A Simple Visualization Tool for NBA Statistics

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Figure 1: How four teams compare to league average from 1996 to 2016 in effective field goal percentage.

Introduction

Sports analytics has become widely utilized over the past two decades to determine a team's or player's effectiveness. The main drawback is that most publicly available sports statistics are in the form of spreadsheets with hundreds of numbers, requiring page reloads in order to view a different set of statistics, and often do not support dynamic queries. Determining trends from the data should be as simple as seeing a decreasing line graph over time generated from a few finger taps, not repeated, tedious row and column lookups. Moreover, if one wants more advanced statistics and an analysis of their meanings and pertinence to specific teams or players, these are usually found on esoteric sports blogs or deep in a website's article history.

Using statistics from the National Basketball Association over the past twenty years, we created a framework for a centralized database that allows intuitive visualization, team comparison, and dynamic queries in an iOS application. We intend to allow the user to select teams and statistical categories from the past twenty NBA seasons and see a concise visualization accordingly. This way, a user can click their way through a significant chunk of NBA history without having to spend hours collecting data and looking at spreadsheets.

Related Work

Sports Reference LLC, whose website provided our data [1], has a rather comprehensive set of publicly available statistics from the past several decades, though many statistics, such as blocks and steals, didn't exist until relatively recently, and the 3 pointer was introduced in the 1979-1980 season (which is why we focused on the 1995-1996 season and onwards). Aforementioned, the data is in the form of hundreds of spreadsheets; a determined or avid fan may make good use of them, but with undue difficulty. Figure 2 is just from one year, so gleaning information from multiple years would take a lot of back and forth. The website also does not intuitively visualize any of the data (with the exception of the spreadsheet format).

The article "NBA Champions Overall Win Records" from NBA Miner's website [2] presents an interesting line graph of the win-loss percentages of every championship team from 1947 to 2015. Though there is great information there, it is an isolated article in one of many hundreds, possibly thousands, of basketball websites. This information is present in very many public databases, but rarely can it be visualized in such a clear way, especially through dynamic queries. A valuable tool would easily allow users to go from an overload of information, such as each individual win and loss for each NBA team in history, and through a

