In Search of Jail Blazers' Years
The Team, The Results
and The String of Controversialities and Obscenities
Sport Analytics (753A01)

Dimitra Muni- @dimmu472
Julia Lindohf - @julso810

Summer 2021

Abstract

Portland Trail Blazers undergone an impressive transformation at the end of the 90s. The club recruited a number of young, talented basketball players, who loved their games and wanted to enjoy the flare and excitement. which the celebrity status entailed. The record was impressive; the lads won in average 55 games out of 82 in the regular season. In season 1998-1999, Portland was the champion of the Pacific division. One of the most expensive teams, Los Angeles Lakers could only claim the second position in the same division. However, their off-court behaviour attracted more media attention, than their on-court success. In order to ameliorate the team's reputation and to stop the decline of the number of paying spectators of the home games, the club made a number of bold decisions between season 2003 - 2004, and season 2005 - 2006. At the end, the Portland could only win 21 games in the regular season. In this project, the players' skill and the strength of the core squads were analysed with a number of computational data mining and statistical methodologies. The intention was to learn which mistakes the club made, when attempting to replace the trouble maker bad boys with a group of new players. The obtained results from the cluster analysis proved that the top offensive players could perform well, if and only if the defensive players possessed the skills, which the offensive players lacked, were willing to the share the ball for the benefit of the team. Furthermore, as a team, the players could play well together, if there was a real sense of camaraderie both on and off the court.

keywords: regularised skill plus minus; skill assessment dimension reduction; multivariate gradient boost classification; team wise skill assessment with K-Means clustering method; Sport analytics

Contents

List of Figures

List of Tables

Nomenclature

$2P$ Two Points Goal Made

$2PA$ Two Points Attempts

$3P$ Three Points Goal Made

$3PA$ Three Points Attempts

$3PAr$ 3 Point Attempt Rate

AST Assists

AST Assists Per Game

BLK Blocks

BPM Box Plus Minus

$DRAPM$ Defensive Regularised Adjusted Plus/Minus

DRB Defensive Rebounds

$FG\%$ Field Goal Percentage

FG Field Goal Made

FGA Field Goal Attempts

$FT\%$ Field Throw Percentage

FTr Free Throw Attempt Rate, Number of FT attempts per FG attempts

MP Minutes Played

$ORAPM$ Offensive Regularised Adjusted Plus/Minus

ORB Offensive Rebounds

PER Player Efficiency Rating

PF Personal Foul

PGA Points Generated by Assists

$RAPM$ Regularised Adjusted Plus/Minus

STL Steals

TO Turnover

$USG\%$ Usage Percentage

1 Introduction

Portland Trail Blazers recruited once upon a time, a group young, talented players, who brought the best out of each other on the court and gave the home crowd a dramatic show of infuriation, excitement and resentment upon the epic level. **The Jail Blazers** became a loved and hated sobriquet, which still lingers in the vernacular amongst the most zealous fans in Oregon today. They brought Portland to the play-off seasons multiple times, and gave the best teams, from both the Eastern and Western Conference a taste of their audacious team spirit. Two of them, Rasheed Wallace and Damon Stoudamire are still considered as best players, Portland ever possessed, together with the legendary players, such as Clyde Drexler and Scottie Pippen; others are remembered as the most aggressive players on the court, who pushed their opponents with their fists and arms, as they attempted to steal the balls resolutely. Off the court, they gained their reckless notoriety through a number of petite crimes and endured their share of cruel media coverage through their active years. Although the media coverage was centred around their their off-court transgressions, their warrior-like achievements, especially in their play-off seasons are still discussed, amongst the basketball supporters around the world via different social media platforms. The critics could vilify them, glorify them, however they could never neglect their existence, because their journey and shared memories demonstrate how vulnerable the young players were, when being held upon the pedestal before they could handle the dire consequence of being a member of the boiling cauldron of the entertainment industry.

As the Jail Blazers continued to attract massive negative spotlight, nation wide, the number of spectators who would attend the home game in Rose Garden decreased noticeably. In order to change the negative image of the city, Portland, also the basketball team, the team president Steve Patterson and the general manager John Nash decided to trade the "outlaws" away, with a group of young players with a spotless record.[1] The new players might have displayed a better off court judgement, however, the number of winning games decreased dramatically. In season 2005 - 2006, they could only win 22 out of 82 games in the regular reason.

1.1 Purpose

The aim of this wee project is to use a few of the data mining and pattern recognition tools, which were introduced in the MSC programme *Statistics and Machine Learning* to study the individual skills, as well as their on-court collaborations of the Jail Blazer players, retrospectively. The comparison between the choices of players are compared, in terms of the individual on-court achievement, also the collaborations between the defensive and offensive players in various ensemble formations, in combination with the economical aspects and the psychological condition. The outcome might be able to answer why the team from season 1999 - 2000 could defeat a few of the best paid teams both in Rose Garden and in their road games, despite some of their best players were suspended from some of their games, regularly. The result could also pinpoint down, which type

[1]The era of the cleaning the negative image of Jail Blazers began around season 2003, Rasheed Wallace and Bonzi Wells were the first two players, who were traded away after a quick decision: `https://www.blazersedge.com/2011/8/16/2366652/the-history-of-the-portland-trail-blazers-the-darkest-days`

of players the team from season 2005 - 2006 needed, in order to improve their on-court performance.

1.2 Research Questions

Three research questions are addressed in this project:

1. Why could **The Jail Blazers** become a winning team, which brought a small club to the semi-final in NBA play-offs at the end of the nineties? How to predict the result of a game, based upon their unique mixture of basketball skills?

2. Did the young lads play better in front of the home crowd in Rose Garden, despite the Portland supporters were offended by their notorious off-court crimes?

3. Which mistakes did the club managers make, when they recruited the new players in season 2005-2006?

1.3 Scope of the Investigations

The investigations are centred around nine seasons, from season $1998 - 1999$ to season $2005 - 2006$. The studied members of **The Jail Blazers** are:

- Rasheed Wallace, (Power Forward, Centre), stayed with Portland between 1996 and 2003. When he arrived to Trail Blazers, he was only 22 years old.[2] He suffered anger control problems and disputed against the referees and other officials multiple times on the court. Furthermore, he disdained the team events openly, especially the charity activities. For this reason, he was not a player in Rose Garden, despite his excellent record as a player. In Portland, he enjoyed his first wave of massive success. during his service in Portland, he was selected to NBA All Star Games twice, season 1999 - 2000 and season 2000 - 2001.

- Damon Stoudamire, (Point Guard), stayed with Portland between 1997 to 2005. As a young lad, he was arrested a number of times for marijuana possession. He was a far field specialist, who set a club record of seven consecutive 3 point scores in season 2004 - 2005.

- Bonzi Wells, (Shooting Guard, Small Forward), stayed with Portland between 1998 and 2004. Portland was his first team in NBA. Through the years, he was one of the most colourful personalities. Some of the young female fans adored him as their basketball Prince charming [3]. Others resented him, after he flipped off a fan in a game in Rose Garden. As one of the bad boys, he had his share of verbal combat with both the referees and other officials on the court. Off court, he was a heavy drinker, who was arrested by the patrolling police multiple times, after being involved in various verbal disputes in the night clubs.

[2]Rasheed Wallace, a native of Philadelphia, played college basketball at the University of North Carolina, prior his professional career in NBA. A short introduction of his NBA career was published on: `https://biography.jrank.org/pages/2998/Wallace-Rasheed.html`

[3]The original report was published at `https://www.nbcsports.com/northwest/portland-trail-blazers/time-goes-jail-blazers-trying-hard-shed-nasty-image`

- Ruben Patterson, (Small Forward, Shooting Guard), stayed with Portland between 2001 and 2005. He was portrayed as a tall sex addict by the media, after he was sentenced to jail, for attempting to rape a nanny at home.[4] On the court, he was a resolute rebounder.

- Zach Randolph, (Power Forward, Center) stayed with Portland between 2001 and 2007. He was only 20 years old, when he signed his first contract with Portland. He endured his first round of negative spotlight, after sucker-punching Ruben Patterson in the face during a practice session. [5]

- Qyntel Woods, (Small Forward, Power Forward) played only two seasons with Portland, between 2002 and 2004. He also displayed the anger management related problems. In his early 20s, he was sentenced to jail, after abusing dogs. After the age of 25, he moved over to Europe and played for a number of European professional teams.

Other formidable key players, who had contributed to the successful results between 1999 and 2004 are:

- Scottie Pippen, (Small Forward) is a proud Basketball hall of fame player, who represented the United States in two Olympic games. Prior to his arrival to Portland, he was one of the most important foundation stones beneath Chicago's successful years. On the court, he was dexterous defensive offensive player, who travelled a large distance in every game.

- Arvydas Sabonis, (Centre) is also a proud Basketball hall of fame player, who represented the Soviet Union team, which defeated team USA in the Seoul Olympic game and later his native Lithuania in two Olympic games.

- Steve Smith (Shooting Guard) represented the United States in Sidney Olympic game. Prior to his arrival to Portland, he played three seasons in Miami Heat and five seasons in Atlanta Hawks.

1.4 Basketball Data

The analysed data are based on the game data, which were published by two commercial actors:

- Basketball Reference: `https://www.basketball-reference.com/`

- Official NBA Stats: `https://www.nba.com/stats/`

[4]He was sentence to jail in 2001 by a County Superior Court Judge in Seattle.`https://archive.seattletimes.com/archive/?date=20010515&slug=rubenweb15`

[5]Zach Randolph was forced to hide himself in a friend's home, after he had punched Ruben Patterson: `https://www.opencourt-basketball.com/when-zach-randolph-went-into-hiding-after-shattering-his-teammates-eye-socket-fearing-he-was-going-to-shoot-him/`

2 Analytical Methodologies

The players' skill and the team performance in each game were analysed statistically. Each brick contributed to a better understanding, why the team could from 1999 was a serious threat to the top teams from both conferences in the play-off season, despite the team endured massive negative media coverage in the dawn of the Internet era. The analysis could also shed a light over which type of players Portland might want to recruit, through the rebuilding process in season 2005 - 2006.

2.1 Analysis of the Strength of a Team

The strength of a team depends upon each player's ability to collaborate with the rest of the team, both in terms of their propensity to compensate each others' short comings, also their willingness to share the balls in a heated moment. In modern games, the players often switch between different positions back and forth, adopting different play styles in the same game, as an increased number of players have developed both offensive and defensive skills(Gordon, Furlong, & Pendleton, 2018). Therefore, it is increasingly difficult to categorise the play style with the traditional position definition. For this reason, the performance from each season was studied with the unsupervised clustering method. The applied method in this project is a further development of Patel's proposal(Patel, 2017). In his study, he could prove that the locations of the players in the best teams, were further away from the centroid points in most of the clusters. Furthermore, the linear regression between the team rankings and the results confirmed if the skills of the players were very different, their potential to support each other in an aggressive play on the court was often higher. With another word, a strong team was often made up by players, who possessed not only extraordinary skills, also very diversified skills. The lads could play well together, because their strengths and short-comings were very different, hence they could act as each other's aid on the basketball court.

The assessments were based on the performance data, averaged over 100 ball possessions through one season. The results summarised how the players handled the ball, when they had a ball in their hands, in both the offensive and defensive plays. The included player specific performance data were:

- Points Scored
- Field Goals Made
- Field Goals Attempted
- Field Goal Scored Percentage
- 2-Point Field Goals Made
- 2-Point Field Goals Attempted
- 2-Point Field Goal Scored Percentage
- 3-Point Field Goals Made
- 3-Point Field Goals Attempted

- 3-Point Field Goal Scored Percentage
- Free Throws Made
- Free Throws Attempted
- Free Throw Scored Percentage
- Offensive Rebounds
- Defensive Rebounds
- Assists
- Steals
- Blocks

Through the process of data cleaning, the data of a player, who had played less than 15 games in each studied season, were tossed away. Their averaged performance data were often deceptive.

The unsupervised clustering procedure involved the following steps:

I 18 features were involved in this procedure. Before reducing the dimensionality of the random variables to two, the magnitude of each random variable was scaled to a comparable level.

II To reduce the number of dimensions from 18 to 2, with the unsupervised, non-linear technique, t-Distributed Stochastic Neighbour Embedding (*t-SNE*) method, based on the performance similarities, in terms of the skills.

III The partitions were performed on the two dimensional data, with K-means method. The number of clusters was optimised with the Elbow method.

IV The distance between a player's performance and the centroid point of each cluster was determined with Euclidean norm. The most important result is the average distance, across all included clusters.

When studying the results, two aspects were scrutinised closely. To begin with, the Portland players who possessed the most extraordinary skills were often the outliers of each cluster. It is therefore crucial to study which clusters the core players belonged to, also the distance between the core players in the same cluster. Secondly, the average distances of all teams were studied by performing a linear regression. The aim is to compare the team average distance between Portland and the rest of the Western Conference of a particular season.

2.2 The Survey of Salary Budget

The salary budget for each season was studied; the aim was first and foremost to analyse if a team with a higher salary budget played better; secondly it was relevant to investigate if the salary difference should be included in the gradient boost prediction, which was the goal of this project.

Two aspects were examined closely:

- The total budget over all players, who played for Portland Trail Blazers: The aim of this survey is to determine if the franchise had a genuine interest in investing their resources on the best players, which they could find, to win more games. The survey of the individual players could reveal if the franchise had an intention to keep their best players in the club.
- The sum of the salary of the players, who played in a specific game: The players were divided into two groups, the defensive players and the offensive players. The intention was to verify if the highly paid players always performed better on the court.

In addition, six stellar players, who were active during the Jail Blazers' period, were studied with a correlation heat map, the intention was to determine if their salary reflected their on-court performance.

2.3 Psychological Influences

The psychological conditions were studied from three different aspects in this project.

- Did the players performed better in front of the home crowd, given the fact that some of the players were scorned by the local spectators? The second question is if there was a correlation between the team performance and the number of spectators in each home game?
- How did the team perform, after a winning and losing a game in general? Was there a hot hand which pushed the players to perform better, after a winning game, against a strong team?
- How did the suspensions of the best players influenced the overall performance of the players on the court?

2.3.1 Home Crowd Advantage

The home crowd advantage is a highly questionable psychological condition, which had been studied by many behaviouristic and cognitive psychologists in the past. According to an earlier study, the home crowd might be able to play a minor role. The most prominent factor was that the players, who had not travelled across a number of time zones, for a game, were often more energetic on the court (Nevill & Holder, 1999). In addition, another study confirmed that the an emotive crowd could indeed manipulate the decision making negatively, however subconsciously. The studied players often allowed their instinct to take over, in front of an electrified crowd, rather than following

an agreed game strategy. When three out of five players had decided to follow their instinct in a heated moment, the team was no longer a team, a group of well-synchronised players, who played towards same goal. The clinical survey, in the past, indicates that the intuition was often a result of the unverified bias and prejudice, which an individual had collected through the course of life(Chamorro-Premuzic & Furnham, 2005). For this reason, when a group of players begin to follow their individual instinct in a game simultaneously, the number of bad ball passes and personal fouls would increase and the number of successful assist would decrease. Such a change of mental mode often brought a negative impact to the game. According to Pojskić, the home crowd reaction was in fact a disadvantage in the juvenile leagues, many of the inexperienced young players often displayed a less satisfactory performance, when playing in front of a cheering home crowd, due to the palpable expectations which their friends and family members displayed (Pojskić, Šeparović, & Užičanin, 2011). However, they could prove that there was a noticeable difference between the number of successful assists and steals, between the home team and the road team, amongst the studied matches results, which they collected from the European league. A more recent statistic investigation has revealed that the home crowd advantage in modern basket ball games could be a misperception (Harris & Roebber, 2019). The best teams often recruited players, who were masters of scoring the three point field goals. When playing in front of the home crowd, the success rate of the 3 point field goal decreased slightly. In this statistical investigation, we would like to find out how the home crowd influenced the performance of the core squad in the Jail Blazer years.

A simple Student T-test was employed to assess the home crowd advantage in this project. The T test is a hypothesis test, which was developed to estimate how significant the difference is between two groups of comparable samples, see equation 1. The most articulating assumption is that both scrutinised sample sets are normally distributed. This test method works well, if the sample size is less than 30. The T-test statistic was later compared with t-value for given degree of freedom to test the Null Hypothesis.

$$T_{test} = \frac{|\mu_1 - \mu_2|}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{1}$$

in which, μ_i is mean value of sequence i, s_i^2 is variance of sequence i and n_i is length of sequence i and $i = 1, 2$.

Four opponent teams were selected for the T-test assessment. The results were fetched between season 1999 - 2000 and season 2003 - 2004, see table 1. Two of the selected teams were the champions of one of the divisions, Los Angeles Lakers won 67 out of 81 games in the regular season 1999 - 2000; San Antonio won 53 out of 75 in the the regular season 1999 - 2000. The aim is to investigate if the Jail Blazers played differently, against their strongest opponents, when playing in front the home crowd. Furthermore, two less aggressive teams are included in this study as well, Los Angeles Clippers was the least competitive team in the pacific division, they could only win 15 out of 81 games in season 1999 - 2000. The Golden State Warriors and Denver Nuggets were the easy victims on the court in the Jail Blazer heydays; in season 1999 - 2000, the Golden State Warriors could win 19 out of 82 games. It is therefore adequate to learn if the Jail Blazer would win more grandly, when playing against a bottom team in Rose Garden.

Table 1: The selected teams from Western Conference, Season 1999-2004

Team	Number of Home Games	Number of Away Games
Denver Nuggets	10	10
Golden State Warriors	10	10
Los Angeles Clippers	10	10
Los Angeles Lakers	10	10
Phoenix Suns	10	10
San Antonio Spurs	10	10

In this project, the following random variable sequences have been utilised, to examine the players' performance on the court:

- Offensive Rebound
- Field Goals Percentage
- Free Throw Percentage
- The overall scores difference between Portland and the opponent teams

In addition, the game results were studied in conjunction with the total budget of the Player's salary, aiming to investigate the underlying trend between the score difference and the fluctuation of the total team salary. Furthermore, the salary difference between Portland Trail Blazers' and opponent team's cumulative salaries, was calculated. The intention was to assess if the better paid team performed more superiorly in a road game. In this assessment, the linear regression was performed upon two random variables, the logarithmic salary difference and the score difference. The linear regression was performed by using the ordinary least squares method.

2.3.2 Evaluation of the Hot Hand Effect

The hot hand phenomena have been studied scientifically; the scholars have arrived to very different conclusions. The hot hand fallacy describes a psychological condition, that a gambler often believes that the performance of a player depends on the results from the previous attempt. When a crowd of gamblers congregate around a Black Jack table, the players who have won a number of times, have a tendency to believe that he has a hot hand, and he could win in the next attempts as well, regardless the preconditions. It is of course a chimera. However, a strong psychological belief proves to be important for some players. When a diver has performed well in an important competition, he is more likely to feel more confident, when performing their most difficult dives in the last round of the grand final(Louganis, 1995). Furthermore, the hot hand phenomena have been studied extensively in NBA ball games. The focus question is whether a player who has attained a goal is more likely to score again on the next attempt. According to Henry, the hot hand phenomenon is only a fallacy, because a player who had scored would face an improved defence on his next attempt, which might result in a less satisfying shot (Henry, 2019). Other cognitive psychological studies have suggested that it might be a misperception(Gilovich, Vallone, & Tversky, 1985). When a spectator identifies a short sequence of multiple successes in a row, he often perceives this occurrence as a representative of entire sequence, which could be heterogeneous in its nature.

The study of how the results from the previous games could influence the basketball players' general attitude in the next game has not been conducted clinically. For this reason, we would like to study if the winning streak had influenced the play statistics in the years, when the Jail Blazer played together, statistically. The most articulating incentive was to survey if the previous win and loss had any impact upon the young players' choices on the court.

The impact of the hot hand was evaluated with the conditional probability assessment, that is to determine if the game result from the previous games had a palpable impact on the current game. To begin with, we designed four different cases:

- the conditional probability that Portland Trail Blazers would win, if they won the previous game.
- the conditional probability that Portland Trail Blazers would win, if they won two previous games in a row.
- the conditional probability that Portland Trail Blazers would win, if they lost the previous game.
- the conditional probability that Portland Trail Blazers would win, if they lost 2 previous games in a row.

The studied period is between season 1999 - 2000 to season 2003 - 2004. It was a tumultuous period; Portland Trail Blazers was a strong and infamous team, as the media kept reporting the controversies surrounding a few of the most delirious players. In this project, we only focused on the games results from the regular seasons, due to the fact that the game dynamics could be very different in the play-off seasons and the media coverage, together with the electrified reaction from the spectators in the stadium often altered the players' mental conditions radically. In our idealised models, we have not included a number of important external factors, which are not always plausible to quantify, despite the Jail Blazer lads were often influenced by these factors:

- the negative, sometimes racist media coverage, from both the local news media, also the national TV channels
- the internal animosities between the young players and the off-court clashes
- the wild party the night before a game, the careless consumption of alcoholic beverages and narcotic products
- the media exposure of the break-ups from the loved ones
- the decline in attendance at Rose Garden when playing their home games.

The simple estimations was by all means relevant, since it provided an important indicator, if the lads could be influenced from the results of the previous game. If the T-test could prove that there is statistically significant evidence that the previous game could indeed influence the next game, the previous win or loss should be used as a categorical variable in the gradient boost prediction.

Conditional probabilities were calculated for the Jail Blazer years 1999 - 2004 regular seasons, employing various scenarios in which Trail Blazers won a game given N previous wins or losses in a row. The number of games considered for each event are described in the Table 2.

Table 2: Trailblazer's Wins and Losses, Season 1999 - 2004

Event	Number of Games
One Previous Wins	249
One Previous Wins and Current Win	155
Two Previous Consecutive Wins	155
Two Previous Consecutive Wins and Current Win	95
One Previous Losses	161
One Previous Losses and Current Win	94
Two Previous Consecutive Losses	134
Two Previous Consecutive Losses and Current Win	40
Total Games Considered	410

The conditional probability that Portland Trail Blazers would win current game given a loss in prior game can be modelled as,

$$P(X_i = 1|X_{i-1} = 0) = \frac{P(X_i = 1, X_{i-1} = 0)}{P(X_{i-1} = 0)}, 2 \leq i \leq n \tag{2}$$

The conditional probability that Portland Trail Blazers would win current game given two consecutive losses in prior games can be modelled as,

$$P(X_i = 1|X_{i-2:i-1} = 0) = \frac{P(X_i = 1, X_{i-2:i-1} = 0)}{P(X_{i-2:i-1} = 0)}, 3 \leq i \leq n \tag{3}$$

The conditional probability that Portland Trail Blazers would win current game given a win in prior game can be modelled as,

$$P(X_i = 1|X_{i-1} = 1) = \frac{P(X_i = 1, X_{i-1} = 1)}{P(X_{i-1} = 1)}, 2 \leq i \leq n \tag{4}$$

The conditional probability that Portland Trail Blazers would win current game given two consecutive wins in prior games can be modelled as,

$$P(X_i = 1|X_{i-2:i-1} = 1) = \frac{P(X_i = 1, X_{i-2:i-1} = 1)}{P(X_{i-2:i-1} = 1)}, 3 \leq i \leq n \tag{5}$$

in which win and loss are denoted by 1 and 0 accordingly, X_i indicates Jail Blazer's game result in i^{th} game, n indicates total number of games between 1999 - 2004.

The Hot Hand analysis has been examined by an entire scientific community, who supported very different theories. Amongst the researchers, who disproved the reliability of its implication, their approach was often related to the fact that the assessment, which was based on a small sample, was performed with a noticeable bias. For this reason, the quality of the results should be viewed as a general reference, rather a strong evidence. On the other hand, the Hot Hand analysis which focused on a specific player's performance on the court has gained more credentiality (Gilovich et al., 1985).

2.3.3 Week Day Bias

The weekend warriors is a concept, which has been employed in various popular cultural media to describe the athletes who displayed a better performance in the weekend games, when the media coverage is more aggressive, than other week day games (Christensen, 2007). Jail Blazers were a group of young ball players and their mental state wobbled, whenever the pressure was overwhelming. Some of the lads displayed an increased tendency to initiate a verbal dispute with the officials, others had a habit to emblazon their signature skills, such as the fancy dribbles or backward ball passes, which gave the opponent team an opening to steal the ball away, when the number of TV views increased. Therefore, it is adequate to investigate if Portland's winning against a group of specific teams in the Western Conference (San Antonio Spurs, Phoenix Suns, Denver Nuggets, Golden State Warriors, Los Angeles Clippers and Los Angeles Lakers) has a relation with which day of the week they are playing. The reason to include Los Angeles Clippers, Denver Nuggets and Golden State Warriors was to consider a mix of, relatively weaker teams of the Western Conference along with Los Angeles Lakers and San Antonio Spurs, which were two strong teams during the years 1999 - 2004. Phoenix Suns was a team which performed relatively well in years 1999 - 2001, on the other hand, their performance deteriorated in following years.

The procedure of a χ^2 test is by all means straight forward. To begin with, the result from the χ^2 test would reveal the distribution of the number of observed winning games for certain day against expected winning games of that day, which was used to identify presence of underlying relation. The incentive of performing a χ^2 test is to find out if the likelihood of winning the game on a certain day of the week is higher than others. The test per se followed the following algorithm:

$$\chi^2_{statistics} = \sum_{i=1}^{n} \frac{(X_i - \mathbb{E}[X_i]))^2}{\mathbb{E}[X_i]} \tag{6}$$

in which X_i denotes the observed value on day i and E denotes the expectation value and $n = 7$ denotes the total number of days in a week.

2.4 Skill Plus and Minus

The individual skills were evaluated, in terms of the on-court chemistry of the core squad; the employed data were collected from the play-to-play score, rather than the box score plus and minus metric, which was based on the traditional box scores. The incentive behind this choice was the fact that certain players might not be considered as the outstanding basketball heroes by themselves, as a group, the squad could crush the strongest opponent. The skill plus and minus (SPM) is an assessment, which evaluates whether a group of players could complement each other well on the court, both in a offensive play, also a defensive play(Kuehn, 2016). The blue-print of the current algorithm was based on the statistical investigation of the on court chemistry (Goldberg, 2020).

