Basketball Analytics Pipeline – An Offensive Analysis

Undergraduates: Anshul Shah (as817@duke.edu), Jack Lichtenstein (jsl61@duke.edu), Will Schmidt (wrs18@duke.edu)
Project Leads: Fan Bu and Dr. Alexander Volfovsky
Duke University Data+

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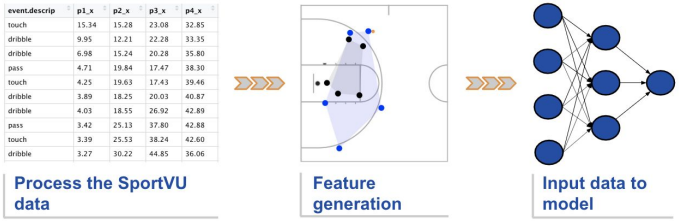
Introduction

A quick glance at a basketball box score can give someone a brief summary of what took place in a given game. However, the box score is a rather "empty" sample of descriptive statistics. There are countless actions that take place during a basketball game that are not visible on the simple box score. Motivated by this disparity between the box score and on-court action, our project seeks deeper insights into shooting and floor spacing to evaluate offensive efficiency using 2014-15 Duke Men's Basketball player-tracking data from SportVU.

Objectives

Expected Points per Shot (ePPS): the likelihood of a shot being made multiplied by the shot's value

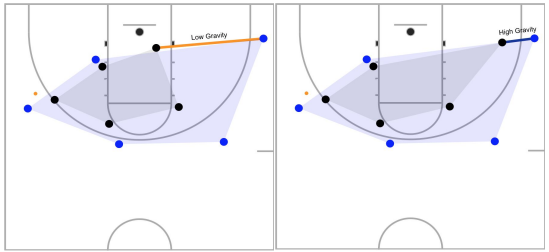
- Features: shot distance, distance and angle to to nearest defender, velocity while shooting, time on the shot clock, etc.
- Fit models to output the probability of a made shot



event.descrip	p1_x	p2_x	p3_x	p4_x
touch	15.34	15.28	23.08	32.85
dribble	9.95	12.21	22.28	33.35
dribble	6.98	15.24	20.28	35.80
pass	4.71	19.84	17.47	38.30
touch	4.25	19.63	17.43	39.46
dribble	3.89	18.25	20.03	40.87
dribble	4.03	18.55	26.92	42.89
pass	3.42	25.13	37.80	42.88
touch	3.39	25.53	38.24	42.60
dribble	3.27	30.22	44.85	36.06

Off-Ball Gravity Score: the amount of attention defenses must give toward a certain offensive player - in this way, defenders may be pulled toward offensive players, thus the notion of "gravity"

- Quantify how much "attention" the defense must pay to an off-ball offensive player
- Develop off-ball gravity scores for players in different zones on the court

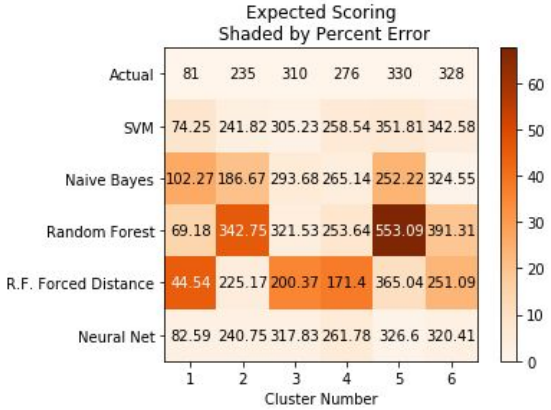


Predicting Shooting Outcomes

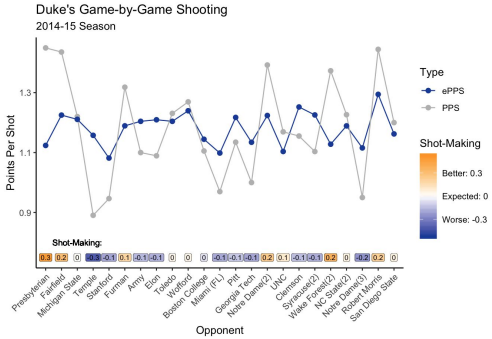
Methods:

Experiment with algorithms such as Random Forests, Neural Networks, and Support Vector Machines

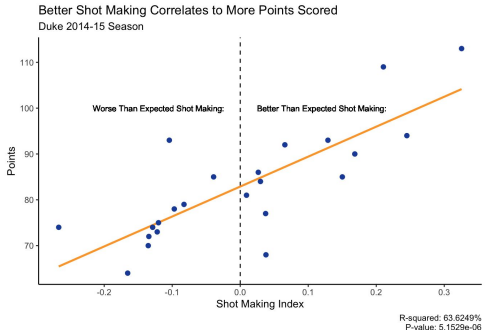
- To evaluate ePPS, shots were clustered to produce sets of similar shots e.g. corner three-point shots, layups, long two-point shots, etc.
- Expected points found by summing products of shot probability and shot values



