Increasing whiff rate for Pitcher X

Or, how Pitcher X learned to stop worrying, throw less fastballs, and trust his changeup

Ken Schroeder
schroeder.w.ken@gmail.com

Dataset, goals

The study in question uses a dataset of all pitches from a real-life MLB pitcher from the 2021 baseball season. For this presentation we are hoping to help Pitcher X make strategic and mechanical changes with the hope of improving the probability of batters swinging and missing on pitches for the 2022 season.

Dataset is available at: https://github.com/KenSchroeder/Baseball/pitcherX2021.csv

All programming done in Python. Some tables made in Excel.

Overview

1. **What is whiff rate? Does it matter?**
2. Context, context, context
3. Improving Whiff Rate
4. Conclusions

What is Whiff Rate? Does it Matter?

What is whiff rate?
Whiff rate is percentage of pitches a batter swings at and misses. In 2021 qualified pitchers whiff rate ranged between 8.1-16.6% and league average was 11.3%. Pitcher X would be expected to elicit a swing and miss on 11.6% of pitches in the dataset.

Does it matter?
Yes, it matters.
Take a look at the 2021 whiff rate leaderboard. You'll note that among qualified pitchers, both the NL leader (Corbin Burnes - 16.6%) and AL leader (Robbie Ray - 15.5) won the Cy Young Award for their league. In fact, in none of the last 5 full seasons has the Cy Young winner finished outside his league's top 3 on the swinging strikes leaderboard. Whiff rate is clearly correlated with success. Additionally swinging strikes correlates well year to year.

Conclusion
This is a stat we are very interested in improving for pitcher X.

Overview

1. What is whiff rate? Does it matter?
2. **Context, context, context**
3. Improving Whiff Rate
4. Conclusions

Context: Key takeaways

If we wish to improve the whiff rate for pitcher X, we need to understand the contexts of each pitch.

The base whiff rate of a 0-2 pitch vs. a right handed batter is not the same as a 3-0 pitch vs. a left handed batter. Count, batter side, and pitch count must be taken into account as we attempt to improve the whiff rate for Pitcher X.

As such, i has to be noted that for some combinations of count, batter side, and pitch thrown there is simply not enough data to make any conclusions (e.g. Pitcher X only threw 2 changeups vs right handed batters on a full count.)

Whiff Probabilities- by Pitch, Hand

Overall

Pitch	N	%	%vL	SwingProb	MissProb	WhiffProb
Fastball	1087	40.0%	38.3%	0.478	0.225	0.086
Cutter	789	29.1%	37.9%	0.571	0.341	0.139
Change	422	15.5%	80.3%	0.502	0.397	0.153
Curve	418	15.4%	36.6%	0.362	0.373	0.110
Total	2716	-	44.4%	0.491	0.308	0.116

vs. Left

Pitch	N	% Thrown	SwingProb	MissProb	WhiffProb
Fastball	416	34.5%	0.423	0.233	0.069
Cutter	299	24.8%	0.610	0.266	0.125
Change	339	28.1%	0.499	0.377	0.148
Curve	153	12.7%	0.320	0.315	0.092
Total	1207	-	0.477	0.292	0.108

vs. Right

Pitch	N	% Thrown	SwingProb	MissProb	WhiffProb
Fastball	671	44.5%	0.512	0.221	0.097
Cutter	490	32.5%	0.547	0.386	0.147
Change	83	5.5%	0.518	0.481	0.172
Curve	265	17.6%	0.386	0.406	0.121
Total	1509	-	0.502	0.321	0.122

Observe that 80% of changeups were thrown against left-handed batters.

