

Baseball Analytics: Past, Present and Beyond



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Esteban



**Universidad Nacional
Autónoma de México**

Bachelor's in Mathematics,
2013-2018



New York University

MS in Data Science,
2018-2020



Los Angeles Dodgers

Quantitative Analyst,
2020-2021



Zelus Analytics

Technical Product
Manager, 2022-present





Zelus Analytics



70+ Staff

20+ PhDs

30+ Clubs

Zelus Previous Club Experience Includes:





Zelus Baseball

- Teams outside MLB:
 - International
 - College!
- Data engineering as a service / consulting
- Non-team partners:
anyone interested in data-driven player evaluation





Baseball Analytics 101

Def. Data-driven tools to improve decision making and gain a competitive edge

- Roster construction: Player evaluation, acquisition and contract extensions, MiLB promotion, usage optimization
- In-game strategy: Pitching plans, defensive positioning
- Player development: Kinematics, improvement plans
- How good is my organization now and in the future?



Baseball Analytics 102

Descriptive

- Assign patterns / probabilities to past events
- Statistics to summarize and explain the past
- What should we measure?

e.g. Strike probability

Predictive

- Assign probabilities to future events
- Separate skill from luck in residuals
 - Value and projections

e.g. Catcher framing

Prescriptive

- Assign actions to probabilities
- Decision making under uncertainty
- Creates actionable insights by contextualizing models

e.g. Catcher trade

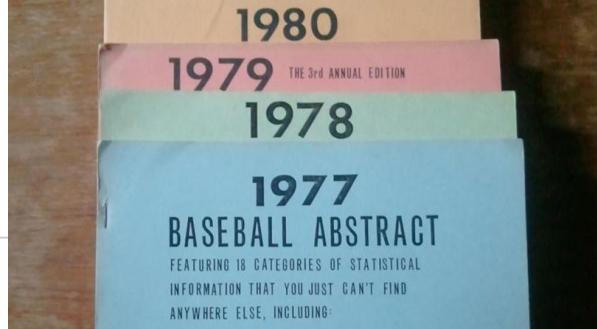


A brief history of Baseball Analytics

From Bill James to pose tracking



Bill James



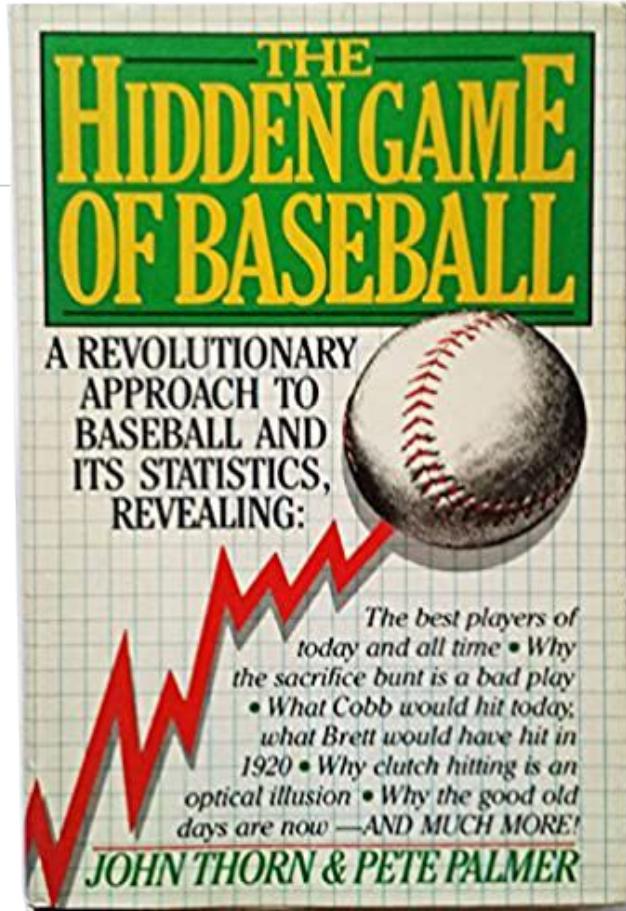
- 1977: First edition of the **Baseball Abstract**
 - In the first 5 years: Aging curves, runs created, replacement value, defensive spectrum, park effects
- 1985: Major-League equivalencies for Minor-League stats
 - Very much an open problem
- 2002: Win Shares



