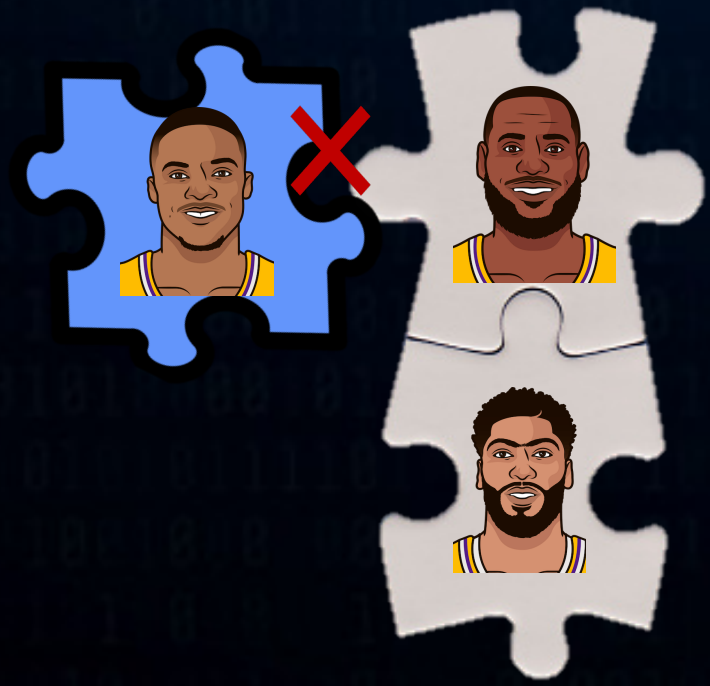
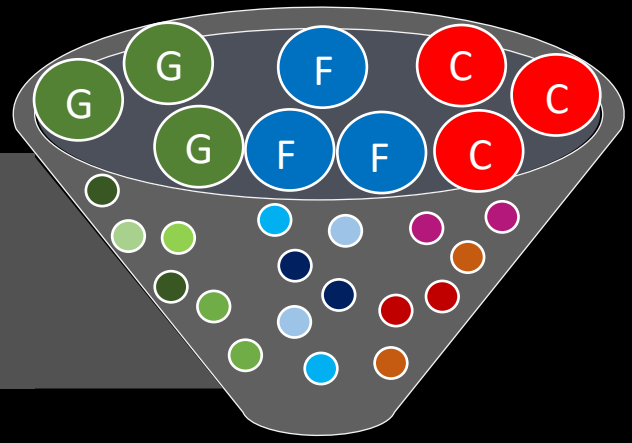
Constructing an Ideal NBA Roster



4449 | Mid-Term | Romith Challa

Project Pipeline

"Sub-Positions" / "Archetypes"



Data Collection

- Offensive Stats
- Defensive Stats
- Adv. Metrics

Data Pre-Processing

Unsupervised Clustering Algorithms

2021-2022 Lineup Data

Data Wrangling

Regression & Classification Techniques

Interactive Dashboard Tool

How will a NBA [lineup] fit and perform?

Use-Cases:

Data Engineering

Data Retrieval

40+ NBA Stats-API Endpoints

500+ Total Attributes

→ < 80 Total Features

Scoring Stats

- 2-PT vs. 3-PT vs. FT
- Catch-And-Shoot vs. Pull-Up
- RA vs. Non-RA-Paint vs. Mid-Range
- Corner3 vs. Above-the-Break3

Playmaking Stats

- Primary vs. Secondary Ast
- Screen Assists
- Turnovers
- % Ast on Drives, etc.

Offensive Style

- Transition vs. PnR vs. Isolation
- Cuts vs. Drives vs. Putbacks
- Assisted vs. Unassisted Attempts
- Elbow vs. Paint touches
- Touch time, # of dribbles, dist. run

Defensive Stats

- Deflections, Steals, Blocks
- Loose Balls, Charges, Fouls
- Opponent volume & efficiency by zones, shot type, offensive style type

Data Preparation

Goal: Balance between O vs. D and style vs. production

- Standardize player & attribute names between player stats vs. lineup data (account for trades)
- Truncate redundant features & filter low-PT players
- Transform non-attempt scoring stats into per-basis (by possession or minute); percentile-based conversions for efficiency stats
- Custom aggregations for grouped players (lineups)
- ML-PreReqs: Handle missing values, Scaling, Encoding
- PCA for dimensionality reduction

Exploratory Analysis

Goals for EDA:

- Assess the level of separability among guards, wings, forwards, bigs
- Feature distributions & correlations to aid feature engineering / selection process
- Determine characteristics of players belonging to “Net-Positive” vs. “Net-Negative” lineups

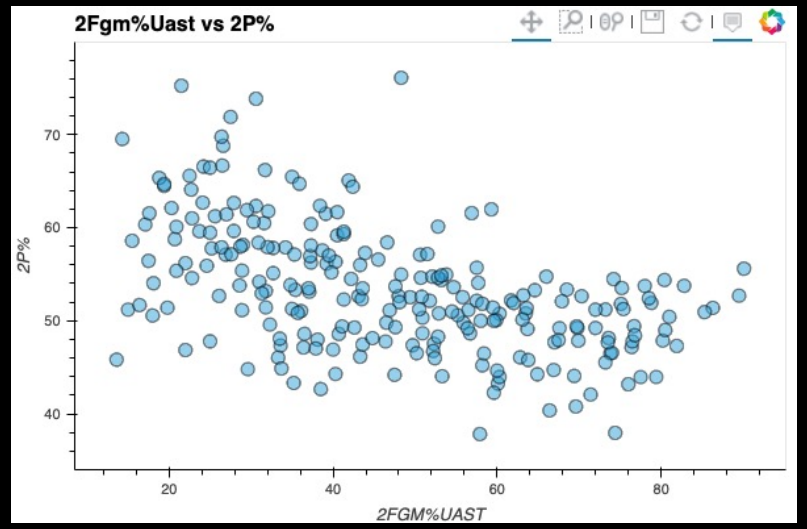
Methods Implemented:

PANDAS PROFILING | AUTOVIZ | SWARM-VIOLINS

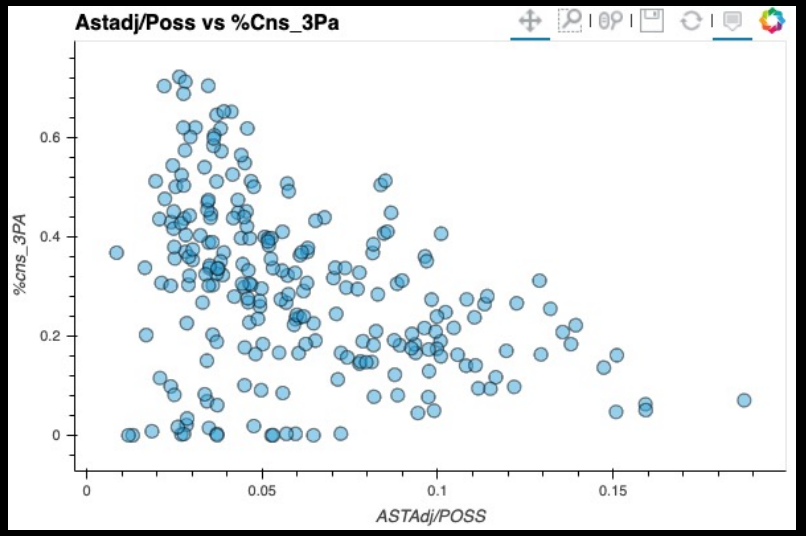
PAIR-WISE FT. INTERACTIONS | SHOT-CHARTS (O & D)

High-Level Insights:

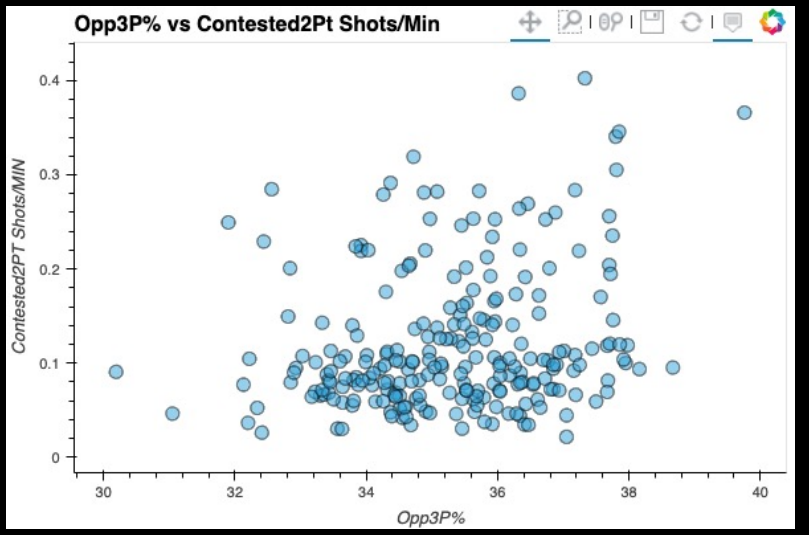
- High correlations among attributes --> truncate feature set
- Individual base-level stats not correlated with lineup ORTG or DRTG
- Specialized offensive play-types for position – has to be taken into account while handling missing data; reinforced need to cluster by position



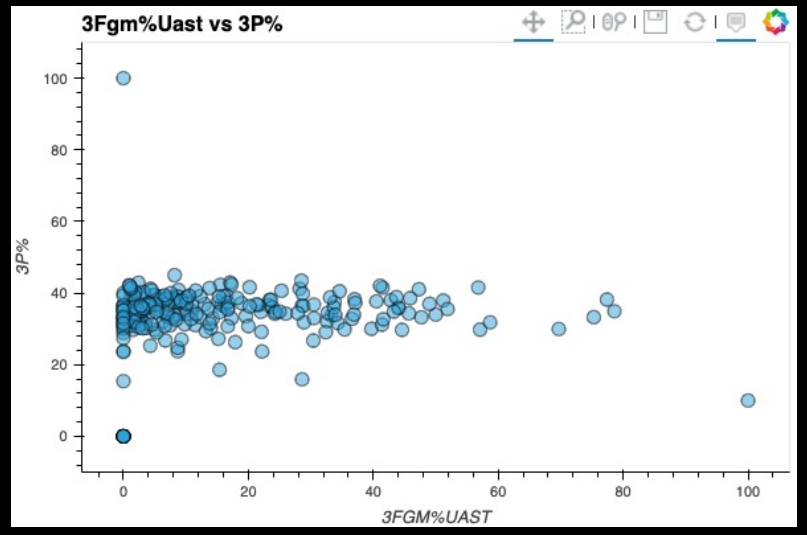
Proportion of unassisted vs. assisted FG% is impacted for 2-pointers but no such relationship exists for 3s