The assessment procedure was based on the play-to-play data, fetched separately from each and every game. The data summarise both the defensive play and the offensive play, also the on-court collaborations between the players. Two arrays of rebound data were included, the defensive rebound and the offensive rebound. According to Goldberg and

Rao, the offensive rebounding requires a higher degree of self-focus and self-confidence (Goldman & Rao, 2012). Some of the younger players often displayed a poor mental strength, for this reason, the inexperienced players often displayed a less satisfactory performance, in the heat of the moment. The following offensive play-to-play data were included in the analyses:

- field goal attempt/game: the evaluation of scoring burden
- personal fouls drawn/game: the evaluation of the ability to draw fouls
- free throw attempt/field goal attempt: the evaluation of the general ratio
- free throw %: the evaluation of the ability to convert shooting fouls
- % of 2-pt FGM assisted: the evaluation of the tendency to create 2-pt shots
- % of 3-pt FGM assisted: the evaluation of the tendency to create 3-pt shots
- AST/teammate FGM: to evaluate the tendency to facilitate other players' actions
- Lost balls/game: to evaluate the tendency to lose the ball
- Bad passes/game: to evaluate the tendency to throw bad passes
- Travels/game: to evaluate the tendency to travel
- Offensive fouls/game: to evaluate the tendency to commit offensive fouls
- % of FGA by region, in this analysis, the 2P and 3P field goals have been discritised into four distinct different regions: to evaluate the distribution of FGA distances
- FG % by region: to evaluate the efficiency from different distances

The following defensive play-to-play data are included:

- Block rate: to evaluate the tendency to protect the possessions of the ball
- Steals/play: to evaluate the ability to steal the ball from the opponents' possession
- PF/play: to evaluate the tendency to commit defensive fouls
- Opponent TO/play: to evaluate the ability to generate turnovers

The following rebound data are included:

- Offensive rebounding rate: to evaluate the ability to grab offensive boards
- Defensive rebounding rate: to evaluate the ability to grab defensive boards

Two additional variables are included in the clustering, the regularised adjusted plus/minus data, $RAPM$, for both defensive and offensive play, based on the traditional plus and minus game scores; the game-specific box plus and minus scores for each players were fetched from the game log.[6] The adjusted plus and minus score measures contribution

[6]The box scores were based on their on court play-to-play scores, based on the video footage. `https://www.nba.com/stats/`

of each player on the scoring margin of a specific game; the margin depends on both the home team's, also the opponent team's performance on the court(Rosenbaum, 2004). The margin of an arbitrary game i is:

$$Y_i = \beta_1 \cdot A_{1,i} + \beta_2 \cdot A_{2,i} + \beta_3 \cdot A_{3,i} + \beta_4 \cdot A_{4,i} + \beta_5 \cdot A_{5,i} + \beta_6 \cdot B_{1,i} + \beta_7 \cdot B_{2,i} + \beta_8 \cdot B_{3,i} + \beta_9 \cdot B_{4,i} + \beta_{10} \cdot B_{5,i} \tag{7}$$

in which Y_i denotes the margin from game i, β denotes the intercept coefficient vector, A denotes the home team player and B denotes the opponent team player. According to the original publication, the intercept coefficient could be obtained by performing the ordinary linear regression, based on a large data set. The performance of all the studied players from all the games is denoted with the matrix X. The β vector could be obtained by a standard minimisation procedure. In the current study, the number of games, which were played between the Jail Blazer lads and the other teams on the Western Conference is far less than 6000. For this reason, a Bayesian ridge regression technique based statistic method is the preferable option(Maymin, Maymin, & Shen, 2013). The most important assumption is that the distribution of the margins from the studied games could be regarded as a Gaussian distribution. To begin with, to multiply both sides of the last equation with the transposed version of matrix X:

$$X^T \cdot Y = (X^T \cdot X) \cdot \beta \tag{8}$$

An additional regularisation factor was introduced on the right hand side, intending to eliminate the degree of over-fitting, when performing the linear regression.

$$X^T \cdot Y = (X^T \cdot X + \lambda \cdot I) \cdot \beta \tag{9}$$

in which I is the identity matrix and λ depends on the variance of game margins. The intercept coefficient could therefore be obtained with the following expression:

$$\beta = \frac{X^T \cdot Y}{X^T \cdot X + \lambda \cdot I} \tag{10}$$

The magnitude of the β vector could be obtained by performing the standard singular value decomposition procedure(James, Witten, Hastie, & Tibshirani, 2013).

Before the clustering process, the play-to-play data were sorted. The players, which played less than 15 games in the studied season were not included in the clustering process. The utilised data were averaged over the games, which the players participated. For this reason, the players, who participated a small number games, could sometimes obtain a very impressive score, if they performed well, when the team combated against a relatively weak team.

The unsupervised clustering of each player's skill in the entire league involved the following steps:

I 30 features were included initially, fetched from the play-to-play scores. Two $RAPM$ variables were also included as the two last variables. The magnitude of each random variables was scaled to a comparable level, prior the clustering procedure.

II The dimension reductions were achieved by using a non-linear embedding technique, the isomap method. This procedure was proposed in Goldman's original investigations (Goldberg, 2020).

III The players would be clustered into a number of clusters, with K-means method. The players in each cluster would be investigated further, in combination with their trademark skills, and their defensive short-comings, based on the tabulated values(Kuehn, 2016).

The aim is to evaluate the core players' skill, which should be evaluated in conjunction with the performance of the rest of the team. The result could shed a light on which mistakes, the management group made, when replacing three of the most dominating players with other players, which have performed well in their university teams. Some of the new players might be brilliant players in terms of their individual skills, however they could not maximise the performance of the team amidst a crowd of professional aggressive players.

2.5 Predicting The Outcome of The Games

In this project, we would like to propose a new method to predict the outcome of a game, based on the results, which were obtained from the previous statistical analyses, by using gradient boosting machine (Friedman, 2002), which converts a number of weak algorithms into one powerful learning machine. The training proceeded sequentially, in a graduate and additive style. The advantage of using gradient boosting method, over a non-parametric classification method, such as the support vector machine or neural network, is the fact that the input random variables could be both numerical data and categorical data at the same time. The classification could be achieved step-wise.

The gradient boosting machine is a supervised machine learning method, which is based on a number of ensemble trees and the prediction is achieved step-wise. The performance data were the target variable x_i and the results were the predictor variable y. Initially, the first prediction is obtained with the following algorithm:

$$f(x_i) = \frac{\sum_{i=1}^{n} y_i}{n} \tag{11}$$

In each step, the output is predicted by a small number of weak classifiers. The residues, which are used to optimise the classifier of the next step, could be obtained with the mean square error method:

$$L(f) = \frac{1}{2N} \sum_{i=1}^{N} (y_i - f(\bar{x}))^2 \tag{12}$$

in which y is the real value, $f(\bar{x})$ is the predicted value and N is the number of element. The goal of the step-wise classification procedure was the minimise the residues. The negative gradient of each class could be obtained with the following equation:

$$-g_A(x_i) = -\frac{\partial L(f)}{\partial F_A(x_i)} \tag{13}$$

in which g_A is the gradient of an arbitrary class, A. The regression tree h updates with the help of the negative gradients. Thereafter, the model updates, with the updated regression tree:

$$F_{nextstep} = F_{current} + \rho \cdot h \tag{14}$$

ρ is a regularisation factor, which varies between 0 and 1. A new step begins, following the same procedure.

The prediction occurred sequentially for both predicted seasons. The most articulating incentive of this prediction paradigm was the fact that the team was transforming through the seasons. In season 1999-2000, three new players joined the team, in the beginning of the season, including their stellar small forward Scottie Pippen. The players were cordial towards each other on the court, learning how to play as a team. However, three experienced players soon found a strategy to play with each other. On the other hand. the season 2003-2004 was a chaotic season. Many players were traded away and many other new players were recruited.

We would like to propose to use the following variables to perform the result predictions. In this list, we also include our incentive behind each and every selection choice.

- The logarithmic salary difference between the offensive players from the two teams: the skill of the offensive players determine the number of field goal attempt, also the likelihood to score the free throws.
- The logarithmic salary difference between the defensive players from the two teams: the skill of the defensive players is the foundation of a team's performance.
- The location of the match, two variables are included, either home or away: The home crowd advantage is a highly disputable theory. The previous statistical investigation might be able unveil whether the home crowd had any impact on the performance.
- The week day of the match date: some of the younger players are often the weekend warriors, who outperform themselves in the weekend games (Fort-Vanmeerhaeghe, Montalvo, Latinjak, & Unnithan, 2016).
- The game result of the previous game: some players plays better, if the team has been winning frequently in the previous games; other players have a palpable tendency to over-compensate on the court, if their previous results are less satisfying.
- The number of minutes, each type of players have played on the court. If the number of SPM clusters is eight, the number of variables would be 16. If two players belong to the same cluster, the result is the sum of both players' playing time on the court.

The incentive of using this model to predict the result of a specific match are:

- The prediction of the result of a game is based on the compositions of the players from both teams, also their momentary market values.
- The Jail Blazers were a herd of young lads, who were balancing between the temptations and the worldly consequences.
- The comparison between the player compositions between 2003 and 2005 might give the posterity an indication how to collect an effective group of players, when combating against the strongest team in the league.

3 Result Outline

The results from the statistical calculation are outlined in this section. Three seasons have been studied exclusively, in this project:

- season 1999 to 2000: Portland enjoyed its glorious days. In the regular season, they won 59 out of 81 games. Young Rasheed Wallace and Damon Stoudamire played along with the experienced basketball hall of famers, such as Scottie Pippen, Arvydas Sabonis and Steve Smith.
- season 2003 to 2004: It is the beginning of the end of Jail Blazers' golden days. In the regular season, they won 50 out of 81 games. Rasheed Wallace was suspended from multiple games, after his mental break downs in the middle of the game. The young Zach Randolph, who was awarded as the most improved player of the year in NBA; he also became Portland's heaviest offensive machinery. Bonzi Wells was traded away in the middle of the season. Soon after, the club traded most of the other bad boys away.
- season 2005 to 2006: A new team took over. They won only 21 out of 82 games. Portland Trail Blazers officially became the bottom tier of the North West division in the Western conference.

3.1 Salary Budget of Portland Train Blazers, between 1998 and 2006

In this section, the choice of players were studied in terms of the total team salary budget, in the Jail Blazers' years. The intention was to find out if an increased budget would always entail a better performance on the court.

The salary budget and individual annual salary of the most expensive players are outlined in this section, the intention is to highlight which players required the highest economic reward. The bar chart plot of the total annual salaries between 1998 and 2006 are displayed on figure 1. The team achieved their best record in season 1998 - 1999, when they employed an arsenal of top guns who required a high salary, also a group of promising young players, who required a relatively humble reward. With the years, they began to trade a number of more established players to Portland, nevertheless the number of winning games in each regular season decreased. When they traded away Damon Stoudamire and Rasheed Wallace, after season 2003 - 2004, intending to rebrand their image, their performance declined drastically. The total salary budget was back to a similar level, as the season 1998 - 1999. In season 2005 - 2006, the team only won 21 games out of 82 in the regular season.

In season 1998 - 1999, Portland Trail Blazers was the champion of Pacific division; the top paid players were:

- Damon Stoudamire (25 years old): 9 000 000 USD
- Rasheed Wallace (24 years old): 9 000 000 USD

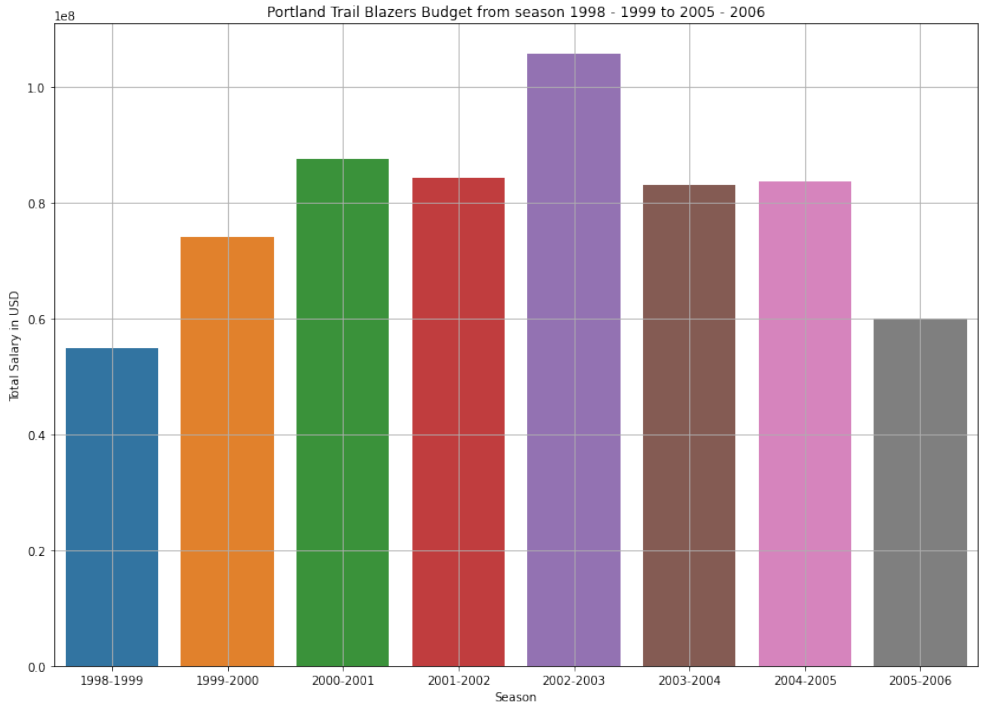

Figure 1: Portland Trail Blazers salary between 1998 and 2006

- Arvydas Sabonis (34 years old): 9 000 000 USD
- Brian Grant (26 years old): 6 000 000 USD

In season 1999 - 2000, Portland Trail Blazers played in Western Conference finals and secured 2^{nd} place in Western Conference; the top paid players were:

- Scottie Pippen (34 years old): 14 795 642 USD
- Rasheed Wallace (25 years old): 10 800 000 USD
- Damon Stoudamire (26 years old): 10 125 000 USD
- Arvydas Sabonis (35 years old): 9 818 481 USD

In season 2000 - 2001, Portland Trail Blazers' performance declined significantly and ended up at 4^{th} place in Pacific Division; the top paid players were:

- Scottie Pippen (35 years old): 13 750 000 USD
- Rasheed Wallace (26 years old): 12 600 000 USD
- Shawn Kemp (31 years old): 11 720 000 USD
- Arvydas Sabonis (36 years old): 11 250 000 USD
- Damon Stoudamire (27 years old): 11 250 000 USD

In season 2001 - 2002, Portland Trail Blazers' performance remained relatively unchanged but they ended up at 3^{rd} place in Pacific Division; the top paid players were:

- Scottie Pippen (36 years old): 18 083 564 USD
- Rasheed Wallace (27 years old): 14 400 000 USD
- Shawn Kemp (32 years old): 12 660 000 USD
- Damon Stoudamire (28 years old): 12 375 000 USD

In season 2002 - 2003, Portland Trail Blazers' retained their 3^{rd} place in Pacific Division; the top paid players were:

- Scottie Pippen (37 years old): 19 727 524 USD
- Rasheed Wallace (28 years old): 16 200 000 USD
- Shawn Kemp (33 years old): 12 621 028 USD
- Damon Stoudamire (29 years old): 12 375 000 USD

In season 2003 - 2004, Portland Trail Blazers' continued to retain their 3^{rd} place in Pacific Division; the top paid players were:

- Rasheed Wallace (29 years old): 17 000 000 USD
- Shawn Kemp (33 years old): 14 941 935 USD
- Damon Stoudamire (30 years old): 12 375 000 USD

In season 2004 - 2005, Portland Trail Blazers' performance declined further and finished at 4^{th} place in Northwest Division; the top paid players were:

- Shareef Abdur-Rahim (28 years old): 14 625 000 USD
- Damon Stoudamire (31 years old): 12 500 000 USD
- Nick Van Exel (33 years old): 11 933 252 USD
- Theo Ratliff (31 years old): 10 937 500 USD

In season 2005 - 2006, Portland Trail Blazers' finished at 5^{th} place in Northwest Division; the top paid players were:

- Theo Ratliff (32 years old): 11 666 666 USD
- Zach Randolph (24 years old): 10 666 667 USD
- Derek Anderson (31 years old): 9 093 000 USD

3.2 Assessment of Home Crowd Advantage

The assessments of home crowd advantage, in season 1999 - 2000, season 2003 - 2004 are outlined in this section. Their performance in the home games were compared with the game results from the away game, important parametres, such as the salary differences and score difference were included in the assessment.

3.2.1 Game Statistics versus Salary Budget, Season 1999 - 2000

The game statistics of Portland Trail Blazers in the season 1999 - 2000 were analysed and the results are outlined in this section. Two random variables were utilised, when performing linear regression, the score fluctuation, and the logarithmic difference in salaries between two teams, aiming to obtain a general trend. The intention was to verify if a more expensive team might win more frequently. Portland's home games during season 1999 - 2000 were visualised, see figure 2, the difference in salary displayed an increasing trend along with score difference, a team that had lower cumulative salary than Portland had a higher score difference with Portland. Furthermore, the game results of Portland's road games are displayed on figure 3. A similar trend, in terms of the sharper increase in score difference with salary, could be obtained as well.

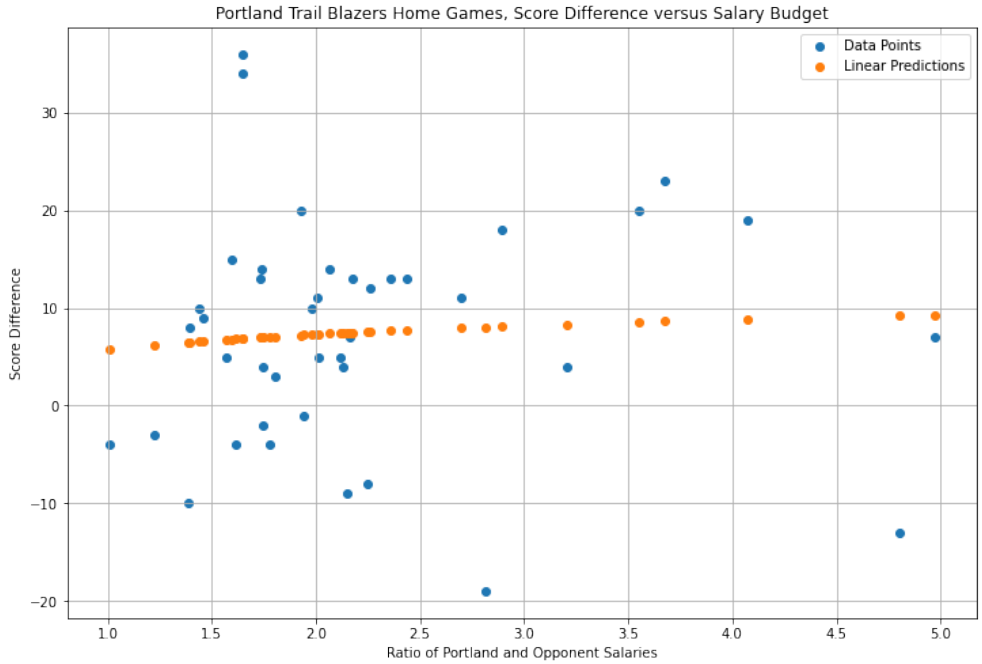

Figure 2: Portland Trail Blazers Home Games, salary disparity versus score difference, Season 1999 - 2000

3.2.2 Game Statistics versus Salary Budget, Season 2003 - 2004

The game statistics of Portland Trail Blazers in season 2003 - 2004 were analysed and results are outlined in this section. The home game results of this season does not follow the same trend, as the home game results from season 1999 - 2000. Portland was more likely to loss against a team, which had a lower budget, when playing in Rose Garden, see figure 4. When scrutinising the game statistics in detail, it was obvious that the Jail Blazers lost most of their home games during the winter months, when some of the players were traded away from Portland. The new players, who arrived at the same time, performed moderately well, when combating on the court with their new team mates.

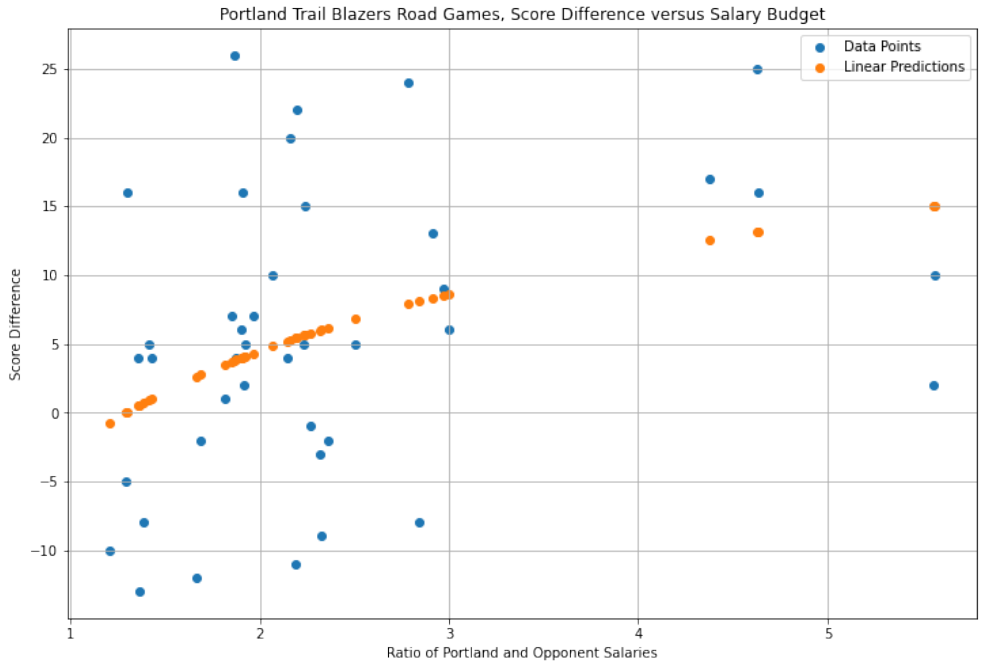

Figure 3: Portland Trail Blazers Road Games, salary disparity versus score difference, Season 1999 - 2000

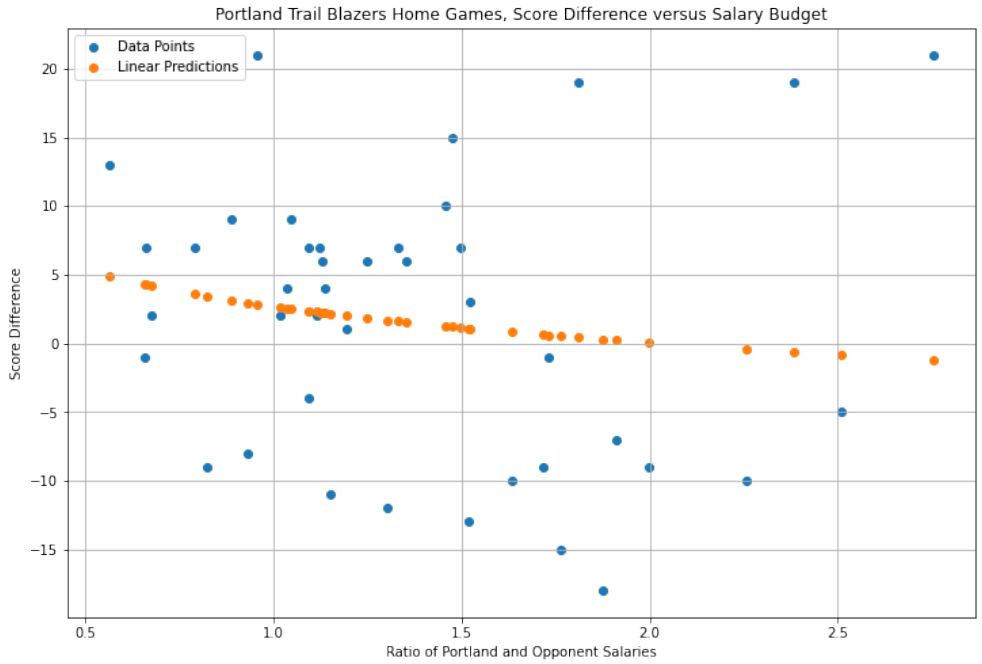

Figure 4: Portland Trail Blazers Home Games, salary disparity versus score difference, Season 2003 - 2004

The results of the road games are displayed on figure 5, the slop of the general slop is not as steep as the trend, which was obtained previously. The magnitude of the intercept is negative, which indicates that they were more prone to lose in a road game. The game statistics confirmed this founding as well.

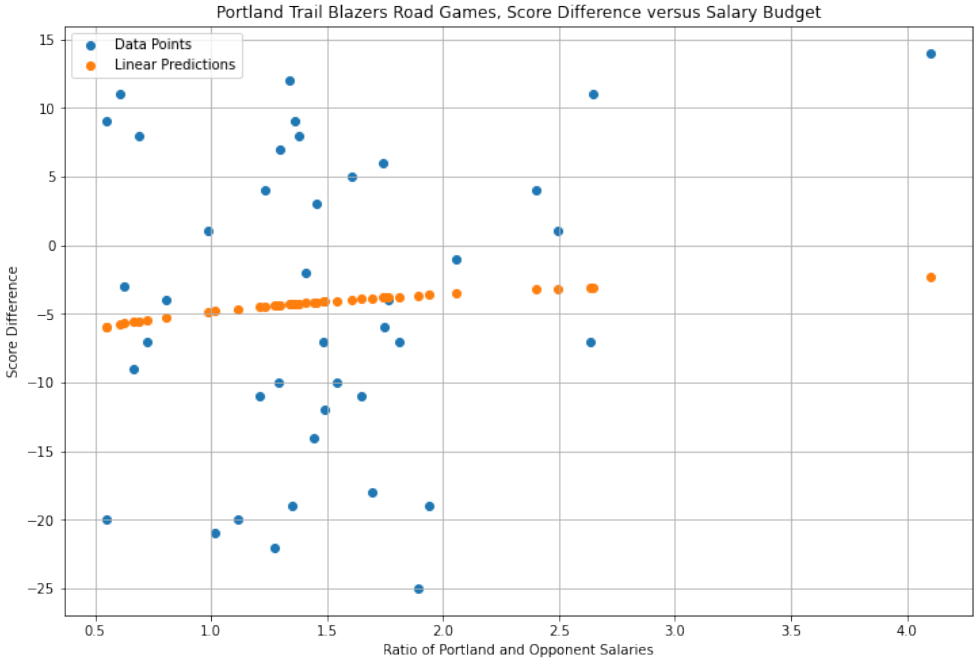

Figure 5: Portland Trail Blazers Road Games, salary disparity versus score difference, Season 2003 - 2004

3.2.3 Hypothesis Tests for Home Crowd Advantage

The calculated results of home crowd advantage for each metric between seasons 1999 - 2000 and 2003 - 2004, for the Portland Trail Blazers, are outlined upon table 3. The hypothesis test for each metric has been assessed at 99.5% level.

The hypotheses for the home crowd assessment are formulated as follow,

- H_0 : − Portland Trail Blazers' playing at Rose Garden arena [7] had no noticeable impact on the metric, whilst playing against a team in a road game.
- H_1 : − There was statistically significant difference in metric for Portland when playing against a certain team at home and away.

Statistical hypothesis tests were performed using student t-value at 99.5% level for each metric. The results, which are displayed upon table 3 for Score Difference metric, act as a new evidence which reveal that when Portland Trail Blazers played against Los Angeles Clippers, the home crowd advantage could be statistically assessed; however, the other assessments, within the Western Conference, see the Score Difference metric, give a different narrative, the impact of the home crowd advantage was relatively vague. Result displayed upon table 3, for metrics Field Goal % and Free Throw % from attest to absence of home crowd advantage for playing against any of the teams considered from Western Conference. The results, which are displayed on table 3, for metric offensive rebound, emphasise that Portland Trail Blazers had a pronounced home crowd advantage in playing against Los Angeles Lakers; however, there was no obvious home crowd advantage

[7]Rose Garden arena, in Portland, Oregon, was the home court of Portland Trail Blazers. From the beginning, the arena was owned by Paul Allen, one of the co-founders of Microsoft. In August 2013, the franchise changed its name to Moda Center `https://bleacherreport.com/articles/1736748-portland-trail-blazers-rename-home-arena-from-rose-garden-to-moda-center`.

Table 3: Home Crowd Advantage for Portland Trail Blazers , between seasons 1999 - 2000 and 2003 - 2004

Metric	Null Hypothesis Not Rejected	Null Hypothesis Rejected
Score Difference	Los Angeles Lakers San Antonio Spurs Phoenix Suns Golden State Warriors Denver Nuggets	Los Angeles Clippers
Field Goal%	Los Angeles Lakers San Antonio Spurs Phoenix Suns Los Angeles Clippers Golden State Warriors Denver Nuggets	None
Free Throw%	Los Angeles Lakers San Antonio Spurs Phoenix Suns Golden State Warriors Denver Nuggets Los Angeles Clippers	None
Offensive Rebound	San Antonio Spurs Phoenix Suns Golden State Warrior Denver Nuggets Los Angeles Clippers	Los Angeles Lakers

against the rest of teams from Western Conference when playing at home.

In conclusion, the list of the locations of the game, home or away, should be included in the gradient boost prediction.

3.3 Assessment of Hot Hand Fallacy

The assessments of the hot hand condition are outlined in this section. The estimated results of the hot hand condition, based on Portland Trail Blazers' play statistics, between seasons 1999 - 2000 and 2003 - 2004, are outlined upon table 4.

Table 4: Hot Hand Assessment of Portland Trail Blazers' performance , between Seasons 1999 - 2000 and 2003 - 2004

Events	Conditional Probability in %
Winning current game if they lost one previous game	58.35
Winning current game if they lost 2 previous games	29.85
Winning current game if they won one previous game	62.24
Winning current game if they won 2 previous games	61.29

After winning one or two games, the Portland Trail Blazers lads often displayed an increased fighting spirit on the court compared to one or two consecutive losses in games. For this reason, the previous game results should be included in the gradient boost prediction.

