1 Introduction to Pitcher Deception

Pitching deception in baseball refers to a pitcher's ability to enhance the perceived effectiveness of their pitches by misleading batters and complicating their decision-making process. This crucial skill manifests through multiple techniques that work in concert to increase the difficulty of making solid contact:

- **Movement Deception:** The difference between expected and actual pitch movement based on velocity and spin rate
- **Release Point Strategy:** Utilizing consistent or strategically varied release points to obscure pitch type
- **Contact Management:** The ability to induce weak contact through deceptive pitch sequences

To quantify these aspects of deception, we developed a comprehensive model incorporating four key metrics:

$$\text{Pitcher Deception} = \text{SMR} \times 0.3 + \text{RPD} \times 0.2 + \text{PMD} \times 0.25 + \text{WCR} \times 0.25$$

Where SMR (Swing and Miss Rate), RPD (Release Point Deviation), PMD (Pitch Movement Deception), and WCR (Weak Contact Rate) work together to evaluate a pitcher's overall deceptive capabilities. Using data from Baseball Savant (Statcast) and Pybaseball, this analysis examines how elite pitchers like Carlos Rodon and Shota Imanaga employ different combinations of these elements to achieve similar levels of effectiveness. Detailed derivations of these equations, comprehensive statistical analyses, and additional visualizations are provided in the appendix for further reference.

1.1 Key Metrics

1. **Swing and Miss Rate (SMR):**
    - Measures a pitcher's ability to generate swings that result in misses
    - Normalized against league average (23%)
    - Weighted by pitch usage frequency

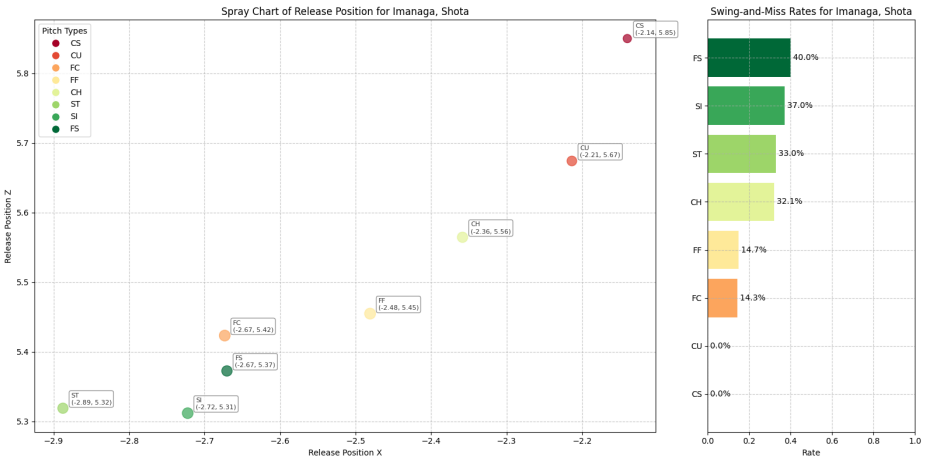
2. **Pitch Movement Deception (PMD):**
    - Quantifies deviation between actual and expected pitch movement, assumes ball travels to the heart of the plate with no movement
    - Based on velocity, spin rate, and pitch type
    - Normalized against league average deviation (2.0 inches)
3. **Release Point Deviation (RPD):**
    - Evaluates consistency of release points across pitch types
    - Considers x, y, and z coordinates
    - Normalized against league average standard deviation (0.1 feet)
4. **Weak Contact Rate (WCR):**
    - Assesses quality of contact when batters hit the ball
    - Based on launch angle (10°-25°) and exit velocity (<80 mph)
    - Includes ground ball hits (launch angle < 10) in WCR scoring
    - Normalized against league average rates

1.2 Data Sources

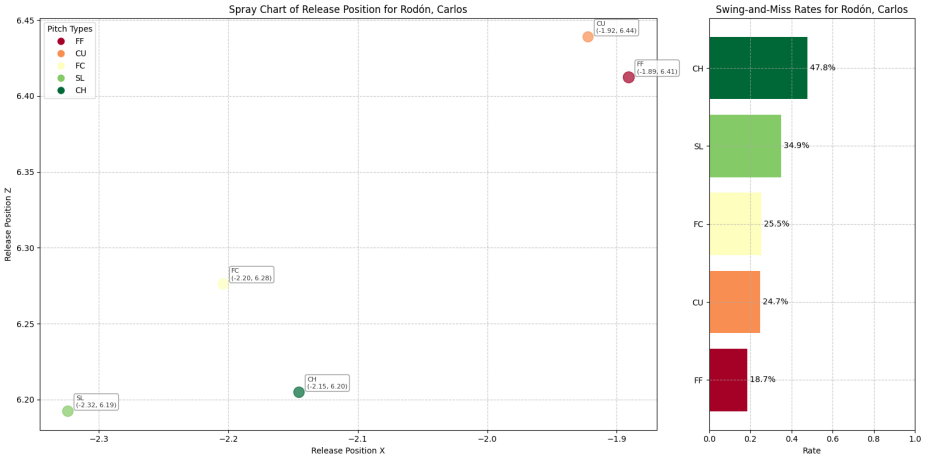
Analysis utilizes Statcast data from Baseball Savant and Pybaseball, focusing on the 2024 MLB season. This comprehensive dataset provides detailed pitch characteristics, movement patterns, and outcome metrics necessary for our analysis.

