# Three Point Shooting: What works?

Bradley A. Sliz

# Basketball Basics

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- 2 teams


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- 2 teams
- 5 players per team


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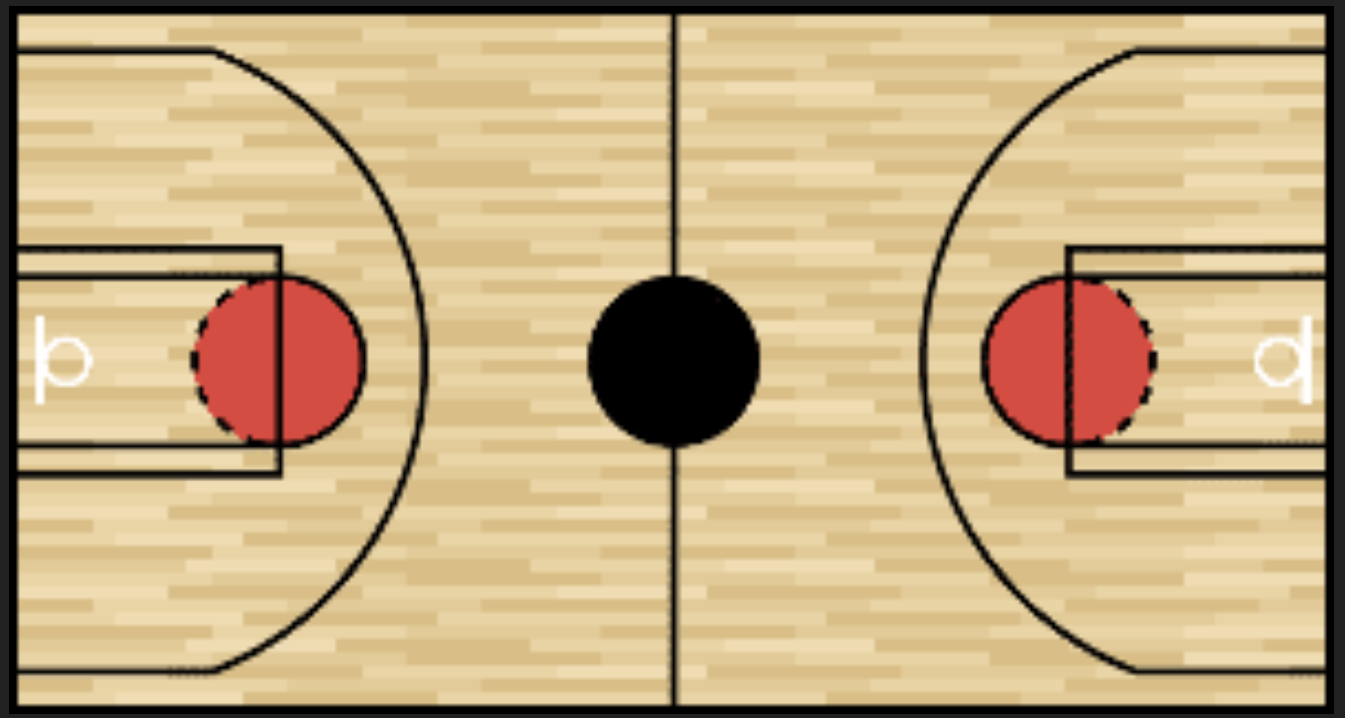
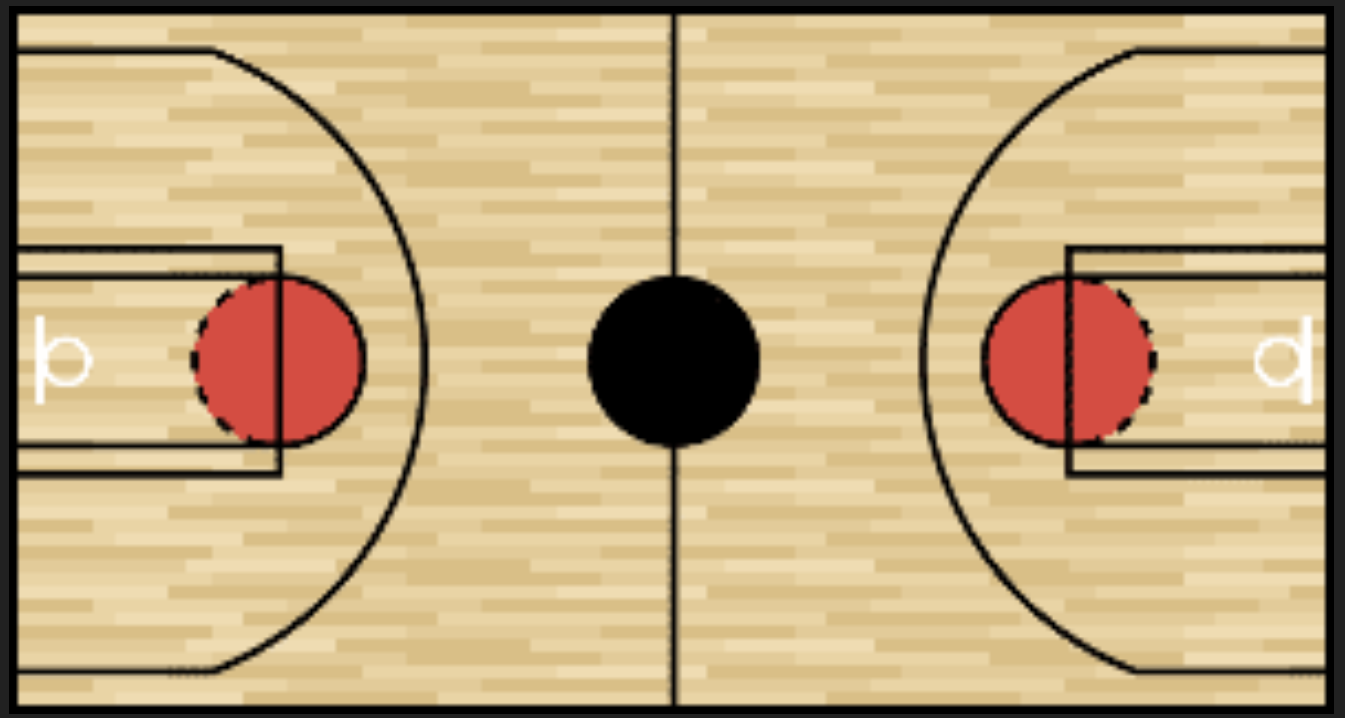
- 2 teams
- 5 players per team
- Shoot the ball through the hoop to score points


# Basketball Basics



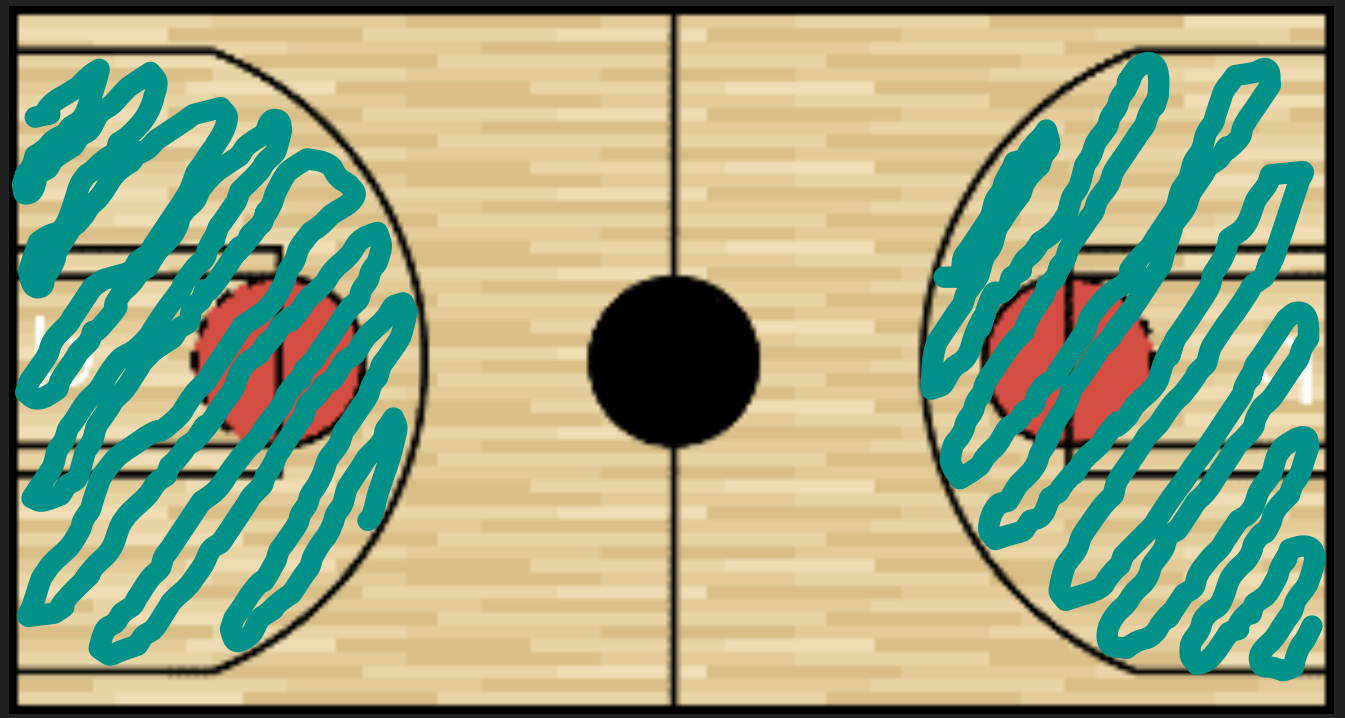
# Basketball Basics

- 2 hoops (1 for each team)



