



The Influence of Bat Speed and Swing Length on Fouling Off 2-Strike Pitches

Ebenezer Olubayode, Dr. Daniel Larson

Sports Data Analytics, Department of Health & Exercise Science, University of Oklahoma, USA



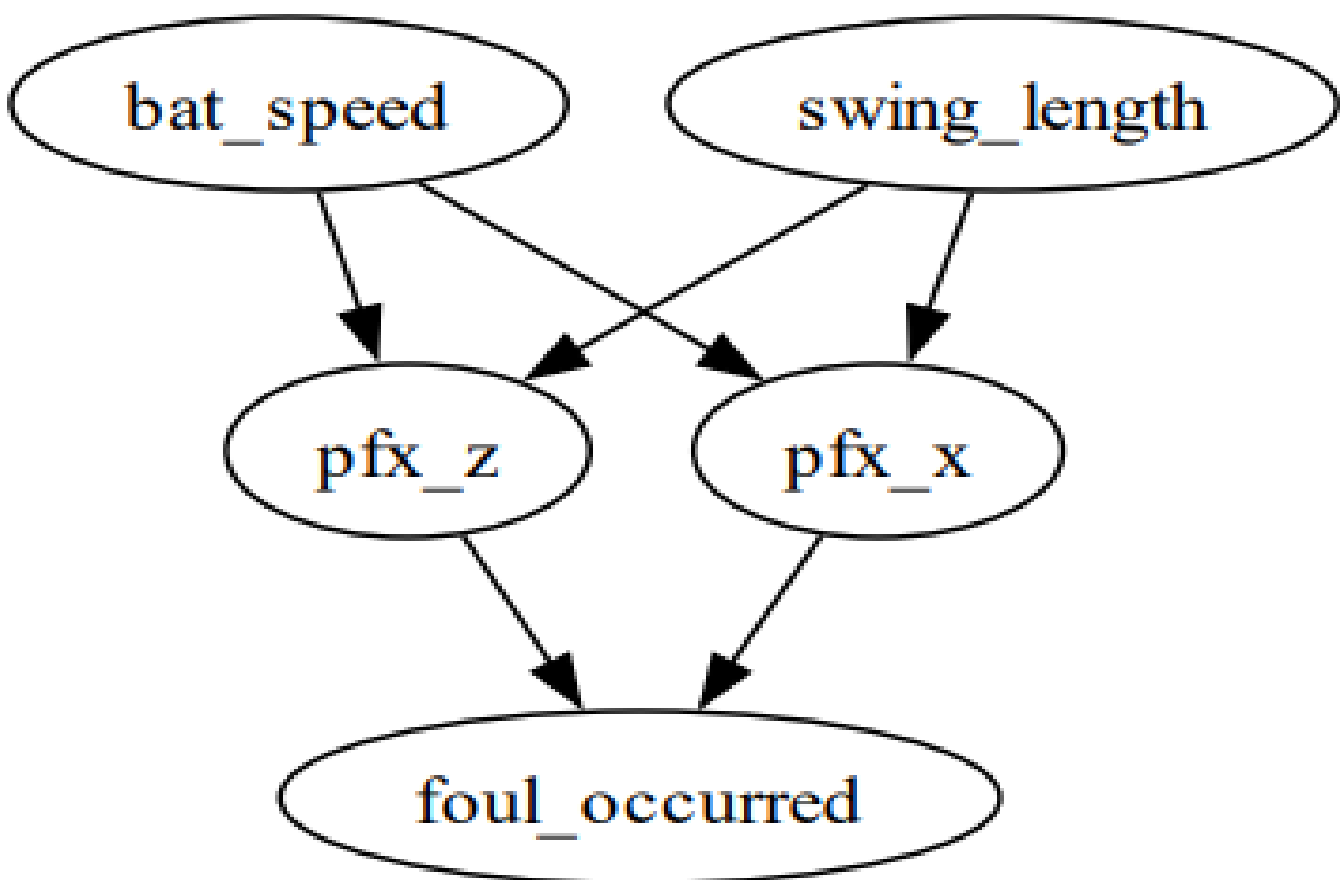
Background

- In baseball, fouling off 2-strike pitches is a critical skill that allows batters to extend at-bats, tire pitchers, and increase the chances of favorable outcomes.
- However, the factors influencing this skill, such as batter mechanics (bat speed and swing length) and pitch characteristics, are not well understood.
- Also, despite recent studies have applied advanced statistical methods to analyze baseball performance, none have integrated batter mechanics & pitch characteristics to study fouling behavior in 2-strike count.
- Hence, this study is the first to apply Bayesian causal inference to examine how bat speed, swing length, and pitch characteristics interact to influence the likelihood of fouling off 2-strike pitches.
- By leveraging new pitch-level data of 58,566 from Baseball Savant, this research provides a comprehensive analysis of these factors. The use of Bayesian methods ensures robust causal inference, offering actionable insights for players, coaches, and analysts to refine strategies and optimize performance.