2 Analysis of Top Performers

To demonstrate our model's effectiveness, we analyze Carlos Rodon and Shota Imanaga, focusing on their deceptive capabilities through each metric.



(a) Imanaga Spray Chart + Swing and Miss Rate

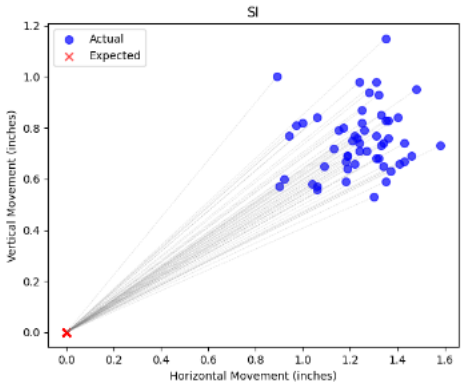


(b) Rodon Spray Chart + Swing and Miss Rate

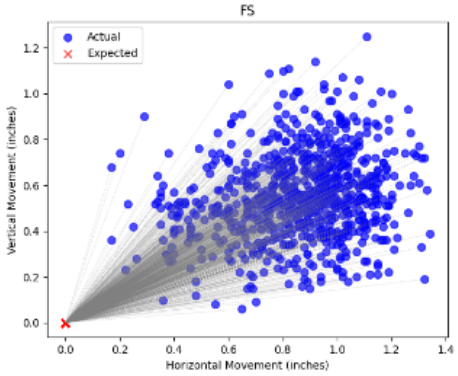
Figure 1: Spray Charts + Swing and Miss Rates

2.1 SMR Analysis (Swing and Miss Rate)

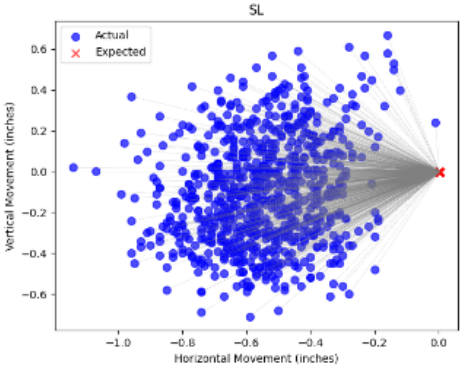
Key findings show Rodon's superior SMR score (119 vs 106), driven by his highly effective changeup. Both pitchers demonstrate strong secondary pitches, contributing to their overall deceptiveness.



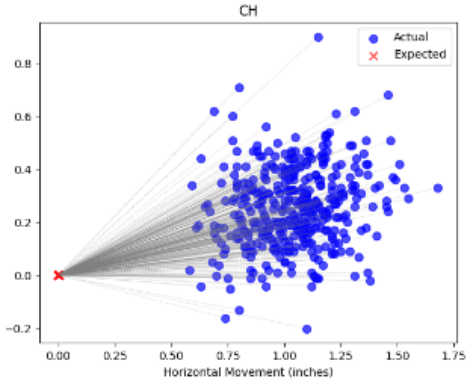
(a) Act vs Exp - Imanaga SI



(b) Act vs Exp - Imanaga FS



(c) Act vs Exp - Rodon SL



(d) Act vs Exp - Rodon CH

Figure 2: Pitch Expectancy vs Actual for Imanaga and Rodon

2.2 PMD Analysis (Pitch Movement Deception)

Imanaga recieves a score of 71 and 62 for Rodon through different approaches:

- **Imanaga:** Dramatic vertical movement (Splitter: 12", Sinker: 17")
- **Rodon:** Balanced deviations (Changeup: 12", Slider: 6")
- **Both Takeaways:** The red X is placed for reference of a straight trajectory towards the center of the plate and the separations demonstrate the movement trajectories in their pitch arsenal

