
His field goal percentage for jump shots only:



Kobe's career field goal percentage against opponents, ranked from best to worst:



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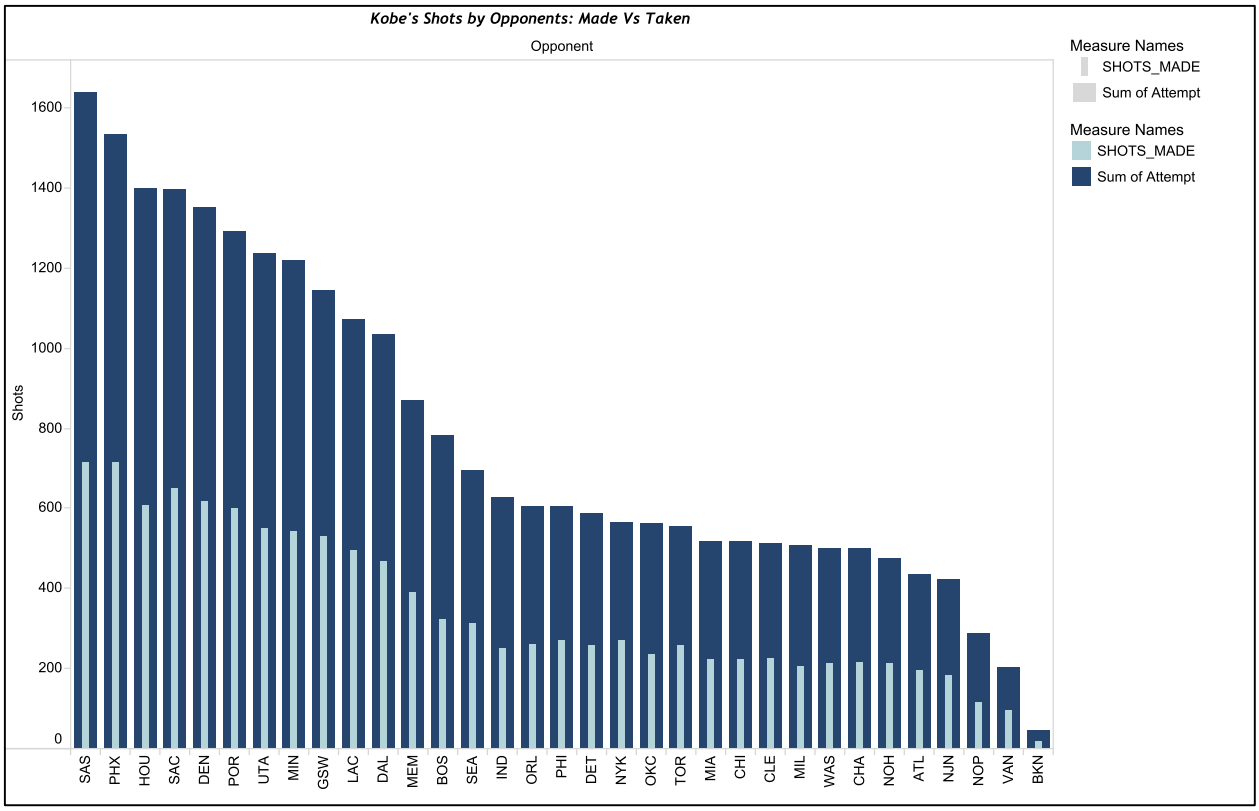
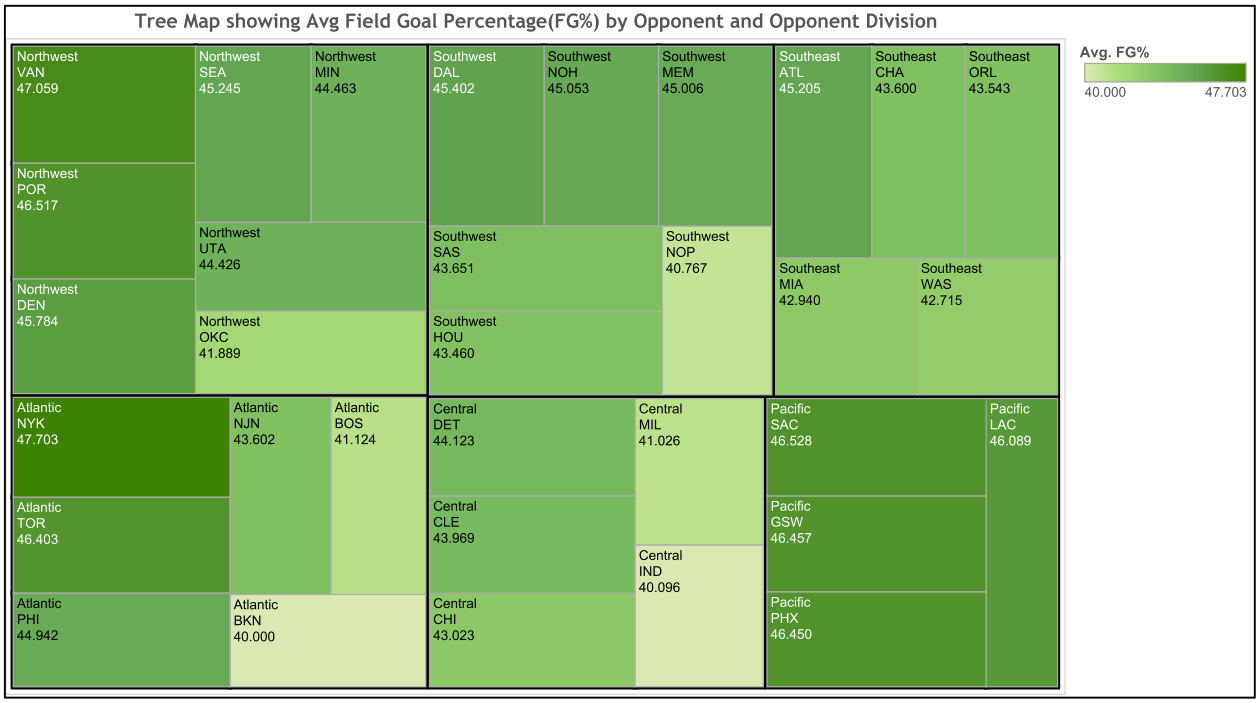
Shots made vs. taken by opponent:



Tree map of average field goal percentage by opponent and division:



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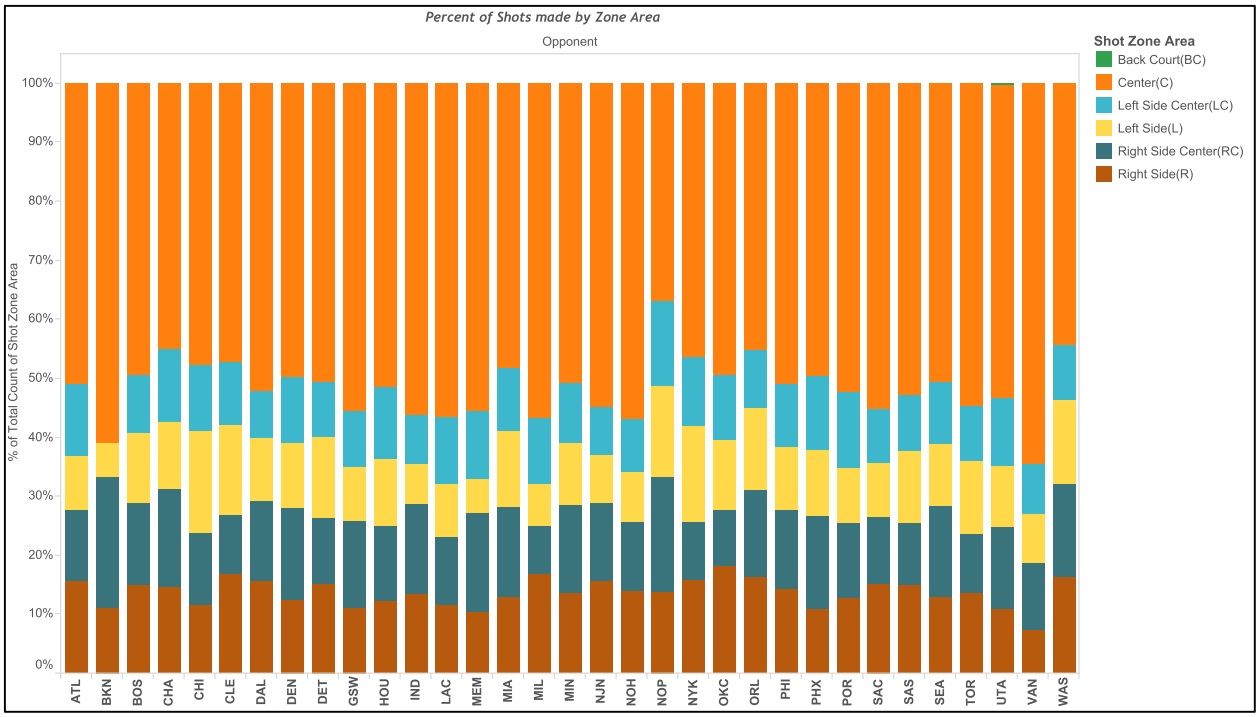
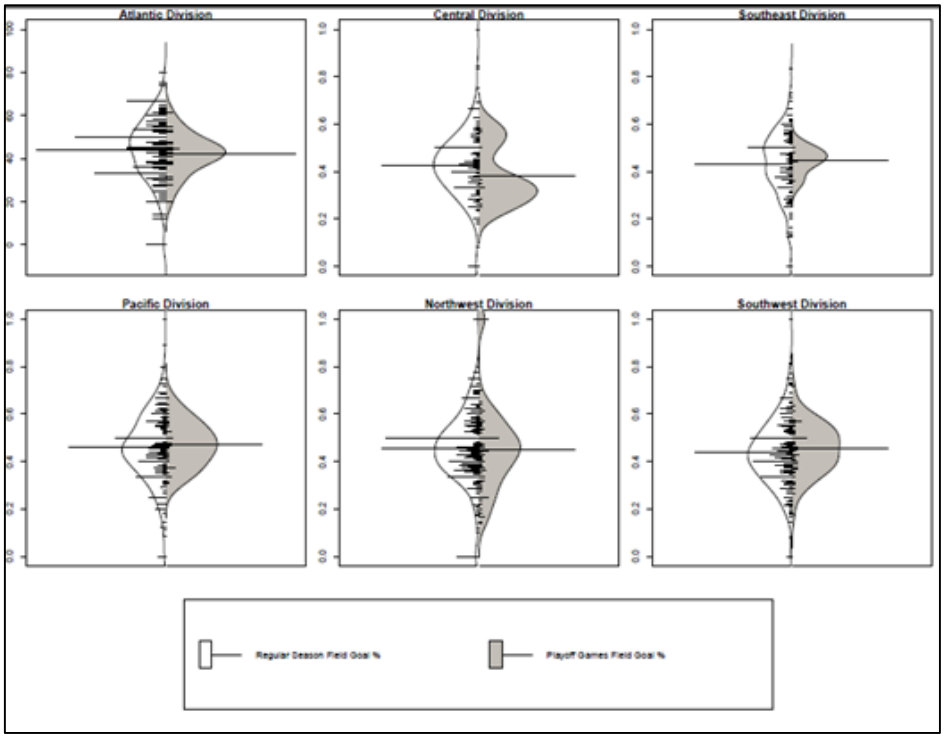
Percent of shots made by area:



Bean plots of field goal percentage by division, regular season and playoffs:



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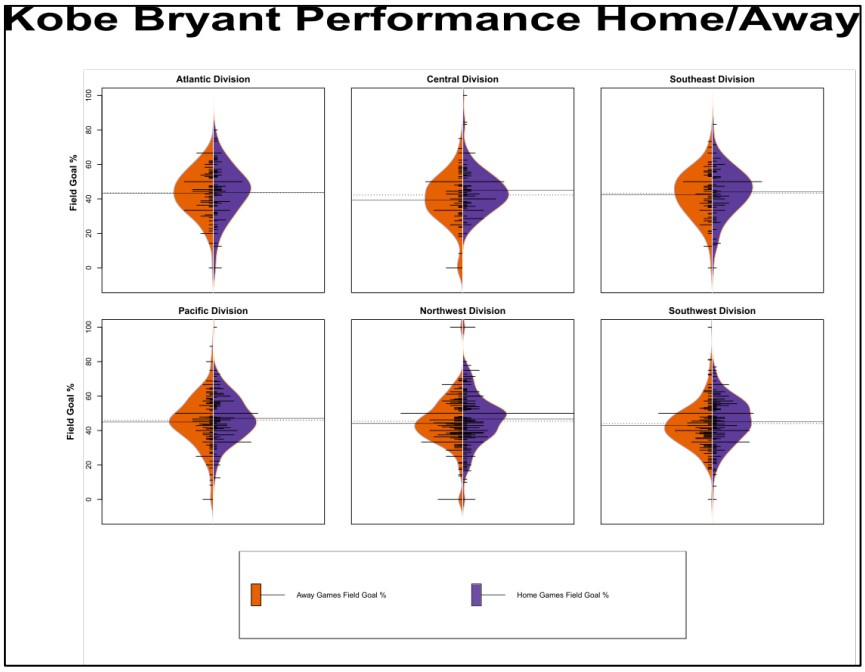
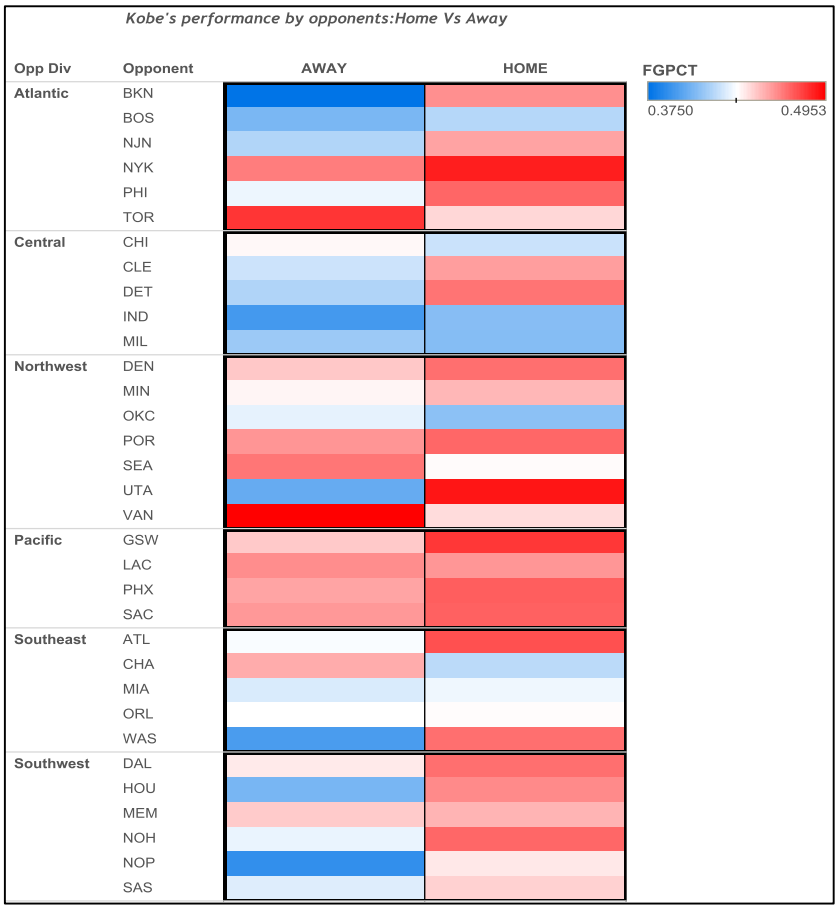
Bean plots of Home vs. Away Field Goal Percentage:



Kobe's field goal percentage against opponents, broken out by Home versus Away:



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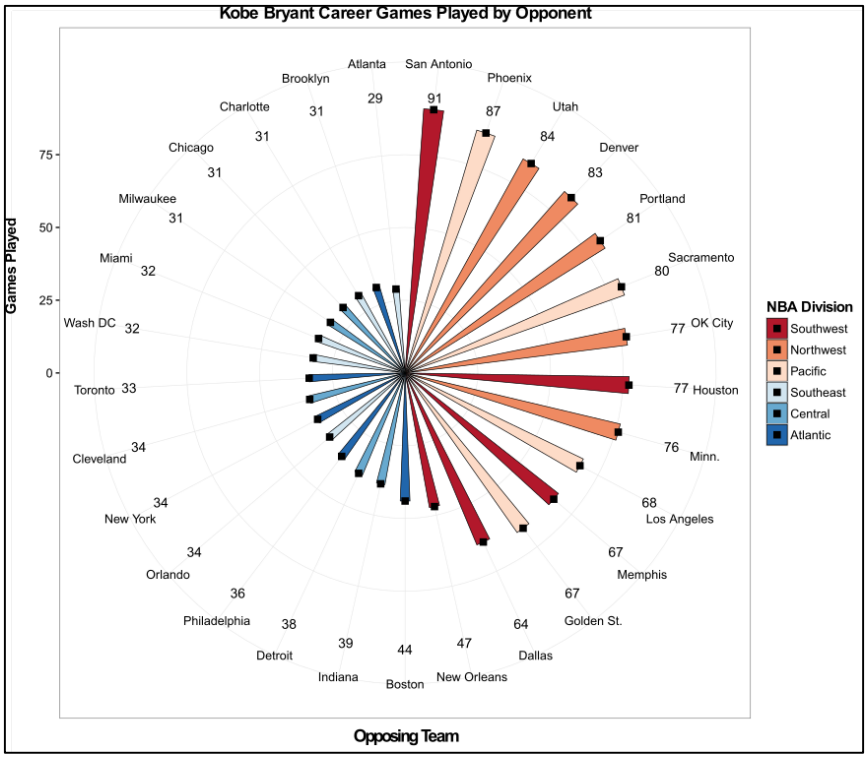
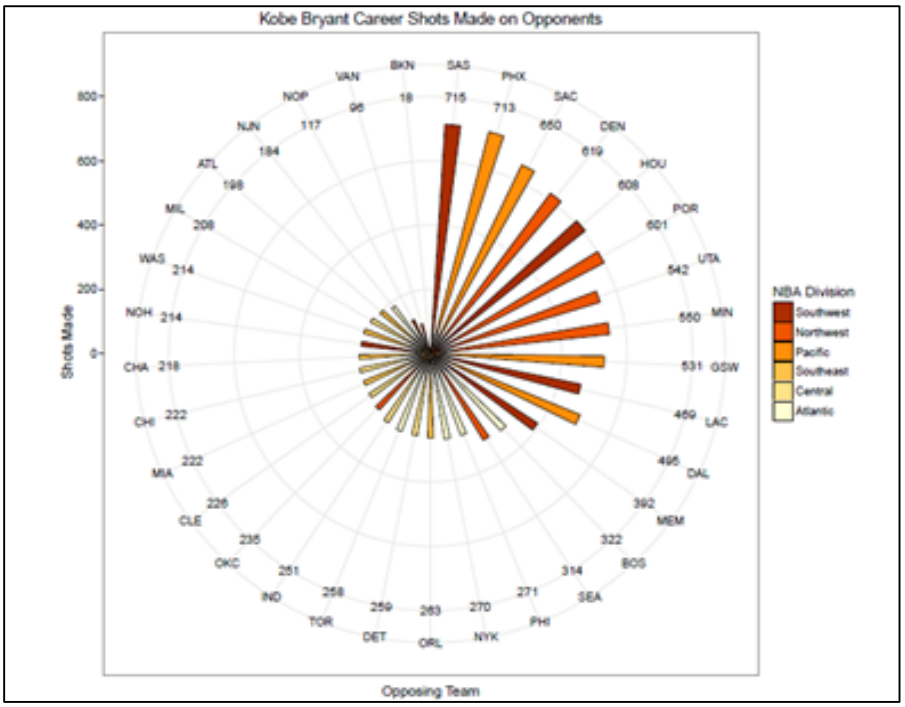
A radial plot of games played against each opponent:



Radial plot of shots made by opponent:



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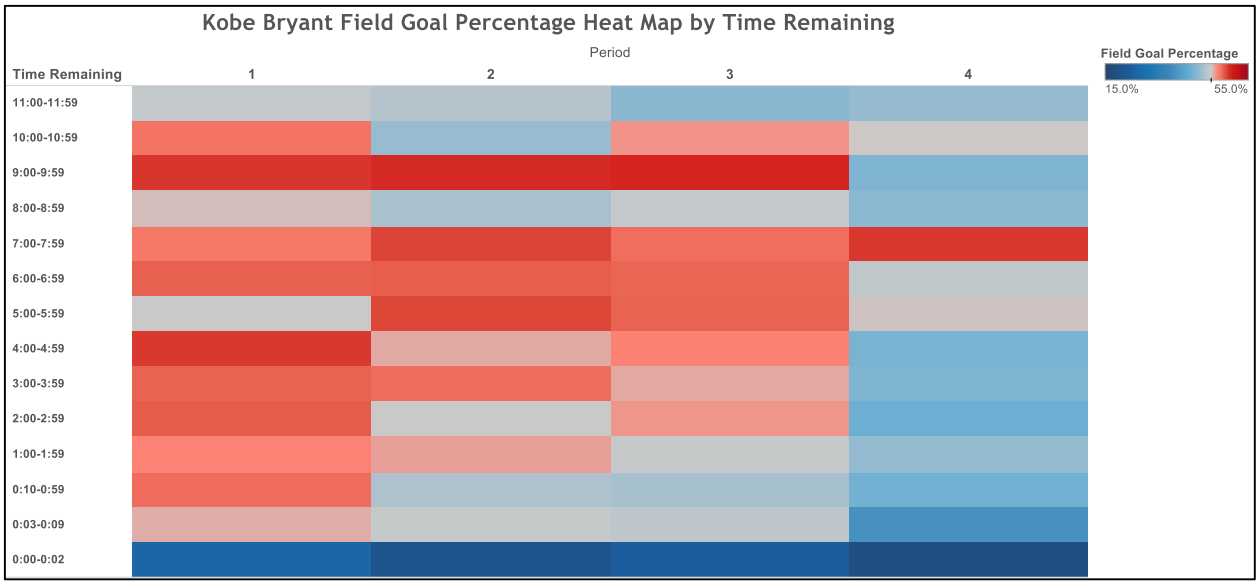
A field goal percentage heat map by time remaining in each quarter:



Similarly, a shots taken mosaic broken out by time remaining within the quarters:

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INDIVIDUAL REPORTS

Brunda Chouthoy

Among the different storylines we created for our project, I chose to work on exploring and creating visualizations to evaluate Kobe's performance against different opponents. The NBA is divided into Conferences and Divisions. There are two Conferences, the East and the West. There are three divisions in each Conference. In the East, there are the Atlantic, Central and Southeast divisions. In the West, there are the Pacific, Northwest, and Southwest divisions. Each division has five teams, so Kobe and the Los Angeles Lakers had twenty-nine competitors to play in any given year.