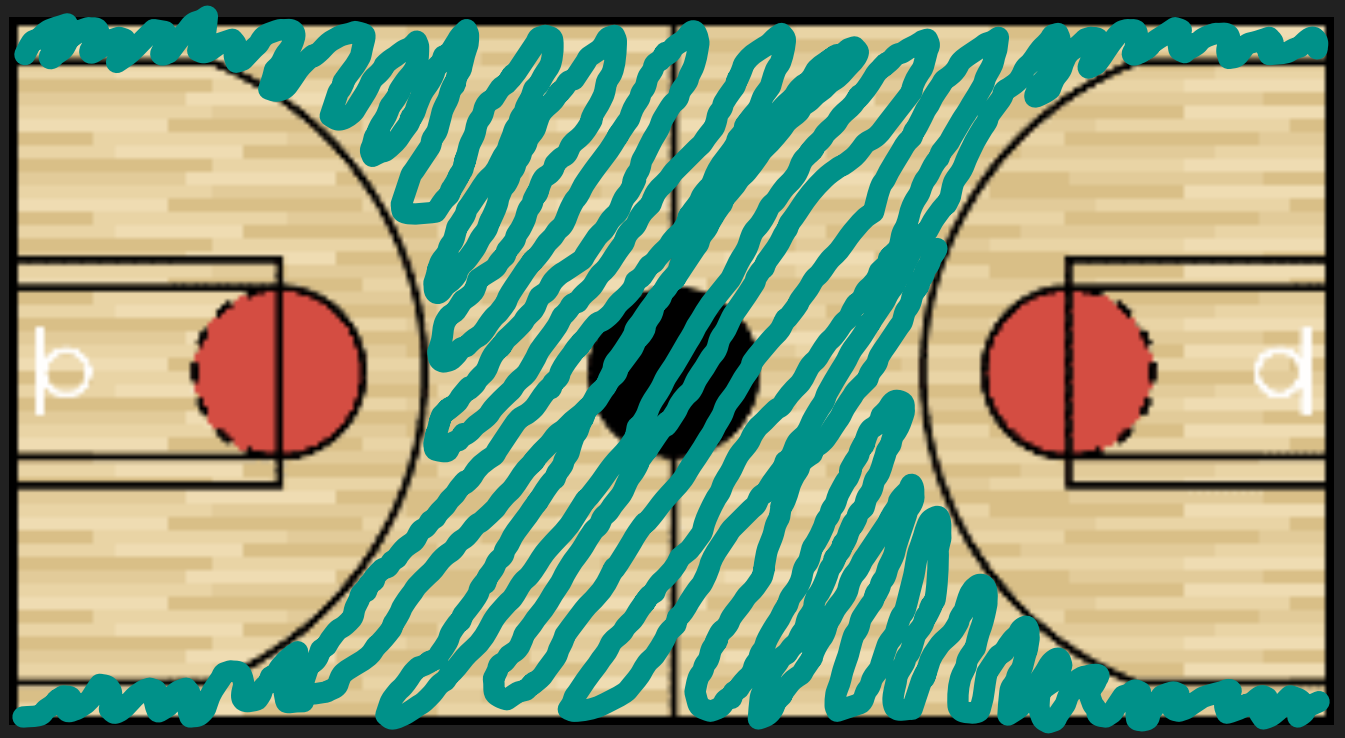
# Basketball Basics

- 2 hoops (1 for each team)
- Made shots within the arc = 2 points



# Basketball Basics

- 2 hoops (1 for each team)
- Made shots within the arc = 2 points
- Made shots beyond the arc = 3 points



# The Coaching Conundrum

- Many competing strategies

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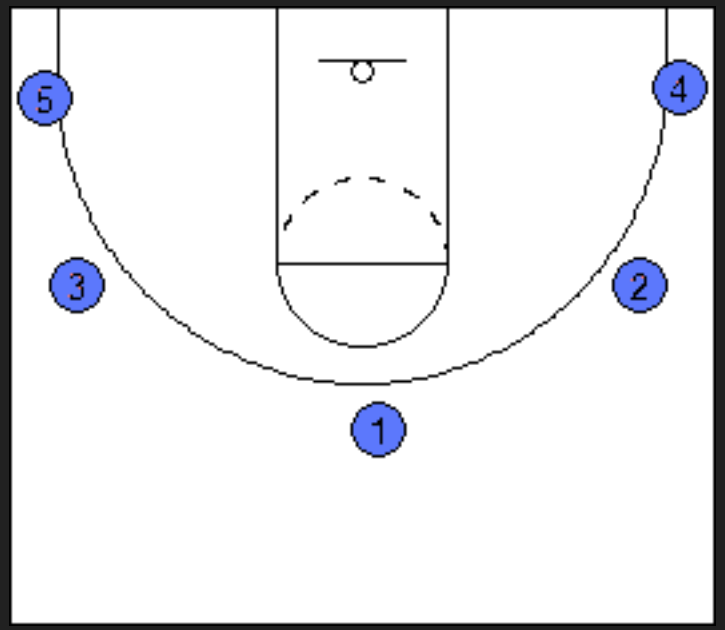
- Many competing strategies