Whiff Probabilities – by Pitch, Hand

Overall						
Pitch	N	%	%vL	SwingProb	MissProb	WhiffProb
Fastball	1087	40.0%	38.3%	0.478	0.225	0.086
Cutter	789	29.1%	37.9%	0.571	0.341	0.139
Change	422	15.5%	80.3%	0.502	0.397	0.153
Curve	418	15.4%	36.6%	0.362	0.373	0.110
Total	2716	-	44.4%	0.491	0.308	0.116

vs. Left					
Pitch	N	% Thrown	SwingProb	MissProb	WhiffProb
Fastball	416	34.5%	0.423	0.233	0.069
Cutter	299	24.8%	0.610	0.266	0.125
Change	339	28.1%	0.499	0.377	0.148
Curve	153	12.7%	0.320	0.315	0.092
Total	1207	-	0.477	0.292	0.108

vs. Right					
Pitch	N	% Thrown	SwingProb	MissProb	WhiffProb
Fastball	671	44.5%	0.512	0.221	0.097
Cutter	490	32.5%	0.547	0.386	0.147
Change	83	5.5%	0.518	0.481	0.172
Curve	265	17.6%	0.386	0.406	0.121
Total	1509	-	0.502	0.321	0.122

Platoon effects are real. For all pitches, right handers were more likely to whiff.

Whiff Probabilities – by Count

			Overall			
Count	N	%	%vL	SwingProb	MissProb	WhiffProb
0-0	716	26.4%	46.5%	0.282	0.286	0.065
0-1	364	13.4%	44.2%	0.509	0.348	0.138
0-2	165	6.1%	45.5%	0.517	0.397	0.131
1-0	256	9.4%	51.6%	0.473	0.305	0.114
1-1	276	10.2%	43.1%	0.532	0.352	0.139
1-2	257	9.5%	38.9%	0.601	0.337	0.151
2-0	79	2.9%	54.4%	0.471	0.252	0.090
2-1	148	5.4%	43.9%	0.655	0.294	0.146
2-2	242	8.9%	37.6%	0.669	0.291	0.149
3-0	20	0.7%	50.0%	0.113	0.182	0.022
3-1	54	2.0%	51.9%	0.603	0.252	0.110
3-2	139	5.1%	36.0%	0.773	0.198	0.129
Overall	2716	-	44.4%	0.491	0.308	0.116

Whiff Probabilities – by Count

	Overall					
Count	N	%	%vL	SwingProb	MissProb	WhiffProb
0-0	716	26.4%	46.5%	0.282	0.286	0.065
0-1	364	13.4%	44.2%	0.509	0.348	0.138
0-2	165	6.1%	45.5%	0.517	0.397	0.131
1-0	256	9.4%	51.6%	0.473	0.305	0.114
1-1	276	10.2%	43.1%	0.532	0.352	0.139
1-2	257	9.5%	38.9%	0.601	0.337	0.151
2-0	79	2.9%	54.4%	0.471	0.252	0.090
2-1	148	5.4%	43.9%	0.655	0.294	0.146
2-2	242	8.9%	37.6%	0.669	0.291	0.149
3-0	20	0.7%	50.0%	0.113	0.182	0.022
3-1	54	2.0%	51.9%	0.603	0.252	0.110
3-2	139	5.1%	36.0%	0.773	0.198	0.129
Overall	2716	-	44.4%	0.491	0.308	0.116

Whiff probabilities can be dramatically different based on count. A 1-2 pitch is almost seven times as likely to be whiffed at than a 3-0 pitch.

Whiff Probabilities - by Count

			Overall			
Count	N	%	%vL	SwingProb	MissProb	WhiffProb
0-0	716	26.4%	46.5%	0.282	0.286	0.065
0-1	364	13.4%	44.2%	0.509	0.348	0.138
0-2	165	6.1%	45.5%	0.517	0.397	0.131
1-0	256	9.4%	51.6%	0.473	0.305	0.114
1-1	276	10.2%	43.1%	0.532	0.352	0.139
1-2	257	9.5%	38.9%	0.601	0.337	0.151
2-0	79	2.9%	54.4%	0.471	0.252	0.090
2-1	148	5.4%	43.9%	0.655	0.294	0.146
2-2	242	8.9%	37.6%	0.669	0.291	0.149
3-0	20	0.7%	50.0%	0.113	0.182	0.022
3-1	54	2.0%	51.9%	0.603	0.252	0.110
3-2	139	5.1%	36.0%	0.773	0.198	0.129
Overall	2716	-	44.4%	0.491	0.308	0.116

Sample size: We have 716 cracks at 0-0 to figure out how to improve the whiff rate. There were only twenty 3-0 pitches.