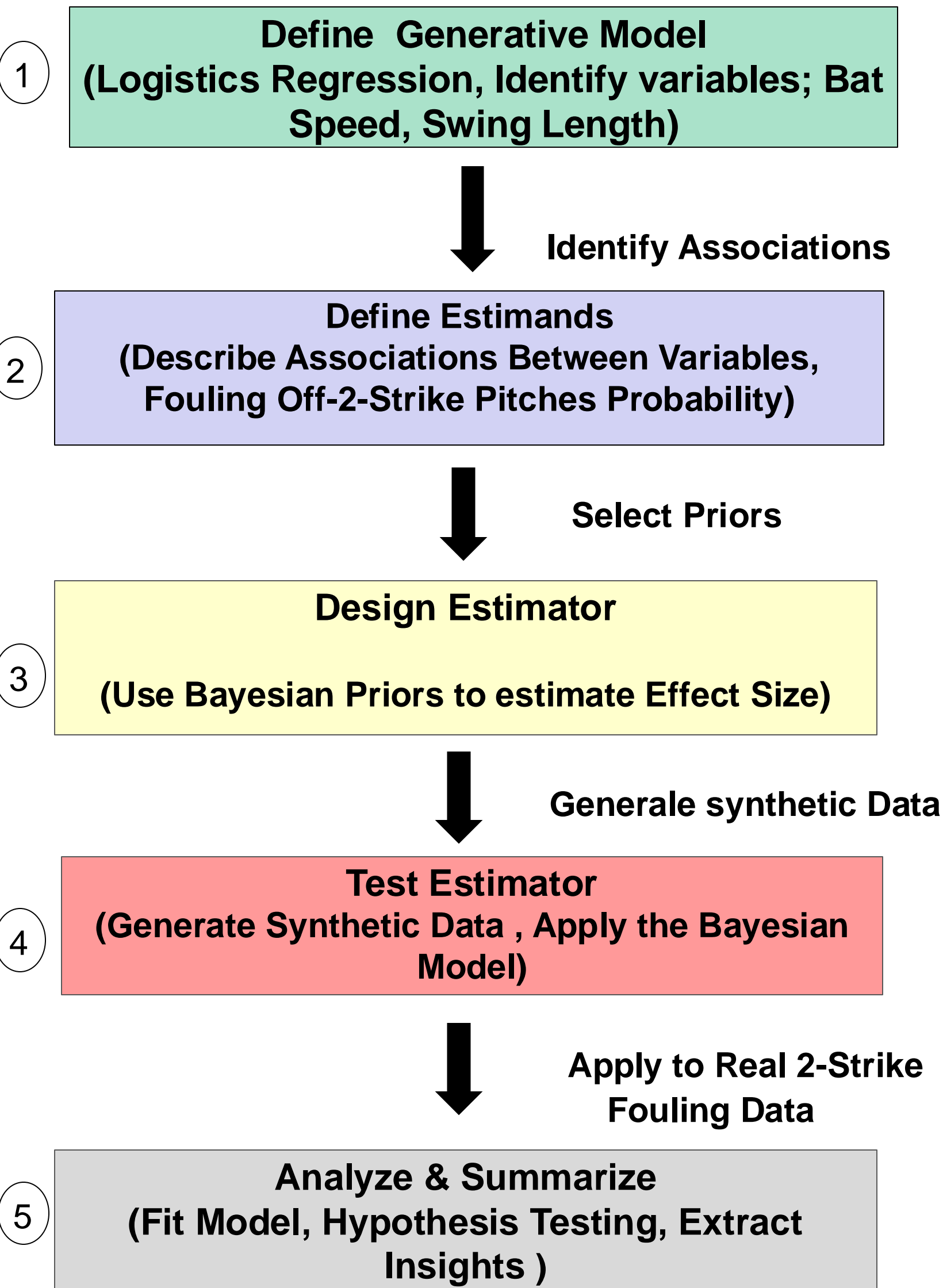
Objectives

- Examine the impact of bat speed and swing length on the probability of fouling off 2-strike pitches.
- Assess the role of pitch characteristics (release speed, vertical movement, horizontal movement) in mediating the relationship between batter mechanics (bat speed and swing length) and fouling.

Drawing the DAG



Methods Schema



Statistical Analysis

- Markov Chain Monte Carlo (MCMC) methods were employed for parameter estimation.
- Model diagnostics (R-hat and Effective Sample Size) ensured convergence and estimate reliability.
- Contrast analyses were conducted to compare fouling probabilities across key conditions (e.g., high vs. low bat speed, short vs. long swing length).

Results

Factor	Comparison	Contrasts	95% CI	Interpretation
Swing Length	Short vs. Long	48% vs. 37%	[0.46, 0.50] vs. [0.34, 0.40] Significant effect, as CI does not include zero	Shorter swing lengths increase fouling probability
Bat Speed	High vs. Low	41% vs. 44%	[0.39, 0.43] vs. [0.42, 0.46]	Higher bat speed slightly reduces fouling probability
Vertical Pitch Movement	Effect with Swing Length	0.50	[0.48, 0.53]	Short swings are more effective against high pfx_z.
Bat Speed & Swing Length	High Bat Speed & Low Swing Length vs. High Bat Speed & High Swing Length	-0.105	[-0.145, -0.063]	Significant effect; lower fouling probability with high bat speed and long swings