3.4 Assessment of Week Day Bias

The assessment of week day bias has been outlined in this section. Portland Trail Blazers' performance against six teams of Western Conference, including Los Angeles Lakers, San Antonio Spurs, Phoenix Suns, Los Angeles Clippers, Golden State Warriors and Denver Nuggets, were closely scrutinised numerically. The data, which were used in this survey are presented on table 5.

Table 5: Portland Trail Blazers Assessment of Week Day Bias, between Seasons 1999 - 2000 and 2003 - 2004

Day of the Week	Number of Games	Number of Games Won	Number of Games Lost
Monday	3	3	0
Tuesday	15	7	8
Wednesday	17	13	4
Thursday	8	6	2
Friday	13	8	5
Saturday	13	8	5
Sunday	11	4	7

Portland Trail Blazers played more matches against these six teams on Tuesday and Wednesday than Monday and Thursday, in order to determine the veracity of the general trend, the following hypotheses were formulated, aiming to investigate if there was an noticeable week day bias amongst the studied game data.

- $H_0 : -$ The selection of the week day did not have any noticeable impact on the out come of the game.
- $H_1 : -$ There was a statistically significant advantage to play on certain day of the week for Portland Trail Blazers.

The hypothesis test utilised χ^2 statistical measure at 99.5% level with 6 degree of freedom. The degree of freedom, df, in the calculation is based on seven different random variables.

$$df = n - 1 \tag{15}$$

in which, n denotes the number of random variables.

According to the Gregorian calendar, the number of days in a week is seven, the degree of freedom is therefore six. The tabulated threshold value at 99.5% should be less than 18.5475, if the degree of freedom is 6 (Johnson & Wichern, 2007). The obtained value from the current χ^2 assessment was 9.1428, which was lower than the threshold value, for this reason the null hypothesis could not be rejected. The choice of week day had no effect on winning the game. When predicting the game outcome with gradient boost machine, the week day should not be used as one of the variables.

3.5 The Assessment of the Condition of the Teams

The general condition of each team in the three studied seasons was scrutinised further with K-means clustering method. The intention was to assess the skill diversity within each team in a given season.

3.5.1 Season 1999 - 2000

Season 1999 - 2000 is a successful season for the newly forged fantasy team, Portland Trail Blazers. Three of the Olympic dignitaries played on the court together with three of the best Jail Blazers Damon Stoudamire, Rasheed Wallace and Bonzi Wells. The team was vicious in the offensive play, and their defensive play was nonetheless impressive as well, in comparison with other teams, in the Western Conference. The lads won 59 out of 82 games during the regular season. In the play-off season, they defeated Minnesota Timberwolves in the first round and the Midwest division champion Utah Jazz in the second round. The most powerful treasure in Utah was the power forward, Karl Malone, who was 36 years old and the best point guard in NBA's history, John Stockton, who was 37 years old. In the semi-finals, the Jail Blazers fought courageously against the NBA champion Los Angeles Lakers, nevertheless they succumbed to Lakers in the seventh game, which employed one of the most expensive squad in the league. Shaquille O'Neal, who was 27 years old, enjoyed the prime years of his career. The young star, Kobe Bryant, who was only 21 years old, demonstrated clearly that he was destined to become the most powerful shooting guard in NBA.

The cluster formations were performed, based on the method, which was described in section 2,1. The results were based on the performance data of 434 players from all NBA teams; all of which played 15 or more games. Four distinct clusters were obtained with the described methodology, see figure 6. The representative players from each cluster are outlined upon table 6.

The average distance between the player and their respective centroid point, is a strong indicator of the diversity of skills within a team. The average distance of all NBA teams from season 1999 - 2000 are outlined on figure 7. The regression line demonstrates clearly that the best teams, the teams with the lowest ranking number, displays a larger average distance between the player and their respective centroid point. The results of the four of the best team, Los Angeles Lakers, Indiana Pacers, Miami Heat and Utah Jazz are

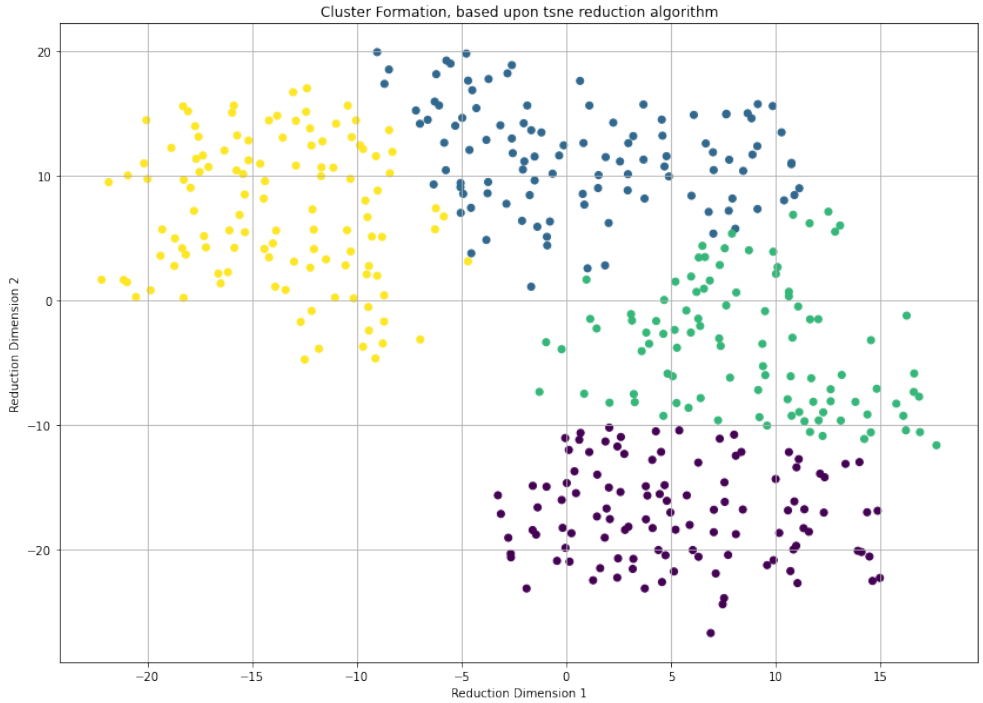

Figure 6: The cluster formations of Season 1999 - 2000

Table 6: The cluster formations, Season 1999 - 2000

Cluster	Skills	Players
cluster one	a flexible defensive small forward alternatively an offensive point guard	Rasheed Wallace Arvydas Sabonis Detlef Schrempf
cluster two	a group of flexible small forwards they are equally dexterous both as a guard and as a forward	Damon Stoudamire Scottie Pippen Steve Smith
cluster three	a strong defensive guard who is a master in stealing ball in near field combat	Jermaine O'Neal John Stockton Grant Hill
cluster four	a powerful power forward or centre	Greg Antonio Karl Malone Jermaine Jackson

outlined in appendix B, at the end of the report.

The skills of the Portland lads from this season are outlined on figure 8. Their three most powerful line-ups through the season were:

- Scottie Pippen, Arvydas Sabonis, Steve Smith, Damon Stoudamire and Rasheed Wallace
- Greg Anthony, Brian Grant, Detlef Schrempf, Steve Smith and Rasheed Wallace
- Jermaine O'Neal, Scottie Pippen, Steve Smith, Damon Stoudamire and Rasheed Wallace

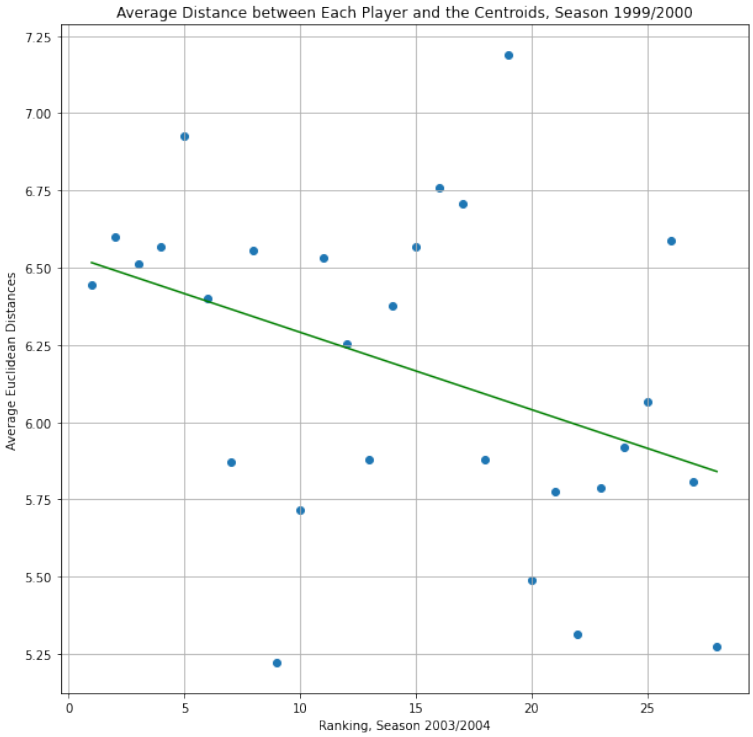

Figure 7: The average distance between a player and the respective centroid point, Season 1999 - 2000

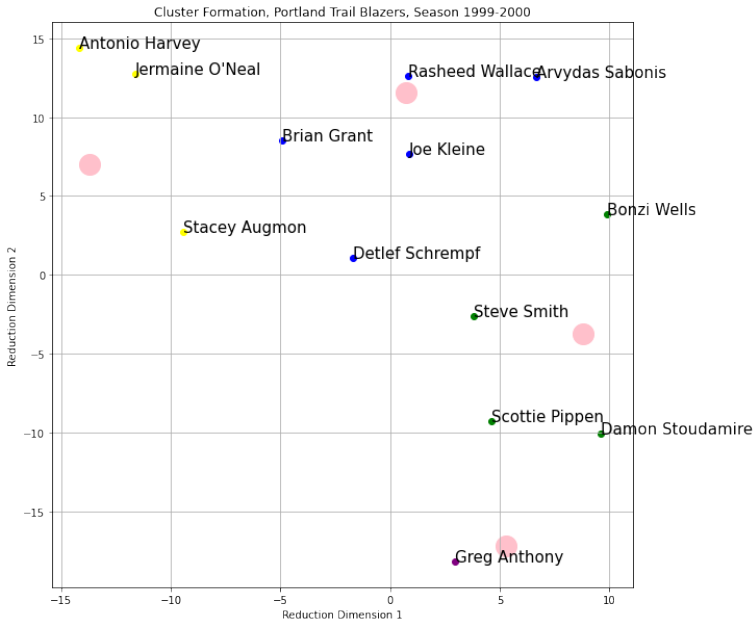

Figure 8: The performance of the players from Portland Trail Blazers, Season 1999 - 2000

Although three of the players were experienced basketballer, who had played a number of important international championship games; however, none of the players could be qualified as the outliers, in comparison with John Stockton, Anthony Carter, Karl Malone or Kobe Bryant, see the figures in appendix B1. The calculated average distance of team Portland was 5,85, whilst the NBA champion team Los Angeles Lakers was 6,45.

3.5.2 Season 2003 - 2004

The rankings in the Western conference changed radically in season 2003 - 2004. The champion of Midwest Division was Minnesota Timberwolves, see figure 35. Their best player in this season was Kevin Garnett, who was elected as the most valuable player in NBA in this season. The champion of Pacific Division was again Los Angeles Lakers, see figure 36, which employed a number of famous Olympians, for instance Shaquille O'Neal, Kobe Bryant, Gary Payton and Karl Malone. Los Angeles Lakers reached to the NBA final at the end, however was defeated by Detroit Pistons, which employed Rasheed Wallace in the second half of the season.[8] Portland Trail Blazers never made to the play-off season, they won nevertheless 41 out of 82 games during the regular season. Three years earlier, they traded the centre Jermaine O'Neal to Indiana Pacers, for Dale Davis; he was voted into the NBA All-Star team six times in his career.[9] Portland's most ferocious centre, Arvydas Sabonis made a conscientious decision to leave NBA in the beginning of 2003, to move back to his native country, Lithuania.[10]

The cluster formations were based on the performance of 439 players from all NBA teams; all of them had played 15 games or more. Four distinct clusters were obtained with the described methodology, see figure 9. The representative players from each cluster are outlined upon table 7.

Table 7: The cluster formation of teams, Season 2003 - 2004

Cluster	Skills	Players
cluster one	a strong defensive guard who is a specialist of assist	Qyntel Woods Jason Kidd Gary Payton
cluster two	a very flexible small forward or an offensive point guard	Derek Andersson Horace Grant Damon Stoudamire
cluster three	a powerful power forward or a centre who often scored 2p field goals	Zach Randolph Kobe Bryant Latrell Sprewell Kevin Garnett
cluster four	a player who could act both as a flexible small forward or a powerful shooting guard	Ruben Patterson Horace Grant Brian Grant

The average distances between the players and each centroid points are outlined upon

[8] Rasheed Wallace was traded from Portland to Atlanta, prior season 2003-2004; he was 29 years old, enjoyed his prime years of his basketball career. In February, he was traded from Atlanta to Detroit. `https://www.nba.com/pistons/news/rwallace_040219.html`

[9] Jermaine O'Neal was one of the important players upon the front court, together with Arvydas Sabonis, Rasheed Wallace, and Clifford Robinson. In late summer 2000, Jermaine O'Neal was traded to Dale Davis, who was voted into the All-Star team 2000. `https://nbatrades.tumblr.com/post/30903207675/jermaine-onealdale-davis-trade`

[10] Arvydas Sabonis was a legendary basketball player, who was elected in the last Soviet national basketball team at the end of the eighties. In 2003, he announced that he would finalise his professional basketball career in his native Lithuania.[11]

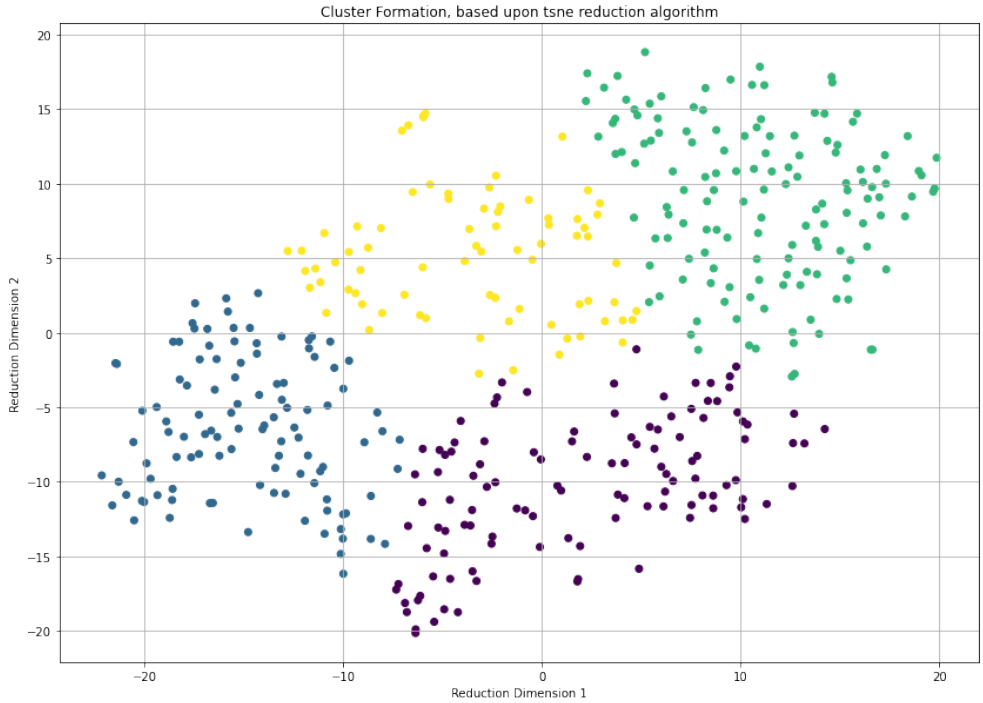

Figure 9: The cluster formations of Season 2003 - 2004

figure 10. The utilised index of each team depends on the team's performance during the regular season. The first team is Detroit Piston, which was the NBA champion of the season. The next team is Los Angeles Lakers. The last team is Orlando Magic, which won 21 games, during the regular season. The calculated average distance between the Portland Trail Blazers players and their respective centroid points is 6,21, the locations of each players are outlined on figure 11. The big, pink spots show the locations of the four centroid points. The average distance of Los Angeles Lakers was as high as 7,4, due to the fact that they possessed a few of the most successful forwards and centres.

The skills of the best Portland squads from this season are outlined on figure 11. Their three most powerful line-ups through the season were:

- Derek Anderson, Darius Miles, Zach Randolph, Theo Ratliff and Damon Stoudamire
- Derek Anderson, Dale Davis, Darius Miles, Zach Randolph and Damon Stoudamire
- Ruben Patterson, Wesley Person, Zach Randolph, Damon Stoudamire and Rasheed Wallace

The most employed squads in season 2003 - 2004 were all very experienced players, who were around 30 years old, except the young Zach Randolph. Some of them have played together in five or six years in Portland. According to the cluster formations in figure 11, Wesley Person, Derek Anderson and Rasheed Wallace possessed the most extraordinary skills. The absolute distance between them and the respective centroid points is higher than the average distance of the team. When studying their results per game closely, both Damon Stoudamire and Derek Anderson had developed into three points field goal specialists.

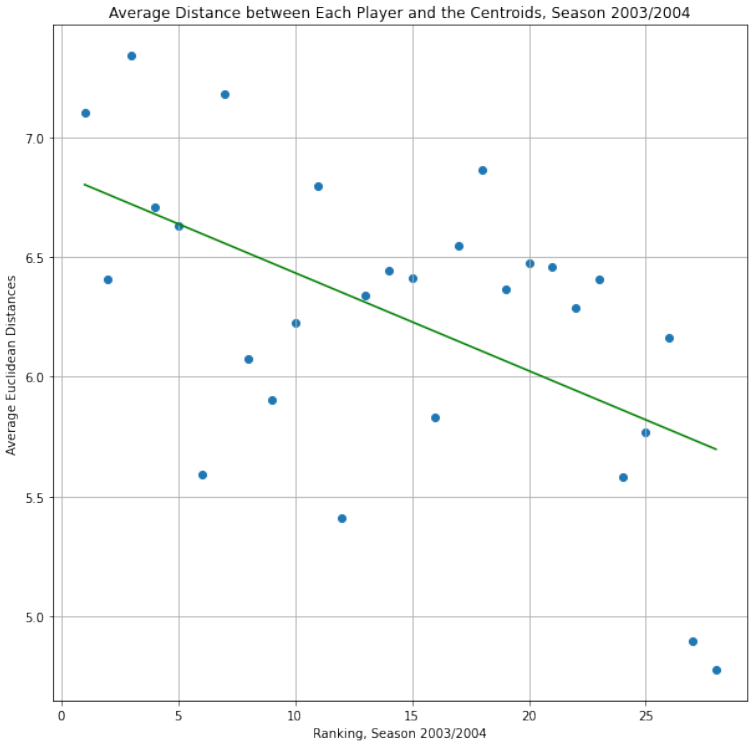

Figure 10: The average distances between each player and their respective centroid points, Season 2003 - 2004.

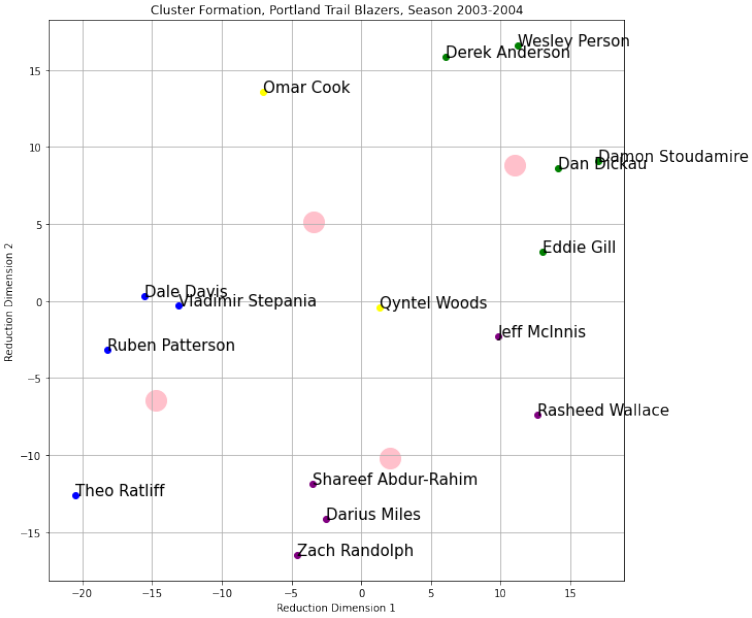

Figure 11: Portland players and the cluster formations, season 2003 - 2004.

3.5.3 Season 2005 - 2006

Most of the legendary Jail Blazers lads had been traded away by the season 2005 - 2006. The core squads were populated with a new group of players, nevertheless lead by one of the last Jail Blazer bad boys, Zach Randolph. In this season, Portland belonged to North West division. During the regular season, they won 21 games out of 82. The core squads

were made up by a group of lads, who never collaborated prior to the beginning of the season. Moreover, three of the lads in the core squad were younger than 25 years of age. Miami Heat, who recruited Portland's Derek Anderson, who was a moderately popular player amongst the Jail Blazer bad boys, won the NBA champion, after being traded to Houston.[12] Their most powerful artilleries in their expensive arsenal were the former Los Angeles Lakers' super stars, Shaquille O'Neal who was 33 years old and Gary Payton, who was 37 years old. Rasheed Wallace who played for Detroit Pistons, the champion of the Central Division, had developed into one of the best power forward in the league. Damon Stoudamire began to play for Memphis Grizzlies,[13] his team was qualified for the play-off season, however the Memphis lads lost their battle against Dallas in the first round.

The cluster formations were based on the performance of 456 players from all NBA teams; all of them had played 15 games or more. Four distinct clusters were obtained with the described methodology, see figure 12. The representative players from each cluster are outlined upon table 8.

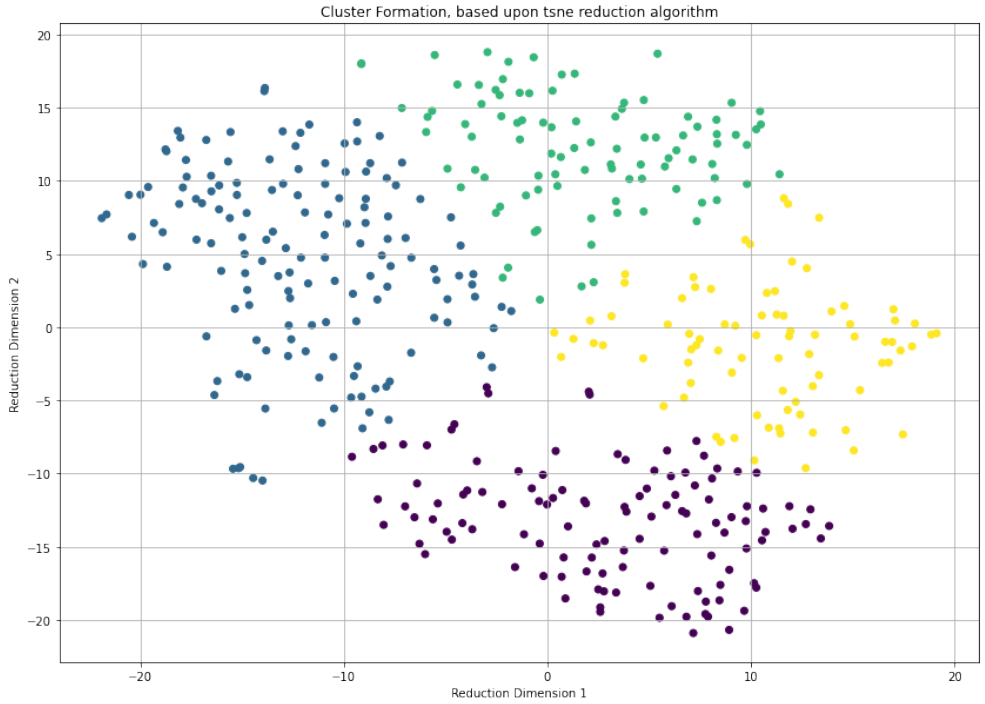

Figure 12: The cluster formations of Season 2005 - 2006

Portland Trail Blazers was a failure in season 2005 - 2006; the average distance between their players and their respective centroid points, see figure 13, is much lower than most

[12]Derek Anderson was traded to Miami Heat, via Houston Rocket, in season 2006 - 2006. Miami won over Dallas Maverick, after six difficult games. He was team with three hall of famers, Alonzo Mourning, Shaquille O'Neal and Gary Payton. `https://airalamo.com/2018/08/02/spurs-blazers-trade-derek-anderson-steve-smith/`

[13]Damon Stoudamire signed a four years' contract with Memphis Grizzlies, a bottom tier NBA team in South-West division, prior season 2005 - 2006. He was 32 years old. `https://www.nytimes.com/2005/08/06/sports/basketball/stoudamire-signs-with-memphis.html`

Table 8: The cluster formations, Season 2003 - 2004

Cluster	Skills	Players
cluster one	A dominant power forward some of them displayed their skill to score the 3P field goals This skill was more important than in the previous seasons	Juan Dixon Dirk Nowitzki Rasheed Wallace
cluster two	a viscous power forward or centre who scored many field goals in the front court	Zach Randohf Kobe Bryant Viktor Khryapa Kevin Garnett
cluster three	either a defensive forward or a centre or an offensive guard, who move freely between the front court and the defensive team	Brian Skinner Udonis Haslem Theo Ratliff
cluster four	a flexible guard, who was a specialist in stealing and scoring	Steve Blake Antoine Walker Lindsey Hunter

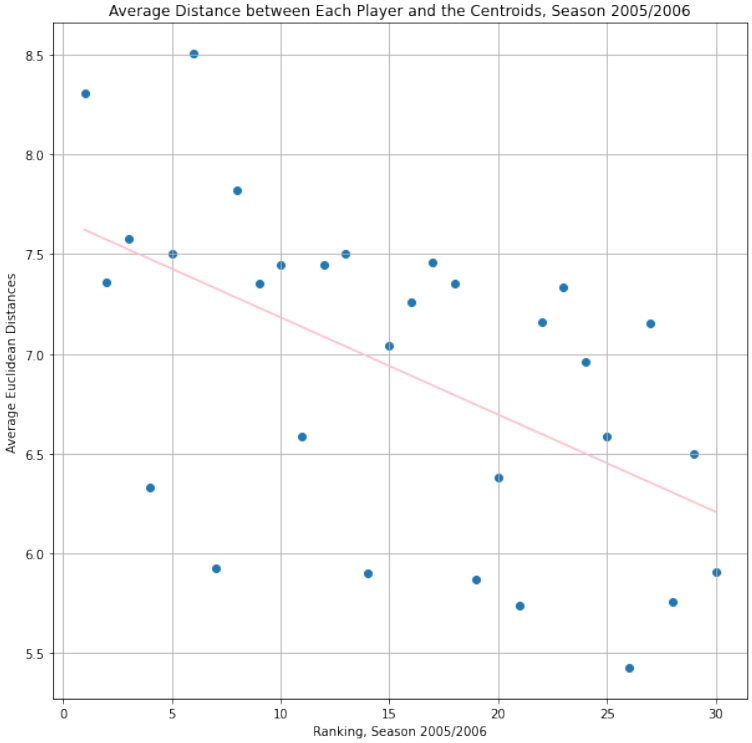

Figure 13: The average distances between each player and their respective centroid points, Season 2005 - 2006.

of the NBA teams. Many of their newly recruited players possessed very similar skills, see figure 14.
The most frequently appeared core squads from this season were:

- Steve Blake, Juan Dixon, Viktor Khryapa, Joel Przybilla and Zach Randolph
- Jarett Jack, Travis Outlaw, Randolph Patterson, Theo Ratliff and Sebastian Telfair
- Juan Dixon, Darius Miles, Joel Przybilla, Zach Randolph and Sebastian Telfair

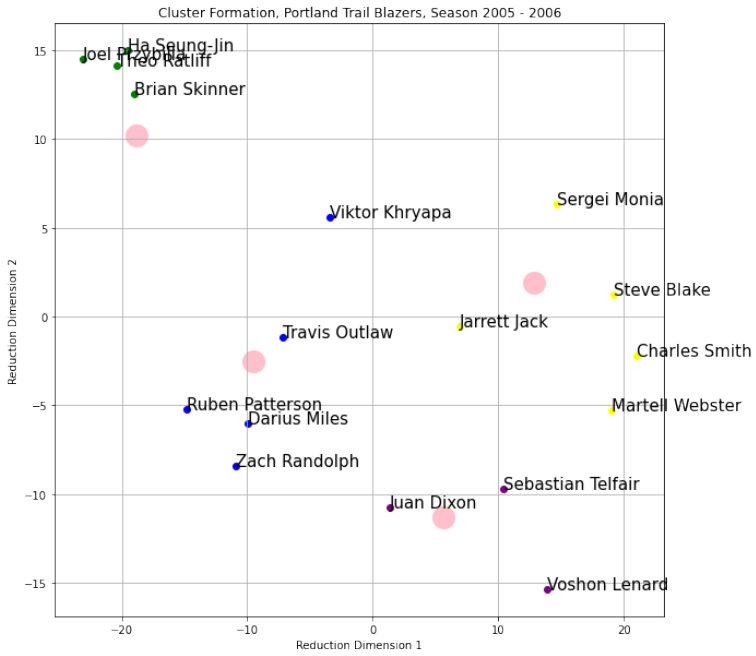

Figure 14: Portland players and the cluster formations, season 2005 - 2006.