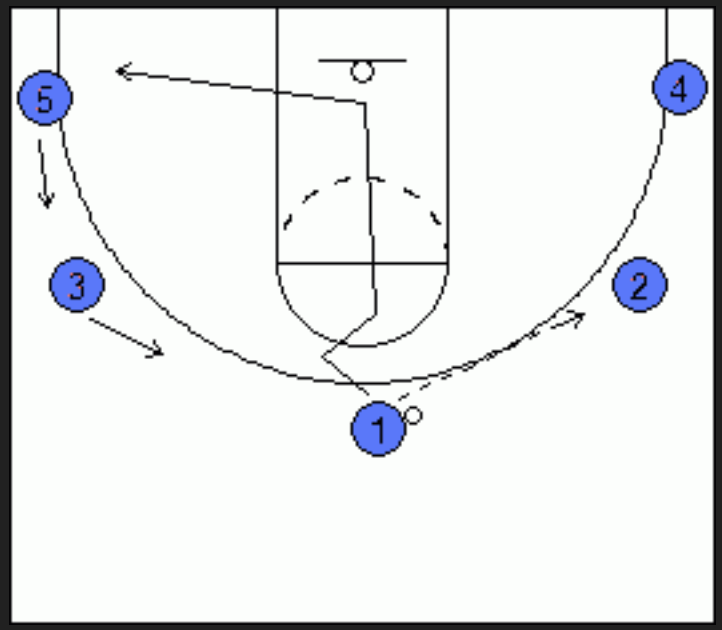
Space the offense



# The Coaching Conundrum

- Many competing strategies

Drive and Kick



# The Coaching Conundrum

- Many competing strategies

Defender Matchup

# The Coaching Conundrum

- Many competing strategies

Move the ball

# The Coaching Conundrum

- Many competing strategies
- Hard to know what works best

# What does this have to do with data science?

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- The NBA has great data
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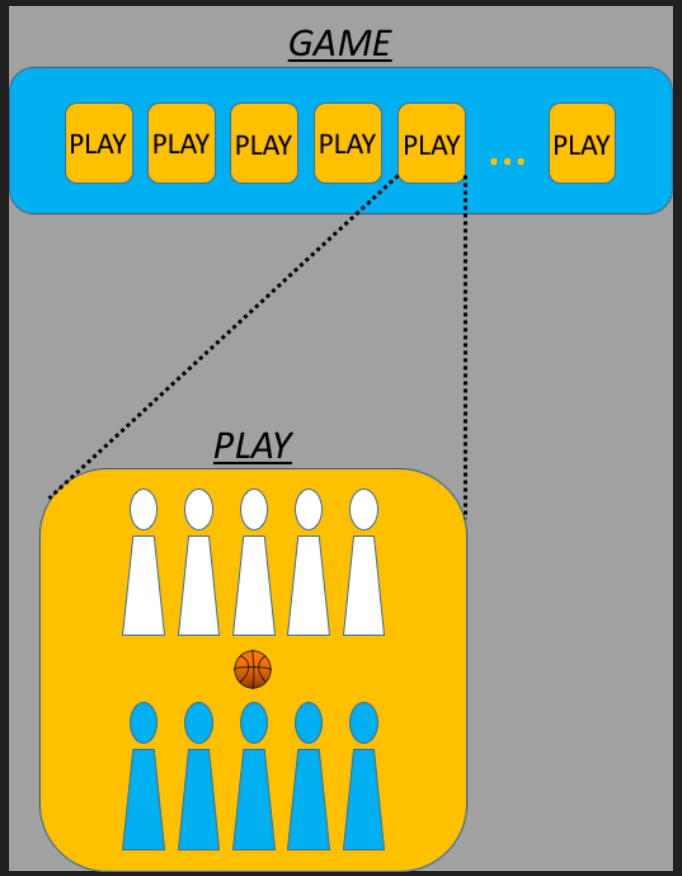
- In-game player & ball tracking -25 Hz
- Data Science Playground
- Animation

# Problem Statement

- Use player tracking data to analyze three point shooting
- Rank the relative effectiveness of various three point shooting strategies

# Methods

- Find plays that result in three-point shots



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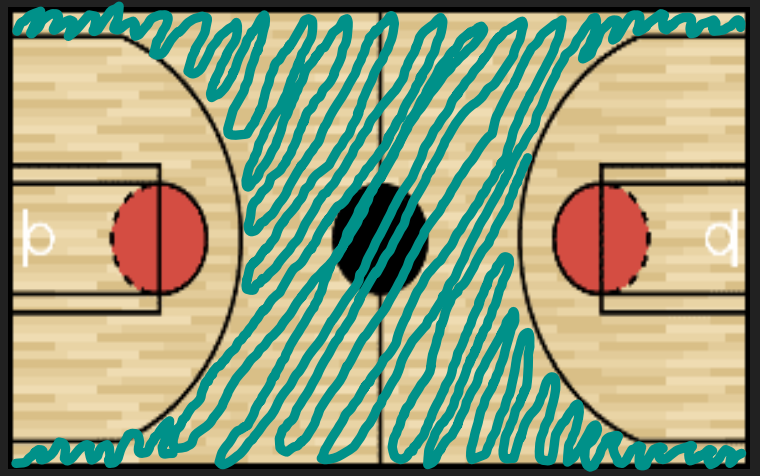


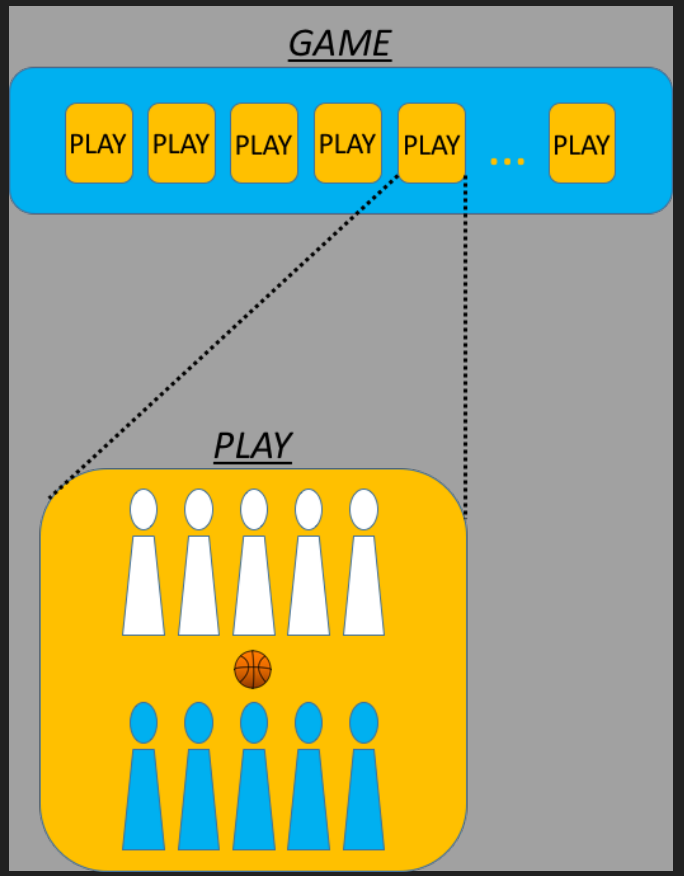

# Methods

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- Engineer custom strategy feature set for each play

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- Engineer custom strategy feature set for each play

- ✓ Ball Movement
- ✓ Defender matchups
- ✓ Court Spacing

…

# Methods

- Find plays that result in three-point shots
- Engineer custom strategy feature set for each play

Strategies

| | # Passes | Defender Distance | Height Difference | … | Outcome |
|---|---|---|---|---|---|
| Play_1 | 3 | 2.5 | 0.5 | … | Miss |
| Play_2 | 2 | 1.4 | 2.1 | … | Miss |
| Play_3 | 6 | 7.8 | 0.9 | … | Make |

# Methods

- Find plays that result in three-point shots
- Derive custom strategy feature set for each play
- Use strategy features to predict outcome (make / miss)

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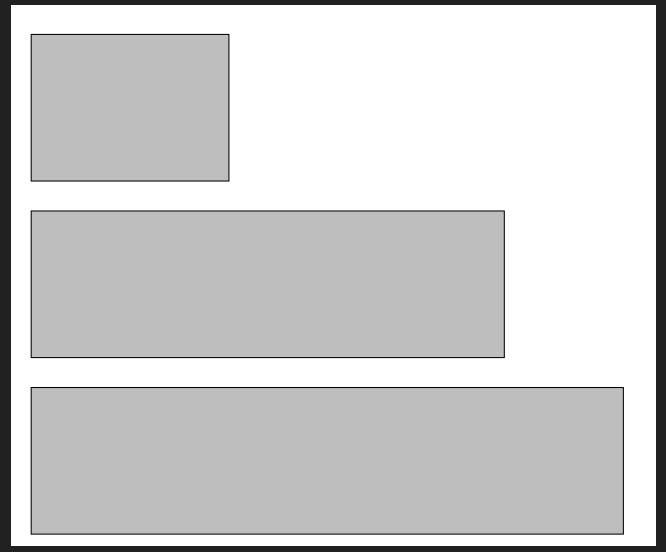
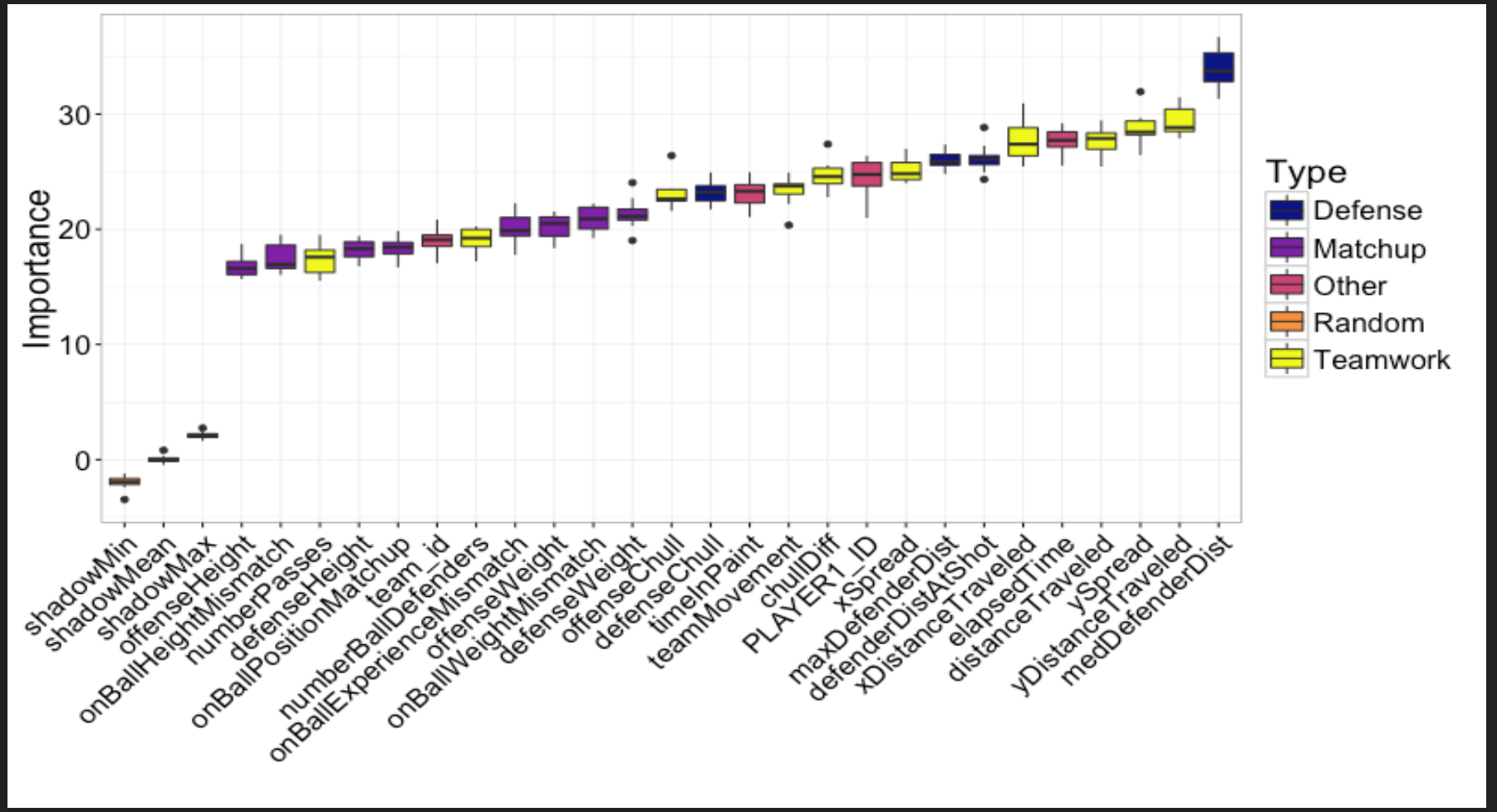
# Methods

