

How NBA Player Salaries Relate to Individual and Team Performance: Using Visualizations to Maximize a Team's Success

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Abstract— This paper describes a tool that can be used to evaluate whether an NBA player's salary can be beneficial or detrimental to their team based on their performance in several statistical categories. This serves as a useful starting point for front office professionals employed by NBA teams who wish to make reasoned judgments about whether they should extend a player's contract or let them walk into free agency. After all, statistics in NBA basketball have become nuanced and sophisticated in the past decade, and perpetually successful teams like the San Antonio Spurs have embraced their use and excel perhaps as a result. We believe that visualizations are the best method for truly understanding the effectiveness of an NBA player in the context of their salary since when these statistics are merely presented in their numerical form, people who are not mathematical experts (such as NBA General Managers, who are responsible for offering contracts to players) may not grasp their impact, or even worse, they may get the wrong impression about a certain player. Through the use of radar and bar charts, our tool looks at several NBA players' statistical performances and how their salary matches up to similarly performing players.

1 INTRODUCTION

Basketball players employed by the National Basketball Association (NBA) are some of the highest paid athletes in the world. Their agents negotiate with the general managers of professional teams in order to get a salary that they think their performance warrants. Unlike professional sports leagues like Major League Baseball (MLB), though, NBA teams have a *salary cap*, which is a limit to the amount of money they can spend to field a 15-man team of \$102 million. This means that it is within each NBA team's interests to pay each player in, the average case, the exact salary which fairly corresponds to their on-court performance and, in the best case scenario for the team, a salary that is as low as possible for a player that is extremely good. A good example of the latter case being beneficial to a team is Stephen Curry of the Golden State Warriors, who gets paid \$12 million a year, and yet is a two-time MVP who is commonly considered one of the best players of all time. This low salary allowed the Warriors to spend money on acquiring Kevin Durant, another MVP, for a max salary.

This paper describes the process of our visualizations of radar and bar charts of specific players we believe are beneficial to observe in this way, since it has the capacity to captivate general managers of NBA teams into making reasoned decisions about who to sign and who to let walk in free agency. The paper will consist of several sections to achieve this effect, including the related visualizations we have found, the method we used to generate our visual computations, our programming implementation of these concepts, our results and their impact, and what we can conclude from our project and what future visualizations in this realm should address.

2 RELATED WORK

The use of radar and bar charts to visualize NBA statistics is prevalent in the realm of entertainment, but not in information visualization research.

2.1 In Information Visualization Research

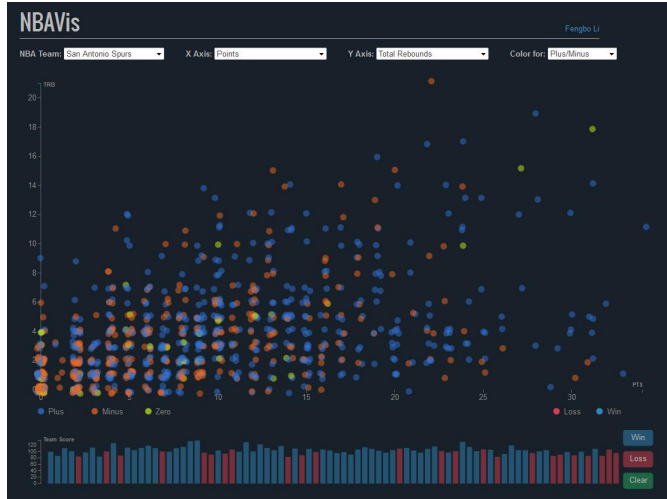
Historically, academic publications in information visualization rarely tackle the topic of sports, much less radar and bar charts devoted to NBA player statistics and their salary. However, over the past several years, this trend has begun to reverse, with conferences such as the IEEE VIS sponsoring workshops on sports data visualization. Unfortunately, the majority of these visualizations regard sports such as football, soccer, and baseball. Nevertheless, it is important for our

