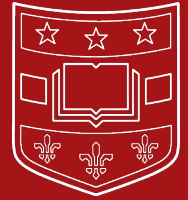


WUSTL



Washu Umpire-correcting Simulated Time Line

Simon Todreas, Max Hanley, Jake Engelberg, Cooper Yan





Outline

- Introduction
- Method
- Results
- Conclusion





INTRODUCTION



Missed Calls Classification

Calculated missed calls with ZERO margin of error

Used Baseball Savant's strike zone parameters and the average size of a baseball ($r = 1.45$ in.)





Missed Calls Classification

Umpire Scorecards

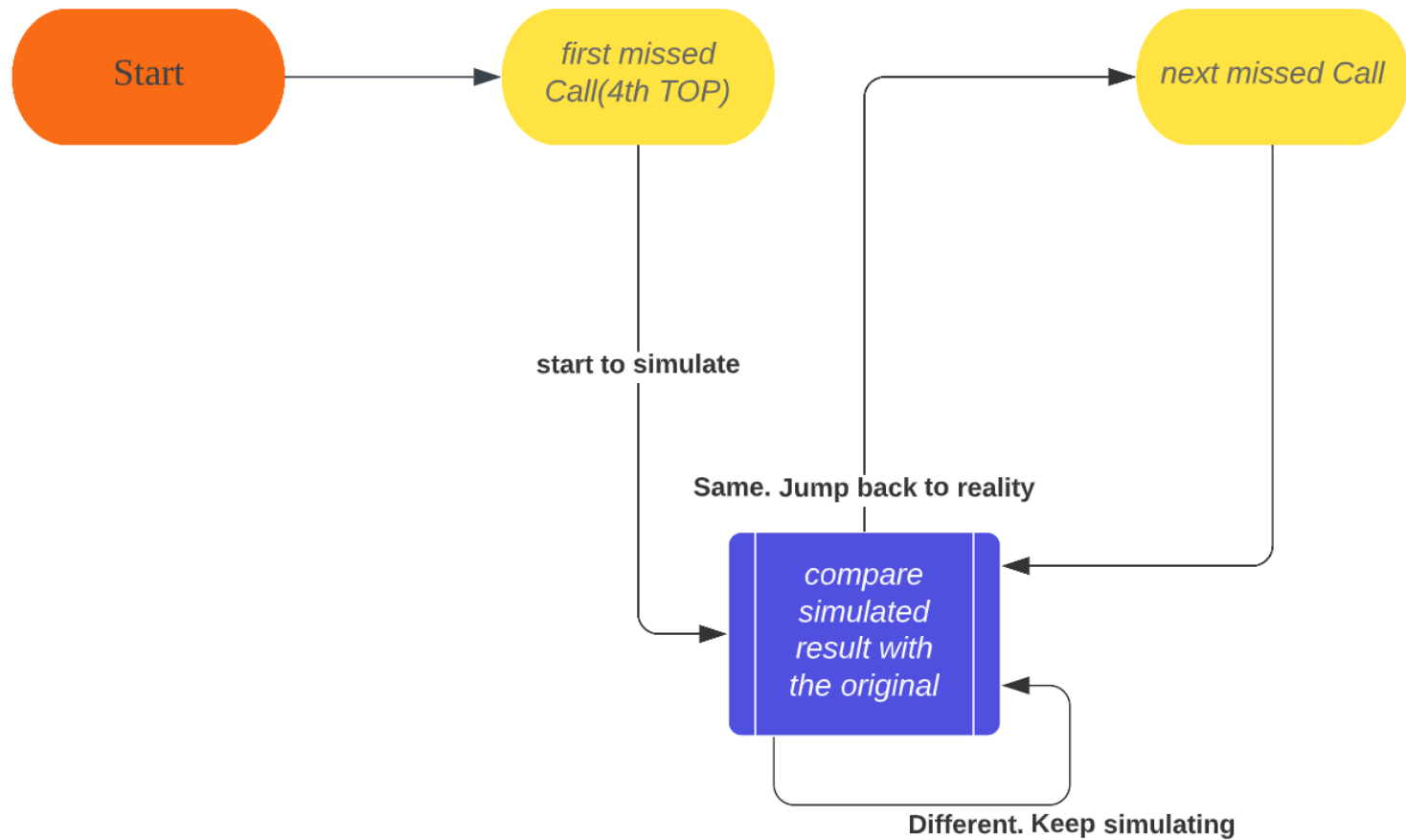
- NYY @ MIL, 9/16/22
 - 22 missed calls
- SFG @ ATL, 6/22/22
 - 5 missed calls