Pete Palmer



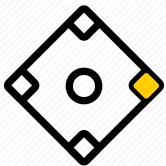
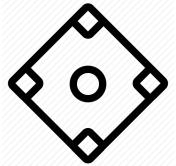
- 1974: Batter's Run Average (eventually, OPS)
- 1984: Publishes The Hidden Game of Baseball with John Thorn
 - Linear Weights
 - Total Player Rating (precursor for WAR)



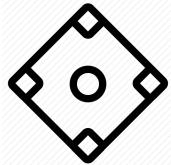


Expected Runs Matrix

Runners	0 Outs	1 Out	2 Outs
Empty	0.461	0.243	0.095
1 __	0.831	0.489	0.214
_ 2 _	1.068	0.644	0.305
1 2 _	1.373	0.908	0.343
_ _ 3	1.426	0.865	0.413
1 _ 3	1.798	1.140	0.471
_ 2 3	1.920	1.352	0.570
1 2 3	2.282	1.520	0.736



Linear Weights



Run value = 0.28

Linear Weights



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Linear Weights

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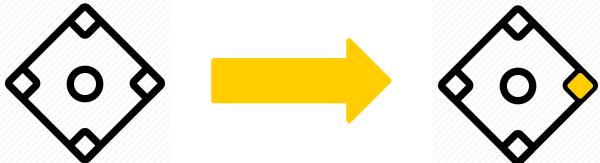


Run value = 0.28



Run value = 0.41

Linear Weights



Run value = 0.28

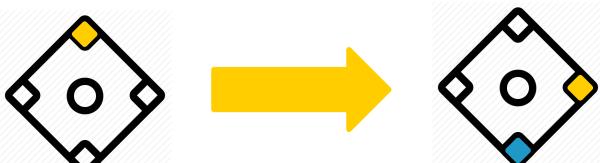


Run value = 0.41

(...)



Run value = 0.62

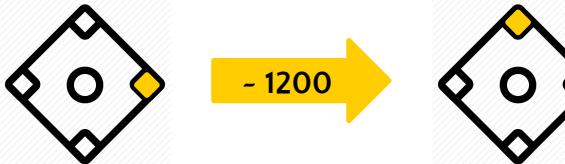


Run value = 0.88

Linear Weights



Run value = 0.28

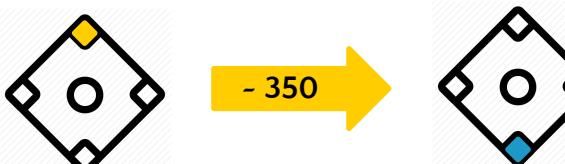


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(...)