| Rk | Team | Age | PW | PL | MOV | SOS | SRS | ORtg | DRtg | Pace | Advanced | | | Offense Four Factors | | | | Defense Four Factors | | | | Arena | Attendance |
											FTr	3PAr	TS%	eFG%	TOV%	ORB%	FT/FGA	eFG%	TOV%	DRB%	FT/FGA		
1	Golden State Warriors*	27.4	65	17	10.76	-0.38	10.38	114.5	103.8	99.3	.250	.362	.593	.563	13.5	23.5	.191	.479	12.6	76.0	.208	Oracle Arena	803,436
2	San Antonio Spurs*	30.3	67	15	10.63	-0.36	10.28	110.3	99.0	93.8	.246	.223	.564	.526	12.4	23.0	.197	.477	14.1	79.1	.182	AT&T Center	756,445
3	Oklahoma City Thunder*	25.8	59	23	7.28	-0.19	7.09	113.1	105.6	96.7	.292	.275	.565	.524	14.0	31.1	.228	.484	11.7	76.0	.205	Chesapeake Energy Arena	746,323
4	Cleveland Cavaliers*	28.1	57	25	6.00	-0.55	5.45	110.9	104.5	93.3	.259	.352	.558	.524	12.7	25.1	.194	.496	12.6	78.5	.205	Quicken Loans Arena	843,042
5	Los Angeles Clippers*	29.7	53	29	4.28	-0.15	4.13	108.3	103.8	95.8	.318	.324	.556	.524	12.1	20.1	.220	.480	13.8	73.8	.222	STAPLES Center	786,910
6	Toronto Raptors*	26.3	53	29	4.50	-0.42	4.08	110.0	105.2	92.9	.328	.287	.552	.504	12.3	24.6	.255	.498	12.7	77.7	.201	Air Canada Centre	812,863
7	Atlanta Hawks*	28.2	51	31	3.61	-0.12	3.49	105.1	101.4	97.1	.237	.336	.552	.516	13.8	19.1	.185	.480	14.4	74.6	.194	Philips Arena	690,150
8	Boston Celtics*	25.2	50	32	3.21	-0.37	2.84	106.8	103.6	98.5	.264	.293	.531	.488	12.1	25.1	.208	.487	14.6	74.6	.231	TD Garden	749,076
9	Charlotte Hornets*	26.0	49	33	2.72	-0.36	2.36	107.1	104.3	95.7	.280	.348	.545	.502	11.7	20.0	.222	.496	12.5	79.8	.191	Time Warner Cable Arena	716,894
10	Utah Jazz	24.2	46	36	1.79	0.05	1.84	105.9	103.9	91.0	.286	.297	.540	.501	14.2	25.9	.213	.495	13.5	77.7	.210	Vivint Smart Home Arena	791,489
11	Indiana Pacers*	26.9	46	36	1.71	-0.09	1.62	104.6	102.9	96.6	.268	.270	.536	.497	13.5	23.4	.205	.489	14.3	76.0	.205	Bankers Life Fieldhouse	690,733
12	Miami Heat*	28.4	46	36	1.65	-0.14	1.50	106.1	104.4	93.6	.282	.221	.545	.508	13.3	23.8	.210	.485	12.1	77.8	.196	AmericanAirlines Arena	809,350
13	Portland Trail Blazers*	24.3	43	39	0.83	0.15	0.98	108.8	108.0	96.0	.268	.332	.548	.511	13.2	25.9	.202	.503	12.1	76.2	.225	Moda Center	794,085
14	Detroit Pistons*	25.0	43	39	0.61	-0.18	0.43	106.1	105.5	95.1	.296	.303	.522	.491	12.2	27.0	.197	.504	12.5	79.3	.196	The Palace of Auburn Hills	677,138
15	Houston Rockets*	27.8	42	40	0.20	0.14	0.34	108.3	108.1	97.6	.352	.370	.553	.516	14.2	25.7	.244	.516	14.7	72.8	.219	Toyota Center	737,244