Whiff Probabilities – by Count

- Players generally avoid swinging on 0-0, 3-0 counts but tend to make contact when they do
- Players swing more later in the count.
- Whiffs are more common as strikes increase. Less common with 0 or 3 balls.

Swing

		STRIKES		
B		0	1	2
A	0	0.28	0.51	0.52
L	1	0.47	0.53	0.6
L	2	0.47	0.66	0.67
S	3	0.11	0.6	0.77

Miss

		STRIKES		
B		0	1	2
A	0	0.29	0.35	0.4
L	1	0.31	0.35	0.34
L	2	0.25	0.29	0.29
S	3	0.18	0.25	0.2

Whiff

		STRIKES		
B		0	1	2
A	0	0.065	0.138	0.131
L	1	0.114	0.139	0.151
L	2	0.09	0.146	0.149
S	3	0.022	0.11	0.129

Overview

1. What is whiff rate? Does it matter?
2. Context, context, context
3. **Improving Whiff Rate**
4. Conclusions

Improving Whiff Rates

Are there situations where Pitcher X is throwing certain pitches suboptimally?

- What does optimal look like?
  - Game theory suggests optimization occurs when all pitches produce the same whiff rate
  - For individual pitches, certain mechanical factors could also improve performance
- Remember: Context, context, context
  - From earlier slides, we know that all pitches do not present equal whiff opportunities.
    - Count, pitch type, batter hand appear to have significant influence

Note that for specific pitch, count, hand data, only pitches thrown at least 10 times were considered

Improving Whiff Rate – Strategy Point #1

Throw Less Fastballs vs. Lefties (and more changeups!)

- There are no counts where the fastball is the pitch most likely to whiff a lefty
- Consider the 1-0 pitch (table below):
  - Changeups are thrown as often as fastballs but are over twice as likely to draw a whiff
  - Cutters are significantly more effective as well with similar usage
- The fastball is similarly ineffective at upping whiff probability vs. righties. Ranked as the least effective pitch in all counts but 1-1

vs. Lefties, Count: 1-0					
	N	%	SwingProb	MissProb	WhiffProb
FASTBALL	41	31%	45%	0.186	0.056
CUTTER	42	32%	53%	0.269	0.109
CHANGEUP	44	33%	39%	0.377	0.133
CURVEBALL	*5*	*4%*	*16%*	*0.541*	*0.073*

Improving Whiff Rate – Strategy Point #1

Throw Less Fastballs vs. Lefties (and more changeups!)

- The only counts a fastball isn't the least likely pitch to whiff a lefty are 0-0, and 1-1
- Both times it beats a curveball by less than 1%.
- Fastball is always a below average pitch with regards to whiff rates.

Fastball Performance vs. Lefties, by count

Count	N	Best Pitch	WhiffProb (Best)	WhiffProb (FB)	Diff	Rank
0-0	333	Changeup	0.092	0.043	-0.049	3/4
0-1	161	Changeup	0.149	0.114	-0.035	LAST
0-2	75	Changeup	0.155	0.082	-0.073	LAST
1-0	132	Changeup	0.133	0.056	-0.077	LAST
1-1	119	Changeup	0.152	0.107	-0.045	3/4
1-2	100	Curveball	0.195	0.100	-0.095	LAST
2-0	43	Changeup	0.118	0.000	-0.118	LAST
2-1	65	Changeup	0.133	0.098	-0.035	LAST
2-2	91	Changeup	0.206	0.138	-0.068	LAST
3-0	10	-	0.143	0.006	-0.137	-
3-1	28	Cutter	0.126	0.074	-0.052	LAST
3-2	50	Changeup	0.191	0.066	-0.125	LAST
Overall	1207	Changeup	0.148	0.069	-0.079	LAST

Note: Only pitches thrown at least 10 times considered for best pitch.

Improving Whiff Rate – Strategy Point #2

Throw the changeup vs. righties (and less fastballs!)