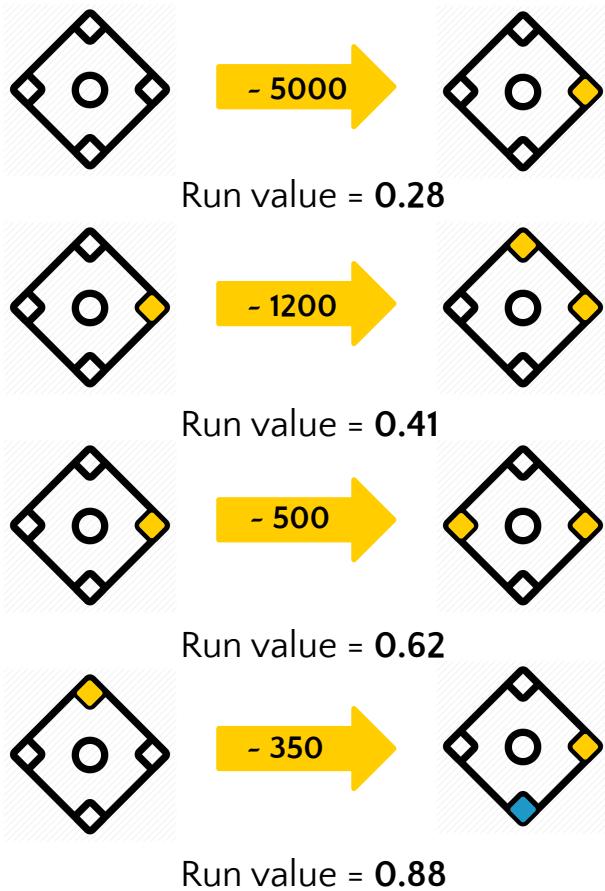


Run value = 0.62



Run value = 0.88

Linear Weights



Run value of a
single: **0.46**



Keith Woolner



- 1995: Created Value Over Replacement Player (VORP) a direct predecessor of WAR
- 1998: Joins Baseball Prospectus, eventually becomes director of Research & Development
 - 2000: Publishes Baseball's Hilbert Problems
- 2007: Joins Cleveland Guardians as Director of Analytics
 - Still at the Guardians as R&D's Principal Data Scientist



Baseball's Hilbert Problems: Keith Woolner (2000)

- 1. To be relevant, sabermetrics must inform a decision**
2. Must consider the economic, social, technological, competitive and governmental context of the game
3. The resources to answer these questions may not be available at present
4. A line of reasoning is valid even if it can't be quantified or measured cleanly yet



Pitching Evaluation

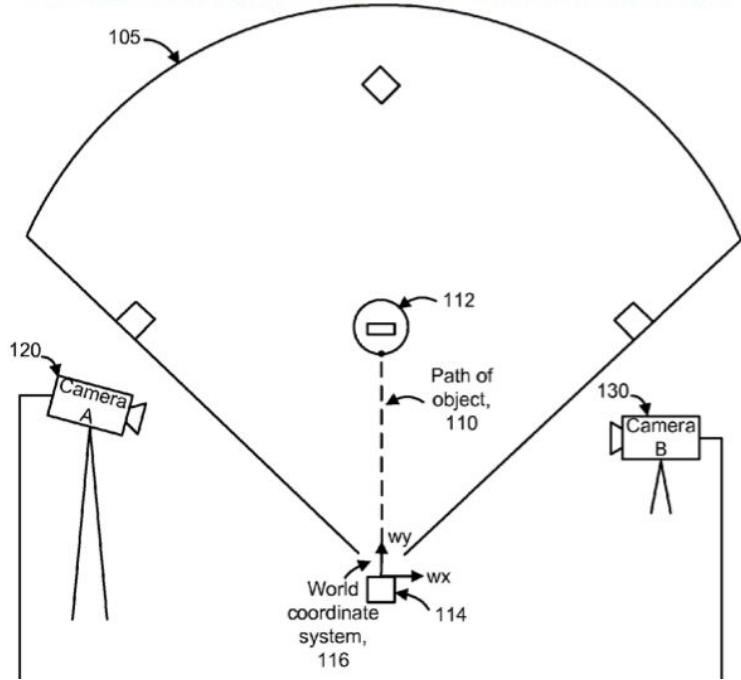
1. Separate defense into pitching and fielding
 - “Pitching and fielding are so intertwined that they seem impossible to separate.”
10. Projecting minor league pitchers accurately
 - “While strikeout-to-walk ratios and other means of assessment can give us rough guides to good and bad young pitchers, we’re nowhere near the level of certainty we want to achieve.”



PitchFx (2006)

- Two-camera system
- 20 images of flight, fits trajectory based on 3D location of the ball in those
- Speed, break, location
- Manual: Pitch/AB result (e.g. called strike), substitutions, fielding location