WUSTL

- NYY @ MIL, 9/16/22
 - 24 missed calls
 - SFG @ ATL, 6/22/22
 - 8 missed calls
-



Approach





METHOD



Simulation Overview



Start	Start at first missed call
Correct	Correct the call
Simulate	Simulate next pitch
Check	Check to rejoin original timeline
Simulate	If not, simulate next pitch
Continue	Continue until rejoin or until game concludes



Pitch Models

- Data from MLB regular season 2017-2022
 - Create independent models for every event
 - Models for hit-into-play events are conditional on the ball being hit into play
 - Model inputs are pitcher event rates, batter event rates, count, and handedness for batter and pitcher
-



Pitch Models

- Example (swinging strike):
 - Aaron Judge (R) vs. Adrian Houser (R)
 - Judge has 14% swinging strike rate
 - Houser has 9% swinging strike rate
 - 0-1 count

In 1645 instances of this matchup, there is an **11.0%** swinging strike rate



Pitch Models

- Weighted Least Squares regression
 - Weights are number of instances of a particular matchup
 - Filtered out rare occurrences (e.g. 2% swinging strike rate)
 - Very high R^2 across all models
-



Pitch Models

- Example (swinging strike, cont.):
 - Model predicts this situation will have a swinging strike rate of 12.26%
 - If the count were 1-0, the model predicts swinging strike rate of 10.07%
 - If Houser was lefthanded (0-1 count), 11.67% swinging strike rate
-



Pitch Models

- This is also created for balls, called strikes, fouls, hit by pitch**, and balls hit into play
- Normalize probabilities
- Randomly select outcome

	S St	C St	Ball	Foul	HBP	HIP
Prob.	10.08%	11.55%	47.90%	15.55%	0.29%	14.64%



Pitch Models

- If hit into play:
 - Repeat procedures with singles*, doubles**, triples**, home runs*, line outs**, ground outs, fly outs, pop outs