In terms of analyzing how Kobe fared against opponents, several different metrics and dimensions are useful. The first useful metric, field goal percentage, shows the percentage of shots made vs shots taken. During the initial exploratory phase, I identified that Kobe's field goal percentages were higher against Western conference teams. The Western conference has a reputation of playing a more open, offensive oriented game. Whereas the Eastern divisions tend to play defensive, hard fought games that often result in lower scoring than their Western counterparts. As a result of the initial exploratory analysis, I worked to build several visualizations to show Kobe's performance, in terms of field goal percentage, against different individual teams and the conferences as a whole.

I started with an initial graphic that visualizes the percentage of shots made. This visualization differed significantly based on which team Kobe played. Kobe's results against half the teams was above his average (as one would expect of an average). It was apparent that the majority of the teams where Kobe had results above his overall average were in the Western Conference. Where, in general, offense is stressed more than defense. However, Kobe's highest field goal percentage was against the New York Knicks – Kobe always got up for playing New York. Furthermore, I worked on creating a tree map of nodes to compare the field goal percentage over different opponent divisions and opposing teams. This visualization did a good job at telling the story of Kobe's performance and how often he played against particular teams and divisions.

After looking at tree maps for the data, I worked on an exploratory visual that highlights the number of shots taken and made against every opponent throughout his career. As I investigated this visualization, I was looking for patterns that illuminated key performance differences. Initially, I created a side-by-side bar graph which was later revised to a 'dual axis' bar graph with overlapping bars. I used a dual axis in order to show both the shots made on one of the y-axis and shots taken (attempted) on the other and synchronized axis to improve readability. Again, the higher blue bars (shots taken) and smaller bars (shots made) are generally against west conference teams. Further, while working on this exploratory visualization, I examined the variable 'shots zone area' to examine the total percent of shots made from different shot zone areas against every opponent. It can be seen that Bryant was highly dominant and had highest percent of shots in the center zone area against every opponent.

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For my portion of the group project, the storyline revolves around Kobe's performance against other teams throughout his career. After the exploratory visualization phase, I came to the conclusion that traditional heat maps are a terrific way to examine Kobe's performance in home vs. away games and his performance against different opponents. While heat maps may appear to be simple, it took many modifications to deliver the final product. The visual highlights the differences in field goal percentages of home versus away games and we can see a clear pattern that Kobe shoots better at Home games - there are mostly reds (higher percentages) for home games.

After executing the project, I determined that it would be useful to illustrate Kobe's field goal percentage (which is considered the most important metric to evaluate performance in basketball) against all the opposing teams on a U.S map using a geographical "glyph" scatterplot.

Most of the red circles (higher percentages) reside in the Western portion of the U.S., implying Kobe tended to have his better performances against Western Conference teams. This is significant because teams play a much larger percentage of their games against teams from their own conference.

One of the biggest takeaways from this project was that though visualizations are easier to understand and look more attractive to the audience, it is crucial to achieve a perfect balance between visual appeal and functionality. A beautiful presentation which fails to emphasize relevant data or is not clear enough is of little value. For that reason, it is highly important to clearly present the data in a manner which is aesthetically appealing without being overwhelming.

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John Misailedes

The role I played on the team: Our project team is composed of veteran MSPA students who have multiple group projects under our belt. As such, we collaborated very effectively on the overall objectives and named the most senior student our group leader. Our chosen data set was Kobe Bryant's career shots taken and made, which we pulled from a current Kaggle project. Craig had drafted an initial list of possible 'story lines' to explore, and we divided these up (per instructions) into two subgroups for further exploratory work. Four of these story lines (two per subgroup) proved viable and my subgroup focused on a story line evaluating his performance against opponents and another focused on whether he performed well in clutch situations or instead showed signs of fatigue.

My focus within our subgroup was on visualizations using ggplot2 in R Studio. My subgroup-mates were focused primarily on Tableau, but I liked the customization possible with ggplot. I also took notes for our group lead while he led our calls, and coordinated with my team-mates on logistics, technical, and creative reviews. Because I was digging into coding in ggplot, I started exploring shiny and bokeh – two interactive java script libraries that result in html pages with interactive visualizations.

The Specific Visualizations I worked on: Once we moved past our exploratory phase there were two main visualizations I wanted to develop. The first is a radial plot showing the number of games Kobe played against each of the other 31 NBA teams (in six total divisions). The purpose of this visualization was to make it clear to a general audience that professional sports teams in general, and the NBA teams specifically, do not play all opposing teams the same number of times. In fact, Kobe and the Lakers played some of the teams 3x more than other teams. This led to significant findings in our exploratory work. We wanted to set the stage for these findings by first highlighting the disparity in the number of times he competed against (and thus his familiarity with) each NBA team. So as I reviewed this very simple subset of data (game totals for each of the opposing teams) I went back over my notes to identify all possible appropriate visualization forms. Certainly a stacked bar chart would have been a great choice to show the six divisions, and six teams within each – and this was a relevant dimension because we found differences at the division and even conference level reflected by how many games they had played.

A great deal of our exploratory work had been bar and stacked bar charts, and I was eager to use a more unique approach. I reviewed the radial plot and studied its implementation in ggplot. Basically it's a simple bar chart with the addition of + coord_polar(). So the science of the plot was simple, the art would be combatting its biggest weakness – **The Area Problem**. Because of the distortion caused by the bars being redrawn in radial form, a taller bar has disproportionally more area than a bar with a lower y value. While not as severe as it is with circles in a bubble chart, (where doubling the radius will quadruple the area) the area problem is certainly present in the vanilla implementation of the radial plot. There is even a warning about it in the R Graphics Cookbook, in section 8-16. I decided to at least take a look and see what I thought. The root problem is that there is not a parameter to control the area of the bars. The height is a frequency count, or, to reflect a data value you use stat="identity". The width is controllable via a numeric setting, but this is applied prior to the coord_polar() command. The result of rotating the bars is thus inherent distortion of the area of the individual bars. Once complete, I liked the visualization because it appeared reminiscent of a dart board, and I imagined

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Kobe throwing darts accurately at each opponent over his career. I liked it because it really brought out the significant differences in game counts by division and team. But the area . . . what to do? I ended up deciding to combine two ggplot geoms, bar and point, to place a plotted point on the end of each bar. By placing an absolute point on the end of each bar, with each point having the same size, the amount of distortion of any bar became readily apparent. The bars themselves became secondary to the points, basically their encoded value was focused on color (indicating division) rather than size/area (indicating # games played). I liked it. Unfortunately we elected to trim our visuals down and chose not to include this plot in our final presentation or paper.

