

# **Comprehensive Analysis of Max Fried's Performance: A Five-Year MLB Pitching Review**

STA 160

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# 1 Abstract

Max Fried, a professional baseball pitcher for the Atlanta Braves, has demonstrated notable improvements in his pitching performance over the past five years. This study leverages data from MLB Statcast, covering the period from 2017 to 2021, to analyze Fried's pitching dynamics. By focusing on key metrics such as release speed, spin rate, and effective speed, we aim to understand the evolution of his pitching effectiveness. Our analysis reveals significant correlations between these metrics and pitch outcomes, highlighting the impact of speed and spin on Fried's success. The study also addresses the challenges of unbalanced data and provides insights into the variability of pitch types over time. The results underscore Fried's adaptability and strategic adjustments, contributing to his increasing strike rates and overall effectiveness on the mound.

## 2 Introduction

Undoubtedly one of the United States' most popular sports, baseball has left a significant mark on the nation's sporting scene ever since its establishment in 1903. Major League Baseball (MLB) stands as the pinnacle of this classic sport, providing a stage where the world's greatest professional athletes showcase their talents at the highest level.

**The Baseball Game:** In a typical baseball game, the duel between the pitcher and the batter is one of the most intriguing aspects. The pitcher's role is crucial as they aim to retire batters by throwing various pitches, each with different speeds, spins, and trajectories. The effectiveness of a pitcher is determined by multiple factors including their pitch speed, spin rate, and the type of pitches they throw.

**Introduction of the Pitcher: Max Fried** Max Fried is an American professional baseball pitcher for the Atlanta Braves of MLB. Max Fried was drafted in 2012 by the San Diego Padres in the first round as the 7th overall pick, and debut in August 2017. This report focuses on his performance over his beginning five years (2017 - 2021), aiming to understand how his pitching metrics have evolved and impacted his success on the mound.

## 3 Exploratory Data Analysis

### 3.1 Dataset Description

In this study, we obtained data scraped from MLB Statcast, a state-of-the-art tracking system implemented across all Major League ballparks since the beginning of the 2017 season. We utilized the Statcast Pitcher API from GitHub to retrieve the

dataset for Max Fried, covering the period from 2017 to 2021.

Focusing exclusively on pitcher statistics, we preprocessed the dataset to include only relevant metrics related to baseball pitching dynamics.

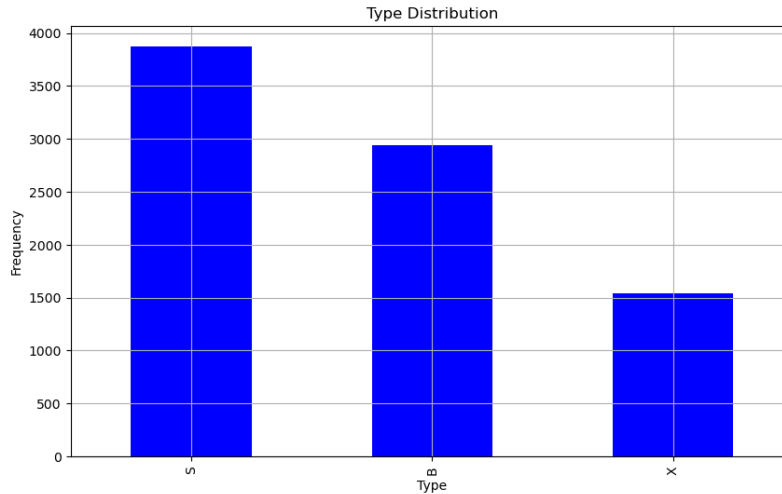
## 3.2 Data Cleaning and Preparation

Prior to working on the pitching dynamics dataset, we filtered the data to include only records from 2017 to 2021. To increase the accuracy and reliability of the dataset, we dropped features with NA values (e.g. `spin_dir`, `spin_rate_deprecated`, `break_angle_deprecated`, `break_length_deprecated`). We then removed predictors not associated with pitch dynamics, as they were meaningless (e.g. `post_fld_score`, `at_bat_number`, `fielder_2`, `fielder_3`). Furthermore, we dropped release parameters for pitching due to their complexity (e.g. `spin_axis`, `pfx_x`, `pfx_z`, `plate_x`). Additionally, we discarded predictors that were too influenced by the previously dropped predictors (e.g. `delta_home_win_exp`, `delta_run_exp`). To focus on performance changes over the years, we added the *year* column.