None of the three combinations could be regarded as the full-fledged squad, which played well with each other. Amongst the core players, Jarett Jack and Travis Outlaw had played professionally for one season, prior the to beginning of season 2005 - 2006. Viktor Khryapa was an Ukrainian player and played in the European league, before he moved to NBA. Initially, his on-court contribution was far below the average level. As a power forward, his shooting record was by all means mediocre, however the number of violations which he caused, was low, in comparison with most North American players.

3.6 The Assessment of Players' Skills

The on-court performance of each player was analysed with SPM method, described in the method section 2,4. The intention was assess their individual skills, as well as the on-court collaboration between the players.

3.6.1 Season 1999 - 2000

The studied 434 players, who played five different positions could be divided into 8 different clusters, in accordance with the cluster optimisation assessment; the results is displayed in figure 15. The formations are displayed in figure 16.

The players possessed distinctively different skills in each cluster.

- Cluster 1: This group was filled with moderately successful offensive players. They scored better in the near field goals than the far field goals. They often shoot from the right hand side. The number of successful rebound was also low. A few examples are: Travis Knight, Tony Massenburg and Aleksandar Radojević.

- Cluster 2: This was a group of visciously dexterous defensive players, who were equally brilliant in shooting from the near field as well as the far field. Some of

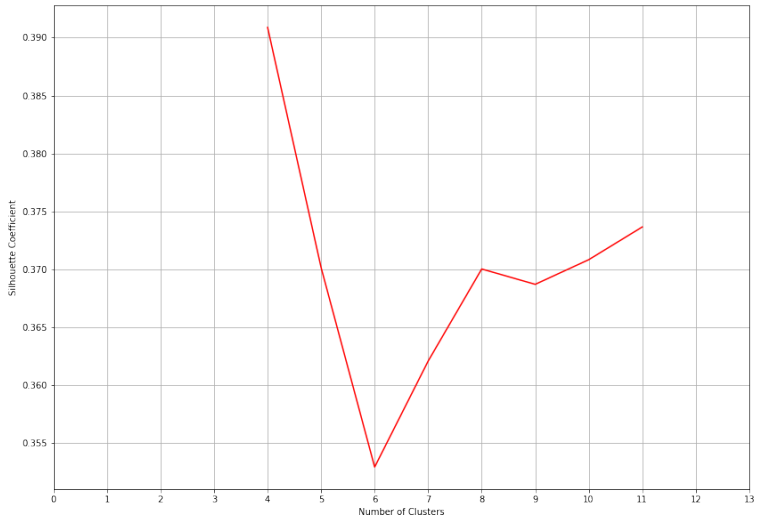

Figure 15: The optimisation of the skill plus and minus cluster formations, Season 1999 - 2000.

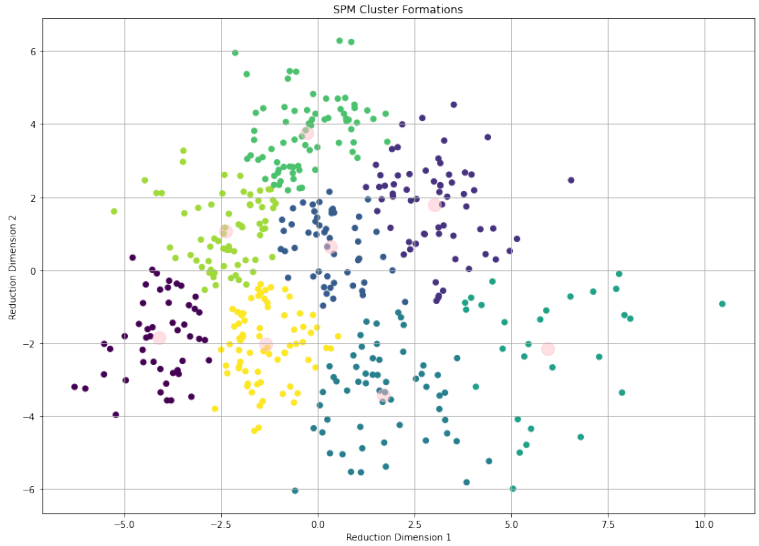

Figure 16: Skill plus and minus cluster formations, season 1999 - 2000.

the players were the small forward, others were shooting guards. The most stellar examples are: Arvydas Sabonis, Reggie Miller, John Stockton, Nick Van Exel and Dirk Nowitzki.

- Cluster 3: It was a group of powerful offensive players, who mastered the skill of re-bound; some of which were close to the end of their career, others were the rising stars, who had not yet defined their basketball identity yet. A few of the most well-known players were: Patrick Ewing, Christian Laettner, Bonzi Wells and Clarence Weatherspoon.

- Cluster 4: This cluster was made up by a group of players who were equally qualified as a shooting guard or as a small forward. Many of the players had just entered to the league and had not adjusted themselves well to the aggresive NBA playing style; a small number of the players played previously in the European League; others

were in their twilight years. A few examples are: Mirsad Türkcan, Otis Thorpe, Damon Stoudamire, Scottie Pippen, Steve Smith and Al Harrington.

- Cluster 5: This cluster was populated by the most powerful offensive players in the league. A few of the most emblematic super stars were: Karl Malone, David Robinson, Alonzo Mourning, Allen Iverson, Kobe Bryant and Shaquille O'Neal. All of them were the Hall of Famers. The young Rasheed Wallace was also grouped into this cluster. His record in the number of rebound per game from this season was very much higher than his previous season.

- Cluster 6: It was a group of confident offensive players, many of whom were excellent rebounders, many of whom also were the tallest players in their teams. The most tale-telling examples are: Charles Barkley, Ron Harper, Donyell Marshall, Horace Grant and A.C. Green.

- Cluster 7: This group of defensive players often shot from both the far field and the near field, and passed many balls to their front-court players in the heated near field combat. They could play both as a reliable defensive player, as well as an ad-hoc offensive player. A few examples were: Toni Kukoč, Wesley Person

- Cluster 8: This cluster is populated by the group of defensive players who scored well in assist. Many of them began to approach their twilight years. The best examples were: Steve Kerr, Christopher Mullin and Dale Ellis.

Portland Trail Blazers possessed only one extremely aggressive front-court offensive players, in accordance with SPM clustering results, however both Scottie Pippen and Steve Smith were equally brilliant in far field shootings. Moreover, Damon Stoudamire proved to be an effective defensive Great Wall of Oregon, who successfully prevented the players from the offensive teams from taking balls away from Jail Blazers.

Table 9: The Cluster formation of the Player Skills, Portland Trail Blazers, Season 1999 - 2000

Clusters	Players
Cluster 2	Arvydas Sabonis, Brian Grant
Cluster 3	Bonzi Wells, Detlef Schrempf, Stacey Augmon
Cluster 4	Damon Stoudamire, Scottie Pippen, Steve Smith
Cluster 5	Rasheed Wallace
Cluster 6	Antonio Harvey, Jermaine O'Neal
Cluster 8	Greg Anthony

Table 10: The most powerful line-ups, Portland Trail Blazers, Season 1999 - 2000

Clusters	The Squads
4, 2, 4, 4, 5	Scottie Pippen, Arvydas Sabonis, Steve Smith, Damon Stoudamire, Rasheed Wallace
8, 2, 3, 5, 3	Greg Anthony, Brian Grant, Detlef Schrempf, Rasheed Wallace, Bonzi Wells
6, 4, 2, 4, 4	Jermaine O'Neal, Scottie Pippen, Arvydas Sabonis, Steve Smith, Damon Stoudamire
4, 3, 4, 4, 5	Scottie Pippen, Detlef Schrempf, Steve Smith, Damon Stoudamire, Rasheed Wallace

3.6.2 Season 2003 - 2004

The studied 434 players from season 2003 - 2004, who played five different positions could be divided into 9 different cluster, in accordance with cluster optimisation assessment, the result is displayed in figure 17.

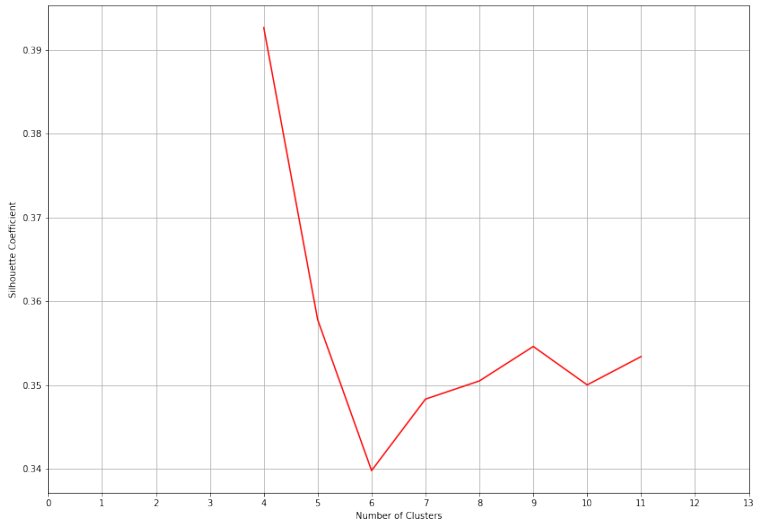

Figure 17: The optimisation of the skill plus and minus cluster formations, Season 2003 - 2004.

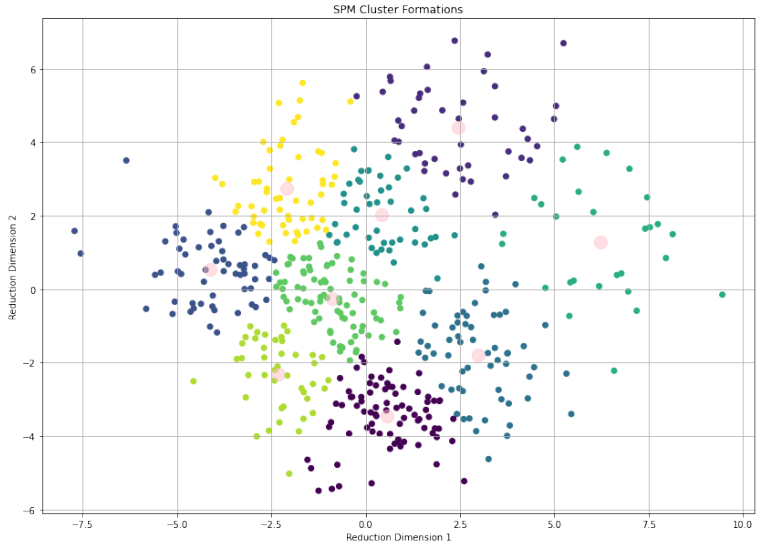

Figure 18: Skill plus and minus cluster formations, season 2003 - 2004.

The players, in each and every cluster possessed a specific set of skills.

- Cluster 1: The first cluster was a large cluster, which contained up to 80 players. Most players in this cluster were conventional offensive players. The success rate of their long distance field goals was often less than 30% and the number of violations per game were limited in comparison with the most aggressive players. Their travelling distance per match was limited as well. A few interesting examples were: Dale Davis, Clarence Weatherspoon, Joel Przybilla and Reggie Evans.

- Cluster 2: The second cluster was the smallest cluster, which was populated with the most powerful players, many of whom were awarded later as the Hall of Famers. All players held an impressive record, both in terms of far field three point shootings, as well as near field shootings. A few of the most stellar defensive players scored impressively in terms of assist. Their defensive skills were often very impressive in comparison with most other offensive players in the league. This group of players were the best played NBA super stars, the best examples are: Allen Iverson, Kobe Bryant, Dirk Nowitzki and Jason Kidd.

- Cluster 3: This was a relatively small cluster, which was populated with a crowd of mediocre defensive players. Some of the players switched back and forth between a position as the small forward, and as the shooting guard. Others were experienced players, who had already slipped into their twilight years. Their travelling distance on the court was limited, however, their average number of on-court violations were limited as well. A few examples are: Scottie Pippen, Dan Dickau, Anthony Goldwire and Shammond Williams.

- Cluster 4: It was a group of gleeful, tall offensive players, many of whom kept an impressive record, as a rebounder. The lads, who belonged to this group often attempted to shoot from the far field and their effectivity was impressive by all means. At the same time, they were reliable defensive players as well, who often successfully blocked the opponent team's offensive players. A few examples were: Shareef Abdur-Rahim, Zendon Hamilton, Lorenzen Wright and Corliss Williamson.

- Cluster 5: This was a small group of offensive players. Some of the lads were the former super stars, who played their final season. A few examples were Karl Malone, Clifford Robinson and Toni Kukoč. Others were emerging new offensive stars, for instance Bonzi Wells, who had just been traded away from Portland. Most of the players were powerful shooters.[14]

- Cluster 6: This was a very small group. All players were tall and sturdy, great defensive blockers. Many of the players were international super stars. All of them were great defensive rebounders, who were equally brilliant in shooting from the near field. The number of on-court violations were relatively modest. The best examples were Zydrunas Ilgauskas, Shaquille O'Neal, Zach Randolph and Jermaine O'Neal.

- Cluster 7: This was a large group, which was populated by the tall power forwards. Their rebound records were mediocre and their travelling distance was however impressive. Their greatest contribution to the team was their offensive play. The performance of this group of players was heavily dependent on the defensive players on the court. A few examples were: Chris Crawford, Qyntel Woods and Christian Laettner.

- Cluster 8: This small group of players participated a small number of games. Their on-court performance was mediocre and their defensive play was especially weak. However, the number of violations which they committed on the court was rather

[14]Bonzi Wells was traded from Portland to Memphis in December 2003, when he was 27 years old. `https://nbatrades.tumblr.com/post/132006215644/memphis-grizzlies-acquire-bonzi-wells-from`

high. The most interesting examples were: Nikoloz Tskitishvili, Ruben Boumtje-Boumtje and Tremaine Fowlkes.

- Cluster 9: This group of defensive players were far field goal specialists. In this season, an increased number of NBA clubs began to hunt for powerful 3 point shooters, who were equally impressive in blocking and stealing. The best examples were: Damon Stoudamire, Erick Strickland and Morris Peterson.

The cluster formations of the Jail Blazer lads are outlined on table 11. A few of the players, who played in more than one teams in this season, slipped into different roles in different games. When Wesley Person played for Portland, he was clustered in the fourth cluster, however when he played for Atlanta and Memphis, his performance data put him into cluster three. Rasheed Wallace and Dan Dickau were also qualified into different clusters in two different teams. The most frequently employed squads were outlined on table 12.

Table 11: The Cluster formation of the Player Skills, Portland Trail Blazers, Season 2003 - 2004

Clusters	Players
Cluster 1	Dale Davis, Vladimir Stepania, Travis Outlaw, Kaniel Dickens
Cluster 3	Omar Cook, Dan Dickau, Desmond Ferguson, Tracy Murray, Matt Carroll
Cluster 4	Darius Miles, Theo Ratliff, Shareef Abdur-Rahim, Ruben Patterson
Cluster 5	Jeff McInnis, Rasheed Wallace
Cluster 6	Zach Randolph
Cluster 7	Qyntel Woods, Bonzi Wells
Cluster 8	Ruben Boumtje-Boumtje
Cluster 9	Wesley Person, Derek Anderson, Damon Stoudamire

Table 12: The most powerful line-ups, Portland Trail Blazers, Season 2003 - 2004

Clusters	The Squads
9, 4, 6, 4, 9	Derek Anderson, Darius Miles, Zach Randolph, Theo Ratliff, Damon Stoudamire
1, 5, 6, 9, 5	Dale Davis, Jeff McInnis, Zach Randolph, Damon Stoudamire, Rasheed Wallace
1, 6, 9, 5, 7	Dale Davis, Zach Randolph, Damon Stoudamire, Rasheed Wallace, Bonzi Wells
9, 4, 6, 9, 5	Derek Anderson, Darius Miles, Zach Randolph, Damon Stoudamire, Rasheed Wallace

3.6.3 Season 2005 - 2006

The studied 446 players, who played five different positions could be divided into 9 different clusters, in accordance with cluster optimisation assessment, the result is displayed in figure 19. The obtained cluster formations are displayed on figure 20.

- Cluster 1: This cluster represented the offensive players, such as Rasheed Wallace, Metta World Peace, Gary Payton, Toni Kukoč who played both as the power forward and small forward on the court. Most of the offensive players, who were clustered into this group were moderately aggressive in the near field combat. The number of attempts to score the near field goals was as modest as their attempt to

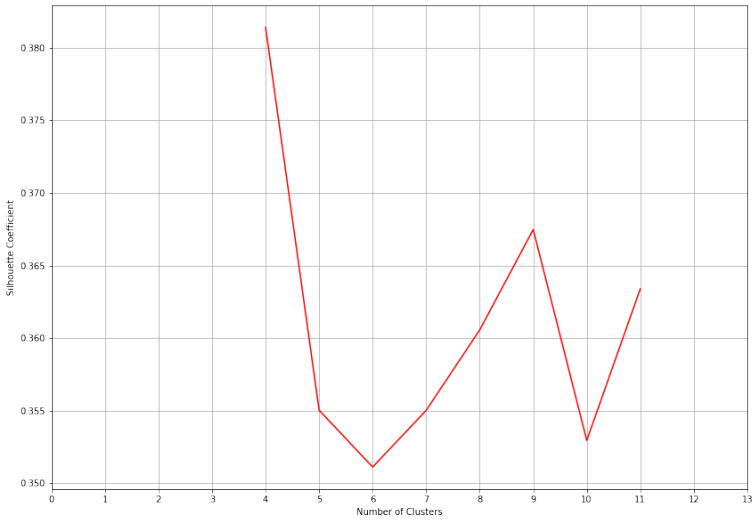

Figure 19: The optimisation of the skill plus and minus cluster formations, Season 2005 - 2006.

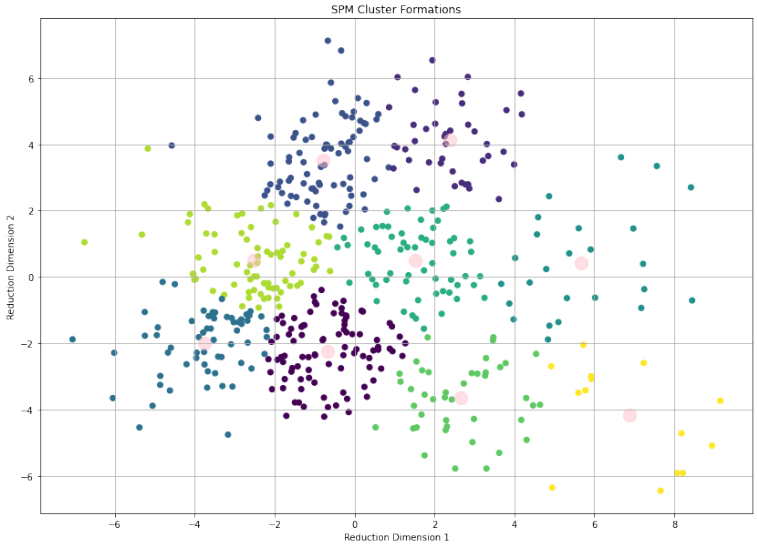

Figure 20: Skill plus and minus cluster formations, Season 2005 - 2006.

rebound. Some of the players belonged once to the strongest offensive clusters in the previous seasons. It included 92 players who played during season 2005 - 2006. This cluster was in fact the largest of all.

- Cluster 2: This cluster constituted of 42 players, most of whom, played as a centre on the court, however a small number of the players, for instance: Ike Diogu and Hakim Warrick, played as the power forward. Most of the lads in this cluster were mainly involved in the near field combats. Moreover, they were powerful rebounders. A few interesting players are: Alonzo Mourning, Ben Wallace, Theo Ratliff and Joel Przybilla.

- Cluster 3: This cluster was the second largest, since it included 81 players; some of the players played either as the power forward or as the centre. The majority of the players within this cluster, had a curtailed involvement in the regular season,

in terms of the number games, which they appeared.

- Cluster 4: This cluster included 61 players, in which players played for positions such as Point Guard, Shooting Guard or Power Forward. The players in this cluster had a considerable diversity in term of length of their career span with players such as Arvydas Macijauskas who played for a single season and Jim Jackson who played for 14 seasons.

- Cluster 5: The players, who were grouped into this cluster, were in fact the most powerful offensive players in the league, in season 2005 - 2006. Many of them, became later the hall of famer or the core squad players in the Olympic games. This exclusive cluster was made by 25 players and all of whom played either as the power forward or the centre. When viewing their play statistics, we realised that a significant number of players from this cluster had already played more than 10 seasons in NBA; most of them were equally brilliant as a near field combating vehicle, as a viscious rebounder. A few of the best examples from this cluster were among others, Shaquille O'Neal, Tim Duncan and Kevin Garnett.

- Cluster 6: This was one of the largest clusters with 60 players. They played either as the power forward or as the shooting guard with ferocity in near field play. Three of the ex-Jail Blazer players who were traded away in previous seasons, Qyntel Woods, Ruben Patterson and Bonzi Wells belonged to this cluster, Trail Blazer's declining performance could be attributed to these unsound trades.

- Cluster 7: This cluster consisted of 42 players. The players in this cluster played as the shooting guard or as the point guard, however, there were some exceptions such as Al Harrington who played exclusively in offensive role. This cluster consisted of hall of famers such as Ray Allen and Jason Kidd.

- Cluster 8: This was the third largest cluster with 74 players, players in this cluster played in defensive position either as the shooting guard or as the point guard.

- Cluster 9: This was the smallest cluster for season 2005 - 2006, with just 14 players, these players can be considered high achievers, as the cluster included hall of famers such as Kobe Bryant, Steve Nash and Allen Iverson. Additionally, it also consisted of multiple all star game players such as LeBron James and Brad Miller.

Table 13: The Cluster formation of the Player Skills, Portland Trail Blazers, Season 2005 - 2006

Clusters	Players
Cluster 1	Jarrett Jack, Juan Dixon, Sebastian Telfair, Steve Blake
Cluster 2	Theo Ratliff, Joel Przybilla
Cluster 3	Brian Skinner, Ha Seung-Jin
Cluster 4	Charles Smith, Martell Webster, Voshon Lenard
Cluster 5	Zach Randolph
Cluster 6	Darius Miles, Viktor Khryapa, Ruben Patterson
Cluster 8	Travis Outlaw, Sergei Monia

Table 14: The most powerful line-ups, Portland Trail Blazers, Season 2005 - 2006

Clusters	The Squads
1, 1, 6, 2, 5	Steve Blake, Juan Dixon, Viktor Khryapa, Joel Przybilla, Zach Randolph
1, 1, 6, 5, 2	Steve Blake , Juan Dixon, Viktor Khryapa, Zach Randolph, Theo Ratliff
6, 8, 2, 5, 1	Darius Miles, Sergei Monia, Joel Przybilla, Zach Randolph, Sebastian Telfair
1, 6, 2, 5, 1	Juan Dixon, Darius Miles, Joel Przybilla, Zach Randolph, Sebastian Telfair

3.7 Game Result Predictions using Gradient Boost Algorithm

The gradient boost machine was employed to predict the game results in two of the Jail Blazer seasons. In each prediction, the target variables were fetched from 82 games, which were played in the regular season. The target variables summarise both the psychological conditions of the lads, who played on the court, as well as their playing styles, which was classified with the SPM method. The predictor variables was boolean, either winning or losing. The prediction results are outlined in this section.

3.7.1 Season 1999 - 2000

Season 1999 - 2000 was a successful season for Portland. In this season, the three dignitaries played alongside with the young talents through out the season. On the court, they shared balls and allowed all the lads to participate in every game. Although some of the young lads violated the regulations, the core squad, which played together on the court remained relatively stable. The training data was the first 71 games and the test data was the last 11 games. The prediction proceeded sequentially. The prediction accuracy was beyond our initial expectation.

Table 15: Test Prediction Result Using Gradient Boost, Season 1999 - 2000, Seed 1728

Match Number	Actual Result	Predicted Result
72	W	W
73	W	W
74	L	L
75	L	W
76	W	W
77	W	W
78	L	L
79	W	W
80	W	W
81	W	W
82	L	W

3.7.2 Season 2003 - 2004

Season 2003 - 2004 was a hurry-scurry season. The players such as Rasheed Wallance, Bonzi Wells and Jeff McInnis were traded away in the middle of the season, as the club attempted to wash away their tainted image; Wesley Person played a few games with the team, before he was traded further to a new team; two relatively experienced players joined the team. Theo Ratliff was 30 years old, he was traded from Philadelphia and was elected into the NBA All star team two years previously; Shareef Abdur-Rahim was traded from Atlanta, who also was elected to the NBA All star team two years before. The team underwent readjustments again and again. For this reason, the results of this season were much more challenging to predict.

Table 16: Test Prediction Result Using Gradient Boost, for Season 2003 - 2004, Seed 1728

Match Number	Actual Result	Predicted Result
72	W	L
73	L	W
74	W	W
75	W	L
76	L	W
77	W	W
78	W	W
79	L	L
80	L	W
81	L	L
82	L	L

The prediction occurred sequentially as the last time. However, they did not have a core squad in the second half of the season. The head coach was testing which players played well together. In some of the matches, most players, who played on the court belonged to cluster 2 and cluster 3, whilst in some other matches, most players who played belong to cluster 3 and cluster 7.

4 Analysis and Discussions

4.1 Psychological Evaluations

Between 1998 and 2006, Portland Trail Blazer underwent a series of drastic transformations, recruited multiple talented players. As a team, they achieved fantastic success, many young players developed fast into ferocious basketball warriors, defeated some of the most well-synchronised squads on the court. In this section, their playing style were analysed from three aspects, if the previous game result had any mental impact on their performance, if the date of the game influence their performance, also if the home crowd encouraged them to excel on the court.

4.1.1 Hot Hand Condition

The hot hand condition assessment was performed to investigate if the previous game results had any psychological impact on the performance of the lads on the court. The conditional winning probability after losing one game was slightly lower than winning one game, furthermore the conditional winning probability after losing two games was much lower. Although the calculation result could not confirm whether the hot hand effect assailed, however the outcome demonstrated that the previous game result, especially the negative results had a noticeable impact on the young lads' performance on the court. For this reason, it is adequate to include the previous game result as a variable in the gradient boost prediction.