	Single	Double	Triple	HR
%	20.54%	5.88%	0.50%	10.45%

	Ground	Fly	Pop	Line
%	36.78%	14.94%	2.92%	7.98%

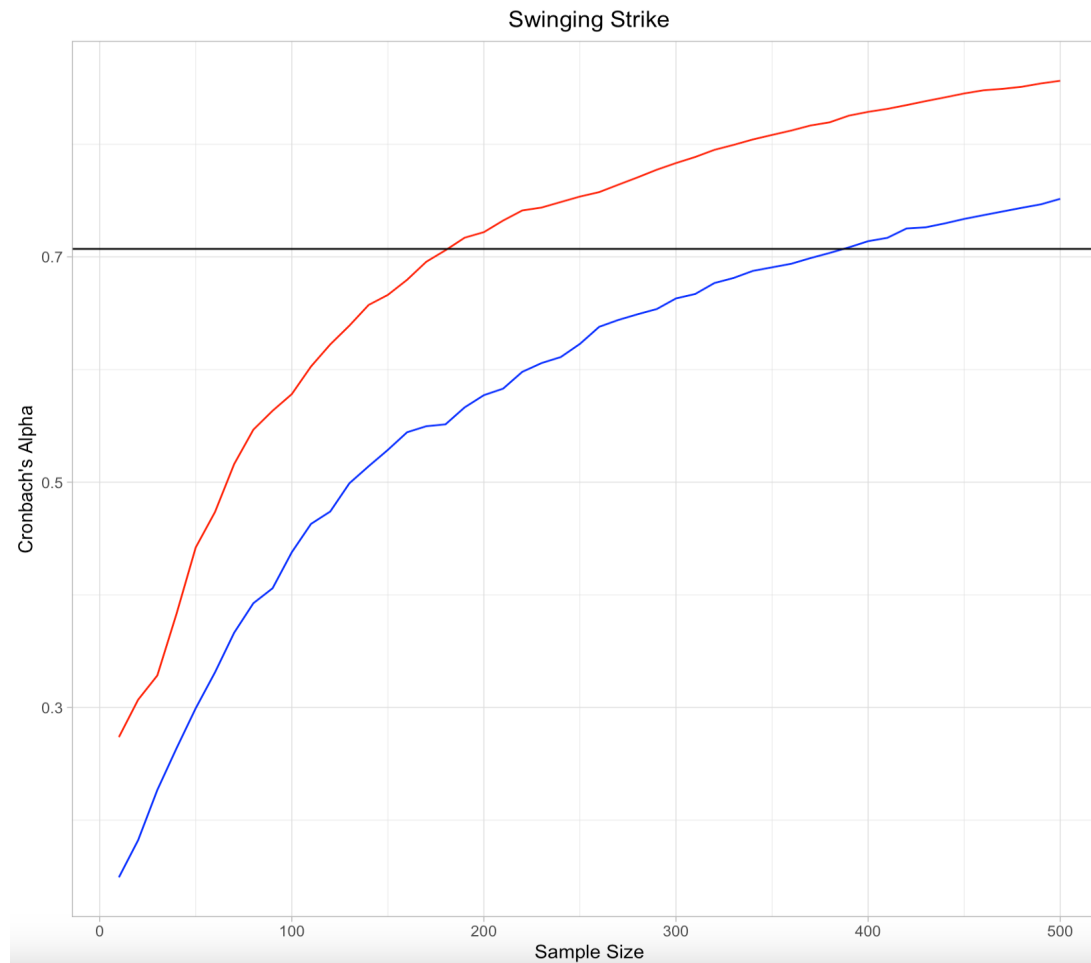


Stability Analysis

- Used Cronbach's Alpha to find the stabilization points for every event for batters and pitchers
 - Stabilization point is defined when alpha crosses $1/\sqrt{2} \approx 0.707$



Stability Analysis





Stability Analysis

	S St	C St	Ball	Foul	HBP	HIP	1B	2B	3B	HR	Gro. Out	Fly Out	Line Out	Pop Out
Pitcher	390	1450	1270	1170	>2k	745	>1k	>1k	>1k	>1k	160	310	>1k	410
Batter	190	370	770	790	>2k	535	790	>1k	>1k	210	320	380	>1k	310



Stabilization Analysis

- In cases where neither batter nor pitcher event statistic stabilizes in a reasonable number of instances, we use the league wide average
 - Hit by pitch, doubles, triples, line outs
- In cases where only the batter event statistic stabilizes, only the batter rate is used in the respective model
 - Singles, home runs

