NBA Basketball Game Forecasting System:
A Fuzzy Forecasting System

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Table of Contents

1 Introduction

1.1 Basketball Game Forecasting

If someone were to ask me who I thought would be this year's NBA champion I could easily come up with an answer. In fact, most people who follow basketball to some degree can quickly and easily arrive at an opinion on who it will be. Computers, however, aren't so great at making these types of forecasts. Computers can quickly search through enormous amounts of data to provide statistical probabilities of events based on any number of relationships such as past occurrences with little trouble. But, most people do not find comfort with these types of forecast results. For example, if I asked someone why they thought the Chicago Bulls were going to beat the Portland Trailblazers and they responded by saying, "well, since the Bulls have a 54% probability of winning based on 10 statistical categories that have been shown 86% of the time to be the most important factors in 200 randomly sampled games," I would probably think that it was a very odd response. If instead they said, "well, no one on the Blazers can stop Michael Jordan," I would probably tend to agree with them and their forecast.

With people, the act of predicting events does not seem to be precise at all and yet the forecasts seem to make common sense and are often times very accurate. The goal of this thesis is to create a system which can predict basketball game outcomes, but in a way more in tune with how people go about making these same types of predictions.

1.2 Fuzziness and Forecasting

There are two basic responses that a basketball game forecasting system should provide. The first, and most obvious response, is the predicted winner of the game. Regardless of the approach used to construct the forecast, the predicted winner must be provided by any forecasting system. The second response is a description of the reasoning the system used to generate the forecast. This can range from a vague, or high level description, to a very detailed analysis. The second response is where different approaches to forecasting systems can diverge as exemplified by the discussion above.

When people typically generate forecasts, they tend to make generalizations from statistical data. For example, when a typical basketball game prediction is made, the analysis does not start with actual statistics but rather with higher level concepts which are combined from other

concepts or statistics. Here is an example from CBS Sportline USA's weekly team insider reports on April 14, 1998:

> "Tuesday night [Seattle] vs. Vancouver -- The reeling Grizzlies, who have lost eight of their last 10 games, don't have much to offer offensively aside from Shareef Abdur-Rahim, who has always played well against the Sonics. But while the Sonics have a tough time keeping tabs on the athletic Abdur-Rahim, the Griz have little more to depend on for consistent offense."

The forecaster is predicting the Seattle Supersonics victory based on the Vancouver Grizzlies lack of consistent offense. The concept of a consistent offense used by the forecaster to explain the prediction is a generalization based on other concepts (such as a team's offensive ability) and actual data (such as player scoring).

It is important to realize that concepts used to describe reasons for basketball game outcomes are not precise. For example, there is no way to demarcate what a consistent offense is. There isn't a specific deviation of average point totals that distinguishes a team with a consistent offense from a team with a lack of consistent offense. This describes why giving probabilities as a reason why a particular team will win a game is unnatural to people. There aren't crisp boundaries for these concepts which using probabilities assumes. The concepts used to predict basketball game outcomes are vague, or fuzzy, concepts. In order to forecast more like people are able to do, a basketball game forecasting system should use these fuzzy concepts to construct predictions.

The approach I will use to construct basketball game forecasts will be to use fuzzy sets to represent fuzzy concepts, as described above. Fuzzy sets not only give the ability to represent concepts which are not precisely defined, but also lay out an entire approach to the forecast reasoning system. This is because fuzzy sets allow generalization quite easily. By combining fuzzy sets to create new fuzzy sets, a more general fuzzy concept is formed. This is similar to what people do in making basketball game forecasts. More general concepts are based on less general concepts all the way down to actual data just as in the concept of consistent offense.

Another key advantage to using fuzzy sets to construct basketball game forecasts lies in the ease with which we can speak about fuzzy sets. When the basketball game forecasting system describes the results of a forecast, it can use a more natural language that is a result of using fuzzy sets since they are descriptive by nature (e.g. the set "very consistent offense") [2, 4].

1.3 Thesis Statement

Using fuzzy sets, we can develop an effective forecasting system for NBA basketball games that provide natural explanations for its decisions.

1.4 Thesis Overview

The rest of this thesis consists of 8 sections (Sections 2-6, Appendix A, B, and C). Section 2 describes fuzzy set technology and how it is used in the basketball game forecasting system. Section 3 describes the basketball game forecasting system in greater detail, including the architecture of the system and the fuzzy sets used by the system. Section 4 reports the results of the basketball game forecasting system. Section 5 gives a conclusion to the thesis and section 6 contains a list of references. Appendix A describes all of the fuzzy sets used in the system; Appendix B gives examples of some of the Java source code of the system; and Appendix C lists results of the system which includes the output of the system, previews of the games, and recaps of the games.

2 Fuzzy Set Technology

2.1 History of Fuzzy Sets and Their Applications

Fuzzy set theory builds on classical set theory which was developed by Georg Cantor in the 19th century [2]. The classical set theory of Cantor formally defines the notion of classes, also known as categories. Humans, and even animals [2], are constantly forming categories, such as "table" or "chair". For example, humans classify many objects as chairs, such as rocking chairs, recliners, stools, and folding chairs. The ability to form categories is very important to humans, as suggested by theorist David Marr, it is the primary role of the neocortex [7].

In classical set theory, a set is typically represented as a circle. Everything inside the circle belongs to the set and everything outside of the set does not belong to the set. For example, given the set "chair" a rocking chair would be inside the circle and anything that is a "table" would be outside the "chair" set (see figure 2.1). In Cantor's classical set theory, sets have sharp boundaries. Things are either in the set or not in the set. Cantor also developed operations to be performed on sets. These included complement, intersection, and union. The complement of a set is simply its opposite. The intersection of two sets determines the members in both sets. The union of two sets determines all of the unique elements of both sets. Figure 2.1 graphically represents each of these operations. Often times, elements are assigned the membership values 1 or 0 (or true and false) depending on whether the elements are in a particular set. For example, since a rocking chair is in the set "chair", rocking chair's membership in the set "chair" would be 1. Likewise, a dining room table is not in the set "chair" and so its membership value in the set "chair" would be 0.

Classical set theory, while incredibly useful, is unable to deal with a certain paradox which is commonly known as the paradox of the heap [2]. The paradox of the heap is as follows: remove one grain of sand from a heap of sand until you no longer have a heap of sand. The problem is, at how many grains of sand does the heap cease to be a heap. There really isn't any one particular grain count which a heap stops being a heap and vice versa, which is the paradox. In classical set theory, the solution to the heap paradox is to select a specific lower bound on the number of grains it takes to make a heap of sand. This sharp cutoff does not solve the paradox since it does not follow most people's intuitive definition of heap. When someone talks of a heap, they are not using the term as precisely as classical set theory prescribes. In this case, it would seem that the sharp edges of the classical set need to be softened.

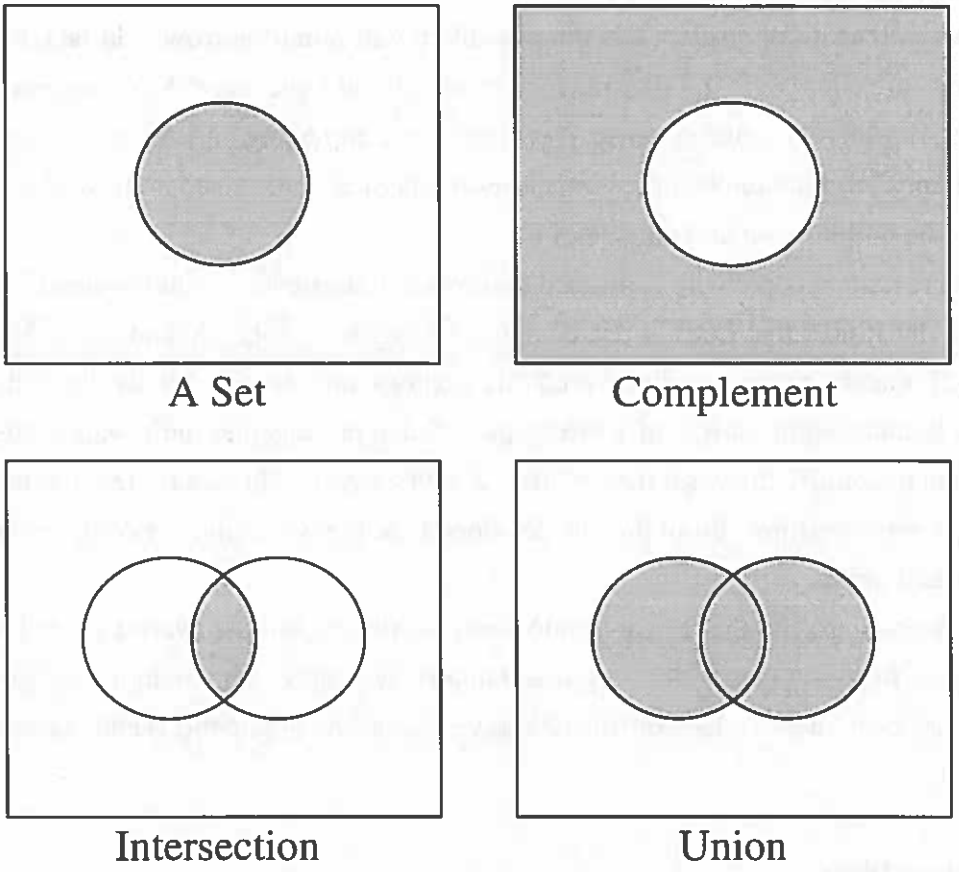


Figure 2.1 - *Set representation and the three set operations complement, intersection, and union*

Many scholars found that the problem of classical set theory to solve the heap paradox was not an isolated event, but rather a more general problem due to the fact that there are many sets which require looser boundaries. These boundaries became known as "vague" boundaries. Charles Sanders Peirce and Bertrand Russell were some of the first to begin seriously looking at the idea of vagueness in sets [2]. In 1923, Bertrand Russell published a paper in which he explored vagueness in language and introduced an informal idea of fuzzy sets stating that "Vagueness, clearly, is a matter of degree" [8].

The first person to make a stab at a formal model of vagueness was Jan Lukasiewicz who in 1920 published a paper which described a multi-valued logic [9]. In it, he assigned values to degrees. The value 1 stood for set membership, 0 stood for non-membership, and 1/2 stood for possible membership. Although this addition to classical set theory may not seem extraordinary, it had many consequences. It allowed for statements such as: "It is true that it will rain tomorrow," and "It is not true that it will rain tomorrow", which are both valid statements in

classical set theory. However, it also allowed for a statement such as: "It is possible it will rain tomorrow" as well as it's opposite, "It is not possible it will rain tomorrow". In fact, these later two statements are equivalent in Lukasiewicz's mutli-valued logic since the complement of 1/2 would be 1/2. Intuitively it makes sense, it is similar to a cup being half-full at the same time as being half-empty. But it stretched the boundaries of classical logic since it allowed for something to be both in a set and outside of it.

There were many people who continued to develop Lukasiewicz's multi-valued logic, but it was not until the 1960's that Lotfi Zadeh developed fuzzy set theory. According to McNeill and Freiberger [2], Zadeh "not only rediscovered this territory, but identified it, explored it, mapped it, promoted it, and fought for it." In a 1965 paper, Zadeh put together multi-valued logic and the work of others to solidify fuzzy set theory [10]. Zadeh's key insight was to treat membership in sets as graded memberships. From this, he developed the fuzzy versions of complement, intersection, and union.

Zadeh's work sparked other research into fuzzy set theory, but the overall growth and development of fuzzy set theory has progressed relatively slowly. The main reason for this slow progression has been due to a lack of financial investment into applications and research of fuzzy set theory [2].

2.2 Motivating Ideas

The main applications of fuzzy set theory have been in the area of fuzzy control [2] [12]. There are many different types of control problems which range from complex tasks such as robotics to less complex tasks such as controlling washing machine cycles. Fuzzy controllers differ from classical controllers in that classical controllers are based on mathematical models whereas fuzzy controllers are based on knowledge learned from human operators [12]. The human knowledge is extracted and used to form fuzzy control rules which guide the control process. The advantages of using fuzzy set theory over mathematical models in control applications are performance, simplicity, and its ability to solve certain complex control problems that are not feasible using classical methods [12]. The ability of fuzzy controllers to successfully move away from purely mathematical models into a more human based approach by using fuzzy sets was a motivating factor for using fuzzy sets in the basketball game forecasting system.

Another motivating factor lies in the adeptness of fuzzy set theory at handling the complexity of language. Language is filled with vagueness, and as Zadeh says, "most words are fuzzy" [2]. According to McNeill and Freiberger, "[l]anguage is a vast shorthand, the

outstanding instance of our ability to summarize" [2]. Language is an important aspect of the basketball game forecasting system since the system must provide natural explanations for its decisions.

The decisions made by the basketball game forecasting system must be based on a reasoning system. This reasoning system could be a mathematical model, such as probability theory, fuzzy set theory, or by some other means. However, as Zadeh claims [2], people reason in fuzzy terms. This is to say that concepts are heavily used in the reasoning process and concepts are fuzzy. In 1977, Gregg Oden conducted a study which reflected this notion of vagueness in concepts [2] and in 1978 Willett Kempton did a study that led him to propose that fuzzy set theory offered a powerful formalism for modeling cognition [11].

2.3 Fuzzy Sets

Classical set theory assumes that sets are precise and set membership is determined with complete certainty. Set membership is sharply delineated because something must either be in a set or not in a set. Fuzzy sets on the other hand take into account that not all things behave in this manner. For example, the set of all basketball players who are tall is not precisely defined. In order to precisely define the set of tall basketball players, an artificial boundary would need to be created such as 76 inches. That is, a basketball player who is greater than or equal to 76 inches is considered tall, and any basketball player who is less than 76 inches is not a tall basketball player. The problem with this is that it doesn't conform to the meaning of tall. If someone is 75.9 inches, it does not seem to follow our intuitive definition of tall to say that this person is not a tall basketball player when someone who is 76 inches is considered a tall basketball player. According to the meaning of tallness, there should be a smooth transition between being tall and not being tall, which is not provided for in classical set theory.

2.4 Basic Fuzzy Set Theory

It is important to understand the basic ideas of fuzzy set theory in order to see how fuzzy sets are used in the basketball game forecasting system. In this section I will discuss the basic properties of fuzzy sets which include membership functions, graphical representations of fuzzy sets, and fuzzy set operations.

2.4.1 The Membership Function

The important difference between fuzzy sets and classical sets (also known as crisp sets) is that fuzzy set membership is a matter of degree. While this is true for classical sets, the degree is only binary since an element is either a member or is not a member of the crisp set. Fuzzy set membership is an infinite range of degrees. This notion of membership in degrees is so important in fuzzy set theory that fuzzy sets are characterized by what is called a membership function. A membership function assigns each element in a relevant universal set by a number in the closed unit interval [0, 1] that characterizes the degree of membership of an element x in the fuzzy set [12]. Every fuzzy set is uniquely defined by one particular membership function.

Using the example of tall basketball players, we can define the relevant universal set as the height in inches of all basketball players. Given the membership function A(x), for each height x, A(x) will return a value in the closed unit interval [0,1] which reflects the degree of membership that the height x has in the set of tall basketball players. For example, if x was 96 inches (8 feet), we might expect the membership value to be 1. If x were 76 inches we might expect the value to be less than or equal to .5 depending on the actual membership function.

2.4.2 Graphical Representations of Fuzzy Sets

There are many ways to represent membership functions. The two most common ways are by using analytical representations and graphical representations. Analytical representations are simply the mathematical formula which is used to compute the membership function. As an example, figure 2.2 shows one possible tall basketball fuzzy set membership function expressed in analytical representation.

$$A(x) = \begin{cases} 0 & \text{for } 0 \le x \le 72 \\ \dfrac{x-72}{24} & \text{for } 72 < x < 96 \\ 1 & \text{for } x \ge 96 \end{cases}$$

Figure 2.2 - *Analytical Representation of "Tall Basketball Player" fuzzy Set*

Graphical representations of fuzzy sets provide a more intuitive representation as opposed to the analytical representations. Typically in a graphical representation of a fuzzy set, A(x) is displayed on the y-axis and x is displayed on the x-axis. Note that not all graphical

representations are restricted to 2 dimensions. The graphical representation of the tall basketball player fuzzy set is shown in figure 2.3.

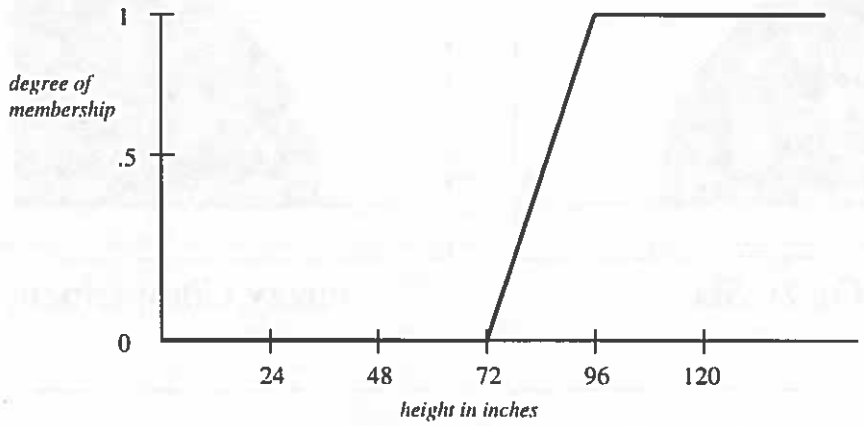


Figure 2.3 - *Graphical Representation of the "Tall Basketball Player" fuzzy Set*

2.4.3 Fuzzy Set Operations

In fuzzy set theory there are three standard fuzzy set operations. These are standard fuzzy complement, standard fuzzy union, and standard fuzzy intersection. Given that A(x) and B(x) are both fuzzy sets defined on a universal set X and all $x \in X$, the fuzzy complement of the fuzzy set A is defined as being the set which expresses the degree to which x does not belong to A. The most natural way to express this idea formally is to use the formula $\neg A(x) = 1 - A(x)$ for all $x \in X$ [12]. The standard fuzzy union of fuzzy sets A and B is defined as $(A \cup B) = \max[A(x), B(x)]$ for all $x \in X$ [12]. The standard fuzzy intersection of fuzzy sets A and B is defined by the membership functions via the formula $(A \cap B) = \min[A(x), B(x)]$ for all $x \in X$ [12]. Figure 2.4 graphically depicts fuzzy sets and the standard fuzzy operations.

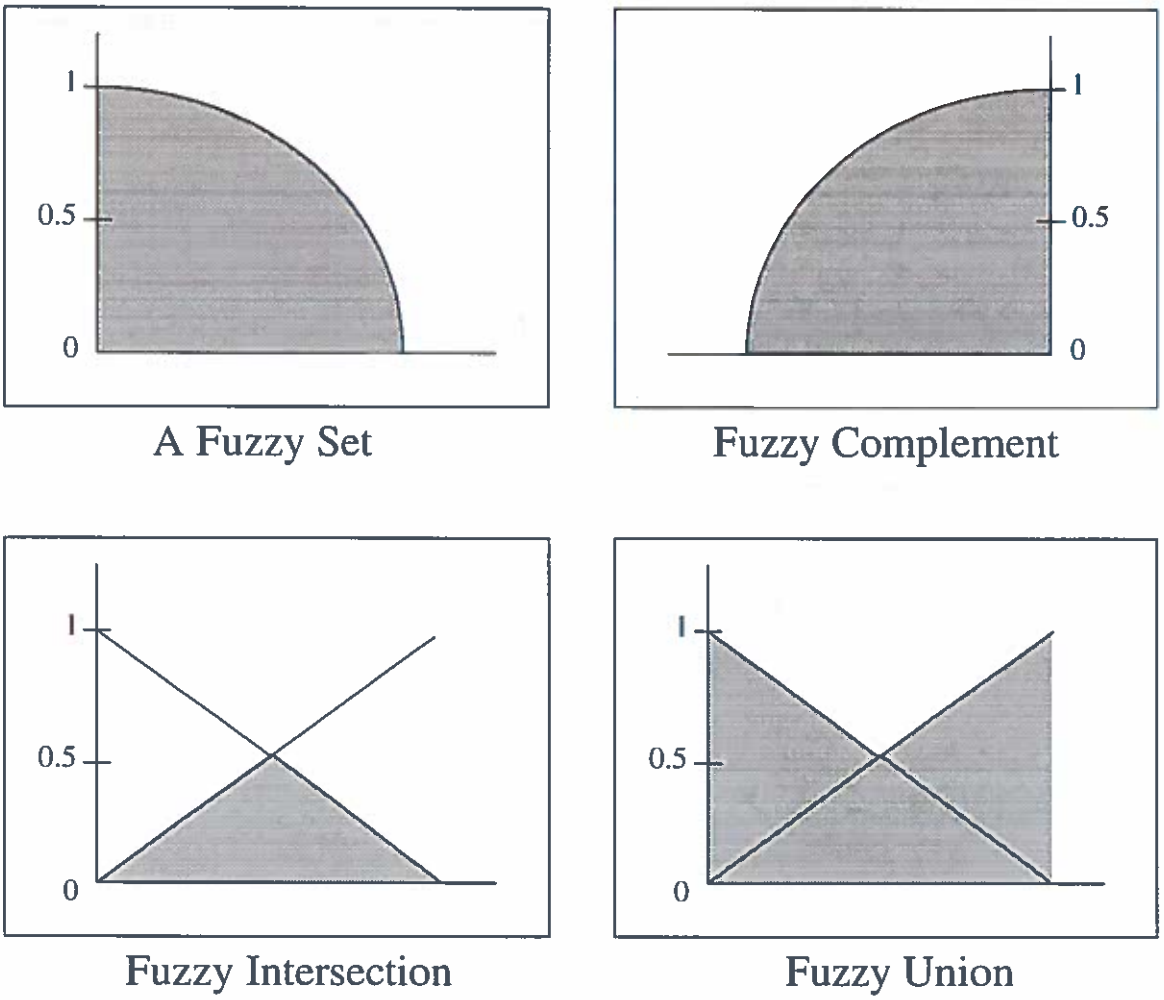


Figure 2.4 *-Fuzzy set representation and the three fuzzy set operations fuzzy complement, fuzzy intersection, and fuzzy union*

The reason that these implementations of the basic fuzzy set operations are considered standard is due to the fact that the operations satisfy the same properties as the complement, union, and intersection operators do for classical sets. That is, they satisfy the commutativity, associativity, distributivity, idempotency, and the De Morgan laws (see figure 2.5). While there are many other formulas to represent the membership functions of the complement, union, and intersection operations, the nonstandard implementations do not fulfill all of the properties of their corresponding classical set operations. For example, the standard operations are the only ones that are idempotent.

Commutativity	$A \cap B = B \cap A, A \cup B = B \cup A$
Associativity	$(A \cap B) \cap C = A \cap (B \cap C),$
Distributivity	$A \cap (B \cup C) = (A \cap B) \cup (A \cap C),$
	$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$
Idempotency	$A \cap A = A, A \cup A = A$
De Morgan laws	$\neg(A \cap B) = \neg A \cup \neg B, \neg(A \cup B) = \neg A \cap \neg B$

Figure 2.5 - *Basic Properties of Fuzzy Sets*

The standard fuzzy operators are not the only possible interpretations of the operations. In fact, they represent bounds on the actual implementations. For example, the standard fuzzy union is actually the smallest fuzzy set containing both A and B and the standard fuzzy intersection is the largest fuzzy set contained by both A and B. The standard fuzzy operations define only one type of operations on fuzzy sets.

In order for an operation to be qualified as a union operation or an intersection operation, it must satisfy a specific set of properties. In the case of union, if an operation satisfies the defined properties, it is referred to as an s-norm (see figure 2.6a). For intersection it is referred to as a t-norm (see figure 2.6b). The standard operations are simply unique implementations of s-norms (for standard union) and t-norms (for standard intersection) with the additional law of idempotency.

1. $1 \cup 1 = 1, 0 \cup a = a \cup 0 = a$ (boundary condition)
2. $a \cup b = b \cup a$ (commutative condition)
3. If $a \leq a'$ and $b \leq b'$, then $a \cup b \leq a' \cup b'$ (nondecreasing condition)
4. $(a \cup b) \cup c = a \cup (b \cup c)$ (associative condition)

Figure 2.6a - *Properties of s-norms*

1. $0 \cap 0 = 0, a \cap 1 = 1 \cap a = a$ (boundary condition)
2. $a \cap b = b \cap a$ (commutativity)
3. If $a \leq a'$ and $b \leq b'$, then $a \cap b \leq a' \cap b'$ (nondecreasing)
4. $(a \cap b) \cap c = a \cap (b \cap c)$ (associativity)

Figure 2.6b - *Properties of t-norms*

2.5 New Fuzzy Sets and Operators Used in the Basketball Game Forecasting System

Each fuzzy set in the basketball game forecasting system was constructed using the analytical representation which included either a formula or a combination of fuzzy set operators (for a detailed description of each fuzzy set used in the basketball game forecasting system see section 3.2 and Appendix A). However, not all fuzzy sets in the system could be constructed using the standard operations, and so the basketball game forecasting system uses operations other than fuzzy complement, fuzzy union, and fuzzy intersection. This section explains these operations in detail and describes the motivation for using them.

2.5.1 Integration (Fuzzy Counting) Operation

While creating the fuzzy sets for the basketball game forecasting system it became necessary to construct fuzzy sets which summarize the contributions that players make to their team. As an example, it might be necessary to create a fuzzy set based on how many tall players are on a team. A set such as "tall team" could take advantage of such an operation. A "tall team" could be defined as a team with about nine tall basketball players. By saying "about nine" in the tall team fuzzy set, we are saying that a team with nine tall players is optimal. There are really two versions of the integration operation, the about k and at least k counting operators, both of which create new fuzzy sets.

If we were using crisp sets, the formula for the about k and at least k counting operators would be quite simple. This is because each player belongs to the tall player crisp set either fully or not at all. To determine the tall team set we would simply add up all of the team's tall player set membership values and then compare that number to nine. If it was equal to nine, we would have full membership in the tall team set and if it wasn't we would have no membership in the tall team set.

Unfortunately, we cannot directly use the crisp set implementation. There are additional properties that must be satisfied for the fuzzy set version. Three properties that must hold for the about k counting operator are shown in figure 2.7.

1. K membership values of 1 should produce a value of 1, if all other values are 0.
2. N items less than K should give the same value as N items greater than K.
3. K-i V's should produce a smaller value than K-i+1 V's. The opposite is also true, K+i V's should produce a smaller value than K+i-1 V's (for $1 < i < K$ and $0 \leq V \leq 1$).

Figure 2.7 - *Fuzzy Integration properties*

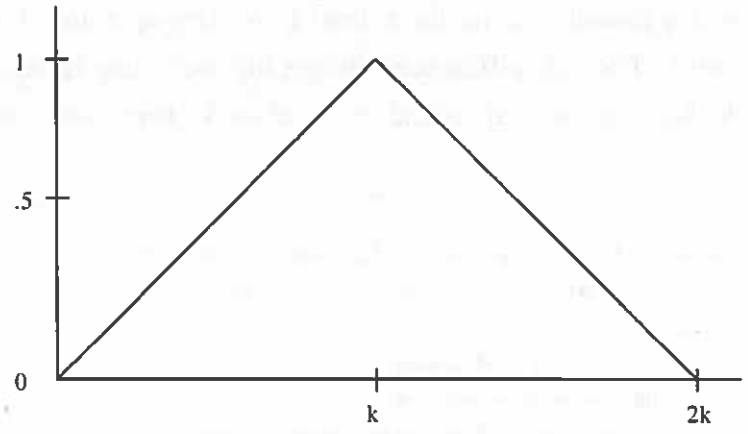
Essentially, these properties describe the intuitive meaning of "about". The first property states that for the about k operator, if k of the individual fuzzy sets membership value's were all 1 (full participation) then we have full membership in the generated fuzzy set. The second property states that having a certain number less than the optimal amount is equivalent to having the same number more than the optimal amount. The third property states that the farther you are from the optimal number of items, the less degree of membership you have in the resultant set.

Figure 2.8 shows the psuedocode for the about k counting operator. Notice that this solution is very similar to the classical set formula, but uses a fuzzy set to represent the meaning of "about".

```
about_K_op( aboutKfset, values_array[] )
      range_length <- values_array length
      sum <- 0
      for i=0 to range_length - 1
         sum <- sum + values_array[i]
      return aboutKfset.membership( sum )
end about_K_op
```

Figure 2.8 - *About k integration operator*

The algorithm in figure 2.8 sums each of the player's individual fuzzy set memberships and then uses the sum's membership in the "about k" fuzzy set as the resulting about k membership value. The "about k" fuzzy sets used in the basketball game forecasting system are piece-wise linear functions where the membership value at k is 1. Below is the general graphical representation for the "about k" fuzzy sets used in the system:



Using this graphical representation for the "about k" fuzzy set allows the fuzzy integration properties of figure 2.7 to hold. For property one, if we had k membership values of 1 and the

rest of the values were 0, we would have a membership value of 1 in the "about k" fuzzy set. The second property holds since the graph of "about k" is a mirror image around the x-axis at k. The third property also holds since the slope is positive from 0 to k and negative from k to 2k. There are many different possible representations for "about k" fuzzy sets, but they must guarantee the properties in figure 2.7 to work for the fuzzy integration algorithm.

The fuzzy integration algorithm is not perfect. Problems can arise when the number of players on a team exceeds k. For example, if k were equal to 9 and we had 18 players whose "tall player" fuzzy set membership values were each .5, we would end up with a membership value in the fuzzy set "about 9 tall players" of 1 since the sum of the player's "tall player" fuzzy set membership values is 9. For the basketball game forecasting system this is a minor problem since membership values are expected to be fairly diverse. In many situations however, a more accurate algorithm may be needed.

The at least k counting operator is very similar to the about k counting operator. There are, however, only two properties that must hold for the at least k counting operator (instead of the three for the about k counting operator). These are shown in figure 2.9.

1. *K* membership values of 1 should produce a value of 1, regardless of the rest of the values.
2. *K*-i membership values of *V* should produce a lesser value than K-*i*+1 values of *V* (for $1 < i < K$).

Figure 2.9 - *At least k counting operator properties*

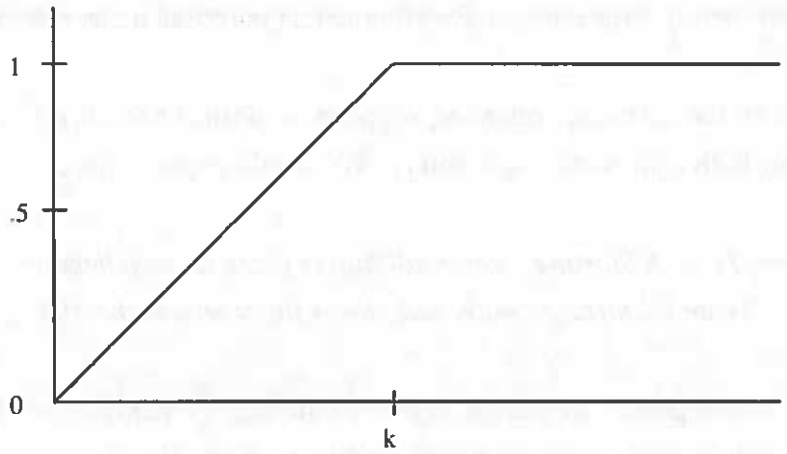
These properties provide the intuitive meaning of "at least". The first property is identical to the first about k counting property. The second property states that the fewer values you have than the optimal, the less degree of membership you have in the resultant set.

Figure 2.10 shows the psuedocode for the at least k counting operator. It is similar to the about k counting operator. The only difference between the two is that in the at least k counting operator an "at least k" fuzzy set is used instead of an "about k" fuzzy set to determine membership.

```
at_least_K_alg( atleastKfuzzyset, values_array[])
  range_length <- values_array length
   sum <- 0
   for i=0 to range_length - 1
      sum <- sum + values[i]
   return atleastKfuzzyset.membership( sum )
end at_least_K_alg
```

Figure 2.10 - *At least k counting operator*

The algorithm in figure 2.10 sums each of the player's individual fuzzy set memberships and then uses the sum's membership in the "at least k" fuzzy set as the resulting at least k membership value. The "at least k" fuzzy sets used in the basketball game forecasting system are piece-wise linear functions similar to the "about k" fuzzy sets except they attempt to define the intuitive meaning of "at least k" instead of "about k". Below is the general graphical representation for the "at least k" fuzzy sets used in the system:



Using this representation of the "at least k" fuzzy sets allows the at least k counting algorithm to fulfill the properties in figure 2.9. As can be seen, if there were k values of one with all other values of zero, then the membership in the "at least k" fuzzy set is 1. This satisfies the first property. The second property is satisfied since the slope of the function from 0 to k is positive. Just like the "about k" fuzzy sets, the "at least k" fuzzy sets have many possible representations. However, for a particular representation to work for the at least k counting algorithm it must satisfy the properties in figure 2.9

2.5.2 Advantage Operator

The advantage operator arose out of the need to compare two team's players. Figure 2.11 shows the advantage operator's formula. The advantage operator's intuitive meaning is essentially the question "does x have an advantage over y". The result is a membership value in the advantage fuzzy set. The multiplier in the algorithm is used to spread out membership values in the fuzzy set.

```
Advantage( x, y )
  if( x <= y )
     return 0
  else
     return min( multiplier*( x - y), 1)
end Advantage
```

Figure 2.11 - *The advantage operator*

In the basketball game forecasting system this multiplier is 1.75 which was arbitrarily chosen. If the multiplier is sufficiently large enough, for all practical purposes it can reduce the advantage fuzzy set to a crisp set.

As an example of the advantage operator, suppose we wished to compare two team's tall player fuzzy sets for both team's starting Centers. We would express this as:

advantage(Team A Starting Center tall player fuzzy set membership,
Team B Starting Center tall player fuzzy set membership).

This would give us the degree of advantage Team A's starting Center has over Team B's starting Center in terms of each player's membership in the fuzzy set tall player.

There are a number of properties that the advantage operator must satisfy in order to be true to the meaning of an advantage. First, the advantage operator must truly produce a fuzzy set. That is, it must return values in the unit interval [0, 1]. This holds, based on the algorithm in figure 2.11, since the smallest value returned is 0 and the largest value returned is 1. Second, in order for there to be an actual advantage, the first argument to the advantage operator must be greater than the second. In other words, the advantage operator is not commutative. The third property states that if the first argument to the advantage operator has full membership (is equal to 1) and the second argument lacks any membership (is equal to 0) then the result is full membership in the advantage fuzzy set. The last property states that the larger the range between first and second arguments (for arguments where the first argument is greater than the second), the larger the advantage. This fits with the intuitive meaning of advantage. Figure 2.12 lists these properties.