Bat Speed & Swing Length	Low Bat Speed & Low Swing Length vs. Low Bat Speed & High Swing Length.	-0.11	[-0.146, -0.083]	Significant effect; shorter swings increase fouling even with low bat speed

Discussion

- Swing length is the primary factor in fouling behavior, short swings increase fouling (48% vs. 37%), extend at-bats, and improve plate discipline.
- Bat speed plays a smaller role, low bat speed slightly increases fouling (44% vs. 41%), but swing control matters more than power.
- Vertical pitch movement (pfx_z) challenges plate discipline, but short swings adjust better to high pfx_z, reducing strikeouts.
- Interaction effects confirm that short swings + high bat speed yield the highest fouling rates, reinforcing the importance of mechanics over power for 2-strike survival.

Conclusions

- For Batters:**
- **Short swings** are the most effective approach for protecting the plate, particularly against pitches with **high vertical movement**.
 - While **bat speed** alone does not significantly improve 2-strike survival, **controlled swing mechanics** (e.g., shorter swings) are crucial for extending at-bats and fouling off tough pitches.
- For Pitchers:**
- To reduce foul balls, pitchers should aim to **induce longer swings** by targeting specific pitch locations and exploiting **vertical movement**.
 - Focusing on **challenging vertical pitches** can help pitchers control at-bats and increase strikeout opportunities.