purposes to survey the few visualizations within this subcategory of information visualization pertaining to the NBA that are present in academic research. [3], a paper that introduces an interactive shot chart tool that allows the user to choose a player and see on a virtual basketball court the physical areas on the court where they perform best, presents the idea of using visualization to enhance the assessments of NBA players' in-game performances, but does not describe how tools like this could be used by NBA executives to make reasoned decisions about players' salaries. [2] proposes a new way of presenting post-game information, gravitating away from webcasts and towards "season level, game level, and session level" visualizations, but the purpose of this work is to augment the NBA fan's experience and, while this work does include some visualizations of performances that are relevant to our research, the purpose of such visualizations is for entertainment consumption and not for the maximization of team success. [8] includes some visualizations that are similar to the ones we present in this work, including radar charts with steals, points, rebounds, assists, blocks, and turnovers as graph points of players such as Steve Nash, Deron Williams, and Rajon Rondo. However, these visualizations do not include player salary, which means they do not explore the financial implications of player performance that come in handy when making player personnel decisions. [7] uses line graphs and bar graphs to visualize and compare team performances, but provides no application of the importance of such visualizations to executive decision making nor does it provide visualizations of individual player performance. A compelling sequence of different sports visualizations can be found courtesy of the Information Interfaces team at Georgia Tech University. One interactive visualization of NBA player and team data by this team, a snapshot of which can be seen in *Figure 1*, was particularly influential to the software development necessary for our project since it was the only open source visualization of NBA data.

2.2 In Entertainment

Radar charts being used for the representation of NBA data is common on sports entertainment websites. [9] uses machine learning to generate radar charts that correspond to individual players with a dataset consisting of statistical categories such as 3 pointers attempted per game. Additional players are layered on top of the specific player for comparison purposes. [1] is a visualization of players' shot frequency percentage by distance, field goal percentage by distance, and several other interesting statistics. [4] displays NBA player salary, divides their salary by the number of field goals they've made, and displays how much money they make per field goal. [10] has a chart that places each NBA team on a scatterplot where the X axis is offensive efficiency and the Y axis is defensive efficiency. [5] is similar to our module in that they use radar charts to overlap two players on top of each other to see who is better overall. Use of radar charts to evaluate players has even

Fig. 1. A snapshot of an interactive visualization of basketball data.



been done by professional organizations such as the Miami Heat [6], demonstrating their validity. Since these visualizations are intended for entertainment, they do not provide conclusions about players that NBA executives may want to make, a gap in visualization research that the present work hopes to address.

3 METHOD/COMPUTATIONAL MODEL

3.1 Method Overview

Figure 3 is a flow chart diagram of the components necessary to program our module, which is an interface consisting of three graphs. The first graph is a bar chart that shows the user how many points a player averages a game and compares this visually to how many points the average player averages a game. The second graph is a radar chart that corresponds to a player's assists per game (APG), steals per game (SPG), blocks per game (BPG), rebounds per game (RPG), and turnovers per game (TPG). The third graph is a bar chart that has the player's salary stacked up against similarly scoring players' salaries so the user can see whether a player's value translates well into how much they get paid. For each node in the flow chart diagram, there is a subsection within this section that corresponds to an explanation of how this step in the software engineering process was approached.

3.2 PHP Environment

This node is the start block that represents how each subsequent step can be completed. In order to satisfy the following requirements, we must operate in a PHP environment.

3.3 CSV File of Statistics

An input block, this node represents the NBA statistics we require to generate meaningful charts. In our file "Document2.csv", we have entries consisting of players like James Harden, Danilo Gallinari, and Jordan Clarkson with statistics ranging from their PPG to their RPG.

3.4 Plug Statistics of Players into Database

In order to do anything meaningful with the data we gathered in our CSV, we must place the data into a database for later use in the pChart environment. To do this, we have a file "insert_nba.php" that uses MySQL to connect to a database, parse our .csv file, and place it into a table called player_info. Some code pertaining to these steps: To connect to the database:

```
$user = 'root';
$pass = '';
$db = 'nba';
mysql_connect('localhost', $user, $pass);
mysql_select_db($db);
```

To parse our .csv file:

```
$parsed_data = array_map('str_getcsv',
file('Document2.csv'));
```