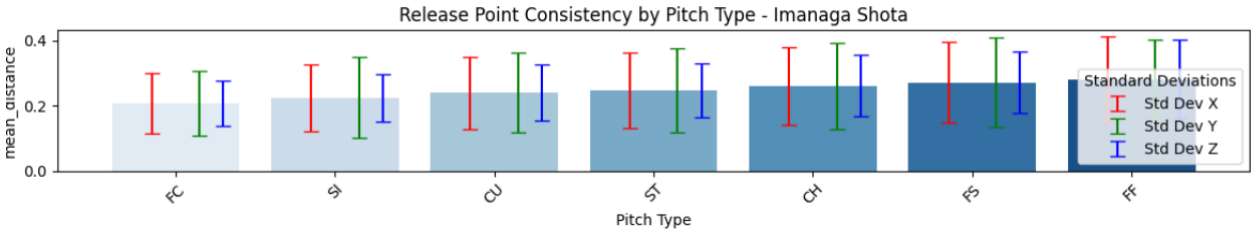


Figure 3: Release Point Consistency - Imanaga

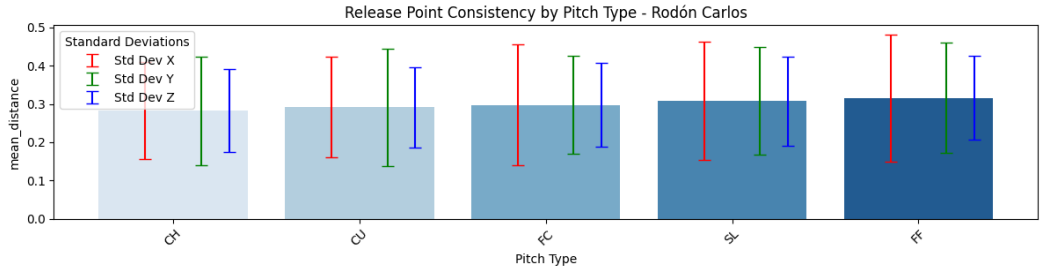


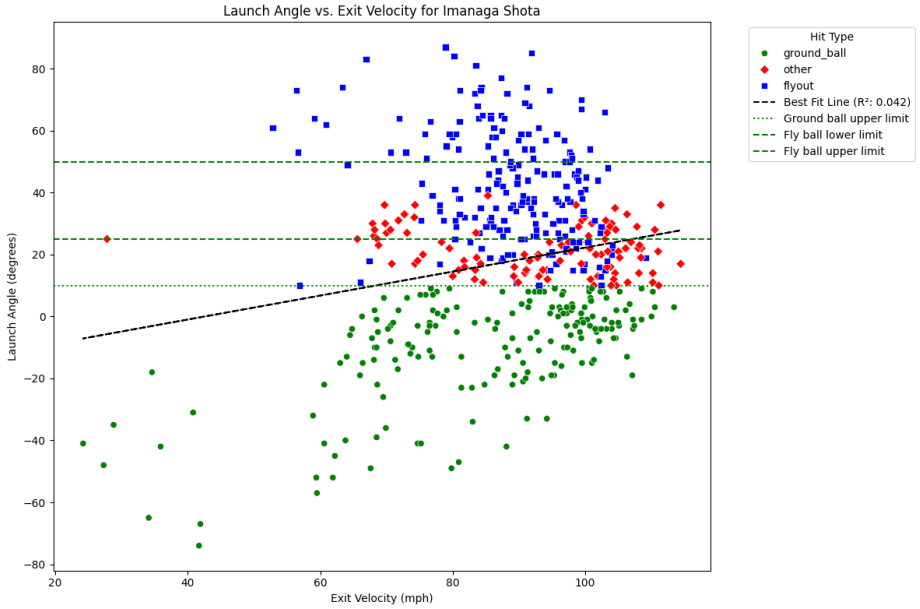
Figure 4: Release Point Consistency - Rodon

2.3 RPD Analysis (Release Point Deviation)

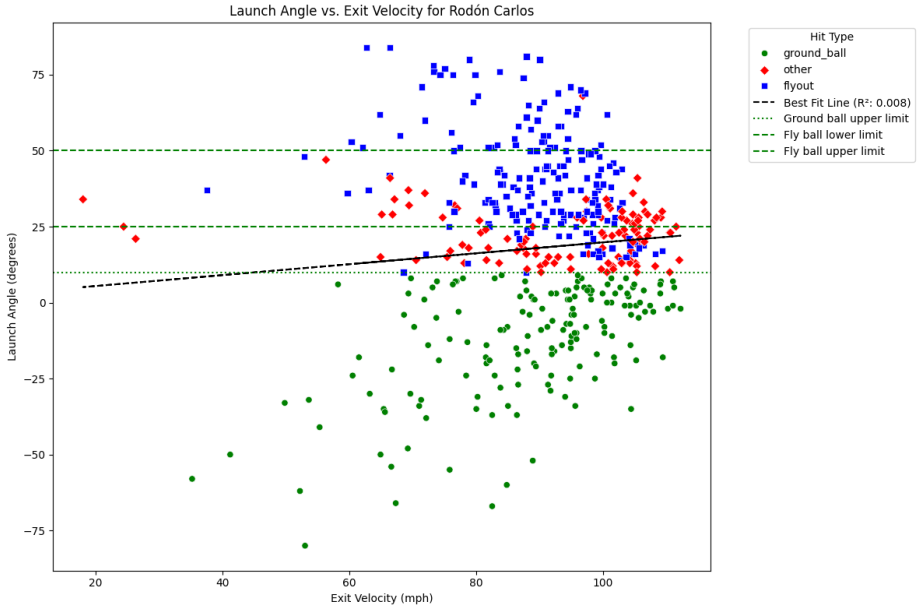
Release point analysis reveals:

- **Imanaga- RPD(78.8)**: Greater y-axis variation, particularly with Splitter/Sinker
- **Rodon - RPD(74)**: Significant x-axis variation in primary pitches
- **Assumptions**: Standard Deviation errors bars are intentional by the pitcher and not due to pitching mechanical issues
- **Both Pitchers**: Standard deviations on all three directions, signifying intentional deviations to throw batters off with each unique pitch

We will now Analyze the Weak Contact Rates (WCR), with plots and analysis in the next page.



