Chosen prompt: Develop a new method or tool for evaluation of defensive performance in the NBA

Theoretical Underpinnings: One of the most important things for an NBA defender is to prevent dribble penetration so a very natural measure for the efficacy of the defense of an NBA defender is the distance an offensive player is allowed to travel towards the hoop while the NBA defender was serving as the primary defender. We can further extend this by indexing the distances from the hoop according to an expected value from a shot at each distance from the hoop.

This requires us to answer two questions:

1) How can we model the expected value of a shot from a given distance from the hoop? Can we include closest defender distance in this metric?

2) How much distance did a given NBA defender give up when serving as the primary defender?

**Modeling the expected value**

1st Objective: Develop a mathematical model for the expected value of a shot from each distance from the basket

Things to consider: shot distance, closest defender distance

Common knowledge (as a defender):

- The closer I am, the better

- Midrange shots are good

- 3 pointers and layups are dangerous

Model Assumptions:

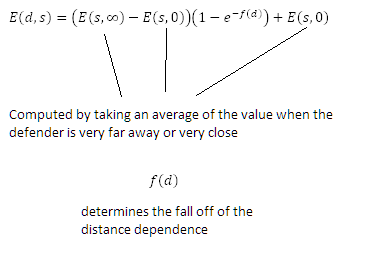
- exponential drop off of defender’s impact with distance

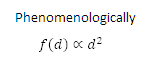
- 1 foot of separation vs 2 feet of separation is pretty different

- 21 feet vs 22 feet of separation is not that different

- expected value decays from the expected value of totally guarded (closest defender is 0 feet away) to totally unguarded (closest defender is infinite distance away)

Introducing an ansatz:





We used the dataset Hackathon\_sv\_shot\_summary\_2014-2015.txt and did as follows:

Consider a bin of size dx for shot distance and of size dy for defender distance

As x varies from 0 to maximum shot distance:

As y varies from 0 to maximum defender distance:

Consider shots taken at distance x and x+dx and defenders at distance y and y+dy

Gradient=Number of points scored from this situation divided by total number of shots taken from this situation

Gradient represents the average number of points scored from a situation. It is calculated for all possible situations.

We consider the expected value when defender distance 0 and the expected value when the defender distance goes to infinity. These serve as our boundary conditions.

After some empirical fitting, we obtain a working model that roughly agrees with intuition.

Predictions:

Predictions of Model

|  |  |  |
| --- | --- | --- |
| **Shot Distance** | **Defender Distance** | **Expected Value** |
| 1 foot | 1 foot | 1.16 points |
| 1 foot | 3 feet | 1.83 points |
| 7 feet | 1 foot | 0.788 points |
| 7 feet | 3 feet | 0.957 points |
| 22 feet | 1 foot | 0.878 points |
| 22 feet | 3 feet | 1.23 points |

Possible Next Steps for existing model:

Analytically fit the exponential function and eliminate free parameters.

Determine a curve for unguarded shots that can be represented mathematically.

**Figuring out the amount of distance given up**

2nd Objective: Calculate how much distance an NBA defender gave up

Data set used: Raw playoff possessions data set used

Methodology:

1. Track position of the ball handler and the ball, based on the x, y, coordinates found in the raw playoff data. We then used the position data to help determine the offensive player with the ball, and used the shot clock to determine when to start calculating our Defensive rankings. We went further and determined the distance the player with the ball was from the hoop, and his nearest defender and gave this a particular expected value based on the generated model. In the next frame, we reevaluate where the offensive ball carrier is and/or where the new ball carrier is, and determine the distance from the hoop again, nearest defender, and a new expected value for the positioning of the offensive player and the nearest defender.
2. Identify primary defender at the beginning of this position, and attribute the penetration to the primary defender.
3. Determine what happens to the ball
   1. If a pass occurs, identify new primary defender and ball handler and repeat steps 1 and 2
   2. If a change of possession occurs, move on to examining the next possession
4. Compare the expected value of the initial position of the ball handler to the expected value at the final position of the ball handler
5. If the change in expected value is positive, our defensive player has played poor defense. Else, our defensive player has played good defense