16	Dallas Mavericks*	30.3	40	42	-0.30	0.29	-0.02	106.7	107.0	94.3	.265	.339	.544	.502	12.0	20.6	.211	.504	12.8	76.2	.198	American Airlines Center	825,901
17	Washington Wizards	27.3	40	42	-0.50	0.00	-0.50	105.3	105.8	98.5	.263	.282	.544	.511	13.1	20.6	.192	.515	14.6	77.7	.218	Verizon Center	725,426
18	Chicago Bulls	27.6	37	45	-1.48	0.01	-1.46	105.9	105.5	95.7	.240	.245	.526	.487	12.6	24.5	.189	.485	10.7	74.9	.182	United Center	894,659
19	Orlando Magic	23.9	36	46	-1.62	-0.06	-1.68	105.1	106.8	96.0	.232	.255	.533	.500	12.8	23.1	.175	.513	13.8	76.5	.215	Amway Center	719,275
20	Memphis Grizzlies*	30.5	35	47	-2.24	0.11	-2.14	105.4	107.8	93.3	.295	.222	.524	.477	12.3	25.3	.231	.518	15.2	75.1	.251	FedEx Forum	701,894
21	Sacramento Kings	26.6	34	48	-2.48	0.16	-2.32	106.0	108.4	100.0	.295	.260	.546	.510	14.2	23.9	.214	.521	14.0	74.9	.202	Sleep Train Arena	707,526
22	New York Knicks	27.2	33	49	-2.73	0.00	-2.74	104.6	107.6	93.4	.255	.256	.527	.483	12.6	23.7	.205	.487	10.5	75.8	.204	Madison Square Garden (IV)	812,292
23	Denver Nuggets	24.7	33	49	-3.10	0.29	-2.81	105.6	108.8	95.7	.282	.277	.531	.489	13.2	25.8	.216	.515	12.6	77.3	.216	Pepsi Center	577,898
24	Minnesota Timberwolves	24.6	31	51	-3.54	0.15	-3.38	106.5	110.1	95.2	.332	.202	.549	.498	13.9	24.3	.263	.524	13.6	74.7	.200	Target Center	581,178
25	New Orleans Pelicans	26.6	31	51	-3.79	0.24	-3.56	105.6	109.5	96.8	.259	.277	.537	.498	12.3	21.2	.201	.523	12.7	78.8	.225	Smoothie King Center	688,549
26	Milwaukee Bucks	23.5	29	53	-4.18	0.20	-3.98	104.3	108.7	94.2	.276	.189	.537	.499	14.2	24.9	.207	.510	14.2	73.1	.221	BMO Harris Bradley Center	621,808
27	Phoenix Suns	26.0	24	58	-6.66	0.34	-6.32	102.2	109.0	98.5	.271	.302	.526	.487	15.2	25.4	.204	.523	13.5	77.1	.237	Talking Stick Resort Arena	701,405
28	Brooklyn Nets	26.9	22	60	-7.35	0.24	-7.12	103.2	110.9	95.2	.246	.218	.527	.492	13.6	24.1	.186	.534	13.1	75.7	.176	Barclays Center	620,142
29	Los Angeles Lakers	26.5	17	65	-9.56	0.64	-8.92	101.6	111.6	95.6	.292	.290	.509	.460	12.5	23.1	.228	.523	11.6	74.7	.202	STAPLES Center	778,877
30	Philadelphia 76ers	23.3	16	66	-10.23	0.31	-9.92	98.8	109.2	97.9	.269	.327	.512	.487	14.8	20.6	.186	.510	13.5	74.0	.240	The Center	614,650
	League Average	26.8	41	41	0.00	0.00	0.00	106.4	106.4	95.8	.276	.285	.541	.502	13.2	23.8	.209	.502	13.2	76.2	.209		732,555

