# The Four Tool Pitching Metric

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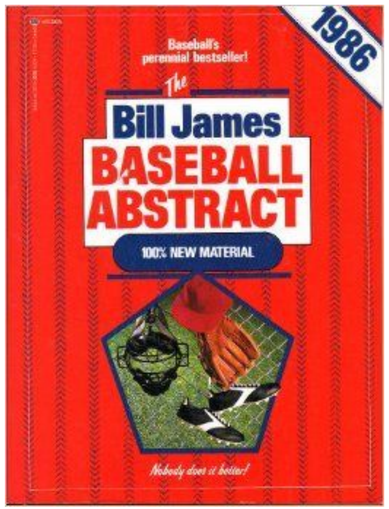
# Background

**Game Score**

- Created by Bill James in 1980's
- Tool for comparing starting pitching performances across time; average = 50
  - Based on simple statistics: outs, strikeouts, walks, hits, and runs allowed

**Game Score 2**

- Tom Tango (aka Tangotiger) adapted original Game Score in 2019
- Attempting to remove bias for pitchers that face very few batters
- Adds home runs and values walks with equal weight as hits



# Game Score vs Game Score 2

**The order at the top is unchanged, but v.2 punishes pitchers for not pitching deep into games**

Top 10 Game Scores

| | | Game Score v1 | | Game Score v2 | |
|---|---|---|---|---|---|
| Pitcher | Date | Score | Rank | Score | Rank |
| Justin Verlander | 9/1/2019 | 100 | 1 | 106 | 1 |
| German Marquez | 4/14/2019 | 94 | 2 | 101 | 2 |
| Shane Bieber | 7/24/2019 | 94 | 2 | 100 | 3 |
| Chris Sale | 6/5/2019 | 93 | 4 | 100 | 3 |
| Lucas Giolito | 8/21/2019 | 93 | 4 | 100 | 3 |
| Shane Bieber | 5/19/2019 | 92 | 6 | 99 | 6 |
| Stephen Strasburg | 8/31/2019 | 92 | 6 | 98 | 7 |
| Masahiro Tanaka | 6/17/2019 | 92 | 6 | 98 | 7 |
| Chris Sale | 8/8/2019 | 91 | 9 | 97 | 9 |
| Mike Fiers | 5/7/2019 | 91 | 9 | 96 | 10 |

Data: Provided to Diamond Dollars Case Competition by Ben Jedlovec and his team at MLB

Bottom 10 Game Scores

| | | Game Score v1 | | Game Score v2 | |
|---|---|---|---|---|---|
| Pitcher | Date | Score | Rank | Score | Rank |
| Masahiro Tanaka | 7/25/2019 | -13 | 4858 | -14 | 4855 |
| Nick Margevicius | 6/16/2019 | -10 | 4857 | -8 | 4848 |
| German Marquez | 7/15/2019 | -9 | 4856 | -8 | 4848 |
| Edwin Jackson | 5/31/2019 | -6 | 4853 | -4 | 4831 |
| Chase Anderson | 8/18/2019 | -6 | 4853 | -15 | 4856 |
| Mike Fiers | 9/9/2019 | -6 | 4853 | -28 | 4858 |
| Steven Brault | 9/13/2019 | -3 | 4852 | -24 | 4857 |
| Kevin Gausman | 5/29/2019 | -2 | 4850 | 3 | 4790 |
| Pablo Lopez | 5/10/2019 | -2 | 4850 | -11 | 4852 |
| Homer Bailey | 7/22/2019 | -1 | 4849 | -13 | 4854 |

Data: Provided to Diamond Dollars Case Competition by Ben Jedlovec and his team at MLB

# Positives and Negatives of Game Score

**Positives:**

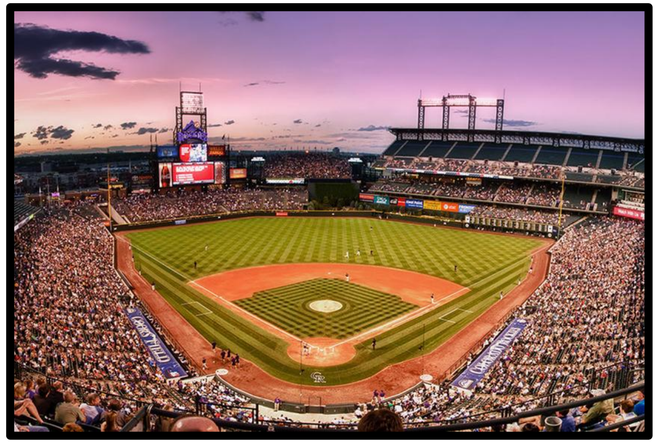
- Simple
- Comparable across time (no use of modern tools)