4.1.2 Week Day Bias

The χ^2 test was performed to assess if the date of the game might impact the performance of the team. The result confirmed that it was not possible to obtain any correlation between the choice of the game date and the performance of the players. The number of attempts to score depended chiefly on the composition of the squad of the opponent team. For this reason, this variable should not be included in the gradient boost prediction.

4.1.3 Home Crowd Advantage

The regression analysis between the salary difference and the probability of winning indicated that the team, which hired a group of expensive players were more likely to crush the Jail Blazer lads, when playing in front of their home crowd. Conversely, the team which had a modest budget compared to that of Portland Trail Blazers were more likely to beat the Trail Blazers in the road games.

Career salary analyses of the six of hall of fame players revealed intriguing trend in the player salary and age. A player who commenced their professional NBA career, either in their late teens or in early 20s, were not likely to to showered with a pot of gold in a whim, despite their consistently stellar records. Their salary increased radically in the latter half of the career, when their on-court performance began to falter. The number of minutes, which they played in each game gradually decreased. Despite of this decline in their individual performance, they were paid significantly higher. In their mid 30s, their higher salary began to decline slightly, however, they still were profitable players, since these famous veterans could attract many 30 plus spectators and sports journalists,

who had watched their games through their teenage and college years, they remained the golden attractions of the club, bringing the very much needed sponsors to the games.

The basketball club is a commercial enterprise, who needs to have a steady income, in order to play their best paid players. To begin with, the club needs to gain media attention, in order to attract a group of wealthy sponsors in the home state. However, the sponsors want to use the image of a team to attract their own consumers. In the age of market economy, there is a very thin line between what is exciting and what is too exciting. As the delinquencies transformed to serious crimes, including sexual harassment, the excitement turned into appalling accusations. The basketball warriors were surrounded with resentment in their home town. At this point, the team lost their value for most sponsors, which wanted to use the team as the stepping stones to foster their own business interest. The winning games became a proof that those lads had only one skill, to play the ball, using dirty language to trash talk each other down, and to use their fists to abuse others brutally, whenever they felt that others treated them wrongly.

The accumulative salary is an important indicator, in terms of the level of the players, however the analyses have proved that some of the best paid players in Jail Blazers' era, were paid for their reputation, historical performance, rather than their current physical condition. For this reason, the salary budget should included in the gradient boost machine.

4.2 The Economical Aspects and The Media Coverage

The National Basketball Association is the highest basketball league in North America. The game results made headlines in both local press, as well as national and international news media. At the same time, the National Basketball Association was never a charity organisation, hence the economical aspects should never be ignored. The spectacular performance of the American National Men's team in 1992 Olympic game, had launched the NBA games as one of the most momentous element of the American popular culture. In the dawn of digitalisation era, every NBA team did what they could to hunt for the treasure in a new gold mine, the internet, without knowing how to navigate themselves amongst the new demands as well as the unprecedented possibilities. In this section, the media coverage and the selection of the players are discussed, in conjunction with the new consumers' market. The question is if the recruitment of a group of Jail Blazers was a deliberate choice, or a consequence of creating a fantasy team.

4.2.1 Portland, the Obscure Sport Metropolis

Portland is Oregon's largest city, however the city did not attract a lot of media attention in the past. Portland Trail Blazers was the only professional team, who played in the national league in the nineties. The main income sources for the franchise were the tickets and memorabilia sells, commercials from the enterprises around Oregon and the sponsorship from the large sport article manufactures around the US. The business opportunities for a small franchise in a modest town was limited. To create emblematic sport icons without a high salary budget in NBA is an impossible endeavour. Portland successfully recruited Clyde "The Glide" Drexler from his college team in the eighties and created

their first media super star, who was one of the members in Dream Team in 1992.[15] However, a brilliant player, who had won many prestigious accolades, required a high salary. To keep a group of expensive players required a huge salary budget. For this reason, many clubs attempted to create a fantasy team by tracking down the promising young players, who mastered the skills, which the team lacked and had the ability to analyse the games, but had not acquired the notoriety yet. The winning games could boost the local patriotic sentiments, hence helping the club to sell more home game tickets.

4.2.2 Media Coverage and Racism

Everyone, who has followed the tumultuous Jail Blazer years, has weaved their own tapestries of memories and impressions of this dysfunctioning and aggressive team. Each and every story has many interconnected layers of sentimental reflections, as well as resentment and contempt. Portland Trail Blazers, a relatively small club in a sparsely populated state attracted an unprecedented media attention within the Jail Blazer years. The trips to the court and the drug crimes dominated the head lines in the evening news around the globe. Some of the Trail Blazer-centric fans claimed that the media blackened the imagery of the Jail Blazer lads, which confirmed the traditional stereotype. The combination of a strong physique, a set of simple vocabularies and the inability to control their anger was what the American media needed to craft a piece of sensational evening chronicle about a Tarzan like savage. The sport journalist Martin Fisher described the Trail Blazer games as *Cheering for the Blazers today seems almost dirty, tantamount to selling one's soul for a cheap thrill.* (Gordon et al., 2018) Most American news media reported about their games, specifically the disputes between one of the young African American players and the officials and their game suspensions frequently. At the same time, a few of the most celebrated stand-up comedians talked about their notoriously ridiculous scandals on the weekend scenes. Very soon, when the names of the Jail Blazer lads appeared in a conversation, the topics were often centred around their scandals(Eggers, 2018).

The African American players resented their negative media coverage and claimed that they were the target of the sensational journalism. Ruben Pattersson endured his share of negative media attention, during his trial for sexual assault in 2001.[16] When googling this incident today, the most frequently appeared citation is: *I'm not no bad guy. I'm not no rapist. I'm a great guy.*(Eggers, 2018) The double negations in this string of words were used by many journalists, as if this piece of expression could prove his inability to navigate himself in a civilised society. In the prime years of his basketball career, this conviction was often disclosed with harsh wordings, whenever he performed sensationally well on the court. A second example is, Zach Randolph, who was Portland Trail Blazers' rising star already at the age of 24; later in his career he transformed himself into the most viscious offensive player in Memphis Grizzlies.[17] Sadly, his time in Portland was often portrayed

[15]Clyde Drexler was initially drafted to Houston Rocket, when he played for the college basketball team in University of Houston. As a young lad, he played in the same squad with Hakeem Olajuwon and Michael Young. In 1983 NBA draft Drexler was selected by Portland Trail Blazers.`https://www.hoophall.com/hall-of-famers/clyde-drexler/`

[16]Ruben Pattersson was convicted for for attempted third-degree rape, a gross misdemeanor assault in 2001, by the court in 2001.`http://www.espn.com/nba/news/2001/0507/1192941.html`

[17]Zach Randolph was a left handed offensive player, who played in Portland Trail Blazers between 2001 and 2007. He joined later Memphis in 2007 and became a dominant rebounder.`https://bleacherreport`

through his involvement in the scrimmage between Ruben Patterson and Qyntel Woods. His wounded eye socket became one of the frequently used image to demonise the African American ball players. When reflecting upon this chunk of history retrospectively, some of the African American basketball stars which were called *the notorious figures* by the press, saw themselves as the victims of the white supremacy campaigns.

4.2.3 The Interplay between Media and Income

The reputation of a team has a strong impact on the overall financial condition. In the entertainment industry, the negative media coverage often attract more attention than the positive reports, especially if the sexual assaults or the misdemeanours are involved. The phrase, *Jail Blazer bad boys* still appear frequently in American media today, to some extent more often than Portland's most emblematic super stars, such as the Olympians Clyde Drexler or Arvydas Sabonis. Their media coverage had put Portland into people's attention, around the world. From this aspect, the recruitment of the Jail Blazers was a successful project.

There was however a tipping point. When the home crowd began to be offended by their off-court crimes and their on-court mental break-downs, the number of spectators in Rose Garden faltered. At the end, the club was forced to take actions.

4.3 The Dignitaries and the Jail Blazer Lads

Three Olympians joined Portland Trail Blazers in the middle of the Jail Blazer era. Two of them had already enjoyed massive success in the past. Steve Smith was on the summit of his basketball career, when he arrived to Portland in autumn 1999. In the next three years, the experienced players played alongside with the young, talented lads.

4.3.1 The Dignitaries

Scottie Pippen, the six-time NBA champion, was traded to Portland in 1999, at the age of 34, after one season in Houston.[18] His last nomination to the NBA All Star team occurred three years earlier and the rate of the successful field goals began to drop gradually. In Portland, he played as a defensive player, alongside Rasheed Wallace and Steve Smith. Both the skill cluster analysis, which was based on the 100 poss data, and the SPM cluster analysis, demonstrated that his skill at that period was still impressive. His performance data were equally high as Steve Smith, who was an American Olympian 2000, and Damon Stoudamire. The number of bad ball pass was slightly higher initially, however the number of defensive rebounds increased slightly, after playing with his new squad a number of games in Oregon.

Arvydas Sabonis belonged to the core squad in the Soviet Union Golden Olympic team, which defeated the United State in semi-final in South Korea. After a few seasons in a professional Spanish club, he moved to Portland. Unlike his contemporary American players, he was trained to score the far field 3 point goals from his childhood. At the

.com/articles/1480289

[18]Scottie Pippen was traded was traded from Houston Rocket in 1999, for six other players in October 1999. https://www.nytimes.com/1999/10/02/sports/pro-basketball-rockets-are-sending-pippen-to-trail-blazers-for-six-players.html

same time, he was a brilliant defensive rebounder, who was not hesitant to share the ball with his team mates in the near field combat. For this reason, he was an outlier in the cluster analysis, as a centre on the court, based on the 100 poss match data. As a tall and sturdy centre, he was an aggressive offensive player, who often blocked the opponent players from advancing further in their offensive far field play. For this reason, he could pair up with Steve Smith, creating a number of lethal attacks, when playing against some of the most powerful NBA teams in the road games.

Steve Smith was selected to NBA All Star team, the season before he arrived to Portland Trail Blazers. As a shooting guard, he averaged 14.9 points per game in regular season and 17.1 in play-off season, the second best player of the Western Division in season 1999-2000. He was the star on the court, until he was injured in the beginning of 2000.

The three above-mentioned experienced players were the foundation stones of Portland Trail Blazers' initial success, before the turn of the millennium. To begin with, the lineups of season 1999 - 2000 demonstrates that the three experienced players were behind most of the winning games. Through the season, they played in sum 1524 minutes together. After five seasons with Portland, Sabonis had developed into the informal captain of the team, which steered the lads to steal the balls in the near field combats. The video footage from the play-off matches revealed that he knew his teammates well, therefore he could pass the ball to other players from behind, whilst moving forwards towards the basket. Furthermore, the collaboration between Pippen and Smith provided the very much needed transition between the defensive play and the offensive advancement, which allowed the young Rasheed Wallace to score the near field goals.

4.3.2 Jail Blazer Lads

The young Jail Blazer lads were a group of talented, energetic basketball players. Their skills complemented each other on the court, and their off-court behaviours attracted even more attention around the globe.

Before Damon Stoudamire became the core squad in Portland, he was an avid Portland fan, when growing up in the vicinity of Memorial Coliseum in Northeast Portland.[19] At the age of 24, Damon Stoudamire was traded from Toronto Raptor to Portland Trail Blazers. As a young player, his 100 poss record revealed that his basketball skill was very similar to two of the dignitaries, Pippen and Smith. As a point guard, he often attempted to score far field goals. As a defensive player, he was the most important team mate, which pushed the offensive players to score in the near field offensive play. As a mature player, he set a number of club record, including the consecutive scored far field goals. In season 2005-2006, his club record was 21 far field goals in one single game.[20] In spite of his stellar performance, he remained infamous for several marijuana possession infractions; which led to his subsequent suspension for prolonged time. He was traded

[19]Stoudamire played in Portland through the entire Jail Blazer period, (eight seasons) enjoyed their most glorious season, when the lads out-performed Los Angeles Lakers in the regular season, also the most turbulent moment, when multiple talented were traded away, to white-wash their tainted reputation. https://www.oregonlive.com/blazers/2020/02/damon-stoudamire-reflects-on-portland-trail-blazers-tenure-with-mixed-emotions-we-had-a-good-run-here-rip-city-50.html

[20]Damon Stoudamire's on-court performance was published in the following website: https://www.landofbasketball.com/nba_players_stats/top_pts/damon_stoudamire.htm

away to Memphis Grizzlies in the season 2005 - 2006.

Ruben Patterson arrived to Portland in season 2001 - 2002 and played as the small forward, shooting guard and power forward over the years. Although he rarely appeared in the starting line up, he played in average more than 20 minutes per game in the regular seasons. He was often involved in the near field combat, equally capable as both a defensive and an offensives rebounder. Furthermore, his offensive rating was nearly as high as his defensive rating. For this reason, it is adequate to conclude that he was an intermediate player, who switched his role on the court depending on the need. After playing at Portland Trail Blazers for five subsequent season, he was traded to Denver Nuggets in mid way through the season 2005 - 2006.

Qyntel Woods was drafted by Portland Trail Blazers in the season 2002 - 2003. On the court, he was an offensive player, who switched his roles between the small forward and the power forward. In NBA, he was a mediocre player, who kept an average record in both the near field goals and the far field goals. Furthermore, his performance varied noticeably, depending on the performance of the players, which paired up with him. His most important contribution was his ability to pass the ball to the shooters, in the near field combat. Like the other young players, he committed many violations, whilst blocking the opponent players from passing balls to other players. After two seasons, he was released from his contract at Portland Trail Blazer. Soon after he was hired by Miami Heat in the subsequent season.

Bonzi Wells was traded from Detroit Piston to Portland, in the season 1998 - 1999. On the court, he switched between playing as the small forward and the shooting guard. He was equally capable of shooting from the far field as the near field, the type of players, which NBA began to love and hunt. As a bounty player, he run tirelessly between two baskets and did what he could to spot new opportunities to steal the balls from the opponent players. After the initial years of adjust, he became gradually a brilliant rebounder, who was a specialist of defensive rebound. He was traded away to Memphis Grizzlies midway through the next season 2003 - 2004. In Memphis, he tasted for the first time the aroma of stardom.

Rasheed Wallace was a stellar performer in Portland, who was traded from Washington Bulllets at the age of 22 in season 1996 - 1997. Through his career, he played mostly as the power forward on the court. As he continued to gain his on-court self-confident, he began to develop into a brilliant far field three point specialist, who was at the same time a hungry rebounder. This combination of skills allowed him to travel farther and farther away from centroid points, when assessing the team condition with the 100 poss data. Rasheed Wallace was received a number of suspensions, after he had gained some degree of fame, due to among others the violent dispute in the game, as well as the off-court transgression. When he was away, the team's overall condition decreased noticeably. When scrutinising the cluster formations, which were based on the play-by-play data, it is obvious that in his prime years, he was cluster in the same group as a few of the most brilliant offensive players, such as Kobe Bryant, Karl Malone and Tim Duncan.

Portland Trail Blazers was Zach Randolph first professional team in NBA. He was recruited in the season 2001 - 2002, as a 20 years old. Already from the very beginning,

he switched between the role as a power forward and a centre. After Rasheed Wallace' departure, Randolph became the most important offensive player in the core squad. The 100 poss based cluster formations revealed that Randolph was a very different kind of offensive player than Rasheed Wallace. Initially, he was by no means a stand-out forward. The box score plus and minus hints that he was extremely dependent on a group of powerful defensive players, who could watch out for him in the near field combat. When he began to play in the core squad, he eventually slipped into a new role, the most heroic defensive rebounder of the team. After six seasons of service, he was traded away to New York Knicks during season 2007 - 2008.

4.4 The Performance of the Core Squad

The overall strength of each team has been assessed from two aspects: the diversity of the skills and the combination of the players on the court and off the court. Furthermore, Portland Trail Blazers might be a dysfunctional team, however the off-court chemistry was an important contributing factor of their unprecedented on-court success.

4.4.1 Season 1999 - 2000

In season 1998 - 1999 Portland won 35 out of 50 games in the regular season; in season 1999 - 2000, the lads defeated the opponents in 59 out of 82 games. The two cluster analyses could give us some clue, why they were so successful, despite the club did not possess any of the best offensive players. To begin with, the cluster formation for Portland Trail Blazers, based on the 100 poss data from season 1999 - 2000, see figure 8, revealed that players were positioned farther away from each other, in comparison with the cluster formations which were based on the 100 poss data from season 2003 - 2004 (figure 11) and season 2005 -2006 (figure 14).

How could Portland crush Los Angeles Lakers, despite they did not possess the most admired players? Portland and Lakers met four times during the regular season. Portland won two times, with two different line-ups. During the first winning match, Kobe Bryant was away and Rasheed Wallace was suspended. Lakers had two very experienced players on the court, A C Green and Ron Harper, both were experienced players, which switched swiftly between playing as a small forward and as a shooting guard. The composition of Portland's team was different, their defensive team was made by Scottie Pippen, Steve Smith and Detlef Schrempf. Detlef Schrempf was an experienced, mediocre defensive player, who was clustered in cluster three, as A C Green and Ron Harper. However Scottie Pippen and Steve Smith were clustered in cluster four, so was Lakers' Glen Rice. For this reason, Portland could win grandly over Lakers. Although three of Lakers' players were great rebounders, Portland was equipped with near field defensive specialists. For this reason, Lakers lost their battle. Furthermore, Portland won slightly in one more game against Lakers in front of the home crowd in the spring. In this game, Kobe Bryant played over 36 minutes. In this game, the best line-up, which included Wallace, Pippen, Saboni, Stoudamire and Smith. Kobe Bryant's performance was disappointing, in comparison with his normal record. However, both Wallace and Pippen had an impressive record, in terms of assists, rebound and near field goals. The team, as a whole, committed a very small number of violations.

4.4.2 Season 2003 - 2004

The overall strength of Portland Trail Blazers in season 2003 - 2004 decreased, despite their salary budget increased. A number of the lad, possessed very similar skills. After Rasheed Wallace was traded away to Detroit, the team no longer possessed a lethal offensive shooter in the near field combat, in accordance with the result from SPM cluster analysis. Moreover, both $RAPM$ scores and BSP scores demonstrates that many of the newly arrived players held a negative score, in both defensive and offensive plays, through the season. The players, who once played in the All Star Games, with their previous team mates, held a mediocre record in Portland. The number of lost games was highest in the second quarter, that was between the 13:th December and 20:th January. During this time, the constitution of the core squad changed every second week.

The performance of some of the former All Star Team members, were highly dependent on the performance of the other team mates. Shareef Abdur-Rahim, Wesley Person, Matt Carroll and Theo Ratliff were traded to Portland, in the middle of season 2003 - 2004, from other NBA clubs. Two of the players changed their positions radically, Wesley Person slipped into the role as a offensive player in Portland, despite he previously played a defensive fortress in Atlanta. Matt Carroll made a reverse trip, from a far field specialist to a mediocre offensive player. The SPM cluster analysis, which was based on the play-by-play data, revealed that their performance changed drastically, in the middle of the season, which was expected, see table 17. The first four players transferred from other NBA clubs to Portland; the last two players were traded away from Portland, to other clubs. The on-court plus and minus, as well as the net plus and minus, averaged

Table 17: SPM cluster categorisation, the players, which changed their club in the middle of season 2003 - 2004.

player	SPM Cluster Team 1	SPM Cluster Team 2
Shareef Abdur-Rahim	3	4
Wesley Person	3	9
Theo Ratliff	1	4
Matt Carroll	9	3
Rasheed Wallace	5	7
Bonzi Wells	7	8

over 100 poss of all three players, were negative, when they played with Portland. The number of assists decreased most noticeably for all three, initially, as expected. During this season, most of Portland's players were clustered as mediocre players. Their BPM scores, as well as $RAPM$ scores for both defensive play and the offensive plays were actually negative values, see figure 21. When looking forward retrospectively, all players, who stayed with Portland in the next season, increased their SPM score, both in their offensive, as well as their defensive plays, with the team.

During this season, the star line-up of Portland altered three times, as their head coach Maurice Cheeks attempted to test his troop, against different opponents. Some of the players, who had played in Portland in the previous season, had changed their cluster belonging through this experimental season. For this reason, the regularised skill plus and minus scores based play-by-play data of the original Jail Blazers, who still played in

the team was negative.

Figure 21: RAPM score, Portland Trail Blazers, Season 2003 - 2004.

4.4.3 Season 2005 - 2006

Most of the original Jail Blazer lads had been traded away from Portland. The new team was made by a number of players, who displayed very similar skills, assessed by their 100 poss record. Most of the offensive players, such as Brian Skinner, Theo Ratliff and Joel Przybilla, kept a very similar statistics. Their best offensive player was Zach Randolph, however the number of rebounds per game was slightly above NBA's average level. The SPM scores of all newly arrived players were negative. During this season, none of the players was clustered together with the best NBA offensive or defensive players. Nor was any of the players awarded with any accolade by the sport critics.

The regularised skill plus and minus, see figure 22, confirmed that the players, both the defensive and offensive ones, did not collaborate well on the court. We could not detect one single player, which had a positive score both in defensive and offensive play, in comparison with season 2003 - 2004. Seven of the players received negative scores in both assessment, although two of the players, Zach Randolph and Ruben Patterson had played with the same team in multiple season before. For this reason, the team was defeated again and again, despite the total team salary budget was in the comparable level as the team salary budget in season 1998 - 1999.

4.5 Game Result Prediction

The accuracy of the game prediction results vary noticeably between the two studied season.

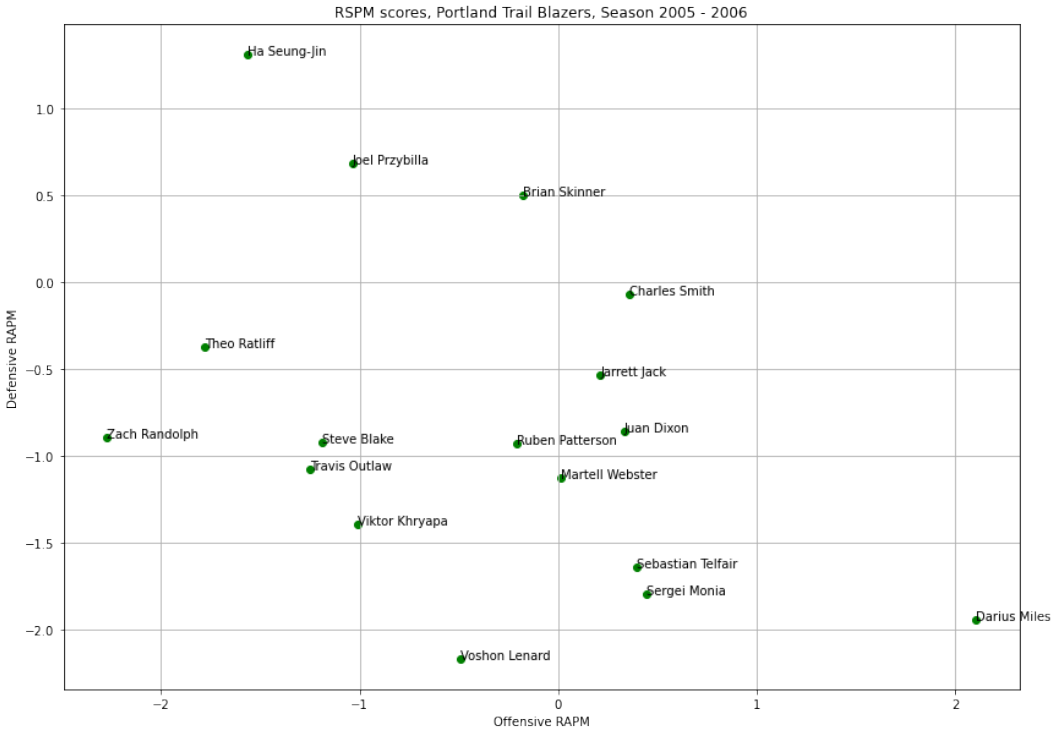

Figure 22: RAPM score, Portland Trail Blazers, Season 2005 - 2006.

4.5.1 Choice of Variables

The choice of variables summarised three different aspects of the games, the psychological conditions, the salary budget and the player skill. However very few external factors, such as the intensity of the media coverage, the injury information of the players and the recovery, the physical fatigue, caused by long travelling distance between two consecutive games and the number of time zones, one of the team had to adjust themselves with, to play a specific road match.

4.5.2 Prediction Results

The predictions in general were more reliable, when Portland played against a team, which was composed by a group of very different types of skill combinations than Portland Trail Blazers. The included data set is however small. The only match data which are studied in this wee project are the matches, in which Portland Trail Blazers participated. The results might be caused by the following problems:

- When breaking the salary difference into two groups, all the defensive players and the offensive players, who played on the court were included. We never constructed a weight function, which differentiate the more dignitary players ahead of the commoners.

- When performing SPM clustering, three large clusters of players were obtained, from each and every season. These groups of players displayed mediocre performance on the court (in accordance with the NBA standard); many of them were either a defensive player, who was a poor far field shooter, or an offensive player, who often pass bad balls in a near field combat.

- The injury information of the participated players from both team was not included in the classification. Nor was the game suspension list of the most brilliant players were included in the consideration.

The accuracy of the prediction of the game results depended on the composition of the core squad players. The predictions accuracy was much more successful, when training and validation data were fetched from season 1999 - 2000 than season 2003 - 2004.

- The number of players, which played in Portland Trail Blazer in season 1999 - 2000, was eleven; most of the players played in average 20 minutes or more on the court. 63% of the players played in Portland Trail Blazers in season 1998 - 1999 as well.

- During season 2003 - 2004, a number of players were transferred away to other teams and traded back new players. The SPM clustering analysis demonstrated that some of the players, which were traded to Portland were categorised to the same cluster as the players, which had been traded away, prior their departure to Portland. Their disparity between their salaries was insignificant. However, the SPM clustering analysis which were based the new players' performance Portland, gave a rather unexpected result. Some of the players were categorised into a very different cluster.

- Many of the newly transferred players received negative SPM scores, after they have arrived to Portland. The difference between their defensive SPM scores based on their performance on the court was more noticeable than their offensive SPM scores. The disparity signified that the collaboration between the players had not reached to the expected level yet.

- In season 2003 - 2004, some of the former Portland players participated a small number of games, which they became the opponents. The training data were no longer consistent. For this reason, the prediction rate dropped drastically. Due to the change of the core squad through the season, the challenge of using the SPM scores to predict the match results was more and more noticeable.

5 Summaries and Conclusions

5.1 Farewell to Fairground

Portland Jail Blazer lads were a crowd of boisterous players, who created the club records on the court and made many head lines in the global news media at the end of the 90s. Their off-court behaviours were initially tolerated, even welcomed somehow by the club, since the delinquencies attracted massive media attention. Any exposure in the limelight was a piece of free advertisement for the club(Tyson, 2021). It was the dawn of development of the on-line community, an increased number of fans began to use social media to discuss about the game results, as well as the players' on-court performance. The professional sport clubs did what they could to attract more fans to pay attention to both the game results, and the gossips. According to the survey of the basketball game ticket buyers(Wolff, 2016), the fans, who often discussed about the game results or the players' action, were more likely to renew the season's membership ticket. In addition, the fans, who often expressed their critical opinions vehemently in the questionnaires were more likely to purchase the tickets in the near future(Péter, 2013). Furthermore, the outlaw spirit was celebrated by the most Trail-blazer-centric fans.[21] The defiant attitude which Damon Stoudamire, Rasheed Wallace and Zach Randolph displayed in their disputes with the referees became to some extent the symbol of the African American's attempt to fight for equality. The lads, who grew up in a stereotypical blue-collar area, became a new type of role-model for the young African-American lads. Instead of displaying a submissive attitude towards the game officials, who were often the well-educated, affluent European-American gentlemen, they spoke about their own truth confidently and did not allow an authoritarian voice to mute their urge to defend their actions. Such actions developed gradually into important elements of the American pop culture (McCallum, 2013). For all above-mentioned reasons, the Jail Blazer lads were initially the club's financial driving engine.