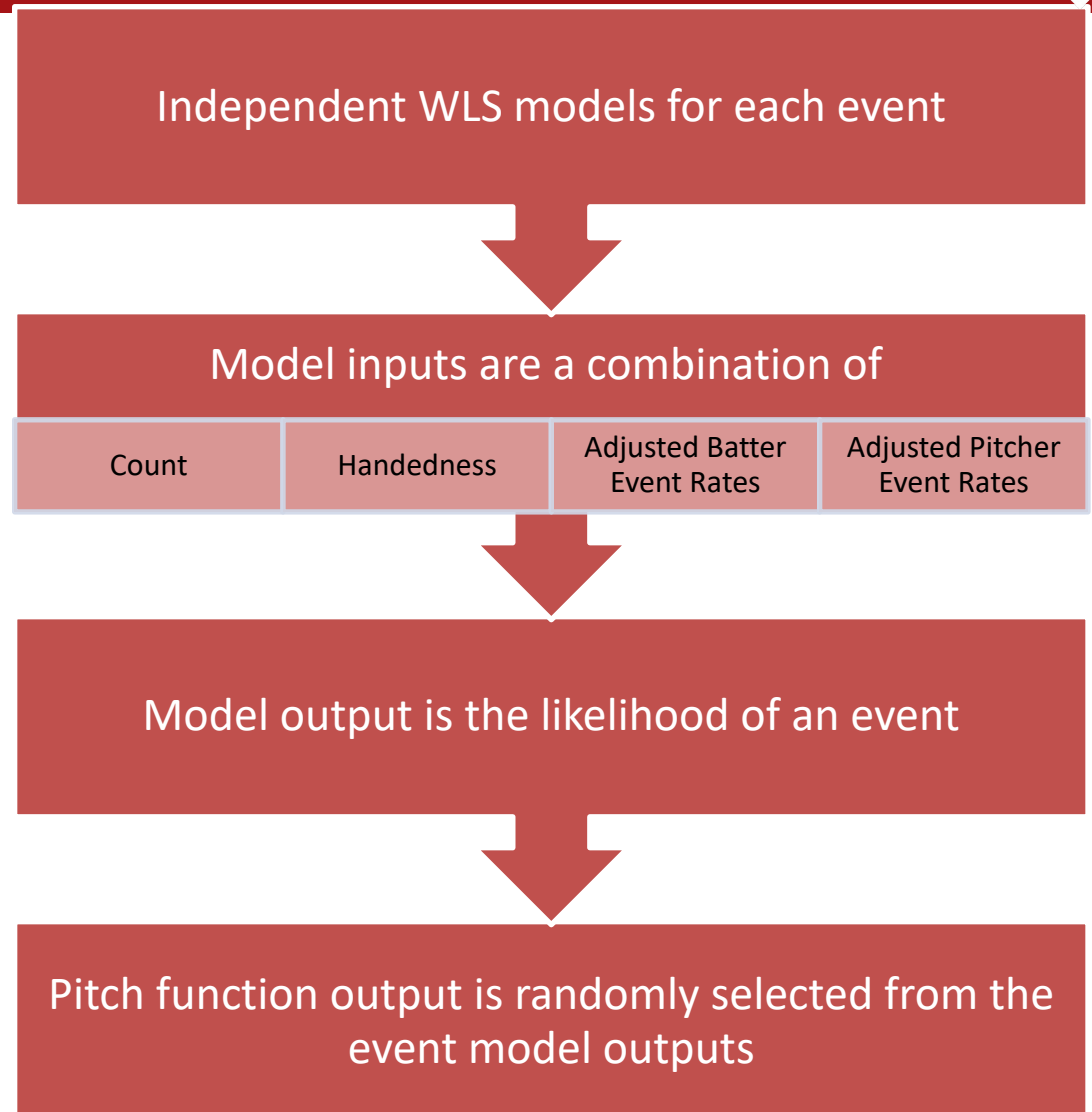


Stabilization Analysis

- Input data
 - Count, handedness
 - Batter/pitcher event rate is 2021 + 2022 rate regressed by the amount of data points for stability at the league average rate
 - This number is (handedness) park adjusted by Fangraphs park factors
-



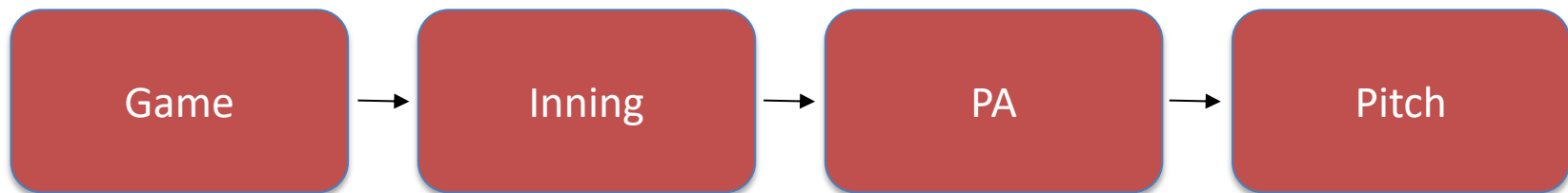
Pitch Models: Recap





Simulation Explanation

- Pitch model can be called iteratively for PAs, innings, and games
- Check after each pitch if we've reached an identical outcome to any pitch in the “real timeline” at which point, rejoin the real timeline and skip to the next missed call