SOURCE - http://www.patentlens.net/patentlens/patent/US_7062320/

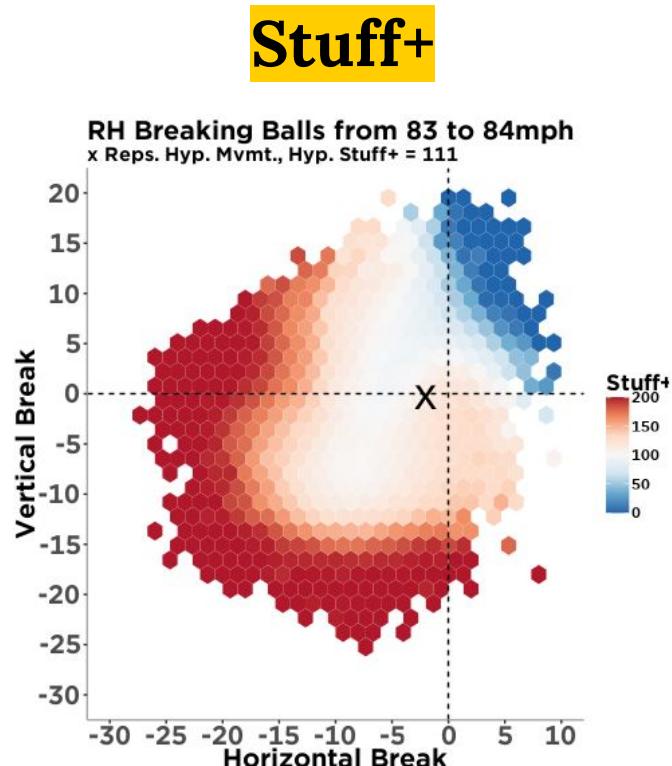




Pitching Evaluation

Defense-Independent Pitching

- DIPS, created by Voros McCracken (2001)
 - Only what the pitcher controls (K, BB, HR, HBP)
- Popularized By Tom Tango's FIP and other variants

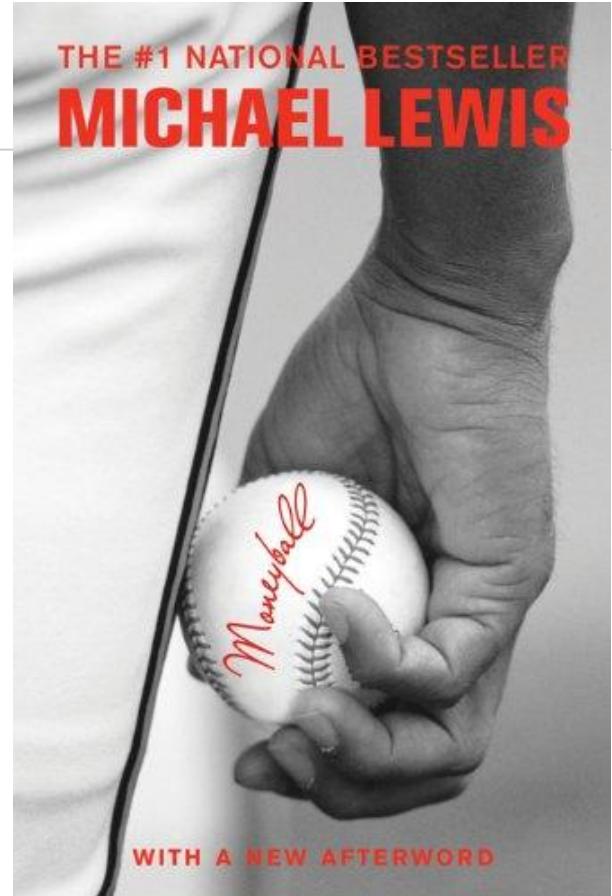




League environment

19. Optimizing the competitive ecology of the game

“(...) ‘small-market’ teams can’t hold onto their own farm-developed talent (...) long enough to contend. However, if we went back to making it easier for teams to retain their own players, you risk creating long-term dynasties (...) So what’s the best way to achieve league-wide competitiveness?”