Figure 2: Most sports statistics come in this form. They are comprehensive, maybe, but not intuitive.

few clicks, swipes, or pinch gestures have a very succinct bit of useable information. Then just as simply, revert to the original state.

Sporting Charts' website has intuitive visualizations [3], and a decent user experience that allows easy selection of statistics and teams to compare against each other, but does not allow comparison between teams and the league average (Figure 3). Also, there is no immediate description of what each stat means; one would have to open a separate tab and manually look it up. Lastly, the webpage where the following graph is displayed has several other spreadsheets below it that add to its visual clutter and complexity and, due to the medium, five thumbnails linking to different articles on the same website. We chose to implement an iOS application to create a self-contained tool without any
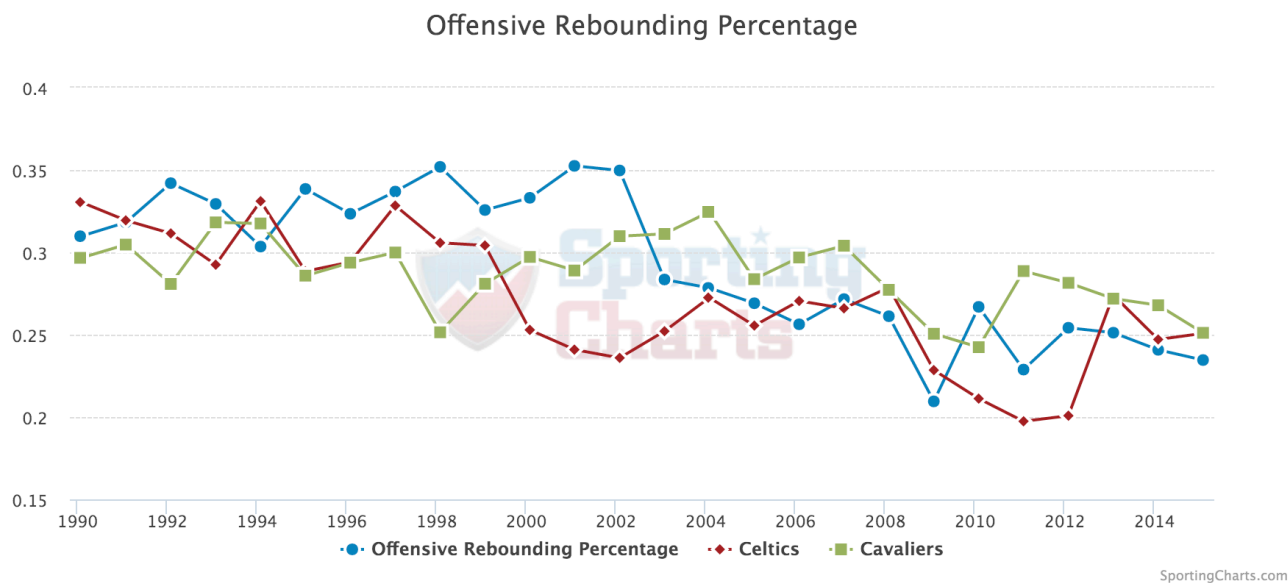