(a) Launch Angle vs Exit Velocity - Imanaga



(b) Launch Angle vs Exit Velocity - Rodon

Figure 5: Launch Angle vs Exit Velocity Comparison

2.4 WCR Analysis (Weak Contact Rate)

Contact patterns show distinct approaches:

Imanaga: WCR(2.9)

- High ground ball rate (60-90 mph EV)
- FS: 24.7% fly out rate
- SI: 54.1% fly out rate

Rodon: WCR(2.7)

- Balanced contact distribution
- SL: 34.8% fly out rate
- CH: 30.6% fly out rate

Takeaways:

- **Exit Velo Distributions:** Imanaga Shota and Cole Ragans show similar exit velocity ranges (roughly 20-100 mph), but their launch angle distributions reveal key differences in their deceptiveness.
- **Deception Analysis:** Imanaga appears more deceptive for several reasons:
  - His flyouts (blue squares) are more densely clustered in the upper range of launch angles (40-80 degrees)
  - There's a clearer separation between his ground balls and flyouts, suggesting better control of contact type
  - His best fit line has a lower R^2 value (0.042 vs 0.052), indicating more unpredictable contact
- **Contact Pattern Differences:**Imanaga generates more varied launch angles on similar exit velocities
- The spread of his ground balls (green dots) is more dispersed, making it harder for batters to anticipate contact
- **Whos Better?** Imanaga demonstrates superior pitch deception because his contact patterns are less predictable and show more variation in launch angles at similar exit velocities. This unpredictability makes it more challenging for batters to square up his pitches effectively, even when they make contact.

2.5 Metric Relationships

The analysis reveals key relationships between metrics:

- High PMD scores correlate with increased swing-and-miss rates
- Release point consistency impacts movement deception effectiveness
- Weak contact patterns align with pitch movement characteristics

3 Conclusion

Our comprehensive analysis of pitcher deception, focusing on Carlos Rodon and Shota Imanaga, demonstrates the multifaceted nature of effective pitching in MLB. Through our four-component model (SMR, PMD, RPD, and WCR), we've quantified how different approaches to deception can lead to similar levels of effectiveness:

- **Contrasting Styles:** While Rodon excels through balanced deception (SMR: 119) with moderate movement patterns, Imanaga achieves success through extreme vertical movement (Sinker: 17") and consistent release points (RPD: 78.8).
- **Component Integration:** The interaction between metrics reveals that effective deception can be achieved through various combinations, with each pitcher leveraging their strengths differently.
- **Practical Impact:** This model provides actionable insights for player development, scouting, and in-game strategy by quantifying previously subjective aspects of pitching deception.

Table 1: Final Deception Scores

Pitcher	Deception Score	SMR	PMD	RPD	WCR	Rank
Carlos Rodon	66.22	119	62	74.0	2.7	1
Shota Imanaga	65.35	106	71	78.8	2.9	2

Now using the model on a much bigger data set we compare the top 10 most ranked pitchers based on their pitch arsenal according to StatCast. Here is the Leaderboard on pitchers considered the most deceiving league wide.

Rank	**Player**	**PD Score**	**Best Pitch + Swing Miss Rate**	**2nd Best**
1	Rodón Carlos	66.22	CH (0.478)	SL (0.349)
2	Imanaga Shota	65.35	FS (0.400)	SI (0.370)
3	Ragans Cole	62.54	CH (0.456)	KC (0.311)
4	Gore MacKenzie	61.95	CH (0.472)	ST (0.391)
5	Cease Dylan	61.57	SL (0.409)	ST (0.357)
6	Gausman Kevin	60.44	FS (0.311)	SL (0.266)
7	Peralta Freddy	59.54	SL (0.391)	CH (0.327)
8	Greene Hunter	59.45	SL (0.357)	FS (0.244)
9	Parker Mitchell	49.72	SL (0.352)	FS (0.333)
10	Nelson Ryne	46.89	CH (0.197)	ST (0.167)

Table 2: Top 10 Most Deceptive Pitchers Rankings for 2024

A Supplementary Figures and Data

A.1 Data Tables

Pitcher	Pitch Type	Usage (%)	Velocity (mph)	SwM Rate	Norm. SMR
Rodón	Fastball	49.4	95.4	18.7	81.2
	Curveball	8.3	81.0	24.7	107.2
	Cutter	3.5	91.8	25.5	110.8
	Slider	26.0	86.8	34.9	151.8
	Changeup	12.9	85.5	47.8	207.8
Imanaga	Fastball	52.1	91.7	14.7	63.8
	Changeup	3.9	81.6	32.1	139.5
	Sinker	2.1	88.7	37.0	161.0
	Splitter	30.5	82.9	40.0	173.7
	Straight	7.6	81.7	33.0	143.4
	Cutter	0.5	89.8	14.3	62.1
	Curveball	3.3	72.7	0.0	0.0