- The changeup was thrown significantly less often vs. righties than lefties (5.5% vs. 28.1%)
- It is the most effective whiff-inducing pitch (17.2%). Even though it is expected to be swung at as often as a fastball, it is over TWICE as likely to be whiffed at if a swing is made than a fastball (48.1% vs 22.1%) and also more likely than a cutter or curve
    - In spite of this the only two counts where a change was thrown at least ten times were 1-2 and 2-2. Thrown 3% of time in other counts.
        - In all cases, the changeup more than holds its own.
- Pitcher X is needlessly limiting himself to being effectively a three-pitch pitchers for 80% of his pitches vs. righties

Improving Whiff Rate – Strategy Point #2

vs. Righties, 1-1 or 2-2 counts					
	N	%	SwingProb	MissProb	WhiffProb
FASTBALL	139	45.1%	0.626	0.231	0.124
CUTTER	76	24.7%	0.634	0.350	0.161
CHANGEUP	44	14.3%	0.554	0.488	0.178
CURVEBALL	49	15.9%	0.623	0.333	0.149
Total	308	-	0.617	0.313	0.145

vs. Righties, other counts					
	N	%	SwingProb	MissProb	WhiffProb
FASTBALL	532	44.3%	0.483	0.218	0.090
CUTTER	414	34.5%	0.531	0.393	0.145
CHANGEUP	39	3.2%	0.478	0.472	0.164
CURVEBALL	216	18.0%	0.332	0.423	0.114
Total	1201	-	0.472	0.323	0.116

Improving Whiff Rate - Strategy Point #3

Be more aggressive on full counts

- Batters swing on 77% of full count pitches, by far the most of any pitch
  - In spite of swinging so often, batters only miss ~20% of the time, second lowest of any pitch (only 3-0 is lower)
- In addition to mixing up pitches, an opportunity exists to throw more selectively
  - In spite of the fact that batters are most likely to swing at a 3-2 pitch, it is the pitch where Pitcher X puts the ball in the heart of the plate most often

Swing		STRIKES		
BALLS		0	1	2
	0	0.28	0.51	0.52
	1	0.47	0.53	0.6
	2	0.47	0.66	0.67
	3	0.11	0.6	0.77

Heart		STRIKES		
BALLS		0	1	2
	0	0.161	0.104	0.115
	1	0.145	0.101	0.093
	2	0.203	0.155	0.091
	3	0.1	0.093	0.209

Improving Whiff Rate - Strategy Point #3

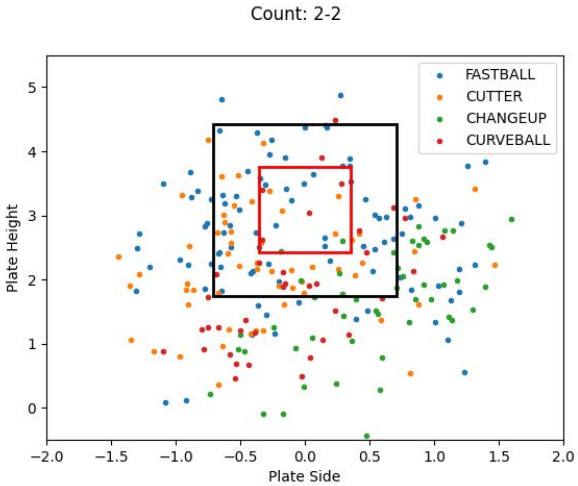
Be more aggressive on full counts

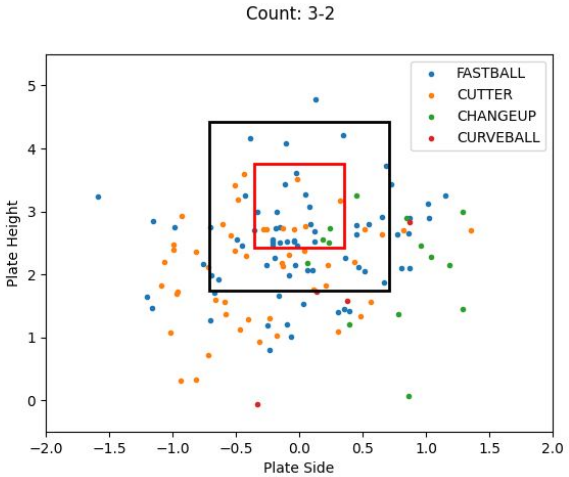
- Batters swing on 77% of full count pitches, by far the most of any pitch
  - In spite of swinging so often, batters only miss ~20% of the time, second lowest of any pitch (only 3-0 is lower)
- In addition to mixing up pitches, an opportunity exists to throw more selectively
  - In spite of the fact that batters are most likely to swing at a 3-2 pitch, it is the pitch where Pitcher X puts the ball in the heart of the plate most often