Offensive Rebounding Percentage

Figure 3: An intuitive visualization, but we have no concept of league average and no description of what Offensive Rebounding Percentage is. There are also some odd design decisions: the blue line represents the Golden State Warriors, but since it was the first of the three graphed, the key denotes it as "Offensive Rebounding Percentage."

undue visual clutter and very little loading time between changes in visualization.

Methods

We decided to focus on eight statistics that are highly indicative of success in basketball, four offensive and four defensive. The four offensive measures are:

1) Effective Field Goal % (eFG%): The percentage of made field goals (the ball goes through the hoop) out of the total number of field goal attempts, taking into account that 3 pointers are more difficult but yield one more point. *The formula is (# of 2 pointers made + 1.5 * # of 3 pointers made) / # of field goal attempts*

2) Turnover % (TOV%): An estimate of the number of turnovers (losing possession of the ball to the other team) per 100 possessions. *The formula is 100 * # of turnovers / (# of field goal attempts + 0.44 * # of free throw attempts + # of turnovers)*

3) Offensive Rebound % (ORB%): An estimate of the percentage of available offensive rebounds (regaining possession of the ball after your team's missed shot) grabbed. *The formula is # of offensive rebounds / (# of offensive rebounds + # of opponent's defensive rebounds)*

4) Free Throw Factor (FT/FGA): A measure of both how often a team gets free throw attempts (occurring when the opponent commits a penalty) and how often they make them. *The formula is # of free throw attempts / # of field goal attempts*

The four defensive factors are the same as the above four except pertaining to a team's opponent. The only difference is the third factor, ORB%, which becomes:

Defensive Rebound % (DRB%): An estimate of the percentage of available defensive rebounds (gaining possession of the ball after an opponent's missed shot) grabbed. *The formula is # of defensive rebounds / (# of defensive rebounds + # of opponent's offensive rebounds)*

Figure 4: The league average in eFG% from 1996 to 2016.

Figure 5: How four teams compare against league average in eFG% from 1996 to 2016. Clicking on the Chicago Bulls' data point in 2008 displays a light orange reference line to compare against other data points.

We have two main graph types to display this information. First, we have line graphs that track teams' offensive and defensive four factors data from the 1995-1996 to the 2015-2016 seasons. To avoid clutter, we only allow visualization of one of the eight total factors at a time, but allow for multiple teams' lines, as well as the league average, to be placed on top of each other for easy comparison. Tapping a data point displays a horizontal reference line to allow comparison between multiple data points. Moreover, we included an information button that, when clicked, displays information regarding the current statistic.

