Optimizing Defensive Softball Shifting Models

Chloe Kelly, Matthew Lemoine, Gowri Priya Sunkara, and Finley Westmoreland

April 28, 2026

Outline

Introduction

The Goal of Shifting Models

In softball, like baseball, the main goal is to score runs. A run is scored when a player advances through all 3 bases and touches home plate. There are 7 innings, which gives each team's lineup 7 opportunities to run the bases after batting.

The Goal of Shifting Models

In softball, like baseball, the main goal is to score runs. A run is scored when a player advances through all 3 bases and touches home plate. There are 7 innings, which gives each team's lineup 7 opportunities to run the bases after batting. When an offensive player bats, the defense's job is to get that player out by either catching the ball or tagging the player out.

Ted Williams

Lou, Ted Williams Still Remember That Shift

COOPERSTOWN, N.Y. (AP) — The Lou Boudreau Shift is over 33 years old now but Boudreau hasn't forgotten. Neither has Ted Williams, the man it was designed to hobble.

"I had thought about it for weeks," said Boudreau, one of the four new members inducted Monday into baseball's Hall of Fame. "Ted killed us when we played at League Park with its short right field line."

"In the first game of a doubleheader with Boston July 14 1947," said the former player-manager of the Cleveland Indians, "I got five extra base hits but Williams beat us with three home runs — he scored three and knocked in six. Right then and there, between games of the doubleheader, I decided to use the shift."

In the Boudreau shift, all of the infielders stacked up on the right side and the center fielders moved into right center. They dared the left handed hitting slugger to go to the opposite field. The only man on the left side of second base was Dale Mitchell the left fielder, who shortened up a bit.

"In all the years since then," said Boudreau, "Ted mentioned it to me only once. That was when he came to Cleveland for a celebration a year or two ago."

"Ted was such a great hitter that there was no way of stopping him at bat. You just tried to cut down on the damage. But I know he did admit to somebody up in Boston that, from 1947 until he quit in 1960, that the shift took a total of 200 points off his average."

Boudreau, who won a pennant in 1948 by hitting two home runs and two singles in the tie playoff game at Boston, was the last of the successful player-managers.

"The reason you don't see player-managers any more," said Boudreau, "is that they give present day managers more responsibilities, the individuals play more than one or two positions now. In my day nobody played more than two positions. Now a fellow may play three or four.

"A manager has to be in a position where he can study his bench and make shifts when necessary. A lot of games are won that way by studying the lineup and making the switch at the right time."

Did Boudreau think the day of the player-manager was over for all time?

"No" he said. "Eventually somebody will come along who can handle the new faster game and still play at the same time."

Boudreau, 53, was inducted into the Hall of Fame Monday with Ford Frick, Earl H. Combs and Jesse Haines. The four new inductees whose plaques were unveiled by Commissioner Bowie Kuhn, boosted the total membership at 138.

Boudreau was voted in by the veteran baseball writers. Frick, 76, Haines, 74, and Combs, 70, were elected by the special veterans committee which considers only players out of action at least 19 years and retired executives and umpires.

Frick, actually the founder of the Hall of Fame in his days first as National League president and later as commissioner, said, "without the memories of the past there can be no dreams of greatness for the future."

Haines recalled the old days when he was purchased by the St. Louis Cardinals, for whom he pitched 18 years, at the price of $50,000 and asked "what do you suppose they would pay for a pitcher like that (he won 210 games) in this day and age?"

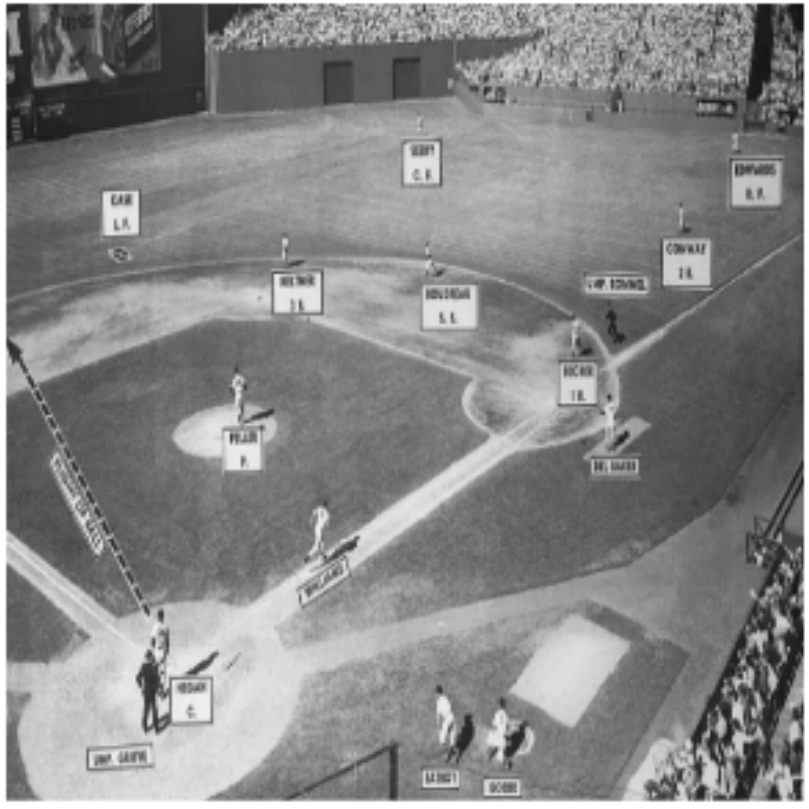


Figure 1: History of shifting with Ted Williams from Boston Red Sox playing against the Cleveland Indians.