- Find plays that result in three-point shots
- Derive custom strategy feature set for each play
- Use strategy features to predict shot outcome (make / miss)
- Measure feature importance to rank strategy effectiveness

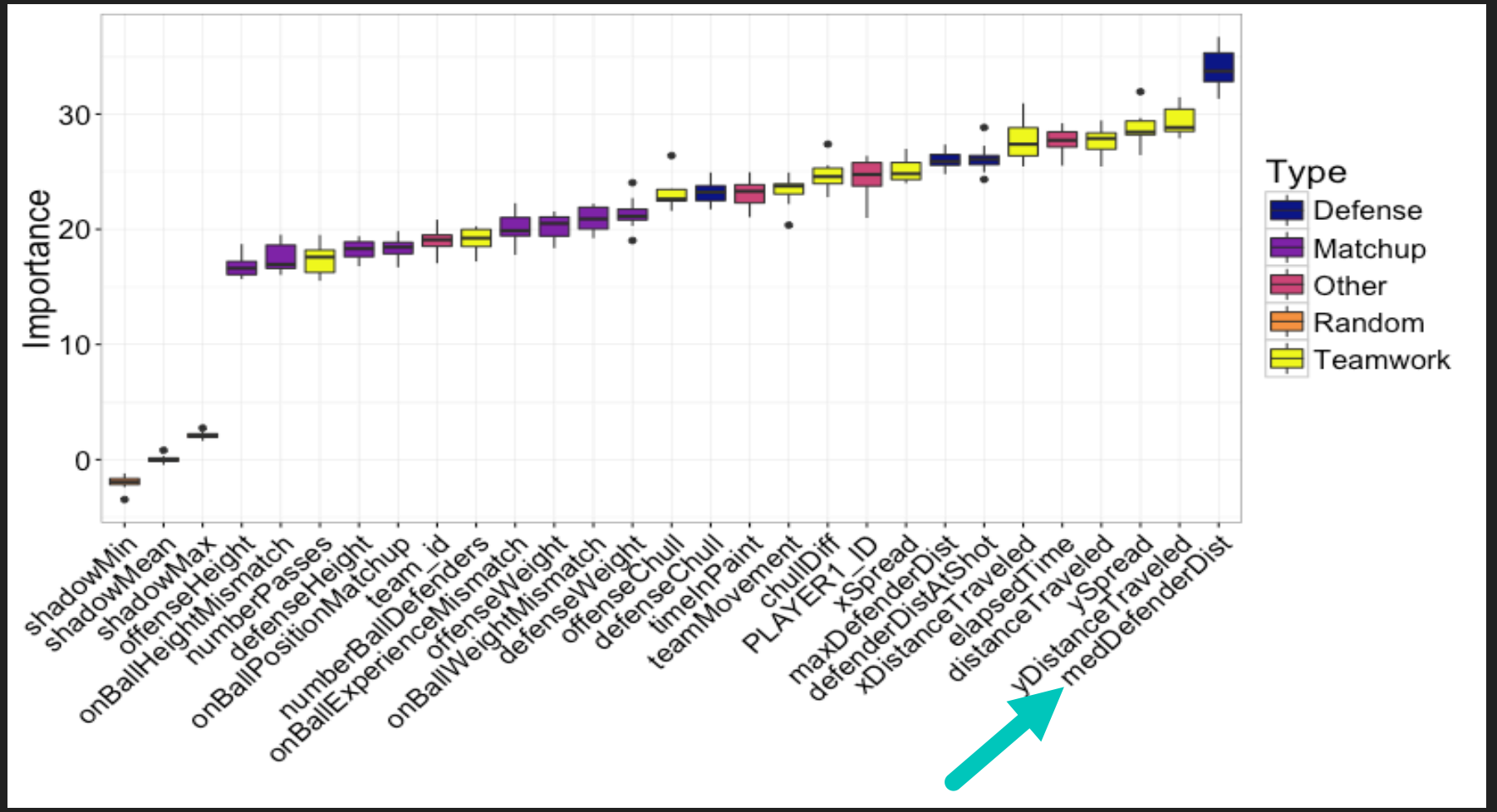


# Results


Importance
30
20
10
0
shadowMin
shadowMean
shadowMax
offenseHeight
onBallHeightMismatch
numberPasses
defenseHeight
onBallPositionMatchup
team_id
numberBallDefenders
onBallExperienceMismatch
offenseWeight
onBallWeightMismatch
defenseWeight
offenseChull
defenseChull
timeInPaint
teamMovement
chullDiff
PLAYER1_ID
xSpread
maxDefenderDist
defenderDistAtShot
xDistanceTraveled
elapsedTime
distanceTraveled
ySpread
yDistanceTraveled
medDefenderDist
Type
Defense
Matchup
Other
Random
Teamwork