Swing		STRIKES		
BALLS		0	1	2
	0	0.28	0.51	0.52
	1	0.47	0.53	0.6
	2	0.47	0.66	0.67
	3	0.11	0.6	0.77

Heart		STRIKES		
BALLS		0	1	2
	0	0.161	0.104	0.115
	1	0.145	0.101	0.093
	2	0.203	0.155	0.091
	3	0.1	0.093	0.209

Improving Whiff Rate – Strategy Point #3



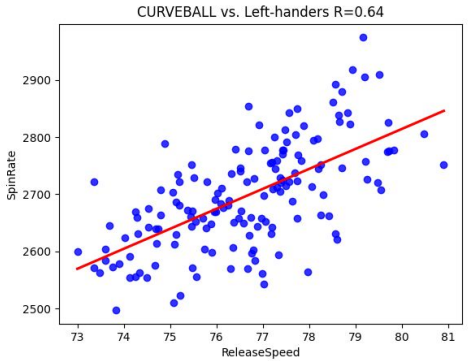


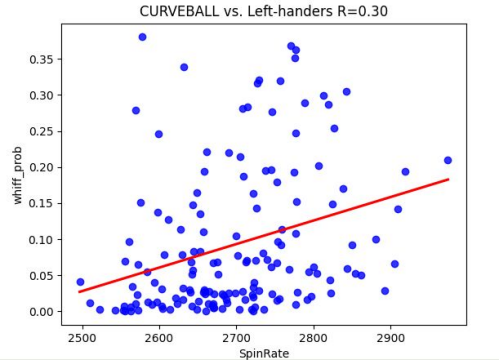
The two pitches with the highest swing probability are 2-2 and 3-2. On 2-2 pitches Pitcher X throws a pitch in the heart of the plate only 9% of the time to take advantage (fewest of all pitches). On 3-2 pitches he throws a pitch down the middle over 20% of the time.

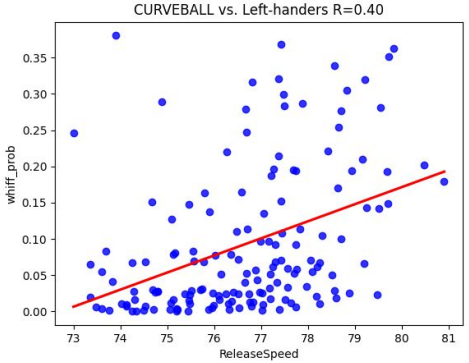
Improving Whiff Rate - Strategy Point #4

Throw the curveball harder, and with more spin

- ReleaseSpeed and SpinRate help in most circumstances against both handed batting.
- For curveballs more than any other pitch, higher release speed and spin rate have a greater chance of being whiffed at.
- Release speed and spin rate are well correlated.