Interpretation:



Duke generated roughly the same *quality* of looks game-to-game (their ePPS was rather consistent). The difference between actual points per shot (PPS) and ePPS reveals another insight into Duke's shooting: their ability to *make* shots. If Duke's PPS is greater than ePPS, then the team converted on more shots than expected, indicating higher shot *making* ability. We call this new value (the difference between PPS and ePPS) the shot making index (SMI). We explore the relationship between SMI and points scored. There is a strong positive correlation between SMI and points scored, with larger values of SMI (indicating better than expected shot making) correlating to scoring more points (which contributes to winning).

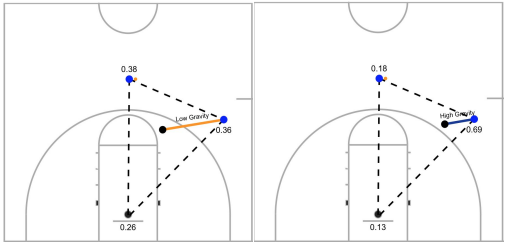


Measuring a Player's Off-Ball "Gravity"

Methods:

To find off-ball gravity score for Player A:

- Draw a triangle connecting vertices at the basket, ball and Player A
- Calculate the barycentric coordinates[2] of Player A's primary defender inside this triangle - the value of Player A's vertex is his gravity score



$$P_x = W_{v1}X_{v1} + W_{v2}X_{v2} + W_{v3}X_{v3}$$
$$P_y = W_{v1}Y_{v1} + W_{v2}Y_{v2} + W_{v3}Y_{v3}$$
$$W_{v1} + W_{v2} + W_{v3} = 1$$

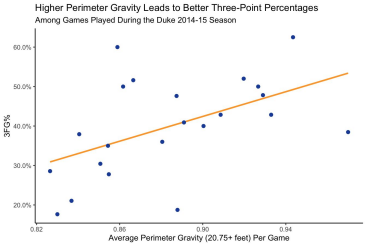
*where P_x, P_y are defender's coordinates

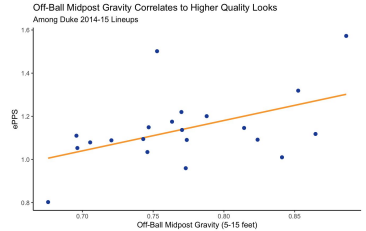
Gravity is *contextual* - it changes based on the location of the offensive player on the court as well as the relative locations of the ball and basket

- Scale this value by the distance from the ball and basket to help provide context

Findings:

Off-ball perimeter gravity correlates with better three-point shooting both on an individual and team level. In combining our results from the shot predicting model and gravity measurements, we find that off-ball midpost gravity correlates to higher quality shot attempts (ePPS) among five-man lineups that shot a minimum of nine field goal attempts in the half-court.





Player Gravity Rankings:

Duke's 2014-15 Off-Ball Perimeter Gravity

Player	Games	Position	Perimeter Gravity	Frames/Game
Guards/Wings				
Quinn Cook	22	G	0.93	347
Tyus Jones	22	G	0.91	284
Justise Winslow	22	F	0.89	244
Matt Jones	22	G	0.86	229
Rasheed Sulaimon	13	G	0.94	187
Grayson Allen	21	G	0.92	110
Bigs				
Amile Jefferson	22	F	0.87	72
Jahlil Okafor	21	C	0.92	2[illegible]
Marshall Plumlee	22	C	0.86	2[illegible]

Note:
Perimeter defined as area behind three-point line
[1] One frame roughly equal to one second of game time

Duke's 2014-15 Off-Ball Midpost Gravity

Player	Games	Position	Midpost Gravity	Frames/Game
Bigs				
Jahlil Okafor	21	C	0.81	340
Amile Jefferson	22	F	0.76	170
Marshall Plumlee	22	C	0.71	130
Guards/Wings				
Justise Winslow	22	F	0.85	4[illegible]
Matt Jones	22	G	0.84	3[illegible]
Quinn Cook	22	G	0.84	2[illegible]
Tyus Jones	22	G	0.77	2[illegible]
Rasheed Sulaimon	13	G	0.82	2[illegible]
Grayson Allen	21	G	0.81	1[illegible]

Note:
Midpost defined as area 5-15 feet from basket
[1] One frame roughly equal to one second of game time

[1] Pelton, Kevin. "Explaining 'gravity' in Basketball." ESPN.com, October 22, 2014. https://www.espn.com/nba/story/_/id/11744634.
[2] Van Winkle, Lewis. "Interpolating in a Triangle." Blog. *Code Plea* (blog), November 30, 2016. https://codeplea.com/triangular-interpolation.