Table 3: Pitch Summary Comparison

Pitcher/Pitch	Avg Deviation (ft)	Usage (%)	Norm. Deviation (ft)
Rodón			
Changeup	1.08	12.9	0.54
Curveball	1.04	8.3	0.52
Cutter	0.93	3.5	0.47
Fastball	1.66	49.4	0.83
Slider	0.62	26.0	0.31
Imanaga			
Changeup	1.29	3.9	0.64
Curveball	1.30	3.2	0.65
Fastball	1.75	52.0	0.88
Splitter	1.04	30.6	0.52
Sinker	1.45	2.1	0.72
Straight	0.92	7.7	0.46

Table 4: Pitch Deviation Comparison

A.2 Graphs

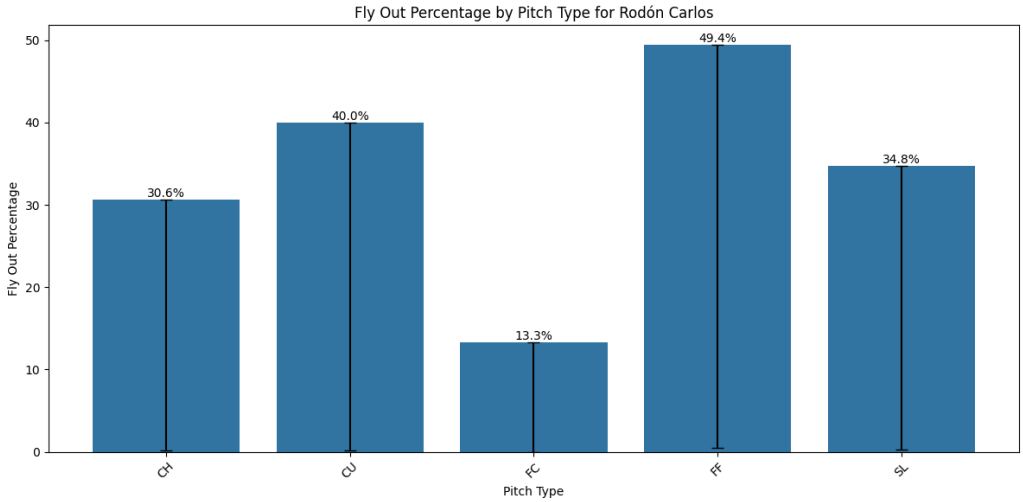


Figure 6: Fly out Percentage Rodon

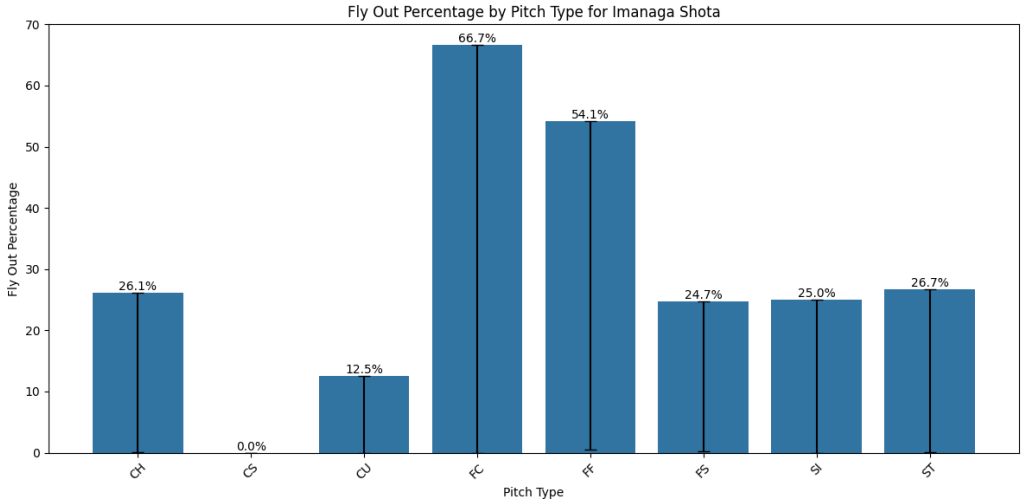


Figure 7: Fly out Percentage Imanaga

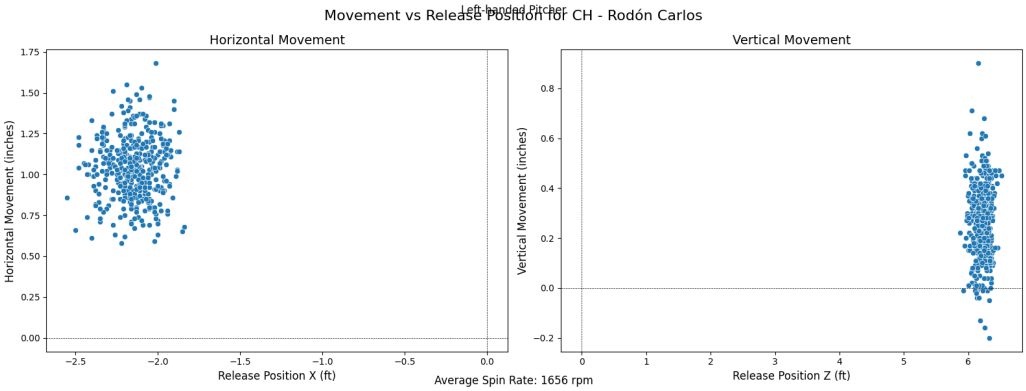


Figure 8: Rodon Change Up Movement vs Release Position

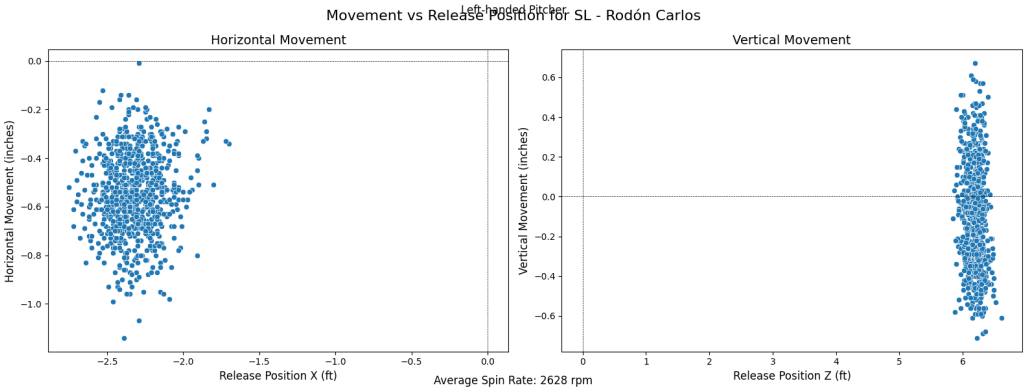