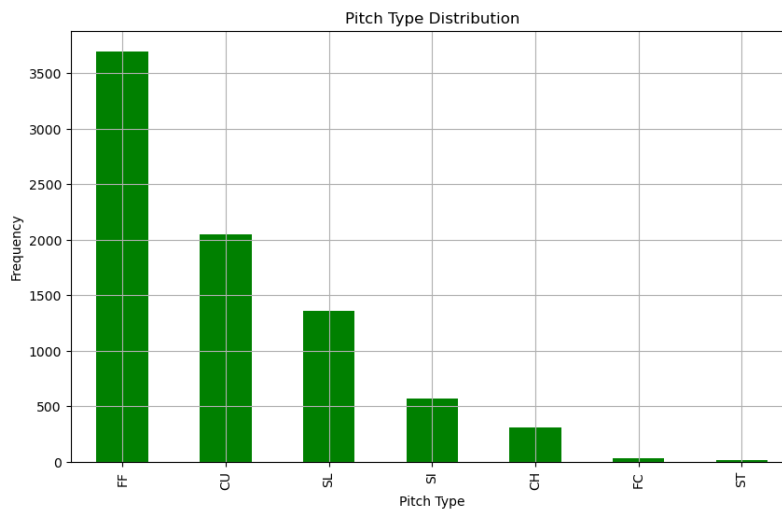
Column	Non-Null Count	Description
<code>pitch_type</code>	10418	Type of pitch thrown
<code>release_speed</code>	10417	Speed of the pitch at release (in mph)
<code>p_throws</code>	10743	Hand used by the pitcher to throw
<code>type</code>	10743	Result of the pitch
<code>effective_speed</code>	10415	Effective speed of the pitch
<code>release_spin_rate</code>	10395	Spin rate of the pitch at release (in RPM)
<code>release_extension</code>	10414	Distance from the pitcher's release point to plate
<code>year</code>	10743	Year in which the pitch was thrown

## 3.3 Initial Analysis

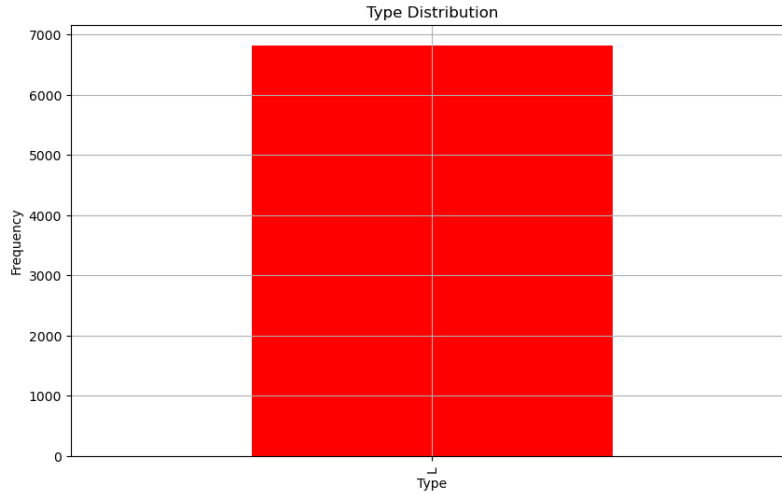
In the feature we choose, `type`, `pitch_type` and `p_throw` are categorical, we will plot the distribution.



The type variable has three values: S (strike), B (ball), and X (in play). We will remove the in play data since it represents the uncertainty of the pitch outcome. The result of an in play pitch can vary widely and the data size for X , potentially leading to inaccurate calculations of the proportion of strikes in the dataset.

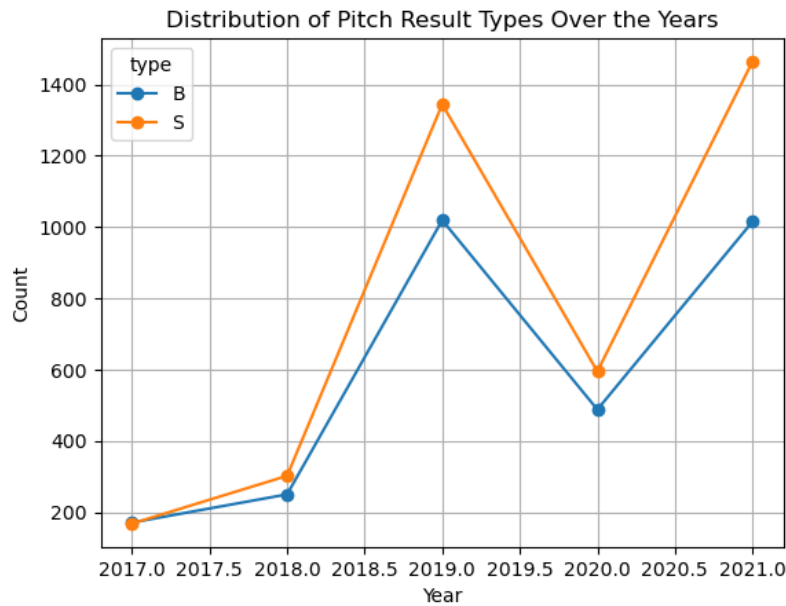


Based on the bar plot, we can see that Max has a wide selection of pitching types under his belt with fastballs (FF) being his most prominent pitch of choice. This data is supported by evidence indicating that Max is known to rely heavily on his fastball arsenal during games, leveraging its speed and movement to challenge opposing batters.



