Analysing Basketball Shots with Graph Embeddings

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1 Introduction

In recent years, methods to quantify shot-making in basketball and specifically in the NBA evolved from passive statistics to sophisticated models incorporating many features to educate players and coaches about their decisions. Shot-making depends on multiple features, those incorporating the probability that a shot is made, given some specific situation, as well as how many points a specific shot will add to the scoreboard. In this work, we focus mainly on the probability that a shot is made, which is stated as expected shot quality (ESQ) in recent literature. An intuitive way to assign an ESQ value is to run statistics on the players' shots taken and made over the spatial area of the basketball field. This results in spatial shot maps that visualize the probability of making a field goal concerning the spatial distribution of the shots. With the emergence of Tracking data, methods incorporate features like closest defender, shot creation type, recent shooting performance and many more to account for an expectation of making the shot. Those features generally lead to a better predictor than spatial statistics. Lately, graph neural networks reached SOTA results in many fields, including autonomous driving, quantum chemistry, biology and many more, where properties could be presented in a graph structure. This can be beneficial for ESQ calculation and will be explored in the following.

2 Methodology and Results

Spatio-temporal tracking data of team sports can be represented as a graph with a spatial and temporal component. The players and ball coordinates for every time frame can be connected in a spatial domain, while the different time frames can be connected in a temporal domain. This definition defines a spatio-temporal graph that can be passed through a graph neural network (GNN). We train the GNN with SportsVU NBA data from the season 2016. We use up to ten time frames scaled exponentially into the past, while the last time frame is where the shooter throws the ball (without the ball leaving the hand of the shooter). The best results are given by a model trained with the Brier-loss wrt.

calibration of the GNN (as in general neural networks and especially GNNs are not well calibrated). The main advantage of using a GNN over other methods like logistic regression, GBM or Tree models is that we can analyze the embeddings of the GNN. We averaged the embeddings of every players shot by

$$h_p = \frac{1}{|H_p|} \sum_{i \in H_p} h_i \tag{1}$$

where h_p are the player embeddings and H_p is the set of shots a specific player attempted. This enables us to analyse how similar shot dicision making is for all the players in the NBA and compare them by distance (see Fig.1 left). Furthermore, we can find similar plays by searching the embedding space for closest neighbours (Fig.1 mid). Additionally, the GNN can add semantics to the different plays by visualizing the attention mechanism incorporated in the model to imagine the focus of the GNN (Fig.1 right). This can be a method to highlight specific situations or positioning that is essential for making the shot (pick and roll, kick-out passes and many more).

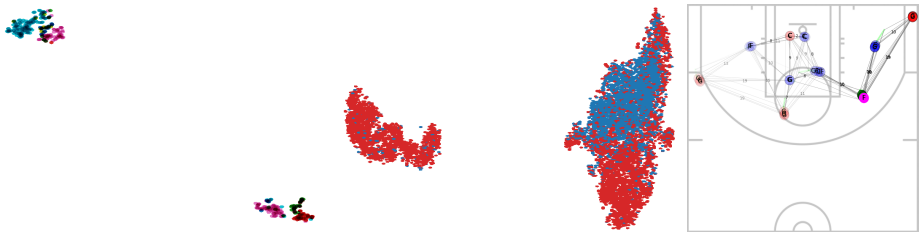

Fig. 1: Left to right: T-SNE of player embeddings, colors are displaying the position (G,C,F, G-F, C-F) of the player. T-SNE of shot embeddings, color indicate if it was a three point (blue) shot or two point shot (red). Exemplary visualization of attention mechanism for a shot.

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