Extra Bases and Double Plays

- Singles, Doubles, Ground Outs, and Fly Outs:
 - Compares the state of the game entering the event with state of the game after the event
 - Inputs: runners on base, outs
 - Outputs: runners on base, outs, runs
 - Randomly selects outcome from historical probabilities
-



Extra Bases and Double Plays

- Example:
 - Runner on 2nd, 1 out, single
 - 42.1% -> runners on 1st and 3rd
 - 41.5% -> runner on 1st, run scores
 - 6.8% -> runner on 2nd, run scores
 - 3.5% -> runners on 1st and 2nd
 - 2.0% -> out recorded, run scores
 - 4.1 -> other
-



Relief Pitching



Begin every half inning by considering if it's time to pull the pitcher

Starters:

Find probability they get pulled during each inning across 2021-2022 seasons

Randomly select if starting pitcher will remain

Relievers:

Find frequency that reliever comes in each inning

Normalize frequencies by inning across each bullpen

Randomly select reliever



Full Example

SFG @ ATL: Top 4th, Tommy La Stella vs. Charlie Morton

Called a strike,
should have been
a ball

Enter Simulation





Full Example

SFG @ ATL: Top 4th, Tommy La Stella vs. Charlie Morton

Reality:

Strike (0-2)

Ball (1-2)

Ball (2-2)

Line out

Simulation:

Ball (2-0)

Ground out

Rejoin Timeline





Full Example

SFG @ ATL: Top 5th Mike Yastrzemski vs. Charlie Morton

Reality:

X Called strike (1-2)
Called strike (K)

Simulation:

Ball (2-1)
Foul (2-2)
Single

Does Not Rejoin





Full Example

SFG @ ATL: Bottom 8th Michael Harris II vs. John Brebbia

Reality:

X Called strike (0-1)
Swinging strike (0-2)
Ball (1-2)
Swinging strike (K)

Simulation:

Ball (1-0)
Foul (1-1)
Ball (2-1)
Ball (3-1)
Ball (BB)