The Goal of Shifting Models

Our core question: What is the most optimal way to position our players on the field so that they are more likely to catch a ball after it has been hit?

The Goal of Shifting Models

Our core question: What is the most optimal way to position our players on the field so that they are more likely to catch a ball after it has been hit?
This problem is called player shifting. We are analyzing how a defensive player's shift can maximize their probability of getting an out. These shifts will look different based on the batter's hand dominance.

The Code

The Goal of the Code

We have access to Trackman data from LSU Softball. Using this, we are aiming to take three major variables recorded from the motion and final location of batted balls (direction, launch angle, and velocity) and use these variables to create seven "buckets" in which fielders can position themselves on the field to optimize outs.

How it Works

The framework of our code uses k-means clustering with k=7 "buckets" to determine the optimal position (centroid) of each of the seven defensive players.

How it Works

The framework of our code uses k-means clustering with k=7 "buckets" to determine the optimal position (centroid) of each of the seven defensive players. With these centroids, the code runs through minimizing the max-min equation obtained from a zero-sum game to calculate the optimal shift.

The Visualization

The Goal of Visualization

Once we have the data for the optimal fielder positions, we must take that raw data and map it onto a visual representation of the softball field. This will be used by coaches, players, and staff to make quick game-time movement decisions.

How it Works

Visualization begins by mapping the buckets onto a model of Tiger Park's field.

How it Works

Visualization begins by mapping the buckets onto a model of Tiger Park's field. We created a cartesian coordinate system in which the x-axis is situated directly behind home plate, with the y-axis extending perpendicular to the x-axis and bisecting the pitcher's mound to the back fence.