For all x, y ∈ [0, 1]

1.	advantage(x, y) ∈ [0, 1]	for all x, y
2.	advantage(x, y) = 0	for all x ≤ y
3.	advantage(1, 0) = 1	
4.	advantage(x1, y1) > advantage (x2, y2)	for x1 - y1 > x2 - y2 and x1 > y1, x2 > h2

Figure 2.12 - *Properties of the advantage operator*

2.5.3 Team Advantage Composition Operator (Weighted Average of Advantages)

The team advantage composition operator combines a set of advantage fuzzy sets to form a new fuzzy set based on these advantages. Figure 2.13 shows an example of the types of advantages that might be combined to form a fuzzy set called "typical guard defensive advantage". The team advantage composition operator is useful in generalizing team advantages based on the team's players as well as to express certain types of team behavior such as playing style.

advantage(Team A typical Guard pressure defender, Team B typical Guard outside scoring threat)
advantage(Team A typical Guard all-around defender, Team B typical Guard explosive player)
advantage(Team A typical Guard inside defending threat, Team B typical Guard inside scoring threat)

Figure 2.13 - *Example advantages that could be used for the "typical guard defensive advantage" fuzzy set*

There are four main properties that must hold for a team advantage composition operator. The first property, although trivial, is that a fuzzy set must result from the operation. This limits how advantages can be combined to form the resultant fuzzy set. Second, if one team has complete advantages over the other team, then the first team must have full membership in the resultant fuzzy set. The next property is really the opposite of the second, that is, if a team has no advantages over the second team, then the first team should have no membership in the resultant fuzzy set. The last property states that the larger a teams combined advantages are when compared to another team, the larger the membership in the composition advantage fuzzy set. The properties are listed in figure 2.14.

Let α be Team A's associated fuzzy sets and β be Team B's associated fuzzy sets.

1. composition_advantage(α, β).membership( ) $\in$ [0,1]
2. If each advantage function in composition_advantage equals 1, then composition_advantage(α, β).membership( ) = 1
3. If each advantage function in composition_advantage equals 0, then composition_advantage(α, β).membership( ) = 0
4. Let α' be Team C's associated fuzzy sets and β' be Team D's associated fuzzy sets. For each fuzzy set *i* in α, β, α', and β', then if α_i.membership() - β_i.membership() > α'_i.membership() - β'_i.membership() where each *i* also corresponds to an advantage operation in composition_advantage, then composition_advantage(α, β) > composition_advantage(α', β').

Figure 2.14 - *Properties of the team composition operator*

For the basketball game forecasting system I have chosen to combine the advantages by using a weighted average. Although other possible implementations exist (such as using the union operator or intersection operator to combine advantages), using a weighted average allowed for the most flexibility (see section 5.1's discussion on learning). For one, the weighted average allows for more expressive power. Advantages can be weighted according to there intuitive contribution to the team composition fuzzy set. Also, it is less restrictive than the standard union operator (which will result in higher membership values), but also more discriminating than the standard intersection operator. Since, in accordance with figure 2.14, this operator did not need to be an s-norm or t-norm, we did not need to use a more complicated nonstandard union or intersection operator. Finally, using a weighted average to combine advantages satisfies each required property in figure 2.14. Property one is satisfied by using a weighted average to combine the advantage operations due to the fact that for any one advantage, the largest value it can result in is 1. The second property is satisfied by definition of weighted average. That is, for weights w_1 to w_i, we have the following:

$$(w_1*1 + w_2*1 + ... + w_i*1) / (w_1 + w_2 + ... + w_i) = 1$$

which fulfills property two. Property three is satisfied by a similar argument:

$$(w_1*0 + w_2*0 + ... + w_i*0) / (w_1 + w_2 + ... + w_i) = 0.$$

By using weighted averages, property four can also be satisfied. By letting x be the resulting values of Team A and Team B's advantage operators and y be the resulting values of Team C and Team D's advantage operators with weights w_1 to w_i, the following must hold:

$$(w_1*x_1 + w_2*x_2 + ... + w_i*x_i) / (w_1 + w_2 + ... + w_i) > (w_1*y1 + w_2*y2 + ... + w_i*yi) / (w_1 + w_2 + ... + w_i)$$

since for each i, $x_i > y_i$. Therefore, the fourth property is satisfied and using weighted averages is a valid implementation of the composition advantage operator.

2.5.4 Overall Advantages Operator

The overall advantages operator is very similar to the team advantage composition operator. The main difference is that the overall advantages operator requires that the domain of fuzzy sets used to compute the advantages is restricted to fuzzy sets generated by the team advantage composition operator. In other words, the overall advantages operator computes higher level advantages, or advantages of advantages. Figure 2.15 shows an example of the advantage operators used by an overall advantage operator to construct the fuzzy set "team style advantage".

advantage(Team A veteran advantage, Team B veteran advantage)
advantage(Team A journeyman advantage, Team B journeyman advantage)
advantage(Team A ¬ youth advantage, Team B ¬ youth advantage)

Figure 2.15 - *Example advantages that could be used for the "team wisdom advantage" fuzzy set where "veteran advantage", "journeyman advantage", and "youth advantage" are all fuzzy sets generated by the team advantage composition operator*

The overall advantage operator has the same properties as the team advantage composition operator plus a subtle new property. Figure 2.16 shows this new property. The reason this property is essential for overall advantages is that it requires the two teams being compared to have a combined advantage membership less than or equal to 1 (and of course greater than or equal to 0). This is saying that both teams must share in the overall advantage. Taking the example in figure 2.15, this intuitively makes sense. In this case, it would be misleading to say that both team's membership in the fuzzy set "team wisdom advantage" should be greater than the total possible membership allowed by the "team wisdom advantages" fuzzy set. This is because either the teams should share the same amount of overall advantage, or one team should have more of an overall advantage than the other team. Also realize that it is not required for

both teams to share in all of the overall advantage fuzzy set. Some of the overall advantage can in effect be canceled out by both team's status when compared to each other.

Let α be Team A's associated fuzzy sets and β be Team B's associated fuzzy sets.

1. overall_advantage(α, β).membership( ) $\in$ [0,1]
2. If each advantage function in overall_advantage equals 1, then overall_advantage(α, β).membership( ) = 1
3. If each advantage function in overall_advantage equals 0, then overall_advantage(α, β).membership( ) = 0
4. Let α' be Team C's associated fuzzy sets and β' be Team D's associated fuzzy sets. For each fuzzy set *i* in α, β, α', and β', then if α_i.membership() - β_i.membership() > α'_i.membership() - β'_i.membership() where each *i* also corresponds to an advantage operation in overall_advantage, then overall_advantage(α, β) > overall_advantage(α', β').
5. overall_advantage(α, β).membership( ) + overall_advantage(β, α).membership $\in$ [0,1]

Figure 2.16 - *The overall advantage operation property*

Looking back at the fuzzy sets generated by the team advantage composition operator, the question arises as to whether or not this extra property should be included in the operator's list of properties. However, this extra property is not necessary for team advantage composition operators. Going back to the "typical guard defensive advantage" fuzzy set in figure 2.12, it can be shown that it is reasonable for the property in figure 2.16 to be violated. For example, let's assume we have the following:

Team A and B's typical Guard pressure defender membership = 1
Team A and B's typical Guard all-around defender membership = 1
Team A and B's typical Guard inside defending threat membership = 1
Team A and B's typical Guard outside scoring threat membership = 0
Team A and B's typical Guard explosive player membership = 0
Team A and B's typical Guard inside scoring threat membership = 0

When we calculate the typical guard defensive advantage for both teams, we end up with both teams having full membership. That is, both teams have a membership value of 1 in the "typical guard defensive advantage" fuzzy set.

Team A Guard Defensive Advantage

advantage(Team A typical Guard pressure defender = 1, Team B typical Guard outside scoring threat = 0)
advantage(Team A typical Guard all-around defender = 1, Team B typical Guard explosive player = 0)
advantage(Team A typical Guard inside defending threat = 1, Team B typical Guard inside scoring threat = 0)
=
advantage(1, 0) = 1
advantage(1, 0) = 1
advantage(1, 0) = 1
= 1

Team B Guard Defensive Advantage

advantage(Team B typical Guard pressure defender = 1, Team A typical Guard outside scoring threat = 0)
advantage(Team B typical Guard all-around defender = 1, Team A typical Guard explosive player = 0)
advantage(Team B typical Guard inside defending threat = 1, Team A typical Guard inside scoring threat = 0)
=
advantage(1, 0) = 1
advantage(1, 0) = 1
advantage(1, 0) = 1
= 1

While having this property in team advantage composition operators may not seem advantageous at first, it is important to keep in mind the meaning of the fuzzy sets being generated by the operator. They reflect an advantage based on criteria that both teams can achieve (having good defending guards and lousy offensive guards) and so it makes sense that this property should hold. The teams do not share membership in team advantage composition fuzzy sets, they each have their own team advantage composition fuzzy set. The following shows the result of calculating the overall guard defensive advantage for both teams:

Overall Guard Defensive Advantage:

Team A's Membership:

advantage(Team A's Guard Defensive Advantage = 1, Team B's Guard Defensive Advantage = 1)
=
advantage(1, 1) = 0

Team B's Membership:

advantage(Team B's Guard Defensive Advantage = 1, Team A's Guard Defensive Advantage = 1)
=
advantage(1, 1) = 0

Form this we see that neither team ends up with an overall guard defensive advantage since both teams have a membership value in the fuzzy set "overall guard defensive advantage" of 0. Both teams advantages were essentially canceled out in this example.

The overall advantage operator uses weighted averages to combine the advantage operators in an identical way as team advantage composition operators. The main reason for this is to allow future implementations the ability to adjust the contributions of each team advantage fuzzy set when combined to create the resultant overall advantage fuzzy set. The reasons outlined in section 2.5.3 for using weighted averages also apply.

3 The Basketball Game Forecasting System

3.1 Architecture

The basketball game forecasting system is divided into three logical units which include the data retrieval unit, the parsing unit, and the fuzzy forecasting unit. Each unit will be described in this section. The entire system was written using the Java programming language (JDK version 1.1.5).

3.1.1 Data Retrieval Unit

All the data for the system was obtained by downloading National Basketball League's (NBA) web pages over the internet. The retrieval system is fairly simple. It uses the Java language to perform the socket connections and downloading. Once the pages are downloaded they are then saved locally as text files. For each game there is a total of four files per team that needs to be downloaded by the retrieval unit. These four files include the player statistics page for the team, the player roster page for the team, the team's season schedule page, and the league standings page.

3.1.2 Parsing Unit

The parsing unit uses Java's string tokenizer package to parse the html syntax of the downloaded webpages. The data obtained includes player names and statistics as well as team statistics (for a more detailed description see section 3.2). Once this data is obtained, the parsing unit is used to create Team and Player objects which it passes to the fuzzy forecasting unit to process.

3.1.3 Fuzzy Forecasting Unit

The fuzzy forecasting unit consists of five main parts which include Teams, Players, a Game, a Fuzzy Space, and a Fuzzy Instance. Figure 3.1 is a high level view of the entire unit.

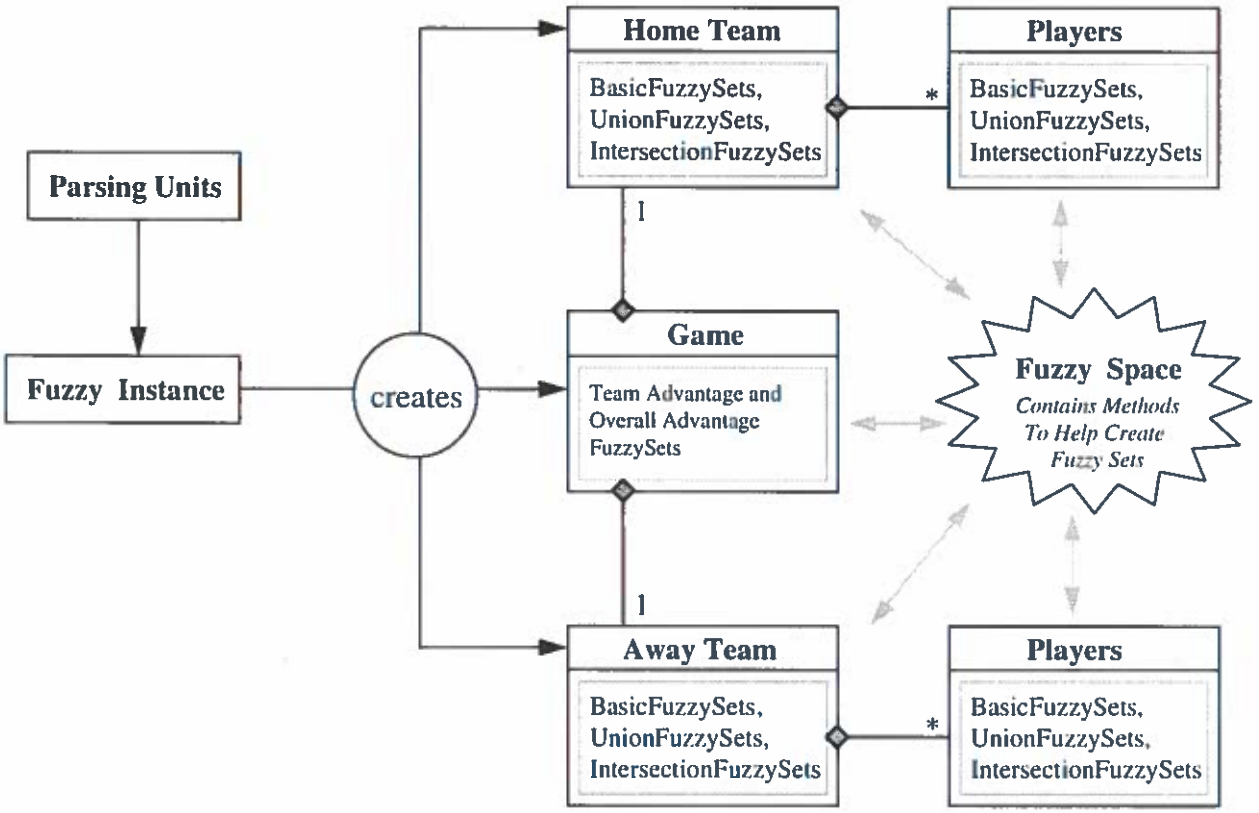


Figure 3.1 - *High level view of the fuzzy forecasting unit*

Every Player contains each of their individual fuzzy sets. A Team contains numerous Players and the fuzzy sets of the team it represents. A Team goes through each of its Players and determines typical players per position. A typical player per position has all of the fuzzy sets that a normal player has, and represents how the typical player at a specific position performs during a game. The Team constructs typical players by determining the contributions all of the players make to their position based on the average percentage of time each player plays, and uses this to determine what each position's typical in-game fuzzy sets would be. This means that a Team object contains not only the Player objects and team fuzzy sets, but also the typical Player objects based on position.

A Game consists of two Teams (the home and away teams) and additional fuzzy sets which are the team advantage composition fuzzy sets and overall advantages fuzzy sets. The Fuzzy Space acts as a repository of instructions on how to construct each fuzzy set in the system. The Fuzzy Instance runs and manages the Game which includes creating and initializing it. The Fuzzy Instance also creates the parsing unit and formats all of the output of the system. Along with running and managing the Game, the Fuzzy Instance is also the communicator to the outside world.

The main ingredients to the fuzzy forecasting unit are the fuzzy sets. There are 6 different types of fuzzy sets in the unit. These include the classes BasicFuzzySet, ComplementFuzzySet, UnionFuzzySet, IntersectionFuzzySet, IntegrationFuzzySet, and AdvantageFuzzySet (see figure 3.2). All fuzzy sets in the unit extend the FuzzySet class and each fuzzy set has a membership function. The AdvantageFuzzySet includes functionality for computing weighted averages and the advantage operation. Additionally, the AdvantageFuzzySet takes into account that the basketball game forecasting system implements team advantage composition and overall advantages identically and so the membership function in AdvantageFuzzySet is actually implementing these operations. A BasicFuzzySet is slightly different in that it contains a MembershipFunction object which computes a degree of membership based on some type of analytical representation implemented by MembershipFunction. These include bell curve formulas and piece-wise linear formulas. For more information about the details of the actual implementation of the fuzzy forecasting unit see Appendix C.

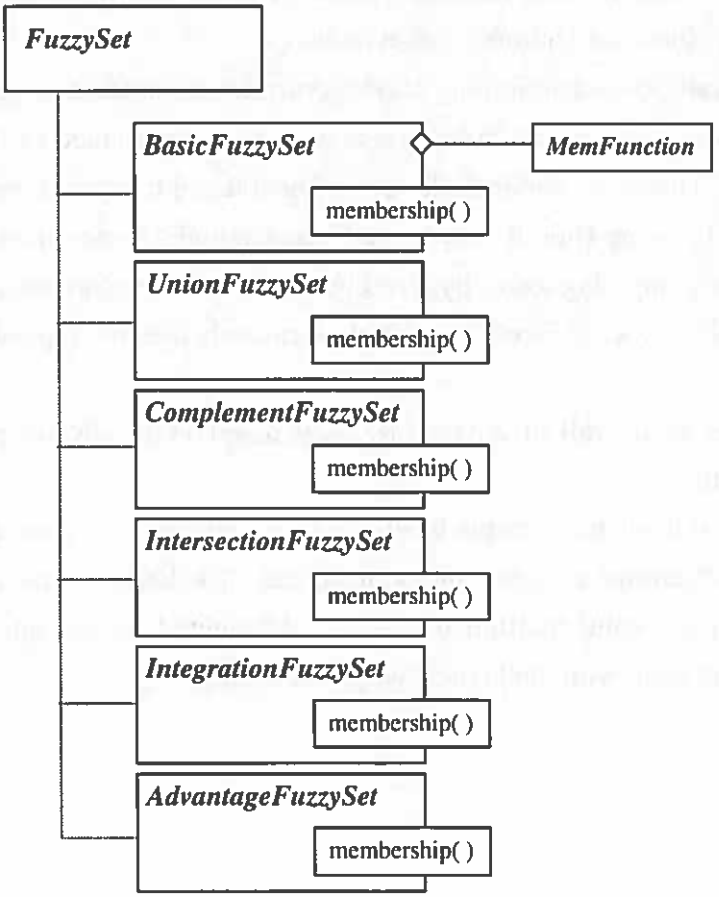


Figure 3.2 -*Top Level FuzzySet Hierarchy*

3.2 Description of the Fuzzy Sets

All of the fuzzy sets were constructed based on my personal knowledge of the NBA and basketball, much of which was learned from the NBA's website. The fuzzy sets used in the basketball game forecasting system are divided into six sections called levels (for a list of all the fuzzy sets used in the system see Appendix A). Figure 3.3 graphically depicts each of the six levels as well as level 0 which contains the initial statistics.

The first level consists of the fuzzified data created by the retrieving and parsing units. These are team and player fuzzy sets which are created based on whether or not the data is related to a team or a specific player. Each fuzzy set in this level uses the class BasicFuzzySet. This means that each level one fuzzy set is constructed by a formula, or analytical representation.

The second level fuzzy sets group player and team fuzzy sets from level one into more generalized team or player fuzzy sets by using the standard fuzzy union and intersection operators. This means that all of the fuzzy sets created from level two are either IntersectionFuzzySet objects or UnionFuzzySet objects.

The third level consists of determining player contributions to teams by combining level one and level two fuzzy sets into integration fuzzy sets which are represented by the class IntegrationFuzzySet. This level also includes a few generalized fuzzy sets based on previous level team fuzzy sets by using UnionFuzzySet and IntersectionFuzzySet classes.

Level four begins comparing teams by creating team advantage composition fuzzy sets which are AdvantageFuzzySet objects. This level extensively uses the typical players developed by the Team objects.

Level five creates the overall advantage fuzzy sets based on the advantage fuzzy sets developed in level four.

The sixth and final level analyzes the level five fuzzy sets for each team and performs a weighted average to determine a winner and point spread. The latter is done rather crudely. The point spread is just a point value multiplied by the final weighted average and the winning team is determined to be the team with the highest weighted average.

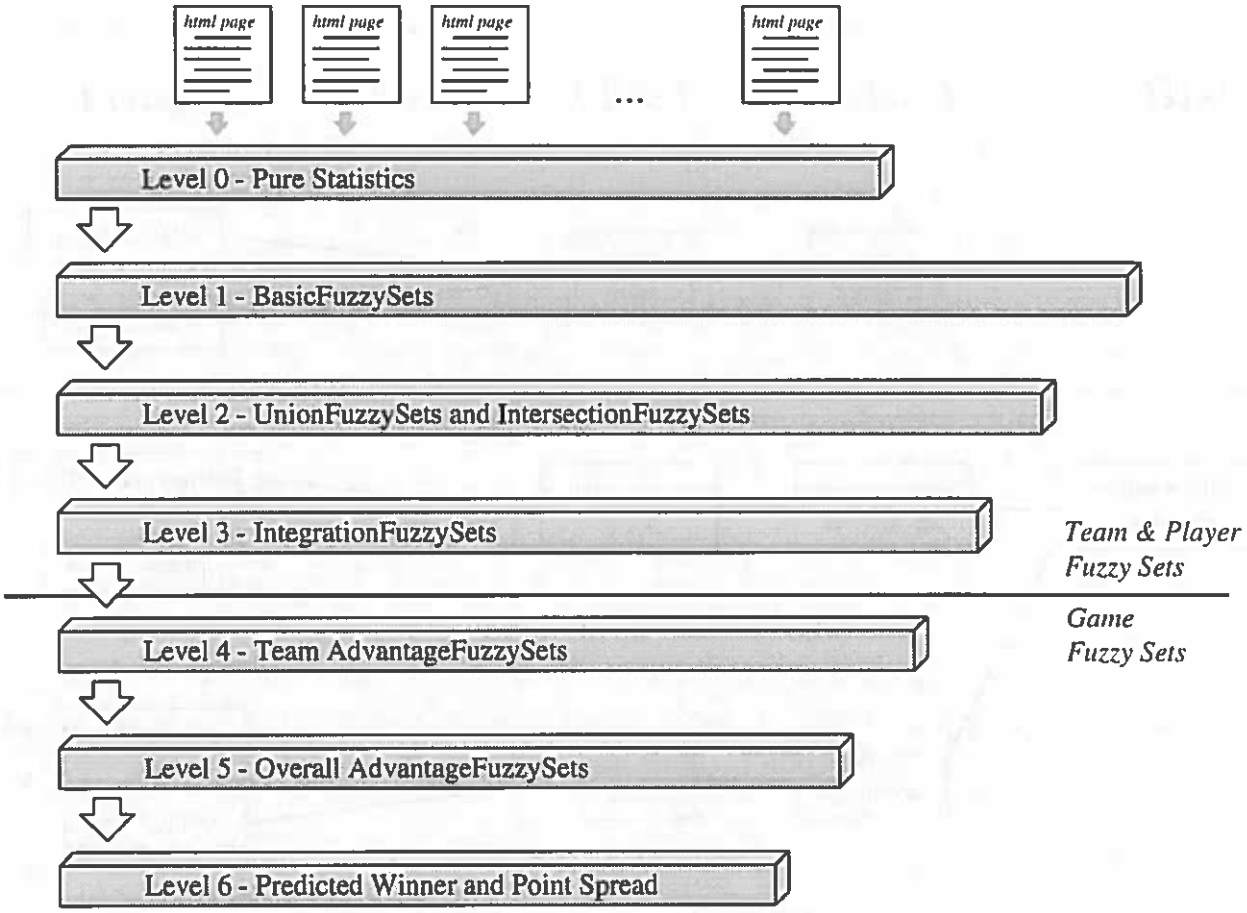


Figure 3.3 - *Fuzzy Set levels 1 through 6 and statistics (level 0).*

In order to explain the results and reasoning used in determining a forecast, the Game object works its way back through the each levels fuzzy sets (starting at level 6) and flags the fuzzy sets which contributed most to the higher level fuzzy set. While not the only approach, the basketball game forecasting system selects only the two most influential fuzzy sets to report.

3.3 An Example

This section steps through a simple example which demonstrates how fuzzy sets in each level are generated. The data from game 20, the Grizzlies against the Sonics, will be used to construct the fuzzy set levels 1 through 5. To simplify the process, only fuzzy sets that have to do with the level 5 fuzzy set "team wisdom advantage" will be constructed. Figure 3.4 shows the hierarchy of fuzzy sets required by the level five "team wisdom advantage" fuzzy set.

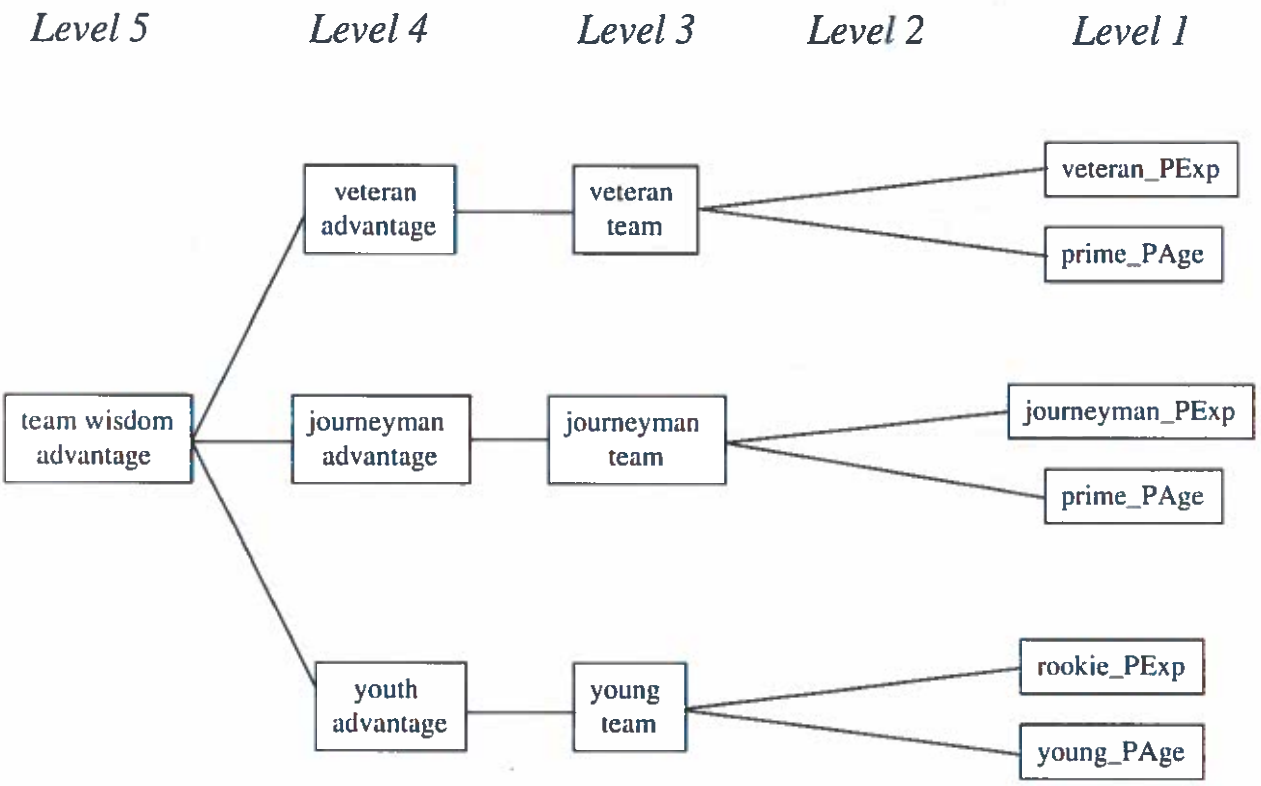


Figure 3.4 - *"team wisdom advantage" fuzzy set hierarchy*

The "team wisdom advantage" fuzzy set hierarchy does not rely on any level two fuzzy sets. Level two fuzzy sets are constructed by using the standard fuzzy union and standard fuzzy intersection operations. However, even without level two fuzzy sets, this example still shows the basic ideas behind the work involved by the basketball game forecasting system in constructing the fuzzy set levels. Figure 3.5 shows the initial data used by the system.

Team	Player	PMinPerGame	PAge	PExp
Grizzlies	Shareef Abdur-Rahim	35.8	22	1
Grizzlies	Pete Chilcutt	17.2	30	6
Grizzlies	Antonio Daniels	26.5	23	0
Grizzlies	Blue Edwards	24.1	33	8
Grizzlies	Bobby Hurley	14.1	27	4
Grizzlies	George Lynch	18.2	28	4
Grizzlies	Tony Massenburg	13.1	31	5
Grizzlies	Lee Mayberry	23.0	28	5
Grizzlies	Ivano Newbill	8.5	28	2
Grizzlies	Bryant Reeves	34.1	25	2
Grizzlies	Larry Robinson	6.8	30	4
Grizzlies	Michael Smith	22.1	26	3
Sonics	Greg Anthony	12.5	31	6
Sonics	Vin Baker	35.9	27	4
Sonics	Dale Ellis	24.5	38	14
Sonics	Hersey Hawkins	31.5	32	9
Sonics	Jerome Kersey	19.2	36	13
Sonics	Jim McIlvaine	15.8	26	3
Sonics	Nate McMillan	15.2	34	11
Sonics	Gary Payton	38.4	30	7
Sonics	Sam Perkins	20.6	37	13
Sonics	Detlef Schrempf	35.1	35	12
Sonics	Aaron Williams	11.9	27	3
Sonics	David Wingate	9.4	35	11

Figure 3.4 - *Statistics needed for the "team wisdom advantage" fuzzy set*

The first step in constructing the fuzzy sets are to create each of the level 1 fuzzy sets for the players and the teams. While this example does not contain any level 1 team fuzzy sets, there are five player fuzzy sets. These are the "veteran player experience", "journeyman player experience", "rookie player experience", "prime player age", and "young player age" fuzzy sets

which are denoted as veteran_PExp, journeyman_PExp, rookie_PExp, prime_PAge, and young_PAge respectively. Figure 3.5 shows the graphical representation of each of these sets.

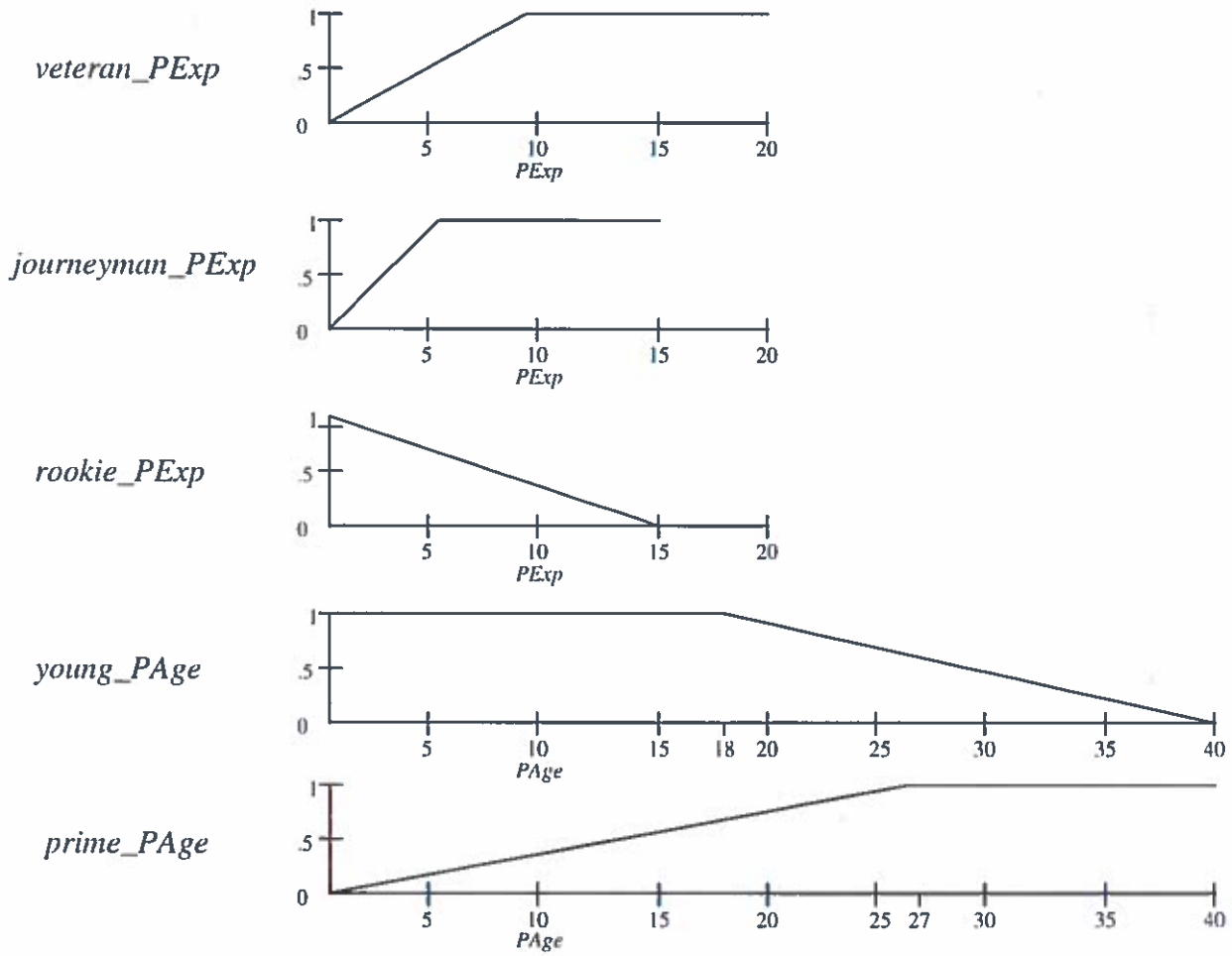


Figure 3.5 - *Graphical representations of the veteran_PExp, journeyman_PExp, rookie_PExp, prime_PAge, and young_PAge fuzzy sets.*

The next step is to determine each of the player's membership values in the level 1 fuzzy sets. Figure 3.6 shows these values.