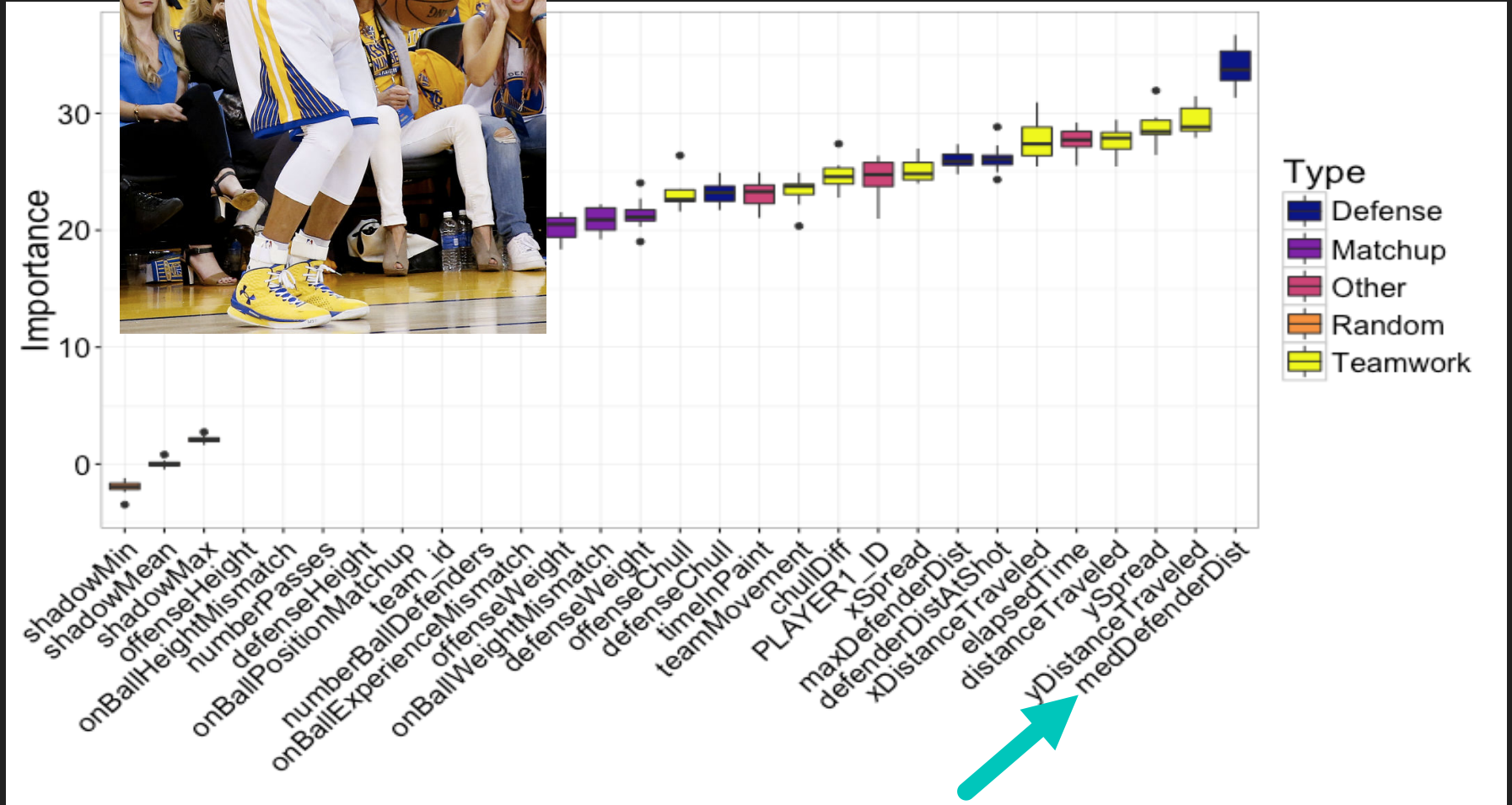
# Results

- Defender proximity is most predictive of shot outcome



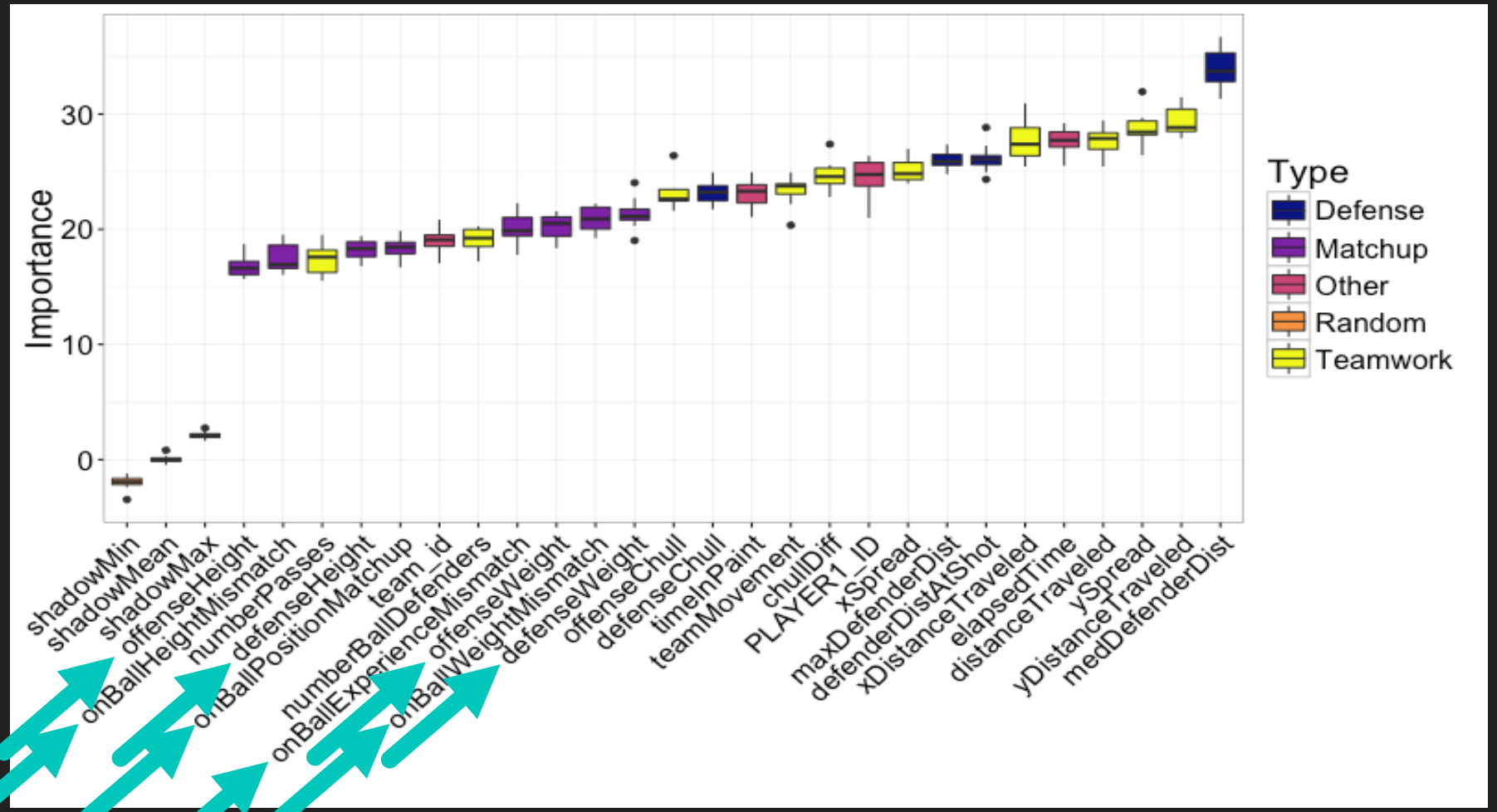
# Results

- Defender proximity is most predictive of shot outcome
- Easiest to shoot when you are un-guarded