The players composition during the Jail Blazer era was the reason behind their success. Firstly, the young players and the experienced players, played alongside each other. The players, who often played on the court together possessed very different skills; the offensive players could perform well, when the defensive players often switched their positions between small forward and shooting guards. In the play-off games, Portland sent three of their most experienced players, together with Wallace and Stoudamire, to combat against Los Angeles Lakers, which possessed both Bryant and O'Neal. When scrutinising the players' performance on the court through the regular season, the likelihood is not high, that Portland could win more than one games. None of the player in Portland belonged to the exceptional cluster of players. However they crushed Lakers in three matches out of seven. The SPM scores, as well as the BPM scores revealed that the defensive play during the Jail Blazer years were excellent. None of the lads, who belonged to the core squad had a negative defensive SPM or BPM score. For this reason, the offensive armoured fighting vehicles could acquire multiple shooting opportunities in a heated cauldron of play-off games.

[21] The technical fouls, confrontations with referees and the dispute with the trainer on the court was not rejected by the spectators, by any means. The players' defiant attitude was glorified by the fans fervently, when the lads went to the semi-final in the play-off season at the end of the 90s. `https://deadspin.com/portland-wronged-the-jail-blazers-more-than-the-jail-bl-1834341801`

The period between season 2003 - 2004 and season 2005 - 2006 was a dramatic, whimsical time; the franchise traded many players back and forth between different teams and hunted new unicorns amongst the university players nation wide.[22] Rose Garden was no longer an eventful fairground. The poor performance in season 2005 - 2006 was expected, viewed from the cluster formations. Both SPM and BPM scores revealed that the lads did not know how to play with each other. The defensive scores of all players who belong to one of the core squad were negative. The offensive score was mostly negative as well, despite many of the players, had a positive SPM and BPM, when they played with other teams in the previous seasons. Therefore, the data analysis proved that the post Jail Blazers team was a destructive team.

5.2 To Predict the Result of a Game

5.2.1 Team Skill Assessment

The 100 poss stat based cluster formations are powerful visualisation tool, which revealed the condition of a team. The stronger team possessed a crowd of diversified players, whilst a relatively weak team recruited a group of players, who performed in a similar fashion on the court. One of the main reason that Portland's performance declined in season 2005 - 2006 was the fact that many players possessed the average skill, in terms of the NBA standard. The cluster formation demonstrated that the number of outliers was extremely few.

5.2.2 SPM Assessment

The on-court Skill plus and minus have granted the betting firm an unprecedented insight into how the players are playing together on the court; the details from the regularised regression unveil how a player had contributed to the team play on the court. To begin with, some of the stellar players, who scored massively, did not always contributed to the team play as much as they could have done. The SPM tool takes variables, such as bad ball pass, as well as various on-court violations into considerations, when assessing a player's performance into consideration. Secondly, the SPM method employs the play-by-play data, rather than the traditional box score, when assessing a player's performance on court, which allows the betting firm to obtain which squad is the most powerful line-up, when playing against a specific opponent. When reading the game results, together with the line-ups and the SPM scores, a training could have a relatively accurate overview of the collaborations between the core players, also which skills might lack in a specific moment. However, the difference in terms of performance between the players who have been categorised into the same cluster, is noticeable. If the regularisation factor is not included, it might be impossible to avoid overfitting. For this reason, additional manual inspection is needed, especially in terms which data should be included in the training.

[22] Unicorns is a metaphor, which was introduced by the basketball panel in 2021 MIT Sloan conference. A unicorn is an exceptional talented player, who possesses the gift to play on the highest level. `https://www.sloansportsconference.com/conference/2021-conference`

5.2.3 Gradient Boost Machine

The Gradient Boost Machine, which predicts the result step-wise, based on both the skill of the players, as well as the psychological aspects upon a general level, have delivered satisfactory results. To begin with, when making the prediction, we could utilise both the numerical data, in terms of the total playing time, as well as the categorical data. The flexibility itself allows the prediction to include variables, which are not always possible to combine, in classifiers, such as support vector machine or logistic regression. For this reason, the prediction is more accurate. Furthermore, the step-wise obtained residues allow the classifier to adjust the errors from each and every categories of data, iteratively. For this reason, the classifier could capture the fluctuations in each categories more consciously. However, it still is a static model, when learning the match result from a team, which changed their players through a season, the result is much less satisfactory. In order to ameliorate the results, a sequential learning tool is needed. Finally, the method could be improved further, if the training data are not confined to one team's match results, rather the entire league from one specific season. When doing so, we could include more varieties, in terms of the team compositions, also the combinations of psychological condition and the performance. Nevertheless, it is out of the scope of this wee project.

This prediction model could be an aid for the trainer, when discussing about the game strategies. To begin with, the advantage of using the SPM clustered results, together with the salary budget disparity in the training model, is to give the trainer a tool to assess the adequacy of a line-up, when combating against a specific team. The previous results might be able to give the trainer an indication how to initiate a collaboration amongst the players in possession, also how much each players should participate in a specific game. Moreover, the play-by-play data based cluster results might be able to give the trainer a vague indication, whether a newly acquired player could maximise his performance, when playing with the new team mates.

5.3 How to Build a Successful Team?

How to build a team? The person, who has a good answer to this question might be able to receive the Nobel Prize in Economy again and again. To begin with, a good team is a team which could win the sympathy of the home state, as well as the attention from the sport journalists. NBA is a business empire. The league could survive, if and only if they could attract a passionate crowd, who wants to buy the tickets, discuss about the game results in various social media, work with their stat as their school work and watching the commercials during the breaks. Scottie Pippen made headline in Chicago, when he guarded their future team mates Toni Kukoc viciously on the Court in the Olympic games, also his decision to delay his surgery, intending to demonstrate his anger towards club's decisions attracted far more attention, than his ingenious pass on the court. There are so many brilliant players in NBA. An ordinary player, who plays well, would never be able to bring the club into the centre of fan's attention.

A team, which is made up by players with very different skills, who grew up under different circumstances, is often more difficult to play against. When recruiting a new player, it is also important to assess the team's collective skill. The score from their previous record much be scrutinised together with the skills of the current team. The intention is to find out if the skill of a specific player could fill the blank spot in the cluster

formation. Every offensive player needs to have a defensive player, who could steal a ball from the opponent, and pass the ball to the next player, in the most unexpected moment. For this reason, the players need to have time to learn how to play with each other on the court. Nevertheless, to have a few of the top players is important! Portland possessed a well-synchronised line-up, season 1998 - 1999 and season 1999 - 2000, however, they lacked one or two powerful centres, which Los Angeles Lakers had. The SPM clustering result confirmed that a team, which possess one or two extremely powerful offensive players, are more likely to win the game.

A team is a good team, which could crush the strongest team in the league, if the players have fun, whilst playing together as a team. When the former Chicago Bulls player summarised his experience with the Jail Blazers' lads, he articulated the following string of words: *What a great experience that was. That was awesome. That might've been the most fun year I've ever had in the NBA, just to see the dysfunction. I had never seen it anywhere else.*[23] The players, such as Rasheed Wallace and Zach Randolph thrived in Portland, despite they played in a highly dysfunctional team, because the players could entertain each other. When the political correctness was not a priority in the club and the players could enjoy a sense of real personal liberty, the lads became more innovative on the court. The appreciation per se was a driven engine of their personal development as a ballplayer.

5.4 Proposal to Future Projects

As the next step, two additional tasks could be relevant to carry out, aiming to improve the prediction accuracy:

- In order to make a more reliable game result prediction model, we need to scrape the play-by-play data of all players, game wise, within the same season, rather than using the season averaged value in SPM estimation. In addition, the regularisation constant should be optimised, in accordance with the most dominating play statistics, which changes slightly from season to season. Such an advancement might be able to provide a more detailed on court performance information of each player in Portland, depends on the performance of the opponent players.

- In order to better accommodate the need to predict which players could quickly adapt to the play style of a new team, before making a business decision, a combination of box score plus and minus could be used to estimate a weight constant, when assessing the new team - dependent SPM scores.

[23] At the age of 36, Steve Kerr played for Portland Trail Blazers in season 2001 - 2002. He was team mate with among others Scottie Pippen (his former team mate from Chicago Bulls), Damon Stoudamire, Rasheet Wallace, Ruben Patterson and Derek Andersson. `https://www.oregonlive.com/blazers/2019/05/warriors-coach-steve-kerr-on-the-trail-blazers-i-know-this-city-loves-this-team-and-they-should-love-this-version.html`

A Correlation Heat Maps for Six Players

Six stellar players, who were active in the Jail Blazers years are analysed. The aim is to find out if we could obtain a palpable correlation between the years of on-court experience, their physical age and the performance.

A.1 David Robinson

David Robin was one of members in Dream Team in 1992, and was selected in the All Star team 10 times.[24] He was a left-handed centre player. The following correlation heat map of his career is based on his on-court performance between season 1989 - 1990 and season 2002 - 2003. He retired at the age of 37.

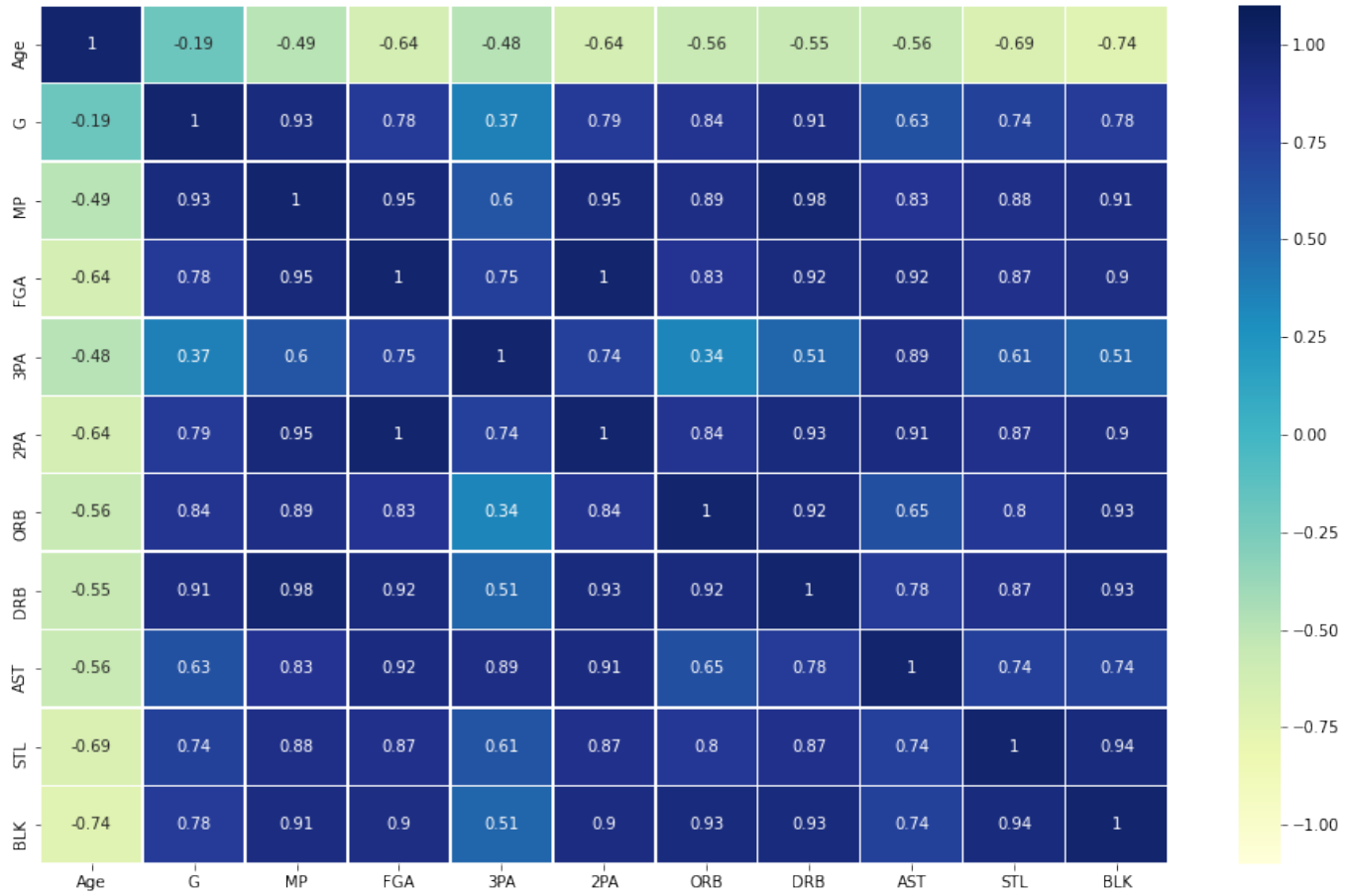

Figure 23: The summary of David Robinson's Professional Career in NBA in a correlation heat map

The correlation heat map revealed that David Robinson, see figure 23, his development of the defensive playing style did not accommodate with the change of playing style in NBA through his career. With age, he became a less aggressive rebound player in the near field combat.

[24]David Robinson joined NBA season 1989-1990, the year before, he was a college player, who represented the United States in the Olympic game 1988 in South Korea. Through his entire career, he played for San Antonio Spurs. `https://www.basketball-reference.com/players/r/robinda01.html`

A.2 Karl Malone

Karl Malone was a contemporary player to David Robinson who represented the United States in 1992 Summer Olympics in Barcelona, [25]

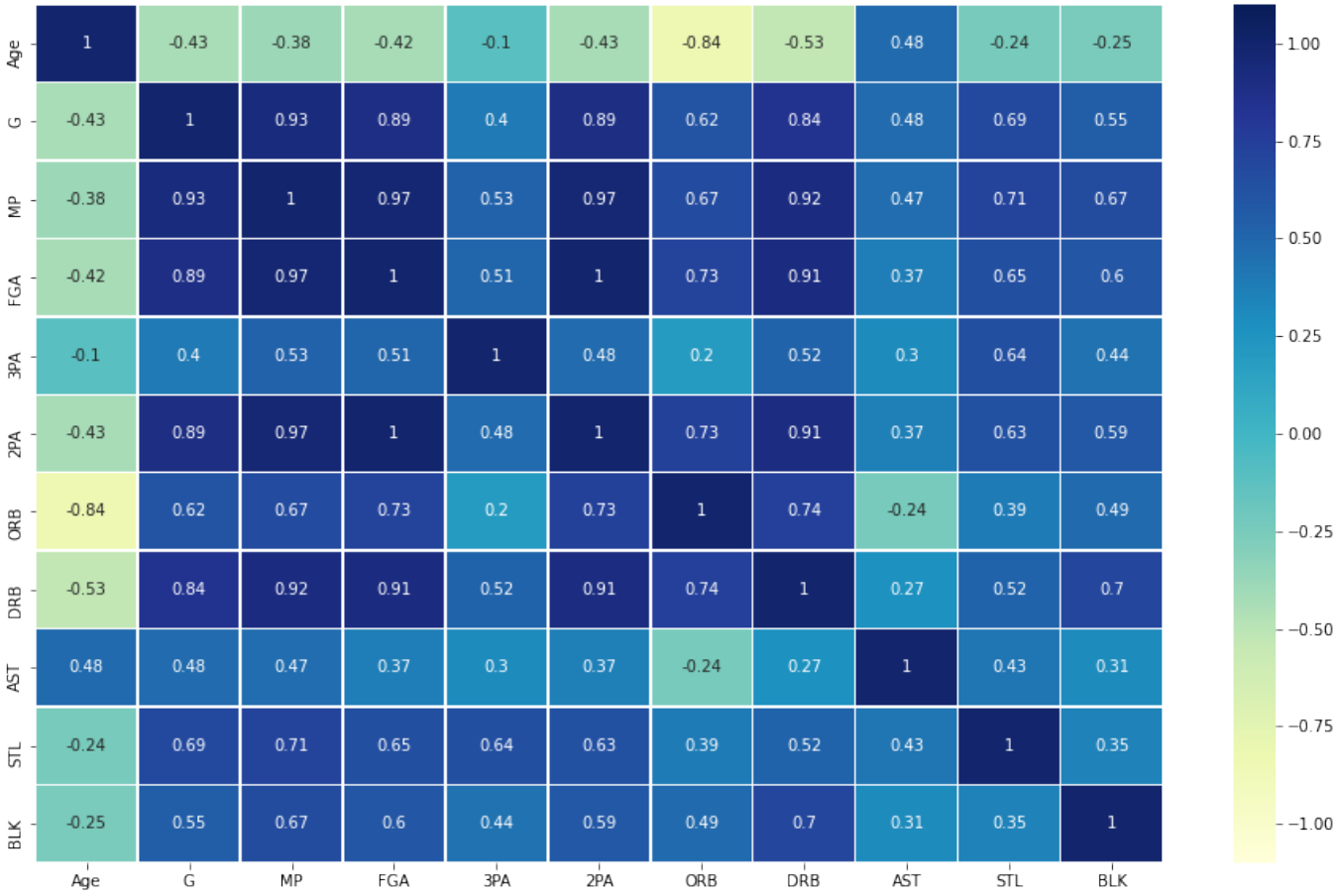

Figure 24: The summary of Karl Malone's Professional Career in NBA in a correlation heat map

The correlation heat map disclosed that Karl Malone, see figure 24, had adapted relatively successfully to the transformation in playing style in NBA, comparing with David Robinson, who had relatively lower negative correlation between 3 Point field goal Attempts and Age. As an offensive player, he was first and foremost a defensive rebounder in the near field combat. The heat map has in additional proved that his assist attempt increased with age, as well, which indicated that he shifted from an exclusive power forward, to an intermediate position, between a powerful power forward and a small forward, in his mature years.

[25]Karl Malone played for Utah Jazz as Point Forward for 18 years consecutively, he earned a spot in 14 all star games and was inducted in hall of fame in 2010. `https://www.basketball-reference.com/players/m/malonka01.html`

A.3 Scottie Pippen

Scottie Pippen was also member of Dream Team 1992, a team made up of NBA players for the first time in American history for Olympics, the team ended up winning Olympic Gold medal at that event.[26]

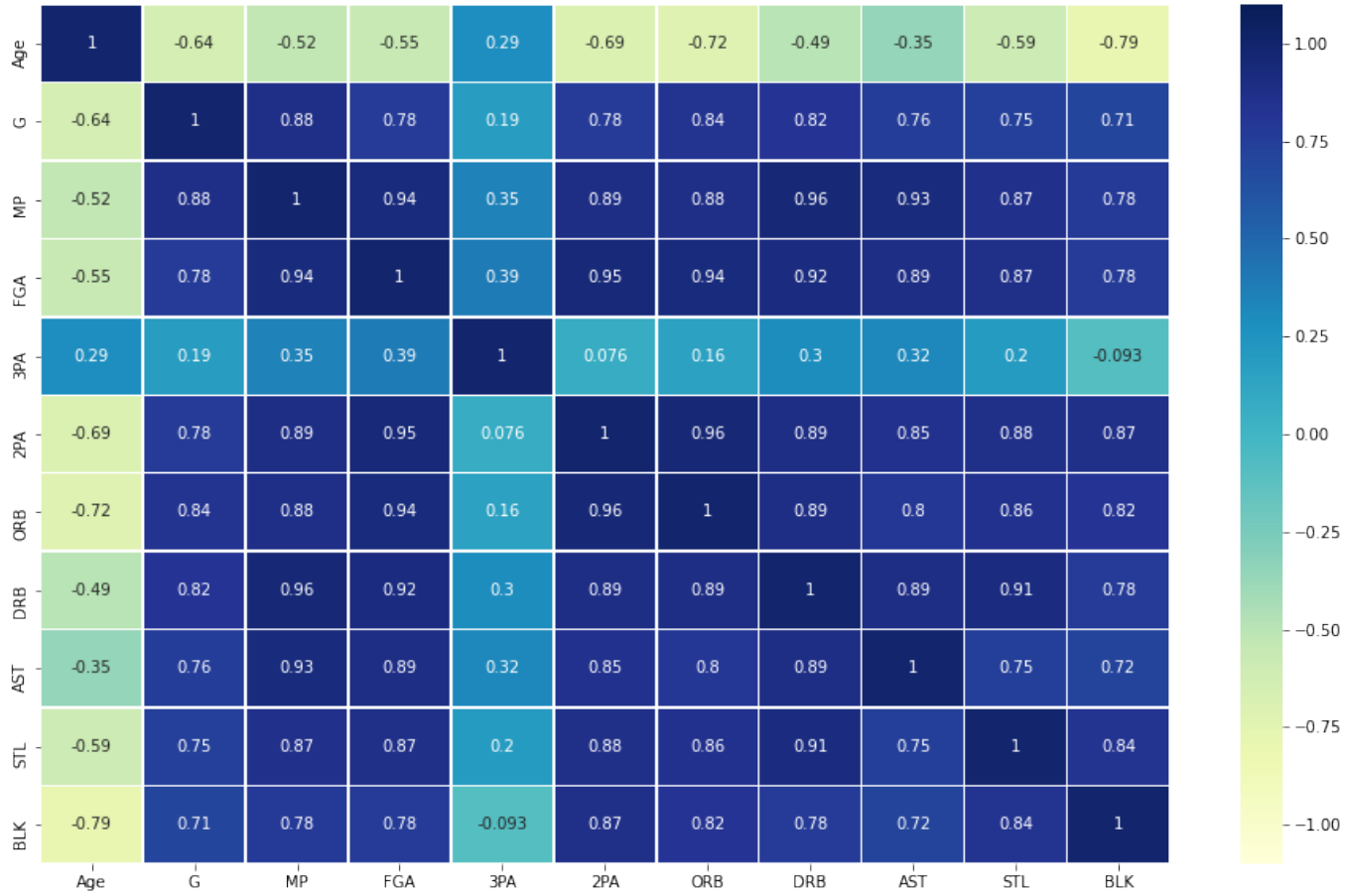

Figure 25: The summary of Scottie Pippen's Professional Career in NBA in a correlation heat map

The correlation heat map of Scottie Pippen's career, see figure 25, affirmed that there is a noticeable correlation between age and the number of three point attempts. He was more vigorous than his contemporaries David Robinson and Karl Malone, which might depend on the fact that he played with the Jordan and Rodman in Chicago previously. The core squad in Chicago won many of their most difficult games in the play-off seasons with far field 3 point goals, especially when playing against their arch-enemy Detroit Pistons. After his arrival to Portland, he played with the next generation offensive player, Steve Smiths, who had already adapted to a new play style, at the end of his career. However, the number of games had a strong negative correlation with age, which indicated the number of games, which he played in regular season declined apace compared to David Robinson and Karl Malone, at the end of his career.

[26]Scottie Pippen had 17 years old career, which constituted playing for Chicago Bulls, Houston Mavericks and Portland Trail Blazers as Small Forward. He was part of seven all star games and part of six times NBA champion team at Chicago Bulls. `https://www.basketball-reference.com/players/p/pippesc01.html`

A.4 Shaquille O'Neal

Shaquille O'Neal was a Centre player from New Jersey, who had 19 years of prolonged career in NBA, he was named as most valuable player three times. [27]

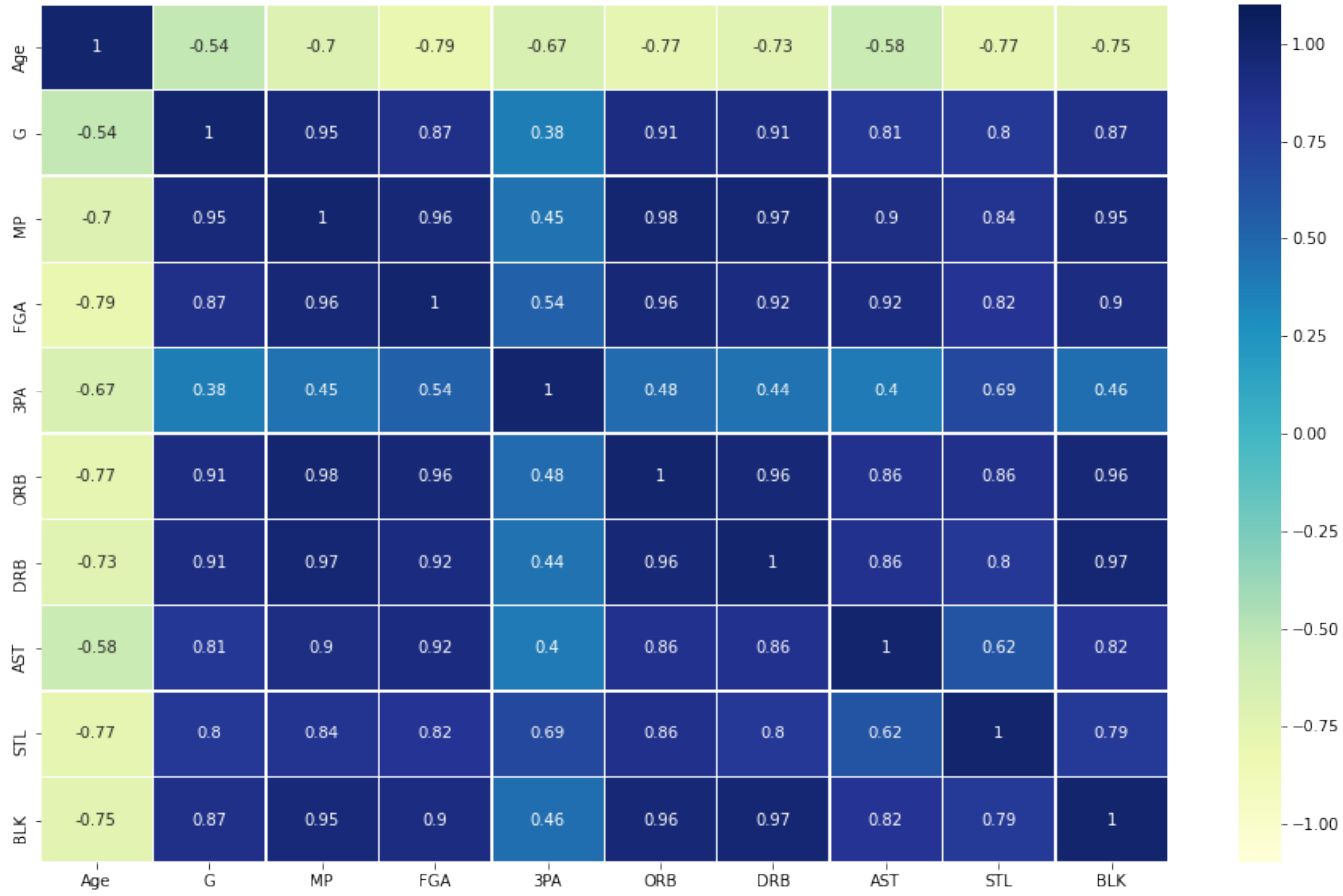

Figure 26: The summary of Shaquille O'Neal's Professional Career in NBA in a correlation heat map

Shaquille O'Neal is not a player, whom you would like to have in the opponent team; at the height of his career, he was an aggressive and dexterous offensive gladiator in the near field combat. The play statistics from his 20s, reveal his achievement as one of the greatest rebounder in his time. However, the correlation heat map enunciated that Shaquille O'Neal, see figure 26, was a mortal, who could not escape the wheel of time. With an increased age, his rebound performance, as well as other offensive play performance became weaker, with each year it went.