Team	Player	Page	Pexp	veteran_PExp membership	journeyman_PExp membership	rookie_PExp membership	prime_PAge membership	young_PAge membership
Grizzlies	S. Abdur-Rahim	22	1	0.1	0.2	0.9	0.8	0.8
Grizzlies	P. Chilcutt	30	6	0.6	1.0	0.6	1.0	0.5
Grizzlies	A. Daniels	23	0	0.0	0.0	1.0	0.9	0.8
Grizzlies	B. Edwards	33	8	0.8	1.0	0.5	1.0	0.3
Grizzlies	B. Hurley	27	4	0.4	0.8	0.7	1.0	0.6
Grizzlies	G. Lynch	28	4	0.4	0.8	0.7	1.0	0.5
Grizzlies	T. Massenburg	31	5	0.5	1.0	0.7	1.0	0.4
Grizzlies	L. Mayberry	28	5	0.5	1.0	0.7	1.0	0.5
Grizzlies	I. Newbill	28	2	0.2	0.4	0.9	1.0	0.5
Grizzlies	B. Reeves	25	2	0.2	0.4	0.9	0.9	0.7
Grizzlies	L. Robinson	30	4	0.4	0.8	0.7	1.0	0.5
Grizzlies	M. Smith	26	3	0.3	0.6	0.8	1.0	0.6
Sonics	G. Anthony	31	6	0.6	1.0	0.6	1.0	0.4
Sonics	V. Baker	27	4	0.4	0.8	0.7	1.0	0.6
Sonics	D. Ellis	38	14	1.0	1.0	0.1	1.0	0.1
Sonics	H. Hawkins	32	9	0.9	1.0	0.4	1.0	0.3
Sonics	J. Kersey	36	13	1.0	1.0	0.1	1.0	0.2
Sonics	J. McIlvaine	26	3	0.3	0.6	0.8	1.0	0.6
Sonics	N. McMillan	34	11	1.0	1.0	0.3	1.0	0.3
Sonics	G. Payton	30	7	0.7	1.0	0.5	1.0	0.5
Sonics	S. Perkins	37	13	1.0	1.0	0.1	1.0	0.1
Sonics	D. Schrempf	35	12	1.0	1.0	0.2	1.0	0.2
Sonics	A. Williams	27	3	0.3	0.6	0.8	1.0	0.6
Sonics	D. Wingate	35	11	1.0	1.0	0.3	1.0	0.2

Figure 3.5 - *Player membership values for the veteran_PExp, journeyman_PExp, rookie_PExp, prime_PAge, and young_PAge fuzzy sets.*

After the level 1 fuzzy sets are created and membership values are determined, our next step is to create the level 2 fuzzy sets. However, as stated earlier, there are no level 2 fuzzy sets in this example. After the level 2 fuzzy sets are created, the construction of the level 3 fuzzy sets begins. For this example, the level 3 fuzzy sets are the "veteran team", "journeyman team", and "young team" fuzzy sets. To construct these fuzzy sets we do the following (taken from appendix A):

young team:

```
at least 6 rookie_PExp AND at least 8 young_PAge
```

veteran team:

```
at least 6 veteran_PExp AND at least 8 prime_PAge
```

journeyman team:

```
at least 6 journeyman_PExp AND at least 8 prime_PAge
```

We will need to construct the membership values of these sets for each team. In order to construct the Grizzlies' "young team" fuzzy set we need to calculate two sums. The first is a sum of each player's rookie_PExp membership values and the second sum is of each player's young_PAge membership values:

Player	rookie_PExp membership	young_PAge membership
S. Abdur-Rahim	0.9	0.8
P. Chilcutt	0.6	0.5
A. Daniels	1.0	0.8
B. Edwards	0.5	0.3
B. Hurley	0.7	0.6
G. Lynch	0.7	0.5
T. Massenburg	0.7	0.4
L. Mayberry	0.7	0.5
I. Newbill	0.9	0.5
B. Reeves	0.9	0.7
L. Robinson	0.7	0.5
M. Smith	0.8	0.6
	sum: 9.1	sum: 6.7

Now, we need to determine the "at least 6" membership value and the "at least 8" membership value (see figure 3.6). The construction of the "at least k" fuzzy set is described in section 2.

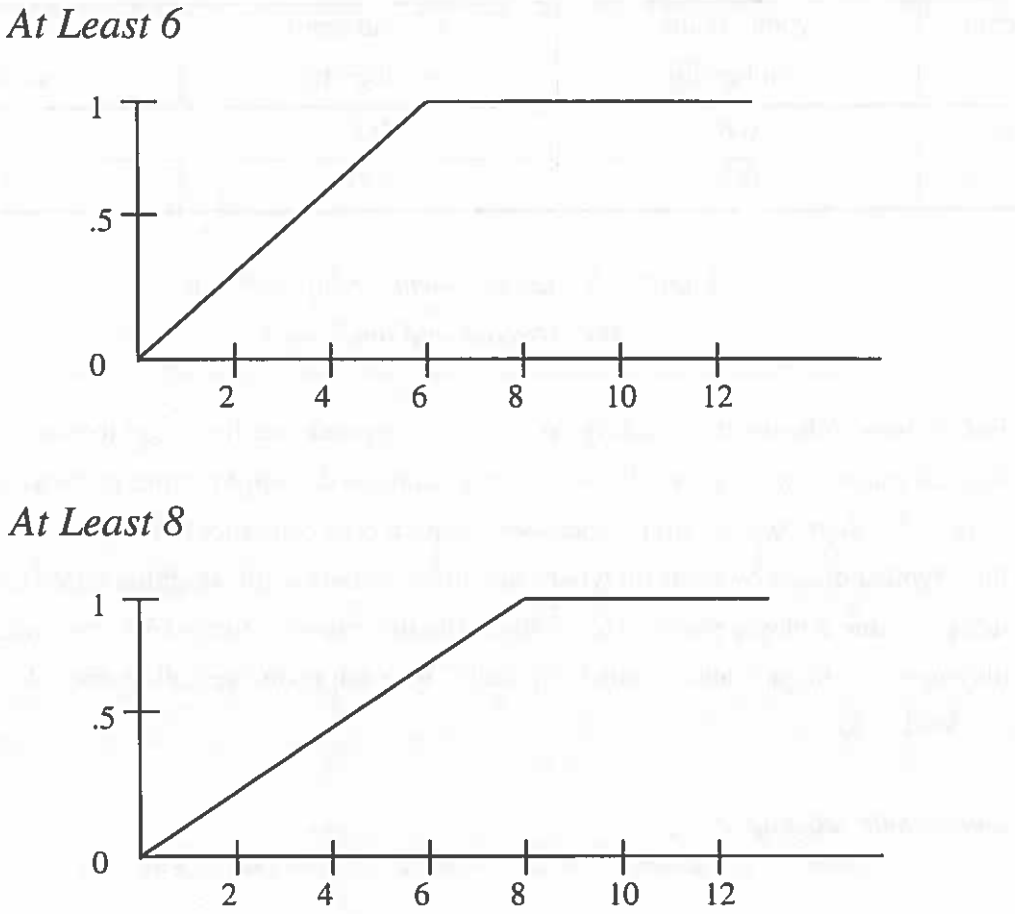


Figure 3.6 - *Graphical representation of the "at least 6" and "at least 8" fuzzy sets*

Now we can determine the Grizzlies' membership in the level 3 fuzzy set "young team". This is done by using the sums to determine the membership values for the "at least 6" and "at least 8" fuzzy sets which are defined in figure 3.6:

```
at least 6 membership(9.1) AND at least 8 membership(6.7) =
1.0 AND 0.8 =
min( 1.0, 0.8 ) =
0.8.
```

Figure 3.7 shows each of the level 3 fuzzy set membership values for both teams. Each were constructed in a similar manner as the above.

Team	young team membership	veteran team membership	journeyman team membership
Grizzlies	0.8	0.7	1.0
Sonics	0.5	1.0	1.0

Figure 3.7 - *Level 3 membership values for the Grizzlies and the Sonics*

Before we can begin constructing the level 4 fuzzy sets, we first need to construct the prototypical players by position. However, this example does not require prototypical players so I will not show their construction. The essential idea is to construct the level 1 and level 2 fuzzy sets for a typical player by position where the initial statistics are weighted based on how many minutes per game a player plays. To construct the three level 4 fuzzy sets "veteran advantage", "journeyman advantage", and "youth advantage" for each team, we follow the rules below (taken from appendix A):

journeyman advantage

```
adv( Team A journeyman team, Team B journeyman team )
```

veteran advantage

```
adv( Team A veteran team, Team B veteran team )
```

youth advantage

```
adv( Team A young team, Team B young team )
```

Here are the calculations for the Grizzlies three level 4 fuzzy sets:

Journeyman Advantage for Grizzlies

```
adv(Grizzlies journeyman team membership, Sonics journeyman team
    membership) =
adv(1.0, 1.0) = 0.0
```

Veteran Advantage for Grizzlies

```
adv(Grizzlies veteran team membership, Sonics veteran team
    membership) =
adv(0,7, 1.0) = 0.0
```

Youth Advantage for Grizzlies

```
adv(Grizzlies young team membership, Sonics young team membership) =
adv(0.8, 0.5) = min( 1.75*(0.8 - 0.5), 1) =
min( 0.5, 1 ) = 0.5
```

Figure 3.8 shows the level 4 fuzzy set membership values for both teams.

Team	journeyman advantage membership	veteran advantage membership	youth advantage membership
Grizzlies	0.0	0.0	0.5
Sonics	0.0	0.5	0.0

Figure 3.8 - *Level 4 membership values for the Grizzlies and the Sonics*

We now have all of the pieces we need to construct the level 5 fuzzy set "team wisdom advantage". The overall advantage fuzzy set is constructed as follows (from appendix A):

team wisdom advantage

```
Take the weighted average (with w=1) of the following:
    adv( Team A veteran advantage, Team B veteran advantage )
    adv( Team A journeyman advantage, Team B journeyman advantage )
    adv( Team A NOT youth advantage, Team B NOT youth advantage )
```

The "team wisdom advantage" fuzzy set requires the use of a complement fuzzy set to construct the third advantage operation. This is easily achieved in this example by taking the "youth advantage" fuzzy set membership value and subtracting it from one. Here are the required calculations to achieve the "team wisdom advantage" fuzzy set membership value for the Grizzlies:

Team Wisdom Advantage for Grizzlies

```
(1*adv(0.0, 0.5) + 1*adv(0.0, 0.0) + 1*adv(1-0.5, 1-0.0)) / (1+1+1) =
(0.0 + 0.0 + 1*adv(0.5, 1.0)) / 3 =
(0.0 + 0.0 + 0.0) / 3 =
0.0 / 3 = 0.0
```

Figure 3.9 shows the "team wisdom advantage" fuzzy set membership values for both teams.

Team	team wisdom advantage membership
Grizzlies	0.0
Sonics	0.6

Figure 3.9 - *Level 5 membership values for the Grizzlies and the Sonics*

As shown by figure 3.9, the Sonics have a "team wisdom advantage" over the Grizzlies. Looking back at the original data from figure 3.4 this seems to make sense due to the fact that the Sonics' players are generally older and more experienced than the Grizzlies' players.

While some of the pieces were left out from this simple example, each of the fuzzy sets built by the basketball game forecasting system were constructed in a similar manner. The system starts with the statistical data and works its way up through the five levels constructing the more general fuzzy sets.

4 Results

4.1 Results and Analysis

In order to analyze the basketball game forecasting system, twenty games were selected from the 1997-1998 NBA season. The results of running the basketball game forecasting system on these games is shown in detail in Appendix D. Figure 4.1 shows the forecasted winners and forecasted point spreads for each of the twenty test games.

Game	Date	Home	Away	Result	Forecast
1	0308	Knicks	Bulls	Bulls 102, Knicks 89	Bulls by 6
2	0310	Bulls	Heat	Bulls 106, Miami 91	Bulls by 2
3	0311	Pistons	Pacers	Pistons 122, Pacers 91	Pacers by 3
4	0315	Magic	Heat	Heat 79, Magic 76	Heat by 4
5	0316	Sonics	Lakers	Sonics 101, Lakers 89	Sonics by 3
6	0317	Pacers	Bulls	Bulls 90, Pacers 84	Pacers by 3
7	0318	Hornets	Jazz	Hornets 111, Jazz 85	Jazz by 5
8	0320	Lakers	Sonics	Lakers 93, Sonics 80	Sonics by 4
9	0322	Celtics	Sixers	Celtics 108, Sixers 90	Celtics by 4
10	0323	Sonics	Kings	Sonics 109, Kings 83	Sonics by 6
11	0326	Hornets	Bucks	Hornets 94, Bucks 80	Hornets by 3
12	0327	Magic	Rockets	Magic 100, Rockets 75	Magic by 5
13	0331	Sonics	Jazz	Sonics 88, Jazz 86	Sonics by 4
14	0401	Magic	Celtics	Celtics 98, Magic 87	Celtics by 3
15	0405	Grizzlies	Jazz	Jazz 99, Grizzlies 93	Jazz by 5
16	0406	Sonics	Suns	Suns 102, Sonics 92	Sonics by 4
17	0407	Hawks	Knicks	Hawks 92, Knicks 79	Hawks by 4
18	0409	Mavericks	Sonics	Sonics 103, Mavericks 101	Sonics by 5
19	0410	Raptors	Heat	Heat 111, Raptors 105	Heat by 5
20	0414	Sonics	Grizzlies	Sonics 110, Grizzlies 98	Sonics by 6

Correct Forecasts: 15 out of 20 = 75%
Incorrect Forecasts: 5 out of 20 = 25%

Average Point Spread Deviation for Correct Forecasts = 8.33 points
The Median Point Spread Deviation for Correct Forecasts = 8 points (Game 14)
Closest Games: 4 (1 pt), 15 (1 pt), 19 (1 pt), 13 (2 pts), and 18 (3 pts)
Worst Games: 10 (20 pts), 12 (20 pts), 9 (14 pts), 2 (13 pts), and 11 (11 pts)

Figure 4.1 - *List of the Results (forecasted winners and forecasted point spreads) of running the basketball game forecasting system on the twenty test games*

4.2 Results and Analysis of the Forecasted Winners

As figure 4.1 shows, the basketball game forecasting system forecasted the correct winner fifteen out of the twenty test games, which results in a seventy-five percent accuracy rate for the twenty test games. Five of the twenty test games were inaccurately forecasted, which results in a twenty-five percent inaccuracy rate for the twenty test games.

4.3 Results and Analysis of the Forecasted Point Spreads

The basketball game forecasting system did not fare quite as well in forecasting point spreads as it did forecasting winners. The point spreads of the correctly forecasted winners were analyzed, and on average the basketball forecasting system is off by about eight points for every point spread forecast (see figure 4.1). However, five of the fifteen game's point spreads were forecasted very closely (within at least three points), which implies that thirty three percent of the point spread forecasts made by the basketball game forecasting system are fairly accurate for the twenty test games. Five of the fifty game's point spreads were forecasted very inaccurately (forecasts were off by more than ten points), which implies that thirty three percent of the point spread forecasts made by the basketball game forecasting system are very inaccurate for the twenty test games.

One explanation for the sporadic point spread forecasts made by the basketball game forecasting system is a result of the method used to calculate the forecasts. For one, the largest possible point spread prediction can only be ten points. In other words, a team will not be forecasted to win by more than ten points. With a more sophisticated method for forecasting point spreads, I believe that the accuracy could be improved (see the discussion about learning in section 5.1).

4.4 Results and Analysis of the Reasoning

In order to analyze the results of the basketball game forecasting system's reasoning I chose to compare the detailed descriptions produced by the system to the recap pages provided by the NBA's website. These recap pages simply recap the results of each basketball game, describing the players and factors that contributed most to the outcomes. Appendix D contains a list of all the forecasts along with the recaps for each of the twenty test games.

There are many ways to conduct an analysis of the reasoning behind the basketball game forecasting system's choice of game winners – I decided to take an informal approach. I simply

looked through each detailed description of a forecast (the description of the reasoning of the system) and compared the results with the recap page for that particular game. I found eight games out of the twenty test games whose forecast descriptions shared similar outcome factors as the recap of the game. I will describe five of these games below.

The following was part of the detailed description produced by the forecasting system for game 1:

```
Bulls Half Court Team Advantage (0.05) because:
  * Bulls Low Post Team

  Bulls Low Post Team (1.0) because:
       * Bulls Excellent at Outrebounding Opponents
       * Bulls Aggressive Overall Rebounding

       Bulls Excellent at Outrebounding Opponents (1.0) because:
            * Bulls Rebounds Per Game Differential: 5.89

       Bulls Aggressive Overall Rebounding (0.96) because:
            * Bulls Rebounds Per Game: 46.1
```

This is saying that the Bulls have an advantage over the Knicks because the Bulls are a better half court team. This is a result of being a good low post team which is caused by being good at rebounding. Essentially, the system is saying that one of the main reasons the Bulls should win is because they will be able to dominate the Knicks in terms of rebounding. This factor turned out to be the main factor the Bulls won the game over the Knicks, which is stated in the following excerpt from the recap:

> Scottie Pippen added 25 points, nine rebounds and six assists and Dennis Rodman grabbed 20 boards as the Bulls had a 48-33 advantage on the glass in defeating the Knicks for the third time in as many meetings this season.

The coach for the Knicks goes on to verify this rebounding factor:

> "I thought our rebounding was where we lost the game," said New York coach Jeff Van Gundy. "They put it to us on the boards. I thought Pippen's points really hurt us badly. Offense wasn't our problem. We shot 50 percent for the game, but we have to make our free throws and we're going to have to rebound the ball."

In game 4, the basketball game forecasting system correctly forecasted the Heat to defeat the Magic. The Heat's shooting advantage was listed as an important outcome factor by the system. In particular, Voshon Lenard and Tim Hardway's solid three point shooting percentage was listed as a key factor to the outcome of the game:

```
Heat Typical Guard is an All Around Shooter (0.66) because:
  * Heat Typical Guard Solid 3 Point Shooting Percentage
  * Heat Typical Guard Solid Shooting Percentage

 Heat Typical Guard Solid 3 Point Shooting Percentage (0.81) because:
      * Typical Heat G 3 Point Shooting Pct: 0.28
      * (e.g. Tim Hardaway: 0.359, Voshon Lenard: 0.403)
```

As the recap shows, Voshon Lenard scored the winning basket which was a three point shot:

> Voshon Lenard hit a three-pointer at the buzzer to lift the Miami Heat to a 79-76 victory over the Orlando Magic, who were held scoreless in the final 1:56.

Of course this was not the only factor that won the game for the Heat, but Lenard's three point shooting ability helped the Heat to the victory.

In game 10, the Sonics defeated the Kings which the basketball game forecasting system correctly forecasted. The system listed two outcome factors in its detailed description that directly related to the actual outcome. The first was the observation that the Sonics are a highly skilled team with the help of Gary Payton:

```
Sonics Highly Skilled Team (0.37) because:
        * Sonics Winning Team
        * Sonics Gary Payton is a Star Player
```

The other is that the Sonics are a fast break team when compared to the Kings:

```
Sonics Up Tempo Team Advantage (0.27) because:
      * Sonics Fast Break Team
      * Sonics Young Team
```

These, among other reasons, resulted in the Sonics win:

> Gary Payton scored 24 points and handed out eight assists in three quarters as the Seattle SuperSonics crushed the fading Sacramento Kings, 109-83. ... The Sonics continued pouring it on in the third, scoring 15 of the first 21 points to open a 73-46 bulge on Payton's layup. Payton closed the third quarter and his evening with consecutive layups to make it 86-54 heading into the fourth.

Game 13, the Sonics against the Jazz, was forecasted by the basketball game forecasting system to be a game in which the Sonics would win because of their advantage in the forward position:

```
Sonics Player Matchups Advantage (0.22) because:
    * Sonics Forward Offensive Advantage
    * Sonics Forward Defensive Advantage
```

```
Sonics Forward Offensive Advantage (0.61) because:
  * Sonics Typical Forward is an Inside Scoring Threat
  * Sonics Typical Forward is an All Around Shooter
```

The two key players at the forward spot were forecasted to be Detlef Schrempf and Vin Baker in the offensive category:

```
Sonics Forward Offensive Advantage (0.61) because:
  * Sonics Typical Forward is an Inside Scoring Threat
  * Sonics Typical Forward is an All Around Shooter

  Sonics Forward Offensive Advantage (0.61) because:
          * Sonics Typical Forward is an Inside Scoring Threat
          * Sonics Typical Forward is an All Around Shooter

      Sonics Typical Forward is an Inside Scoring Threat (0.82) because:
          * Sonics Typical Forward Lethal Shooting Percentage

          Sonics Typical Forward Lethal Shooting Percentage (0.82) because:
              * Typical Sonics F Field Goal Shooting Pct: 0.47
              * (e.g. Vin Baker: 0.544, Detlef Schrempf: 0.482)

      Sonics Typical Forward is an All Around Shooter (0.74) because:
          * Sonics Typical Forward Solid Shooting Percentage

          Sonics Typical Forward Solid Shooting Percentage (0.98) because:
              * Typical Sonics F Field Goal Shooting Pct: 0.47
              * (e.g. Vin Baker: 0.544, Detlef Schrempf: 0.482)
```

and defensive category:

```
Sonics Forward Defensive Advantage (0.2) because:
  * Sonics Typical Forward is a Big Player

  Sonics Typical Forward is a Big Player (0.5) because:
      * Sonics Typical Forward Hefty
      * Sonics Typical Forward Towering

      Sonics Typical Forward Hefty (0.56) because:
          * Typical Sonics F Weight: 242.8
          * (e.g. Vin Baker: 250.0, Detlef Schrempf: 235.0)

      Sonics Typical Forward Towering (0.5) because:
          * Typical Sonics F Height: 81.62
          * (e.g. Vin Baker: 83.0, Detlef Schrempf: 82.0)
```

According to the recap, it turns out that both of these players made big impacts on the actual game between the Jazz and Sonics:

> Baker had 18 points and 10 rebounds and Schrempf added 17 and nine for Seattle, which won for the fourth time in five games and second in four meetings with the Jazz this season.

But, not only were Baker and Schrempf the highest scorers on the Sonics, they played excellent defense on Karl Malone, the Jazz's biggest scoring threat who averages more than 25 points a game:

> Malone had 20 points and 10 boards and Adam Keefe and Shandon Anderson each added 12 points for the Jazz, who had a five-game winning streak snapped.

Baker and Schrempf also stopped Keefe and Anderson who are the other top Jazz forwards.

In game 17, the Hawks were correctly forecasted to beat the Knicks based on the play of Hawks center Dikembe Mutombo:

```
Hawks Player Matchups Advantage (0.42) because:
  * Hawks Center Offensive Advantage

 Hawks Center Offensive Advantage (0.64) because:
      * Hawks Typical Center is an Inside Scoring Threat

      Hawks Typical Center is an Inside Scoring Threat (0.71) because:
           * Hawks Typical Center Lethal Shooting Percentage

           Hawks Typical Center Lethal Shooting Percentage (0.71) because:
                * Typical Hawks C Field Goal Shooting Pct: 0.44
                * (e.g. Dikembe Mutombo: 0.546, Greg Anderson: 0.444)
```

Dikembe Mutombo was not only a offense force in the Hawks victory, but he was also very tough on defense:

> Dikembe Mutombo scored 17 points, grabbed 19 rebounds and blocked six shots to help the Atlanta Hawks clinch a playoff berth with a 92-79 victory over the reeling New York Knicks, who lost for the fifth time in six games.
> "I thought Dikembe was just a monster defensively. He really helped us close down the inside and blocked a lot of shots. He intimidated them so they couldn't get easy looks," Atlanta coach Lenny Wilkens said.

The other three games whose forecasted outcomes resulted in actual outcomes included games 11, 15, and 20. In game 11, David Wesley and Glen Rice were both forecasted to be big factors and both resulted in the Hornet win. Karl Malone, Jeff Hornacek, and John Stockton were each forecasted as being outcome factors in game 15. Malone and Hornacek both ended up leading the Jazz to the victory. In game 20, Hersey Hawkins, Gary Payton, and Vin Baker were all tagged to be big contributors to the outcome of the game. Each provided the offense needed for the Sonics to win the game.

The eight above examples should not be mistaken as implying that the reasoning system accurately determined the main outcome factors in each of the twenty games. However, the accuracy of the reasoning is not entirely essential. What is important is that the reasoning used by the system is plausible. The outcome factors the system chooses as important need to be possible and follow a similar line of reason a person might use.

Game 3 is one example in which the predicted winner was not correctly chosen by the basketball game forecasting system. However, the system's reasoning on why the Pacers should

beat the Pistons is very plausible. According to the system, the Pacers should have beat the Pistons because the Pacers have already beat the Pistons this year and they have a better away winning percentage than the Pistons' home winning percentage.

```
Pacers Winning Advantage (0.16) because:
  * Pacers Away Team History Advantage
  * Pacers Player Matchups Advantage

  Pacers Away Team History Advantage (0.5) because:
    * Pacers Winning Series Percentage

    Pacers Winning Series Percentage (1.0) because:
      * Pacers Series Winning Pct: 1.0
```

Other main factors according to the basketball game forecasting system included Reggie Miller and Mark Jackson's combination to give the Pacers an advantage in the backcourt and Rik Smits' advantage at the center position.

```
Pacers Player Matchups Advantage (0.13) because:
    * Pacers Guard Offensive Advantage
    * Pacers Center Offensive Advantage

    Pacers Guard Offensive Advantage (0.41) because:
      * Pacers Typical Guard is an All Around Shooter

      Pacers Typical Guard is an All Around Shooter (0.7) because:
        * Pacers Typical Guard Solid Shooting Percentage

        Pacers Typical Guard Solid Shooting Percentage (0.91) because:
          * Typical Pacers G Field Goal Shooting Pct: 0.38
          * (e.g. Reggie Miller: 0.484, Mark Jackson: 0.429)

    Pacers Center Offensive Advantage (0.21) because:
      * Pacers Typical Center is an Inside Scoring Threat

      Pacers Typical Center is an Inside Scoring Threat (0.84) because:
        * Pacers Typical Center Lethal Shooting Percentage

        Pacers Typical Center Lethal Shooting Percentage (0.84) because:
          * Typical Pacers C Field Goal Shooting Pct: 0.48
          * (e.g. Rik Smits: 0.498, Mark West: 0.444)
```

The Pistons ended up beating the Pacers by 30 points. This is considered an unusually large margin of victory in the NBA. According to the Pacers coach Larry Bird:

> "Obviously we didn't come to play tonight. Tonight the Pistons played by themselves."

However, Rik Smits and Reggie Miller still played well in relation to the rest of the players on the Pacers team, although they each scored less than they usually do. Dale Davis, Rik Smits, and Reggie Miller were the biggest contributors for the Pacers in the game. Even the Pistons' Jerry Stackhouse said that this was an unusual win for the Pistons:

"This was definitely a huge win, considering it's been an up-and-down season for the team and myself."

As a whole, it seems that the Pacers were the favorites to win the game, but they had a bad, and at least unexpected, performance which led to the Piston win.

In game 19, the basketball game forecasting system correctly forecasted the Miami Heat to beat the Toronto Raptors. The system predicted a Heat advantage in player matchups which was mainly due to Alonzo Mourning's offensive and defensive advantage at center. According to the system:

```
Heat Winning Advantage (0.24) because:
  * Heat Player Matchups Advantage

  Heat Player Matchups Advantage (0.42) because:
    * Heat Center Defensive Advantage
    * Heat Center Offensive Advantage

    Heat Center Defensive Advantage (0.89) because:
      * Heat Typical Center is a Big Player

      Heat Typical Center is a Big Player (0.57) because:
        * Heat Typical Center Hefty
        * Heat Typical Center Towering

        Heat Typical Center Hefty (0.68) because:
          * Typical Heat C Weight: 256.49
          * (e.g. Alonzo Mourning: 261.0, Duane Causwell: 240.0)

        Heat Typical Center Towering (0.57) because:
          * Typical Heat C Height: 82.42
          * (e.g. Alonzo Mourning: 82.0, Duane Causwell: 84.0)

    Heat Center Offensive Advantage (0.76) because:
      * Heat Typical Center is an Inside Scoring Threat

      Heat Typical Center is an Inside Scoring Threat (0.93) because:
        * Heat Typical Center Average 3 Point Shot Taker
        * Heat Typical Center Lethal Shooting Percentage

        Heat Typical Center Average 3 Point Shot Taker (0.96) because:
          * Typical Heat C Average 3 Point Attempts Per Game: 0.0
          * (e.g. Duane Causwell: 0.0, Alonzo Mourning: 0.0)

        Heat Typical Center Lethal Shooting Percentage (0.93) because:
          * Typical Heat C Field Goal Shooting Pct: 0.51
          * (e.g. Alonzo Mourning: 0.554, Duane Causwell: 0.387)
```

While the Heat defeated the Raptors, Mourning did not have as dominating a game as forecasted and the game even went into overtime. According to the recap:

> Alonzo Mourning added 23 points before fouling out and exchanging shoves with John Wallace in overtime. ... A free throw by Mourning gave the Heat a 103-98 advantage [in overtime], but on the next possession he fouled Wallace, who appeared to say something to Mourning. The two shoved each other before Mourning lunged at Wallace.

I believe that as one of the main players on the Heat, had Mourning not fouled out of the game he could have made a bigger impact on the game. However, one could go so far as say that he was frustrated by his play (perhaps he thought he should have a big game too) and that caused his emotional outburst. At any rate, I believe that the reasoning behind the forecast was not too far fetched.

A few of the forecasts generated by the basketball game forecasting system relied on a team wisdom advantage. It is difficult to determine how much of a factor this type of advantage is since veteran players on a team make subtle differences to their team's play. Many of these differences are not reflected in a box score or recap. However, it is well excepted in the NBA that a team's experience makes an impact on games and leads to many victories. It is not unreasonable for the system to use team wisdom as a factor for determining games, however it is hard to examine the outcome of a game and see to what degree a team's wisdom played in the victory.

For more information on the results of the system, appendix C contains a complete list of the results from testing the basketball game forecasting system.

5 Conclusion

5.1 Improvements to the Basketball Game Forecasting System

There are many improvements that can be made to the basketball game forecasting system. The two main improvements include an easier reasoning input system and learning. These two aspects are discussed in the following sections.

5.1.1 Visual Reasoning

A nice enhancement to the basketball game forecasting system would be a unit which allowed the user to create fuzzy sets visually. Each first level fuzzy set currently uses an analytical representation. A better way to do this would be to use a visual, or graphical, approach. This is an enhancement that could be written using a graphical user interface with a mouse. To create a first level fuzzy set, the user would assign the set a name, a link to a piece of data, a range, and an initial membership function. Graphically, this enhancement would enable the user to modify the membership function. This would allow for first level fuzzy sets to be created very quickly. To create higher level fuzzy sets, operators would be available for the user to select. Once an operator is chosen, the needed fuzzy sets previously defined would be linked to the new higher level fuzzy set. Once the user finishes creating all necessary fuzzy sets, the system would create a new Fuzzy Space for the new fuzzy sets and levels.

The benefit of a visual editor (or visual reasoner) would be to allow for the basketball game forecasting system's reasoning to be easily modified. Also, other possible fuzzy set applications could use the editor to create their own Fuzzy Space's.

5.1.2 Learning

One aspect of the basketball game forecasting system that is missing is its ability to adapt. It would be nice if the system could change its reasoning based on the results of actual game outcomes when compared to its own forecasted outcomes. While a full discussion on learning techniques is beyond the scope of this paper, ways to implement learning were designed into the basketball game forecasting system.

As discussed in section 2, using operators that use weighted averages have the advantage that their weights can be manipulated very easily. By manipulating the weights in a weighted average operator such as team advantage composition and overall advantages, the system is reconfiguring which fuzzy sets it believes are more influential in the construction of other fuzzy sets. By using a learning algorithm to adapt the weights to actual outcomes, the operators could potentially become more accurate based on past predicted games. In essence, the operators could learn from their past mistakes by altering the amount of influence the fuzzy sets who are responsible for their construction have.

Point spread predications could also benefit from using adaptation. The point spread predictions are currently calculated by multiplying the membership value in the final winning advantage fuzzy set by a constant number. This could be changed by using a more complex formula which takes into account past point spreads to create a more advanced point spread prediction. Essentially, the point spread calculation algorithm would "learn" from each of the previous games in which a point spread was inaccurately calculated. This could possibly make the point spread predictions more accurate.

There are many different learning algorithms. Finding the appropriate learning algorithms to perform the adaptations to the basketball game forecasting system has not been looked at and is a possible subject for future research.

5.2 Domains for Fuzzy Forecasting

There are many application areas that fuzzy forecasting can be applied to such as weather forecasting and stock market predication. However, the basketball game forecasting system introduces techniques to forecast competing group behavior. The integration operator, team advantage composition operator, and the overall advantages operator enable the system to construct forecasts based on individual member's contributions to a team as well as team advantages when in competition. There are many group behavior forecasting applications.

As an example, software companies are typically composed of several groups of programmers working on different projects. Management tries to arrange group members so that products are finished on schedule with a high degree of quality. The process of trying to decide which people to combine to form a project group could take advantage of a fuzzy forecasting system. Each possible group member has a history which include skills, known programming languages, past project results, education, and so on. Each project has certain data associated with it such as the application area of the project, the target programming language, the projected

size, and complexity of the project to name just a few. By trying different group arrangements, the fuzzy forecasting system can make forecasts about when a project would be finished with a particular group and the resulting quality of the project. Or by using existing teams, the forecasting system can make predictions about which team would be best suited to take on the project. There are many similar competing group behavior forecasting applications that systems like the basketball game forecasting system could be used in.

It is important to keep in mind that the basketball game forecasting system was not designed to do something that people cannot, but rather to do something in a similar fashion as people do. I believe that this has been accomplished in terms of introducing vagueness to a reasoning procedure to produce behavior similar to people. When people reason about basketball game outcomes they do so in vague concepts, which is what the basketball game forecasting system achieves.

5.3 Final Thoughts

I believe that the goal of this thesis to construct a system that can predict basketball game outcomes in a way more in tune with how people make the same types of predictions has been achieved. The positive results of the basketball game forecasting seem to suggest that further work on the subject would be beneficial. Better results might even be obtained through incorporating learning procedures and the system could easily be used in other forecasting domains. Fuzzy sets are a very useful tool in constructing reasoning systems which can handle vagueness especially in systems such as the basketball game forecasting system in which forecasting and vagueness are mixed to provide a more naturally human approach.

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Appendix A: *Fuzzy Sets Used by the System*

The following is lists all of the fuzzy sets used in the system. While not actually discusssed in the paper, the data in Level 0 is the pure data used in the system. Note that the too close to call, close but victory, and easily win categories from Appendix D are not fuzzy sets but are calculated from the level 6 fuzzy sets Winning Advantage. Each team is assigned a Winning Advantage fuzzy set and the team with the highest Winning Advantage membership is the forecasted winner.

Level 0

Level 0 consists of the statistics which are used to build the base for the next levels. These are just statistics and not fuzzy sets.

THomeWinPct	The team's home winning percentage.
SeriesPct	Two teams' series winning percentage (for Home team).
TCurrStreak	The team's current winning streak.
TRecord	The team's overall winning percentage.
TPointsPGDiff	The team's average points per game verus opponents.
TBlocksPGDiff	The team's average blocks per game versus opponents.
TStealsPGDiff	The team's average steals per game versus opponents.
TRebPGDiff	The team's average rebounds per game versus opponents.
TRebPG	The team's average rebounds per game.
TStealsPG	The team's average steals per game.
TBlocksPG	The team's average blocks per game.
TFieldGoalPct	The team's overall field goal percentage.
TFieldGoalAttemptsPG	The team's average number of field goal attempts per game.
TFreeThrowAttemptsPG	The team's average number of free throw attempts per game.
TPointsPG	The team's average points per game.
TAssistsPg	The team's average assists per game.
TFieldGoalsMadePG	The team's average number of field goals made per game.
OFreeThrowAttemptsPG	The opponents average number of free throw attempts per game.
PExp	The player's years of experience.
PAge	The player's age.
PHt	The player's height in inches.
PWt	The player's weight in pounds.
PGameStartedPct	The player's games started percentage.
PGamePlayedPct	The player's games played percentage.
PMinPerGame	The player's average minutes per game.

PPointsPG	The player's average points per game.
PFieldGoalAttemptsPG	The player's average number of field goal attempts per game.
P3PointAttemptsPG	The player's average number of 3 point shot attempts per game.
PFieldGoalPct	The player's field goal shooting percentage.
PFreeThrowPct	The player's free throw shooting percentage.
P3PointPct	The player's 3 point shooting percentage.
PStealsPG	The player's average number of steals per game.
PBlocksPG	The player's average number of blocks per game.
PRebPG	The player's average number of rebounds per game.
PAssistsPG	The player's average number of assists per game.