From the plot, we observe that `p_throw` has only one value: L (left), indicating that Max pitches exclusively with his left hand. Since this variable has no variability, it is not necessary to include it in our analysis. Therefore, we will remove it from the dataset.

Then, we observe the changes in strike vs. ball over time by calculating the mean and plotting it across the years.



Concerning his pitching results, it is evident that Max has shown improvement in the outcomes of his pitches over time, with his strikeouts (S) being higher than the other result (B) each year. This trend highlights Max's effectiveness in inducing swing-and-miss pitches, resulting in favorable outcomes for the defense. However,

there is a noticeable drop in performance in 2020, which can be attributed to various factors such as the unique circumstances of that season, including the shortened schedule and disruptions caused by the COVID-19 pandemic.

## 4 Methodology

**Histogram:** We used histograms to visualize the frequency distribution of variables like release speed, spin rate, effective speed, and release extension. It quantifies the shape, spread, and central tendency of the data, helping compare distributions across pitch types.

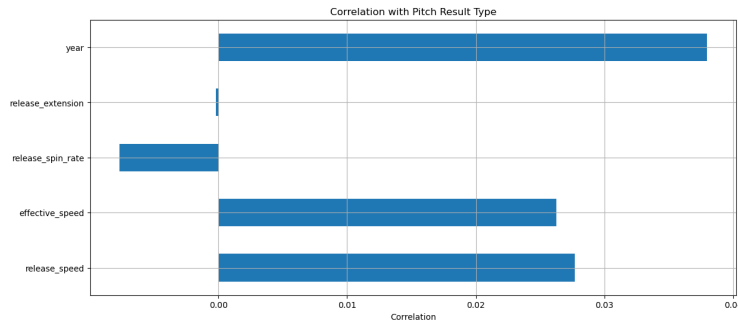
**Line Chart:** We utilized line charts to observe trends over time. It quantifies changes in variables like release speed and spin rate over the years, revealing trends, seasonal patterns, and shifts in performance.

**Mutual Information:** We used mutual information to calculate the amount of information that one random variable contains about another random variable based on our response and predictors. It quantifies the degree of dependence or association between the variables, indicating how much knowing one variable reduces the uncertainty about the other variable. The mutual information  $I(X; Y)$  between two random variables  $X$  and  $Y$  is given by:

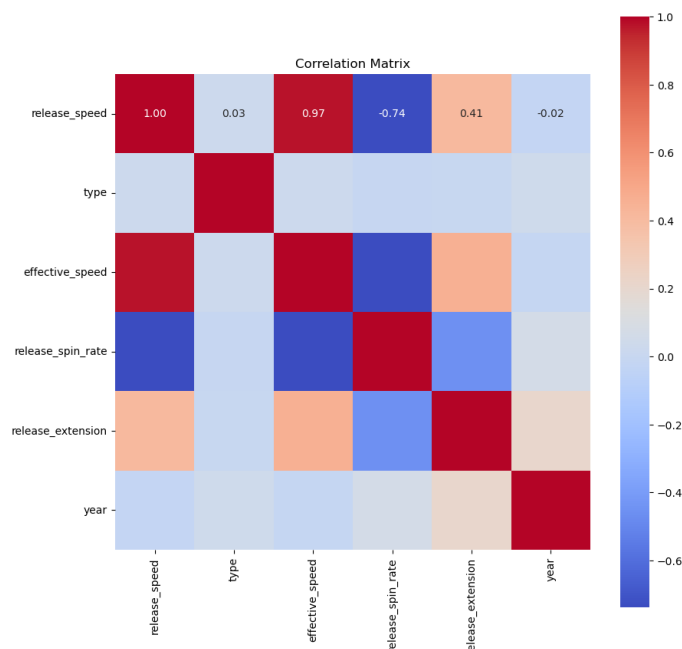
$$I(X; Y) = \sum_{x \in X} \sum_{y \in Y} p(x, y) \log \frac{p(x, y)}{p(x)p(y)}$$

**Correlation:** We analyzed correlations to measure relationships between variables. It quantifies the linear association between pairs, showing which variables are interdependent and influencing performance outcomes.