The second graph type is a bar graph depicting a single statistic among user-selected years and teams. The idea is to allow comparison between many teams, a feature that, if utilized in the line graph, would become too cluttered to
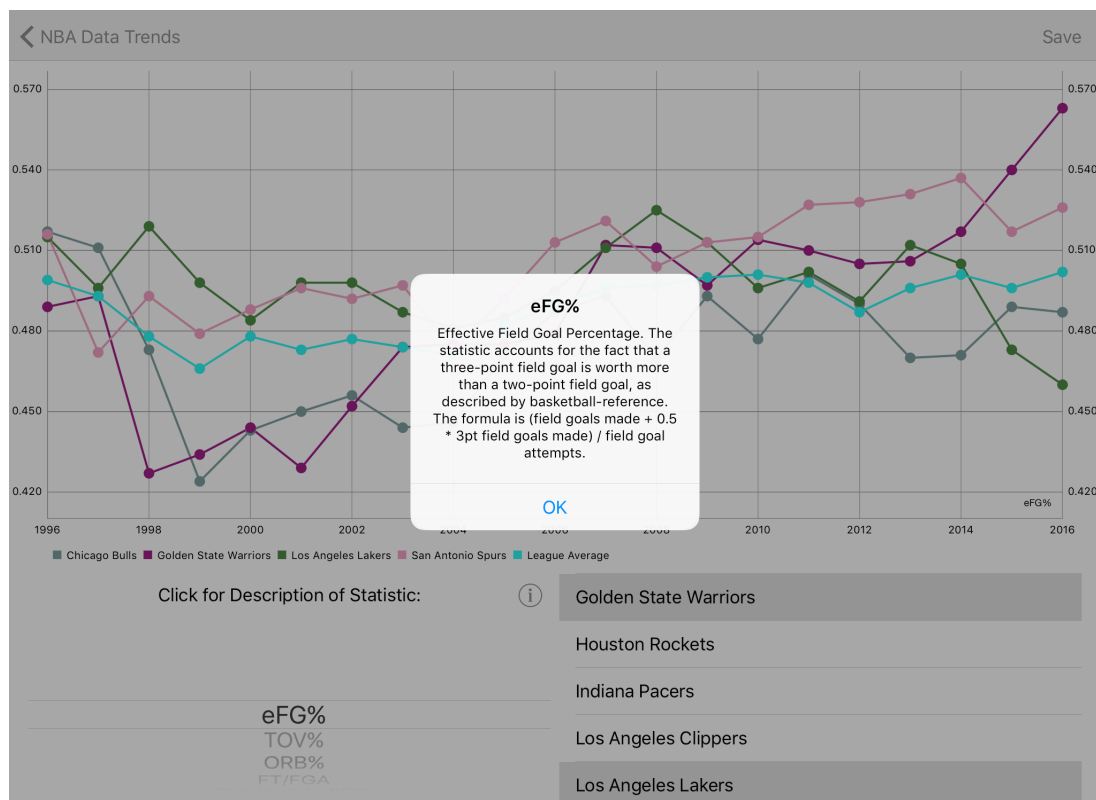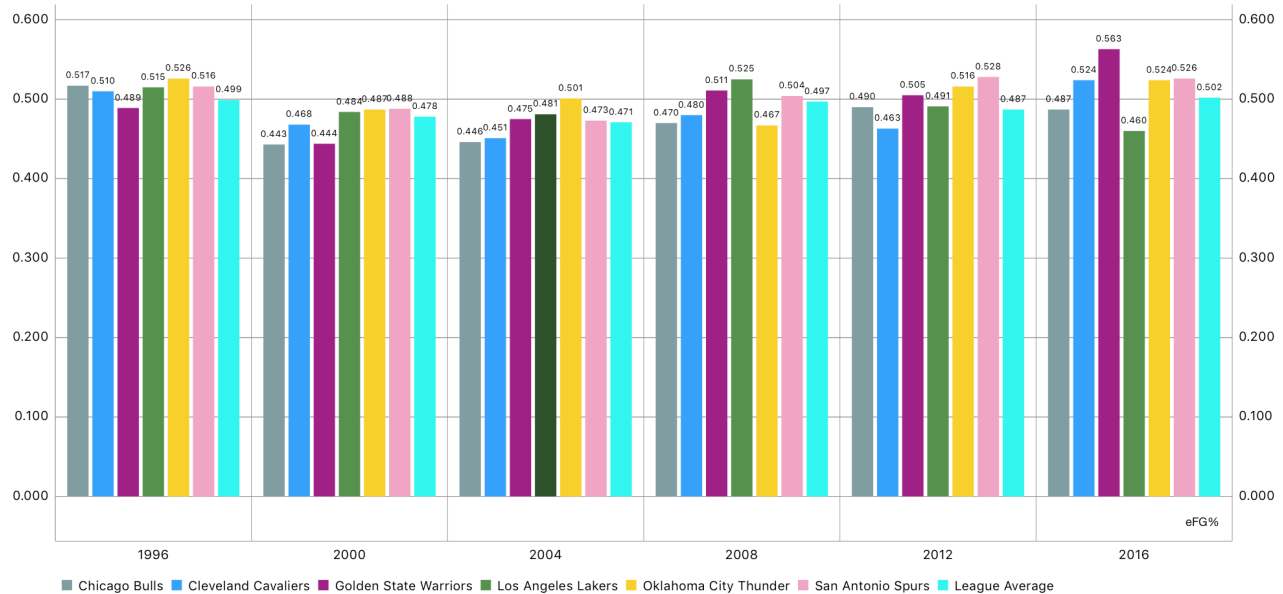