Level 1

The 1st level consists of the fuzzification of Level 0. This involves creating fuzzy sets which correspond to the different sets of values in the original statistics.

high_THomeWinPct	A high home winning percentage.
winning_SeriesPct	A winning series percentage.
winning_TCurrStreak	A winning current streak.
winning_TRecord	A winning overal record.
average_TPointsPGDiff	An average points per game differential.
winning_TPointsPGDiff	A winning points per game differential.
average_TBlocksPGDiff	An average blocks per game differential.
aggressive_TBlocksPGDiff	An aggressive blocks per game differential.
average_TStealsPGDiff	An average steals per game differential.
average_TRebPGDiff	An average rebounds per game differential.
dangerous_TRebPGDiff	A dangerous (to opponents) rebounds per game differential.
danger_TStealsPGDiff	A dangerous steals per game differential.
aggressive_TRebPG	Aggressive rebounds per game.
aggressive_TStealsPG	Aggressive steals per game.
dangerous_TBlocksPG	Dangerous (to opponents) blocks per game.
lethal_TFieldGoalPct	Lethal field goal percentage.
low_TFieldGoalAttemptsPG	Low number of field goal attempts per game.
high_TFieldGoalAttemptsPG	High number of field goal attempts per game.
high_TFreeThrowAttemptsPG	High number of free throw attempts per game.
average_TPointsPG	Average number of points per game.
unselfish_TAssistsPg	Unselfish number of assist per game.
high_TFieldGoalsMadePG	High field goals made per game.
high_OFreeThrowAttemptsPG	High opponent free throw attempts per game.
rookie_PExp	Rookie player experience.
journeyman_PExp	Journeyman player experience.
veteran_PExp	Veteran player experience.

young_PAge	Young player age.
prime_PAge	Prime player age.
average_PHt	Average height.
tall_PHt	Tall height.
towering_PHt	Towering height.
light_PWt	Light weight.
medium_PWt	Medium weight.
hefty_PWt	Hefty weight.
secUnit_PGameStartedPct	Second Unit starting percentage.
backup_PGameStartedPct	Backup starting percentage.
sixMan_PGameStartedPct	Sixth Man starting percentage.
ideal_PGamePlayedPct	Ideal games played percentage.
few_PMinPerGame	Few minutes per game.
regular_PMinPerGame	Regular minutes per game.
high_PMinPerGame	High minutes per game.
solid_PPointsPG	Solid points per game.
superStar_PPointsPG	Super Star like number of points per game.
conservative_PFieldGoalAttemptsPG	Conservative field goal shooter.
aggressive_PFieldGoalAttemptsPG	Aggressive field goal shooter.
conservative_P3PointAttemptsPG	Conservative 3 point shooter.
average_P3PointAttemptsPG	Average 3 point shooter.
aggressive_P3PointAttemptsPG	Aggressive 3 point shooter.
solid_PFieldGoalPct	Solid field goal percentage.
lethal_PFieldGoalPct	Lethal field goal percentage.
solid_PFreeThrowPct	Solid free throw percentage.
solid_P3PointPct	Solid 3 point shooting percentage.
specialist_P3PointPct	Specialist 3 point shooting percentage.
high_PStealsPG	High number of steals per game.
dangerous_PStealsPG	Dangerous (to opponent) number of steals per game.
high_PBlocksPG	High number of blocks per game.
specialist_PBlocksPG	Specialist number of blocks per game.
aggressive_PRebPG	Aggressive number of rebounds per game.
specialist_PRebPG	Specialist number of rebounds per game.
high_PAssistsPG	High number of assists per game.

Level 2

These fuzzy sets are obtained by combining, through intersection and union, the sets from Level 1. These fuzzy sets can be thought of as summaries of the first level fuzzy sets.

unselfish team

```
unselfish TAssistsPG OR
```

```
(high_TFieldGoalsMadePG AND low_TFieldGoalAttemptsPG)
```

winning team

```
winnng_TRecord OR winning_TPointsPGDiff
```

low-post team

```
dangerous_TBlocksPG OR aggressive_TBlocksPGDiff OR
aggressive_TRebPG OR dangerous_TRebPGDiff
```

fast-break team

```
aggressive_TRebPG AND lethal_TFieldGoalPct AND low_TFieldGoalAttemptsPG
```

aggressive team

```
aggressive_TRebPG AND dangerous_TRebPGDiff AND
aggressive_TStealsPG AND dangerous_TStealPGDiff AND
dangerous_TBlocksPG AND aggressive_TBlocksPGDiff AND
high_OFreeThrowAttemptsPG
```

unselfish player

```
high_PAssistsPG OR (conservative_PFieldGoalAttemptsPG AND
conservative_P3PointAttemptsPG)
```

all-around shooter

```
solid_PFieldGoalPct AND solid_P3PointPct AND
solid_PFreeThrowPct AND solid_PPointsPG
```

all-around defender

```
aggressive_PRebPG AND dangerous_PStealsPG AND specialist_PBlocksPG
```

inside scoring threat

```
lethal_PFieldGoalPct OR
(average_P3PointAttemptsPG AND superStar_PPointsPG)
```

outside scoring threat

```
lethal_PFieldGoalPct AND aggressive_P3PointAttempts AND
solid_P3PointPct
```

durable player

```
(journeman_PExp OR veteran_PExp) AND ideal_PGamesPlayedPct AND
(sixMan_PGameStartedPCt OR regular_PGameStartedPct)
```

big player

```
towering_PHt AND hefty_PWt
```

athletic player

```
(young_PAge OR prime_PAge) AND (rookie_PExp OR journeyman_PExp) AND
(tall_PHt OR average_PHt) AND light_PWt)
```

smart player

```
high_PAssistsPG AND high_PStealsPG AND solid_PFieldGoalPct AND
solid_PFreeThrowPct AND aggressive_PRebPG AND
(veteran_PExp OR journeyman_PExp) AND prime_PAge
```

versatile player

```
tall_PHt AND medium_PWt AND high_PAssistsPG AND high_PStealsPG AND
high_PBlocksPG AND aggressive_PRebPG
```

pressure defender

```
dangerous_PStealsPG OR specialist_PBlocksPG
```

inside defending threat

```
towering_PHt AND (high_PBlocksPG AND aggressive_PRebPG)
```

key player

```
(regular_PGameStartedPCt OR sixMan_PGameStartedPct) AND
(veteran_PExp OR rookie_PExp) AND
(superStar_PPointsPG OR specialist_PRebPG OR specialist_P3PointPct)
AND ideal_PGamePlayedPct
```

explosive player

```
aggressive_PFieldGoalAttemptsPG OR aggressive_P3PointAttemptsPG OR
lethal_PFieldGoalPct OR specialist_P3PointPct OR
dangerous_PStealsPG OR few_PMinPerGame
```

star player

```
superStar_PPointsPG AND regular_PGameStartedPct AND high_PMinPerGame AND
veteran_PExp
```

future star player

```
rookie_PExp AND solid_PFieldGoalPct AND
```

```
solid_PPointsPG AND young_PAge
```

Level 3

This level combines sets from level 1 and level 2 to create new sets which are built from looking at each players contributions to the team. This level uses integrations fuzzy sets to do this. Generalizations are made about teams based on both player and team data from level 2.

balanced offensive team

```
about 3 all-around shooters AND
about 3 inside-scoring threats AND
about 2 versatile players
```

balanced defensive team

```
about 3 all-around defenders AND
about 2 inside defending threats AND
at least 2 pressure defenders
```

last-minute team

```
winning team AND average_TPointsPGDiff
```

skilled team

```
at least 3 versatile players AND winning team AND
at least 2 star players OR at least 3 future star players
```

star-player-team

```
at least 2 star players
```

running team

```
at least 4 young_PAge AND at least 1 dangerous_PStealsPG AND
at least 2 specialist_PBlocksPG AND
at least 3 aggressive_PRebPG
```

perimeter team

```
at least 6 high outside scoring threats AND
at least 6 specialist_P3PointPct AND
at least 8 lethal_PFieldGoalPct
```

young team

```
at least 6 rookie_PExp AND at least 8 young_PAge
```

veteran team

```
at least 6 veteran_PExp AND at least 8 prime_PAge
```

journeyman team

```
at least 6 journeyman_PExp AND at least 8 prime_PAge
```

Level 4

This level compares two teams to determine the areas in which a team has advantages over their opponent. It uses the fuzzy sets obtained from level 1, level 2, and level 3.

journeyman advantage

```
adv( Team A journeyman team, Team B journeyman team )
```

veteran advantage

```
adv( Team A veteran team, Team B veteran team )
```

youth advantage

```
adv( Team A young team, Team B young team )
```

center offensive advantage

```
Take the weighted average (with w=1) of the following:
 adv( Team A Typical Center big player,
      Team B Typical Center big player )
 adv( Team A Typical Center inside scoring threat,
      Team B Typical Center inside defending threat )
 adv( Team A Typical Center athletic player,
      Team B Typical Center athletic player )
 adv( Team A Typical Center outside scoring threat,
      Team B Typical Center pressure defender )
 adv( Team A Typical Center durable player,
      Team B Typical Center durable player )
 adv( Team A Typical Center key player,
      Team B Typical Center key player )
```

center defensive advantage

```
Take the weighted average (with w=1) of the following:
     adv( Team A Typical Center big player,
      Team B Typical Center big player )
 adv( Team A Typical Center inside defending threat,
      Team B Typical Center inside scoring threat )
 adv( Team A Typical Center athletic player,
```

```
      Team B Typical Center athletic player )
adv( Team A Typical Center durable player,
      Team B Typical Center durable player )
```

guard offensive advantage

```
Take the weighted average (with w=1) of the following:
     adv( Team A Typical Guard outside scoring threat,
      Team B Typical Guard pressure defender )
 adv( Team A Typical Guard all-around shooter,
      Team B Typical Guard all-around defender )
 adv( Team A Typical Guard inside scoring threat,
      Team B Typical Guard inside defending threat )
 adv( Team A Typical Guard smart player,
      Team B Typical Guard smart player )
 adv( Team A Typical Guard unselfish player,
      Team B Typical Guard unselfish player )
 adv( Team A Typical Guard key player,
      Team B Typical Guard key player )
```

guard defensive advantage

```
Take the weighted average (with w=1) of the following:
     adv( Team A Typical Guard pressure defender,
      Team B Typical Guard outside scoring threat )
     adv( Team A Typical Guard all-around defender,
      Team B Typical Guard explosive player )
     adv( Team A Typical Guard inside defending threat,
      Team B Typical Guard inside scoring threat )
     adv( Team A Typical Guard key player,
      Team B Typical Guard key player )
```

forward offensive advantage

```
Take the weighted average (with w=1) of the following:
     adv( Team A Typical Forward big player,
      Team B Typical Forward big player )
     adv( Team A Typical Forward athletic player,
      Team B Typical Forward athletic player )
     adv( Team A Typical Forward inside scoring threat,
      Team B Typical Forward inside defending threat )
     adv( Team A Typical Forward outside scoring threat,
      Team B Typical Forward pressure defender )
     adv( Team A Typical Forward all-around shooter,
      Team B Typical Forward all-around defender )
     adv( Team A Typical Forward key player,
      Team B Typical Forward key player )
```

forward defensive advantage

```
Take the weighted average (with w=1) of the following:
     adv( Team A Typical Forward big player,
      Team B Typical Forward big player )
     adv( Team A Typical Forward athletic player,
      Team B Typical Forward athletic player )
     adv( Team A Typical Forward pressure defender,
      Team B Typical Forward explosive player )
     adv( Team A Typical Forward inside defending threat,
      Team B Typical Forward inside scoring threat)
     adv( Team A Typical Forward all-around defender,
      Team B Typical Forward outside scoring threat )
```

half-court team advantage

```
Take the weighted average (with w=1) of the following:
     adv( Team A perimeter team, Team B perimeter team )
     adv( Team A skilled team, Team B skilled team )
     adv( Team A low-post team, Team B low-post team )
     adv( Team A unselfish team, Team B unselfish team )
```

up-tempo team advantage

```
Take the weighted average (with w=1) of the following:
     adv( Team A running team, Team B running team )
     adv( Team A young team, Team B young team )
     adv( Team A fast-break team, Team B fast-break team )
     adv( Team A aggressive team, Team B aggressive team )
```

Level 5

This level uses the level 4 advantages to arrive at higher level advantages. It takes the advantages created from level 4 and creates overall advantages.

player matchup advantage

```
Take the weighted average (with w=1) of the following:
 adv( Team A center offensive adv, Team B center offensive adv )
 adv( Team A center defensive adv, Team B center defensive adv )
 adv( Team A guard offensive adv, Team B guard offensive adv )
 adv( Team A guard defensive adv, Team B guard deffensive adv )
 adv( Team A forward offensive adv, Team B forward offensive adv )
 adv( Team A forward defensive adv, Team B forward defensive adv )
```

team style advantage

```
Take the weighted average (with w=1) of the following:
 adv( Team A half-court team advantage,
```

```
      Team B half-court team advantage )
adv( Team A up-tempo team advantage,
      Team B up-tempo team advantage )
adv( Team A up-tempo team advantage,
      Team B half-court team advantage )
adv( Team A half-court team advantage,
      Team B up-tempo team advantage )
```

team chemistry advantage

```
Take the weighted average (with w=1) of the following:
 adv( Team A unselfish team, Team B unselfish team )
 adv( Team A balanced offensive team, Team B balanced offensive team )
 adv( Team A balanced defensive team, Team B balanced defensive team )
 adv( Team A winning team, Team B winning team )
 adv( Team A skilled team, Team B skilled team )
 adv( Team A star player team, Team B star player team )
```

team wisdom advantage

```
Take the weighted average (with w=1) of the following:
 adv( Team A veteran advantage, Team B veteran advantage )
 adv( Team A journeyman advantage, Team B journeyman advantage )
 adv( Team A NOT youth advantage, Team B NOT youth advantage )
```

team history advantage

```
If Team A is Home Team
   Take the weighted average (with w=1) of the following:
    adv( Team A high_THomeWinPct, Team B high_TAwayWinPct )
    Team A winning_TSeriesPct
    adv( Team A winning_TCurrStreak, Team B winning_TCurrStreak )
    adv( Team A winning_TRecord, Team B winning_TRecord )

Else If Team A is Away Team
   Take the weighted average (with w=1) of the following:
    adv( Team A high_TAwayWinPct, Team B high_THomeWinPct )
    Team A winning_TSeriesPct
    adv( Team A winning_TCurrStreak, Team B winning_TCurrStreak )
    adv( Team A winning_TRecord, Team B winning_TRecord )
```

Level 6

Take the weighted average of the Level 5 fuzzy sets (player matchup advantage, team styles advantage, team chemistry advantage, team wisdom advantage, and team history advantage) for both teams.

winning advantage

```
Take the weighted average of the following:
 player matchup advantage
 team style advantage
 team chemistry advantage
 team wisdom advantage
 team history advantage
```

Appendix B: *The Basketball Game Forecasting System Code*

This section contains selected portions of the basketball game forecasting system Java code. Not all of the code is listed, and not all of the classes listed are complete. The code that is contained in this section includes the FuzzySets, the MemFunctions, parts of the FuzzySpace, parts of the Team, parts of the Player, and parts of the Game.

FuzzySet

```
/*  Filename: FuzzySet.java
 *  Author:   Shawn Bowers
 *
 *  Description: This file contains the fuzzy set classes.  The
 *  class FuzzySet is the base class and the children are:
 *  BasicFuzzySet, ComplementFuzzySet, IntersectionFuzzySet,
 *  UnionFuzzySet, IntegrationFuzzySet, and AdvantageFuzzySet.
 */

import java.util.Vector;


/**
 *  @author Shawn Bowers
 */
class FuzzySet  {

   protected String set_name = "";  // the name of the fuzzy set
   private Vector refs = new Vector();
   private double value = 0;

   public FuzzySet() {

   }

   public FuzzySet( String name ) { set_name = name; }

   public FuzzySet( double val, String name ) { value = val; set_name = name; }

   public double membership() { return value; }

   public String toString() { return set_name; }

   public void addRef( FuzzySet fset ) { refs.addElement( fset ); }

   public Vector getRefs() { return refs; }

} // FuzzySet


class IntersectionFuzzySet extends FuzzySet {
   private FuzzySet fset1;
   private FuzzySet fset2;
   private Vector refs = new Vector();

   public IntersectionFuzzySet( FuzzySet a_fset, FuzzySet b_fset, String s ) {
      super( s );
      fset1 = a_fset;
      fset2 = b_fset;
   }

   public IntersectionFuzzySet( FuzzySet a_fset, FuzzySet b_fset ) {
      super( "" );
      fset1 = a_fset;
      fset2 = b_fset;
```

```
   }

   public double membership() {
      if( fset1.membership() <= fset2.membership() )
      return fset1.membership();
      else
      return fset2.membership();
   }

} //IntersectionFuzzySet


class UnionFuzzySet extends FuzzySet {
   private FuzzySet fset1;
   private FuzzySet fset2;

   public UnionFuzzySet( FuzzySet a_fset, FuzzySet b_fset, String s ) {
      super( s );
      fset1 = a_fset;
      fset2 = b_fset;
   }

   public UnionFuzzySet( FuzzySet a_fset, FuzzySet b_fset ) {
      super( "" );
      fset1 = a_fset;
      fset2 = b_fset;
   }

   public double membership( ) {
      if( fset1.membership() >= fset2.membership() )
      return fset1.membership();
      else
      return fset2.membership();
   }

} //UnionFuzzySet


class ComplementFuzzySet extends FuzzySet {
   private FuzzySet fset;

   public ComplementFuzzySet( FuzzySet fs ) {
      fset = fs;
   }

   public ComplementFuzzySet( FuzzySet fs, String s ) {
      super( s );
      fset = fs;
   }

   public double membership() {
      return 1 - fset.membership();
   }

} //ComplementFuzzySet


class BasicFuzzySet extends FuzzySet {
   private MemFunction mem_function;
   private double last_query = 0;
   private double x1range;      // low range of domain
   private double x2range;      // high range of domain
   private String stat_name;        // associated statistic description
   private double stat_value;       // associated statistic value
   private String player_name = ""; // stat player name
   private String typical_name = "";
   private boolean visited = false; // for graph traversal


   public BasicFuzzySet( MemFunction f, String name,
             double x1_range, double x2_range ) {
      super( name );
      x1range = x1_range;
```

```
      x2range = x2_range;
      mem_function = f;
   }

   public void setQueryValue( double x ) {
      last_query = x;
   }

   public double membership( ) {
      if( last_query < x1range || last_query > x2range )
      return 0;
      return mem_function.valueAt( last_query );
   }


   /**
    * Can use Double.NEGATIVE_INFINITY and Double.POSITIVE_INFINITY
    */
   public void setRange( double x1, double x2 ) {
      if( x1 <= x2 ) {
      x1range = x1;
      x2range = x2;
       }
   }

   public double [] getRange( ) {
      double tmp[] = {x1range, x2range};
      return tmp;
   }

   public MemFunction getFunction( ) { return mem_function; }

   public void setFunction( MemFunction f ) { mem_function = f; }

   public void setName( String newname ) { set_name = newname; }

   public void addStatName( String name ) { stat_name = name; }
   public void addStatValue( double val ) { stat_value = val; }
   public void addPlayerName( String name ) { player_name = name; }
   public void setTypicalString( String str ) { typical_name = str; }

   public String getStatName() { return stat_name; }
   public double getStatValue() { return stat_value; }
   public String getPlayerName() { return player_name; }
   public String getTypicalString() { return typical_name; }

   public void setVisited( boolean v ) { visited = v; }
   public boolean isVisited() { return visited; }

   public String toString() {
      String str = "";
      if( getPlayerName().equals( "" ) )
      return set_name;

      str += getPlayerName();
      return str += " " + set_name;
   } //toString

} //BasicFuzzySet


class IntegrationFuzzySet extends FuzzySet {

   private double [] values;        // sorted array of double values
   private BasicFuzzySet fuzzy_set; // fuzzy set for integration

   public IntegrationFuzzySet( double [] arr, BasicFuzzySet fset ) {
      super( "" );

      values = sort( arr );
      fuzzy_set = fset;
   } // Constructor

   public IntegrationFuzzySet( double [] arr, BasicFuzzySet fset, String s) {
      super( s );
```

```
      values = sort( arr );
      fuzzy_set = fset;
   } // Constructor

   public static double [] sort( double [] arr ) {
      double [] tmp_arr = new double[arr.length];
      double tmp = 0;
      double pivot = 0;
      int index = 0;

      // make a copy
      for( int i = 0; i < arr.length; i++ )
      tmp_arr[i] = arr[i];

      // sort it
      for( int i = 0; i < arr.length; i++ ) {
      pivot = tmp_arr[i];
      index = i;
      for( int j = i+1; j < arr.length; j++ ) {
         if( tmp_arr[j] > pivot ) {
            index = j;
            pivot = tmp_arr[j];
         }
      } // for
      tmp = tmp_arr[i];
      tmp_arr[i] = pivot;
      tmp_arr[index] = tmp;
      } // for

      return tmp_arr;
   } // sort

   public double membership() {
      double sum = 0;

      for( int i = 0; i < values.length; i++ )
      sum += values[i];

      fuzzy_set.setQueryValue( sum );
      return fuzzy_set.membership();
   } // membership


} // IntegrationFuzzySet



class AdvantageFuzzySet extends FuzzySet {

   private double last_query = 0;

   public AdvantageFuzzySet(String s ) { super( s ); }

   public void setQueryValue( double x ) {
      last_query = x;
   }

   public double membership() {
      return last_query;
   } // membership

   /**
    *  Calculates x's advantage over y.
    */
   public static double adv( double x, double y ) {
      double result = 0;
      double factor = 1.75;
      if( x <= y )
      return 0;

      return min( factor * (x-y), 1 );
   } // adv

   private static double min( double x, double y ) {
```

```
        if( x > y )
        return y;
        else
        return x;
    } // max

    public static double calc_weighted_avg( double [] weights, double [] vals )
    {
        double tot_sum = 0;
        double weight_sum = 0;

        for( int i = 0; i < weights.length && i < vals.length; i++ ) {
        tot_sum += vals[i] * weights[i];
        weight_sum += weights[i];
        } // for

        return (tot_sum / weight_sum);
    } // calc_weighted_avg

    public static double calc_weighted_avg( double [] vals )
    {
        double tot_sum = 0;

        for( int i = 0; i < vals.length; i++ )
        tot_sum += vals[i];

        return (tot_sum / vals.length);
    } // calc_weighted_advs


} // Advantage
```

MemFunction

```
/*
 * Filename: MemFunction.java
 * Author: Shawn Bowers
 *
 * Description: This file contains a set of Function classes used
 * in fuzzy sets.  Function is the base class.  The children are:
 * LinearFunction, and ExpFunction
 *
 */

abstract class MemFunction {


    /**
     * @param x The domain value.
     */
    abstract double valueAt( double x );

}



/**
 * @author Shawn Bowers
 */
class PieceWiseLinearFunction extends MemFunction {
    private int num_lines = 0;   // number of lines in function
    private double line_array[];     // keeps track of all x1, y1, x2, y2 points


    /**
     * @param lines The number of lines in the total function.
     * @param args The x1, y1, x2, y2 coords for the lines.
     */
    public PieceWiseLinearFunction( int lines, double args[] ) {
        if( lines >= 0 ) {
        num_lines = lines;
        line_array = new double[num_lines * 4];
```

```
      // copy the array
      for( int i = 0; i < args.length; i++ )
         line_array[i] = args[i];
      }
   }

   /**
    * @param x The domain value.
    */
   double valueAt( double x ) {
      int l;
      double h_pct;        // the horizontal percentage
      double rise;         // the amount of rise of the slope
      double yval;         // the resulting value

      // find the correct line (if it exists)
      for( l = 0; l < num_lines; l++ ) {
      if( line_array[ l*4 ] <= x && x <= line_array[ l*4 + 2 ] )
         break;
      }

      // x1 not in the range
      if( l == num_lines )
      return Double.NaN;

      // just to make life a little easier
      double [] tmp = new double[4];
      tmp[0] = line_array[ l*4 ];
      tmp[1] = line_array[ l*4 + 1 ];
      tmp[2] = line_array[ l*4 + 2 ];
      tmp[3] = line_array[ l*4 + 3 ];

      // calculate the value of y1 at x1
      h_pct = 1 - ( tmp[2] - x ) / ( tmp[2] - tmp[0] );
      rise = tmp[3] - tmp[1];
      yval = tmp[1] + h_pct*rise;

      return yval;
   }

   void setLine( int line, double arg[] ) {
      if( line >= 0 && line < num_lines && arg.length == 4 ) {
      line_array[ line*4 ] = arg[0];
      line_array[ line*4 + 1 ] = arg[1];
      line_array[ line*4 + 2 ] = arg[2];
      line_array[ line*4 + 3 ] = arg[3];
      }
   }

   double [] getLine( int line ) {
      double [] tmp = new double[4];
      if( line >= 0 && line < num_lines ) {
      tmp[0] = line_array[ line*4 ];
      tmp[1] = line_array[ line*4 + 1 ];
      tmp[2] = line_array[ line*4 + 2 ];
      tmp[3] = line_array[ line*4 + 3 ];
      }
      else
      tmp[0] = tmp[1] = tmp[2] = tmp[3] = 0;

      return tmp;
   }

}


/**
 * @author Shawn Bowers
 *
 *    f(x) = c*e^-( (x-a)^2 / b )
 */
class BellFunction extends MemFunction {
   private double a = 0;    // a is the mean
   private double b = 0;    // b is dev
   private double c = 0;    // will always be 1 for fuzzy sets
```

```
    /**
     * @params mean This is a.
     * @params dev This is b.
     * @params mult This is c.
     */
    public BellFunction( double mean, double dev, double mult ) {
       a = mean;
       b = dev;
       c = mult;
    }


    /**
     * @param x The value to be evaluated.
     */
    double valueAt( double x ) {
       double y = 0;
       y = java.lang.Math.exp( -1*( ((x-a)*(x-a))/b ) );
       return y;
    }

    /**
     * @param mean The new value of a.
     */
    void setA( double mean ) {
       a = mean;
    }

    /**
     * @param dev The new value of b.
     */
    void setB( double dev ) {
       b = dev;
    }

    /**
     * @param mult The new value of c.
     */
    void setC( double mult ) {
       c = mult;
    }

    /**
     * Returns a.
     */
    double getA() {
       return a;
    }

    /**
     * Returns b.
     */
    double getB() {
       return b;
    }

    /**
     * Returns c.
     */
    double getC() {
       return c;
    }
}
```

FuzzySpace

```
/* Filename: FuzzySpace.java
 * Author: Shawn Bowers
 */

import java.io.*;

class FuzzySpace {
```

```
static final int NUM_LEVEL1_TEAM_SETS = 23;
static final int NUM_LEVEL1_PLAYER_SETS = 37;
static final int NUM_LEVEL2_TEAM_SETS = 5;
static final int NUM_LEVEL2_PLAYER_SETS = 14;


//-------------------------------------------------------------------------
// FIFTH LEVEL RULES
//
//-------------------------------------------------------------------------


public static AdvantageFuzzySet create_home_player_matchup_adv( Game g ) {
   double [] advs = new double[6];
   AdvantageFuzzySet adv_fset =
   new AdvantageFuzzySet( "Player Matchups Advantage" );

   advs[0] =
   AdvantageFuzzySet.adv(g.home_center_offensive_adv.membership(),
                g.away_center_offensive_adv.membership() );
   advs[1] =
   AdvantageFuzzySet.adv(g.home_center_defensive_adv.membership(),
                g.away_center_defensive_adv.membership() );
   advs[2] =
   AdvantageFuzzySet.adv(g.home_guard_offensive_adv.membership(),
                g.away_guard_offensive_adv.membership() );
   advs[3] =
   AdvantageFuzzySet.adv(g.home_guard_defensive_adv.membership(),
                g.away_guard_defensive_adv.membership() );
   advs[4] =
   AdvantageFuzzySet.adv(g.home_forward_offensive_adv.membership(),
                g.away_forward_offensive_adv.membership() );
   advs[5] =
   AdvantageFuzzySet.adv(g.home_forward_defensive_adv.membership(),
                g.away_forward_defensive_adv.membership() );

   adv_fset.setQueryValue( AdvantageFuzzySet.calc_weighted_avg( advs ) );

   if( advs[0] > 0 )
   adv_fset.addRef( g.home_center_offensive_adv );
   if( advs[1] > 0 )
   adv_fset.addRef( g.home_center_defensive_adv );
   if( advs[2] > 0 )
   adv_fset.addRef( g.home_guard_offensive_adv );
   if( advs[3] > 0 )
   adv_fset.addRef( g.home_guard_defensive_adv );
   if( advs[4] > 0 )
   adv_fset.addRef( g.home_forward_offensive_adv );
   if( advs[5] > 0 )
   adv_fset.addRef( g.home_forward_defensive_adv );

   return adv_fset;
} // create_home_player_matchup

  [ Section Removed ]

//-------------------------------------------------------------------------
// FOURTH LEVEL RULES
//
//-------------------------------------------------------------------------

public static AdvantageFuzzySet create_journeyman_adv( Team a, Team b ) {
   AdvantageFuzzySet adv_fset =
   new AdvantageFuzzySet( "Journeyman Advantage" );

   double result = AdvantageFuzzySet.adv( a.journeyman_team.membership(),
                        b.journeyman_team.membership() );
   adv_fset.setQueryValue( result );
   adv_fset.addRef( a.journeyman_team );
   return adv_fset;
} // create_young_adv

  [ Section Removed ]

public static AdvantageFuzzySet create_c_off_adv( Player p1, Player p2 ) {
   double [] advs = new double[6];
```

```
   AdvantageFuzzySet adv_fset =
   new AdvantageFuzzySet( "Center Offensive Advantage" );

   advs[0] = AdvantageFuzzySet.adv(p1.big_Player.membership(),
                    p2.big_Player.membership() );

   advs[1] = AdvantageFuzzySet.adv(p1.inside_ScoringThreat.membership(),
                    p2.inside_DefendingThreat.membership());

   advs[2] = AdvantageFuzzySet.adv(p1.athletic_Player.membership(),
                    p2.athletic_Player.membership() );

   advs[3] = AdvantageFuzzySet.adv(p1.outside_ScoringThreat.membership(),
                    p2.pressure_Defender.membership());

   advs[4] = AdvantageFuzzySet.adv(p1.durable_Player.membership(),
                    p2.durable_Player.membership());

   advs[5] = AdvantageFuzzySet.adv(p1.key_Player.membership(),
                    p2.key_Player.membership());

   adv_fset.setQueryValue( AdvantageFuzzySet.calc_weighted_avg( advs ) );

   if( advs[0] > 0 )
   adv_fset.addRef( p1.big_Player );
   if( advs[1] > 0 )
   adv_fset.addRef( p1.inside_ScoringThreat );
   if( advs[2] > 0 )
   adv_fset.addRef( p1.athletic_Player );
   if( advs[3] > 0 )
   adv_fset.addRef( p1.outside_ScoringThreat );
   if( advs[4] > 0 )
   adv_fset.addRef( p1.durable_Player );
   if( advs[5] > 0 )
   adv_fset.addRef( p1.key_Player );

   return adv_fset;
} // create_c_off_adv

  [Section Removed]

//-------------------------------------------------------------------------
// THIRD LEVEL RULES
//
//-------------------------------------------------------------------------


  [ Section Removed ]

public static IntegrationFuzzySet create_star_player_team(
   double [] star_players, Player [] players )
{
   IntegrationFuzzySet fset =
   new IntegrationFuzzySet( star_players, atleast2(),
                    "Star Player Team" );

   for( int i = 0; i < players.length; i++ ) {
   fset.addRef( players[i].star_Player );
   } // for

   return fset;
} // create_star_player_team

public static IntersectionFuzzySet create_running_team(
   double [] young_PAge,
   double [] dangerous_PSteals,
   double [] specialist_PBlocks,
   double [] aggressive_PReb,
   Player [] players )
{
   IntegrationFuzzySet i1 =
   new IntegrationFuzzySet( young_PAge, atleast4() );
   IntegrationFuzzySet i2 =
   new IntegrationFuzzySet( dangerous_PSteals, atleast1() );
   IntegrationFuzzySet i3 =
   new IntegrationFuzzySet( specialist_PBlocks, atleast2() );
```

```
    IntegrationFuzzySet i4 =
    new IntegrationFuzzySet( aggressive_PReb, atleast2() );

    IntersectionFuzzySet fset = new IntersectionFuzzySet( i1,
        new IntersectionFuzzySet( i2,
              new IntersectionFuzzySet( i3, i4 ) ), "Running Team" );

    for( int i = 0; i < players.length; i++ ) {
    fset.addRef( players[i].young_PAge );
    fset.addRef( players[i].danger_PStealsPG );
    fset.addRef( players[i].specialist_PBlocksPG );
    fset.addRef( players[i].aggressive_PRebPG );
    } // for

    return fset;
} // create_running_team

  { Section Removed }

private static BasicFuzzySet about3() {
    double [] tmp = {0, 0, 3, 1, 3, 1, 6, 0};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "About 3", 0, 6);
}

private static BasicFuzzySet about2() {
    double [] tmp = {0, 0, 2, 1, 2, 1, 4, 0};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "About 2", 0, 4);
}

private static BasicFuzzySet atleast1() {
    double [] tmp = {0, 0, 1, 1, 1, 1, 100, 1};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "At Least 1", 0, 1);
}

private static BasicFuzzySet atleast2() {
    double [] tmp = {0, 0, 2, 1, 2, 1, 100, 1};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "At Least 2", 0, 2);
}

private static BasicFuzzySet atleast3() {
    double [] tmp = {0, 0, 3, 1, 3, 1, 100, 1};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "At Least 3", 0, 3);
}

private static BasicFuzzySet atleast4() {
    double [] tmp = {0, 0, 4, 1, 4, 1, 100, 1};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "At Least 4", 0, 4);
}

private static BasicFuzzySet atleast6() {
    double [] tmp = {0, 0, 6, 1, 6, 1, 100, 1};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "At Least 6", 0, 6);
}

private static BasicFuzzySet atleast8() {
    double [] tmp = {0, 0, 8, 1, 8, 1, 100, 1};
    return new BasicFuzzySet(
        new PieceWiseLinearFunction( 2, tmp ),
        "At Least 8", 0, 8);
}
```

```
//-----------------------------------------------------------------------
// SECOND LEVEL RULES
//
//-----------------------------------------------------------------------

/**
 * Creates an unselfish team fuzzy set (level 2)
 */
public static UnionFuzzySet create_unselfish_Team(
   BasicFuzzySet unselfish_TAPG,
   BasicFuzzySet high_TFGMPG,
   BasicFuzzySet low_TFGAPG )
{
   UnionFuzzySet fset =
   new UnionFuzzySet( unselfish_TAPG,
       new IntersectionFuzzySet( high_TFGMPG, low_TFGAPG ),
           "Unselfish Team" );
   fset.addRef( unselfish_TAPG );
   fset.addRef( high_TFGMPG );
   fset.addRef( low_TFGAPG );
   return fset;
}//create_unselfish_Team

  [ Section Removed ]

/**
 * Creates a fastbreak team fuzzy set (level 2)
 */
public static IntersectionFuzzySet create_fastbreak_Team(
   BasicFuzzySet aggressive_TRPG,
   BasicFuzzySet lethal_TFGPct,
   BasicFuzzySet low_TFGAPG )
{
   IntersectionFuzzySet fset = new IntersectionFuzzySet( aggressive_TRPG,
          new IntersectionFuzzySet( lethal_TFGPct,
          low_TFGAPG ), "Fast Break Team" );
   fset.addRef( aggressive_TRPG );
   fset.addRef( lethal_TFGPct );
   fset.addRef( low_TFGAPG );
   return fset;
}//create_fastbreak_Team

  [ Section Removed ]

//-----------------------------------------------------------------------
// FIRST LEVEL RULES
//
//-----------------------------------------------------------------------

  [ Section Removed ]

public static BasicFuzzySet create_win_TCurrStreak( double x, String s )
{
   // win_TCurrStreak
   double [] tmp = {0, .1, 11, 1, 11, 1, 100, 1 };
   BasicFuzzySet fset = new BasicFuzzySet(
      new PieceWiseLinearFunction( 2, tmp ), "Winning Streak", 0, 100);
   fset.setQueryValue( x );
   fset.addStatName( s );
   fset.addStatValue( x );
   return fset;
}//create_win_TCurrStreak

  [ Section Removed ]

public static BasicFuzzySet create_avg_TPointsPGDiff( double x, String s )
{
   // avg_TPointsPGDiff: assuming -50 to 50
   BasicFuzzySet fset = new BasicFuzzySet(
      new BellFunction(0, 15, 1),
      "Average at Outscoring Opponents", -50, 50);
   fset.setQueryValue( x );
   fset.addStatName( s );
   fset.addStatValue( x );
   return fset;
}//create_avg_TPointsPGDiff
```

```
    [ Section Removed ]

}// FuzzySpace
```