**Negatives:**

- Outcomes are influenced by factors outside of pitcher's control
- Lacks diagnostic capability

*Armando Galarraga's "perfect" game*

*Fielding Error*



*Coors Field (elev. 5200 ft.)*

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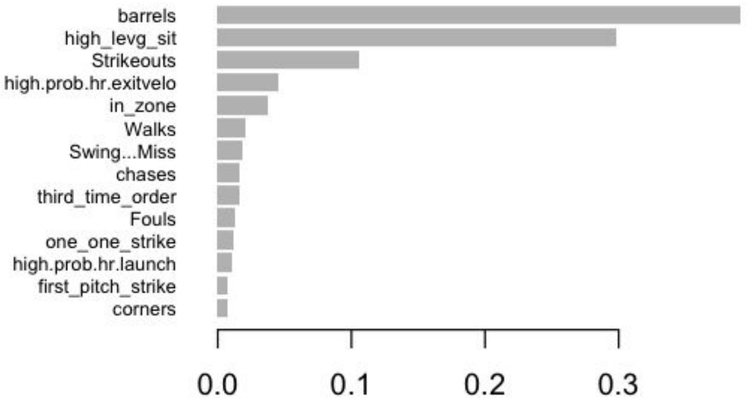
# Our Approach

***A score that focuses on the Hitter vs. Pitcher matchup and removes outside factors***

**Statcast data from baseballsavant.com**

- Launch Angle
- Exit Velocity
- Barrels
- Pitch locations




**Model to determine which stats are most highly predictive of runs**

- Run machine learning models (Ridge Regression, Random Forest, xgBoost)
- Determine variable importance

**Assign weights to selected variables based on ability to predict game score**

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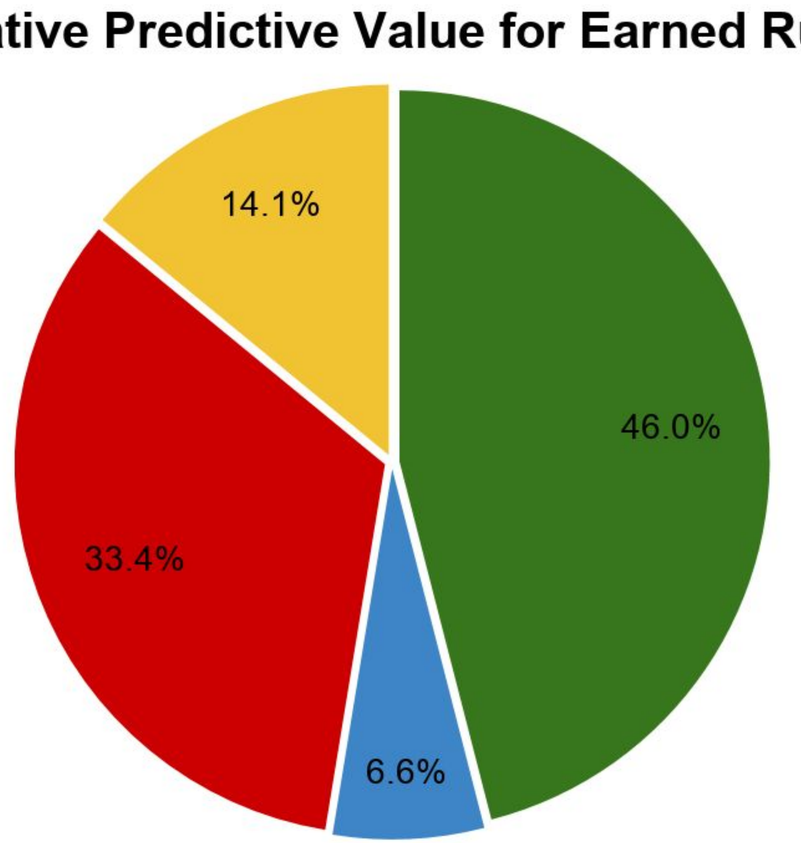
# The Four Tool Pitching Metric