Figure 9: Rodon Slider Movement vs Release Position

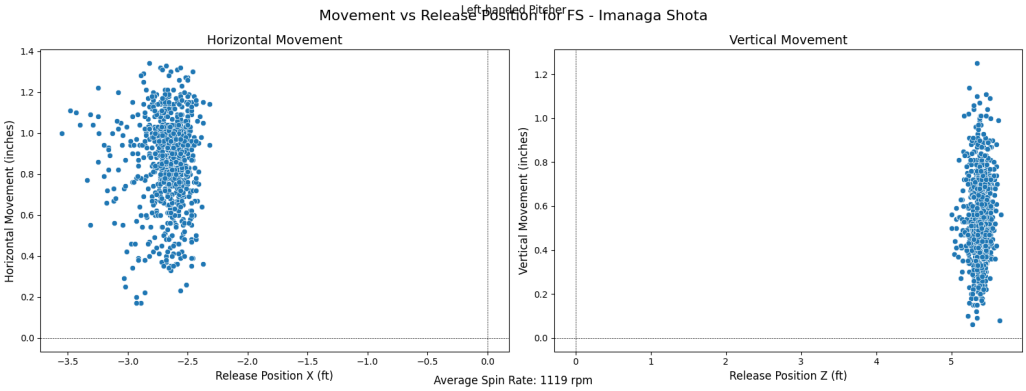


Figure 10: Imanaga Splitter Movement vs Release Position

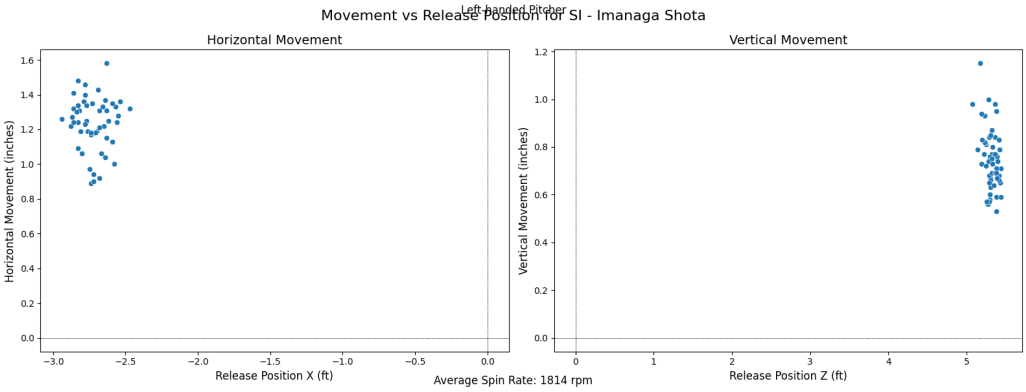


Figure 11: Imanaga Sinker Movement vs Release Position

B Detailed Methodology Overview

To quantify pitching deception, we analyze several key metrics:

1. **Actual vs. Expected Movement:** This visualization allows you to identify pitches that deviate significantly from what is expected based on their velocity and spin rate. Pitches that show greater discrepancies between actual and expected movement can be considered more deceptive, as they may mislead batters about where the ball will end up.