Figure 6: Clicking the info button below the legend gives more information about the current statistic.

Figure 7: How six teams compare against league average in six specific years.

read. Tapping a bar brings up more detailed information about that team's statistic for the given year, e.g. providing the number of 2 pointers and 3 pointers made which factor into eFG%.

Results

In Figure 4, we can see the user interface is very intuitive: the default screen of the line graph page shows the league average eFG% over the last two decades. Simply swiping and tapping with your finger allows easy manipulation of the variables; only one statistic can be viewed at a time to cut down on clutter. If the number of teams selected (including league average) is less than five, the decimal value of the statistic in each year is printed above the data point. If there are five or more teams selected, the decimal values go away to leave a more streamlined look. To compensate for this loss of accuracy, tapping a data point brings up a pair of horizontal and vertical, light-orange lines that allow comparison between different data points, as seen in Figure 5.

In Figure 6, we can see the result of tapping on the information icon below the legend: a text box appears giving a brief description of the statistic as well as its formula.

The second type of graph we implemented allows the user to select specific years, as opposed to viewing all twenty years at once, which makes a less cluttered appearance when comparing more than five teams. Figure 7 shows seven different teams (including league average) during several years and their respective effective field goal percentages. The iOS pinch gesture zooms in and out so the user does not have to view every displayed year at once. Finally, tapping on one of the bars brings up information used to calculate that value. As seen in Figure 8, we can see how many 2 pointers, 3 pointers, and overall field goal attempts the Golden State Warriors took in 2016.
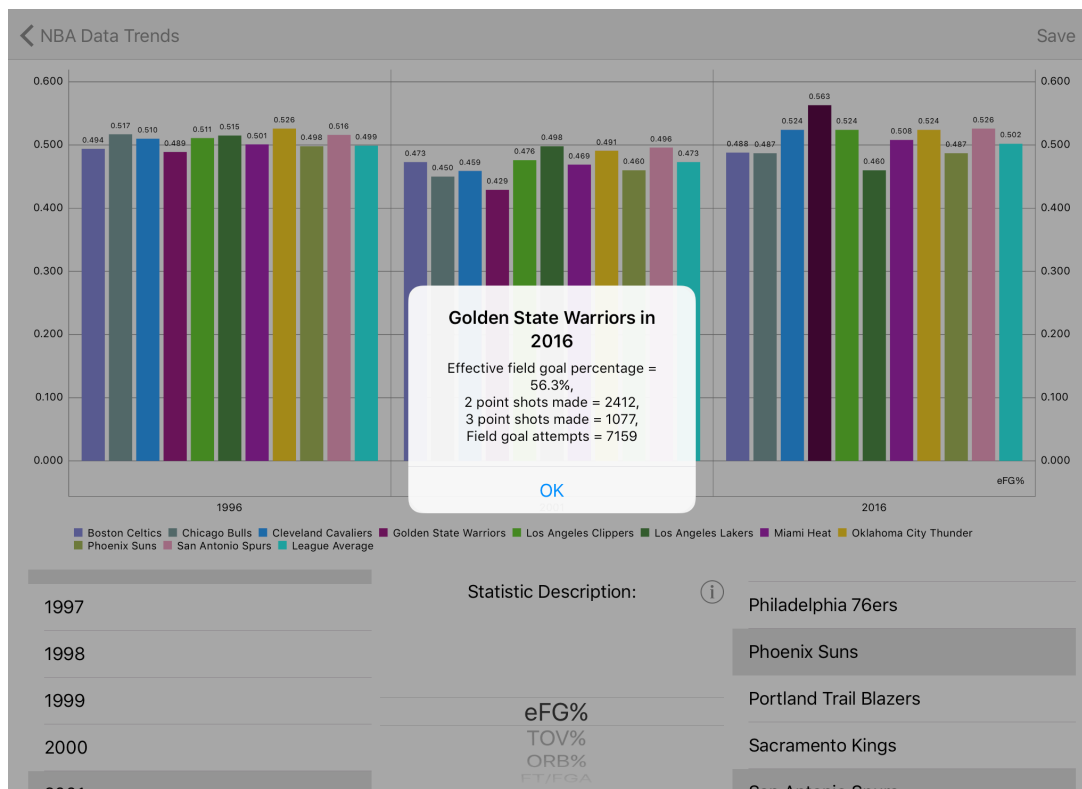
Figure 8: Clicking any of the bars gives additional information about the measured value.

Discussion

Our application is a simple, self-contained, visualization tool. Apple's iOS touch gestures allow intuitive manipulation of the data graphics, including cycling between eight different statistics, adding up to 30 different teams to one graph, getting more detailed information about each statistic and each teams' performance in that statistic, the ability to zoom in and out with the pinch gesture, and a save button in the top right of the screen to get a picture of the currently displayed information.

A minor limitation is that we cannot view more than one statistic at a time: there are often many statistics that are inversely proportional to others and seeing the interplay between them could be very interesting. Ideas like this are discussed more in the next section. Overall though, we favored how intuitive the application was, which influenced every design decision, over how much information it conveyed.

Future Work

Currently, our visualization only covers eight team statistics (four offensive and four defensive). We could continue to improve our tool by visualizing more statistics such as three-point percentage or steals per game. We could also extend our visualization to include individual statistics so users could compare individual players against each other. A common debate among the basketball world is who the best player of all time is. With this added functionality, users could compare the statistics of Michael Jordan, Kobe Bryant, LeBron James, and Stephen Curry all in their respective primes. You could objectively deduce with numbers which player is truly better. Exciting!

Furthermore, our tool currently only covers twenty years of NBA statistics, we could include more years to allow users to also study and visualize the great Celtic and Lakers teams of the 50s and 60s. Additionally, it would be interesting if we could find a way to visualize how a team is coach and managed. Coaching schemes, draft selections, and a NBA organization's overall culture are all supplementary factors that also affect the performance of a team. Lastly, we strongly believe a visualization tool like ours can be the foundation for a similar tool for the other major sports such as football, baseball, or hockey. Ultimately, we hope that our tool helps the casual NBA fan easily learn more about their favorite NBA teams in just a few taps.

References

[1] *Basketball-Reference*. Sports-Reference, LLC. Web. 25 May, 2016.
[2] "NBA Champions Overall Win Records," *NBA Miner*. NBA Miner, 11 May, 2016. Web. 25 May, 2016.
[3] "Golden State Warriors," *SportingCharts*. Leadoff Digital, n.d. Web. 28 May, 2016.

June 5, 2016. Stanford, CA