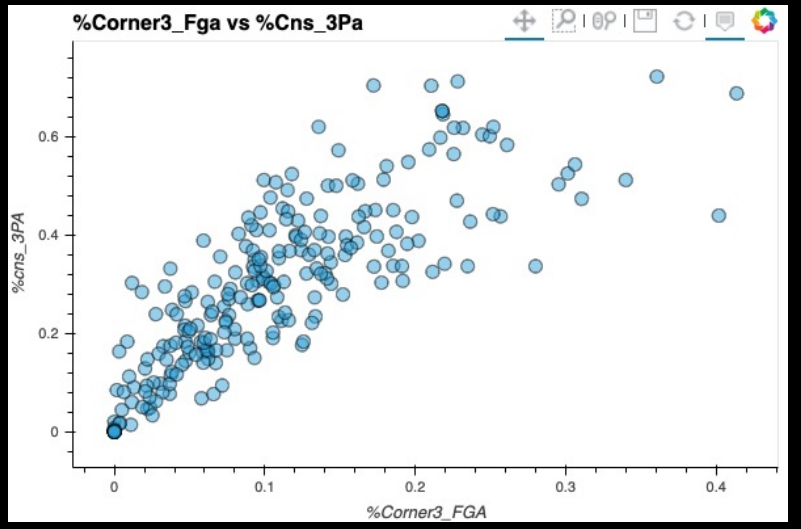


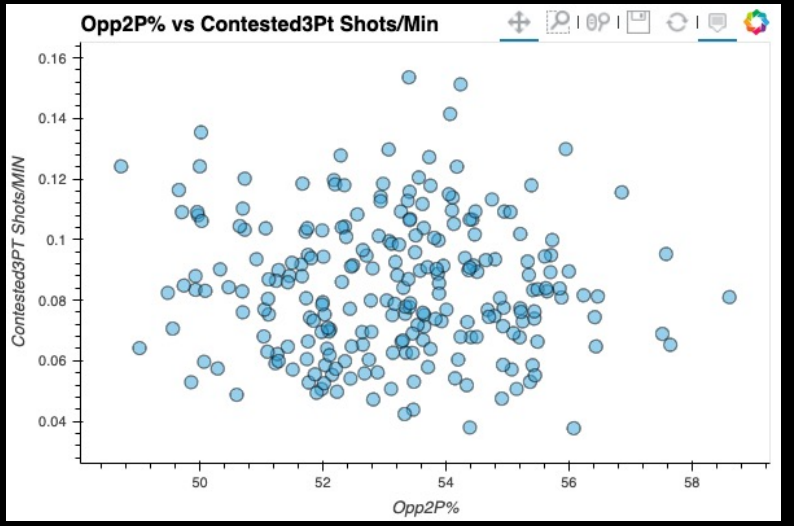
Players less likely to pass if their shot profile consists of mainly C&S shots. ”Hidden redundant” attribute as C&S and Corner3s have strong linear relationship.

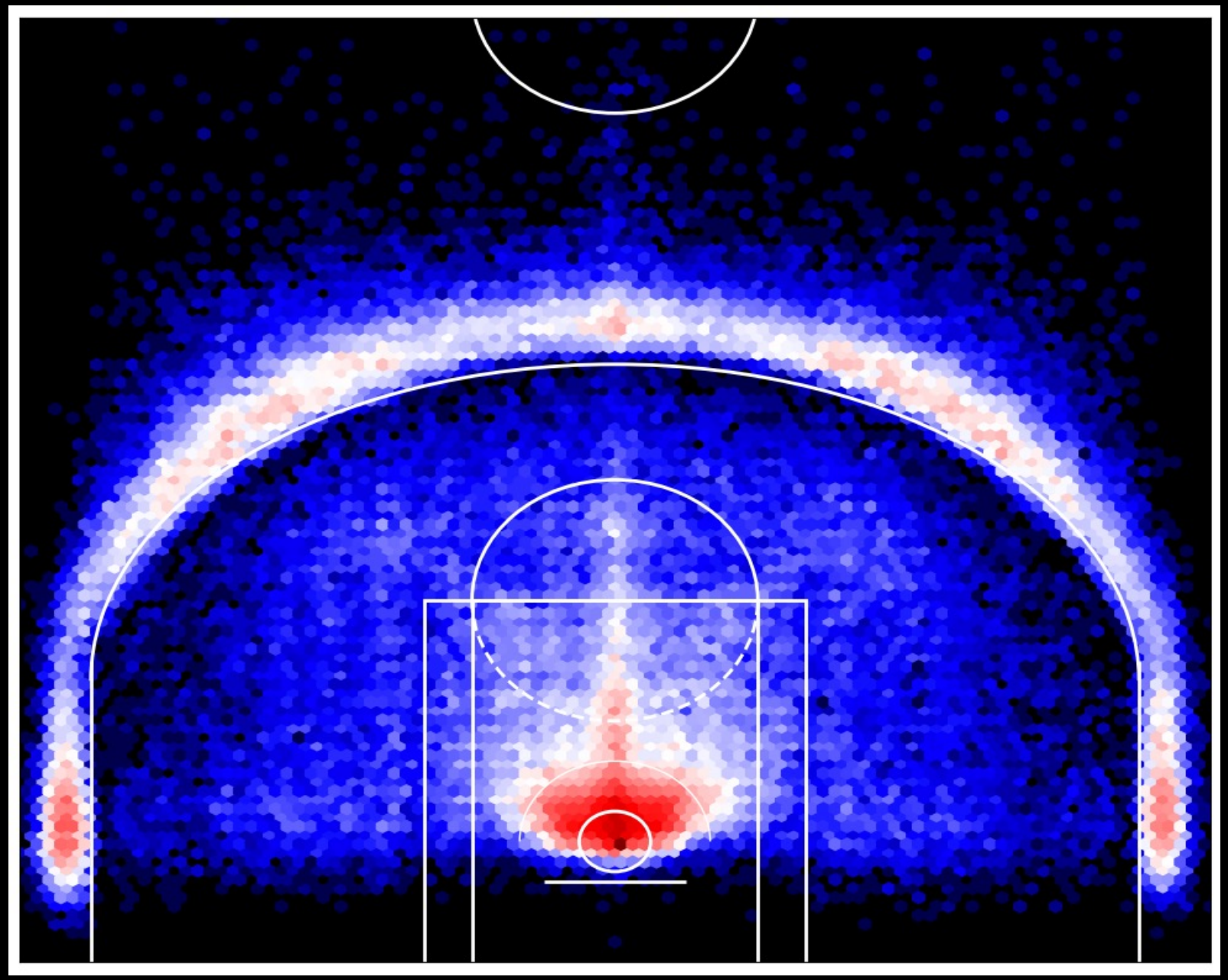


Perimeter defenders have better success against 2-pt shots compared to wing/paint defenders against 3-pt shots.