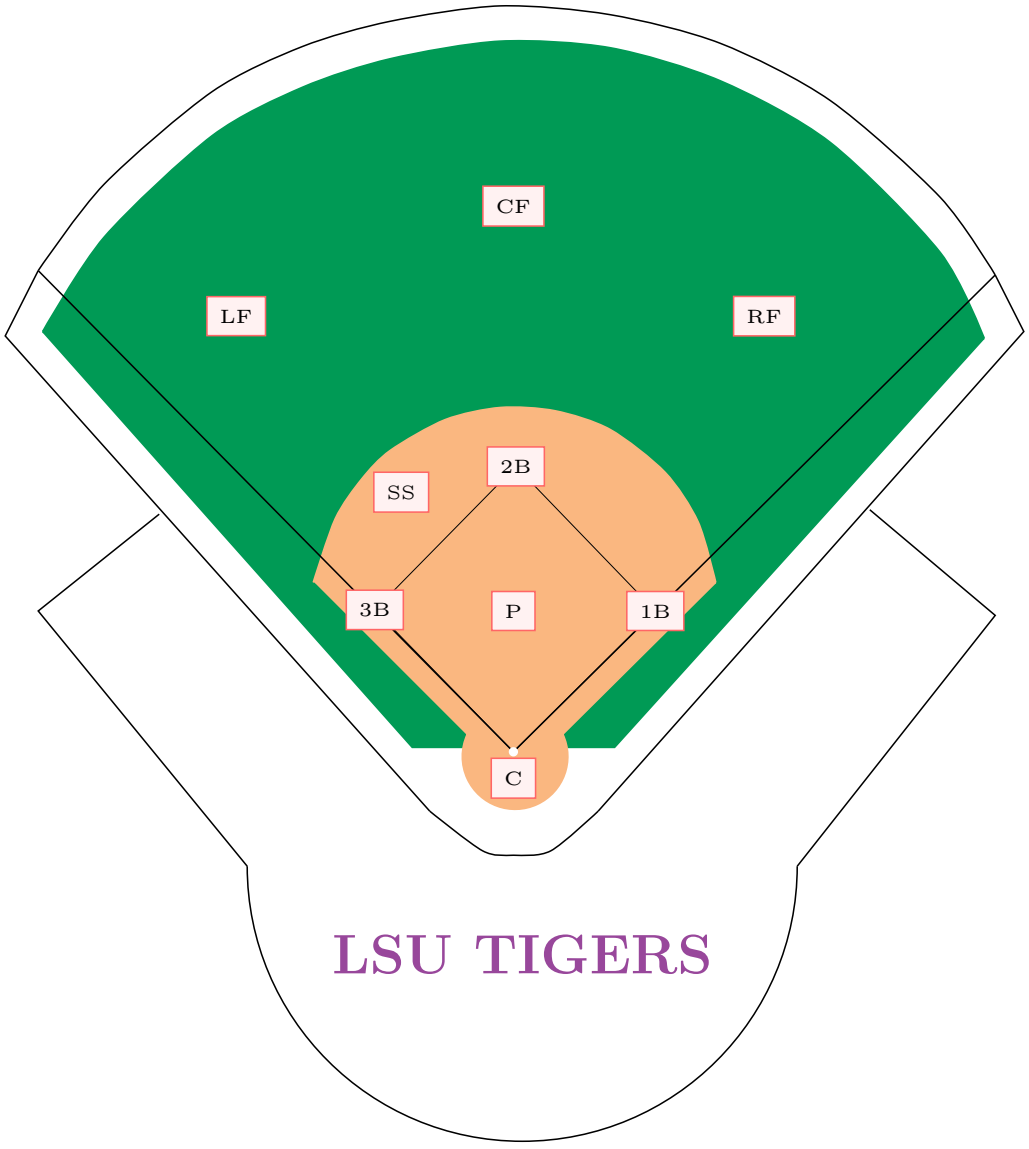


Figure 2: Standard Positioning for Defensive Players

How it Works

Each ball is then converted into cartesian coordinates, using the following process:

How it Works

Each ball is then converted into cartesian coordinates, using the following process:

$$p_i = (x_i, y_i), \quad x_i = d_i \sin(\theta_i), \quad y_i = d_i \cos(\theta_i) \tag{1}$$

How it Works

Each ball is then converted into cartesian coordinates, using the following process:

$$p_i = (x_i, y_i), \quad x_i = d_i \sin(\theta_i), \quad y_i = d_i \cos(\theta_i) \tag{1}$$

Each ball is weighted according to its expected run value and the locations of any runners on base

How it Works

Each ball is then converted into cartesian coordinates, using the following process:

$$p_i = (x_i, y_i), \quad x_i = d_i \sin(\theta_i), \quad y_i = d_i \cos(\theta_i) \tag{1}$$

Each ball is weighted according to its expected run value and the locations of any runners on base

$$w_i = w_i^{xRV} \times w_i^{zone} \tag{2}$$

How it Works

Each ball is then converted into cartesian coordinates, using the following process:

$$p_i = (x_i, y_i), \quad x_i = d_i \sin(\theta_i), \quad y_i = d_i \cos(\theta_i) \tag{1}$$

Each ball is weighted according to its expected run value and the locations of any runners on base

$$w_i = w_i^{xRV} \times w_i^{zone} \tag{2}$$

With this weighted value, we can approximate the optimal solution of the surrounding defenders through iterations of the following equation:

How it Works

Each ball is then converted into cartesian coordinates, using the following process:

$$p_i = (x_i, y_i), \quad x_i = d_i \sin(\theta_i), \quad y_i = d_i \cos(\theta_i) \tag{1}$$

Each ball is weighted according to its expected run value and the locations of any runners on base

$$w_i = w_i^{xRV} \times w_i^{zone} \tag{2}$$

With this weighted value, we can approximate the optimal solution of the surrounding defenders through iterations of the following equation:

$$i^* = \arg\max_i w_i \times \min_j \|p_i - d_j\|, \tag{3}$$

How it Works

The nearest defender is then determined by

$$j^* = \arg\min_j \|p_i - d_j\|$$

How it Works

The nearest defender is then determined by

$$j^* = \arg\min_j \|p_i - d_j\|$$

This defender is then moved to the optimal position by calculating $d_{j*} \leftarrow d_j^* + \eta \left(p_i^* - d_j^* \right)$

How it Works

The nearest defender is then determined by

$$j^* = \arg\min_j \|p_i - d_j\|$$

This defender is then moved to the optimal position by calculating $d_{j^*} \leftarrow d_j^* + \eta \left(p_i^* - d_j^* \right)$, where $\eta > 0$ is a step size parameter.