Team

```
/* File   : Team.java
 * Author: Shawn Bowers
 */

class Team {
   private String team_name;
   private Player [] players;
   private Player typical_center;
   private Player typical_guard;
   private Player typical_forward;
   private RosterParser roster;
   private StatsParser stats;
   private ScheduleParser schedule;
   private StandingsParser standings;

   // Level 1 Fuzzy Sets
   BasicFuzzySet high_THomeWinPct;
   BasicFuzzySet win_TSeriesPct;
   BasicFuzzySet win_TCurrStreak;
   BasicFuzzySet win_TRecord;
   BasicFuzzySet avg_TPointsPGDiff;
   BasicFuzzySet win_TPointsPGDiff;
   BasicFuzzySet avg_TBlocksPGDiff;
   BasicFuzzySet aggressive_TBlocksPGDiff;
   BasicFuzzySet avg_TStealsPGDiff;
   BasicFuzzySet avg_TRebPGDiff;
   BasicFuzzySet danger_TRebPGDiff;
   BasicFuzzySet danger_TStealsPGDiff;
   BasicFuzzySet aggressive_TRebPG;
   BasicFuzzySet aggressive_TStealsPG;
   BasicFuzzySet danger_TBlocksPG;
   BasicFuzzySet lethal_TFieldGoalPct;
   BasicFuzzySet low_TFieldGoalAttemptsPG;
   BasicFuzzySet high_TFieldGoalAttemptsPG;
   BasicFuzzySet high_TFreeThrowAttemptsPG;
   BasicFuzzySet avg_TPointsPG;
   BasicFuzzySet unselfish_TAssistsPG;
   BasicFuzzySet high_TFieldGoalMadePG;
   BasicFuzzySet high_OFreeThrowAttemptsPG;

   // Level 2 Fuzzy Sets
   UnionFuzzySet unselfish_Team;
   UnionFuzzySet winning_Team;
   UnionFuzzySet lowpost_Team;
   IntersectionFuzzySet fastbreak_Team;
   IntersectionFuzzySet aggressive_Team;

   // Level 3 Fuzzy Sets
   IntersectionFuzzySet balanced_offensive_team;
   IntersectionFuzzySet balanced_defensive_team;
   IntersectionFuzzySet last_minute_team;
   IntersectionFuzzySet skilled_team;
   IntegrationFuzzySet star_player_team;
   IntersectionFuzzySet running_team;
   IntersectionFuzzySet perimeter_team;
   IntersectionFuzzySet young_team;
   IntersectionFuzzySet veteran_team;
   IntersectionFuzzySet journeyman_team;


   public Team( String tname, RosterParser prost, StatsParser pstats,
            ScheduleParser psched, StandingsParser pstands )
   {
      team_name = new String( tname );
      roster = prost;
      stats = pstats;
      schedule = psched;
      standings = pstands;
```

```
    players = new Player[roster.getNumOfPlayers()];

    initLevel1();
    initLevel2();

    int num_players = roster.getNumOfPlayers();

    for( int i = 0; i < num_players; i++ ) {
    // initialize each player
    players[i] = new Player( roster.getPlayerFirstName( i ),
                  roster.getPlayerLastName( i ),
                  roster, stats );
    } // for

    typical_center = new Player( "Typical Center" );
    typical_guard = new Player( "Typical Guard" );
    typical_forward = new Player( "Typical Forward" );
    initPrototypes( 'C', typical_center );
    initPrototypes( 'G', typical_guard );
    initPrototypes( 'F', typical_forward );
    typical_center.initLevel2();
    typical_guard.initLevel2();
    typical_forward.initLevel2();

    initLevel3();
} // Constructor

private void initPrototypes( char position, Player p ) {

    /*
     * Creates the prototypical player based on position
     * and weighted values based on MPG.  Each stat
     * except MPG is weighted for each player and summed
     * to create the typical players stat.  The first
     * level fuzzy sets are created here from these
     * new stats.
     */

    int pnum = roster.getNumOfPlayers(); // number of total players
    double sum = 0;              // temporary sum
    double total_minutes = 0;
    double [] weights = new double[pnum];


    /*
     * Find the sum of all of the target players'
     * MPG values.
     */
    for( int i = 0; i < pnum; i++ ) {
    if( roster.getPlayerPosition(i).charAt(0) == position ) {
       String n1 = roster.getPlayerFirstName(i);
       String n2 = roster.getPlayerLastName(i);
       int index = stats.getPlayerIndex(n1, n2);
       total_minutes += stats.getPlayerMPG(index);
    } // if
    } // for

    // PlayerMinPerGame
    p.few_PMinPerGame = FuzzySpace.create_few_PMinPerGame(48.0, p.getName(),
                "Typical " + position + " Minutes Per Game");
    p.high_PMinPerGame = FuzzySpace.create_high_PMinPerGame(48.0,
                          p.getName(), "Typical " + team_name + " " +
                 position + " Minutes Per Game");


    /*
     * Construct the player weights
     */
    for( int i = 0; i < pnum; i++ ) {
    if( roster.getPlayerPosition(i).charAt(0) == position ) {
       String n1 = roster.getPlayerFirstName(i);
       String n2 = roster.getPlayerLastName(i);
       int index = stats.getPlayerIndex(n1, n2);
       weights[i] = stats.getPlayerMPG(index) / total_minutes;
    }
```

```
else {
   weights[0] = 0;
} // if
} // for


/*
 * Construct the rest of the stats and fuzzy sets.
 */
// find number of players at position
int pos_size = 0;
for( int i = 0; i < pnum; i++ )
if( roster.getPlayerPosition(i).charAt(0) == position )
   pos_size++;

// to sort the arrays by index
double [] vals = new double[pos_size];
int [] roster_index = new int[pos_size];
int [] stats_index = new int[pos_size];
double [] pos_weights = new double[pos_size];
int [] indices;
String pname1, pname2, pname = "";

// create stats and roster indices
int j = 0;
for( int i = 0; i < pnum; i++ ) {
if( roster.getPlayerPosition(i).charAt(0) == position ) {
   roster_index[j] = i;
   String n1 = roster.getPlayerFirstName(i);
   String n2 = roster.getPlayerLastName(i);
   int index = stats.getPlayerIndex(n1, n2);
   stats_index[j] = index;
   pos_weights[j] = weights[i];
   j++;
}
}

// PlayerYears
sum = 0;
pname = "";
for( int i = 0; i < pos_size; i++ ) {
int index = roster_index[i];
sum += roster.getPlayerYears(index) * pos_weights[i];
vals[i] = roster.getPlayerYears(index) * pos_weights[i];
} // for
indices = sort( vals, roster_index );
if( indices.length > 0 ) {
pname1 = roster.getPlayerName( indices[0] ) + ": " +
   Game.round3( roster.getPlayerYears( indices[0] ) );
pname = "(e.g. " + pname1;
if( indices.length > 1 ) {
   pname2 = roster.getPlayerName( indices[1] ) + ": " +
      Game.round3( roster.getPlayerYears( indices[1] ) );
   pname += ", " + pname2;
}
pname += ")";
}

p.rookie_PExp = FuzzySpace.create_rookie_PExp(sum, p.getName(),
            "Typical " + team_name + " " + position +
                  " Experience in NBA");
p.journeyman_PExp = FuzzySpace.create_journeyman_PExp(sum, p.getName(),
            "Typical " + team_name + " " + position +
            " Experience in NBA");
p.veteran_PExp = FuzzySpace.create_veteran_PExp(sum, p.getName(),
            "Typical " + team_name + " " + position +
                  " Experience in NBA");
p.rookie_PExp.setTypicalString( pname );
p.journeyman_PExp.setTypicalString( pname );
p.veteran_PExp.setTypicalString( pname );


// PlayerAge
sum = 0;
pname = "";
for( int i = 0; i < pos_size; i++ ) {
```

```
    int index = roster_index[i];
    sum += roster.getPlayerAge(index) * pos_weights[i];
    vals[i] = roster.getPlayerAge(index) * pos_weights[i];
    } // for
    indices = sort( vals, roster_index );
    if( indices.length > 0 ) {
    pname1 = roster.getPlayerName( indices[0] ) + ": " +
       Game.round3( roster.getPlayerAge( indices[0] ) );
    pname = "(e.g. " + pname1;
    if( indices.length > 1 ) {
       pname2 = roster.getPlayerName( indices[1] ) + ": " +
          Game.round3( roster.getPlayerAge( indices[1] ) );
       pname += ", " + pname2;
    }
    pname += ")";
    }

    p.young_PAge = FuzzySpace.create_young_PAge(sum, p.getName(),
                "Typical " + team_name + " " + position + " Age");
    p.prime_PAge = FuzzySpace.create_prime_PAge(sum, p.getName(),
                "Typical " + team_name + " " + position + " Age");
    p.young_PAge.setTypicalString( pname );
    p.prime_PAge.setTypicalString( pname );


  [ Section Removed ]

} // initPrototypes

private void initLevel1() {
   double tmp_val = 0;

   // high_THomeWinPct
   tmp_val = standings.getHomeWinPCT();
   high_THomeWinPct =
   FuzzySpace.create_high_THomeWinPct(tmp_val, team_name +
                      " Home Winning Pct");

   // win_TSeriesPct
   tmp_val = schedule.getSeriesWinPct();
   win_TSeriesPct =
   FuzzySpace.create_win_TSeriesPct(tmp_val, team_name +
                     " Series Winning Pct");

  [ Section Removed ]
} // initLevel1

private void initLevel2() {
   // unselfish_Team
   unselfish_Team = FuzzySpace.create_unselfish_Team(
                      unselfish_TAssistsPG, high_TFieldGoalMadePG,
            low_TFieldGoalAttemptsPG );

   // winning_Team
   winning_Team = FuzzySpace.create_winning_Team(
                      win_TRecord, win_TPointsPGDiff );

   // lowpost_Team
   lowpost_Team = FuzzySpace.create_lowpost_Team(
                      danger_TBlocksPG, aggressive_TBlocksPGDiff,
            aggressive_TRebPG, danger_TRebPGDiff );

   // fastbreak_Team
   fastbreak_Team = FuzzySpace.create_fastbreak_Team(
                      aggressive_TRebPG, lethal_TFieldGoalPct,
            low_TFieldGoalAttemptsPG );

   // aggressive_Team
   aggressive_Team = FuzzySpace.create_aggressive_Team(
                      aggressive_TRebPG, danger_TRebPGDiff,
                      aggressive_TStealsPG, danger_TStealsPGDiff,
                      danger_TBlocksPG, aggressive_TBlocksPGDiff,
            high_OFreeThrowAttemptsPG );

} // initLevel2
```

```
   /**
    *
    */
   private void initLevel3() {
      int len = players.length;
      double [] arr1 = new double[len];
      double [] arr2 = new double[len];
      double [] arr3 = new double[len];
      double [] arr4 = new double[len];


      // balanced offensive team
      for( int i = 0; i < len; i++ ) {
      arr1[i] = players[i].allaround_Shooter.membership();
      arr2[i] = players[i].inside_ScoringThreat.membership();
      arr3[i] = players[i].versatile_Player.membership();
      ) // for
      balanced_offensive_team =
      FuzzySpace.create_bal_off_team(arr1, arr2, arr3, players );

      // balanced_defensive_team
      for( int i = 0; i < len; i++ ) {
      arr1[i] = players[i].allaround_Defender.membership();
      arr2[i] = players[i].inside_DefendingThreat.membership();
      arr3[i] = players[i].pressure_Defender.membership();
      ) // for
      balanced_defensive_team =
      FuzzySpace.create_bal_def_team(arr1, arr2, arr3, players );

     [ Section Removed ]

   } // initLevel3

     [ Section Removed ]

} // Team
```

Player

```
/* File  : Player.java
 * Author: Shawn Bowers
 */

class Player {

   String first_name = "";          // first name
   String last_name = "";           // last name
   RosterParser roster;              // roster parser anchor
   StatsParser stats;           // stats parser anchor

   // FIRST LEVEL FUZZY SETS
   BasicFuzzySet rookie_PExp;
   BasicFuzzySet journeyman_PExp;
   BasicFuzzySet veteran_PExp;
   BasicFuzzySet young_PAge;
   BasicFuzzySet prime_PAge;
   BasicFuzzySet avg_PHt;
   BasicFuzzySet tall_PHt;
   BasicFuzzySet towering_PHt;
   BasicFuzzySet light_PWt;
   BasicFuzzySet med_PWt;
   BasicFuzzySet hefty_PWt;
   BasicFuzzySet secunit_PGameStartedPct;
   BasicFuzzySet backup_PGameStartedPct;
   BasicFuzzySet sixman_PGameStartedPct;
   BasicFuzzySet ideal_PGamesPlayedPct;
   BasicFuzzySet regular_PGameStartedPct;
   BasicFuzzySet few_PMinPerGame;
   BasicFuzzySet high_PMinPerGame;
   BasicFuzzySet solid_PPointsPG;
   BasicFuzzySet superstar_PPointsPG;
   BasicFuzzySet conservative_PFieldGoalAttemptsPG;
   BasicFuzzySet aggressive_PFieldGoalAttemptsPG;
```

```
BasicFuzzySet conservative_P3PointAttemptsPG;
BasicFuzzySet avg_P3PointAttemptsPG;
BasicFuzzySet aggressive_P3PointAttemptsPG;
BasicFuzzySet solid_PFieldGoalPct;
BasicFuzzySet lethal_PFieldGoalPct;
BasicFuzzySet solid_PFreeThrowPct;
BasicFuzzySet solid_P3PointPct;
BasicFuzzySet specialist_P3PointPct;
BasicFuzzySet high_PStealsPG;
BasicFuzzySet danger_PStealsPG;
BasicFuzzySet high_PBlocksPG;
BasicFuzzySet specialist_PBlocksPG;
BasicFuzzySet aggressive_PRebPG;
BasicFuzzySet specialist_PRebPG;
BasicFuzzySet high_PAssistsPG;


// SECOND LEVEL FUZZY SETS
UnionFuzzySet unselfish_Player;
IntersectionFuzzySet allaround_Shooter;
IntersectionFuzzySet allaround_Defender;
UnionFuzzySet inside_ScoringThreat;
IntersectionFuzzySet outside_ScoringThreat;
IntersectionFuzzySet durable_Player;
IntersectionFuzzySet big_Player;
IntersectionFuzzySet athletic_Player;
IntersectionFuzzySet smart_Player;
IntersectionFuzzySet versatile_Player;
UnionFuzzySet pressure_Defender;
IntersectionFuzzySet inside_DefendingThreat;
IntersectionFuzzySet key_Player;
UnionFuzzySet explosive_Player;
IntersectionFuzzySet star_Player;
IntersectionFuzzySet futurestar_Player;



public Player() {} //constructor

public Player( String name ) {
   first_name = name;
} // Constructor

public Player( String fname, String lname,
       RosterParser rostp, StatsParser statp ) {
   roster = rostp;
   stats = statp;
   first_name = new String( fname );
   last_name = new String( lname );

   initLevel1();
   initLevel2();

} // Constructor

  [ Section Removed ]

private void initLevel1() {

   double tmp_val = 0;
   int sindex = stats.getPlayerIndex( first_name, last_name );
   int rindex = roster.getPlayerIndex( first_name, last_name );

   String s = first_name + " " + last_name;

   if( last_name.charAt( last_name.length()-1 ) == 's' )
   s += "'";
   else
   s += "'s";

   // rookie_PExp
   tmp_val = roster.getPlayerYears( rindex );
   rookie_PExp = FuzzySpace.create_rookie_PExp(tmp_val, s, s +
                          " Experience in NBA");

   // journeyman_PExp
```

```
      journeyman_PExp =
      FuzzySpace.create_journeyman_PExp(tmp_val, s, s +
                          " Experience in NBA");

    [ Section Removed ]
   } // initLevel1

   public void initLevel2() {

      String s = first_name;
      if( !last_name.equals("") )
      s += " " + last_name;

      // unselfish_Player
      unselfish_Player = FuzzySpace.create_unselfish_Player(
                  high_PAssistsPG,
                              conservative_PFieldGoalAttemptsPG,
                              conservative_P3PointAttemptsPG, s);

      // allaround_Shooter
      allaround_Shooter = FuzzySpace.create_allaround_Shooter(
                              solid_PFieldGoalPct,
                              solid_P3PointPct,
                              solid_PFreeThrowPct,
                              solid_PPointsPG, s);

    [ Section Removed ]

   } // initLevel2

    [ Section Removed ]

} // Player
```

Game

```
/* File   : Game.java
 * Author: Shawn Bowers
 *
 * Description:
 */

import java.util.Vector;


class Game {

   private String home_team_name;
   private String away_team_name;

   Team homeTeam;
   Team awayTeam;



   // LEVEL 4 Fuzzy Sets
   AdvantageFuzzySet home_journeyman_adv;
   AdvantageFuzzySet home_veteran_adv;
   AdvantageFuzzySet home_youth_adv;
   AdvantageFuzzySet home_center_offensive_adv;
   AdvantageFuzzySet home_center_defensive_adv;
   AdvantageFuzzySet home_guard_offensive_adv;
   AdvantageFuzzySet home_guard_defensive_adv;
   AdvantageFuzzySet home_forward_offensive_adv;
   AdvantageFuzzySet home_forward_defensive_adv;
   AdvantageFuzzySet home_half_court_adv;
   AdvantageFuzzySet home_up_tempo_adv;
   AdvantageFuzzySet away_journeyman_adv;
   AdvantageFuzzySet away_veteran_adv;
   AdvantageFuzzySet away_youth_adv;
   AdvantageFuzzySet away_center_offensive_adv;
   AdvantageFuzzySet away_center_defensive_adv;
   AdvantageFuzzySet away_guard_offensive_adv;
   AdvantageFuzzySet away_guard_defensive_adv;
   AdvantageFuzzySet away_forward_offensive_adv;
```

```
AdvantageFuzzySet away_forward_defensive_adv;
AdvantageFuzzySet away_half_court_adv;
AdvantageFuzzySet away_up_tempo_adv;


// LEVEL 5 Fuzzy Sets
AdvantageFuzzySet home_player_matchup_adv;
AdvantageFuzzySet home_team_style_adv;
AdvantageFuzzySet home_team_chemistry_adv;
AdvantageFuzzySet home_team_wisdom_adv;
AdvantageFuzzySet home_team_history_adv;
AdvantageFuzzySet away_player_matchup_adv;
AdvantageFuzzySet away_team_style_adv;
AdvantageFuzzySet away_team_chemistry_adv;
AdvantageFuzzySet away_team_wisdom_adv;
AdvantageFuzzySet away_team_history_adv;


// LEVEL 6 Fuzzy Sets
double homeResult = 0;
double awayResult = 0;
int homeSpread = 0;
int awaySpread = 0;
BasicFuzzySet home_too_close;
BasicFuzzySet home_win;
BasicFuzzySet home_convincingly_win;
BasicFuzzySet away_too_close;
BasicFuzzySet away_win;
BasicFuzzySet away_convincingly_win;
FuzzySet winners_set;


// ANALYSIS
Team winningTeam;
String win_team_name;
String win_team_str;
String lose_team_name;
String win_team_brief;
String lose_team_brief;
double winningResult = 0;
int winningSpread = 0;

public Game( String homename, String awayname,
          RosterParser home_rost, StatsParser home_stats,
          ScheduleParser home_sched, StandingsParser home_stands,
          RosterParser away_rost, StatsParser away_stats,
          ScheduleParser away_sched, StandingsParser away_stands )
{
   home_team_name = homename;
   away_team_name = awayname;
   homeTeam = new Team( homename, home_rost, home_stats, home_sched,
              home_stands );
   awayTeam = new Team( awayname, away_rost, away_stats, away_sched,
              away_stands );
   initLevel4();
   initLevel5();
   initLevel6();
   analysis();
} // Constructor

private void initLevel4() {

   // journeyman advantage
   home_journeyman_adv =
   FuzzySpace.create_journeyman_adv( homeTeam, awayTeam );
   away_journeyman_adv =
   FuzzySpace.create_journeyman_adv( awayTeam, homeTeam );

  [ Section Removed ]

} // initLevel4

private void initLevel5() {

   // player matchup advantage
   home_player_matchup_adv =
```

```
      FuzzySpace.create_home_player_matchup_adv( this );
      away_player_matchup_adv =
      FuzzySpace.create_away_player_matchup_adv( this );

    [ Section Removed ]

  } // initLevel5

  private void initLevel6() {
     double [] weights = {.25, .2, .2, .2, .15};

     // calc weighted average
     homeResult = home_team_history_adv.membership() * weights[0];
     homeResult += home_player_matchup_adv.membership() * weights[1];
     homeResult += home_team_style_adv.membership() * weights[2];
     homeResult += home_team_wisdom_adv.membership() * weights[3];
     homeResult += home_team_chemistry_adv.membership() * weights[4];

     // find point spread
     homeSpread = calc_spread( homeResult );

     // insert values
     awayResult = away_team_history_adv.membership() * weights[0];
     awayResult += away_player_matchup_adv.membership() * weights[1];
     awayResult += away_team_style_adv.membership() * weights[2];
     awayResult += away_team_chemistry_adv.membership() * weights[3];
     awayResult += away_team_wisdom_adv.membership() * weights[4];

     // find point spread
     awaySpread = calc_spread( awayResult );

    [ Section Removed ]

  } // initLevel6

    [ Section Removed ]

} // Game
```

Appendix C: *Listing of Results (Forecasts and Recaps)*

The following is a list of games used to test the Fuzzy Forecasting System. Each of the 20 games include the forecast generated by the basketball game forecasting system and the recap of the game. The recap was taken from the NBA's web page which is located at *http://www.nba.com.*

Each forecast consists of the projected winner, the point spread, the degrees of victory, and a detailed description of the reasoning used by the system to construct the forecast. Each number in parenthesis is the degree of membership in the listed fuzzy set. For example, "Bulls Young Team (0.55) because:", is stating that the Bull's have membership of .55 in the fuzzy set "Young Team."

Game 1: *March 3, 1998 - Bulls at Knicks*

Forecast

```
BRIEF ANAYLYSIS

The Bulls have the best possibility of winning (0.31).
The point spread will be by about 6 points.

Outlook for the Bulls:

     * There is a small possiblity that the game will
       be too close to call. (0.25)
     * There is an excellent chance that the Bulls will
       win, but the game will be close. (0.8)
     * There is a small possiblity that the Bulls will
       convincingly win. (0.12)

Outlook for the Knicks:

     * There is an excellent chance that the game will
       be too close to call. (0.75)
     * There is a small possiblity that the Knicks will
       win, but the game will be close. (0.26)
     * There isn't much of a chance that the Knicks will
       convincingly win. (0.0)


DETAILED ANALYSIS

The Bulls should beat the Knicks based on the following observations:


Bulls Winning Advantage (0.31) because:
  * Bulls Away Team History Advantage
  * Bulls Team Playing Style Advantage

  Bulls Away Team History Advantage (0.47) because:
    * Bulls Winning Series Percentage

    Bulls Winning Series Percentage (1.0) because:
      * Bulls Series Winning Pct: 1.0

  Bulls Team Playing Style Advantage (0.47) because:
    * Bulls Up Tempo Team Advantage
    * Bulls Half Court Team Advantage
```

```
Bulls Up Tempo Team Advantage (0.48) because:
  * Bulls Young Team

  Bulls Young Team (0.55) because:
    * Bulls Dickey Simpkins' Rookie Experience
    * Bulls Scott Burrell's Rookie Experience

    Bulls Dickey Simpkins' Rookie Experience (0.8) because:
      * Dickey Simpkins' Experience in NBA: 3.0

    Bulls Scott Burrell's Rookie Experience (0.73) because:
      * Scott Burrell's Experience in NBA: 4.0

Bulls Half Court Team Advantage (0.05) because:
  * Bulls Low Post Team

  Bulls Low Post Team (1.0) because:
    * Bulls Excellent at Outrebounding Opponents
    * Bulls Aggressive Overall Rebounding

    Bulls Excellent at Outrebounding Opponents (1.0) because:
      * Bulls Rebounds Per Game Differential: 5.89

    Bulls Aggressive Overall Rebounding (0.96) because:
      * Bulls Rebounds Per Game: 46.1
```

Recap

SUNDAY, MARCH 8
Chicago 102, New York 89

Michael Jordan had 42 points, eight rebounds and six assists in what could have been his final trip to Madison Square Garden as the Chicago Bulls pulled away for a 102-89 victory over the New York Knicks.

Jordan made 17-of-33 shots from the floor and received a standing ovation when coach Phil Jackson removed him with 55 seconds remaining. Jordan has said he will retire after this season if Jackson is not brought back as Chicago coach, a scenario that appears likely.

"Some of the moves seemed to be coming from 1984," said Jordan, who wore a pair of his original "Air Jordan" sneakers from that year. "You can call it luck, you can call it whatever, it brought back a lot of memories. It certainly brought some excitement to the crowd. It was a well-played game from everybody. We could have easily come in here and fell asleep. But I think since we've got back from the All-Star break this is probably the best game we've played.

"You wouldn't believe the blisters I have on my feet right now," he added. "I paid a price for going back to 1984."

Scottie Pippen added 25 points, nine rebounds and six assists and Dennis Rodman grabbed 20 boards as the Bulls had a 48-33 advantage on the glass in defeating the Knicks for the third time in as many meetings this season.

Allan Houston scored 24 points and Larry Johnson added 20 for the Knicks, who matched a season-high three-game losing streak. Charlie Ward contributed 13 points and a career-high 15 assists as New York had a three-game home winning streak stopped. The Knicks shot 50 percent (38-for-76) from the floor but only hit 8-of-16 shots from the free-throw line.

"I thought our rebounding was where we lost the game," said New York coach Jeff Van Gundy. "They put it to us on the boards. I thought Pippen's points really hurt us badly. Offense wasn't our problem. We shot 50 percent for the game, but we have to make our free throws and we're going to have to rebound the ball."

"He's a great player," Knicks forward Charles Oakley said about Jordan. "We can't let both Mike and Scottie get off. When that happens, everything comes together. We need everybody on our team to play well to win. They only need three (Jordan, Pippen and Rodman)."

Jordan and Toni Kukoc combined on a 10-0 third-quarter run that gave the Bulls the lead for good. After Oakley hit a jumper to give the Knicks a 59-56 lead with 6:22 left in the third, Kukoc hit a three-pointer to begin the run 17 seconds later. Jordan drove the lane for a finger roll, giving the Bulls a 61-59 edge with 5:30 to go. Jordan followed with a pair of free throws and Kukoc capped it with another three-pointer, giving Chicago a 66-59 advantage with 4:25 remaining.

Chicago pushed the lead to 68-60 when Jordan hit a jumper in the lane with 3:44 to go in the third. John Starks and Pippen traded three-pointers before Ward sank a three-pointer to pull the Knicks within 71-66 with 2:08 left in the third.

Houston converted a three-point play, cutting Chicago's lead to two points, but Pippen answered with a jumper for a 73-69 advantage with one minute left in the third. The Knicks again closed within two as Chris Mills drove for a layup 16 seconds later. Scott Burrell responded with a free throw and Chicago took a 74-71 lead into the final period.

"Defensively, we got it going in the fourth quarter," Jackson said. "Scottie played a very good game and we got a lot of possessions. Rebounding and turnovers were the things we emphasized tonight. Dennis had fun out there tonight. It was a physical game, a high-contact game, and he likes those kinds of games."

New York stayed close for the first four minutes of the fourth before Pippen sank a three-pointer to spark a 7-1 burst. Jordan capped it with a fadeaway jumper from the lane and free throw for an 86-77 cushion with 6:02 remaining. Ron Harper, who had 10 points and four assists, converted a three-point play to give Chicago its biggest lead of the game, 98-83, with 3:12 left.

Oakley had 10 points and 14 rebounds and Starks totaled 10 points off the bench for New York.

SportsTicker

Game 2: *March 10, 1998 - Heat at Bulls*

Forecast

BRIEF ANAYLYSIS

The Bulls have the best possibility of winning (0.1).
The point spread will be by about 2 points.

Outlook for the Bulls:

* There is an excellent chance that the game will be too close to call. (0.75)
* There is a small possiblity that the Bulls will win, but the game will be close. (0.26)
* There isn't much of a chance that the Bulls will convincingly win. (0.0)

Outlook for the Heat:

* There is an excellent chance that the game will be too close to call. (0.75)
* There is a small possiblity that the Heat will win, but the game will be close. (0.26)
* There isn't much of a chance that the Heat will convincingly win. (0.0)

DETAILED ANALYSIS

The Bulls should beat the Heat based on the following observations:

Bulls Winning Advantage (0.1) because:
  * Bulls Home Team History Advantage
  * Bulls Team Playing Style Advantage

  Bulls Home Team History Advantage (0.26) because:
    * Bulls High Home Winning Percentage

    Bulls High Home Winning Percentage (0.95) because:
      * Bulls Home Winning Pct: 0.9

  Bulls Team Playing Style Advantage (0.08) because:
    * Bulls Up Tempo Team Advantage

    Bulls Up Tempo Team Advantage (0.23) because:
      * Bulls Young Team

      Bulls Young Team (0.53) because:
        * Bulls Dickey Simpkins' Rookie Experience
        * Bulls Scott Burrell's Rookie Experience

        Bulls Dickey Simpkins' Rookie Experience (0.8) because:
          * Dickey Simpkins' Experience in NBA: 3.0

```
Bulls Scott Burrell's Rookie Experience (0.73) because:
  * Scott Burrell's Experience in NBA: 4.0
```

Recap

TUESDAY, MARCH 10
Chicago 106, Miami 91

Michael Jordan scored 37 points and Scottie Pippen had 19 as the Chicago Bulls bettered their NBA-best home record and avenged their worst loss of the season with a 106-91 win over the Miami Heat, who had their 11-game road winning streak snapped.

Jordan, coming off a 42-point effort in Sunday's win at New York, shot 17-of-30 from the field and scored 23 in the first half to lead Chicago to a 53-44 advantage at the break. Jordan scored six points and Pippen and Toni Kukoc each added four points as the Bulls took command with a 21-2 run that spanned the first and second quarters.

Kukoc finished with 16 points and Pippen added eight assists for Chicago, which won its fourth straight game and improved to 29-3 at the United Center.

Steve Kerr, in his second game off the injured list, connected on a trio of three-pointers and finished with 13 points for the Bulls, who shot a season-high 54 percent (44-of-81) from the field. NBA rebounding leader Dennis Rodman pulled down 10 boards to pace Chicago to a slim 37-34 edge on the glass.

"We've got some guys playing well off the bench right now, we feel comfortable like that," said Chicago coach Phil Jackson. "Miami was short some players and we were without Luc Longley, so neither team had a playoff look. It will be different when the playoffs start."

Both Longley and Miami forward Keith Askins missed the game with sprained left knees.

Alonzo Mourning collected 21 points and 13 rebounds and Tim Hardaway totaled 19 points for Miami, which had not lost on the road since February 1st at Madison Square Garden.

The Heat, who earned a 99-72 home win over the Bulls on January 7th, were held without a field goal for over eight minutes during Chicago's decisive run.

"The Bulls were very, very good tonight," observed Heat coach Pat Riley. "We really had no real options to go to after their hot shooting. They took us out of our offense and made us play an entirely different game from what we were used to. We got their best game here, they got our best in Miami."

First-place Miami, which owns a seven-game lead over New York in the Atlantic Division, was held to just 39 percent (30-of-75) from the floor, including 3-of-16 from three-point range.

It was a physical game, as long-time antagonists Mourning and Rodman came together on two separate occasions, with each earning one technical foul.

"You see, there's not much love out there on the basketball court," Jordan said. "I think a lot of it has to do with how they (the Heat) approach the game. Against a Pat Riley-coached team, you have to be defiant. We cannot let anybody try to intimidate us, and Dennis is a good stand-up guy for us."

With Rodman plugging the middle in Longley's absence, Chicago trailed 18-17 after a free throw by P.J. Brown with 3:03 to go in the first quarter. But the Bulls scored 10 of the last 11 points in the period to grab a 27-19 edge after one.

"We know this team and how well they've been playing on the road," said Jordan. "In the first quarter, they usually get out of the blocks quick, so it was important for us to put them on their heels. We controlled the tempo of the game, and when you do that, you usually can win."

Chicago picked up where it left off, rattling off 11 of the first 12 points of the quarter. The Heat chipped away at the deficit for the remainder of the half and part of the third quarter, pulling within 64-57 on Mourning's layup with 6:58 left in the third quarter.

The Bulls answered with a 13-4 burst, building a 77-61 cushion on Pippen's 10-footer with 1:49 left.

After Dan Majerle's jumper with 4:12 to play in the first quarter, the Heat did not convert from the field until a bucket by Mourning at the 6:58 mark of the second.

"It was a rough game all around," Mourning said. "We made a couple of runs at them, but we made too many mistakes and broke down defensively. We just didn't have it tonight, but we do have a good ballclub and a lot of faith in each other."

SportsTicker

Game 3: *March 11, 1998 - Pacers at Pistons*

Forecast

BRIEF ANAYLYSIS

The Pacers have the best possibility of winning (0.16).
The point spread will be by about 3 points.