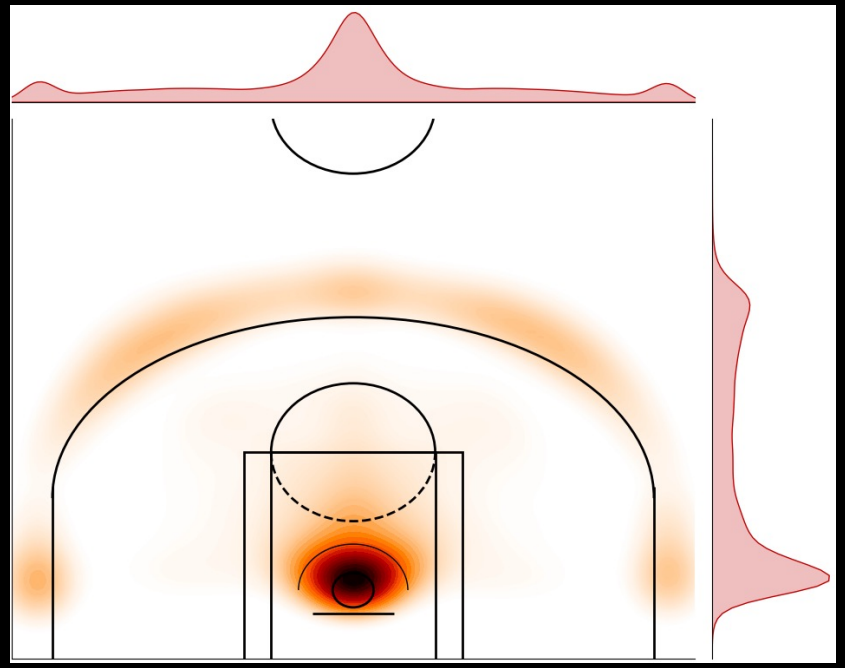


SHOT-CHARTS:

>= 5+ NetRtg

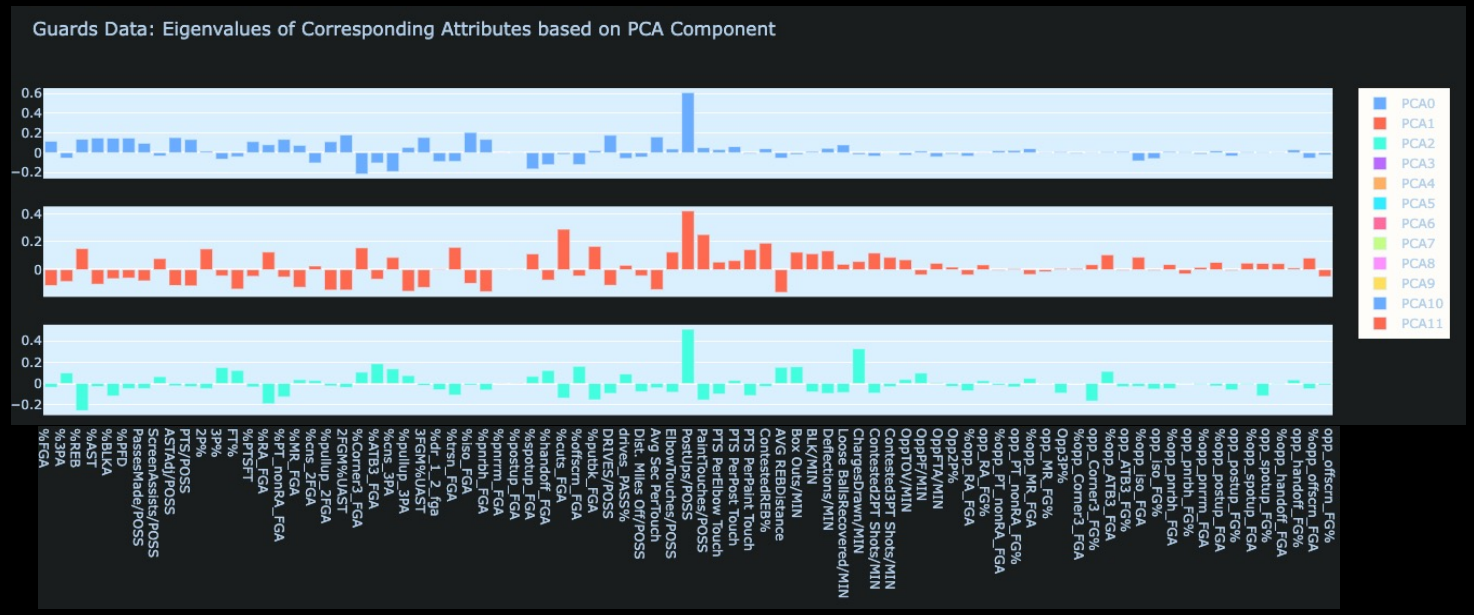
>= 40 min.

Efficiency in RA-Paint & Corners3 are most indicative of a successful lineup.

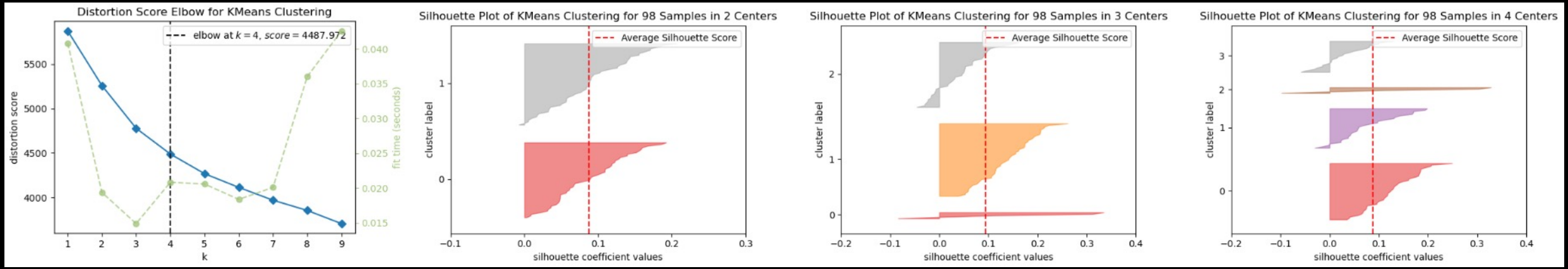


Clustering Pre-Requisites: Guards

(PROCESS REPEATED FOR WINGS, FORWARDS, BIGS)