The second visualization I developed was a two-sided bean plot, showing a drill down to the next point in our story line – that Kobe's performance differed significantly when playing at home versus playing away games. We elected to use a heat map from another team member instead of that.

Reflections on what I learned: I learned the taxonomy of visualization – and a great deal about each of several approaches to visualizing various forms of data. I learned there are ways to articulate the attributes, strengths and weaknesses of a visualization beyond "good" and "crap". I came in aware of the most common ways to mislead a viewer, but was introduced to some subtle variations as well.

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Kiron Mishra

At the beginning of the project, our group met via a Google hangout. Prior to the hangout, I had experimented with a few visualizations regarding Kobe's shots and attempted to create some shot charts overlaid on images of a court. I started with just a single game just to be able to start to utilize Tableau and figure out the different data variables. It also took some time to figure out the scaling with images and the dimensions of the actual basketball court. I immediately decided to throw out back court shots because it would skew the visualization and there are so few shots taken from that area. During the hangout, it was discussed that Craig and I would work on two parts of our storyline. Since I was already making some headway on the shot charts, it was decided that I would continue along that path. I also volunteered to present alongside Brunda since I live in the suburbs.

With regards to the shot charts and the data that I was looking at there, I decided to look specifically at jump shots. The reason being, in my original exploratory analysis, I noticed that including layups, tip-ins, dunks, hook shots, etc., all skewed the data. It made him look like a much better shooter. These are all shot types that are usually within 3 feet of the basket. As a result, you'll see the hex directly under the basket in my images appear quite small.

Creating the images with the hexes was initially a hard thing to do because I had to first figure out the meaning of the coordinates given for the shots. After I managed to figure that out, I then had to figure out how to appropriately bin the shots. The shots had to be binned on an aggregated basis of shots made versus shots taken. Once I was able to accomplish this, I had determined a scaling factor for the hexes that didn't overcrowd the court but had a high enough data to ink ratio. I was also able to assist Samantha with the use of the background image and the making of the shot charts after having gone through a few trial and errors.

Looking at the jump shots through hex plots overlaid on a court and also coloring the hexes as a heat map by Field Goal % allowed for an easy comparison. It's clear to see how the shot taking and accuracy changed based on the seasons chosen. There were different scenarios for seasonal comparisons. For example, there was a look at different seasons based on Championship appearances or based on the players on Kobe's team.

Certain star players can also have a bigger impact on a team. For example, Kobe's shot chart differs when he played the last 3 years with Shaq versus the 3 years immediately without him.

You can see in the shot charts that Kobe's shots are more accurate in the years after Shaq left. It's possible that in an effort to show himself as a #1 option, Kobe would throw up more ill-advised shots when with Shaq. His shot selection is clearly better after Shaq left, perhaps a sign that

Another potential avenue to look at (although I didn't thoroughly examine it because we didn't want to go too many ways) was to look at the coach of Kobe's team to see the impact on his shot chart.

Throughout the project, I learned that data visualization is about a lot of small manipulations. Even the small manipulations can have huge impacts on a visual. For example, the color range that I used for my visualizations has a great impact on the appearance of Kobe's shooting ability. At first, I used a scale from 0 to 100 and marked a good shooting percentage at 50%. This made Kobe look like an absolutely awful shooter. However, setting the shooting percentage too low (at 40%) to account for 3-point shots made the visual appear

homogenous. It took some fine tweaking on the color scales to represent the distribution of field goal percentages (that were in line with the NBA averages). Not only was the scale important, but the colors themselves are quite important for a viewer. While I originally had the visuals show a purple and gold color scale to mirror the colors of the Los Angeles Lakers (the team he played for), this scale doesn't help the viewer. I switched to a blue and red scale to represent "hot" and "cold", a relationship the viewer can imply from the image and could also be familiar with from other scenarios in society.

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Craig Stanek

The role that I played for the project included the following aspects:

- Selection of the data set
- Nearly all of the data exploration, which included numerous Excel pivot tables and several initial visualizations in Tableau
- Initial development of all the story lines, including outlines of key findings from data exploration phase and suggestions of other areas to pursue with a deeper dive into the data
- Gathered all of the examples of other similar types of visualizations from the web
- Wrote the majority of our team's 23-page submission for the group portion of homework assignment #3
- Constructed the visualizations that wound up representing story lines #1 and #4 for our group's presentation and report
- Combined all of the individual subgroup submissions of visualizations into a single, cohesive presentation deck
- Along with John, met with the instructor by phone during office hours to review our presentation deck in order to gain some feedback prior to the actual presentation during the final week of class
- Wrote the draft version of our group's report, incorporating submissions from team members for their respective assigned story lines
- Constructed the final report, which included incorporating all of the revisions to the draft document, inserting each group member's individual report, and assembling the code written
- Also was the only online student to provide feedback for every other group's presentation by the end of the weekend immediately following the in-class session so that they would have sufficient time to incorporate this constructive criticism into their final report

As alluded to above, the specific visualizations that I created were the following:

- Kobe Bryant's Shot Type Distribution and Field Goal Percentage by Season (story line #1)
- Kobe Bryant Shot Contingency Table by Minute Within Period (story line #4)

In terms of what I learned about data visualization from this project, there were several things. First and foremost, it is *very* detail-oriented. Every seemingly little decision can affect how the information is received by the audience: proper font sizes, setting the range for an axis (including the very important choice for the center point when using a diverging color scheme), and consistency in choice of colors to reinforce meaning throughout a deck being worked on by multiple people (e.g., red signifying "hot" and blue for "cold") are a few things that immediately come to mind.