**The "Stuff"**
- Whiffs
- Ks
- Chases

**Game Control**
- First Pitch Strike
- Strike on 1-1 Count
- Batters Faced > 2 Times
- Batters Faced in High Leverage Situations




**Avoiding Hard Contact**
- Barrels
- High Exit Velocity
- High Launch
- Fouls

**Command**
- Walks
- Pitches in the Zone
- Pitches on the Corner

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# Avoiding hard contact

**Barrels**
- Launch angle and exit velocity with min. expected BA of .500 and min. expected SLG% of 1.500

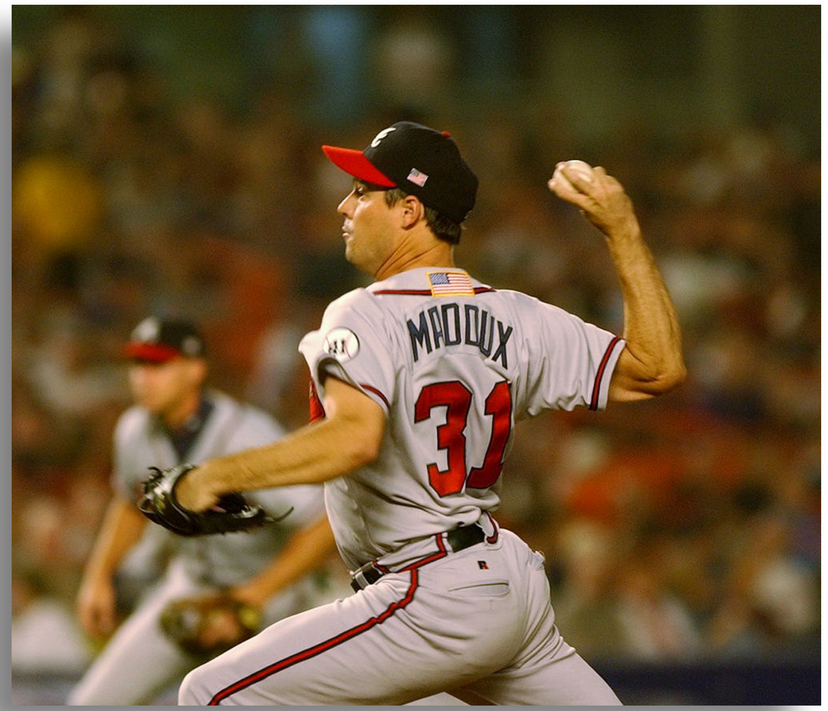
**High Exit Velocity**
- Exit velocity with HR probability >10% (>100 mph)

**High Launch**
- Launch angle with HR probability >10% (between 22 and 38 degrees)

**Foul Balls**
- Pitcher awarded for causing a foul ball

**Avoiding Hard Contact Tool = (-5.6) per barrel + (-1.1) per HEV + (-0.51) per HL + (0.1) per Foul**

# Command




**Walks**
- Pitcher penalized for walks

**Pitches in the Zone**
- Pitches that register in the strike zone according to statcast

**Pitches on the Corner**
- Pitcher rewarded for pitches on the corner of strike zone

**Command Tool = (-2.0) per BB + (0.2) per pitch in zone + (0.1) per pitch on corner**

# Game Control


**First Pitch Strike**
- First pitch to a batter results in a strike. Pitcher starts off ahead in count.

**Strike on 1-1 Count**
- Biggest difference in Batting Avg. by outcome (1-2 or 2-1)

**Batters Faced 3 Times**
- Indication of successful game control

**Batters Faced in High Leverage Situations**
- Pitcher penalized for placing himself in a situation with runners in scoring position with less than 2 outs