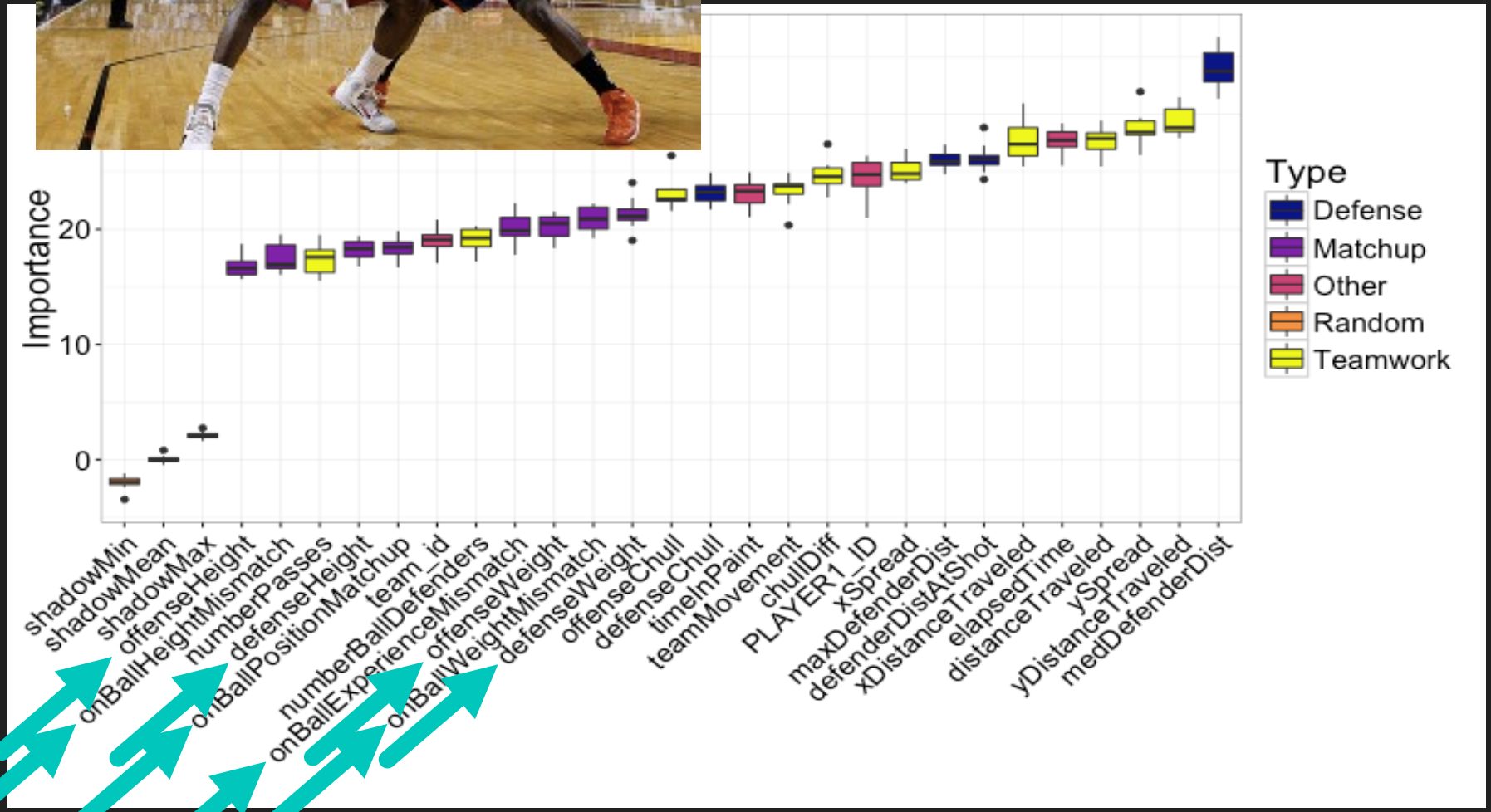
# Results

- Focus on matchups is not the best strategy



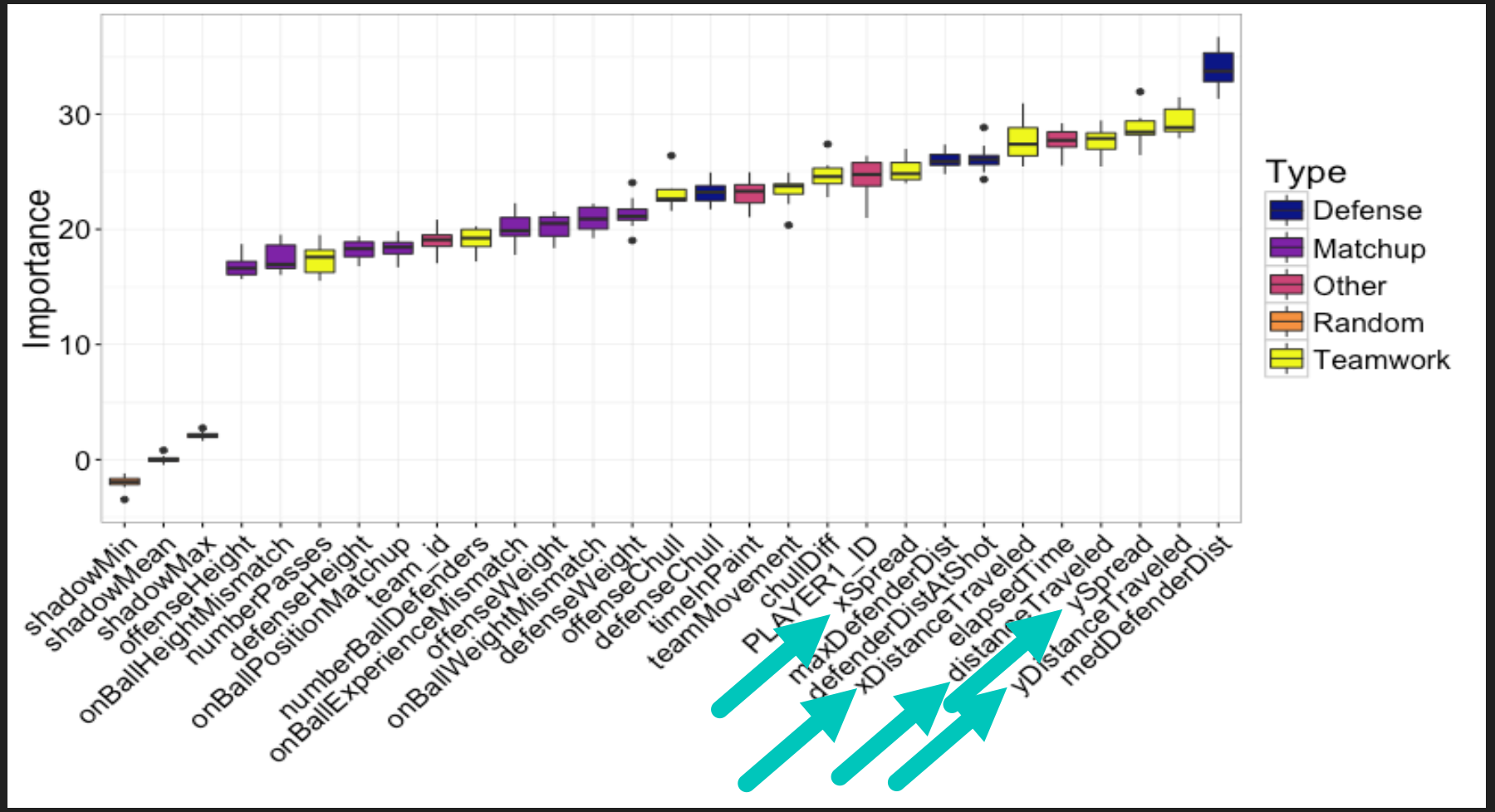
# Results

- Focus on matchups is not the best strategy
- De-emphasizes one-on-one play



# Results

- Teamwork works, especially ball movement

# What else can be done?

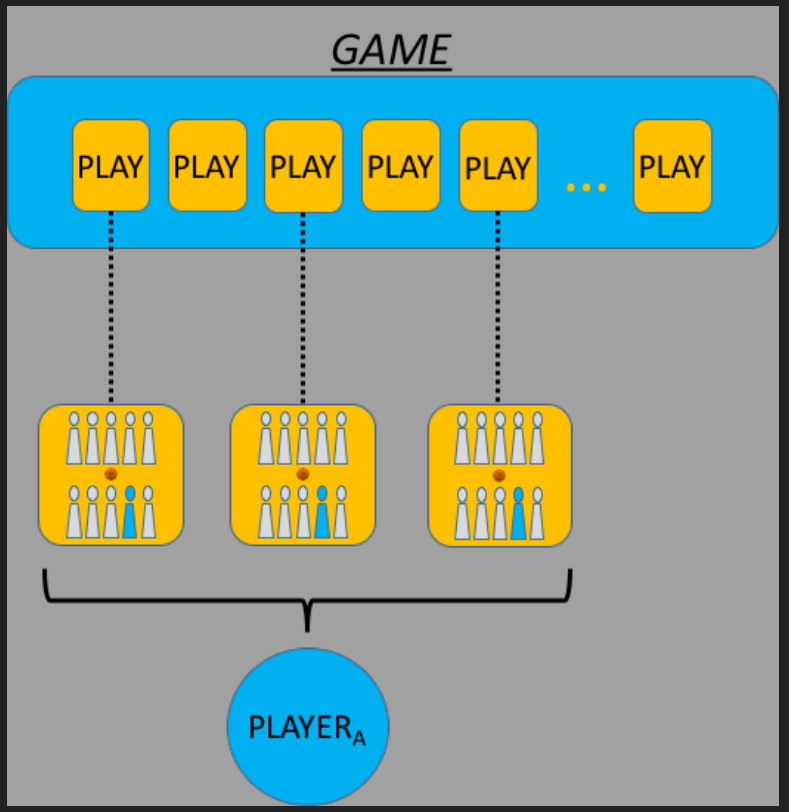
# Player Assessment

# Player Assessment

- Identify the most effective three-point shooters using play context

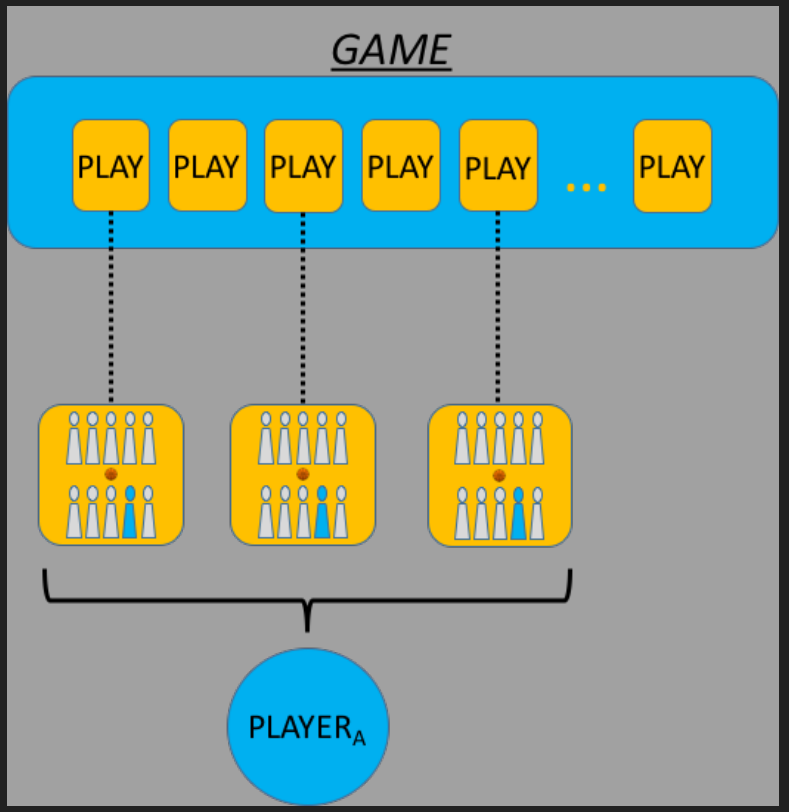
# Methods

- Group plays by shooter



# Methods

- Group plays by shooter
- Compute aggregate statistics for each player across all strategy features



# Methods

- Group plays by shooter
- Compute aggregate statistics for each player across all strategy features

| | Mean # Passes | Mean Defender Distance | Mean Height Difference | … | 3 Point Attempts |
|---|---|---|---|---|---|
| Player_1 | 3 | 2.5 | 0.5 | … | 2.1 |
| Player_2 | 2 | 1.4 | 2.1 | … | 5.4 |
| Player_3 | 6 | 7.8 | 0.9 | … | 3.2 |

# Methods

- Group plays by shooter