2. **Flyout Percentage Based on Launch Angle and Exit Velocity:** By analyzing the flyout percentage in relation to launch angle and exit velocity, you can gauge how effective each pitcher is at inducing weak contact or fly balls. A pitcher who consistently generates flyouts with high exit velocities may be more deceptive than one who does not.

3. **Horizontal and Vertical Movements vs Release Points:** This analysis highlights common trends in release points for different pitches. If a pitcher has similar release points for various pitch types, it can create a "tunneling" effect, making it harder for batters to distinguish between pitches until it's too late.

4. **Release Point Consistency:** Understanding the variation in release points for different pitches helps assess how predictable a pitcher is. A pitcher with low variation in release points across pitch types may be more deceptive, as batters cannot easily adjust their timing based on release position.

5. **Average Release Points and Swing-and-Miss Rates:** Analyzing average release points alongside swing-and-miss rates provides context for how effectively a pitcher can deceive batters. Higher swing-and-miss rates combined with consistent release points may indicate a particularly deceptive arsenal.

C Pitcher Deception Further Analysis

In the competitive landscape of Major League Baseball, pitcher deception plays a crucial role in determining a pitcher's effectiveness. Deceptive pitching can disrupt a batter's timing and perception, leading to increased swing-and-miss rates and reduced contact quality. By analyzing various metrics related to pitch movement, release point consistency, and swing-and-miss rates, we can identify pitchers who excel in creating deceptive conditions for hitters. This analysis not only enhances our understanding of pitching strategies but also provides valuable insights for teams looking to improve their performance on the mound.

The resulting leaderboard ranks pitchers based on their overall deception scores, which are calculated by weighing these metrics according to their impact on a batter's ability to make contact.

For instance, a pitcher with a high deviation score combined with low flyout percentages may indicate effective deception. This suggests that while batters are swinging at pitches, they are unable to make solid contact, leading to ground balls or weakly hit balls instead of flyouts. Additionally, pitchers who maintain consistent release points across different pitch types may benefit from a tunneling effect, making it difficult for batters to distinguish between pitch types until it is too late.

By presenting this analysis along with visualizations of swing-and-miss rates and pitch movement patterns, we can better understand the factors contributing to pitcher success and deception in the game.

C.0.1 SMR Equation

The SMR score is calculated using the following formula:

$$\text{Normalized SMR}_i = \frac{\text{SMR}_i}{\text{League Average SMR}} \times 100 \tag{1}$$

Where:

- i represents the i-th pitch type
- SMR_i is the swing and miss rate for pitch type i
- League average SMR is approximately 23%

The weighted normalized SMR is then computed as:

$$\text{SMR Score} = \sum_{i=1}^{n} (\text{Normalized SMR}_i \times \text{Pitch Usage}_i) \tag{2}$$

C.0.2 PMD Equation

The PMD score is calculated using the following steps:

1. Calculate expected movement for each pitch based on its velocity, spin rate, and type.
2. Compute the deviation between actual and expected movement in both horizontal and vertical directions.
3. Determine the total deviation as the Euclidean distance between actual and expected movement.
4. Normalize the deviations relative to a league average deviation (set at 2.0 inches in our model).
5. Weight the normalized deviations by pitch usage frequency.
6. Sum the weighted deviations to obtain the final PMD score.

The formula for the PMD score can be expressed as:

$$\text{PMD Score} = \sum_{i=1}^{n} \left(\frac{\text{Total Deviation}_i}{\text{League Average Deviation}} \times \text{Pitch Usage}_i \right) \times 100 \quad (3)$$

Where i represents each pitch type in the pitcher's arsenal.

Based on Figures in PMD section we are looking at a spray chart of both horizontal movements and vertical movements for Shota Imanaga. The red X depicts the expected movements that physically should travel/move, calculated using the following equation:

$$\text{Expected movement}_{\text{horizontal}} = \frac{k_{\text{horizontal}} \times \text{spin rate}}{\text{velocity}} \quad (4)$$

Where k is a weighted constant to prevent a division error we may encounter.

C.0.3 Transition to Release Point Deviation (RPD) Scoring

While the PMD scores provide valuable insights into how pitch movement contributes to deception, they don't tell the complete story. To further understand the multifaceted nature of pitcher deception, we now turn our attention to Release Point Deviation (RPD) scoring. This metric will help us analyze how consistent or varied a pitcher's release points are across different pitch types, adding another layer to our understanding of what makes these pitchers particularly deceptive.

C.1 RPD Scoring (Release Point Deviation)

Release Point Deviation (RPD) is a crucial component in our comprehensive pitcher deception model. This metric quantifies the consistency of a pitcher's release points across different pitch types. A consistent release point can enhance deception by making it difficult for batters to distinguish between pitch types based on the pitcher's arm action or release position. Conversely, strategic variations in release points can also contribute to deception by introducing uncertainty in the batter's perception.