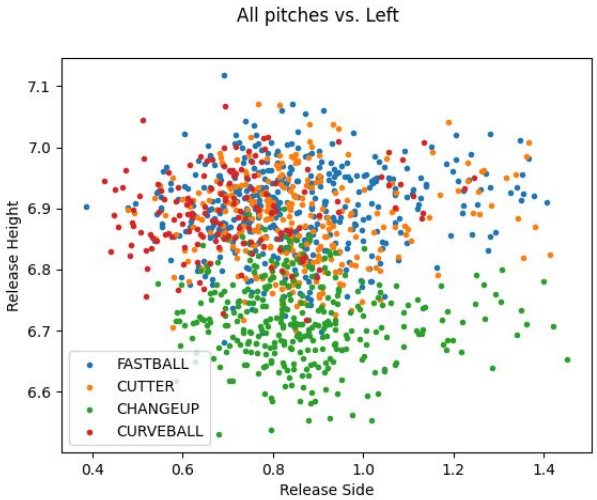




Improving Whiff Rate - Strategy Point #5

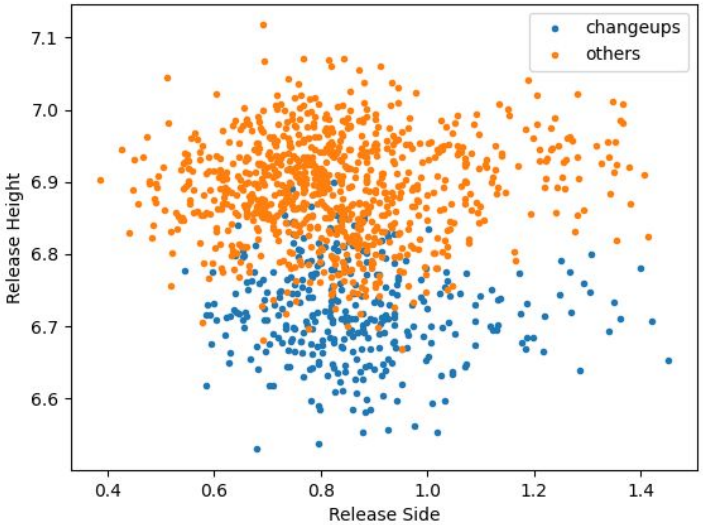
How to improve the changeup

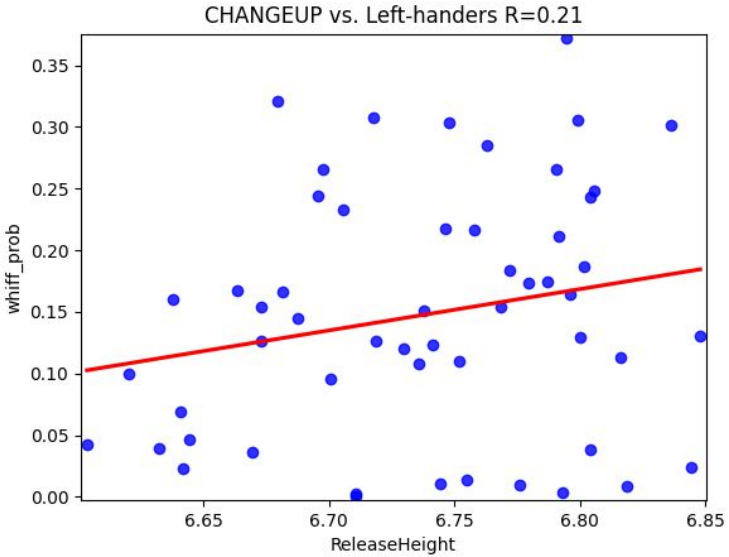
- Could batters discern from arm angle that a changeup is coming? Would that make it less effective?
- While the changeup is pitch with the highest whiff probability, it appears there may be room to make it even better.



Improving Whiff Rate - Strategy Point #5

Looking at 0-1 counts, there appears to be a relationship between ReleaseHeight and whiff probability. Perhaps because the pitch is better disguised?





Overview

1. What is whiff rate? Does it matter?
2. Context, context, context
3. Improving Whiff Rate
4. **Conclusions**

Conclusions

Some suggestions to increase the whiff rate of pitcher X:

1. Less fastballs (and more changeups), especially vs. lefties.
2. More changeups (and less fastballs), especially vs. righties.
3. Be more aggressive on 3-2 counts, move away from heart of plate to take advantage of batter aggressiveness
4. Throw the curveball harder
5. Consider a higher release point on changeups to more closely mimic other pitch release points.

What we left out?

- For the sake of simplicity, we only looked at whiff rate. However, in real life we know that what happens to a ball once put in play is not insignificant.
  - A high variance pitch could produce a lot of dingers AND a lot of whiffs.
  - The chain of all time strikeout leaders in MLB history goes Ruth, Mantle, Stargell, Jackson. That's a nice list.
- Called strikes (especially later in the count) are also valuable and are not included. In fact, no outcomes were noted in the dataset.
- Sequencing of pitches was ignored. Changeups in particular are valuable because of the change of pace. If they were thrown all the time they'd become slow fastballs.
- Sample sizes were very small in certain cases.

Thank you!

Ken Schroeder
schroeder.w.ken@gmail.com