**Enhancing NBA True Shot Charts: A Probabilistic Spatial Approach to Rebounding and Possession Value**

Basketball

Paper ID

**1. Introduction**

What happens when a shot misses? Ideally, a foul is drawn, sending the shooter to the free-throw line. If not, the ball becomes contested, presenting teams with a strategic dilemma: crash the boards or retreat on defense? Traditional shot charts, focusing solely on made baskets, fail to capture these crucial dynamics.

Recent advancements introduced true shot charts, incorporating expected free throw value and revealing an overvaluation of three-point shots in 'make-only' models [1]. Building on this progress, our paper introduces a probabilistic spatial rebounding model to propose a novel metric: Rebound Percentage Above Expected (RB% AE). This metric extends continuous true shot charting, providing additional game state context and offering a more comprehensive view of shot value in basketball analytics.

**2. Data & Methods**

This research is based center of mass tracking from a 10 game sample of the 2023-24 NBA season.

This research leverages two core techniques: Voroni diagrams and rebounds hexmaps [2, 3, 4]. First, hexmap distributions of rebound locations are generated for all standard shot regions (left corner three, right elbow two, etc.). Next, Voroni cell diagrams are created for the players on the court at shot time to assess their ‘real estate’ coverage. Finally, we overlay the coverage polygons with the rebound hexmaps to project a rebound probability for each player, and thus each team. When aggreated, a player’s actual rebounds are compared to his projections to create the RB% AE metric.

Once these projections have been created, we augment the average points per possession (PPP) for shots following an offensive rebound, and add that to the expected free throw value given the foul rate for the shot location. This final augmented PPP is used to create the updated continous true shot charts.

A screenshot of a game

Description automatically generated

The figure above illustrates the overlay of spatial plots for an individual shot attempt.

**3. Results**

The core model showed strong predictive ability, demonstrating a Brier score of 0.0767 and an area under ROC curve of .98. Remaining gaps could be slimmed by incorporating player biometrics or rebounding skills into the Voroni cell plot process.

The spatial nature of the model also restricts against the risk of overfitting with such a small sample. Additionally, when compared to traditional points produced and the free throw augmented true points produced, our ‘true impact’ points produced metric shows greater sensitivity to the dataset, as there are many more miss example in which no fould occurs.

A screenshot of a graph

Description automatically generated

The figure above shows the continuos shot chart styles of each model. Red indicates higher expected value.

**4. Conclusion**

This research presents a novel and powerful rebounding metric whilst supporting the overall conclusion that midrange shots are potentially undervalued in the modern game when you consider the secondary outcomes generated by missed shots. It does, however, suggest less value from these location than when you look at only free throw expected value, indicating the complex and dynamic role rebounding plays in impacting points.

**References**

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