## 5 Result



From the plot, year has the highest correlation, directly indicating that Max is evolving throughout the five year. Surprising, release extension show little correlation to the pitch result.



The correlation matrix reveals a strong positive relationship between release speed and effective speed, indicating that as Max's release speed increases, his effective speed also rises. This relationship suggests that improvements in release speed directly enhance the overall effectiveness of his pitches. Both release speed and effective speed significantly impact the pitch result type, with higher release speeds and effective speeds being associated with a greater likelihood of achieving strikes. The correlation plots and analysis indicate that these metrics play a crucial role in determining the success of pitches, with higher values generally leading to more favorable outcomes (strikes) as opposed to balls.

The release speed and effective speed are critical determinants of a pitch's success. Note: the text on the plot is the strike rate for that year.

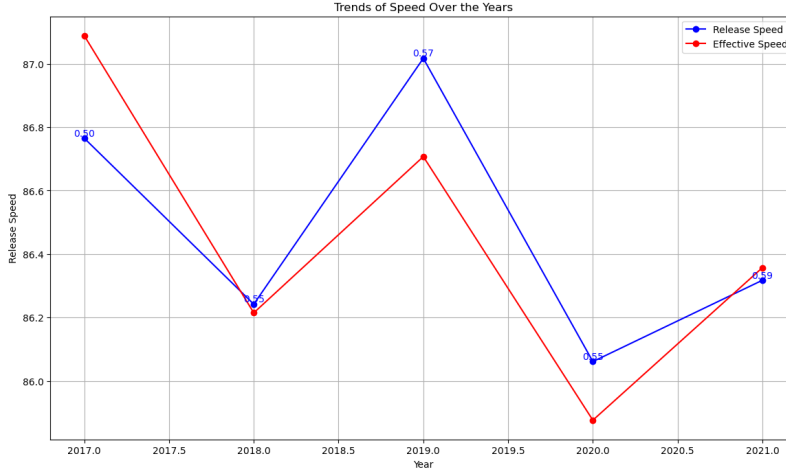
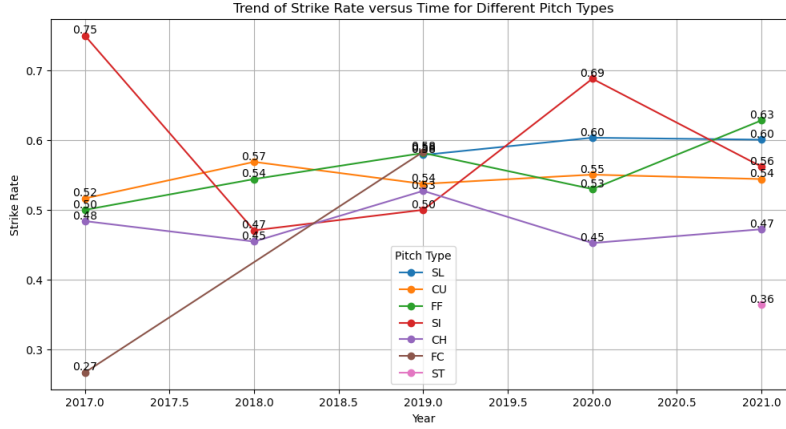


Figure 1: Speed over Time

According to the plot, there is a noticeable improvement in Max's speed from 2017 to 2021. However, the sudden dip observed in 2020 could potentially be attributed to the unique circumstances of that season, which was significantly affected by the COVID-19 pandemic. With only 60 games played in total during the 2020 season, it's possible that the reduced number of games resulted in limited data availability, affecting the accuracy and reliability of the analysis for that particular year. It is important to consider the impact of factors beyond the COVID-19 pandemic on Max's performance. Various variables such as injury, or adjustments in pitching strategy could have also contributed to fluctuations in his release speed over the years. Despite the temporary dip in 2020, Max's overall trend of improvement underscores his adaptability and dedication to enhancing his pitching abilities over the years. As such, further investigation into his pitch selection, including the types and frequencies of pitches thrown, may offer deeper insights into his evolving pitching style and effectiveness on the mound.

However, the speed of the pitch is largely impacted by the pitch type. For example, FF (Four-seam Fastball) is characterized by its high speed, but CU (Curveball), has much less speed compared to FF. Again, the text in black is the strike rate.