Outlook for the Pacers:

* There is an excellent chance that the game will be too close to call. (0.62)
* There is a good possiblity that the Pacers will win, but the game will be close. (0.4)
* There isn't much of a chance that the Pacers will convincingly win. (0.0)

Outlook for the Pistons:

* There is an excellent chance that the game will be too close to call. (0.87)
* There is a small possiblity that the Pistons will win, but the game will be close. (0.13)
* There isn't much of a chance that the Pistons will convincingly win. (0.0)

DETAILED ANALYSIS

The Pacers should beat the Pistons based on the following observations:

Pacers Winning Advantage (0.16) because:
* Pacers Away Team History Advantage
* Pacers Player Matchups Advantage

Pacers Away Team History Advantage (0.5) because:
* Pacers Winning Series Percentage

Pacers Winning Series Percentage (1.0) because:
* Pacers Series Winning Pct: 1.0

Pacers Player Matchups Advantage (0.13) because:
* Pacers Guard Offensive Advantage
* Pacers Center Offensive Advantage

Pacers Guard Offensive Advantage (0.41) because:
* Pacers Typical Guard is an All Around Shooter
* Pacers Typical Guard is a Key Player

Pacers Typical Guard is an All Around Shooter (0.7) because:
* Pacers Typical Guard Solid Shooting Percentage

Pacers Typical Guard Solid Shooting Percentage (0.91) because:
* Typical Pacers G Field Goal Shooting Pct: 0.38
* (e.g. Reggie Miller: 0.484, Mark Jackson: 0.429)

Pacers Typical Guard is a Key Player (0.62) because:
* Pacers Typical Guard Plays in an Ideal Number of Games Per Season
* Pacers Typical Guard Sixth Man Player

Pacers Typical Guard Plays in an Ideal Number of Games Per Season (0.88) because:
* Typical Pacers G Pct of Games Played: 0.82
* (e.g. Reggie Miller: 1.0, Mark Jackson: 1.0)

Pacers Typical Guard Sixth Man Player (0.72) because:
* Typical Pacers G Pct of Games Started: 0.54
* (e.g. Reggie Miller: 1.0, Mark Jackson: 1.0)

```
Pacers Center Offensive Advantage (0.21) because:
  * Pacers Typical Center is a Durable Player
  * Pacers Typical Center is an Inside Scoring Threat

  Pacers Typical Center is a Durable Player (0.89) because:
    * Pacers Typical Center Veteran Experience
    * Pacers Typical Center Plays in an Ideal Number of Games Per Season

    Pacers Typical Center Veteran Experience (0.98) because:
      * Typical Pacers C Experience in NBA: 9.87
      * (e.g. Rik Smits: 9.0, Mark West: 14.0)

    Pacers Typical Center Plays in an Ideal Number of Games Per Season (0.91) because:
      * Typical Pacers C Pct of Games Played: 0.84
      * (e.g. Rik Smits: 0.983, Mark West: 0.213)

  Pacers Typical Center is an Inside Scoring Threat (0.84) because:
    * Pacers Typical Center Average 3 Point Shot Taker
    * Pacers Typical Center Lethal Shooting Percentage

    Pacers Typical Center Average 3 Point Shot Taker (0.96) because:
      * Typical Pacers C Average 3 Point Attempts Per Game: 0.02
      * (e.g. Rik Smits: 0.033, Mark West: 0.0)

    Pacers Typical Center Lethal Shooting Percentage (0.84) because:
      * Typical Pacers C Field Goal Shooting Pct: 0.48
      * (e.g. Rik Smits: 0.498, Mark West: 0.444)
```

Recap

WEDNESDAY, MARCH 11
Detroit 122, Indiana 91

Jerry Stackhouse came off the bench and scored 13 of his 19 points in the second quarter, when Detroit outscored Indiana, 38-20. The Pistons, who had lost the first three meetings with the Pacers this season, shot 91 percent (39-for-43) from the free throw line and made 41-of-70 (58.5 percent) shots from the field.

"As a team we just came out and attacked them right away," Stackhouse said. "This was definitely a huge win, considering it's been an up-and-down season for the team and myself. At this point we need to win all of our home games and hold nothing back."

Dale Davis had 15 points and six rebounds and Rik Smits and Reggie Miller each added 14 points for the Pacers, whose previous worst loss was a 91-79 setback at San Antonio on December 23rd.

"Obviously we didn't come to play tonight," said Indiana coach Larry Bird. "Tonight the Pistons played by themselves, we weren't out there. Grant Hill started off beating us off the dribble then Joe (Dumars) hit some post-up shots. But we just didn't come to play. When a team hits some shots and the other team doesn't come to play, it's easy to get a lead. Guys are just not anticipating like they were."

Dumars contributed 18 points, making 6-of-11 shots from the floor, and Jerome Williams added 12 for the Pistons, who returned home from an 0-3 road trip and received points from 11 players. Detroit's starting point guard Lindsey Hunter was the only Piston without a point, missing five shots from the field.

Stackhouse had six points and Dumars five in Detroit's 21-3 second-quarter run that put away the game. Dumars began the run by making a free throw after an illegal defense violation with 9:18 left and Williams capped it with a tip-in for a 57-31 bulge with 3:41 to go in the second. Detroit shot 62 percent (23-for-37) in the first half for a 68-44 lead at the break.

"We got off to such a good start," said Detroit coach Alvin Gentry. "We were good offensively but I felt we were doing a good job defensively. We were able to play them without doubling. I thought that was the big key. We played well but it's one game. I still think it was our defense that won the game for us. We had 25 fast-break points, anytime you have that you're probably going to score 100 points."

The Pistons had their biggest lead when Stackhouse made a jumper with 10:53 left in the fourth to make it 100-63.

Detroit took the lead for good when Williams hit a hook shot for a 10-8 edge with 8:35 left in the opening quarter. Dumars capped an 8-0 surge with a jumper for a 14-10 advantage with 7:12 left in the first. Hill had 14 points and Williams eight as the Pistons led, 30-24, after the first.

Recaps by SportsTicker
Photos by Elsa Hasch/AllSport/NBA

Game 4: *March 15, 1998 - Heat at Magic*

Forecast

BRIEF ANAYLYSIS

The Heat have the best possibility of winning (0.2).
The point spread will be by about 4 points.

Outlook for the Heat:

* There is a good possiblity that the game will be too close to call. (0.5)
* There is a good possiblity that the Heat will win, but the game will be close. (0.53)
* There isn't much of a chance that the Heat will convincingly win. (0.0)

Outlook for the Magic:

* There is an excellent chance that the game will be too close to call. (0.75)
* There is a small possiblity that the Magic will win, but the game will be close. (0.26)
* There isn't much of a chance that the Magic will convincingly win. (0.0)

DETAILED ANALYSIS

The Heat should beat the Magic based on the following observations:

Heat Winning Advantage (0.2) because:
* Heat Team Wisdom Advantage
* Heat Player Matchups Advantage

Heat Team Wisdom Advantage (0.33) because:
* Heat Not Youth Advantage

Heat Player Matchups Advantage (0.29) because:
* Heat Guard Offensive Advantage
* Heat Center Offensive Advantage

Heat Guard Offensive Advantage (0.45) because:
* Heat Typical Guard is an All Around Shooter
* Heat Typical Guard is a Key Player

Heat Typical Guard is an All Around Shooter (0.66) because:
* Heat Typical Guard Solid 3 Point Shooting Percentage
* Heat Typical Guard Solid Shooting Percentage

Heat Typical Guard Solid 3 Point Shooting Percentage (0.81) because:
* Typical Heat G 3 Point Shooting Pct: 0.28
* (e.g. Tim Hardaway: 0.359, Voshon Lenard: 0.403)

Heat Typical Guard Solid Shooting Percentage (0.78) because:
* Typical Heat G Field Goal Shooting Pct: 0.33
* (e.g. Tim Hardaway: 0.437, Voshon Lenard: 0.431)

Heat Typical Guard is a Key Player (0.58) because:
* Heat Typical Guard Plays in an Ideal Number of Games Per Season
* Heat Typical Guard Rookie Experience

Heat Typical Guard Plays in an Ideal Number of Games Per Season (0.8) because:
* Typical Heat G Pct of Games Played: 0.74
* (e.g. Tim Hardaway: 1.0, Voshon Lenard: 0.984)

Heat Typical Guard Rookie Experience (0.68) because:
* Typical Heat G Experience in NBA: 4.79
* (e.g. Tim Hardaway: 8.0, Dan Majerle: 9.0)

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Heat Center Offensive Advantage (0.42) because:
  * Heat Typical Center is an Inside Scoring Threat

  Heat Typical Center is an Inside Scoring Threat (0.91) because:
    * Heat Typical Center Average 3 Point Shot Taker
    * Heat Typical Center Lethal Shooting Percentage

    Heat Typical Center Average 3 Point Shot Taker (0.96) because:
      * Typical Heat C Average 3 Point Attempts Per Game: 0.0
      * (e.g. Duane Causwell: 0.0, Alonzo Mourning: 0.0)

    Heat Typical Center Lethal Shooting Percentage (0.91) because:
      * Typical Heat C Field Goal Shooting Pct: 0.51
      * (e.g. Alonzo Mourning: 0.551, Duane Causwell: 0.352)
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Recap

SUNDAY, MARCH 15
Miami 79, Orlando 76

Voshon Lenard hit a three-pointer at the buzzer to lift the Miami Heat to a 79-76 victory over the Orlando Magic, who were held scoreless in the final 1:56.

Tim Hardaway scored 22 points and Alonzo Mourning added 16 for the Heat, who fell behind 69-64 when Orlando's Nick Anderson hit two foul shots with seven minutes remaining.

"We made a great shot to win the game that was hard and closely contested," said Miami coach Pat Riley. "I don't think either team played well offensively because both defenses were getting into one another."

There was some initial confusion at the end of the game because referee Ron Olesiak originally ruled Lenard's shot came too late.

"I originally waved it off, but as soon as I did that, I realized that wasn't the correct call," Olesiak said. "I just thought I made the wrong call, and I just wanted to go over and confirm with my partners to make sure that (the) ball was out of his hand. They said absolutely and I went over and changed it (the call)."

"Calls weren't going our way the whole game," added Mourning. "Fortunate enough, that one went our way."

Miami intensified its defense down the stretch, holding Orlando without a field goal in the final seven minutes. The Heat used an 8-1 run to open a 72-70 lead on P.J. Brown's two foul shots with 3:11 left.

"We could have lost the game because we put them on the line with silly fouls at the end of the game," added Riley.

Orlando stayed in the game at the foul line as six straight foul shots -- two by Horace Grant and four by Danny Schayes -- propelled the Heat to a 76-72 lead with 1:56 remaining. Orlando scored its final nine points from the line.

"(Miami) did what they had to do," said Orlando coach Chuck Daly. "That is why they are leading the Atlantic Division. They hung in there and made the big plays at the end. It's a tough loss and one we just have to try to recover from." Hardaway's two foul shots pulled Miami within 76-74 with 40 seconds left, before the Magic committed two crucial turnovers in the final minute.

"Fortunately enough, things went our way down the stretch," said Mourning. "It was tough. It was a nail-biter all the way to the end. But we continued to fight and we stayed in the game. We made plays down the stretch." Mourning and Dan Majerle stripped Schayes as the Orlando center tried to drive to the basket. On the other end, Mourning missed a fallaway jumper on the baseline, but Lenard was fouled while grabbing the offensive rebound. Lenard made both foul shots to tie the game at 76-76 with 7.7 seconds left.

Miami got the ball back when Hardaway stripped Mark Price with 1.9 seconds to play. The Heat called timeout to get the ball at midcourt. Eight-tenths of a second went off the clock when an in-bounds pass was deflected out of bounds.

Miami finally got the ball into Lenard's hands on the left wing. After dribbling once, he got off a 23-footer just before the time expired.

"Evidently, someone got lost guarding him," said Daly. "It should not happen, but these are people playing the game. They are not robots. They are people and they make mistakes."

"It was a rhythm shot," added Lenard. "I had enough time to bounce the ball one time, and I took the shot and it went in."

Anderson scored 30 points and Schayes added 14 for the Magic, who dropped their third straight and fell 1 1/2 games behind New Jersey and Washington for the final playoff spot in the Eastern Conference.

Miami, which opened a nine-game lead over the New York Knicks in the Atlantic Division, won for the 18th time in its last 21 games and improved to 3-0 against Orlando this season. The Heat has given up an average of 72 points in its three wins over the Magic.

Anderson led Orlando in scoring for the sixth straight game and for the 13th time in his last 15 outings. He is averaging 25.5 points in his last six contests.

SportsTicker

Game 5: *March 16, 1998 - Lakers at Sonics*

Forecast

BRIEF ANAYLYSIS

The Sonics have the best possibility of winning (0.16).
The point spread will be by about 3 points.

Outlook for the Sonics:

* There is an excellent chance that the game will be too close to call. (0.62)
* There is a good possiblity that the Sonics will win, but the game will be close. (0.4)
* There isn't much of a chance that the Sonics will convincingly win. (0.0)

Outlook for the Lakers:

* There is an excellent chance that the game will be too close to call. (0.75)
* There is a small possiblity that the Lakers will win, but the game will be close. (0.26)
* There isn't much of a chance that the Lakers will convincingly win. (0.0)

DETAILED ANALYSIS

The Sonics should beat the Lakers based on the following observations:

Sonics Winning Advantage (0.16) because:
  * Sonics Home Team History Advantage
  * Sonics Team Wisdom Advantage

  Sonics Home Team History Advantage (0.29) because:
    * Sonics High Home Winning Percentage

    Sonics High Home Winning Percentage (0.93) because:
      * Sonics Home Winning Pct: 0.86

  Sonics Team Wisdom Advantage (0.25) because:
    * Sonics Journeyman Advantage

    Sonics Journeyman Advantage (1.0) because:
      * Sonics Journeyman Team

      Sonics Journeyman Team (0.93) because:
        * Sonics Vin Baker's Prime Age
        * Sonics Jim McIlvaine's Prime Age

        Sonics Vin Baker's Prime Age (1.0) because:
          * Vin Baker's Age: 27.0

        Sonics Jim McIlvaine's Prime Age (0.96) because:
          * Jim McIlvaine's Age: 26.0

Recap

MONDAY, MARCH 16

Seattle 101, LA Lakers 89

Gary Payton shook off a pair of injuries to score 12 of his 27 points in the final quarter as the Seattle SuperSonics earned their third win as many tries against the Los Angeles Lakers this season, 101-89.

Detlef Schrempf added 21 points and also scored 12 in the final period for the Sonics, who blew a 21-point lead before winning their fourth straight game and extending their lead over the Lakers in the Pacific Division to four games.

Shaquille O'Neal scored 25 points and Eddie Jones added 20 for the Lakers, whose six-game winning streak was their second-longest of the season. Nick Van Exel chipped in 10 points in 22 minutes off the bench in his second game off the injured list.

"This was a good win for us because it keeps us up on them," Payton said. "They were really playing very well so it was very good for us to win. We needed to make a statement against these guys and we did."

Van Exel completed the Lakers' comeback from 21 points down when his two free throws tied the game at 74-74 with 8:18 left in the fourth quarter. But Schrempf responded with a 15-footer and a five-footer to put the Sonics in front for good at 78-74 with 7:18 to play.

O'Neal sank a pair of free throws to make it a two-point game, but Schrempf scored six straight Seattle points around one foul shot by O'Neal to increase the Sonics' lead to 84-77 with 5:42 to play.

Payton took over from there, nailing consecutive three-pointers with 4:18 to play and again at the 3:47 mark to give the Sonics a 90-77 bulge. Hersey Hawkins capped the 17-3 surge with a technical foul shot four seconds later and the Lakers did not get closer than four points thereafter.

The Sonics led by four points after one quarter, but used a 17-4 surge early in the second period to build a 40-25 cushion on a layup by Schrempf with 6:39 remaining in the half. The Lakers got within 40-32 after a flurry by Jones, but Seattle scored 20 of the final 27 points of the half and opened its largest lead when Payton drilled a three-pointer with 9.7 seconds left in the half to make it 60-39 at the break.

The Lakers stormed back in the third, helped by Payton's injuries. Just over a minute into the period, an injury to his left shoulder forced him to go into the locker room. He returned but was forced to the bench with just over 6 1/2 minutes left when he took an elbow to the hip.

"In the first half we played probably as well as we did in a long time against a good team," Seattle coach George Karl said. "And then in the second half Gary got hit and I couldn't tell if he could play or not and offensively we just didn't get anything done very well."

Payton was asked if he thought the elbow was intentional.

"Well, probably so," he said. "But I'm not going to be a crybaby and talk about it. Everthing is going to come back to somebody, and he and I will work it out when the time comes."

Meanwhile, O'Neal and Jones combined for 18 points in the period as Los Angeles outscored Seattle, 25-11, to close within 71-66 entering the fourth. The Sonics were just 4-of-15 in the period.

"I felt good about the way our guys came back," Los Angeles coach Del Harris said. "In the first half the Sonics played about as well as any team we've seen play a half and it was tough for us. We probably dug a little too big of a hole on the second night of a back-to-back."

Vin Baker scored 21 points and Sam Perkins added 10 for the Sonics, who shot 51 percent (33-of-65) from the field. Payton handed out nine assists.

Derek Fisher finished with 13 points for the Lakers, who shot 42.5 percent (31-of-73) and outrebounded the Sonics, 38-32.

SportsTicker

Game 6: *March 17, 1998 - Bulls at Pacers*

Forecast

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BRIEF ANAYLYSIS

The Pacers have the best possibility of winning (0.15).
The point spread will be by about 3 points.

Outlook for the Pacers:

     * There is an excellent chance that the game will
       be too close to call. (0.62)
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     * There is a good possiblity that the Pacers will
       win, but the game will be close. (0.4)
     * There isn't much of a chance that the Pacers will
       convincingly win. (0.0)

Outlook for the Bulls:

     * There is an excellent chance that the game will
       be too close to call. (0.75)
     * There is a small possiblity that the Bulls will
       win, but the game will be close. (0.26)
     * There isn't much of a chance that the Bulls will
       convincingly win. (0.0)


DETAILED ANALYSIS

The Pacers should beat the Bulls based on the following observations:


Pacers Winning Advantage (0.15) because:
  * Pacers Player Matchups Advantage

  Pacers Player Matchups Advantage (0.26) because:
    * Pacers Center Offensive Advantage

    Pacers Center Offensive Advantage (0.53) because:
      * Pacers Typical Center is a Durable Player
      * Pacers Typical Center is an Inside Scoring Threat

      Pacers Typical Center is a Durable Player (0.9) because:
        * Pacers Typical Center Plays in an Ideal Number of Games Per Season
        * Pacers Typical Center Veteran Experience

        Pacers Typical Center Plays in an Ideal Number of Games Per Season (1.0) because:
          * Typical Pacers C Pct of Games Played: 0.98
          * (e.g. Rik Smits: 0.984)

        Pacers Typical Center Veteran Experience (0.9) because:
          * Typical Pacers C Experience in NBA: 9.0
          * (e.g. Rik Smits: 9.0)

      Pacers Typical Center is an Inside Scoring Threat (0.87) because:
        * Pacers Typical Center Average 3 Point Shot Taker
        * Pacers Typical Center Lethal Shooting Percentage

        Pacers Typical Center Average 3 Point Shot Taker (0.96) because:
          * Typical Pacers C Average 3 Point Attempts Per Game: 0.03
          * (e.g. Rik Smits: 0.031)

        Pacers Typical Center Lethal Shooting Percentage (0.87) because:
          * Typical Pacers C Field Goal Shooting Pct: 0.49
          * (e.g. Rik Smits: 0.499)
```

Recap

TUESDAY, MARCH 17
Chicago 90, Indiana 84

Michael Jordan hit a jumper, sank two free throws and came up with a huge steal in the final 76 seconds and the Chicago Bulls allowed three points over the last six minutes, sending a message to the Indiana Pacers with a 90-84 victory.

After trailing Indiana for much of the first half of the season, the two-time defending champion Bulls have won 15 of their last 17 games to take a 3 1/2-game lead over Indiana in the Central Division.

"The Pacers are capable," said Jordan. "They have great players and a great bench and it's very likely we'll see them in the playoffs. But, we've shown that we can play well against the contenders in the East and West."

"I knew how much this game meant for our confidence level," said Indiana coach Larry Bird. "If we had got this, it would have helped down the stretch."

Jordan, who finished with 35 points despite sitting out five minutes of the fourth quarter, came off Dennis Rodman's screen and hit a fadeaway jumper with 76 seconds left, capping an 8-2 spurt and giving Chicago an 86-83 lead.

"Anytime you have Jordan on your team, it makes it easier on the other guys," said Bird. "It's awesome to watch. He hits tough shots and creates opportunities for the other guys to score."

After Rik Smits made the second of two free throws to cut the deficit to 86-84, Jordan threw up a 20-foot air ball but redeemed himself by deflecting Reggie Miller's entry pass from the top of the key with 28 seconds left. On the Bulls' next possession, Jordan drew a foul on a drive to the basket and sank both free throws, extending Chicago's lead to 88-84 with 11 seconds to play.

Indiana was held to a season-low 11 points in the fourth quarter and had a 3:43 scoring drought, enabling the Bulls to take the lead for good. Jalen Rose's layup with 6:07 to go gave the Pacers an 81-78 lead, but Chicago scored six straight points to take control.

"That's not good," said Bird of his team's poor fourth quarter. "I thought we had good opportunities to score, but overall I thought we were tentative."

"I don't think they ever got into a rhythm and you have to credit our defense for that," Jordan added.

Scottie Pippen started the burst with an eight-foot hook and Toni Kukoc added two free throws and a 17-footer, giving the Bulls an 84-81 edge. Antonio Davis' tip-in with 2:24 to play cut Chicago's lead to 84-83 and ended the Pacers' drought but was also Indiana's final field goal.

The Pacers shot 5-of-16 (31.3 percent) from the floor in the fourth quarter and committed four turnovers.

Jordan hit 14-of-28 shots in 42 minutes and Rodman totaled six points and 19 rebounds without a breather as Chicago snapped the Pacers' four-game home winning streak.

"Our bench players just seem to rack up fouls," explained Bulls coach Phil Jackson. "But, we felt this was an important enough game to play our starters a lot."

"Phil (Jackson) kind of stuck with the starting five," said Jordan. "The bench didn't give us any input. But that won't happen too often."

Kukoc scored 17 points and Pippen added 15 for the Bulls, who shot 50 percent (36-of-72) from the field but just 60.9 percent (14-of-23) from the free-throw line.

Chris Mullin scored 18 points, Smits chipped in with 14 and Davis added 14 off the bench for the Pacers, whose bench outscored Chicago's 32-0. Miller scored just 12 points, nearly eight below his average, on 4-of-14 shooting.

"We didn't come with a lot of enthusiasm and we must be ready from the get-go the rest of the way out," admitted Davis. "We must learn from this loss and get better."

The Bulls grabbed their biggest advantage at 60-53 with 8:42 left in the third quarter, but the Pacers used a 12-2 run to take a 65-62 lead with 4:27 remaining. Mullin had eight points in the spurt, which he capped with a pair of three-pointers.

Indiana guard Mark Jackson had nine assists, moving him into a fifth-place tie on the all-time list with Maurice Cheeks at 7,392. Smits, in his ninth season, surpassed the 11,000-point plateau (11,005).

SportsTicker

Game 7: *March 18, 1998 - Jazz at Hornets*

Forecast

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BRIEF ANAYLYSIS

The Jazz have the best possibility of winning (0.24).
The point spread will be by about 5 points.

Outlook for the Jazz:

     *  There is a good possiblity that the game will
        be too close to call. (0.37)
     *  There is an excellent chance that the Jazz will
        win, but the game will be close. (0.66)
     *  There is a small possiblity that the Jazz will
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        convincingly win. (0.06)

Outlook for the Hornets:

     *  There is an excellent chance that the game will
        be too close to call. (0.62)
     *  There is a good possiblity that the Hornets will
        win, but the game will be close. (0.4)
     *  There isn't much of a chance that the Hornets will
        convincingly win. (0.0)


DETAILED ANALYSIS

The Jazz should beat the Hornets based on the following observations:


Jazz Winning Advantage (0.24) because:
  * Jazz Away Team History Advantage
  * Jazz Team Wisdom Advantage

  Jazz Away Team History Advantage (0.49) because:
    * Jazz Winning Streak
    * Jazz Winning Record

    Jazz Winning Streak (1.0) because:
      * Jazz Winning Streak: 11.0

    Jazz Winning Record (0.87) because:
      * Jazz Winning Pct: 0.75

  Jazz Team Wisdom Advantage (0.33) because:
    * Jazz Journeyman Advantage

    Jazz Journeyman Advantage (1.0) because:
      * Jazz Journeyman Team

      Jazz Journeyman Team (0.85) because:
        * Jazz Adam Keefe's Journeyman Experience
        * Jazz Howard Eisley's Prime Age

        Jazz Adam Keefe's Journeyman Experience (1.0) because:
          * Adam Keefe's Experience in NBA: 5.0

        Jazz Howard Eisley's Prime Age (0.96) because:
          * Howard Eisley's Age: 26.0
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Recap

WEDNESDAY, MARCH 18
Charlotte 111, Utah 85

Glen Rice scored 26 points on 11-of-15 shooting and Vernon Maxwell added nine of his 14 in a pivotal second-quarter run as the red-hot Charoltte Hornets snapped the Utah Jazz's 11-game winning streak, 111-85.

David Wesley added 13 points and tied a season high with 13 assists as the Hornets, who have won 12 of 13, shot 60 percent (45-of-75) from the floor. Vlade Divac also tied a season high with seven assists.

Charlotte led 24-23 just under a minute into the second quarter when Maxwell sparked a 26-8 burst that broke open the game. Anthony Mason capped the spurt with a dunk with 1:45 to go in the half.

"Obviously this was one of our best games of the year," Cowens said. "We executed our offense very well; we had excellent movement and that resulted in a lot of layups. We seemed to take a page out of the Jazz's playbook by playing close to a perfect game."

"Tonight the execution on offense and defense was great," said Rice. "This was one of my best games all season. It was the type of game we've been working for all season. We're playing with a lot of confidence."

Karl Malone, who shot 6-of-15 from the field, led Utah with 17 points. Chris Morris added 12 and Bryon Russell 10 for the Jazz, who suffered their worst setback of the season but lost for just the second time in 20 games.

"They beat us every way we could be beaten," said Jazz coach Jerry Sloan, who was ejected in the second quarter. "We had no answer for them. They took us out of everything we wanted to do. If we don't execute, we won't beat any team in this league. This is not an athletic team. I don't have a 1-on-1 player who can break down a defense."

"The Hornets came out and beat us at every aspect of the ballgame," Malone said. "To put it simply, they kicked our butts."

After opening up a six-point lead late in the first quarter, the Hornets had to settle for a 22-21 edge. Rice opened the second period with a layup but Morris answered 33 seconds later to cut the deficit to 24-23.

Maxwell then began the key burst with a seven-foot runner and Bobby Phills followed with a jumper. Morris hit another layup to draw Charlotte within 28-25, but J.R. Reid buried a 16-footer and added a fast-break layup off a feed from Wesley for a 32-25 advantage.

Wesley hit a technical free throw with 7:31 left as Sloan was ejected for arguing and Reid added two more from the line to push the lead to 35-25. Shandon Anderson made a layup to temporary halt the burst, but Maxwell sank a three-pointer.

Anderson hit a five-footer and Malone sank a free throw around a 19-footer by Wesley before the Hornets scored eight straight points. Divac had two free throws, Maxwell made back-to-back baskets and Rice drained a five-footer with 3:53. After a free throw by Malone, Mason capped the burst at 50-31 with 1:45 to go with a dunk off a feed from Rice.

"This was close to a total game for us on offense and defense," said Mason. "We finally put a team away by pulling ahead early. We're more confident and we're playing that way. We're the hungriest team in the league."

Charlotte made 12-of-17 shots in the second quarter.

The Jazz never got within single digits thereafter and trailed by 29 late in the contest. Malone had 13 points in the third quarter.

SportsTicker

Game 8: *March20, 1998 - Sonics at Lakers*

Forecast

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BRIEF ANAYLYSIS

The Sonics have the best possibility of winning (0.19).
The point spread will be by about 4 points.

Outlook for the Sonics:

     *  There is a good possiblity that the game will
        be too close to call. (0.5)
     *  There is a good possiblity that the Sonics will
        win, but the game will be close. (0.53)
     *  There isn't much of a chance that the Sonics will
        convincingly win. (0.0)

Outlook for the Lakers:

     *  There is an excellent chance that the game will
        be too close to call. (0.75)
     *  There is a small possiblity that the Lakers will
        win, but the game will be close. (0.26)
     *  There isn't much of a chance that the Lakers will
        convincingly win. (0.0)


DETAILED ANALYSIS

The Sonics should beat the Lakers based on the following observations:


Sonics Winning Advantage (0.19) because:
  * Sonics Away Team History Advantage
  * Sonics Team Wisdom Advantage
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Sonics Away Team History Advantage (0.4) because:
  * Sonics Winning Record
  * Sonics Winning Series Percentage

  Sonics Winning Record (0.88) because:
    * Sonics Winning Pct: 0.76

  Sonics Winning Series Percentage (0.75) because:
    * Sonics Series Winning Pct: 0.75

Sonics Team Wisdom Advantage (0.33) because:
  * Sonics Journeyman Advantage

  Sonics Journeyman Advantage (1.0) because:
    * Sonics Journeyman Team

    Sonics Journeyman Team (0.93) because:
      * Sonics Vin Baker's Prime Age
      * Sonics Jim McIlvaine's Prime Age

      Sonics Vin Baker's Prime Age (1.0) because:
        * Vin Baker's Age: 27.0

      Sonics Jim McIlvaine's Prime Age (0.96) because:
        * Jim McIlvaine's Age: 26.0
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Recap

FRIDAY, MARCH 20
LA Lakers 93, Seattle 80

Shaquille O'Neal collected 24 points and 16 rebounds and powered the decisive second-quarter run along with Rick Fox as the Los Angeles Lakers narrowed the gap on the Pacific Division-leading Seattle SuperSonics with a 93-80 victory.

The Lakers put it away early with a 16-1 second-quarter run. After Dale Ellis pulled Seattle within 33-31 with a jumper with 9:13 to go, both O'Neal and Rick Fox went on tears, scoring nine and seven points, respectively, with the Lakers taking a 49-32 bulge with 3:04 remaining on O'Neal's dunk.

"I've been saying all year that if we play smart and play our game, we could pretty much do anything we want," O'Neal said. "We came out and we played well tonight and we kept it going. We kept our composure and played hard and started dominating."

Fox netted 18 points and a team-high seven assists and Kobe Bryant added 16 points for Los Angeles, which avoided being swept in the four-game season series and pulled within four games of Seattle with 16 remaining. O'Neal missed 11-of-15 free throws but the rest of his team picked up the slack by going 18-of-18.

Los Angeles has won seven straight at home and eight of its last nine overall.

Detlef Schrempf totaled 17 points and seven rebounds and Ellis scored 16 points off the bench for Seattle, which had a five-game winning streak snapped and fell to 2-3 in their last five road contests.

Eddie Jones netted 14 points and Robert Horry contributed just five but grabbed seven rebounds and four steals for the Lakers, who held a 44-32 rebounding edge and shot 48 percent (32-of-67) from the floor.

Gary Payton scored 13 points but his six assists were cancelled out by seven turnovers. He also committed a crucial blunder that led to five straight points by the Lakers. Los Angeles also turned 23 Seattle turnovers into 25 points.

Reserve Sam Perkins had 13 points and six assists for Seattle, which shot 41 percent (30-of-73) but made 7-of-16 three-pointers.

The Lakers led 52-38 at the break but went cold in the third quarter, scoring only four points over the first 8:20. The Sonics were unable to capitalize, however, and Los Angeles took a 59-48 cushion Bryant's three-pointer with 3:21 to go.

"Our guys played a terrific game," said Lakers coach Del Harris. "We had a little spell in the third quarter where we got a little happy with our lead, tried to make some difficult plays, but it didn't work for us. Other than that, I thought we played with some effort."

Seattle managed to lower the deficit to seven with 56 seconds left on a free throw by Vin Baker, who was otherwise a non-factor, before costly mistakes bumped the margin up to 12.

Trailing 61-54, the Sonics had the ball with the shot clock off and 12 seconds left in the third quarter. But Payton, instead of holding for the final shot, threw a pass that was intercepted by Nick Van Exel, who was fouled by Greg Anthony with 1.5 seconds remaining. Van Exel hit both free throws and Elden Campbell stole Anthony's ensuing inbounds pass, sinking a 36-foot heave for a 66-54 cushion after three quarters.

"The shot Elden made gave us a big boost. It got things started and picked us up," Bryant said. "Elden has a nice touch. It was a big three, especially in a game like this."

"We just had a bad game," said Payton. "We just didn't play well. We just won five games in a row. You guys say we had a bad game tonight, that doesn't mean anything."

Seattle lost for just the second time in 19 meetings with divisional foes. Its only other defeat was a 111-92 loss at Sacramento on January 26th.

SportsTicker

Game 9: *March 22, 1998 - Sixers at Celtics*

Forecast

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BRIEF ANAYLYSIS

The Celtics have the best possibility of winning (0.18).
The point spread will be by about 4 points.

Outlook for the Celtics:

     * There is a good possiblity that the game will
       be too close to call. (0.5)
     * There is a good possiblity that the Celtics will
       win, but the game will be close. (0.53)
     * There isn't much of a chance that the Celtics will
       convincingly win. (0.0)

Outlook for the Sixers:

     * There is an excellent chance that the game will
       be too close to call. (0.87)
     * There is a small possiblity that the Sixers will
       win, but the game will be close. (0.13)
     * There isn't much of a chance that the Sixers will
       convincingly win. (0.0)


DETAILED ANALYSIS

The Celtics should beat the Sixers based on the following observations:


Celtics Winning Advantage (0.18) because:
  * Celtics Player Matchups Advantage

  Celtics Player Matchups Advantage (0.34) because:
    * Celtics Center Offensive Advantage

    Celtics Center Offensive Advantage (0.47) because:
      * Celtics Typical Center is an Inside Scoring Threat
      * Celtics Typical Center is a Big Player

      Celtics Typical Center is an Inside Scoring Threat (0.82) because:
        * Celtics Typical Center Average 3 Point Shot Taker
        * Celtics Typical Center Lethal Shooting Percentage

        Celtics Typical Center Average 3 Point Shot Taker (0.97) because:
          * Typical Celtics C Average 3 Point Attempts Per Game: 0.33
          * (e.g. Travis Knight: 0.9, Zan Tabak: 0.023)

        Celtics Typical Center Lethal Shooting Percentage (0.82) because:
          * Typical Celtics C Field Goal Shooting Pct: 0.48
          * (e.g. Andrew DeClercq: 0.524, Travis Knight: 0.453)

      Celtics Typical Center is a Big Player (0.5) because:
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* Celtics Typical Center Towering

Celtics Typical Center Towering (0.64) because:
  * Typical Celtics C Height: 83.35
  * (e.g. Travis Knight: 84.0, Zan Tabak: 84.0)
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Recap

SUNDAY, MARCH 22
Boston 108, Philadelphia 90

Dana Barros had 27 points, nine rebounds and nine assists as the Boston Celtics got a big boost from their bench in a 108-90 victory over the Philadelphia 76ers that snapped a six-game losing streak.

The 5-9 Barros narrowly missed his first career triple-double and was part of a bench that outscored its Philadelphia counterparts, 42-8. He learned of an aunt's death on Saturday and nearly chose not to play, but he was 9-of-13 from the field, including four three-pointers.

"I felt real groggy today, like being on the court wasn't real," Barros said. "It was tough playing, but it was good to play because I just went about my business. I didn't think about the number."

Barros was pressed into heavy duty at point guard when Kenny Anderson, who started despite tendinitis in his left knee, played just four minutes.

"We have to work extraordinarily hard to win a game with a guy like Kenny out," Celtics coach Rick Pitino said. "I thought Dana showed great courage becuase he had a death in the family, someone very close to him. He showed up yesterday for practice very distraught. I'm sure he had a lot on his mind. Dana gave a lot to the team tonight with a heavy weight on his heart."

Antoine Walker scored 25 points and Ron Mercer added 24 for the Celtics, who forced 22 turnovers and have beaten the 76ers four straight times.

Travis Knight also came off the bench and contributed 10 points and six rebounds. No one on Philadelphia's bench scored more than two points.

Theo Ratliff scored a career-high 27 points and pulled down 11 rebounds for the Sixers, who have dropped two in a row after winning four of five. Philadelphia again was without forward Joe Smith, who has an abdominal strain.

"We stayed in the game until the very end, but their style of play was too much," Ratliff said. "The pressure was too much to handle for our guards."

In the teams' last meeting in Boston, Sixers guard Allen Iverson was suspended for missing a practice and the Celtics roared to a 100-83 win, forcing 29 turnovers. Iverson scored 21 points and did a satisfactory job against Boston's press, but also had to guard Barros, who was trying to tire out his foe.

"It was different this time around. They had Iverson," Mercer said. "They were able to handle our press differently. But the difference was Dana. Dana really wore him down and that's when we picked up the tempo, when (Iverson) was out of the game."

"I just tried to attack Iverson and wear him down a little bit offensively," Barros said. "I got into a groove but I wasn't aware of the numbers I was putting up."

Boston took the lead for good at 22-20 on a jumper by Knight with 2:51 left in the first quarter. The Celtics led 33-26 after one quarter behind eight points from Walker and seven by Barros.

A dunk by Ratliff cut the deficit to 35-32 with 9:22 to play in the second quarter, but the Celtics rattled off eight straight points. Barros made a runner, Andrew DeClercq threw in a hook, Barros had a steal and two free throws and Mercer added a layup to make it 43-32 with 5:54 remaining.

Ratliff scored 15 points and Iverson 14 in the first half, which ended with the Sixers trailing, 53-48. In the third quarter, Barros scored nine points and Walker eight as Boston extended the lead to 83-72 entering the final 12 minutes.

A jumper by Walter McCarty gave Boston a 94-78 lead with 8:06 to go. Iverson's jumper capped an 8-0 burst that cut the deficit in half, but a jumper by Barros triggered a 14-2 run that sealed the win.

"Dana is capable of breaking out at any time," Walker said. "Today's win was real important because we had that losing streak going and we've got Chicago (Monday) night."

McCarty had 11 points and nine rebounds for the Celtics, who shot 52 percent (41-of-79) from the field and held a 42-38 rebounding advantage.

Tim Thomas scored 16 points and Scott Williams added 14 for the Sixers, who shot 44 percent (32-of-72) and forced 17 turnovers.

SportsTicker

Game 10: *March 23, 1998 - Kings at Sonics*

Forecast

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BRIEF ANAYLYSIS

The Sonics have the best possibility of winning (0.29).
The point spread will be by about 6 points.

Outlook for the Sonics:

     *  There is a small possiblity that the game will
        be too close to call. (0.25)
     *  There is an excellent chance that the Sonics will
        win, but the game will be close. (0.8)
     *  There is a small possiblity that the Sonics will
        convincingly win. (0.12)

Outlook for the Kings:

     *  There is an excellent chance that the game will
        be too close to call. (0.87)
     *  There is a small possiblity that the Kings will
        win, but the game will be close. (0.13)
     *  There isn't much of a chance that the Kings will
        convincingly win. (0.0)


DETAILED ANALYSIS

The Sonics should beat the Kings based on the following observations:


Sonics Winning Advantage (0.29) because:
  * Sonics Home Team History Advantage
  * Sonics Team Playing Style Advantage

  Sonics Home Team History Advantage (0.39) because:
    * Sonics High Home Winning Percentage

    Sonics High Home Winning Percentage (0.93) because:
      * Sonics Home Winning Pct: 0.87

  Sonics Team Playing Style Advantage (0.37) because:
    * Sonics Up Tempo Team Advantage
    * Sonics Half Court Team Advantage

    Sonics Up Tempo Team Advantage (0.27) because:
      * Sonics Fast Break Team
      * Sonics Young Team

      Sonics Fast Break Team (0.78) because:
        * Sonics Few Overall Field Goal Attempts
        * Sonics Aggressive Overall Rebounding

        Sonics Few Overall Field Goal Attempts (0.9) because:
          * Sonics Field Goal Attempts Per Game: 77.91

        Sonics Aggressive Overall Rebounding (0.79) because:
          * Sonics Rebounds Per Game: 38.29

      Sonics Young Team (0.57) because:
        * Sonics George Zidek's Rookie Experience
        * Sonics Jim McIlvaine's Rookie Experience

        Sonics George Zidek's Rookie Experience (0.86) because:
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        * George Zidek's Experience in NBA: 2.0

      Sonics Jim McIlvaine's Rookie Experience (0.8) because:
        * Jim McIlvaine's Experience in NBA: 3.0

  Sonics Half Court Team Advantage (0.18) because:
    * Sonics Unselfish Team
    * Sonics Highly Skilled Team

    Sonics Unselfish Team (0.85) because:
      * Sonics Few Overall Field Goal Attempts
      * Sonics Unselfishly Find the Open Man

      Sonics Unselfishly Find the Open Man (0.85) because:
        * Sonics Assists Per Game: 23.9

    Sonics Highly Skilled Team (0.37) because:
      * Sonics Winning Team
      * Sonics Gary Payton is a Star Player

      Sonics Winning Team (0.87) because:
        * Sonics Winning Record

        Sonics Winning Record (0.87) because:
          * Sonics Winning Pct: 0.74

      Sonics Gary Payton is a Star Player (0.7) because:
        * Sonics Gary Payton's Regular Starter
        * Sonics Gary Payton's A lot of Minutes Per Game

        Sonics Gary Payton's Regular Starter (1.0) because:
          * Gary Payton's Pct of Games Started: 1.0

        Sonics Gary Payton's A lot of Minutes Per Game (0.96) because:
          * Gary Payton's Average Minutes Per Game: 38.6
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Recap

MONDAY, MARCH 23
Seattle 109, Sacramento 83

Gary Payton scored 24 points and handed out eight assists in three quarters as the Seattle SuperSonics crushed the fading Sacramento Kings, 109-83.

Vin Baker added 20 points and nine rebounds and Detlef Schrempf contributed 16 points, 10 rebounds and six assists for the Sonics, who avoided their first three-game losing streak since December 11th-14th, 1996 and regained the best record in the Western Conference by one-half game over the Utah Jazz.

"I really think the starters came out and kind of dictated the third quarter with our defense and run-outs," Baker said. "It was nice, I think after this weekend we definitely neded to come back and get some more confidence going by having a victory like this."

Tariq Abdul-Wahad scored 18 points and Terry Dehere added 14 for the Kings, who dropped their season-high eighth straight game and are 2-15 in their last 17 contests. Sacramento played its second straight game without leading scorer Mitch Richmond, who has a sore right knee.

Seattle put the game out of reach late in the second quarter, surprisingly sparked by Hersey Hawkins. Leading 47-40 with 2:56 remaining in the period, Hawkins -- who had been scoreless on 0-of-13 shooting in the last two games -- hit a running jumper to ignite an 11-0 surge. He added three more points in the run, including a free throw to end the half and make it 58-40 at the break.

"The last three mintues of the first half was the turning point of the game for us," Sacramento coach Eddie Jordan said. "We were down seven, we had a little game going, then they ran off an 11-0 run and we couldn't recover."

The Sonics continued pouring it on in the third, scoring 15 of the first 21 points to open a 73-46 bulge on Payton's layup. Payton closed the third quarter and his evening with consecutive layups to make it 86-54 heading into the fourth.

"I thought we did what we had to do," Seattle coach George Karl said. "I thought our guys played really aggressive and had some leads. The first unit really played well the last two or three minutes of the half and got us a big lead. And then they played great in the third quarter and got us a really big lead."

The lead grew as large as 92-56 on Greg Anthony's three-pointer with 10:50 to play before the Kings made it respectable against the Sonics' reserves.

Hawkins finished with 16 points for the Sonics, who shot 52 percent (44-of-84) from the field and outrebounded the Kings, 42-32.

Anthony Johnson had 13 points and Lawrence Funderburke 11 for the Kings, who shot 49 percent (35-of-71) and got almost nothing from Corliss Williamson. Williamson, who had averaged 22.8 points over the last nine games, had only two on 1-of-4 shooting in 19 minutes.

The win was the 100th for Seattle over Sacramento, the most over any other opponent.

SportsTicker

Game 11: *March 26, 1998 - Bucks at Hornets*

Forecast

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BRIEF ANAYLYSIS

The Hornets have the best possibility of winning (0.17).
The point spread will be by about 3 points.

Outlook for the Hornets:

     *  There is an excellent chance that the game will
        be too close to call. (0.62)
     *  There is a good possiblity that the Hornets will
        win, but the game will be close. (0.4)
     *  There isn't much of a chance that the Hornets will
        convincingly win. (0.0)

Outlook for the Bucks:

     *  There is an excellent chance that the game will
        be too close to call. (0.75)
     *  There is a small possiblity that the Bucks will
        win, but the game will be close. (0.26)
     *  There isn't much of a chance that the Bucks will
        convincingly win. (0.0)


DETAILED ANALYSIS

The Hornets should beat the Bucks based on the following observations:


Hornets Winning Advantage (0.17) because:
  * Hornets Home Team History Advantage
  * Hornets Player Matchups Advantage

  Hornets Home Team History Advantage (0.35) because:
    * Hornets High Home Winning Percentage

    Hornets High Home Winning Percentage (0.88) because:
      * Hornets Home Winning Pct: 0.76

  Hornets Player Matchups Advantage (0.34) because:
    * Hornets Guard Offensive Advantage
    * Hornets Forward Offensive Advantage

    Hornets Guard Offensive Advantage (0.65) because:
      * Hornets Typical Guard is an All Around Shooter
      * Hornets Typical Guard is a Key Player

      Hornets Typical Guard is an All Around Shooter (0.65) because:
        * Hornets Typical Guard Solid 3 Point Shooting Percentage
        * Hornets Typical Guard Solid Shooting Percentage

        Hornets Typical Guard Solid 3 Point Shooting Percentage (1.0) because:
          * Typical Hornets G 3 Point Shooting Pct: 0.35
          * (e.g. Bobby Phills: 0.438, David Wesley: 0.326)
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    Hornets Typical Guard Solid Shooting Percentage (0.95) because:
      * Typical Hornets G Field Goal Shooting Pct: 0.4
      * (e.g. David Wesley: 0.433, Bobby Phills: 0.45)

  Hornets Typical Guard is a Key Player (0.63) because:
    * Hornets Typical Guard Specialist 3 Point Shooting Percentage
    * Hornets Typical Guard Plays in an Ideal Number of Games Per Season

    Hornets Typical Guard Specialist 3 Point Shooting Percentage (0.78) because:
      * Typical Hornets G 3 Point Shooting Pct: 0.35
      * (e.g. Bobby Phills: 0.438, David Wesley: 0.326)

    Hornets Typical Guard Plays in an Ideal Number of Games Per Season (0.72) because:
      * Typical Hornets G Pct of Games Played: 0.67
      * (e.g. David Wesley: 0.985, Bobby Phills: 0.705)

Hornets Forward Offensive Advantage (0.44) because:
  * Hornets Typical Forward is an Inside Scoring Threat
  * Hornets Typical Forward is a Key Player

  Hornets Typical Forward is an Inside Scoring Threat (0.8) because:
    * Hornets Typical Forward Average 3 Point Shot Taker
    * Hornets Typical Forward Lethal Shooting Percentage

    Hornets Typical Forward Average 3 Point Shot Taker (0.99) because:
      * Typical Hornets F Average 3 Point Attempts Per Game: 1.43
      * (e.g. Glen Rice: 3.617, Anthony Mason: 0.059)

    Hornets Typical Forward Lethal Shooting Percentage (0.8) because:
      * Typical Hornets F Field Goal Shooting Pct: 0.47
      * (e.g. Anthony Mason: 0.505, Glen Rice: 0.459)

  Hornets Typical Forward is a Key Player (0.63) because:
    * Hornets Typical Forward Plays in an Ideal Number of Games Per Season
    * Hornets Typical Forward Sixth Man Player

    Hornets Typical Forward Plays in an Ideal Number of Games Per Season (0.98) because:
      * Typical Hornets F Pct of Games Played: 0.92
      * (e.g. Glen Rice: 1.0, Anthony Mason: 0.985)

    Hornets Typical Forward Sixth Man Player (0.96) because:
      * Typical Hornets F Pct of Games Started: 0.78
      * (e.g. Glen Rice: 1.0, Anthony Mason: 0.985)
```