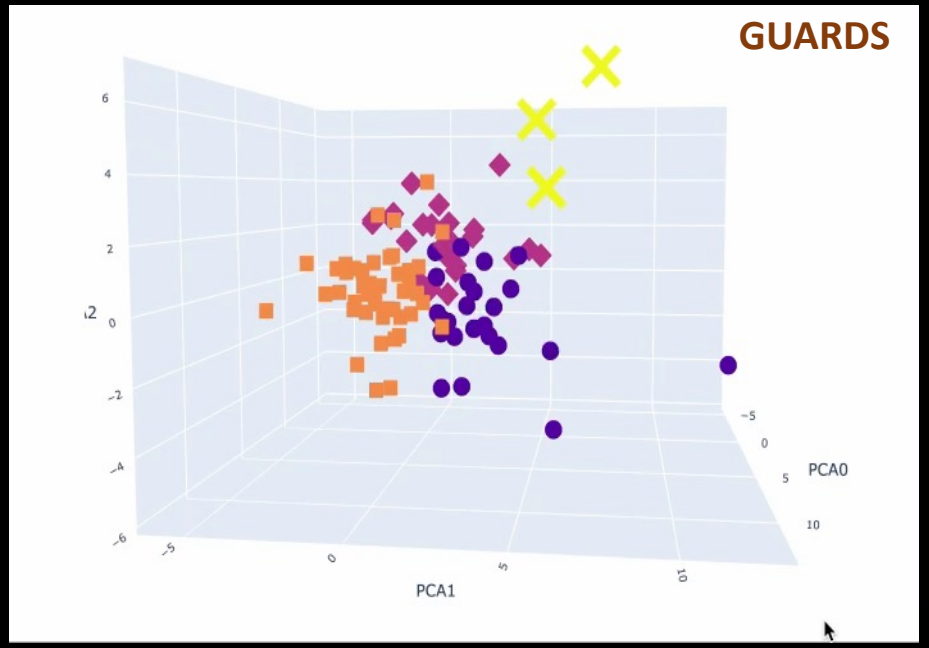


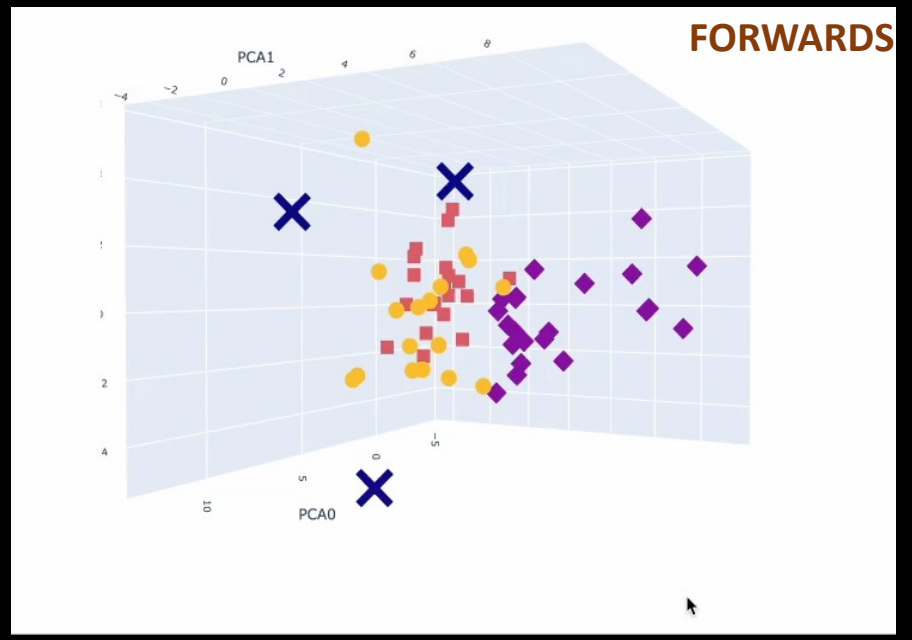
- Plotting explained variance for PCA components
- Charting eigenvalues of each attribute based on PCA component to examine the information captured by each engineered component
- Elbow & Silhouette plots to inform hyperparameter choice
- Baseline clustering & evaluation among relevant metrics



Distortion score: avg sum of squared dist. from each point to its assigned center. Silhouette Coefficient: diff. between avg intra-cluster dist. & mean nearest-cluster dist. for each sample, normalized by max value.