**Game Control Tool = (0.3) per 1st pitch strike + (0.4) 1-1 strike + (1.0) Batters3Times + (-1.9) HLS**

# The “Stuff”

**Whiffs**
- When a hitter swings and misses

**Ks**
- Pitcher awarded for strikeouts

**Chases**
- Anytime a hitter swings at a pitch outside of the strike zone

**The “Stuff” Tool = (0.2) per whiff + (1.5) per K + (0.19) per chases**

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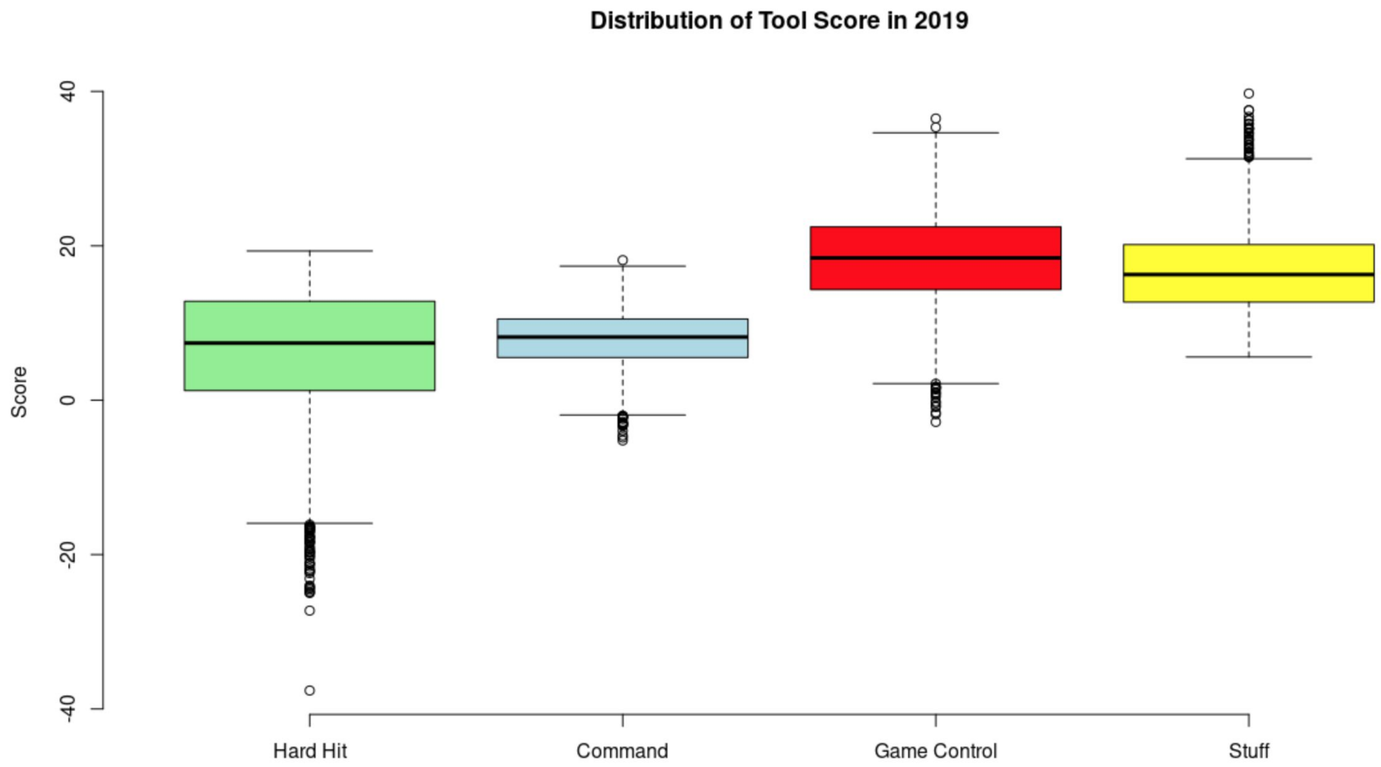
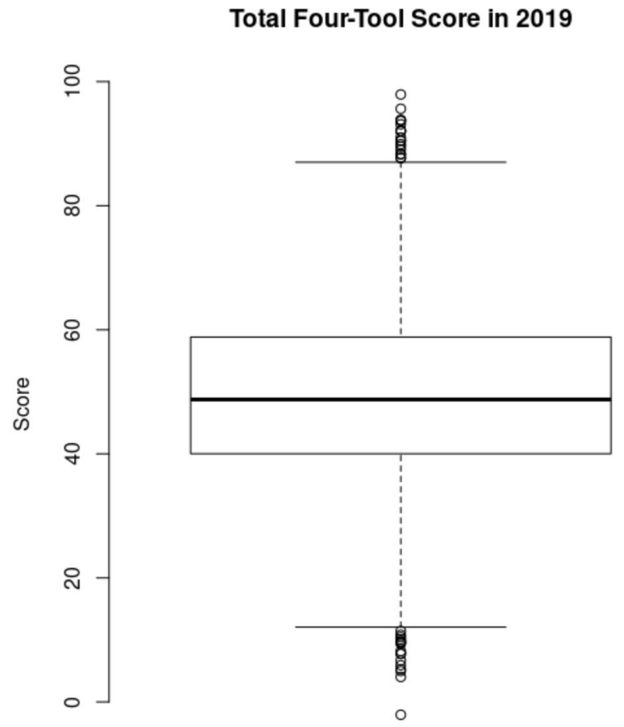
# Summary of the Four Tool Pitching Metric in 2019