Recap

THURSDAY, MARCH 26
Charlotte 94, Milwaukee 80

Glen Rice scored 14 of his 27 points in the fourth quarter as the Charlotte Hornets stayed hot with their 15th victory in 16 games, a 94-80 triumph over the reeling Milwaukee Bucks.

Rice scored eight points in 82 seconds during a 12-0 burst that opened the final period and gave the Hornets the lead for good. He scored as many points in the fourth quarter as the Bucks, who shot just 25 percent (5-of-20).

David Wesley scored 21 points and Matt Geiger added 12 and 15 rebounds for the Hornets, who shot 65 percent (13-of-20) in the final period and held their eighth straight opponent under 90 points. Charlotte won its fifth consecutive game and moved within three games of third-place Indiana in the Eastern Conference.

"We realized that defense can take us a long way," Rice said. "If we play good defense, we're in every game. When we go in there and take care of business like we can, we're a very tough team."

Ray Allen and Elliot Perry each scored 18 points for the Bucks, who have lost 10 of their last 11 games. Milwaukee, which is without injured starters Glenn Robinson, Terrell Brandon and Tyrone Hill, was held to 85 points or less for the 11th time since February 1st.

"Over the last few games, we have been playing well," Bucks coach Chris Ford said. "There has been no quit in this team. We're just undermanned. We battled hard but we had to play against one of the hottest teams in the NBA."

The Hornets trailed 66-63 after three quarters, but a layup by Wesley with 11:05 remaining started the decisive burst. While defended by rookie Jerald Honeycutt, Rice buried three-pointers 22 seconds apart, then added a dunk with 9:06 remaining.

"Glen and David made some big shots and got us rolling in the second half," Hornets coach Dave Cowens said. "We've been really turning it up lately in the fourth. Glen rose to the occasion big-time for us tonight."

"When you're having to play against Glen Rice, you cannot give him any room, no daylight at all," said Bucks center Ervin Johnson, who had 17 rebounds. "He really hurt us there in the fourth quarter."

A dunk by Bobby Phills capped the burst at 75-66 with 8:30 to play.

A free throw by Honeycutt pulled Milwaukee within 77-73 with 5:25 to go, but Wesley made a layup and three-pointer, giving Charlotte an 82-73 advantage with 4:15 remaining. The Hornets closed the game with a 7-0 run.

"Tonight was one of those late-year muscle games," Cowens said. "I think we tired them out a little tonight. Our guys hung tough. There was a lot of banging and their plan was to slow it down."

Vlade Divac scored 14 points and Anthony Mason pulled down 10 rebounds for Charlotte, which shot 48 percent (38-of-80) from the field and committed just 10 turnovers. The Hornets were 6-of-12 from three-point range, including 3-of-3 from Rice.

"We didn't play as well as we'd like to, but we got the job done," Geiger said. "Vlade's getting his jumper back, which is important for the rest of the season."

Honeycutt scored 15 points and Armon Gilliam added 13 and 10 boards for Milwaukee, which shot just 38 percent (33-of-86) and was beaten on the boards, 48-47.

Allen scored nine points in the first quarter as the Bucks took a 23-22 lead. A three-point play by Johnson gave Milwaukee a 32-31 edge with 6:53 to go in the second quarter, but Geiger scored six points in a 15-4 run, including a layup that gave the Hornets a 46-36 advantage with 1:58 left.

The Bucks closed to 48-44 at halftime. A jumper by Wesley gave Charlotte a 52-47 lead four minutes into the third quarter, but Gilliam, Johnson and Perry scored four points each in a 15-5 spurt as Milwaukee reclaimed the lead.

SportsTicker

Game 12: *March 27, 1998 - Rockets at Magic*

Forecast

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BRIEF ANAYLYSIS

The Magic have the best possibility of winning (0.23).
The point spread will be by about 5 points.

Outlook for the Magic:

     *  There is a good possiblity that the game will
        be too close to call. (0.37)
     *  There is an excellent chance that the Magic will
        win, but the game will be close. (0.66)
     *  There is a small possiblity that the Magic will
        convincingly win. (0.06)

Outlook for the Rockets:

     *  There is an excellent chance that the game will
        be too close to call. (0.62)
     *  There is a good possiblity that the Rockets will
        win, but the game will be close. (0.4)
     *  There isn't much of a chance that the Rockets will
        convincingly win. (0.0)


DETAILED ANALYSIS

The Magic should beat the Rockets based on the following observations:


Magic Winning Advantage (0.23) because:
  * Magic Team Playing Style Advantage
  * Magic Player Matchups Advantage
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Magic Team Playing Style Advantage (0.37) because:
  * Magic Half Court Team Advantage

  Magic Half Court Team Advantage (0.25) because:
    * Magic Perimeter Team

    Magic Perimeter Team (0.57) because:
      * Magic Jason Lawson's Lethal Shooting Percentage
      * Magic Kevin Edwards' Specialist 3 Point Shooting Percentage

      Magic Jason Lawson's Lethal Shooting Percentage (1.0) because:
        * Jason Lawson's Field Goal Shooting Pct: 0.58

      Magic Kevin Edwards' Specialist 3 Point Shooting Percentage (0.95) because:
        * Kevin Edwards' 3 Point Shooting Pct: 0.42

Magic Player Matchups Advantage (0.27) because:
  * Magic Forward Offensive Advantage

  Magic Forward Offensive Advantage (0.53) because:
    * Magic Typical Forward is an Inside Scoring Threat
    * Magic Typical Forward is an Athletic Player

    Magic Typical Forward is an Inside Scoring Threat (0.76) because:
      * Magic Typical Forward Average 3 Point Shot Taker
      * Magic Typical Forward Lethal Shooting Percentage

      Magic Typical Forward Average 3 Point Shot Taker (0.97) because:
        * Typical Magic F Average 3 Point Attempts Per Game: 0.34
        * (e.g. David Benoit: 2.227, Horace Grant: 0.111)

      Magic Typical Forward Lethal Shooting Percentage (0.76) because:
        * Typical Magic F Field Goal Shooting Pct: 0.45
        * (e.g. Charles Outlaw: 0.56, Horace Grant: 0.446)

    Magic Typical Forward is an Athletic Player (0.53) because:
      * Magic Typical Forward Tall
      * Magic Typical Forward Journeyman Experience

      Magic Typical Forward Tall (1.0) because:
        * Typical Magic F Height: 80.88
        * (e.g. Horace Grant: 82.0, Charles Outlaw: 80.0)

      Magic Typical Forward Journeyman Experience (0.84) because:
        * Typical Magic F Experience in NBA: 6.53
        * (e.g. Horace Grant: 10.0, Derek Strong: 6.0)
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Recap

FRIDAY, MARCH 27
Orlando 100, Houston 75

Orlando is tied with New Jersey for ninth place in the Eastern Conference one-half game behind Washington, which is playing in Phoenix.

The Magic had six scorers in double figures and committed just 11 turnovers while turning 24 Houston miscues into 25 points. Schayes played a big part in that differential, frustrating Olajuwon -- who scored just 12 points on 6-of-13 shooting -- into committing six turnovers.

Strong led the way with eight points in the decisive second quarter as the Magic took control with a pair of runs. Leading 22-19 after one period, they carried a 48-33 advantage into the break after David Benoit capped an 11-4 surge with a free throw with 3.8 seconds to play in the half.

Kevin Willis had 20 points for Houston, which lost its eighth straight regular-season meeting with Orlando and fell to 2-2 on its five-game road swing.

Recaps by SportsTicker
Photos by Peter Taylor/AllSport/NBA

Game 13: *March 31, 1998 - Jazz at Sonics*

Forecast

BRIEF ANAYLYSIS

The Sonics have the best possibility of winning (0.17).
The point spread will be by about 4 points.

Outlook for the Sonics:

* There is a good possiblity that the game will be too close to call. (0.5)
* There is a good possiblity that the Sonics will win, but the game will be close. (0.53)
* There isn't much of a chance that the Sonics will convincingly win. (0.0)

Outlook for the Jazz:

* There is an excellent chance that the game will be too close to call. (0.62)
* There is a good possiblity that the Jazz will win, but the game will be close. (0.4)
* There isn't much of a chance that the Jazz will convincingly win. (0.0)

DETAILED ANALYSIS

The Sonics should beat the Jazz based on the following observations:

Sonics Winning Advantage (0.17) because:
* Sonics Team Wisdom Advantage
* Sonics Player Matchups Advantage

Sonics Team Wisdom Advantage (0.25) because:
* Sonics Journeyman Advantage

Sonics Journeyman Advantage (1.0) because:
* Sonics Journeyman Team

Sonics Journeyman Team (0.87) because:
* Sonics Vin Baker's Prime Age
* Sonics Jim McIlvaine's Prime Age

Sonics Vin Baker's Prime Age (1.0) because:
* Vin Baker's Age: 27.0

Sonics Jim McIlvaine's Prime Age (0.96) because:
* Jim McIlvaine's Age: 26.0

Sonics Player Matchups Advantage (0.22) because:
* Sonics Forward Offensive Advantage
* Sonics Forward Defensive Advantage

Sonics Forward Offensive Advantage (0.61) because:
* Sonics Typical Forward is an Inside Scoring Threat
* Sonics Typical Forward is an All Around Shooter

Sonics Typical Forward is an Inside Scoring Threat (0.82) because:
* Sonics Typical Forward Average 3 Point Shot Taker
* Sonics Typical Forward Lethal Shooting Percentage

Sonics Typical Forward Average 3 Point Shot Taker (0.99) because:
* Typical Sonics F Average 3 Point Attempts Per Game: 1.18
* (e.g. Detlef Schrempf: 1.88, Sam Perkins: 2.671)

Sonics Typical Forward Lethal Shooting Percentage (0.82) because:
* Typical Sonics F Field Goal Shooting Pct: 0.47
* (e.g. Vin Baker: 0.544, Detlef Schrempf: 0.482)

Sonics Typical Forward is an All Around Shooter (0.74) because:
* Sonics Typical Forward Solid Shooting Percentage

Sonics Typical Forward Solid Shooting Percentage (0.98) because:
* Typical Sonics F Field Goal Shooting Pct: 0.47
* (e.g. Vin Baker: 0.544, Detlef Schrempf: 0.482)

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Sonics Forward Defensive Advantage (0.2) because:
  * Sonics Typical Forward is a Big Player

  Sonics Typical Forward is a Big Player (0.5) because:
    * Sonics Typical Forward Hefty
    * Sonics Typical Forward Towering

    Sonics Typical Forward Hefty (0.56) because:
      * Typical Sonics F Weight: 242.8
      * (e.g. Vin Baker: 250.0, Detlef Schrempf: 235.0)

    Sonics Typical Forward Towering (0.5) because:
      * Typical Sonics F Height: 81.62
      * (e.g. Vin Baker: 83.0, Detlef Schrempf: 82.0)
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Recap

TUESDAY, MARCH 31
Seattle 88, Utah 86

Detlef Schrempf and Hersey Hawkins hit consecutive three-pointers in the final two minutes as the Seattle SuperSonics took over the top spot in the Western Conference with an 88-86 victory over the Utah Jazz.

Utah's Karl Malone made a 12-footer to break an 80-80 tie with 1:54 left in the fourth quarter. Schrempf sank a three-pointer 11 seconds later to give Seattle the lead for good and Hawkins followed that with 74 seconds to play.

"As a team we were able to maintain our composure all game, which is hard to do against a team like Utah," Baker said. "This was playoff-type basketball. All the games are important from here on out. The Sonics are ready for the playoffs."

Jeff Hornacek's jumper pulled Utah within 86-84 with one minute remaining, but Vin Baker answered with a fadeaway jumper from the lane 18 seconds later. Malone had a chance to cut the deficit to one, but missed a free throw after he was fouled on a jumper with 27 seconds left.

"Now we have to win all our games down the stretch," said Hornacek, who had 11 points and seven assists. "They said it was a must win game for them but we both have to win all our games to finish first."

Seattle ran the shot clock down on the following possession and Payton missed a layup with three seconds to go. Howard Eisley grabbed the rebound and Utah called time out to set up a final shot. But John Stockton's jumper from the top of the key hit off the rim at the buzzer.

Baker had 18 points and 10 rebounds and Schrempf added 17 and nine for Seattle, which won for the fourth time in five games and second in four meetings with the Jazz this season. Payton recorded 14 points and nine assists for the SuperSonics, who improved to 32-10 against the Western Conference. Hawkins scored nine points, making 2-of-4 three-pointers, as the Sonics shot 52 percent (12-for-23) from behind the arc.

"This was the biggest game of the year for us," Hawkins said. "We played with aggressive intensity, hanging in there all game and kept the game close and were able to make our shots at the end."

Malone had 20 points and 10 boards and Adam Keefe and Shandon Anderson each added 12 points for the Jazz, who had a five-game winning streak snapped. Stockton was limited to nine points and five assists as Utah fell to 29-12 against conference opponents.

"Every game is a big game this time of year," said Utah coach Jerry Sloan. "Our players are paid to play every night so every night is a big game."

Nate McMillan, who made 2-of-2 three-pointers off the bench, sank a 26-footer to give the Sonics their biggest lead of the game, 71-63, with 9:44 left in the fourth. Chris Morris hit a 15-footer to spark a 14-5 burst that gave Utah a 75-74 edge with 5:25 remaining. Schrempf answered with two free throws but Stockton hit an 18-footer to give Utah a 77-76 edge with 4:36 to go. Shandon Anderson dunked to push the lead to 79-76 with 3:16 left.

Schrempf made a hook shot to pull the Sonics within 79-78 with 3:03 to play. Stockton made one free throw with 2:36 left and Payton tied the game at 80-80 when he made a layup 27 seconds later.

SportsTicker

Game 14: *April 1, 1998 - Celtics at Magic*

Forecast

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BRIEF ANAYLYSIS
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The Celtics have the best possibility of winning (0.16).
The point spread will be by about 3 points.

Outlook for the Celtics:

     * There is an excellent chance that the game will
       be too close to call. (0.62)
     * There is a good possiblity that the Celtics will
       win, but the game will be close. (0.4)
     * There isn't much of a chance that the Celtics will
       convincingly win. (0.0)

Outlook for the Magic:

     * There is an excellent chance that the game will
       be too close to call. (0.62)
     * There is a good possiblity that the Magic will
       win, but the game will be close. (0.4)
     * There isn't much of a chance that the Magic will
       convincingly win. (0.0)


DETAILED ANALYSIS

The Celtics should beat the Magic based on the following observations:


Celtics Winning Advantage (0.16) because:
  * Celtics Team Wisdom Advantage
  * Celtics Team Chemistry Advantage

  Celtics Team Wisdom Advantage (0.33) because:
    * Celtics Not Youth Advantage

  Celtics Team Chemistry Advantage (0.31) because:
    * Celtics Star Player Team
    * Celtics Unselfish Team

    Celtics Star Player Team (0.88) because:
      * Celtics Kenny Anderson is a Star Player

      Celtics Kenny Anderson is a Star Player (0.54) because:
        * Celtics Kenny Anderson's Regular Starter
        * Celtics Kenny Anderson's A lot of Minutes Per Game

        Celtics Kenny Anderson's Regular Starter (0.97) because:
          * Kenny Anderson's Pct of Games Started: 0.91

        Celtics Kenny Anderson's A lot of Minutes Per Game (0.77) because:
          * Kenny Anderson's Average Minutes Per Game: 31.1

    Celtics Unselfish Team (0.78) because:
      * Celtics Few Overall Field Goal Attempts
      * Celtics Unselfishly Find the Open Man

      Celtics Few Overall Field Goal Attempts (0.81) because:
        * Celtics Field Goal Attempts Per Game: 84.47

      Celtics Unselfishly Find the Open Man (0.78) because:
        * Celtics Assists Per Game: 21.9
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Recap

WEDNESDAY, APRIL 1
Boston 98, Orlando 87

Greg Minor and Walter McCarty combined for 12 points in a decisive second-half run as the Boston Celtics kept their fading playoff hopes alive with a 98-87 victory over the Orlando Magic.

Antoine Walker scored 18 points and McCarty finished with 13 for Boston, which is 5 1/2 games behind New Jersey for the final playoff spot in the Eastern Conference with nine games to play. The Celtics prevented Orlando from moving into a tie with the Nets for eighth place.

"We have 10 games left in the season and we are trying to play competitive," said Walker, who also had 15 rebounds. "The good thing is that during those 10 games, we are playing teams that are jockeying for playoff position. That gives us motivation and we are going to give the 'A' game."

Boston snapped a six-game losing streak to the Magic by defeating Orlando for the first time since April 6th. The Celtics also won for only the third time in their last 11 games.

The victory enabled the Charlotte Hornets to become the fourth Eastern Conference team to clinch a playoff spot.

Nick Anderson scored 18 points and Derek Strong added 17 for Orlando, which remained in ninth place, one game behind the Nets and tied with Washington.

"We're against a Washington team trying to make the playoffs," said Magic swingman Gerald Wilkins. "It's going to be tough. We'll just have to continue to play, we'll see what happens. The best thing about this coming up is that we get three days off to rest, try and pull something out."

The Magic pulled within 59-58 on a dunk by Strong with 2:09 to go in the third quarter, but Boston pulled held Orlando without a basket for almost eight minutes to pull away. Zan Tabak had a bucket before Tyus Edney hit a runner to make it 63-58.

Strong sank two free throws, but Edney hit an 18-footer at the buzzer -- the third time Boston successfully operated a final play of a quarter in as many tries -- to give the Celtics a 65-60 lead entering the fourth quarter.

The Celtics then tacked on the first seven points of the fourth quarter as Tabak made a free throw and McCarty hit a basket with 10:53 to play. Two jumpers by Minor gave Boston a 72-60 advantage with 10:01 left.

Anderson made three free throws around a dunk by McCarty, who capped the run with a basket after a jumper by Minor, staking the Celtics to a 78-63 lead with eight minutes to go.

"Minor, I thought, was sensational," said Celtics coach Rick Pitino. "Greg Minor did a lot of things tonight you don't see on the stat sheet. I thought he played really great, he played hard and played great defense."

The Magic, who came no closer than 10 thereafter, finally ended their drought when Bo Outlaw dunked with 6:31 to play.

Dana Barros finished with 17 points and a season-high 10 assists for Boston, which shot 46 percent (39-of-84) and scored 15 points off 14 Magic turnovers. Minor, Travis Knight and Ron Mercer each netted 10 points.

"We wanted to see an incredible effort tonight after last night's debacle, and we got it," added Pitino, referring to Tuesday's 121-95 loss at Miami. "We had only one or two turnovers in the second half. We executed offensively as well as we could without taking our eyes off the rim and we used the clock well."

"We weren't able to stop them, they were very, very good offensively," admitted Magic point guard Derek Harper. "Their guys really took the ball to the basket aggressively. I think the danger of playing a Boston team is once they feel like they have a chance against you, they become more confident as a basketball team and they play a lot better."

Anderson was 4-of-16 from the field as the Magic shot 39 percent (31-of-79) from the floor and scored only five points off 14 Boston turnovers. Orlando also missed 13 free throws and went 2-of-12 from three-point range.

SportsTicker

Game 15: *April 5, 1998 - Jazz at Grizzlies*

Forecast

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BRIEF ANAYLYSIS

The Jazz have the best possibility of winning (0.23).
The point spread will be by about 5 points.

Outlook for the Jazz:

     *  There is a good possiblity that the game will
        be too close to call. (0.37)
     *  There is an excellent chance that the Jazz will
        win, but the game will be close. (0.66)
     *  There is a small possiblity that the Jazz will
        convincingly win. (0.06)

Outlook for the Grizzlies:
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* There is an excellent chance that the game will be too close to call. (0.62)
* There is a good possiblity that the Grizzlies will win, but the game will be close. (0.4)
* There isn't much of a chance that the Grizzlies will convincingly win. (0.0)

DETAILED ANALYSIS

The Jazz should beat the Grizzlies based on the following observations:

Jazz Winning Advantage (0.23) because:
* Jazz Away Team History Advantage
* Jazz Player Matchups Advantage

Jazz Away Team History Advantage (0.58) because:
* Jazz Winning Series Percentage

Jazz Winning Series Percentage (1.0) because:
* Jazz Series Winning Pct: 1.0

Jazz Player Matchups Advantage (0.31) because:
* Jazz Forward Offensive Advantage
* Jazz Guard Offensive Advantage

Jazz Forward Offensive Advantage (0.62) because:
* Jazz Typical Forward is an Inside Scoring Threat
* Jazz Typical Forward is an Outside Scoring Threat

Jazz Typical Forward is an Inside Scoring Threat (0.6) because:
* Jazz Typical Forward Average 3 Point Shot Taker
* Jazz Typical Forward Lethal Shooting Percentage

Jazz Typical Forward Average 3 Point Shot Taker (0.98) because:
* Typical Jazz F Average 3 Point Attempts Per Game: 0.7
* (e.g. Bryon Russell: 2.684, Chris Morris: 1.133)

Jazz Typical Forward Lethal Shooting Percentage (0.6) because:
* Typical Jazz F Field Goal Shooting Pct: 0.4
* (e.g. Karl Malone: 0.529, Adam Keefe: 0.534)

Jazz Typical Forward is an Outside Scoring Threat (0.57) because:
* Jazz Typical Forward Lethal Shooting Percentage

Jazz Guard Offensive Advantage (0.61) because:
* Jazz Typical Guard is a Key Player
* Jazz Typical Guard is an Inside Scoring Threat

Jazz Typical Guard is a Key Player (0.86) because:
* Jazz Typical Guard Sixth Man Player
* Jazz Typical Guard Plays in an Ideal Number of Games Per Season

Jazz Typical Guard Sixth Man Player (0.99) because:
* Typical Jazz G Pct of Games Started: 0.71
* (e.g. Jeff Hornacek: 1.0, John Stockton: 1.0)

Jazz Typical Guard Plays in an Ideal Number of Games Per Season (0.93) because:
* Typical Jazz G Pct of Games Played: 0.86
* (e.g. Jeff Hornacek: 0.972, John Stockton: 0.753)

Jazz Typical Guard is an Inside Scoring Threat (0.79) because:
* Jazz Typical Guard Average 3 Point Shot Taker
* Jazz Typical Guard Lethal Shooting Percentage

Jazz Typical Guard Average 3 Point Shot Taker (0.99) because:
* Typical Jazz G Average 3 Point Attempts Per Game: 1.36
* (e.g. Jeff Hornacek: 1.633, John Stockton: 1.418)

Jazz Typical Guard Lethal Shooting Percentage (0.79) because:
* Typical Jazz G Field Goal Shooting Pct: 0.47
* (e.g. John Stockton: 0.526, Jeff Hornacek: 0.482)

Recap

SUNDAY, APRIL 5
Utah 99, Vancouver 93

Karl Malone scored 11 of his 25 points in the fourth quarter as the Utah Jazz remained in the chase for the NBA's best record and perfect against the Vancouver Grizzlies with a 99-93 victory.