Finally, to place the data into a table:

```
$ins_sql = "INSERT INTO player_info (name, age,
team_name, wins, loss, ppg, bpg, rpg, apg, tpg, spg,
games) VALUES ('$name', '$age', '$team', '$wins',
'$loss', '$ppg', '$bpg', '$rpg', '$apg', '$tpg',
'$spg', '$games')";
```

3.5 Grab Player Statistics From Database

Naturally, it is necessary to access the database we have created in order to use our data for chart generation. This step happens at a similar time as the next step, so there is not necessarily a temporal order. As a code example of this step, let's look at a method in our file "vis_proj.php" file that averages the points per game of a player:

```
function get_average_ppg(){
    $avg_sql = "SELECT ppg
FROM player_info";

    $result = mysql_query($avg_sql);
    $result = mysql_fetch_assoc($result);
    $sum = 0;
    foreach($result as $key => $value){
        $sum += $value;
    }
    $avg = $sum/count($result);
    return $avg;
}
```

3.6 Access pChart API

In order to generate the charts that we want, we utilized pChart. Accessing this API consisted of the following include statements in our "vis_proj" file:

```
include("pChart2.1.4/pChart2.1.4/class/pData
.class.php");
include("pChart2.1.4/pChart2.1.4/class/pDraw
.class.php");
include("pChart2.1.4/pChart2.1.4/class/pRadar
.class.php");
include("pChart2.1.4/pChart2.1.4/class/pImage
.class.php");
```

3.7 Draw radar chart, bar chart 1, bar chart 2

To draw our charts, we utilized pChart's functionalities. Let us explain the process of drawing the radar chart. First, we initialized a pRadar object. Then, we passed this object into a function along with a player's data. In this function, we used the pChart method "setGraphArea" to specify the size of the graph, created an Options object to hold specifications for what we wanted our graph to look like, and then finally passed our pRadar object into the "drawRadar" pChart function.

3.8 Produce pCharts for viewing

This node is the completion of the process of generating charts, a result of compiling the programs outlined in the previous steps. Three charts corresponding to a player are presented to the user.

3.9 Parameters

Since our visualization module uses static data that we gathered via a basketball statistics website, our parameters to pChart functions are unchanging.

4 IMPLEMENTATION

4.1 Different options

In implementing our visualization software, we were surprised to see how many different options for packages there were. Initially, we planned on using Python embedded in HTML in order to use the pyfigure package, but we eventually landed on using pCharts due to its ability to be implemented in a PHP context. We also wanted to include salary in our radar chart but found it virtually impossible to find a reasonable way to describe statistics and salary using the same units due to their large difference in size.

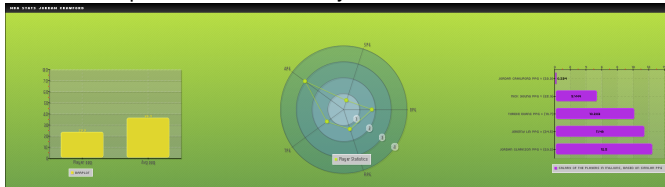
4.2 Rendering salary bar graph

Unfortunately, in our final product, we were unable to properly render bar graphs of salaries. However, from previous iterations of the product, we retained plenty of such graphs, one that corresponds to each player we allow the user to choose. An example of one such salary bar graph is in *Figure 2*.

5 RESULTS AND PERFORMANCE

5.1 Results

Fig. 2. A visualization of Jordan Crawford's performance in the NBA that shows he outperforms his low salary.



We can see in *Figure 2* an example of what our module produces. In the left chart, we can see how many points per game Jordan Crawford averages. In our radar chart, we easily get, through our visual sense, an idea of what kind of player Jordan Crawford is: he averages a fair amount of assists, but not much else. Finally, on the right, we see a bar chart of a sample comparison we can make between Crawford and similarly performing players: Crawford doesn't make much, but he averages a good amount of points per game. Nick Young, who has a similar number of points made per game, gets paid far more than Crawford. We can see through this example that the executive responsible for signing Crawford to such a small contract did a fantastic job, while the executive responsible for paying Nick Young did not.

5.2 Performance Analysis

Because our data set is reasonably small, a performance analysis of the generation of charts is not necessary.