- Compute aggregate statistics for each player across all strategy features
- Use aggregate stats to predict 3 point attempts

| | Mean # Passes | Mean Defender Distance | Mean Height Difference | … | 3 Point Attempts |
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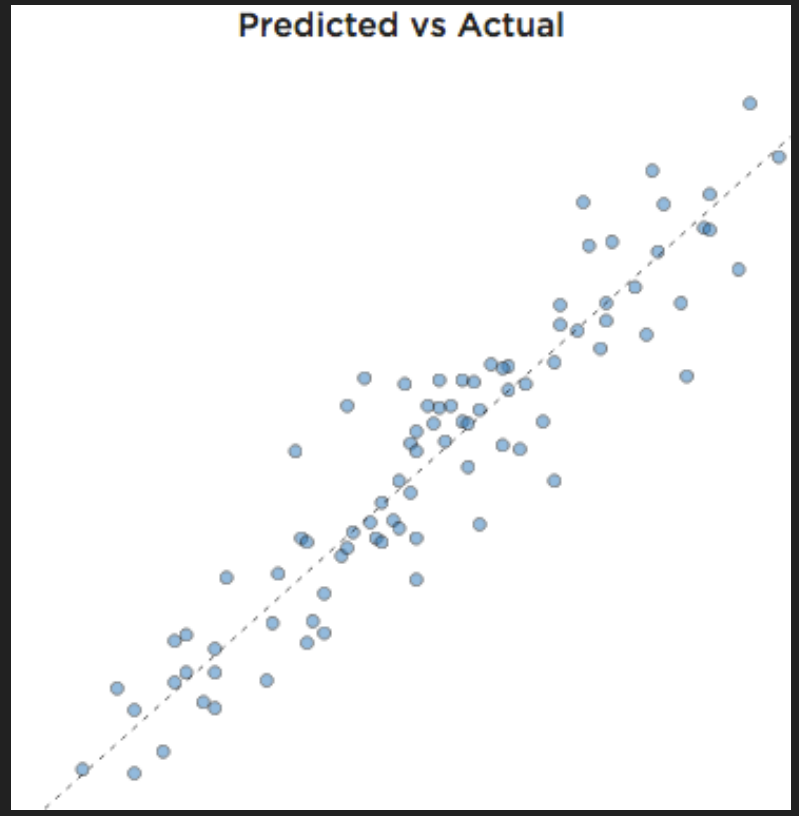
# Methods

- Group plays by shooter
- Compute aggregate statistics for each player across all strategy features
- Use aggregate stats to predict 3 point attempts
- Inspect residuals



# Leave-one-out Modeling

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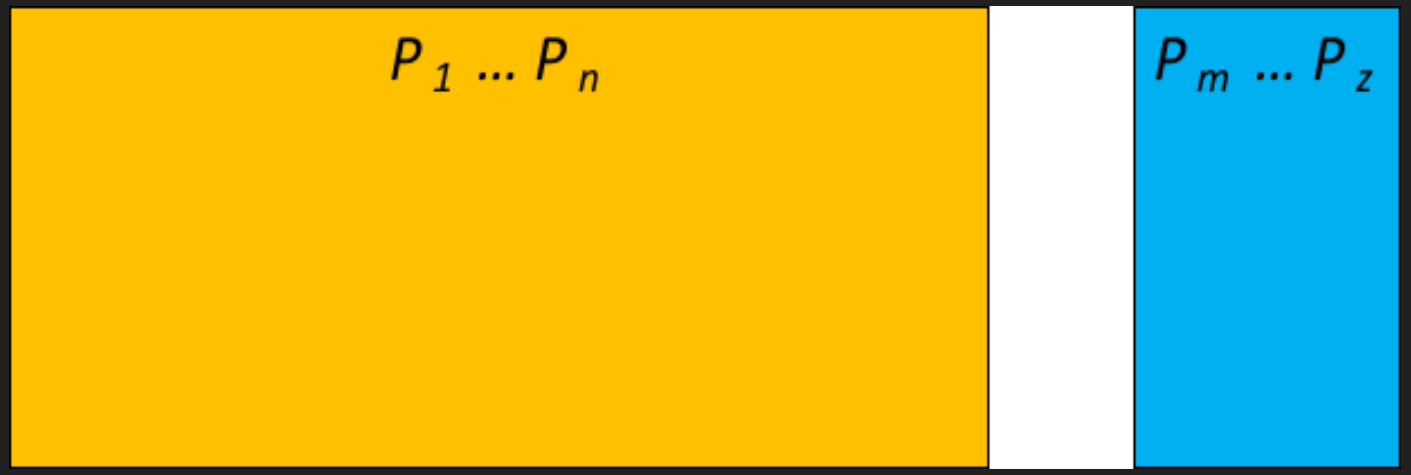
- Used for anomaly detection

# Leave-one-out Modeling

- Typical Train-Test split



# Leave-one-out Modeling

- LOO Train-Test split

| | | | | | |
|---|---|---|---|---|---|
| Player 1 Model | $P_1$ | $P_2$ | $P_3$ | … | $P_z$ |
| Player 2 Model | $P_1$ | $P_2$ | $P_3$ | … | $P_z$ |
| Player 3 Model | $P_1$ | $P_2$ | $P_3$ | … | $P_z$ |
| … | … | | | | |
| Player n Model | $P_1$ | $P_2$ | $P_3$ | … | $P_z$ |