Jeff Hornacek added 17 points for the Jazz, who never trailed and fought off a fourth-quarter rally by the Grizzlies. Utah (56-18) is one-half game behind Seattle for first place in the Western Conference.

The Jazz also remained 1 1/2 games behind the Chicago Bulls, who have the league's best mark. Utah swept the season series from Chicago and owns the tiebreaker edge should the teams finish with identical records.

Bryant Reeves scored 30 points and Shareef Abdur-Rahim added 26 for the Grizzlies, who fell to 0-12 all-time against the Jazz and have lost six straight games overall. Vancouver (16-58) already is assured of its best record since entering the NBA three years ago.

Hornacek scored eight points and Greg Foster added seven of his nine in the first quarter as Utah grabbed a 25-23 lead. The Jazz began the second period with a 17-4 burst featuring seven points from Chris Morris, whose layup opened a 42-27 advantage with 6:37 left in the first half.

Utah shot 50 percent (10-of-20) from the field in the second quarter and held Vancouver to 35 percent (6-of-17) in building a 54-40 lead.

The teams played even through the third quarter and a 20-footer by Malone gave the Jazz an 80-64 lead with 10:56 to play. But Reeves scored seven straight points, cutting the deficit to nine points with 9:09 to go.

Utah responded with layups from Shandon Anderson and Bryon Russell to rebuild the lead to 13 points before Vancouver put together a 13-6 run, closing to 90-84 on an inside hoop from Abdur-Rahim with 3:31 remaining.

Malone scored five points down the stretch to seal the win. The Grizzlies closed to 95-91 on a dunk by Antonio Daniels with 25 seconds left, but John Stockton answered with two free throws to seal it.

Stockton had 11 points and eight assists and Morris scored nine points for the Jazz, who shot 51 percent (38-of-75) and made 21-of-33 free throws.

Lee Mayberry scored nine points and Abdur-Rahim pulled down nine rebounds for the Grizzlies, who shot 45 percent (33-of-73) and made 26-of-31 foul shots. Vancouver held a 41-39 rebounding edge.

SportsTicker

Game 16: *April 6, 1998 - Suns at Sonics*

Forecast

BRIEF ANAYLYSIS

The Sonics have the best possibility of winning (0.19).
The point spread will be by about 4 points.

Outlook for the Sonics:

* There is a good possiblity that the game will be too close to call. (0.5)
* There is a good possiblity that the Sonics will win, but the game will be close. (0.53)
* There isn't much of a chance that the Sonics will convincingly win. (0.0)

Outlook for the Suns:

* There is an excellent chance that the game will be too close to call. (0.75)
* There is a small possiblity that the Suns will win, but the game will be close. (0.26)
* There isn't much of a chance that the Suns will convincingly win. (0.0)

DETAILED ANALYSIS

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The Sonics should beat the Suns based on the following observations:


Sonics Winning Advantage (0.19) because:
  * Sonics Home Team History Advantage
  * Sonics Team Wisdom Advantage

  Sonics Home Team History Advantage (0.34) because:
    * Sonics High Home Winning Percentage

    Sonics High Home Winning Percentage (0.94) because:
      * Sonics Home Winning Pct: 0.89

  Sonics Team Wisdom Advantage (0.25) because:
    * Sonics Journeyman Advantage

    Sonics Journeyman Advantage (1.0) because:
      * Sonics Journeyman Team

      Sonics Journeyman Team (0.87) because:
        * Sonics Vin Baker's Prime Age
        * Sonics Jim McIlvaine's Prime Age

        Sonics Vin Baker's Prime Age (1.0) because:
          * Vin Baker's Age: 27.0

        Sonics Jim McIlvaine's Prime Age (0.96) because:
          * Jim McIlvaine's Age: 26.0
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Recap

MONDAY, APRIL 6
Phoenix 102, Seattle 92

Danny Manning scored 17 of his 23 points in the second half and Rex Chapman buried a pair of key baskets in the final two minutes as the Phoenix Suns snapped the Seattle SuperSonics' 12-game home winning streak with a 102-92 victory.

The Suns led by as many as 21 points in the third quarter, but Seattle opened the final period with an 11-2 spurt to pull within 80-72 with 8:37 to play. The Suns answered with seven of the next eight points, as Manning hit back-to-back layups to increase the lead to 87-71 with 6:44 remaining.

Vin Baker, who had 18 points and 12 rebounds, drained a turnaround jumper to slice it to 93-86 with 2:34 left. After Phoenix missed, Baker had a chance to cut it to five but missed a short jumper.

Chapman, who scored 15 points, made the SuperSonics pay, drilling a three-pointer with 1:55 to go. After Detlef Schrempf and Baker made back-to-back follow shots, Chapman answered with a 19-foot leaner to give Phoenix a 98-90 edge.

Jason Kidd, who had 12 points and nine assists, helped seal the win with a free throw and a three-pointer as the Suns won their fifth straight game and recorded its 12th 50-win season. Phoenix (50-25) moved within 1 1/2 games of San Antonio for fourth place in the Western Conference and homecourt advantage in the first round of the playoffs.

"This was a big win for us against the best team in the league," said Suns coach Danny Ainge. "This gives us a lot of confidence going into the playoffs."

Schrempf scored 23 points and Gary Payton added 22, but only two in the fourth quarter as Seattle had its five-game winning streak snapped. The Sonics (57-19), who suffered their first loss at KeyArena since a 106-96 setback to Boston on February 20th, fell percentage points behind Utah (56-18) for first place in the Western Conference.

Seattle, which ranks third in the league in shooting percentage, shot just 41 percent (33-of-80) and was 7-of-27 from three-point range.

"The three-point shot has brought us to where we are and we're not going to leave it," Baker said. "Our energy level wasn't there in the first half."

The Suns were in control of this contest from the early going, taking the lead for good just over two minutes into the game when Antonio McDyess dunked for an 8-7 edge. Phoenix ended the first quarter with a 9-2 spurt, capped by Chapman's free throw for a 28-20 lead.

McDyess scored all 13 of his points in the first half and dunked four times in the second quarter as the Suns steadily built the lead. One of his dunks closed a 13-5 run with 6:15 left as Phoenix opened a 43-29 advantage.

Kidd fed McDyess for an alley-oop slam to give Phoenix its largest lead of the first half, 52-34, before Baker answered with a 16-footer to make it a 16-point deficit at halftime.

"We were lucky to get the lead early on their home court and when they came back, we made the huge shots when we needed them," Kidd said.

Phoenix shot 54 percent (20-of-37) in the first half while holding Seattle to 35 percent (14-of-40). The Suns also dominated the boards, 24-12.

"We didn't play hard enough in the first half and we were forced to waste too much energy to catch up in the second," Sonics coach George Karl said. "We didn't have enough energy to push through for the win. Lately we've had a lack of energy to start the games. We need to come out in the beginning with more fire and intensity."

Manning made a pair of foul shots with 6:20 remaining in the third quarter for the Suns' biggest lead, 66-45.

Seattle trimmed the deficit to 78-61 after three quarters and Nate McMillan opened the fourth with two straight three-pointers to spark the 11-2 run. Manning responded with a bucket but Baker scored and Greg Anthony drained a three-pointer, pulling the Sonics within 80-72.

"The Suns have great outside shooters," McMillan said. "They're quick and can break down our defense. They're extremely tough to defend. They play like us and that gives us trouble."

Manning and McDyess, the Suns' starting forwards, grabbed seven rebounds apiece and combined to shoot 14-of-18 from the floor. Phoenix hit 52 percent (36-of-69) overall and owned a 42-34 edge on the glass.

SportsTicker

Game 17: *April 7, 1998 - Knicks at Hawks*

Forecast

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BRIEF ANAYLYSIS

The Hawks have the best possibility of winning (0.18).
The point spread will be by about 4 points.

Outlook for the Hawks:

     *  There is a good possiblity that the game will
        be too close to call. (0.5)
     *  There is a good possiblity that the Hawks will
        win, but the game will be close. (0.53)
     *  There isn't much of a chance that the Hawks will
        convincingly win. (0.0)

Outlook for the Knicks:

     *  There is an excellent chance that the game will
        be too close to call. (0.87)
     *  There is a small possiblity that the Knicks will
        win, but the game will be close. (0.13)
     *  There isn't much of a chance that the Knicks will
        convincingly win. (0.0)


DETAILED ANALYSIS

The Hawks should beat the Knicks based on the following observations:


Hawks Winning Advantage (0.18) because:
  * Hawks Player Matchups Advantage

  Hawks Player Matchups Advantage (0.42) because:
    * Hawks Center Offensive Advantage

    Hawks Center Offensive Advantage (0.64) because:
      * Hawks Typical Center is a Durable Player
      * Hawks Typical Center is an Inside Scoring Threat

      Hawks Typical Center is a Durable Player (0.87) because:
        * Hawks Typical Center Journeyman Experience

        Hawks Typical Center Journeyman Experience (0.97) because:
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      * Typical Hawks C Experience in NBA: 4.88
      * (e.g. Dikembe Mutombo: 6.0, Greg Anderson: 9.0)

  Hawks Typical Center is an Inside Scoring Threat (0.71) because:
    * Hawks Typical Center Average 3 Point Shot Taker
    * Hawks Typical Center Lethal Shooting Percentage

    Hawks Typical Center Average 3 Point Shot Taker (0.96) because:
      * Typical Hawks C Average 3 Point Attempts Per Game: 0.0
      * (e.g. Greg Anderson: 0.102, Dikembe Mutombo: 0.0)

    Hawks Typical Center Lethal Shooting Percentage (0.71) because:
      * Typical Hawks C Field Goal Shooting Pct: 0.44
      * (e.g. Dikembe Mutombo: 0.546, Greg Anderson: 0.444)
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Recap

TUESDAY, APRIL 7
Atlanta 92, New York 79

Dikembe Mutombo scored 17 points, grabbed 19 rebounds and blocked six shots to help the Atlanta Hawks clinch a playoff berth with a 92-79 victory over the reeling New York Knicks, who lost for the fifth time in six games.

The Hawks (45-30), who had lost five of seven previous meetings with the Knicks, clinched their sixth consecutive playoff berth. They moved within two games of Charlotte for fourth place in the Eastern Conference and homecourt advantage in the first round.

"It was a very physical game, like we anticipated," Atlanta coach Lenny Wilkens said. "The biggest thing is to keep your presence of mind and play the game and let the officials do their job.

"I thought Dikembe was just a monster defensively. He really helped us close down the inside and blocked a lot of shots. He intimidated them so they couldn't get easy looks. I was really pleased with how we played. Just because we clinched we don't pause, we keep going tomorrow and focus on our next game. That's what you have to do."

New York (41-36), which dropped its fourth straight road game, saw its lead over eighth-seeded New Jersey (39-36) shrink to one game with five to play.

Steve Smith returned from a four-game absence due to a sore right knee and scored 24 points and Alan Henderson added 20 for Atlanta, which won for the ninth time in its last 11 home games. With 17,702 fans at the Georgia Dome, the Hawks set a franchise attendance record of 648,561, surpassing the 644,291 during the 1988-89 season.

"I felt pretty good and it was good to play the Knicks, because coming off an injury you don't have time to think against a tean like that," Smith said. "You just have to go out there and play. The win tonight makes me feel better."

Allan Houston scored 24 points and Larry Johnson added 12 for New York, which was outrebounded 47-37 and dropped to 15-24 on the road.

The Knicks made just 8-of-9 free throws while the Hawks sank 29-of-44. New York shot 40 percent (33-for-82) from the field and Atlanta 44 percent (31-for-71), but the Knicks were 5-of-11 from three-point range and the Hawks just 1-of-12.

"We played hard but it's not about playing hard, you have to play well," New York coach Jeff Van Gundy said. "In some areas we played well but in areas you have to play well in to win the game, such as rebounding, we did not play well.

"We just couldn't get it done. We missed critical rebounds, and other than Allan, we struggled to put the ball in the basket. You've got to find ways to win. That's what the game is all about."

Houston scored 14 points in the first half to pull the Knicks within 41-40 at the break, and New York grabbed a 44-43 lead with 8:59 left in the third quarter after Chris Mills sank a layup.

The lead was short-lived, however, as Atlanta put together a 10-0 spurt to regain the lead for good. Henderson opened the burst with a layup at 8:16 to make it 45-44 and a pair of free throws by Mutombo capped it, moving Atlanta to a 53-44 advantage.

Henderson and Mookie Blaylock -- who hit a 60-footer on the last shot of the quarter -- each scored eight points in the period, helping the Hawks carry a 67-54 lead into the final 12 minutes.

"In the second half, for the past two weeks, when teams make runs at us, we're not as physical or as aggressive as we need to be to get a stop or make a run back at them," said Chris Childs. "Right now we're trying to get ready for the playoffs, or even make the playoffs. Coming out in the third quarter we have to muster up the energy to put teams away. Atlanta was ripe for the picking, but it just didn't happen."

After Corbin hit a drive down the baseline to give Atlanta an 80-66 lead with 6:30 remaining, New York responded with a 10-2 run. Charles Oakley had eight of his 10 points during the spurt, including a jumper at the 2:09 mark to pull New York within 82-76.

Henderson then hit a follow shot off a missed jumper by Blaylock and Mutombo rejected Johnson at the other end, leading to a pair of free throws by Smith to move the Hawks ahead 86-76 with just 1:15 left. The Knicks could only manage three free throws down the stretch.

"We wanted to clinch a playoff spot," Mutombo said. "Still, I'm just glad we were able to come up with this win. I felt that I could come out and contribute offensively. I wanted to play smart, stay focused and win the game."

SportsTicker

Game 18: *April 9, 1998 - Sonics at Mavericks*

Forecast

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BRIEF ANAYLYSIS

The Sonics have the best possibility of winning (0.22).
The point spread will be by about 5 points.

Outlook for the Sonics:

     *  There is a good possiblity that the game will
        be too close to call. (0.37)
     *  There is an excellent chance that the Sonics will
        win, but the game will be close. (0.66)
     *  There is a small possiblity that the Sonics will
        convincingly win. (0.06)

Outlook for the Mavericks:

     *  There is an excellent chance that the game will
        be too close to call. (0.75)
     *  There is a small possiblity that the Mavericks will
        win, but the game will be close. (0.26)
     *  There isn't much of a chance that the Mavericks will
        convincingly win. (0.0)


DETAILED ANALYSIS

The Sonics should beat the Mavericks based on the following observations:


Sonics Winning Advantage (0.22) because:
  * Sonics Player Matchups Advantage

  Sonics Player Matchups Advantage (0.33) because:
    * Sonics Forward Offensive Advantage
    * Sonics Center Defensive Advantage

    Sonics Forward Offensive Advantage (0.51) because:
      * Sonics Typical Forward is an Inside Scoring Threat
      * Sonics Typical Forward is an All Around Shooter

      Sonics Typical Forward is an Inside Scoring Threat (0.82) because:
        * Sonics Typical Forward Average 3 Point Shot Taker
        * Sonics Typical Forward Lethal Shooting Percentage

        Sonics Typical Forward Average 3 Point Shot Taker (0.99) because:
          * Typical Sonics F Average 3 Point Attempts Per Game: 1.15
          * (e.g. Detlef Schrempf: 1.861, Sam Perkins: 2.64)

        Sonics Typical Forward Lethal Shooting Percentage (0.82) because:
          * Typical Sonics F Field Goal Shooting Pct: 0.47
          * (e.g. Vin Baker: 0.547, Detlef Schrempf: 0.487)

      Sonics Typical Forward is an All Around Shooter (0.75) because:
        * Sonics Typical Forward Solid Shooting Percentage

        Sonics Typical Forward Solid Shooting Percentage (0.98) because:
          * Typical Sonics F Field Goal Shooting Pct: 0.47
          * (e.g. Vin Baker: 0.547, Detlef Schrempf: 0.487)
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Sonics Center Defensive Advantage (0.45) because:
  * Sonics Typical Center is a Big Player

  Sonics Typical Center is a Big Player (0.6) because:
    * Sonics Typical Center Towering

    Sonics Typical Center Towering (0.63) because:
      * Typical Sonics C Height: 83.27
      * (e.g. Jim McIlvaine: 85.0, Aaron Williams: 81.0)
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Recap

THURSDAY, APRIL 9
Seattle 103, Dallas 101

Gary Payton had 28 points and 10 assists as the Seattle SuperSonics erased a 13-point deficit and held on for a 103-101 victory over the Dallas Mavericks.

Detlef Schrempf added 22 points, 11 rebounds and seven assists for the Sonics, who won for the sixth time in their last seven games and climbed back within one-half game of Utah for the top spot in the Western Conference. They also increased their lead in the Pacific Division over the Los Angeles Lakers to 1 1/2 games.

Coach George Karl earned his 500th win, becoming the seventh-fastest coach to amass that many victories. He is in his 10th season and sixth with Seattle.

Michael Finley scored 27 points, but missed a potential game-winning three-point attempt as time expired. A.C. Green grabbed a season-high 18 rebounds for the Mavericks, who despite the loss managed to split the season series with the NBA's third-best team.

"Every year you have one team that plays the style, has your number, or had the confidence to play against another team," Karl said. "This team has confidence against us, they've shown it and we are fortunate to be 2-2."

Dallas was within 87-83 with 6:10 left after a bucket by Erick Strickland, who had 12 of his 14 points in the fourth quarter. But then Seattle heated up from three-point range. Payton buried a three-pointer with 5:52 remaining, and after another basket by Strickland, Hersey Hawkins and Schrempf drilled back-to-back shots from behind the arc to give the Sonics their largest lead at 96-85 with 4:26 to play.

Seattle was still up 11 after Dale Ellis' basket with 2:48 to go. But the Mavericks stormed back with the next nine points, highlighted by Finley's three-point play with 1:47 left. Strickland followed that with a runner to bring Dallas within 100-98 with 91 seconds to go, but Ellis hit a back-breaking three-pointer 15 seconds later.

"They played a soft trap and we weren't aggressive," Schrempf said. "We turned the ball over and took some bad shots. We still have a ways to go."

Shawn Bradley's tip-in and a free throw by Green cut the deficit to 103-101 with 43 seconds remaining. Dallas forced Seattle into a shot-clock violation and got the ball back, but Finley missed a three-pointer from the wing at the buzzer.

"Somehow we hung around and stayed in the game and actually had a chance to win it with a three at the end," Dallas coach Don Nelson said. "They (Seattle) approached it very seriously, where I didn't think they did last time they were in here. Tonight they were very serious and we took them right to the wire. It was one whale of a ballgame. Our best player shooting the shot we're looking for to win the game, I'll take that every time."

Dallas led by six points after one quarter and had its largest lead at 38-25 early in the second period. But the Sonics outscored the Mavericks, 27-10, over the next eight-plus minutes behind eight points apiece from Payton and Vin Baker. Payton, who had 16 points in the first half, had a layup with 16 seconds remaining in the period to give Seattle a 52-48 lead.

Late in the third quarter, Dallas used a 12-5 spurt to turn a 65-65 tie into a 77-70 advantage after a pair of free throws by Strickland later in the period.

Ellis finished with 11 of his 16 points in the fourth quarter for the Sonics, who shot 48 percent (42-of-88) from the field and were 10-of-28 (36 percent) from three-point range.

Hubert Davis had 16 points and Bradley had 14 for the Mavericks, who shot 46 percent (35-of-76) and were 28-of-32 (87.5 percent) from the foul line. But they once again lost rookie Chris Anstey to injury. Anstey re-injured his thumb and needed X-rays, though he does not believe it is broken.

SportsTicker

Game 19: *April 10, 1998 - Heat at Raptors*

Forecast

BRIEF ANAYLYSIS

The Heat have the best possibility of winning (0.24).
The point spread will be by about 5 points.

Outlook for the Heat:

- There is a good possiblity that the game will be too close to call. (0.37)
- There is an excellent chance that the Heat will win, but the game will be close. (0.66)
- There is a small possiblity that the Heat will convincingly win. (0.06)

Outlook for the Raptors:

- There is an excellent chance that the game will be too close to call. (0.62)
- There is a good possiblity that the Raptors will win, but the game will be close. (0.4)
- There isn't much of a chance that the Raptors will convincingly win. (0.0)

DETAILED ANALYSIS

The Heat should beat the Raptors based on the following observations:

Heat Winning Advantage (0.24) because:
* Heat Away Team History Advantage
* Heat Player Matchups Advantage

Heat Away Team History Advantage (0.47) because:
* Heat Winning Series Percentage

Heat Winning Series Percentage (1.0) because:
* Heat Series Winning Pct: 1.0

Heat Player Matchups Advantage (0.42) because:
* Heat Center Defensive Advantage
* Heat Center Offensive Advantage

Heat Center Defensive Advantage (0.89) because:
* Heat Typical Center is a Durable Player
* Heat Typical Center is a Big Player

Heat Typical Center is a Durable Player (0.68) because:
* Heat Typical Center Sixth Man Player
* Heat Typical Center Journeyman Experience

Heat Typical Center Sixth Man Player (0.98) because:
* Typical Heat C Pct of Games Started: 0.76
* (e.g. Alonzo Mourning: 0.962, Duane Causwell: 0.057)

Heat Typical Center Journeyman Experience (0.95) because:
* Typical Heat C Experience in NBA: 5.42
* (e.g. Alonzo Mourning: 5.0, Duane Causwell: 7.0)

Heat Typical Center is a Big Player (0.57) because:
* Heat Typical Center Hefty
* Heat Typical Center Towering

Heat Typical Center Hefty (0.68) because:
* Typical Heat C Weight: 256.49
* (e.g. Alonzo Mourning: 261.0, Duane Causwell: 240.0)

Heat Typical Center Towering (0.57) because:
* Typical Heat C Height: 82.42
* (e.g. Alonzo Mourning: 82.0, Duane Causwell: 84.0)

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Heat Center Offensive Advantage (0.76) because:
  * Heat Typical Center is an Inside Scoring Threat
  * Heat Typical Center is a Durable Player

  Heat Typical Center is an Inside Scoring Threat (0.93) because:
    * Heat Typical Center Average 3 Point Shot Taker
    * Heat Typical Center Lethal Shooting Percentage

    Heat Typical Center Average 3 Point Shot Taker (0.96) because:
      * Typical Heat C Average 3 Point Attempts Per Game: 0.0
      * (e.g. Duane Causwell: 0.0, Alonzo Mourning: 0.0)

    Heat Typical Center Lethal Shooting Percentage (0.93) because:
      * Typical Heat C Field Goal Shooting Pct: 0.51
      * (e.g. Alonzo Mourning: 0.554, Duane Causwell: 0.387)

  Heat Typical Center is a Durable Player (0.68) because:
    * Heat Typical Center Sixth Man Player
    * Heat Typical Center Journeyman Experience
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Recap

FRIDAY, APRIL 10
Miami 111, Toronto 105

Tim Hardaway scored 28 points, Voshon Lenard added 24 and each hit a three-pointer in overtime to lead the Miami Heat to a 111-105 victory over the Toronto Raptors, who set a franchise record for losses in a season.

Alonzo Mourning added 23 points before fouling out and exchanging shoves with John Wallace in overtime for the Heat, who bounced back from consecutive losses and swept the season series with Toronto for the first time. The Heat climbed back within one-half game of Indiana for the second-best record in the Eastern Conference.

"It was a good win, and a win is a win," Hardaway said. "That's all that counts. We have to get ourselves right. We're not playing on defense, we're thinking. We just have to play. We did it at times tonight and we didn't."

Doug Christie scored 26 points for the Raptors, who may have had hope when the game went to overtime before suffering their 12th straight loss. Toronto had a five-game overtime winning streak snapped and all of its four wins since the All-Star break have come in overtime.

The Raptors fell to 15-62. They went 21-61 in their inaugural campaign of 1995-96 and 30-52 last season.

"We didn't get it done," Toronto coach Butch Carter said. "When you are playing the good teams, everybody has got to do their jobs. The guys had good energy and went after them. Our inexperience showed in the last seven minutes. Players should take more responsibility for the losses, as they will be rewarded for the wins. The bottom line, someday soon we have to get something done."

Miami, which erased a seven-point deficit in the final 3 1/2 minutes of regulation, scored the first five points of overtime. P.J. Brown hit a free throw to open the extra session, and after a miss by Wallace, Hardaway buried a three-pointer for a 102-98 lead with 4:06 to go.

A free throw by Mourning gave the Heat a 103-98 advantage, but on the next possession he fouled Wallace, who appeared to say something to Mourning. The two shoved each other before Mourning lunged at Wallace. However, he was restrained by female referee Violet Palmer.

Wallace sank both free throws to bring Toronto within three points with 2:36 left, but Lenard drilled a three-pointer 23 seconds later to make it 106-100. The Raptors cut it to three once more, but Marty Conlon hit four free throws in the final 34 seconds to keep Miami safely ahead.

Christie had 17 points in the first half, helping the Raptors to a 55-48 lead. Toronto's lead was still seven after Dee Brown's dunk with 3:53 remaining in regulation. But after baskets by P.J. Brown and Eric Murdock, Hardaway hit consecutive jumpers to give Miami a 95-94 lead with 1:26 to go.

"Tonight it took some gut play to get back in it," Mourning said. "There were calls that weren't going our way and we had to get by some obstacles. The playoffs are around the corner and this type of play isn't going to get it done."

A pair of free throws by Christie put Toronto back on top, but Lenard nailed a three-pointer for a two-point advantage with 52 seconds to play. Oliver Miller's layup tied it at 98-98 just 17 seconds later and the Raptors missed a chance for the win when Dee Brown missed a 20-footer at the buzzer.

Hardaway handed out 12 assists and P.J. Brown collected 10 points and 10 boards for the Heat, who shot 41.5 percent (39-of-94) from the field. Conlon had seven points and seven boards in 11 minutes for Miami, which was a dismal 25-of-42 from the foul line.

Wallace had 19 points off the bench and Miller and Dee Brown and Miller had 13 apiece for the Raptors, who shot 46 percent (39-of-84). Tracy McGrady added 12 points and a season-high 15 rebounds.

Game 20: *April 14, 1998 - Grizzlies at Sonics*

Forecast

BRIEF ANAYLYSIS

The Sonics have the best possibility of winning (0.31).
The point spread will be by about 6 points.

Outlook for the Sonics:

* There is a small possiblity that the game will be too close to call. (0.25)
* There is an excellent chance that the Sonics will win, but the game will be close. (0.8)
* There is a small possiblity that the Sonics will convincingly win. (0.12)

Outlook for the Grizzlies:

* There is an excellent chance that the game will be too close to call. (0.62)
* There is a good possiblity that the Grizzlies will win, but the game will be close. (0.4)
* There isn't much of a chance that the Grizzlies will convincingly win. (0.0)

DETAILED ANALYSIS

The Sonics should beat the Grizzlies based on the following observations:

Sonics Winning Advantage (0.31) because:
* Sonics Home Team History Advantage
* Sonics Player Matchups Advantage

Sonics Home Team History Advantage (0.61) because:
* Sonics Winning Series Percentage
* Sonics High Home Winning Percentage

Sonics Winning Series Percentage (1.0) because:
* Sonics Series Winning Pct: 1.0

Sonics High Home Winning Percentage (0.93) because:
* Sonics Home Winning Pct: 0.87

Sonics Player Matchups Advantage (0.41) because:
* Sonics Forward Offensive Advantage
* Sonics Guard Offensive Advantage

Sonics Forward Offensive Advantage (0.87) because:
* Sonics Typical Forward is an Inside Scoring Threat
* Sonics Typical Forward is an All Around Shooter

Sonics Typical Forward is an Inside Scoring Threat (0.82) because:
* Sonics Typical Forward Average 3 Point Shot Taker
* Sonics Typical Forward Lethal Shooting Percentage

Sonics Typical Forward Average 3 Point Shot Taker (0.99) because:
* Typical Sonics F Average 3 Point Attempts Per Game: 1.17
* (e.g. Detlef Schrempf: 1.88, Sam Perkins: 2.705)

Sonics Typical Forward Lethal Shooting Percentage (0.82) because:
* Typical Sonics F Field Goal Shooting Pct: 0.47
* (e.g. Vin Baker: 0.546, Detlef Schrempf: 0.487)

Sonics Typical Forward is an All Around Shooter (0.75) because:
* Sonics Typical Forward Solid Shooting Percentage

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      Sonics Typical Forward Solid Shooting Percentage (0.98) because:
        * Typical Sonics F Field Goal Shooting Pct: 0.47
        * (e.g. Vin Baker: 0.546, Detlef Schrempf: 0.487)

  Sonics Guard Offensive Advantage (0.54) because:
    * Sonics Typical Guard is an All Around Shooter
    * Sonics Typical Guard is a Key Player

    Sonics Typical Guard is an All Around Shooter (0.76) because:
      * Sonics Typical Guard Solid 3 Point Shooting Percentage
      * Sonics Typical Guard Solid Shooting Percentage

      Sonics Typical Guard Solid 3 Point Shooting Percentage (1.0) because:
        * Typical Sonics G 3 Point Shooting Pct: 0.36
        * (e.g. Hersey Hawkins: 0.419, Gary Payton: 0.343)

      Sonics Typical Guard Solid Shooting Percentage (0.95) because:
        * Typical Sonics G Field Goal Shooting Pct: 0.4
        * (e.g. Gary Payton: 0.448, Hersey Hawkins: 0.444)

    Sonics Typical Guard is a Key Player (0.71) because:
      * Sonics Typical Guard Veteran Experience
      * Sonics Typical Guard Plays in an Ideal Number of Games Per Season

      Sonics Typical Guard Veteran Experience (0.88) because:
        * Typical Sonics G Experience in NBA: 8.86
        * (e.g. Dale Ellis: 14.0, Hersey Hawkins: 9.0)

      Sonics Typical Guard Plays in an Ideal Number of Games Per Season (0.85) because:
        * Typical Sonics G Pct of Games Played: 0.79
        * (e.g. Gary Payton: 1.0, Hersey Hawkins: 1.0)
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Recap

TUESDAY, APRIL 14
Seattle 110, Vancouver 98

Hersey Hawkins scored 12 of his 15 points in the third quarter as the Seattle SuperSonics kept pace in the Western Conference with their 60th win, a 110-98 victory over the Vancouver Grizzlies.

Gary Payton scored 17 of his 27 points in the first quarter for the SuperSonics (60-20), who have won 60 games in three of the last five seasons. Seattle remained one game ahead of the Los Angeles Lakers (59-21) in the Pacific Division and one-half game behind the Utah Jazz (60-19) in the race for best record in the Western Conference.

"Any 60-win season is a great accomplishment and this is our third year," Seattle coach George Karl said. "Some guys might be accepting them as commonplace, but when I first started coaching, I never thought I'd win 60 games. It's a tremendous marathon race to keep your mental confidence and concentration. It's much more mental than physical."

"Sixty wins is pretty big for me," said Sonics forward Vin Baker, who played his first four seasons with the Milwaukee Bucks and never made the playoffs. "George said congratulations to those who haven't gotten 60 wins before. I said 'you could have said that for 40 wins for me'."

For the second straight game, Hawkins took control in the third quarter. He scored six straight points in a 12-0 run that gave the Sonics the lead for good, then added three-pointers on consecutive possessions. On Sunday, Hawkins scored 16 of his 20 points in 5 1/2 minutes of the third period.

"I don't know what it is about the third quarter lately," said Hawkins. "I've been able to come out and get some shots and hit some shots. There weren't any special plays for me tonight. I was just in the flow of the game."

Tony Massenburg scored a season-high 22 points for Vancouver, which fell to 0-6 all-time at KeyArena and 1-11 against Seattle. The Grizzlies dropped to 4-35 on the road.

"Quite honestly, they were giving us a lot of chances to win," Grizzlies coach Brian Hill said. "We were careless with the basketball against their double-teams. We had some defensive breakdowns with rotations that hurt us real bad in the third quarter."

Seattle built a 55-50 halftime lead behind Payton, but Vancouver opened the third quarter with an 8-2 run, taking a 58-57 lead with 9:37 left on a three-point play by Shareef Abdur-Rahim, who scored 18 points.

But Baker dunked to trigger the decisive run. Hawkins had a technical foul shot, a layup and a three-point play in a span of 67 seconds to boost the lead to seven points before a jumper by Detlef Schrempf and a layup by Baker made it 69-58 with 6:17 left.

On Seattle's next two possessions, Hawkins answered Vancouver scores with three-pointers, widening the gap to 75-62 with 4:25 remaining.

"We got back into the game and things fell apart for us," said Grizzlies guard Blue Edwards. "A lot of it was our inability to show patience on the offensive end. We played right into their hands."

The SuperSonics led 85-70 after three quarters and opened their largest lead at 93-73 on a basket by David Wingate with 9:12 to play. The Grizzlies, who again played without injured center Bryant Reeves, got no closer than the final margin.

"We just didn't execute down the stretch and without Country (Reeves), it was tough," Abdur-Rahim said. "They just had us tonight."

Baker had 18 points and nine rebounds, Jerome Kersey scored 14 points and Sam Perkins added 12 for the Sonics, who shot 49.5 percent (45-of-91) and forced 24 turnovers. Seattle was 8-of-17 from three-point range.

Antonio Daniels scored 15 points and George Lynch added 14 for the Grizzlies, who shot 46 percent (32-of-70), but just 2-of-8 from behind the arc. Vancouver made 32-of-42 free throws and battled Seattle to a 41-41 stalemate on the glass.

Payton came out on fire. Working against Lee Mayberry, he had 17 points in the first quarter as Seattle shot 73 percent and opened a 36-30 lead. Payton, who shot 10-of-14 in the first half, added six more points in the second period.

"He was lively," Karl said. "He was penetrating the ball and running up and down the court. Some of the other guys didn't have as much life as he did. Gary kept us in the game. In fact, that was as active and as quick as I have seen him in a long time."

"Coach Karl sat me down about a week ago and told me he wants me to be more aggressive," Payton said. "That's what it takes, playing wild and crazy. I've got to be aggressive, and not worrying about going in there and trying to make passes. When I'm more aggressive, I can get more guys into the game."

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