Cluster Analysis



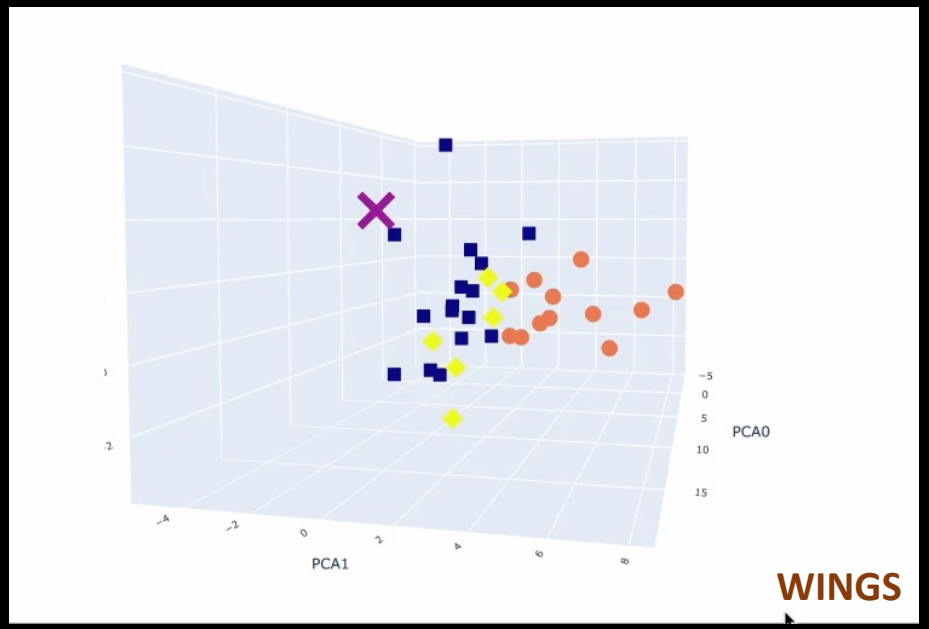


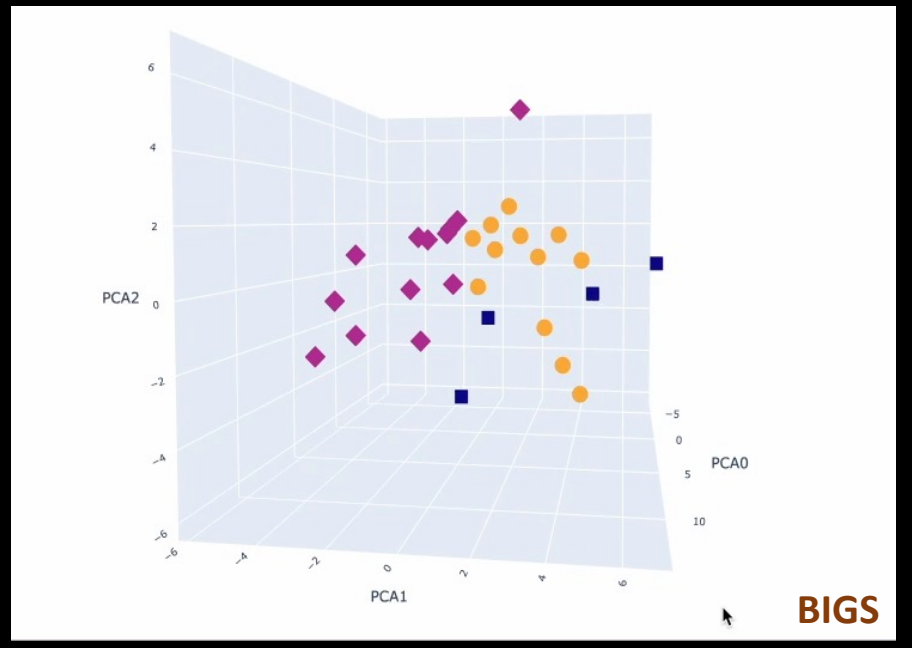
Compared cluster models with appropriate metrics when there is no "ground-truth":

- Silhouette Coefficient
- Calinski-Haribasz Score: ratio of dispersion between and within clusters, averaged out by k
- Davies-Bouldin Index: avg. similarity measure of each cluster with its most similar cluster

- K-Means, Spectral, Birch, Gaussian-Mixture

<u>K-Means performed most consistently and had more evenly dense cluster sizes</u>





Regression

- BASELINE MODELS: Linear, Lasso, ElasticNet, Ridge, Decision-Tree, Random-Forest
- EVALUATION METRICS: R^2, MSE, RMSE, MAE, MedAE, MAPE
- HYPERPARAMETER TUNING: Random-Forest (tree depth & qt)
- TARGETS: O.RTG & D.RTG (separate models; NET RATING estimated after)

OPTIMIZED MODEL PERFORMANCE:

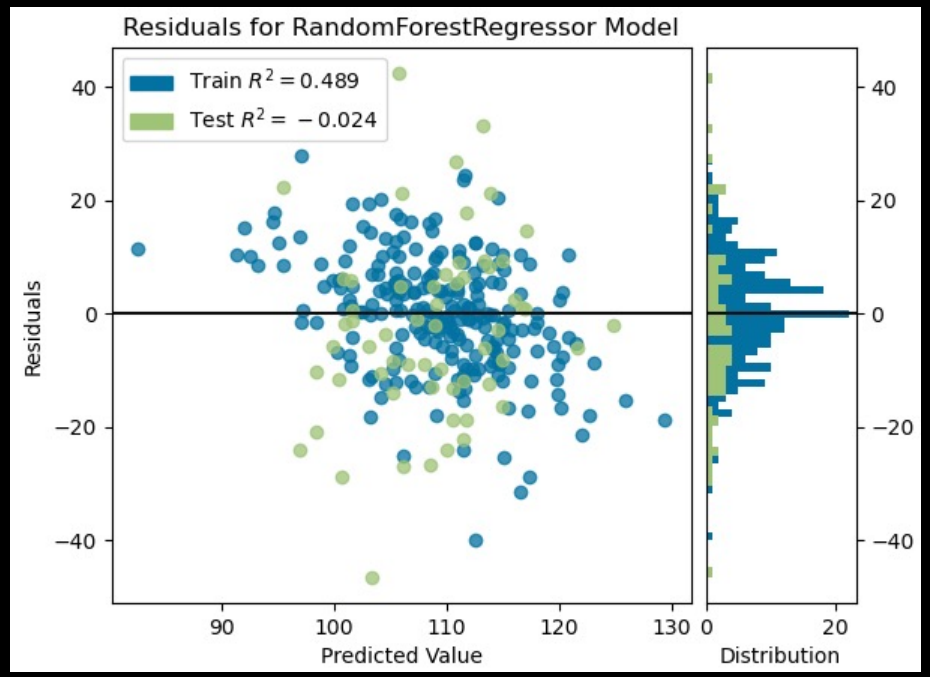
- NET RTG | TRAIN | RMSE (computed): 13.03
- NET RTG | TEST | RMSE (computed): 23.47

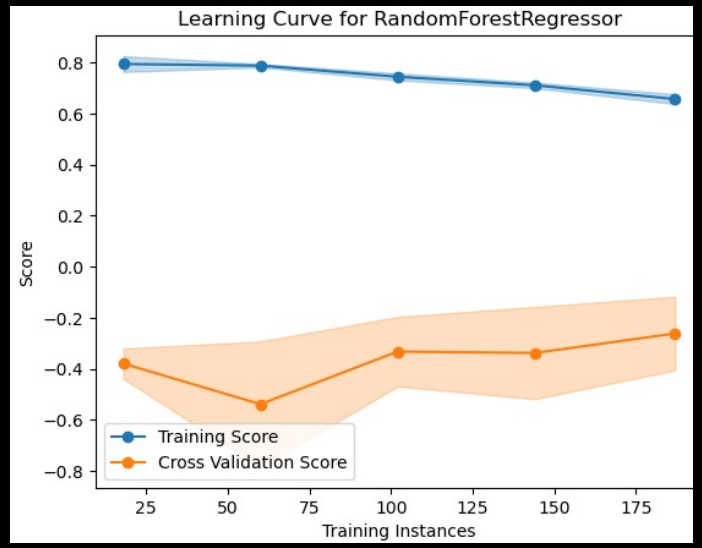
Classification

- BASELINE MODELS: Logistic, Support-Vector Machine, K-Nearest Neighbor, Random-Forest
- EVALUATION METRICS: Accuracy, Precision, Recall, F1-Score
- HYPERPARAMETER TUNING: Random-Forest (tree depth & qt)
- TARGETS: Positive or Negative Net Rating (Binary-class / Boolean)