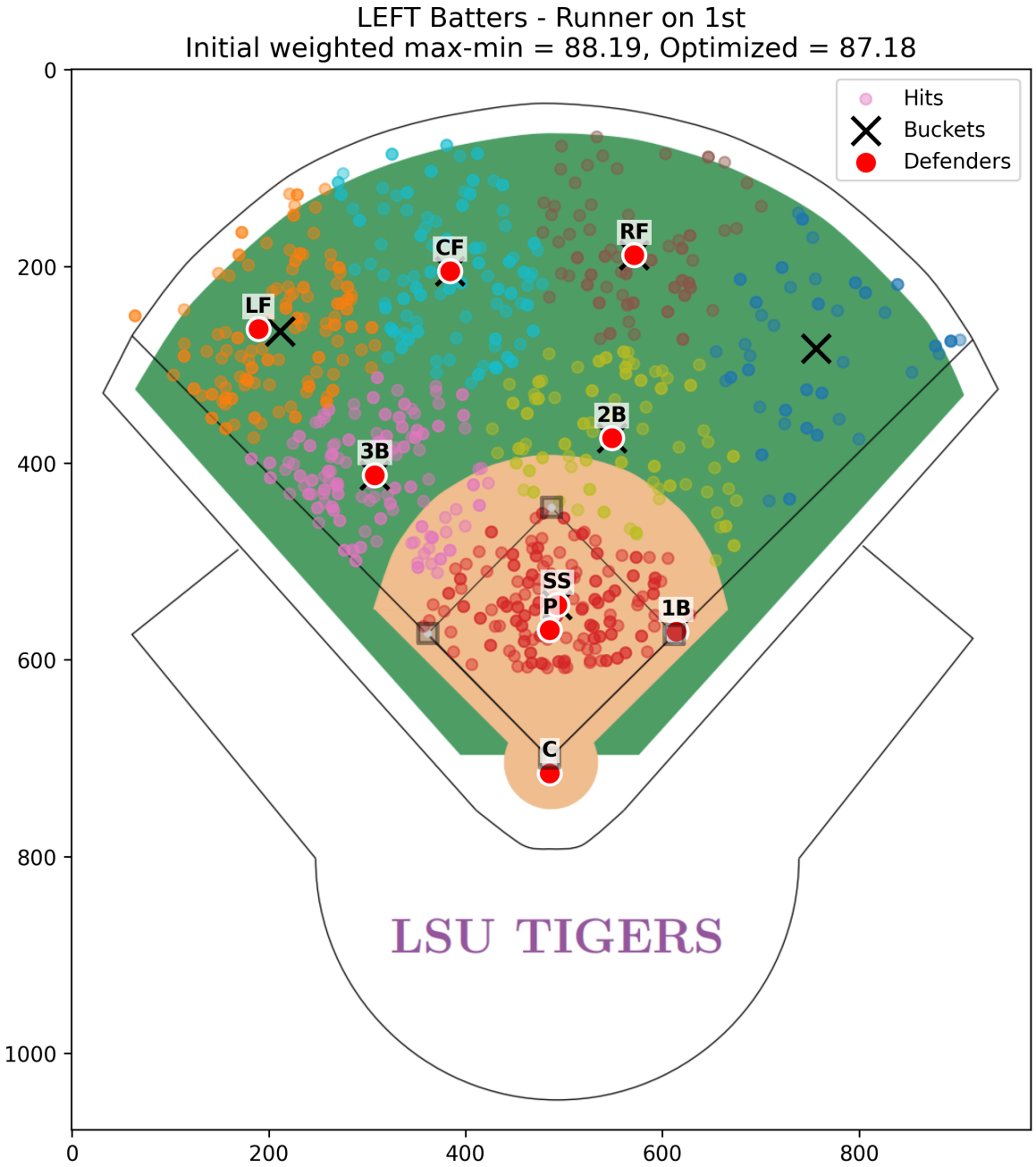
How it Works

The nearest defender is then determined by

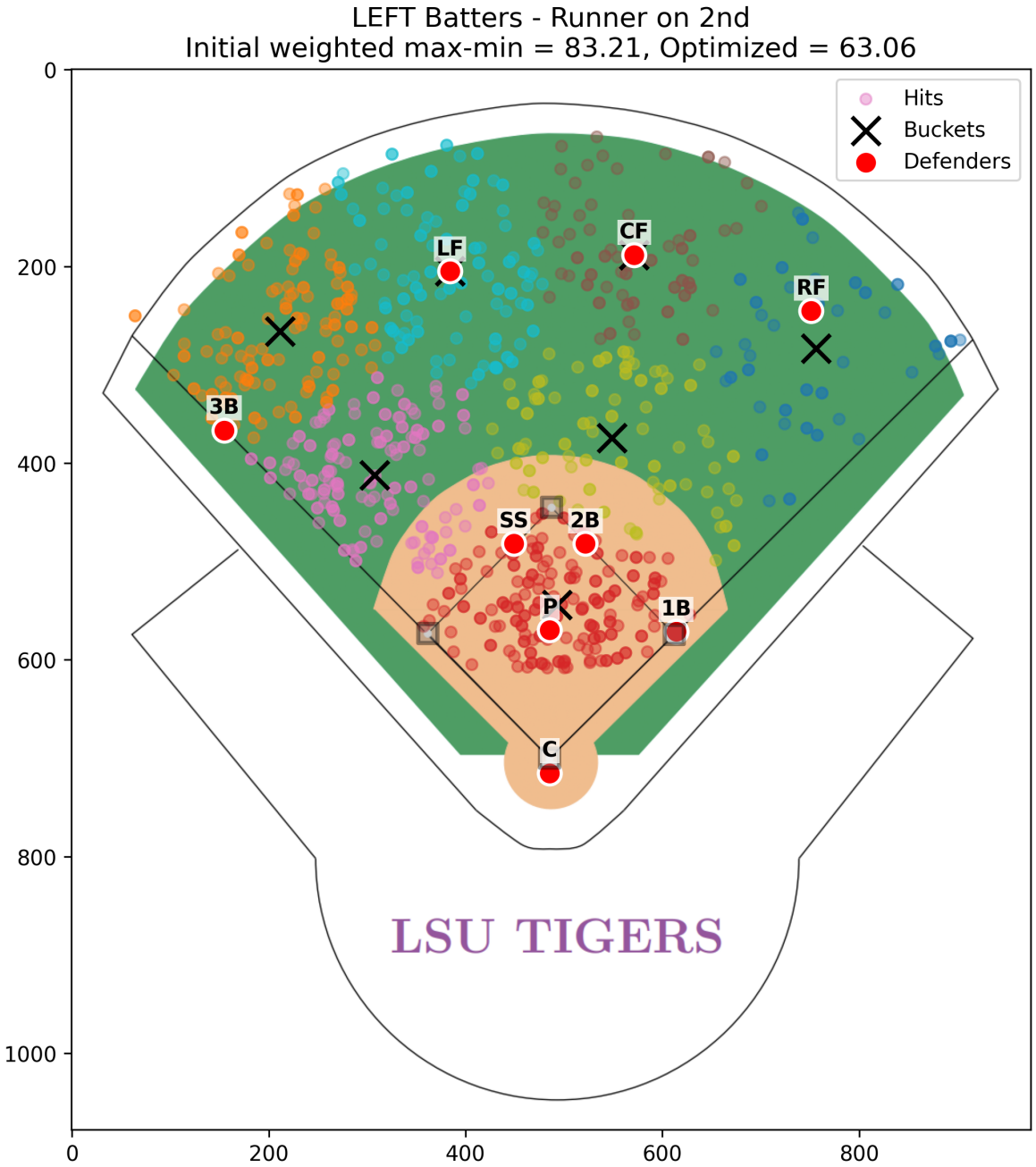
$$j^* = \arg\min_j \|p_i - d_j\|$$

This defender is then moved to the optimal position by calculating $d_{j*} \leftarrow d_j^* + \eta \left(p_i^* - d_j^* \right)$, where $\eta > 0$ is a step size parameter.
This process is repeated with a fixed number of iterations. In every scenario the pitcher and catcher are in fixed positions, and further restrictions are put in place depending on the configuration of runners on base.