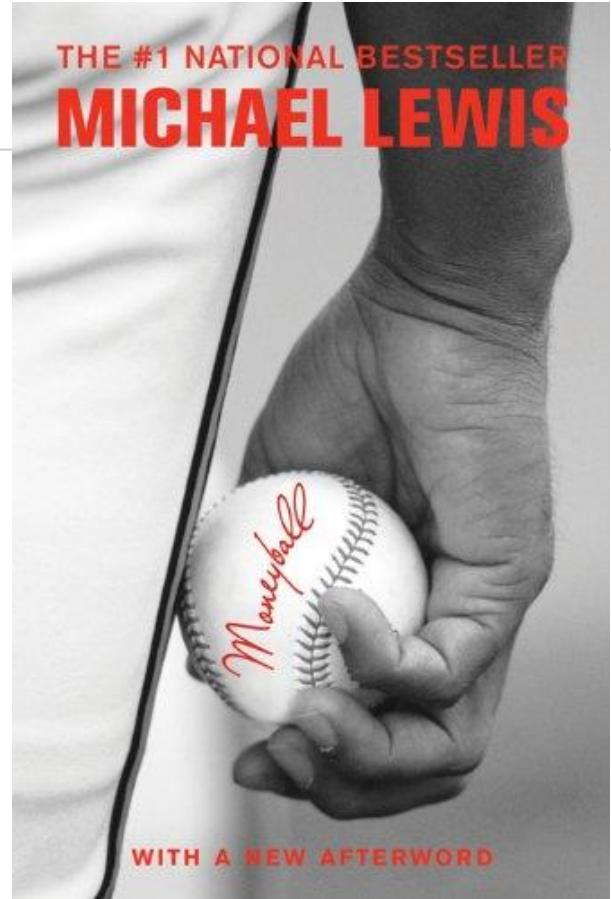




League environment

19. Optimizing the competitive ecology of the game

- Moneyball '03, based on '01/'02 A's
- No B2B champions in 23 seasons
 - Red Sox 4 times (04, 07, 13, 18)
- Perennially competing small market teams, like the Rays





Quantifying defense

3. Measuring the catcher's role in run prevention

- Catcher framing >> blocking and throwing
- Ryan Doumit ('05-'14)
 - Before: +8.2 WAR
 - After: -8.1 WAR
 - Below replacement in 7 seasons

Statcast Catcher Framing Leaderboard

Catcher	Team	Pitches	Catcher Framing Runs	Strike Rate
Bailey, Patrick	SF	2513	16	52.9%
Hedges, Austin	T	2025	13	52.5%
Heim, Jonah	T	3657	10	48.5%
Alvarez, Francisco	NY	3006	9	48.9%
Higashioka, Kyle	NY	2078	7	48.7%



Market value

6. Quantifying the value of positional flexibility

“Fearing, Chan (2018): Top teams can attribute at least one to two wins per season to flexibility alone”

16. Creating a framework for evaluating trades.

Orioles	GET	Brewers	GET
	34		24
	5		15
Corbin Burns	33.8	DL Hall	18.9
		Joey Ortiz	13.6
		Round A Comp Balance Pick	4
Total Value	33.8	Total Value	36.5



The next frontier in Baseball Analytics

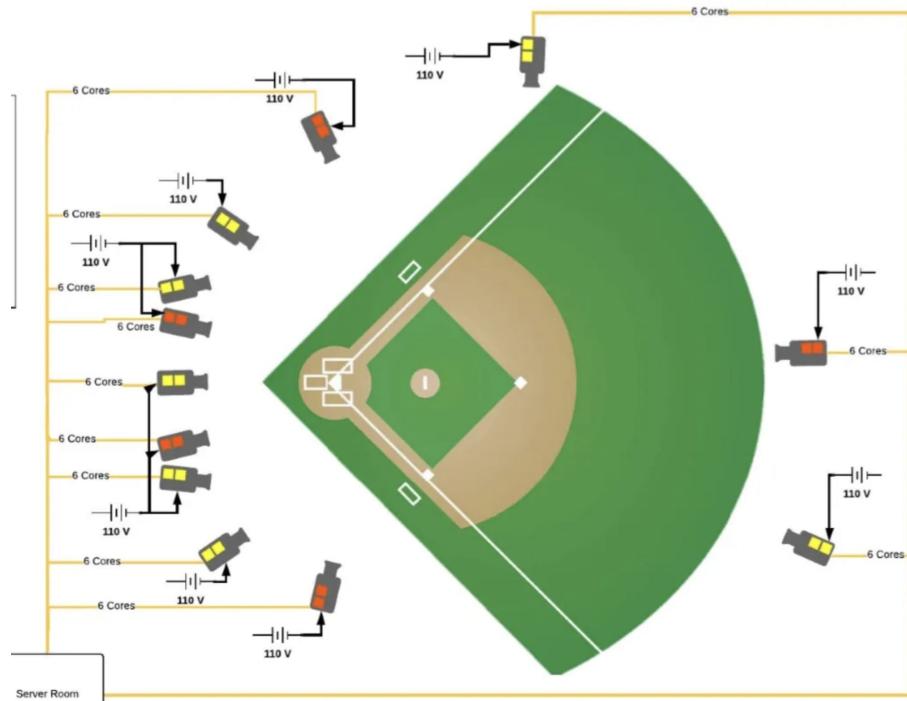
Or rather, my hot takes on the future of baseball