Model Training
Model Testing

# Leave-one-out Modeling

- LOO Train-Test split
- Produces unbiased residuals for every player

| | | | | | |
|---|---|---|---|---|---|
| Player 1 Model | $P_1$ | $P_2$ | $P_3$ | … | $P_z$ |
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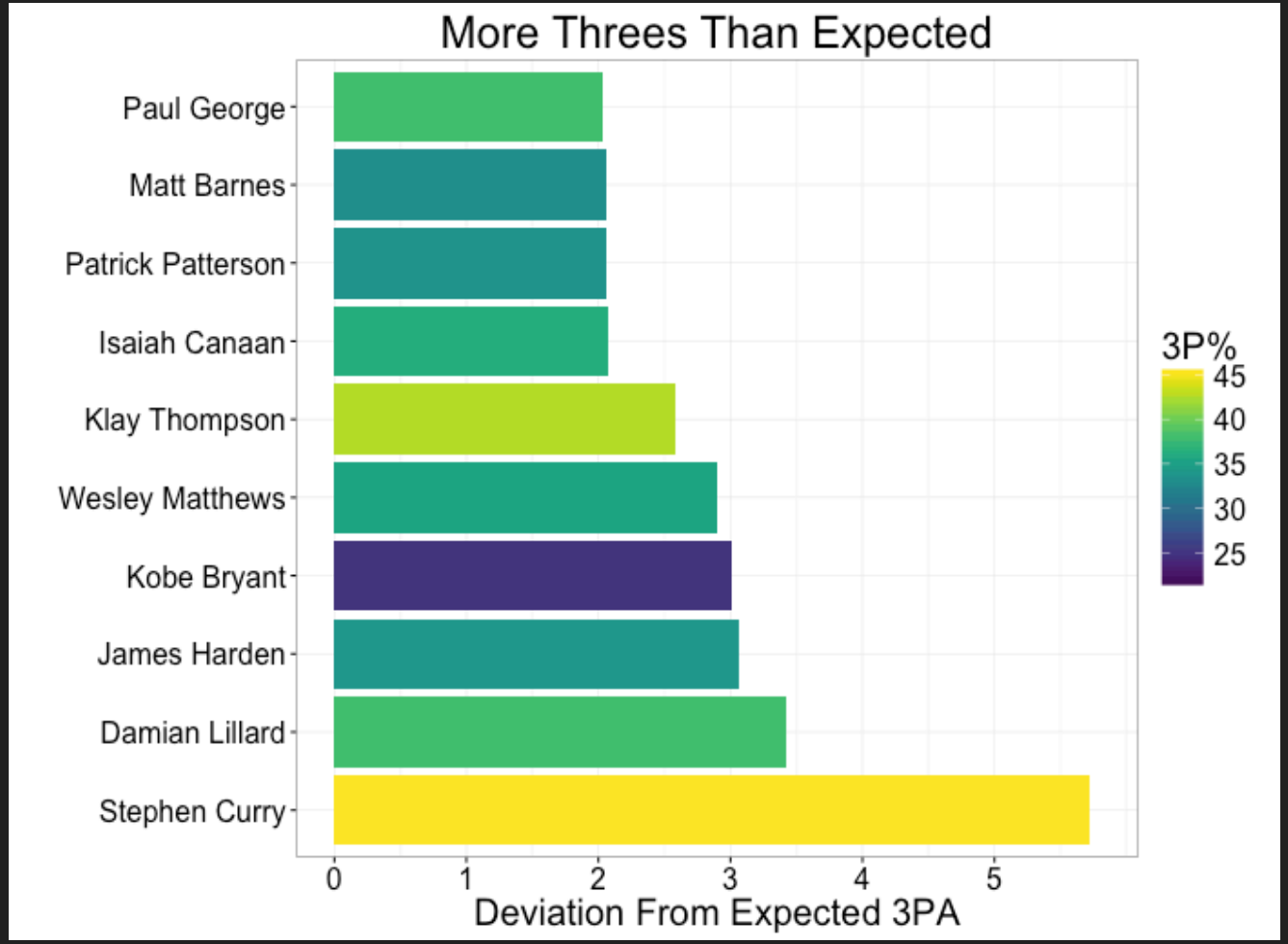
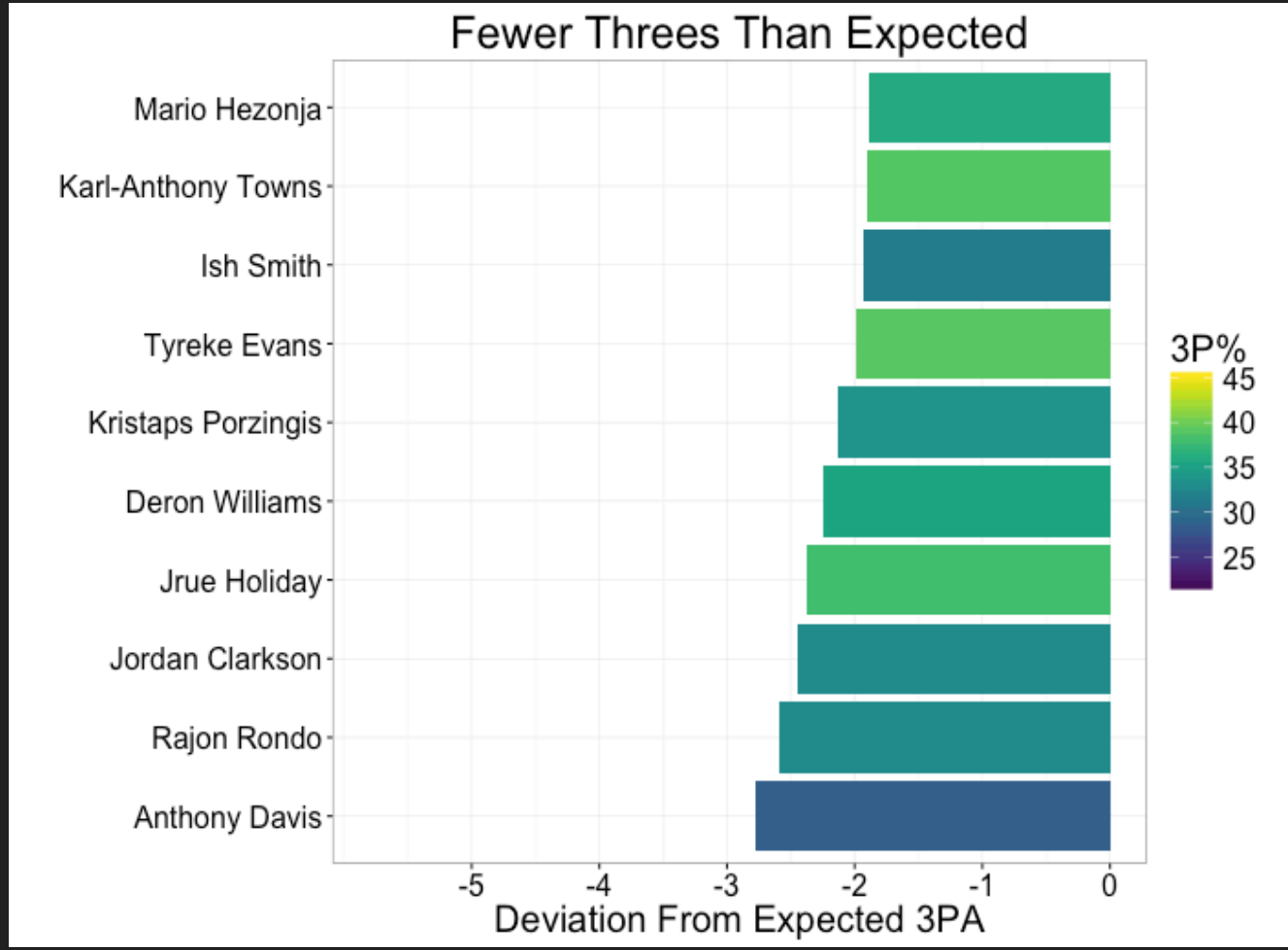
Model Training
Model Testing

# Results


More Threes Than Expected
Paul George
Matt Barnes
Patrick Patterson
Isaiah Canaan
Klay Thompson
Wesley Matthews
Kobe Bryant
James Harden
Damian Lillard
Stephen Curry
0
1
2
3
4
5
Deviation From Expected 3PA
3P%
45
40
35
30
25

# Results


Fewer Threes Than Expected
Mario Hezonja
Karl-Anthony Towns
Ish Smith
Tyreke Evans
Kristaps Porzingis
Deron Williams
Jrue Holiday
Jordan Clarkson
Rajon Rondo
Anthony Davis
-5
-4
-3
-2
-1
0
Deviation From Expected 3PA
3P%
45
40
35
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25

# Results

- Adjust 3PA residuals to 3P%

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**Effective, High-utilization**

| Player | Propensity |
|---|---|
| Stephen Curry | 0.5250 |
| Klay Thompson | 0.1984 |
| Damian Lillard | 0.1881 |
| Wesley Matthews | 0.1310 |
| James Harden | 0.1206 |
| Hollis Thompson | 0.1156 |
| Paul George | 0.1119 |
| Kyle Lowry | 0.1075 |
| J.R. Smith | 0.1008 |
| Isaiah Canaan | 0.0989 |
| ... | |
| Jeff Teague | -0.0939 |
| Troy Daniels | -0.0974 |
| Chris Paul | -0.0977 |
| Deron Williams | -0.1005 |
| Ian Clark | -0.1005 |
| Kawhi Leonard | -0.1023 |
| Karl-Anthony Towns | -0.1117 |
| Tyreke Evans | -0.1179 |
| Jrue Holiday | -0.1290 |
| Luis Scola | -0.1468 |

**Effective, Low Utilization**

# Results

Best of the Best

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Under-the-Radar

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- Identified most effective shooters
- Identified under-the-radar  effective shooters

# Questions?