[27] Shaquille O'Neal played for several teams such as Orlando Magic, Los Angeles Lakers, Miami Heat, Phoenix Suns, Cleveland Cavaliers and Boston Celtics during his long career. He was inducted in hall of fame in 2016. The entire play statistics of his career was published in this website: `https://www.basketball-reference.com/players/o/onealsh01.html`

A.5 Jason Kidd

Jason Kidd played as a point guard and shooting guard; his career in NBA stretched between season 1994 - 1995 and 2012 - 2013. In 2011, he and his team mates from Miami Heat won the admiring NBA championship.[28]

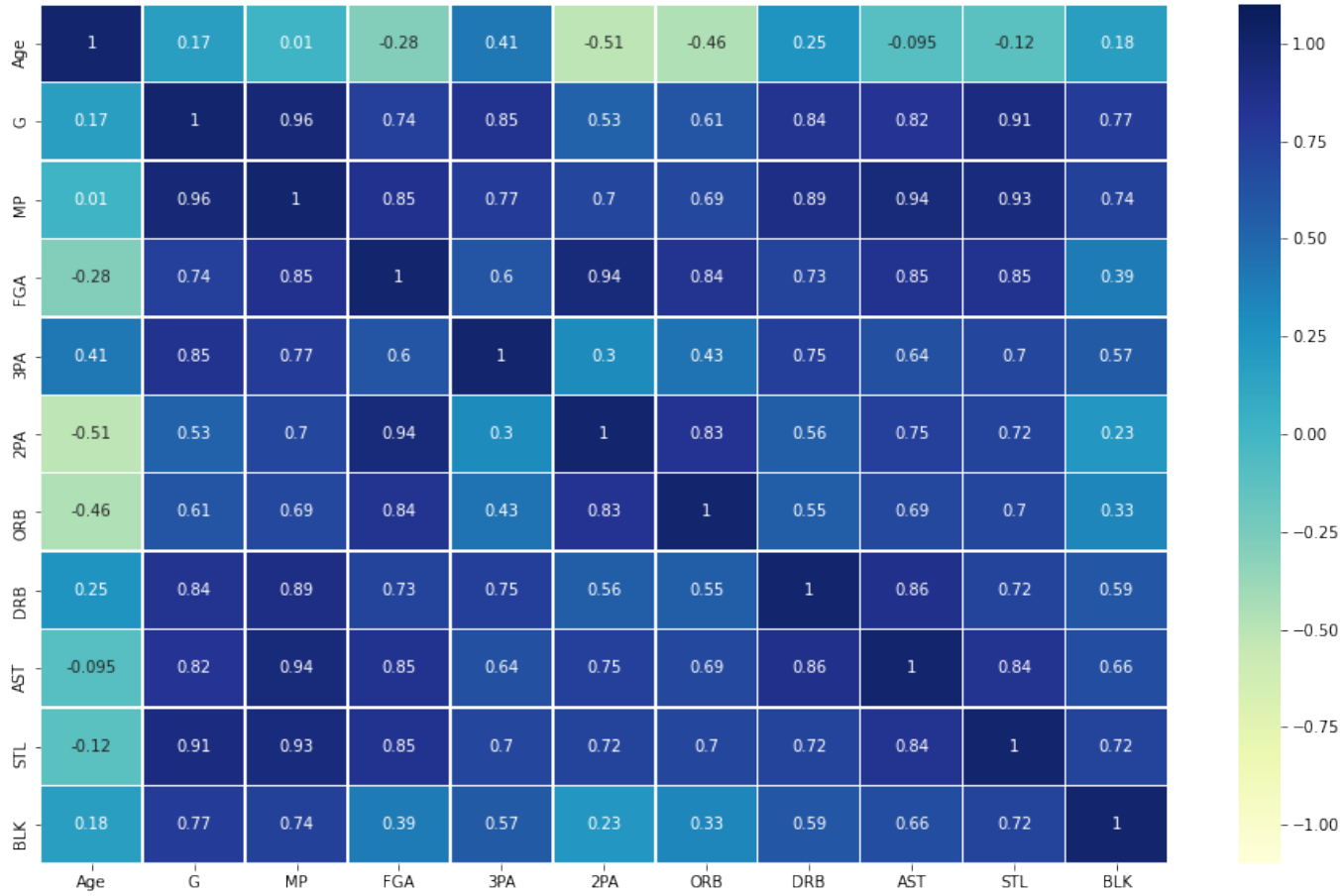

Figure 27: The summary of Jason Kidd's Professional Career in NBA in a correlation heat map

The correlation heat map of Jason Kidd's career, see figure 27, illustrated that he increased the three point attempts as he became more and more mature as a player. Amidst the basketball transition period around the millennium shifted, he changed his playing style, intending to avoid the increased complex defensive plays in the near field combat. The correlation heatmap from above confirms that the number of three point attempts increased after he has passed the height of his prime age. His contribution to the game considering variables such as number of games played and minutes played increase somewhat at the same time.

[28] Jason Kidd was a part of ten all star teams during his 19 years long career, he was was inducted in hall of fame in year 2018. `https://www.basketball-reference.com/players/k/kiddja01.html`

A.6 Kobe Bryant

Kobe Bryant played as a shooting guard and small forward for Los Angeles Lakers through his entire professional career as a basketball player. At the tender age of 18 he already was selected in the NBA all star games.[29]

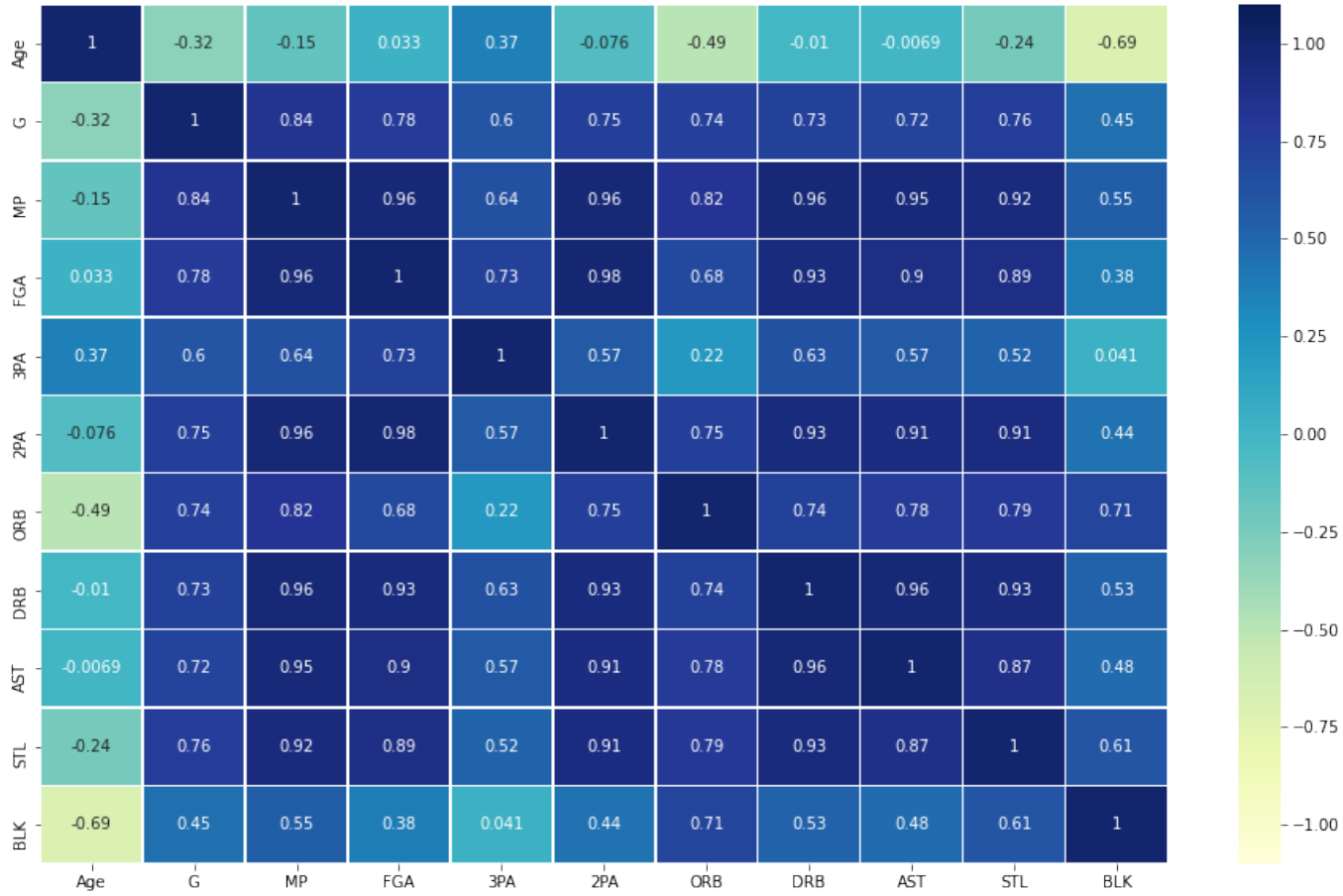

Figure 28: The summary of Kobe Bryant's Professional Career in NBA in a correlation heat map

The correlation heat map gives a strong indication that Kobe Bryant, see figure 28, was a legend, who defied the physical limitation, as he became an older player. Although the number of games, which he played decreased at the end of his professional career, the numbers of field goal attempts, two point attempts, defensive rebounds and assists are weakly correlated with age, substantiating his congruent rendition of play over the course of years.

[29]Kobe Bryant was part of five times NBA champion team at Los Angeles Lakers, he was named as most valuable player four times. He was inducted in hall of fame posthumously in year 2020.`https://www.basketball-reference.com/players/b/bryanko01.html`

A.7 Career Salary Analysis of the six players

The salary of the six studied basketball super stars are outlined, see figure 29. Their salary increased rapidly in the beginning of their professional career, except for Scottie Pippen and Karl Malone. Scottie Pippen signed a long term contract in the beginning of his career, the duration was seven years, which prevented him from negotiating a better economic deal for himself, when he had developed into one of the most important offensive player in the core squad in Chicago Bulls(McCallum, 2013).

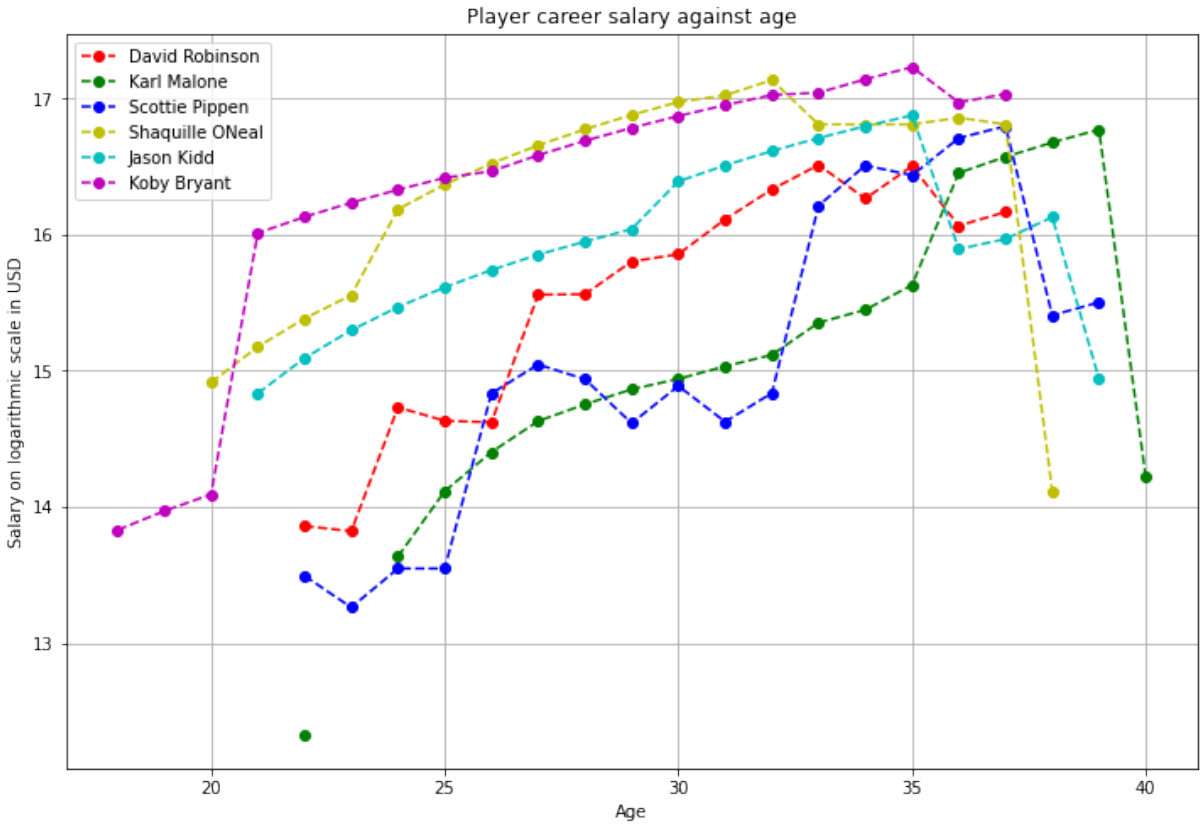

Figure 29: The salary development of all the six studied basketball super stars, through their formative years in NBA.

Although their on-court performance deteriorated with time, after the age of 30, the salary increased, until they reached the age of 35. Utah Jazz' Karl Malone could continue to ask for a higher payment, until the age of 39.

Table 18: NBA Career Information of Six Hall of Famers

Player	Start Age	First Season	Last Season
David Robinson	24	1989 - 1990	2002 - 2003
Karl Malone	22	1985 - 1986	2003 - 2004
Scottie Pippen	22	1987 - 1988	2003 - 2004
Shaquille O'Neal	20	1992 - 1993	2010 - 2011
Jason Kidd	21	1994 - 1995	2012 - 2013
Kobe Bryant	18	1996 - 1997	2015 - 2016

B Clustering Results

The study of team conditions of the four division champions and the NBA champion in the three selected seasons are outlined in this section.

B.1 Season 1999 - 2000

The clustering results of the four best performed teams from season 1999 - 2000 are outlined in the section.

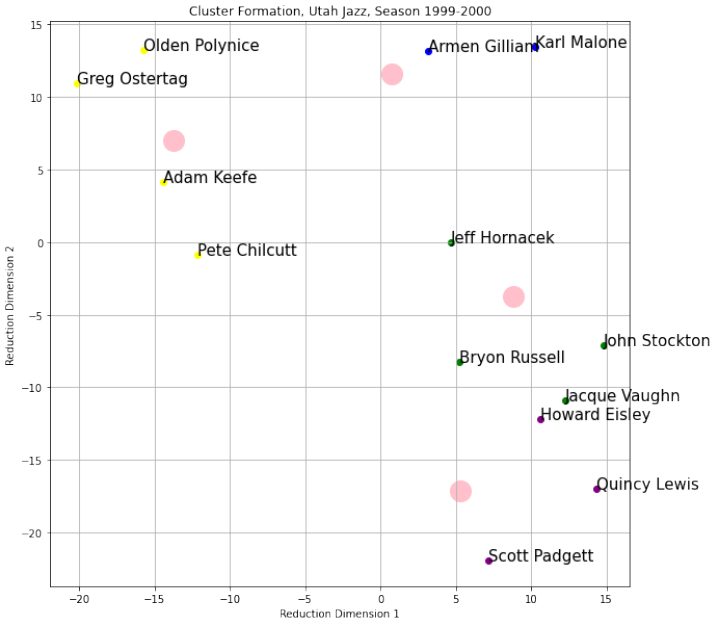

Figure 30: The average distances between each Utah Jazz players and their respective centroid points, Season 1999 - 2000.

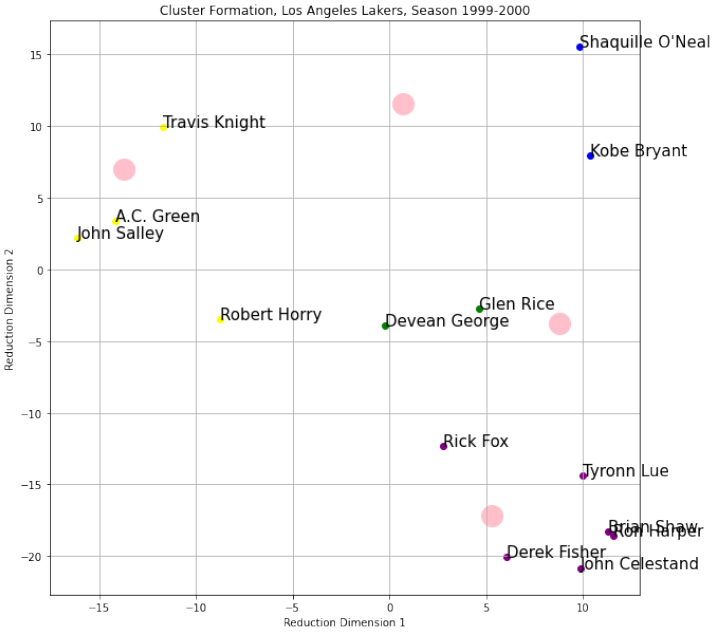

Figure 31: The average distances between each Los Angeles Lakers players and their respective centroid points, Season 1999 - 2000.

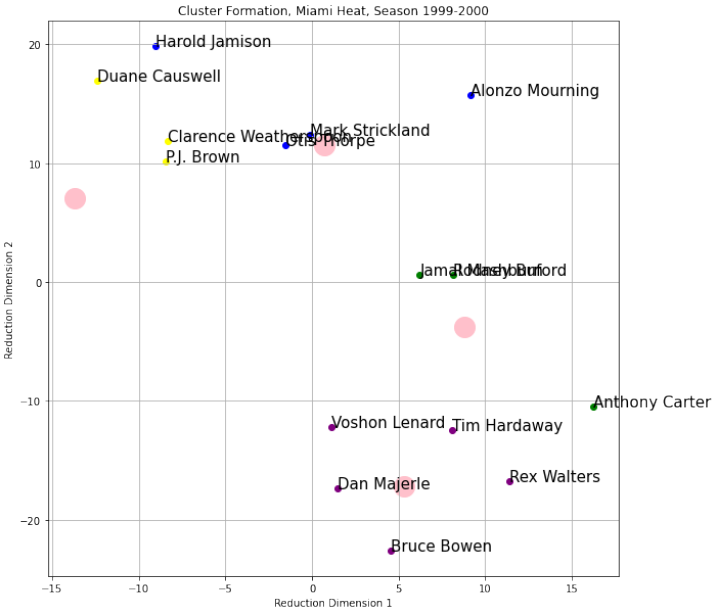

Figure 32: The average distances between each Miami Heat players and their respective centroid points, Season 1999 - 2000.

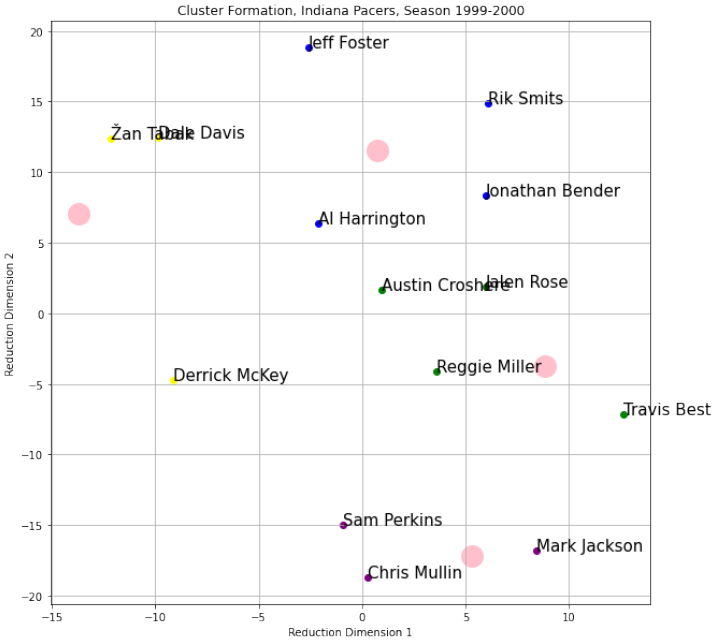

Figure 33: The average distances between each Indiana Pacers players and their respective centroid points, Season 1999 - 2000.

B.2 Season 2003 - 2004

The clustering results of the five best performed teams from season 2003 - 2004 are outlined in the section.

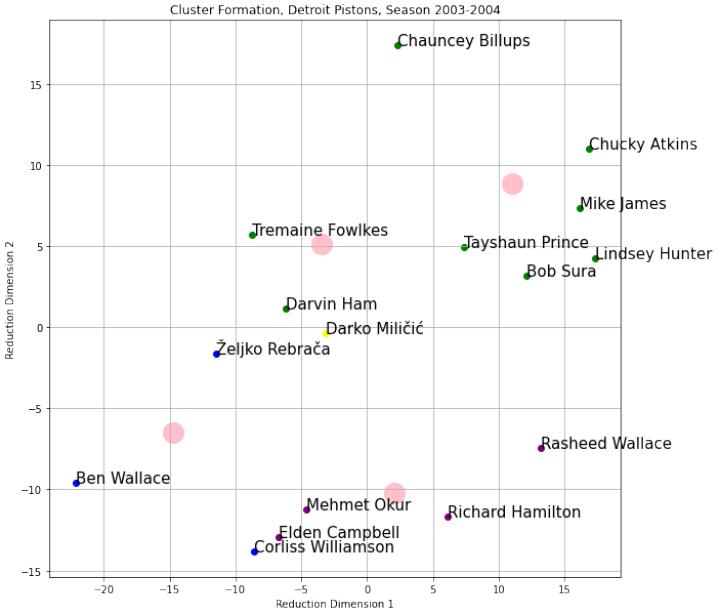

Figure 34: The average distances between each Detroit Pistons players and their respective centroid points, season 2003 - 2004.

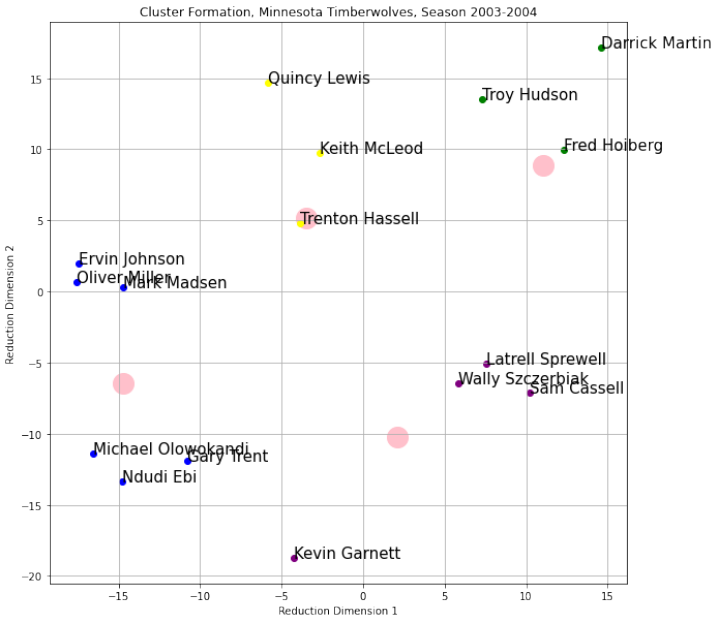

Figure 35: The average distances between each Minnesota Timberwolves players and their respective centroid points, season 2003 - 2004.

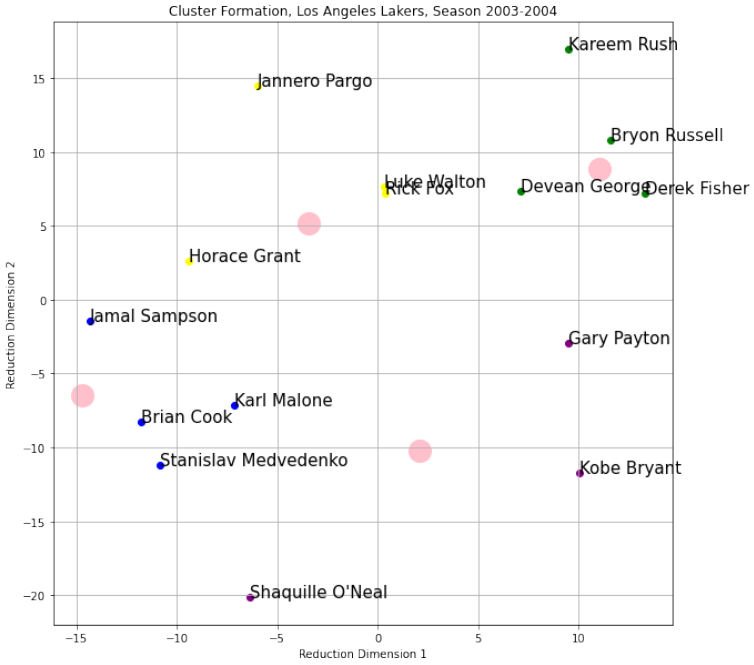

Figure 36: The average distances between each Los Angeles Lakers players and their respective centroid points, season 2003 - 2004.

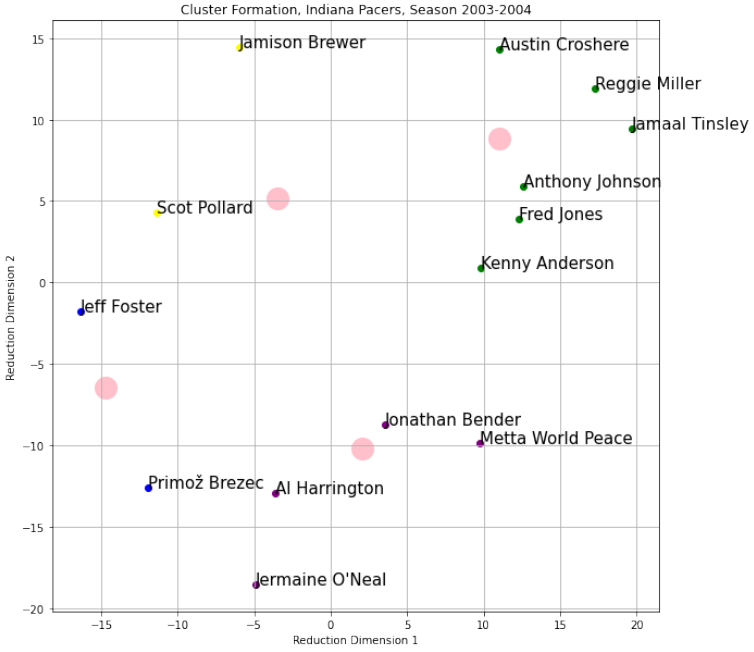

Figure 37: The average distances between each Indiana Pacers players and their respective centroid points, season 2003 - 2004.

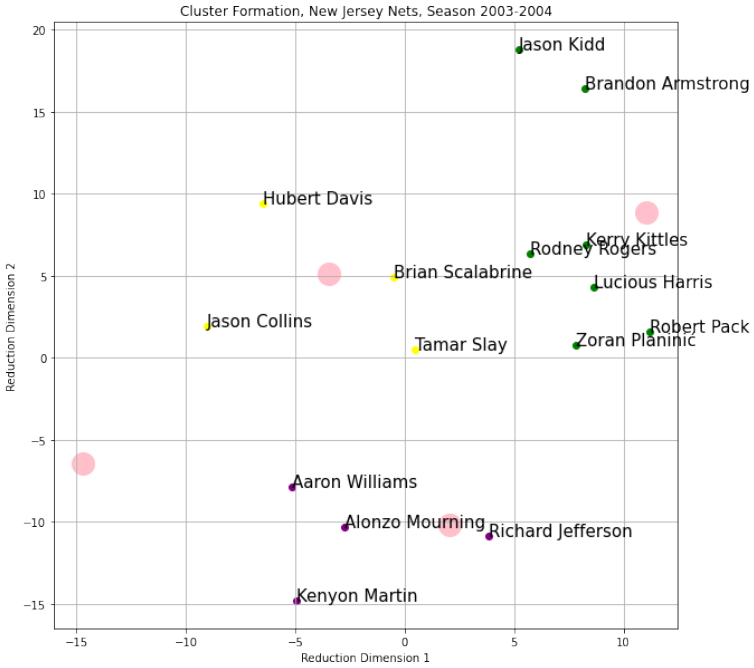

Figure 38: The average distances between each New Jersey Nets players and their respective centroid points, season 2003 - 2004.

B.3 Season 2005 - 2006

The clustering results of the four best performed teams from season 2005 - 2006 are outlined in the section.