| | Hard Hit | Command | Game Control | Stuff |
|---|---|---|---|---|
| Mean: | 6.2 | 8.0 | 18.4 | 16.7 |
| 25%: | 1.2 | 5.5 | 14.3 | 12.7 |
| 75%: | 12.8 | 10.5 | 22.5 | 20.2 |




| | |
|---|---|
| Mean: | 49.2 |
| 25%: | 40.0 |
| 75%: | 58.8 |

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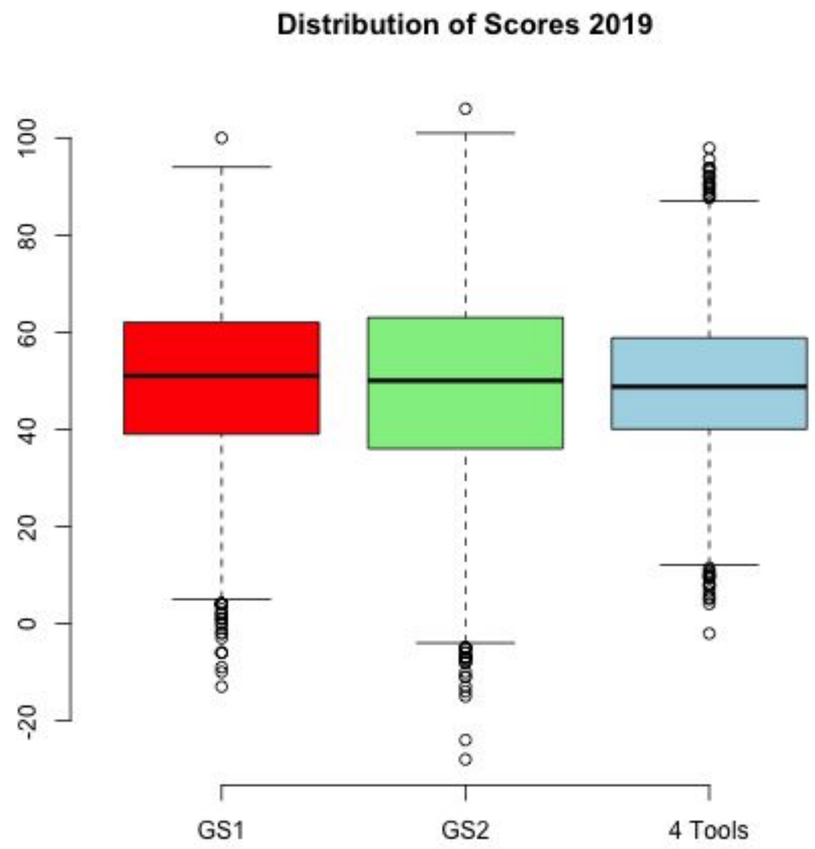
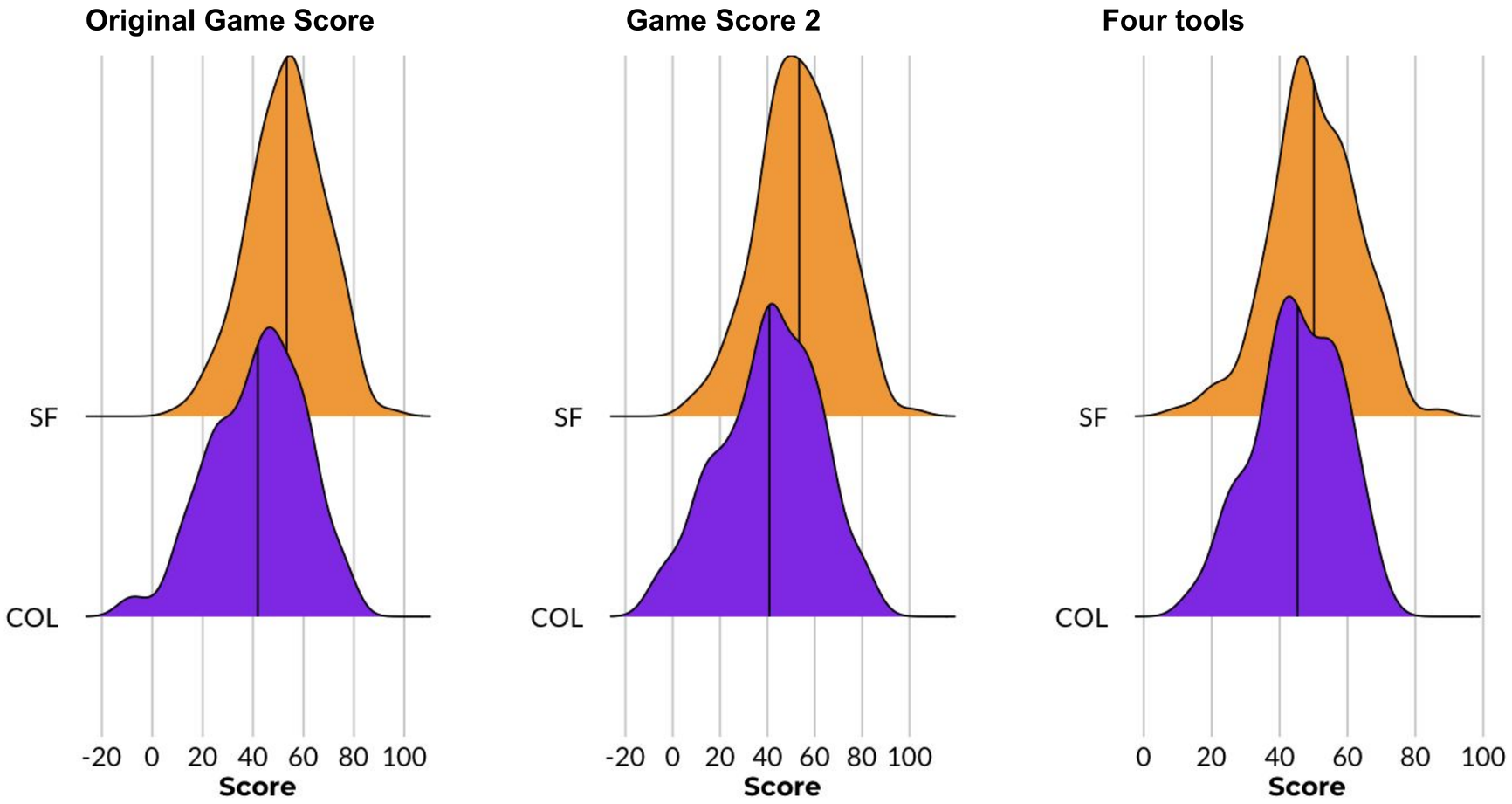
# Comparisons to Game Score




**Summary:**

- The Four Tools sum up to a score that is roughly on the same scale as Game Score
- The distribution of Four Tools scores is tighter around the average
- Four Tools scores are within 0-100 scale, Game Scores 1 and 2 are not

# Four Tools reduces bias from Park Factors




- Less variation in distribution between parks
- Shape of distribution nearly identical between SF and COL
- Fewer scores below 20 in COL