The table below collects the highest strike rate of pitch type for each year:

year	pitch_type	release_extension	release_speed	release_spin_rate	effective_speed	Strike Rate
2017	SI	6.500000	91.500000	1904.000000	92.025000	0.750000
2018	CU	5.821557	74.383234	2844.101796	73.194012	0.568862
2019	FC	5.791667	90.433333	2257.636364	89.983333	0.583333
2020	SI	6.370968	92.702151	1954.333333	92.889247	0.688172
2021	FF	6.397042	94.013295	2116.045455	94.387841	0.628409

**2017: Slider (SI)** The Slider (SI) had the highest strike rate at 0.75 across five years, but the number of pitches in 2017 is the lowest, so the result can be biased. The release speed was 91.50 mph, and the effective speed was 92.03 mph. The high release speed and effective speed, coupled with the slider's sharp horizontal movement, made it an effective pitch in generating swings and misses.

**2018: Curveball (CU)** The Curveball (CU) had the highest strike rate at 0.57 in 2018. The release speed dropped to 74.38 mph, and the effective speed was 73.19 mph. Despite the reduced speed, the curveball's spin rate was the highest across all five years at 2844.10 RPM. This is highlighted in the correlation matrix, which indicates a negative correlation between release/effective speed and spin rate. The highest strike rate for the curveball in 2018 also explains the downward slope observed in the speed trends in Figure 1. The significant drop in speed, combined with the highest spin rate, contributed to the pitch's effectiveness through its sharp downward break. This large spin rate created a more pronounced movement, making the pitch highly deceptive and difficult for batters to hit, resulting in a higher strike rate.

**2019: Cutter (FC)** The Cutter (FC) had the highest strike rate at 0.58 in 2019. The release speed was 90.43 mph, and the effective speed was 89.98 mph. The cutter's late horizontal movement and moderately high speed made it difficult for batters to make solid contact, resulting in a high strike rate. Interestingly, 2019 had

the lowest release extension at 5.79 feet. This is reflected in the correlation matrix, which indicates that release extension has a very low correlation with pitch result type. Despite the lower extension, the cutter’s effectiveness can be attributed to its movement and speed, which more than compensated for the shorter extension. The reduced extension might have contributed to a deceptive late movement, making it harder for batters to gauge the pitch’s trajectory and timing, thereby increasing the likelihood of a strike.

**2020: Slider (SI)** The Slider (SI) again had the highest strike rate at 0.69, indicating slider is the most efficient pitch type for Max. The release speed increased slightly to 92.70 mph, with an effective speed of 92.89 mph. The consistency in high speed and late-breaking movement continued to make the slider an effective pitch.

**2021: Four-seam Fastball (FF)** The Four-seam Fastball (FF) had the highest strike rate at 0.63. The release speed was 94.01 mph, and the effective speed was 94.39 mph, which is the highest across the five year, indicating their positive correlation with pitch result. The high velocity and spin rate of 2116.05 RPM made the fastball a dominant pitch, overpowering hitters and generating a high number of swings and misses.

As a result, the strike rate for Max Fried has gradually increased over the years, reflecting his continuous improvement and adaptability. Max Fried employs a variety of pitching techniques, each with unique characteristics, to achieve high strike rates. His effectiveness with different pitch types—such as the Slider, Curveball, Cutter, and Four-seam Fastball—demonstrates his ability to leverage speed, spin rate, and movement to dominate hitters.

## 6 Discussion

**Removing In-Play Status:** A limitation of this project is the removal of in-game results (X) data from the outcome pitch type variable. By excluding these in-game results, we may have overlooked important aspects of pitch effectiveness that provide a more complete picture of pitching performance. In-game results provide insight into how pitches are struck and received, which are key elements in evaluating a pitcher’s overall effectiveness.

**Calculation on Mean:** Another limitation is that many of our conclusions are based on mean calculations of various variables, such as release velocity and release spin rate. While mean values provide a useful summary of the data, they can cover variability and outliers that may be important to understanding the full range of performance. Reliance on mean values may limit our ability to capture the full dynamic range of pitches and their impact on outcomes.

**Unbalanced Data:** When comparing pitch types with strike rates, the unbalanced distribution of pitch types and the number of pitches each year can introduce bias into the analysis. Certain pitch types might be thrown more frequently than others, affecting the overall strike rate calculations. It is essential to consider this variability and potential bias when interpreting the results, as the distribution of pitches can significantly impact the observed effectiveness of each pitch type.

## 7 Conclusion

The analysis of Max Fried's pitching performance over the five-year period from 2017 to 2021 reveals several key insights into his evolving effectiveness. The data indicates a gradual increase in his strike rate, reflecting his continuous improvement and adaptability as a pitcher. Fried employs a variety of pitching techniques, each with unique characteristics that contribute to his high strike rates.