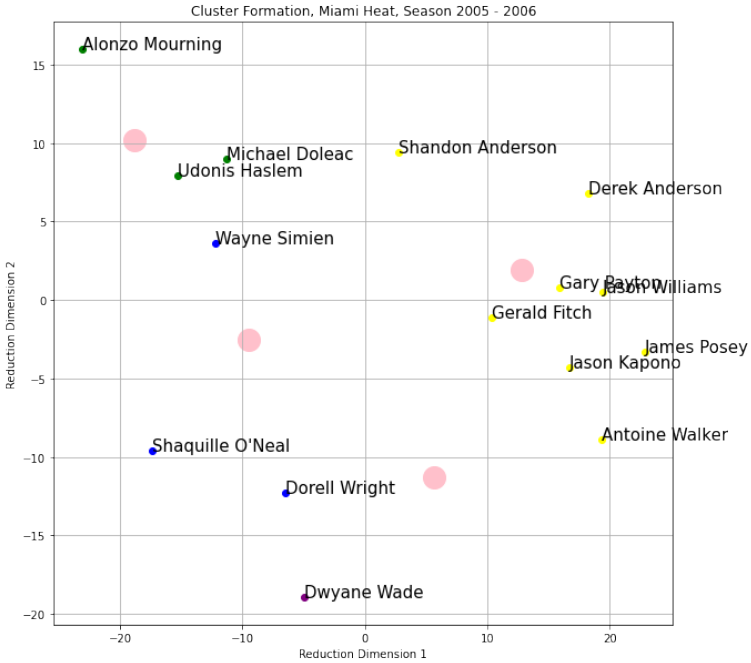

Figure 39: The average distances between each Miami Heat players and their respective centroid points, season 2005 - 2006.

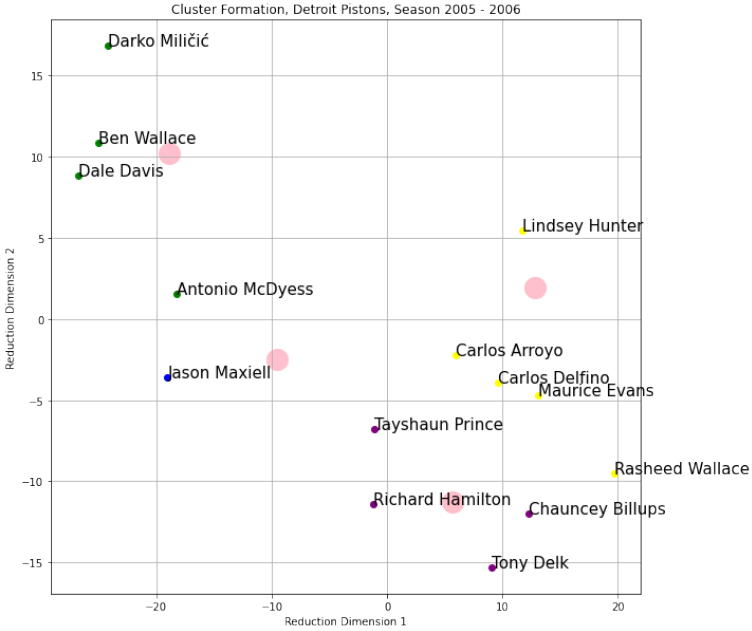

Figure 40: The average distances between each Detroit Pistons players and their respective centroid points, season 2005 - 2006.

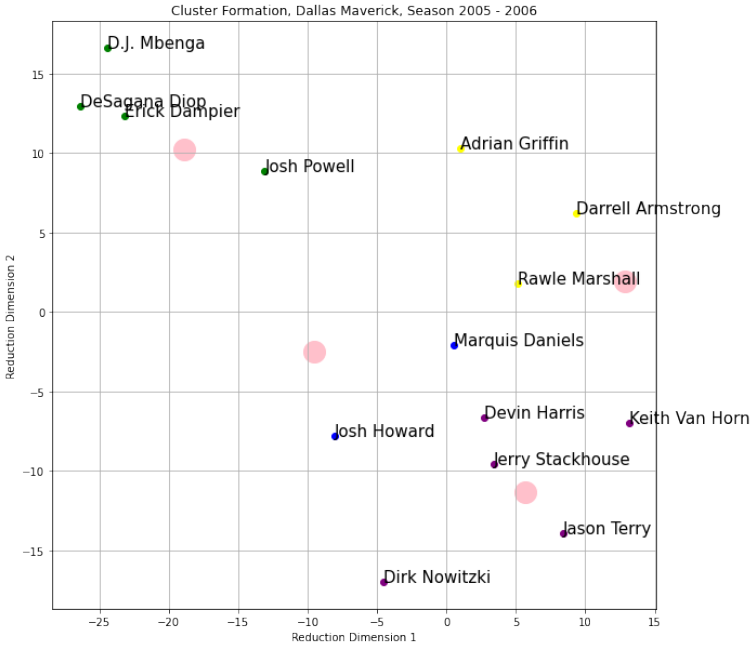

Figure 41: The average distances between each Dallas Maverick players and their respective centroid points, season 2005 - 2006.

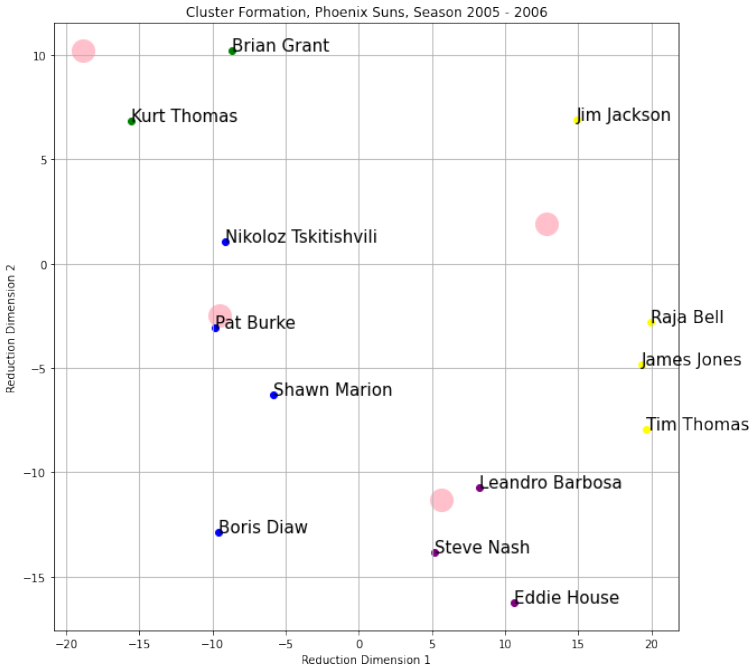

Figure 42: The average distances between each Phoenix Suns players and their respective centroid points, season 2005 - 2006.

C Skill Plus and Minus Clustering Results

Five groups of players are outlined for each studied seasons: four of which are the division champions and the result of best line ups of Portland Trail Blazers.

C.1 Season 1999 - 2000

The NBA Champion of season 1999 - 2000 was Los Angeles Lakers. The cluster formations are outlined in the appendix. The players are listed in the Alphabetical order.

Table 19: The Cluster formation of the Player Skills, Miami Heat, Season 1999 - 2000

Clusters	Players
Cluster 1	Bruce Bowen, Dan Majerle, Rex Walters
Cluster 2	Clarence Weatherspoon, P.J. Brown
Cluster 3	Otis Thorpe
Cluster 4	Jamal Mashburn
Cluster 5	Alonzo Mourning
Cluster 6	Duane Causwell, Harold Jamison, Mark Strickland
Cluster 7	Rodney Buford
Cluster 8	Anthony Carter, Tim Hardaway, Voshon Lenard

Table 20: The most powerful line-ups, Miami Heat, Season 1999 - 2000

Clusters	The Squads
2, 8, 1, 4, 5	P.J. Brown, Tim Hardaway, Dan Majerle, Jamal Mashburn, Alonzo Mourning
2, 8, 1, 4, 5	P.J. Brown, Anthony Carter, Dan Majerle, Jamal Mashburn, Alonzo Mourning
2, 6, 8, 4, 5	P.J. Brown, Tim Hardaway, Voshon Lenard, Jamal Mashburn, Alonzo Mourning
8, 1, 4, 5, 2	Tim Hardaway, Dan Majerle, Jamal Mashburn Alonzo Mourning, Clarence Weatherspoon

Table 21: The Cluster formation of the Player Skills, Indiana Pacers, Season 1999 - 2000

Clusters	Players
Cluster 1	Chris Mullin
Cluster 2	Dale Davis, Rik Smits
Cluster 3	Al Harrington
Cluster 4	Austin Croshere, Jalen Rose, Mark Jackson, Reggie Miller, Travis Best
Cluster 6	Jeff Foster, Žan Tabak
Cluster 7	Derrick McKey, Jonathan Bender
Cluster 8	Sam Perkins

Table 22: The most powerful line-ups, Indiana Pacers, Season 1999 - 2000

Clusters	The Squads
2, 4, 4, 4, 2	Dale Davis, Mark Jackson, Reggie Miller, Jalen Rose, Rik Smits
4, 4, 4, 4, 2	Austin Croshere, Mark Jackson, Reggie Miller, Jalen Rose, Rik Smits
4, 4, 3, 8, 4	Travis Best, Austin Croshere, Al Harrington, Sam Perkins, Jalen Rose
4, 2, 4, 4, 4	Austin Croshere, Dale Davis, Mark Jackson, Reggie Miller, Jalen Rose

Table 23: The Cluster formation of the Player Skills, Utah Jazz, Season 1999 - 2000

Clusters	Players
Clusters 2	Greg Ostertag, Olden Polynice
Clusters 3	Armen Gilliam
Clusters 4	Bryon Russell, Jeff Hornacek, John Stockton
Clusters 5	Karl Malone
Clusters 6	Adam Keefe
Clusters 7	Pete Chilcutt, Quincy Lewis, Scott Padgett
Cluster 8	Howard Eisley, Jacque Vaughn

Table 24: The most powerful line-ups, Utah Jazz, Season 1999 - 2000

Clusters	The Squads
4, 5, 2, 4, 4	Jeff Hornacek, Karl Malone, Olden Polynice, Bryon Russell, John Stockton
4, 5, 2, 4, 4	Jeff Hornacek, Karl Malone, Greg Ostertag, Bryon Russell, John Stockton
8, 5, 2, 4, 4	Howard Eisley, Karl Malone, Greg Ostertag, Bryon Russell, John Stockton
8, 5, 2, 4, 4	Howard Eisley, Karl Malone, Olden Polynice, Bryon Russell, John Stockton

Table 25: The Cluster formation of the Player Skills, Los Angeles Lakers, Season 1999 - 2000

Clusters	Players
Cluster 3	A.C. Green, Robert Horry, Ron Harper
Cluster 4	Glen Rice
Cluster 5	Kobe Bryant, Shaquille O'Neal
Cluster 6	John Salley, Travis Knight
Cluster 7	Devean George, John Celestand
Cluster 8	Brian Shaw, Derek Fisher, Rick Fox

Table 26: The most powerful line-ups, Los Angeles Lakers, Season 1999 - 2000

Clusters	The Squads
5, 3, 3, 5, 4	Kobe Bryant, A.C. Green, Ron Harper, Shaquille O'Neal, Glen Rice
8, 3, 3, 5, 4	Derek Fisher, A.C. Green, Ron Harper, Shaquille O'Neal, Glen Rice
5, 8, 8, 3, 5	Kobe Bryant, Derek Fisher, Rick Fox, Robert Horry, Shaquille O'Neal
8, 8, 3, 5, 8	Derek Fisher, Rick Fox, Robert Horry, Shaquille O'Neal, Brian Shaw

C.2 Season 2003 - 2004

The NBA champion of season 2003 and 2004 is Detroit Pistons. One of the Jail Blazer lads, Rasheed Wallace was traded from Portland to Detroit during this season and became

an prolific player in the core squad.

Table 27: The line-ups,New Jersey Nets, Season 2003 - 2004

Clusters	Players
Cluster 1	Alonzo Mourning
Cluster 2	Jason Kidd
Cluster 3	Anthony Goldwire, Brandon Armstrong, Tamar Slay, Doug Overton
Cluster 4	Jason Collins, Aaron Williams
Cluster 5	Kerry Kittles, Rodney Rogers
Cluster 6	Kenyon Martin, Richard Jefferson
Cluster 7	Brian Scalabrine, Zoran Planinić
Cluster 8	Damone Brown, Mikki Moore, Robert Pack, Hubert Davis
Cluster 9	Lucious Harris

Table 28: The most powerful line-ups, New Jersey, Season 2003 - 2004

Clusters	Players
4, 6, 4, 5, 6	Jason Collins, Richard Jefferson, Jason Kidd, Kerry Kittles, Kenyon Martin
4, 9, 6, 5, 5	Jason Collins, Lucious Harris, Richard Jefferson, Kerry Kittles, Rodney Rogers
6, 2, 5, 6, 4	Richard Jefferson, Jason Kidd, Kerry Kittles, Kenyon Martin, Aaron Williams
4, 6, 2, 5, 7	Jason Collins, Richard Jefferson, Jason Kidd, Kerry Kittles, Brian Scalabrine

Table 29: The line-ups, Detroit Pistons, Season 2003 - 2004

Clusters	Players
Cluster 1	Darko Miličić, Darvin Ham, Željko Rebrača
Cluster 2	Chauncey Billups, Richard Hamilton
Cluster 3	Lindsey Hunter
Cluster 4	Ben Wallace, Corliss Williamson, Elden Campbell, Mehmet Okur
Cluster 5	Tayshaun Prince
Cluster 7	Bob Sura, Rasheed Wallace
Cluster 8	Tremaine Fowlkes
Cluster 9	Chucky Atkins, Mike James

Table 30: The most powerful line-ups, Detroit Pistons, Season 2003 - 2004

Clusters	Players
2, 2, 4, 5, 4	Chauncey Billups, Richard Hamilton, Mehmet Okur Tayshaun Prince, Ben Wallace
2, 4, 2, 5, 4	Chauncey Billups, Elden Campbell, Richard Hamilton Tayshaun Prince, Ben Wallace
2, 2, 5, 4, 2	Chauncey Billups, Richard Hamilton, Tayshaun Prince Ben Wallace, Richard Wallace
2, 2, 5, 4, 4	Chauncey Billups, Richard Hamilton, Tayshaun Prince Ben Wallace, Corliss Williamson

Table 31: The line-ups, Indiana Pacers, Season 2003 - 2004

Clusters	Players
Cluster 1	Primož Brezec, Scot Pollard
Cluster 2	Metta World Peace
Cluster 3	Jamison Brewer
Cluster 4	Jeff Foster
Cluster 5	Fred Jones
Cluster 6	Al Harrington, Jermaine O'Neal
Cluster 7	Austin Croshere, Jonathan Bender, Kenny Anderson
Cluster 9	Anthony Johnson, Jamaal Tinsley, Reggie Miller

Table 32: The most powerful line-ups, Indiana Pacers, Season 2003 - 2004

Clusters	Players
2, 4, 9, 6, 9	Metta World Peace, Jeff Foster, Reggie Miller, Jermaine O'Neal, Jamaal Tinsley
7, 2, 4, 9, 6	Kenny Anderson, Metta World Peace, Jeff Foster, Reggie Miller, Jermaine O'Neal
2, 6, 9, 6, 9	Metta World Peace, Al Harrington, Reggie Miller, Jermaine O'Neal, Jamaal Tinsley
4, 6, 9, 6, 9	Jeff Foster, Al Harrington, Reggie Miller, Jermaine O'Neal, Jamaal Tinsley

Table 33: The line-ups, Minnesota Timberwolves, Season 2003 - 2004

Clusters	Players
Cluster 1	Mark Madsen, Ervin Johnson, Oliver Miller, Michael Olowokandi
Cluster 2	Sam Cassell, Latrell Sprewell
Cluster 3	Quincy Lewis, Anthony Goldwire, Keith McLeod, Darrick Martin
Cluster 4	Gary Trent
Cluster 6	Kevin Garnett
Cluster 7	Trenton Hassell, Wally Szczerbiak
Cluster 8	Ndudi Ebi
Cluster 9	Troy Hudson, Fred Hoiberg

Table 34: The most powerful line-ups, Minnesota Timberwolves, Season 2003 - 2004

Clusters	Players
2, 6, 7, 1, 2	Sam Cassell, Kevin Garnett, Trenton Hassell, Ervin Johnson, Latrell Sprewell
2, 6, 7, 1, 2	Sam Cassell, Kevin Garnett, Trenton Hassell, Michael Olowokandi, Latrell Sprewell
2, 6, 7, 1, 2	Sam Cassell, Kevin Garnett, Trenton Hassell, Mark Madsen, Latrell Sprewell
2, 6, 9, 1, 2	Sam Cassell, Kevin Garnett, Fred Hoiberg, Mark Madsen, Latrell Sprewell

C.3 Season 2005 - 2006

Season 2005 - 2006 NBA champion was Miami Heat. New Jersey Nets and Indiana Pacers were leading in Atlantic and Central Division accordingly, Minnesota Timberwolves secured first spot in Midwest Division and Los Angelese Lakers reigned Pacific Division.

Table 35: The line-ups, San Antonio Spurs, Season 2003 - 2004

Clusters	Players
Cluster 1	Kevin Willis
Cluster 2	Tony Parker, Manu Ginóbili
Cluster 3	Shane Heal, Charlie Ward, Anthony Carter
Cluster 4	Rasho Nesterović, Malik Rose
Cluster 5	Hedo Türkoğlu
Cluster 6	Tim Duncan
Cluster 7	Jason Hart, Robert Horry, Devin Brown, Ron Mercer
Cluster 8	Alex Garcia, Matt Carroll
Cluster 9	Bruce Bowen

Table 36: The most powerful line-ups, San Antonio Spurs, Season 2003 - 2004

Clusters	Players
9, 6, 2, 4, 2	Bruce Bowen, Tim Duncan, Manu Ginóbili, Rasho Nesterović, Tony Parker
9, 6, 4, 2, 5	Bruce Bowen, Tim Duncan, Rasho Nesterović, Tony Parker, Hedo Türkoğlu
9, 4, 2, 4, 5	Bruce Bowen, Rasho Nesterović, Tony Parker, Malik Rose, Hedo Türkoğlu
9, 6, 7, 2, 5	Bruce Bowen, Tim Duncan, Robert Horry, Tony Parker, Hedo Türkoğlu

Table 37: The line-ups, Sacramento Kings, Season 2003 - 2004

Clusters	Players
Cluster 1	Tony Massenburg
Cluster 2	Mike Bibby, Peja Stojaković
Cluster 4	Darius Songaila
Cluster 5	Bobby Jackson, Doug Christie
Cluster 6	Brad Miller, Vlade Divac
Cluster 7	Chris Webber
Cluster 8	Gerald Wallace, Jabari Smith, Rodney Buford
Cluster 9	Anthony Peeler

Table 38: The most powerful line-ups, Sacramento Kings, Season 2003 - 2004

Clusters	Players
2, 5, 6, 6, 2	Mike Bibby, Doug Christie, Vlade Divac, Brad Miller, Peja Stojaković
2, 5, 6, 2, 7	Mike Bibby, Doug Christie, Vlade Divac, Peja Stojaković, Chris Webber
2, 5, 6, 2, 7	Mike Bibby, Doug Christie, Brad Miller, Peja Stojaković, Chris Webber
2, 5, 6, 4, 2	Mike Bibby, Doug Christie, Vlade Divac, Darius Songaila, Peja Stojaković

Table 39: The line-ups, Los Angeles Lakers, Season 2003 - 2004

Clusters	Players
Cluster 1	Jamal Sampson
Cluster 2	Gary Payton, Kobe Bryant
Cluster 3	Jannero Pargo, Maurice Carter
Cluster 5	Devean George, Karl Malone
Cluster 6	Shaquille O'Neal
Cluster 7	Rick Fox, Luke Walton, Brian Cook, Horace Grant, Stanislav Medvedenko
Cluster 8	Ime Udoka
Cluster 9	Derek Fisher, Bryon Russell, Kareem Rush

Table 40: The most powerful line-ups, Los Angeles Lakers, Season 2003 - 2004

Clusters	Players
2, 5, 5, 6, 2	Kobe Bryant, Devean George, Karl Malone, Shaquille O'Neal, Gary Payton
2, 7, 5, 6, 2	Kobe Bryant, Rick Fox, Karl Malone, Shaquille O'Neal, Gary Payton
2, 7, 7, 6, 2	Kobe Bryant, Rick Fox, Stanislav Medvedenko, Shaquille O'Neal, Gary Payton
2, 5, 7, 7, 2	Kobe Bryant, Devean George, Horace Grant, Stanislav Medvedenko, Gary Payton

Table 41: The line-ups, New Jersey Nets, Season 2005 - 2006

Clusters	Players
Cluster 1	Clifford Robinson
Cluster 3	John Thomas, Derrick Zimmerman, Marc Jackson, Linton Johnson
Cluster 4	Boštjan Nachbar, Scott Padgett, Lamond Murray
Cluster 5	Nenad Krstić
Cluster 7	Jason Kidd
Cluster 8	Antoine Wright, Jeff McInnis, Jason Collins, Jacque Vaughn, Zoran Planinić
Cluster 9	Richard Jefferson, Vince Carter

Table 42: The line-ups, Detroit Pistons, Season 2005 - 2006

Clusters	Players
Cluster 1	Rasheed Wallace, Maurice Evans
Cluster 2	Ben Wallace
Cluster 3	Kelvin Cato, Amir Johnson, Darko Miličić, Dale Davis, Jason Maxiell
Cluster 4	Alex Acker, Tony Delk, Lindsey Hunter,
Cluster 6	Tayshaun Prince, Antonio McDyess
Cluster 7	Chauncey Billups, Richard Hamilton
Cluster 8	Carlos Delfino, Carlos Arroyo

Table 43: The line-ups, Miami Heat, Season 2005 - 2006

Clusters	Players
Cluster 1	James Posey, Antoine Walker, Jason Williams, Gary Payton
Cluster 2	Alonzo Mourning
Cluster 3	Matt Walsh, Wayne Simien
Cluster 4	Gerald Fitch, Jason Kapono, Derek Anderson
Cluster 5	Shaquille O'Neal
Cluster 6	Udonis Haslem
Cluster 8	Earl Barron, Dorell Wright, Michael Doleac, Shandon Anderson
Cluster 9	Dwyane Wade

Table 44: The line-ups, Denver Nuggets, Season 2005 - 2006

Clusters	Players
Cluster 1	DerMarr Johnson, Earl Boykins, Earl Watson, Greg Buckner
Cluster 3	Eduardo Nájera, Linas Kleiza, Reggie Evans
Cluster 4	Howard Eisley, Voshon Lenard
Cluster 6	Francisco Elson, Kenyon Martin, Marcus Camby, Ruben Patterson
Cluster 8	Julius Hodge
Cluster 9	Andre Miller, Carmelo Anthony

Table 45: The line-ups, Phoenix Suns, Season 2005 - 2006

Clusters	Players
Cluster 1	Eddie House, James Jones, Leandro Barbosa, Tim Thomas
Cluster 3	Amar'e Stoudemire, Pat Burke
Cluster 4	Jim Jackson
Cluster 5	Boris Diaw, Shawn Marion
Cluster 6	Kurt Thomas
Cluster 7	Raja Bell
Cluster 8	Andre Barrett, Brian Grant, Nikoloz Tskitishvili
Cluster 9	Steve Nash

Table 46: The line-ups, San Antonio Spurs, Season 2005 - 2006

Clusters	Players
Cluster 1	Beno Udrih, Brent Barry, Bruce Bowen, Michael Finley, Robert Horry
Cluster 2	Nazr Mohammed
Cluster 3	Fabricio Oberto, Rasho Nesterović
Cluster 4	Nick Van Exel
Cluster 5	Tim Duncan
Cluster 7	Manu Ginóbili
Cluster 8	Melvin Sanders, Sean Marks
Cluster 9	Tony Parker

References

Chamorro-Premuzic, T., & Furnham, A. (2005). *Personality and intellectual competence.* L. Erlbaum Associates. Retrieved from https://login.e.bibl.liu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=cat00115a&AN=lkp.933308&lang=sv&site=eds-live&scope=site

Christensen, B. (2007). Basketball and philosophy: Thinking outside the paint. *Booklist*, *103*(12), 23 - 24. Retrieved from https://login.e.bibl.liu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=a9h&AN=24242227&lang=sv&site=eds-live&scope=site

Eggers, K. (2018). *Jail blazers: How the portland trail blazers became the bad boys of basketball*. Sports Publishing.

Fort-Vanmeerhaeghe, A., Montalvo, A., Latinjak, A., & Unnithan, V. (2016). Physical characteristics of elite adolescent female basketball players and their relationship to match performance. *Journal of Human Kinetics*, *53*(1), 167 - 178. Retrieved from https://login.e.bibl.liu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=edsdoj&AN=edsdoj.b77562b33de34fabb3ff10ab7c81976d&lang=sv&site=eds-live&scope=site

Friedman, J. H. (2002). Stochastic gradient boosting. *Computational Statistics Data Analysis*, *38*(4), 367-378. (Nonlinear Methods and Data Mining)

Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology*, *17*(3), 295-314. Retrieved from https://www.sciencedirect.com/science/article/pii/0010028585900106 doi: https://doi.org/10.1016/0010-0285(85)90010-6

Goldberg, M. (2020). *Evaluating Lineups and Complementary Play Styles in the NBA* (Unpublished master's thesis). Harvard University, Cambridge, MA, United States.

Goldman, M., & Rao, J. (2012). Effort vs. concentration: The asymmetric impact of pressure on nba performance. *http://www.sloansportsconference.com/wp-content/uploads/2012/02/16-Goldman$_R$ao$_S$loan2012$_u$pdated.pdf*.

Gordon, J., Furlong, G., & Pendleton, K. (2018). *The sports playbook: Building teams that outperform, year after year*. Routledge.

Harris, A. R., & Roebber, P. J. (2019). Nba team home advantage: Identifying key factors using an artificial neural network. *PloS one*, *14*(7), e0220630. Retrieved from https://login.e.bibl.liu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=cmedm&AN=31365592&lang=sv&site=eds-live&scope=site

Henry, S. (2019). *Time-based analysis of the nba hot hand fallacy.*

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning: with applications*. Springer Texts in Statistics.

Johnson, R. A., & Wichern, D. W. (2007). *Applied multivariate statistical analysis.* Pearson Prentice Hall.

Kuehn, J. (2016). Accounting for Complementary Skill Sets When Evaluating NBA Players' Values to a Speciic Team. *MIT Sloan Sport Analytics Conference*. Retrieved from https://www.sloansportsconference.com/conference/2016-conference#research-papers

Louganis, G. (1995). *Breaking the surface: How greg louganis overcame prejudice to take home olympic gold*. Random House.

Maymin, A. Z., Maymin, P., & Shen, E. (2013). Nba chemistry: Positive and negative synergies in basketball. *Microeconomics: Information*.

McCallum, J. (2013). *Dream team: How michael, magic, larry, charles, and the greatest team of all time conquered the world and changed the game of basketball forever*. Ballantine Books.

Nevill, A. M., & Holder, R. L. (1999). Home advantage in sport: An overview of studies on the advantage of playing at home. *SPORTS MEDICINE -AUCKLAND-*(4), 221. Retrieved from https://login.e.bibl.liu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=edsbl&AN=RN069774921&lang=sv&site=eds-live&scope=site

Patel, R. (2017). *Clustering Professional Basketball Players by Performance* (Unpublished master's thesis). University of California, Los Angeles, Los Angeles, CA 90095, United States.

Pojskić, ., Haris, Šeparović, V., & Užičanin, E. (2011). Modelling home advantage in basketball at different levels of competition. *Acta Kinesiologica*, *5*(1), 25 - 30. Retrieved from https://login.e.bibl.liu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=edsswe&AN=edsswe.oai.DiVA.org.lnu.78044&lang=sv&site=eds-live&scope=site

Péter, V. (2013). What kind of effects had the global economic crisis on the attendance of the nba games? *Apstract: Applied Studies in Agribusiness and Commerce*, *7*(1).

Rosenbaum, D. (2004). *Measuring how nba players help their teams win.* Retrieved from http://www.82games.com/comm30.htm

Tyson, K. (2021). How to meet your fan's netflix level expectations. *MIT Sloan Sport Analytics Conference*.

Wolff, M. (2016). Predicting nba season ticket member behavior. *MIT Sloan Sport Analytics Conference*. Retrieved from https://www.sloansportsconference.com/conference/2016-conference#research-papers