# Comparisons to Game Score

Top 10 Four Tools Scores

| | | Game Score | | Game Score v2 | | 4 Tools | |
|---|---|---|---|---|---|---|---|
| Pitcher | Date | Score | Rank | Score | Rank | Score | Rank |
| Walker Buehler | 6/21/2019 | 89 | 15 | 86 | 71 | 97.9 | 1 |
| Chris Sale | 5/8/2019 | 86 | 31 | 93 | 21 | 95.6 | 2 |
| Justin Verlander | 9/1/2019 | 100 | 1 | 106 | 1 | 93.8 | 3 |
| Andrew Heaney | 8/20/2019 | 84 | 48 | 85 | 87 | 93.7 | 4 |
| Gerrit Cole | 9/8/2019 | 91 | 9 | 92 | 27 | 93.7 | 5 |
| Max Scherzer | 6/30/2019 | 84 | 48 | 85 | 87 | 93.1 | 6 |
| Shane Bieber | 5/19/2019 | 92 | 6 | 99 | 6 | 92.1 | 7 |
| Chris Sale | 6/5/2019 | 93 | 4 | 100 | 3 | 92.0 | 8 |
| Gerrit Cole | 6/7/2019 | 75 | 257 | 73 | 471 | 92.0 | 9 |
| Jacob deGrom | 8/23/2019 | 77 | 191 | 82 | 153 | 91.0 | 10 |

Basic gamelog Provided by Ben Jedlovec and his team at MLB; statcast data from baseballsvant.com

## Highlights:

- The top 10 scores for the Four Tools are directionally similar to Game Score
- Justin Verlander's 14K no-hitter moved from 1st to 3rd
- Gerrit Cole's Jun-7 performance is the largest difference, due in large part to 2 unearned runs

**Key Takeaway**:
The Four Tools scores are different, because it is focused on parts of performance pitchers can control

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# Case Study 1: Jacob deGrom 8/23/2019

**Game Score: 75; Game Score 2: 73; Four Tools: 92**

- 13 Ks (8 straight at one point), 1 BB, 1 ER
- 4 hits - all singles
- 3 BBE with an optimal launch angle for homeruns
- 1 BBE with exit velocity over 100 mph
- 0 Barrels

**Four Tool Score**

- Avoiding Hard Contact: 15.99 (90th percentile)
- Command: 9.94 (69th percentile)
- Game Control: 28.76 (97th percentile)
- The “Stuff”: 36.3 (99th percentile)


**deGrom’s 4 hits**

| | | | | |
|---|---|---|---|---|
| **Distance (ft.)** | 16 | 3 | 243 | 74 |
| **Exit Velocity(mph)** | 102 | 86 | 76 | 87 |
| **Launch Angle (deg.)** | -7 | -32 | 21 | 4 |

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# Case Study 2: Masahiro Tanaka 6/17/2019

**Game Score: 92; Game Score 2: 98; Four Tools: 78**

- 10 Ks, 1 BB, 0 ER, 9 IP
- 2 hits - both singles
- 5 BBE with an optimal launch angle for homeruns
- 5 BBE with exit velocity over 100 mph
- 1 Barrel

**Four Tool Score**

- Avoiding Hard Contact: 5.89 (41st percentile)
- Command: 11.64 (84th percentile)
- Game Control: 32.55 (99th percentile)
- The “Stuff”: 27.67 (97th percentile)


**Tanaka’s 2 hits**

| | | |
|---|---|---|
| **Distance (ft.)** | 341 | 278 |
| **Exit Velocity(mph)** | 108 | 107 |
| **Launch Angle (deg.)** | 20 | 12 |

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# Summary

**How to use the Four Tools**

- Pitchers and coaches:
  - Filter out the noise from uncontrollable factors
  - Quickly diagnose areas to dig deeper on for further improvement
- Front offices:
  - Quantifiable measure of pitcher effectiveness independent of non-controllable factors
  - Guide further research into which players are overvalued based on “box score” stats

**How NOT to use the Four Tools**

- To compare players across eras
- As a “holy grail” stat - a starting point for further analysis, not the end-all be-all stat of pitcher performance

# Next Steps

**App development** to bring real-time performance updates to pitching staff and coaches in the dugout and bullpen.

**Monitor new innovation.** Implementation of Hawk-eye and continued R&D might lead to new stats being added to the Four Tools.

**Apply this methodology to relievers, openers, and closers**

# Questions