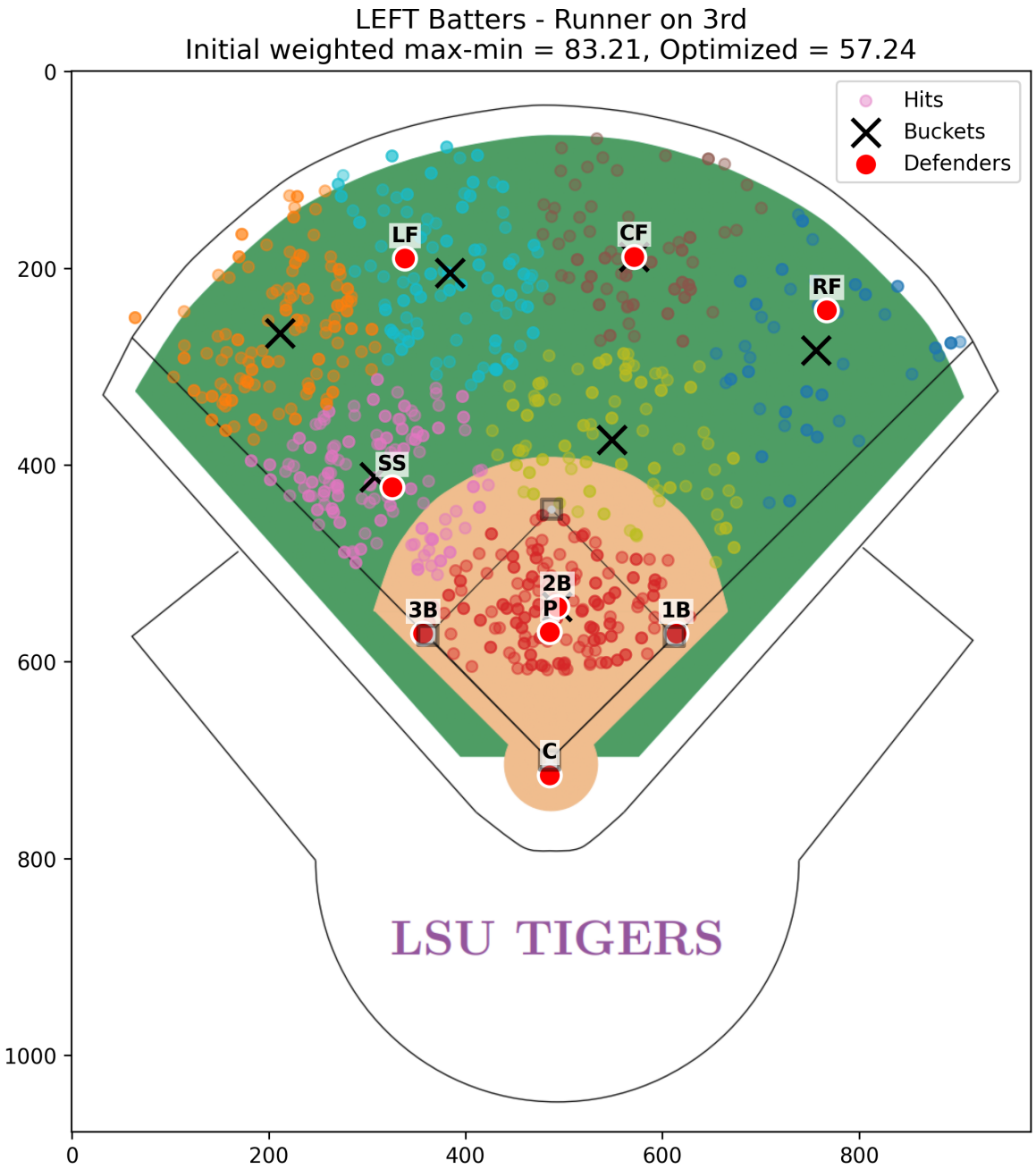
The End Results



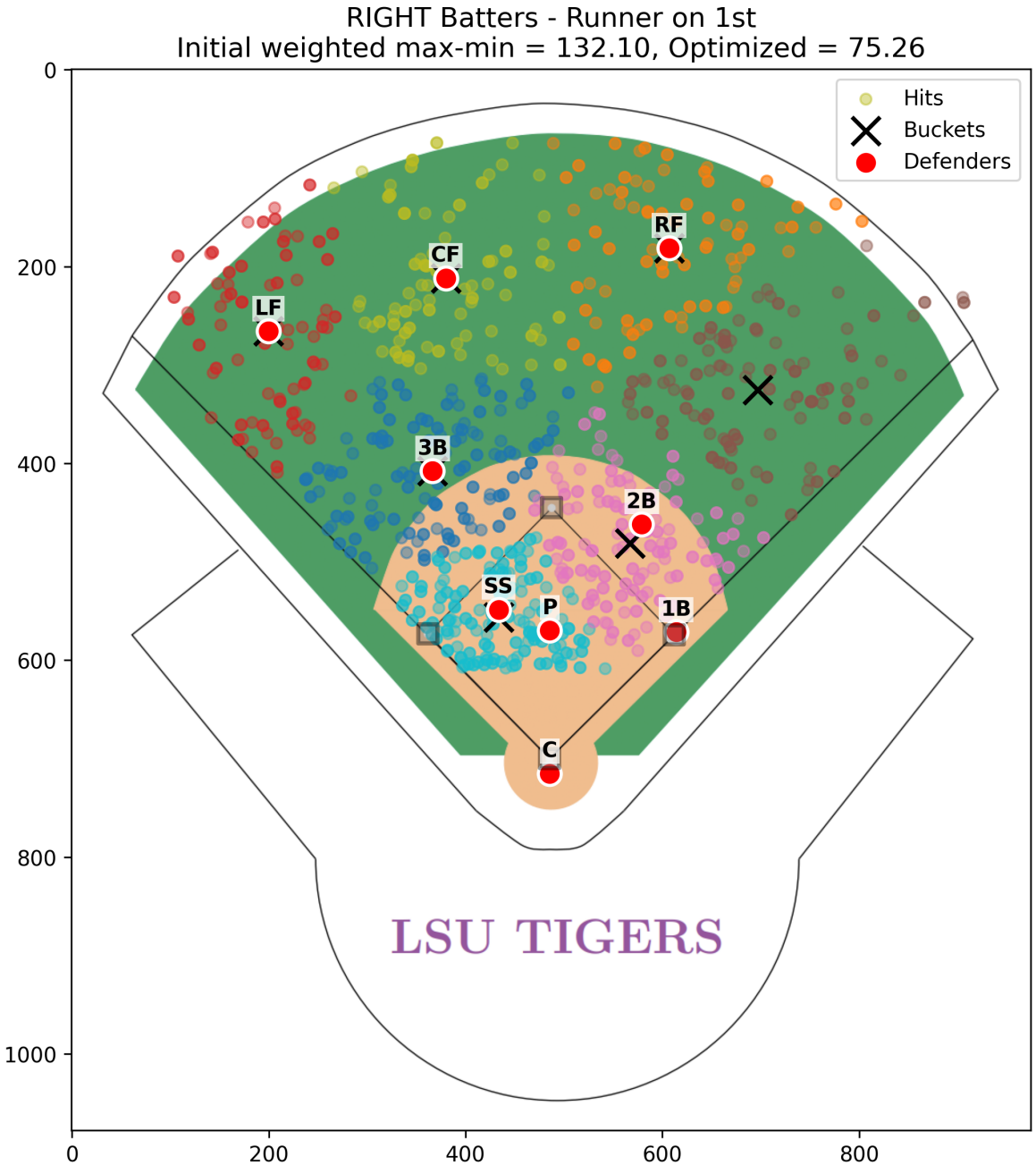
The End Results



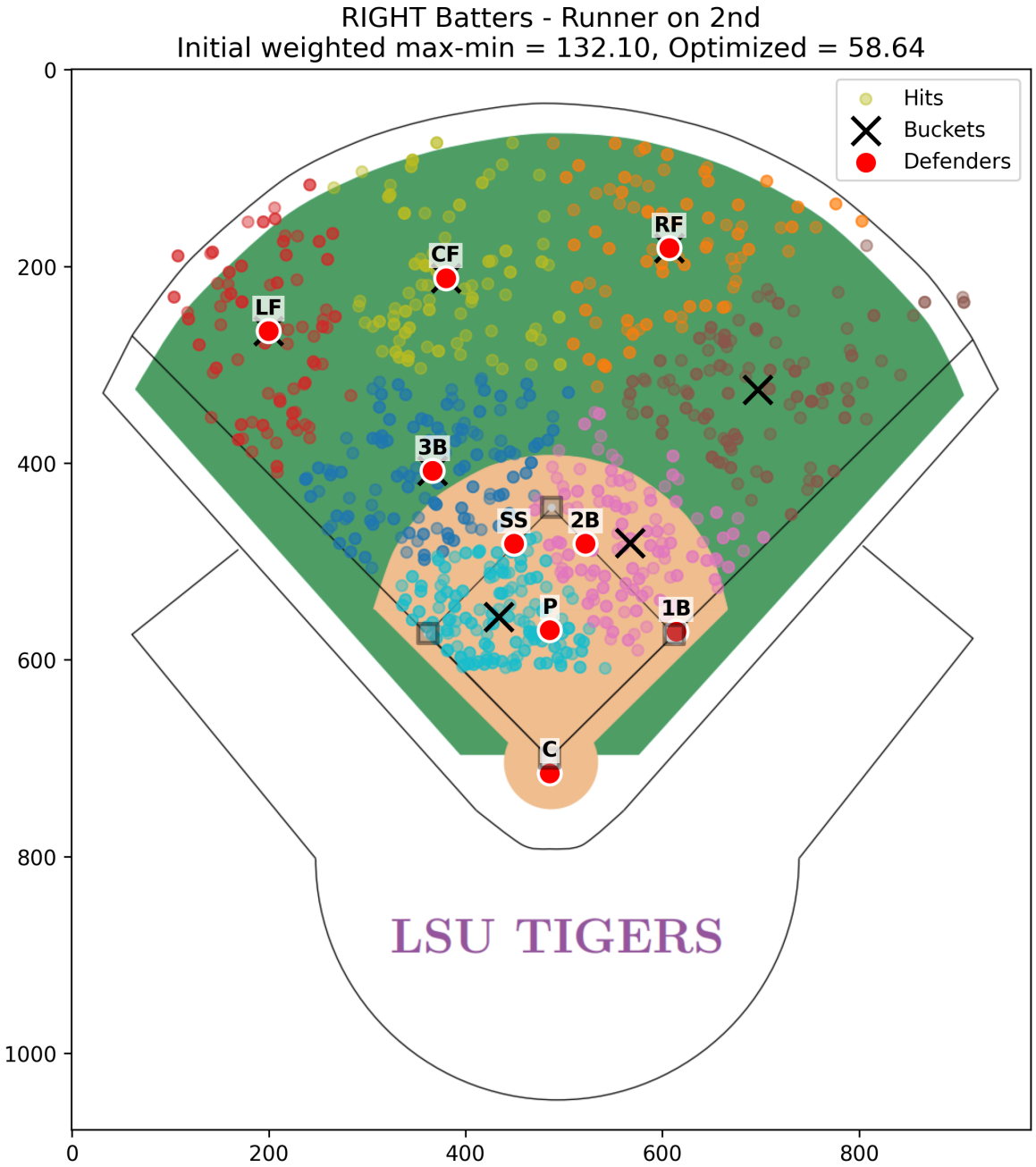
The End Results



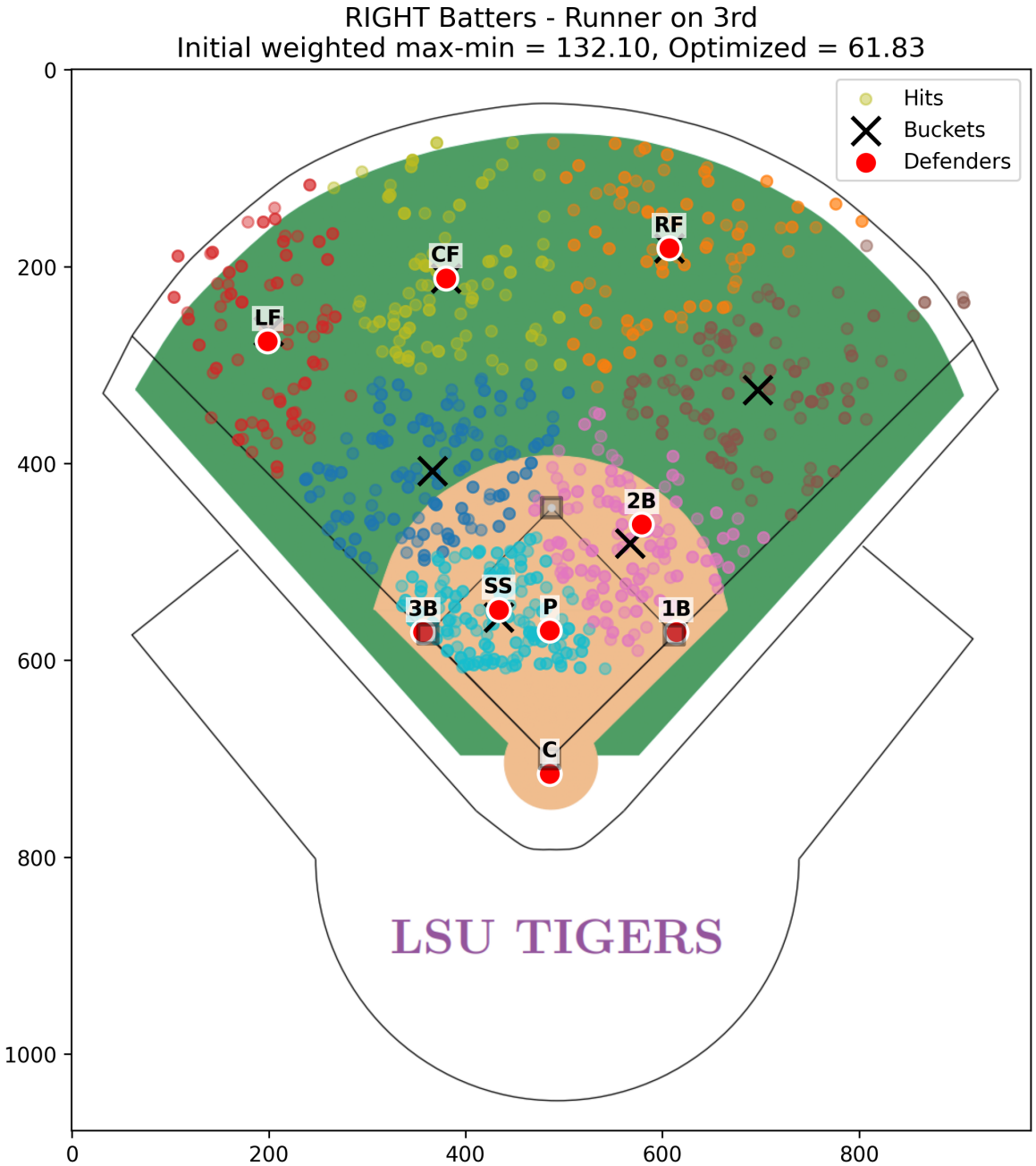
The End Results



The End Results



The End Results



Next Steps

Future Improvements

There is room and opportunity for multiple directions of future research in this project.

Future Improvements

There is room and opportunity for multiple directions of future research in this project.

Adjusting the code with specific teams and players can provide game plans tailored to an opponent's batting lineup and tendencies. This will give LSU an edge in future matchups.

Future Improvements

There is room and opportunity for multiple directions of future research in this project.

Adjusting the code with specific teams and players can provide game plans tailored to an opponent's batting lineup and tendencies. This will give LSU an edge in future matchups.

It would be incredibly beneficial for future research to include multiple runners on base in different iterations, as our code focused on only one runner on base. An immediate opportunity in this research would be to integrate HDBSCAN and Gaussian Mixture Models in addition to our k-clustering model.

References

John Harris, Elizabeth Bouzarth, Benjamin Grannan, Andrew Hartley, Kevin Hutson, and Ella Morton.

Swing shift: A mathematical approach to defensive positioning in baseball.

42 Analytics, 2020.

William Melville, Smuel Wise, Grant Nielson, Tristan Mott, Christopher Archibald, and David Grimsman.

Optimizing baseball fielder positioning with consideration for adaptable hitters.

42 Analytics, 2024.

Neil Paine.

Why baseball revived a 60-year-old strategy designed to stop ted williams.

ABC News, 2016.

Thank You!!
Questions?