Full Example

- Final score: Giants 3 – Braves 2

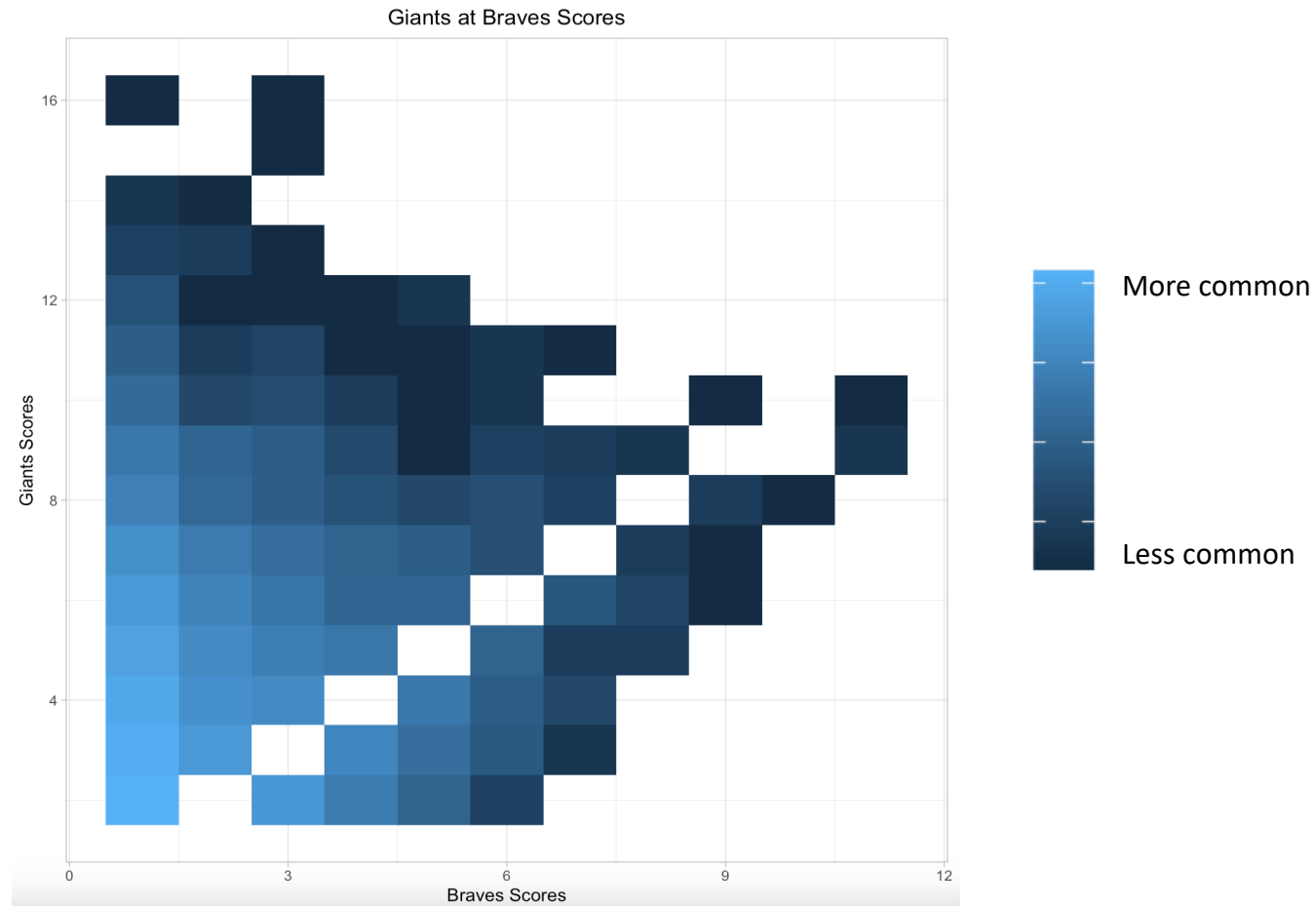




RESULTS



SFG @ ATL





SFG @ ATL

- Mean score
 - Giants - 4.01
 - Braves - 1.70
 - Median score
 - Giants - 4
 - Braves – 1
 - Win Percentages
 - Giants – 88.88%
 - Braves – 11.12%
-



SFG @ ATL

- Umpire Scorecard
 - ATL +1.43 runs
 - SFG -1.22 runs
 - ATL +0.21 runs
 - WUSTL
 - ATL +3.31 runs
 - SFG -1.01 runs
 - ATL +2.30 runs
-