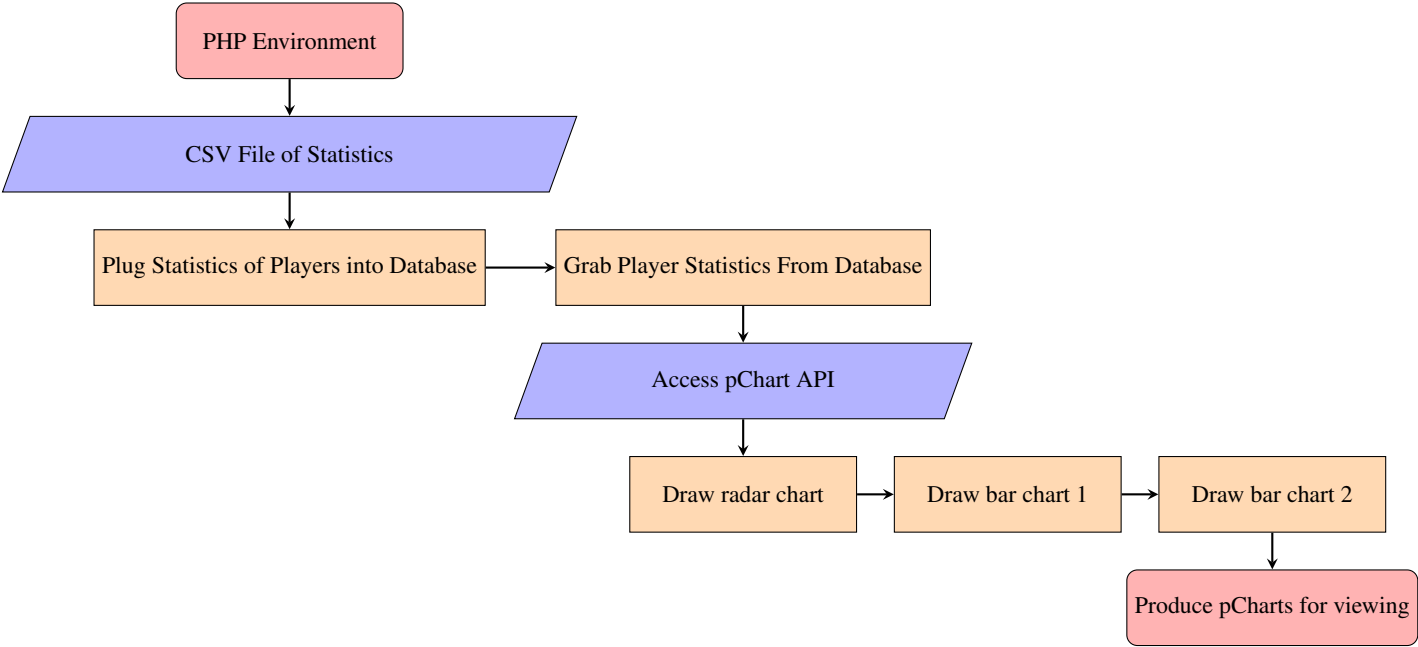
6 CONCLUSIONS AND FUTURE WORK

From our survey of the current visualization research landscape, we see that no other publications have used graphs like radar charts in order to analyze the performance of an NBA player as well as the worth of the player, as judged by salary. In fact, our survey shows us that using visualization techniques to effectively describe NBA players is oddly underdeveloped in the visualization research community. As such, we hope that the novelty of our module inspires others to make NBA visualizations a more robust field. The value of such visualizations are that NBA executives can cite these graphs of players in order to make reasoned judgments on how much they should spend on a specific player. Naturally, since each team must operate within a salary cap, the ability to use visualizations such as these in order to make financially sound decisions is a major advantage to any team that chooses to embrace it.

6.1 Future Work

Since this is a novel work in the realm of visualization research, future opportunities to expand the field of NBA visualization using this as a platform to build off of are plentiful. Visualizations that look into more advanced statistics could allow more concrete conclusions about a player's worth. Additionally, a module that allows for a user to select any player in the NBA and generates these graphs for him would be a big step forward. A wider variety of graphs and charts dedicated to each player would also be helpful in drawing conclusions.

Fig. 3. A flow chart diagram of our programming process.



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