Next, it truly is an iterative process with lots of trial and error. Some of this is the result of trying to figure out how to do things with either R or Tableau. For example, my first visualization was done with Tableau. It seemed pretty simple in its concept—start with a stacked vertical bar chart as the base and then "just" insert a couple of lines on top of it—but it took MANY repeated attempts to figure out how to finally make it work. But just getting to the point of the concept for creating that visual was a process that played itself out in stages … first, analyze the data with some Excel pivot tables to get an initial feel for the data, then create some basic plots to gain a better visual perspective and begin to understand how some of them relate to one another. Even after then devising a way to tell the story with a single visualization, there is still a fine line between seeing how

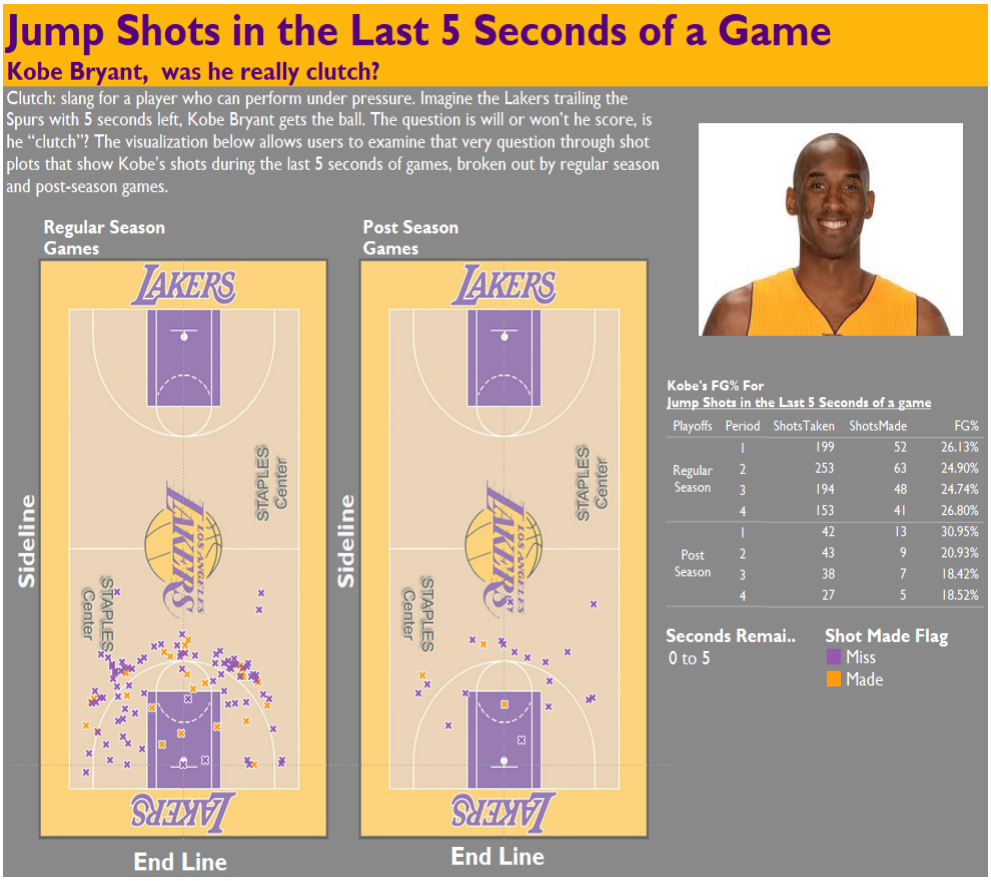
everything interacts and making things too complicated for the viewer to be able to perceive the information properly. And, again, there are still details to add … ok, we can see that Kobe Bryant's field goal percentage season-by-season doesn't *seem* to be at a superstar level, but how does it compare to other similar players? So a benchmark of Michael Jordan's career field goal percentage is added to provide that perspective.

The last thing I would add is not necessarily something that I'd say that I learned but rather a concept that was reinforced about data visualization. And that is: no matter how pretty and proper a visualization is—even it's using the fanciest techniques in the best manner possible—it is useless if it does not accurately and properly represent the data. In other words, there is no substitute for knowing the data first and foremost. Part of this can be a function of domain knowledge, but it also means keeping in mind statistical concepts and being willing to continually dig deeper into the data in order to uncover the true story. During our work, there were some nice visualizations constructed that had to be discarded because they were based on small sample sizes. The initial evidence of Kobe's very poor field goal percentage for shots in the last minute of every period suggested quite emphatically that he was not a good "clutch" shooter. A deeper look revealed that a very large proportion of his last-minute misses were literally shots taken to beat the buzzer, suggesting they were desperation or forced shots that only meant when the clock was running down, the Lakers looked to Kobe to get off whatever shot he could (and his opponents likely knew he would be getting the ball as well).

Kobe Bryant: "A True Shooting Guard" … Or Was He?

By: Brunda Chouthoy, John Misailedes, Kiron Mishra, Craig Stanek, Samantha Stanley

Samantha Stanley



To be clutch or to not be clutch? In many professional sports, the concept of a clutch player is wide-spread. For those who don't know, a clutch player is someone who can perform under pressure or under the buzzer. In basketball, this moment often comes at the end of a game. Throughout his career, many people argued that Kobe Bryant was a horrible clutch player, some argued that he was the opposite, and others argued that he was a solid clutch player but fatigue often took over at the end of the 4th period.