The RPD score complements the previously discussed Swing and Miss Rate (SMR) and Pitch Movement Deception (PMD) metrics, providing a holistic view of a pitcher's deceptive capabilities. By analyzing release point consistency, we gain insights into how pitchers use spatial consistency or variation as part of their deceptive arsenal.

The RPD score is calculated using the following steps:

1. **Data Cleaning:** Remove outliers from release position data using the Interquartile Range (IQR) method to ensure robust analysis.
2. **Consistency Calculation:** For each pitch type:
   - Calculate the standard deviation of release positions in x and z directions.
   - Compute the mean pairwise distance between release points.
3. **Normalization:** Normalize the calculated standard deviations using a league average standard deviation (set at 0.1 feet in our model).
4. **Weighting:** Weight the normalized deviations by pitch usage frequency.
5. **Score Computation:** Sum the weighted, normalized deviations to obtain the final RPD score.

The formula for the RPD score can be expressed as:

$$\text{RPD Score} = \sum_{i=1}^{n} \left(\frac{\text{League Avg Std Dev}}{\text{Release Std Dev}_i} \times \text{Pitch Usage}_i \right) \times 100 \quad (5)$$

Where i represents each pitch type in the pitcher's arsenal.

C.1.1 Analysis of Release Point Consistency

To calculate the standard deviation of the average release points, we considered all three directions (x, y, z) for each pitcher's release points. This analysis allows us to assess the consistency of their pitch delivery.

As shown in Figures for RPD, we have plotted the mean distance (calculated using the Euclidean distance formula in 3D space) for each pitch type in their respective arsenals. The number of pitches thrown for each type is indicated above the bars.

Key observations:

- The average Euclidean distance between pitches varies between 0.28 to 0.302 feet for Rodon's pitch arsenal, with similar ranges for Imanaga.
- Error bars in all three directions are included to account for variability in release points.
- Imanaga's Splitter and Sinker show greater deviations in the y-direction compared to the x and z directions.
- Rodon exhibits even greater deviations for each of his pitches, with the most significant variations in the x-direction for his best pitches, the Changeup and Slider.

C.1.2 Implications for Pitcher Deception

The analysis of release point consistency provides insights into each pitcher's deceptive strategies:

- **Shota Imanaga:** Benefits from varying his release point when his arm is in front of his body, choosing to release the ball slightly earlier or later than his usual delivery.
- **Carlos Rodon:** Gains an advantage by varying his release point in the x-direction, potentially throwing off batters' timing by extending his arm fully outward, perpendicular to home plate.

These variations in release points can contribute to increased swing-and-miss rates and unexpected ball movement, as batters may incorrectly anticipate pitch trajectories based on inconsistent release points.

C.2 WCR Scoring (Weak Contact Rate)

Weak Contact Rate (WCR) is a crucial metric in our comprehensive pitcher deception model. It quantifies a pitcher's ability to induce poor quality contact from batters, complementing the previously discussed Swing and Miss Rate (SMR), Pitch Movement Deception (PMD), and Release Point Deviation (RPD) metrics. By analyzing WCR, we gain insights into how effectively a pitcher's deceptive techniques translate into unfavorable outcomes for batters, even when contact is made.

The WCR score is calculated using the following steps:

1. **Data Filtering:** We consider only batted ball events, excluding non-contact outcomes such as strikeouts, walks, and hit-by-pitches.
2. **Weak Contact Definition:** We define weak contact based on two key parameters:
   - **Launch Angle:** Batted balls with launch angles between 10° and 25°.
   - **Exit Velocity:** Batted balls with exit velocities less than 80 mph.
3. **WCR Calculation:** The weak contact rate is computed as follows:

$$\text{WCR} = \frac{\text{Number of Weak Contact Events}}{\text{Total Number of Batted Ball Events}} \times 100 \tag{6}$$

4. **Normalization:** The calculated WCR is normalized relative to the league average WCR to provide context for individual pitcher performance.
5. **Pitch Type Analysis:** We analyze WCR for each pitch type to identify which pitches are most effective at inducing weak contact.

C.2.1 Significance in Pitcher Deception

A high WCR indicates that even when batters make contact with a pitcher's offerings, the quality of that contact is poor. This suggests that the pitcher's deceptive techniques are effective not only in generating swings and misses (as measured by SMR) but also in disrupting the batter's ability to square up the ball when contact is made.

The combination of WCR with SMR, PMD, and RPD provides a comprehensive view of a pitcher's deceptive capabilities:

- **SMR** captures the ability to generate misses.

- **PMD** measures the unexpected movement of pitches.
- **RPD** quantifies the consistency or strategic variation in release points.
- **WCR** assesses the quality of contact when batters do hit the ball.

By analyzing these metrics together, we can gain a holistic understanding of how a pitcher's deceptive arsenal translates into favorable outcomes, whether through missed swings or poor quality contact.

D Further Research

Future research could expand upon this model by incorporating additional metrics such as pitch sequencing patterns, biomechanical data, or batter-specific outcomes. Nevertheless, the current model provides a robust framework for evaluating pitcher deception and effectiveness in modern baseball.