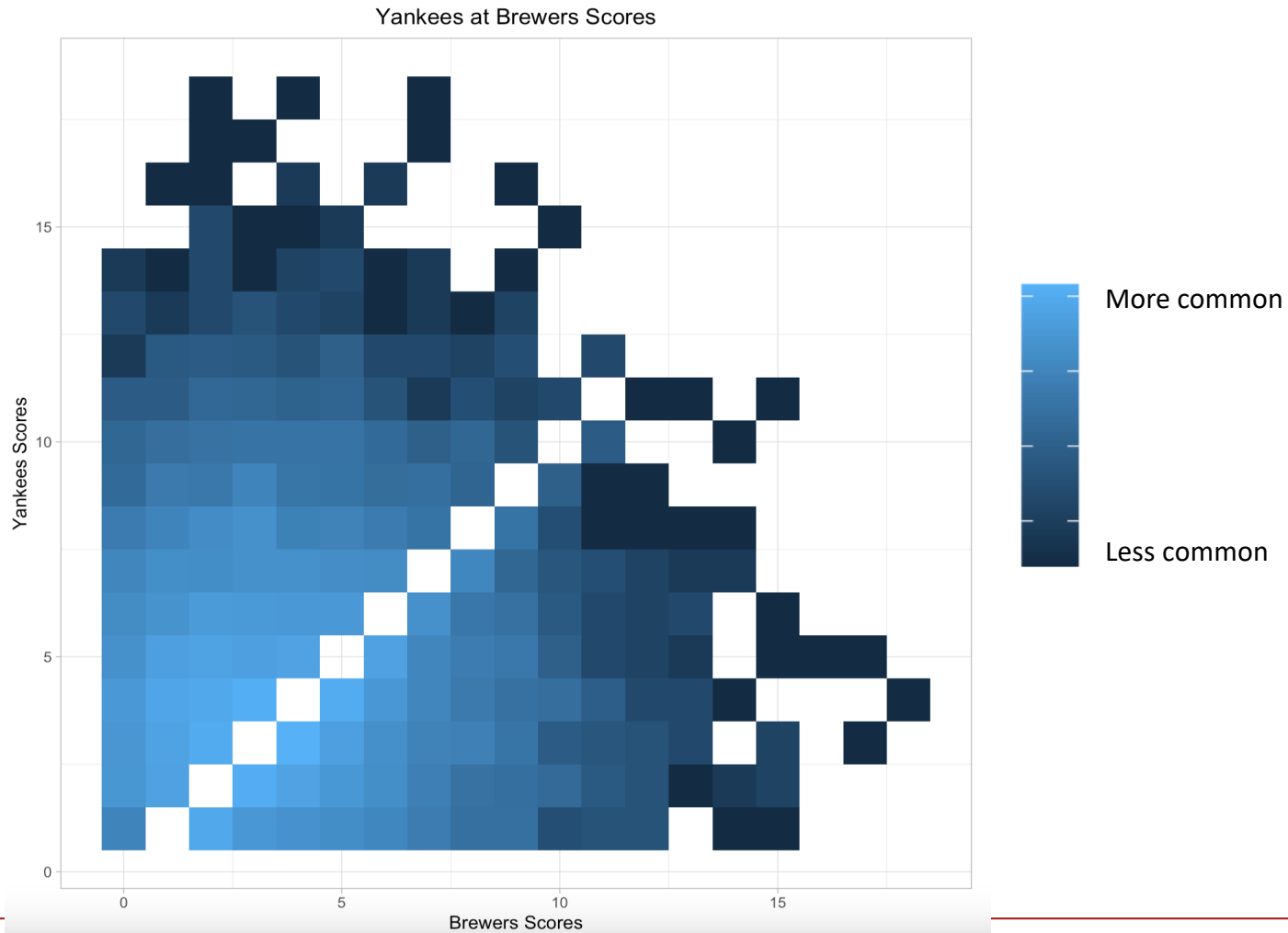


SFG @ ATL

- Most common scores
 - 2-1 Giants, 18.6%
 - 3-1 Giants, 14.8%
 - 4-1 Giants, 12.4%
 - 5-1 Giants, 8.3%
 - 3-2 Giants, 5.2%
 - 6-2 Giants, 5.1%
 - 2-3 Braves, 4.8%
-



NY Yankees @ MIL





NY Yankees @ Milwaukee Brewers

- Mean score
 - Yankees - 4.72
 - Brewers – 3.80
 - Median score
 - Yankees - 4
 - Brewers – 3
 - Win Percentages
 - Yankees – 58.59%
 - Brewers – 41.41%
-



NY Yankees @ Milwaukee

- Umpire Scorecard
 - Milwaukee +2.18 runs
 - NY Yankees -0.93 runs
 - Milwaukee +1.25 runs
 - WUSTL
 - Milwaukee +1.92 runs
 - NY Yankees +1.28 runs
 - Milwaukee +3.20 runs
-



NY Yankees @ MIL Brewers

- Most common scores
 - 3-4 Brewers, 3.76%
 - 4-3 Yankees, 3.33%
 - 2-3 Brewers, 3.26%
 - 4-5 Brewers, 3.09%
 - 3-2 Yankees, 2.94%
 - 1-2 Brewers, 2.79%
 - 4-2 Yankees, 2.77%



CONCLUSION



THANK YOU