OPTIMIZED MODEL PERFORMANCE:

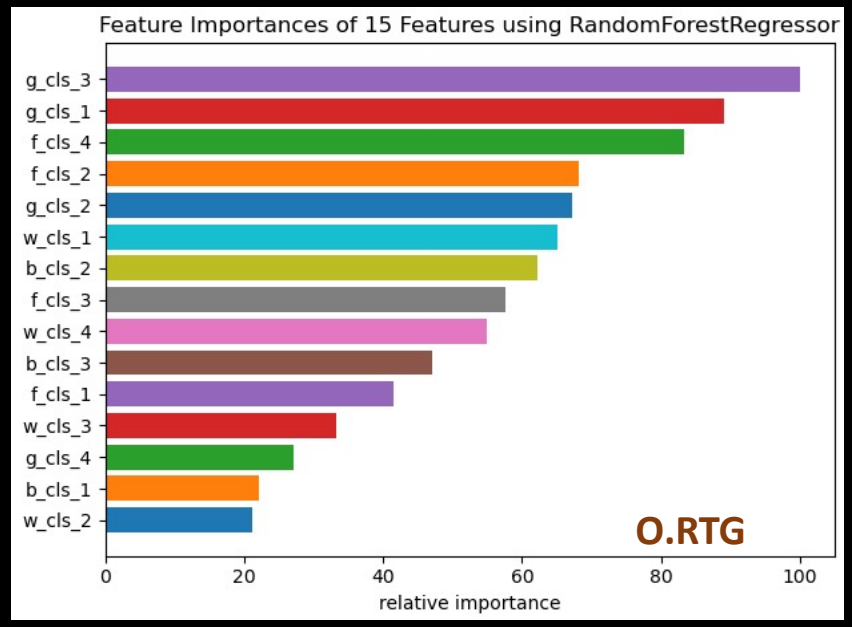
- TRAIN | ACCURACY: **89%**
- TEST | ACCURACY: **69%**
- “Good Lineup” predictions have less inaccuracies than “Bad Lineup” predictions
  - Test Recall: 77%
  - Test Precision: 77%

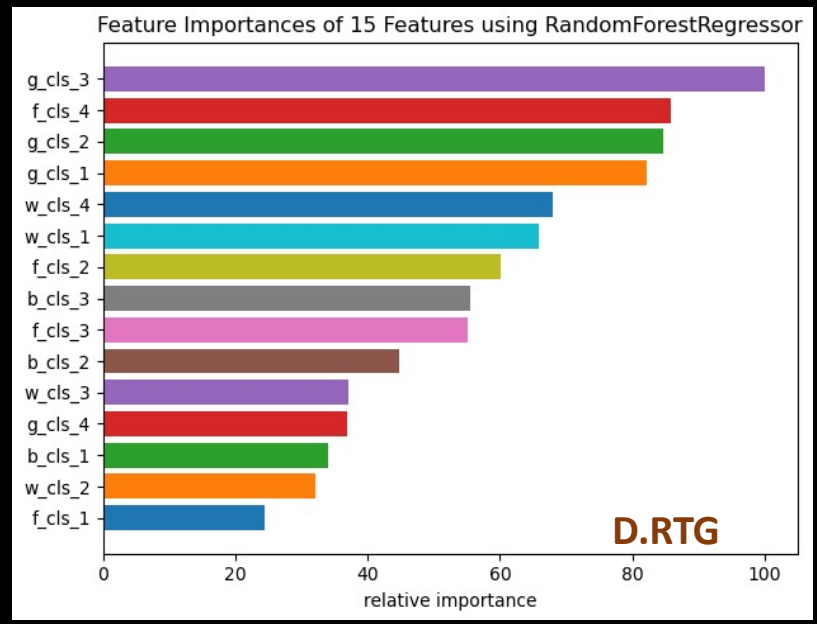


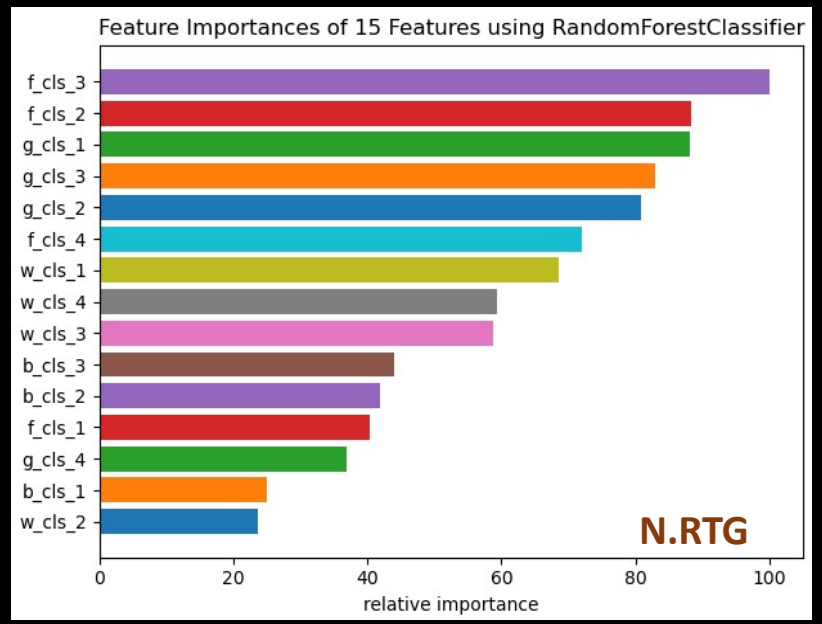


TAKEAWAYS:

- Models valued cluster groups slightly different for offensive vs. defensive ratings
- Classification version saw completely different cluster group importances
- Overall, GUARDS & FORWARDS dictate how well a lineup performs over WINGS & BIGS
- Further tuning of models saw no improvement







Conclusions & Recommendations

ALTERNATIVE STRATEGIES:

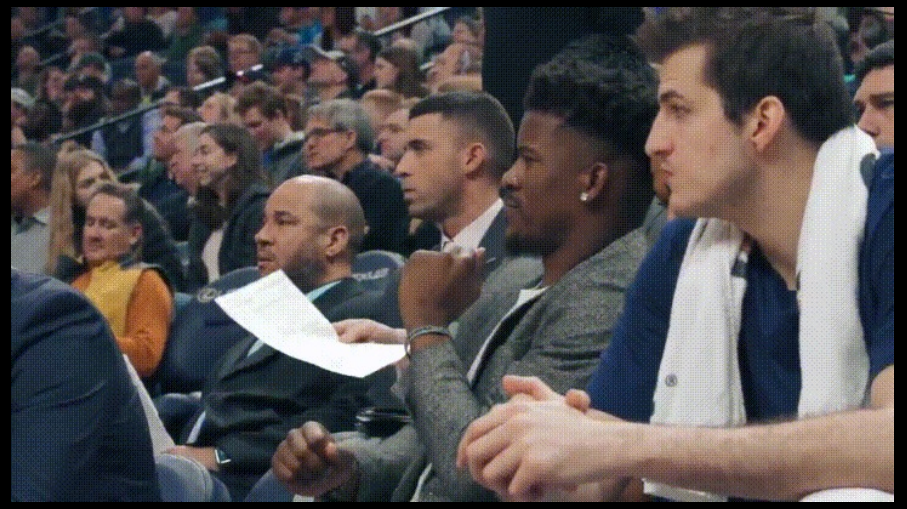
- Using aggregated player stats in lieu of clustering-created feature set
- Re-Calibrating the balance between play-style vs. production
- Tune learners to account for lineup playing-time by using “weights” on minutes attribute

Aggregated combinations of individual player statistics are not conducive to consistently forecasting a lineup’s performance.

ALTERNATIVE USE-CASE:

~~*Comprehensive* tool to drive lineup / roster decisions~~

Complementary tool to assess positional diversity on roster



Lineup Evaluator

This app is designed to aid NBA coaching staff in lineup selections and the front-office in trade/free-agency decisions.

Test out a lineup:

Point-Guard: LaMelo Ball

Shooting-Guard: Nicolas Batum

Small-Forward: Kevin Durant

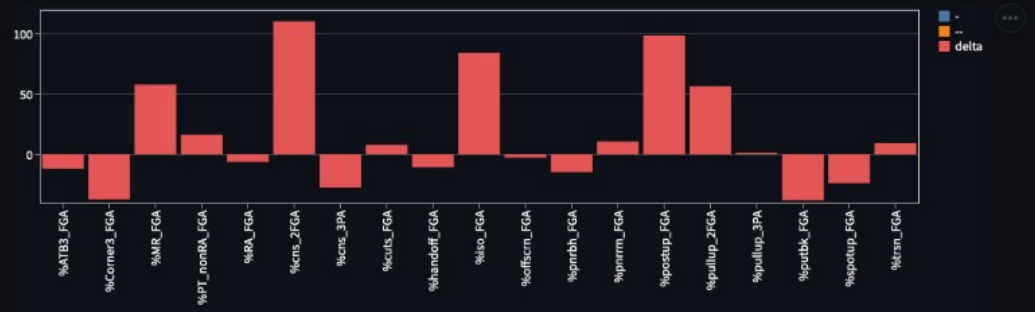
Power-Forward: Giannis Antetokounmpo

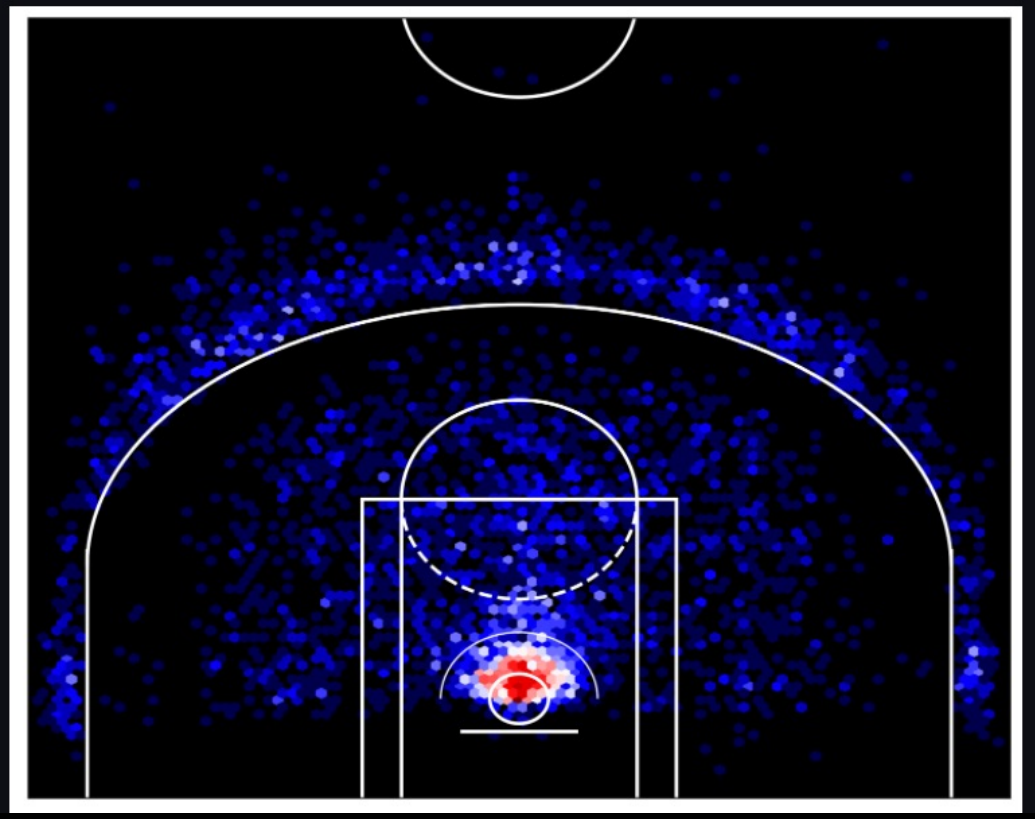
Center: Bam Adebayo





Projected Offensive Rating	Projected Defensive Rating	Estimated Net Rating
113.2	103.7	+9.5





Interactive Web-App made via *Streamlit*