While there are many different measures of fatigue and interpretations of fatigue, in basketball, one's ability to make a jump shot might be a definition of this measure. After all, running up and down the court for almost four periods most likely affects a player's ability to jump and to maintain flawless shooting form, all things that make for a successful jump shot. Therefore, to examine where Kobe was a good clutch player I examined jump shots during the final seconds of regular season and post season games. Furthermore, I examined field goal percentage across periods for jump shots over the course of Kobe's career.

The Tableau Dashboard that I created for this part of the project is interactive in nature. The dashboard allows users to change the amount of seconds remaining in a game and then displays the shots on the appropriate courts. Additionally, when the user modifies the seconds remaining parameter, the stats for Kobe's jump shots update as well. To help the data to stand out, the court images were made to appear more transparent. Furthermore, the axes were relabeled to represent parts of a court rather than using numerical values. This was done because having 500 at center court makes little sense to any audience as the images weren't mapped to the actual dimensions of a basketball court. Furthermore, in keeping with the theme of the Los Angeles Lakers, I decided to map the Laker's colors to the shot made flag value. Given that purple and yellow do not intuitively map to either a made or missed shot, the filter was added to the dashboard to help users better

understand the visualization. Furthermore, given that the entire dashboard is interactive, the user can select either made shots or missed shot (or both) to display on the courts. Being able to switch between these values and to modify the second's remaining without having to switch between screens is extremely useful to an end user and during exploratory data analysis.

After creating the court plots, I determined that it would be useful to have an actual chart of Kobe's FG%'s by period and by season type. While the court plots provide the user with a great visualization it can be more difficult to ascertain direct conclusions from the data. The FG% chart helps the user to do just this. From this chart it was clear that Kobe tends to shoot more jump shots in the 2nd period than in any other period throughout the regular season. However, end users must be careful to remember that we are looking at clutch moments which typically only occur at the end of a game. Therefore, we really want to focus on the last few seconds of the final period. When we do this it appears that with 5 seconds left Kobe's numbers are higher than the FG% of other periods. However, if you reduce the seconds remaining to 2 (the clutch situation) Kobe's 4th period FG% is the lowest of any other period during the regular season. Furthermore, if you drill down to all jump shots taken in the last second of the game Kobe's FG% is a low %17.39.

Fg%

Playoffs	Period	ShotsTaken	ShotsMade	FG%
Regular Season	1	4,380	1,798	41.05%
	2	3,628	1,410	38.86%
	3	4,572	1,794	39.24%
	4	4,008	1,467	36.60%
Post Season	1	725	314	43.31%
	2	634	255	40.22%
	3	770	324	42.08%
	4	748	249	33.29%

ShotsTaken, ShotsMade and FG% broken down by Playoffs and Period. The data is filtered on Combined Shot Type, which keeps Jump Shot. The view is filtered on Period, which keeps 1, 2, 3 and 4.

So, is Kobe really that bad in clutch situations? To answer that question we need to examine Kobe's FG% over the course of entire periods and games. The chart to the left shows Kobe's FG% for each entire period by season. From this it is clear that Kobe has more successful shots in the 1st and 3rd periods. Intuitively this makes sense as he is unfatigued in the 1st period and has half time to recuperate before the 3rd period. Even if you examine Kobe's jump shot FG% between the more fatigue plagued periods, 2nd and 4th, it's quite clear that Kobe does worse during the final period than any other period. Furthermore, if you look at post season games Kobe has higher FG%'s than he does during the regular season for every period except for the 4th period.

FG%

Playoffs	Period	ShotsTaken	ShotsMade	FG%
Regular Season	1	199	52	26.13%
	2	253	63	24.90%
	3	194	48	24.74%
	4	153	41	26.80%
Post Season	1	42	13	30.95%
	2	43	9	20.93%
	3	38	7	18.42%
	4	27	5	18.52%

ShotsTaken, ShotsMade and FG% broken down by Playoffs and Period. The data is filtered on Combined Shot Type, Minutes Remaining and Seconds Remaining. The Combined Shot Type filter keeps Jump Shot. The Minutes Remaining filter ranges from 0 to 1. The Seconds Remaining filter ranges from 0 to 5. The view is filtered on Period, which keeps 1, 2, 3 and 4.

If only regular games were examined, it might be easy to conclude that Kobe suffered from fatigue in clutch moments of a game rather than simply being a bad clutch player. A lost game during the regular season is not season ending, however, it can be during the post season. Subsequently, the clutch moments during the final seconds of the 4th period are far more important than those taken during the regular season. To say that the pressure is on, is perhaps an understatement. In the entire 4th period of the post season, Kobe's FG% is %3.31 lower than his FG% of the regular season. As if that wasn't grim enough, when examining the final 5 seconds of the 4th period, Kobe's post season FG% is a whopping %8.28 lower than his regular season percentage.

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Kobe Bryant is one of America's more well-known basketball stars of the millennial generation who should be remembered as a great player. However, a clutch player he was not. While one could argue that fatigue may have contributed to Kobe's lack of success in the final moments of a game, it is more likely that he doesn't perform well under pressure.

When creating this visualization, I strongly felt that you could present the data in a visually appealing manner. Using color and the courts to plot the data is not only visually appealing but it is also useful in presenting this dashboard to a non-technical audience. Furthermore, I learn that the rules of data visualization are not steadfast and that some rules are made to be broken. If you made a scatter plot on a plain coordinate plane it would have significantly less meaning than it does in the context that I presented it. Furthermore, it became evident how important the audience is in the creation of the visualization. Had this visualization been for a technical audience I may have avoided the use of coloring and images. However, because the likely consumer of this data might be someone with less technical expertise, it was important to make the visualization both appealing and informative.

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CODE

Most of the work surrounding our visualizations used in this report was done in Tableau, which by nature did not really require any accompanying code. However, there was R code used to create some of the exploratory visualizations and as indicated in his individual write-up, John did some pretty cool work with Python, Bokeh, and HTML. Per an e-mail discussion on June 9, all of this code was submitted separately as an additional zipped attachment.