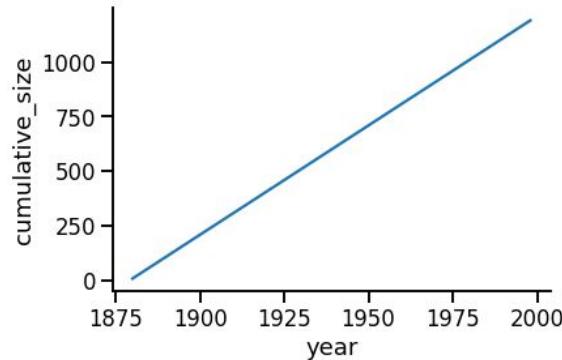
Hawk-Eye (2020)

- 12-camera optical system
- So much more data!
 - 2020: 18-point pose tracking, 100 FPS
 - Now: 29-point pose tracking, 300 FPS

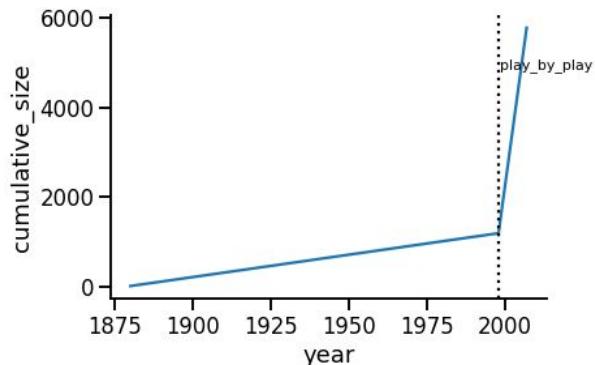
Introducing Statcast 2020: Hawk-Eye and Google Cloud



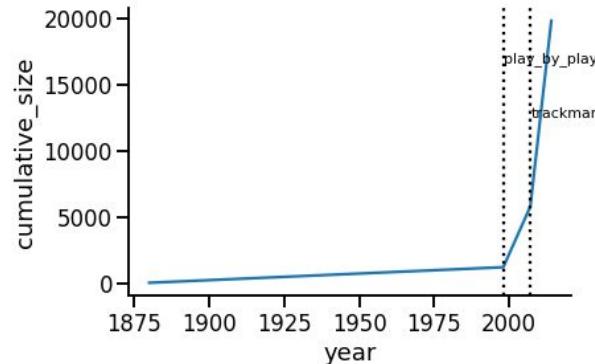
Box score era: 10MB per season



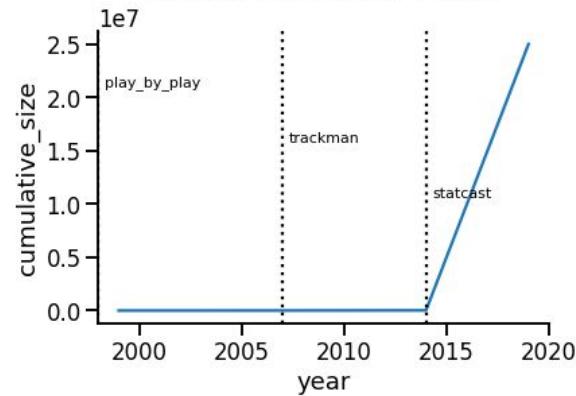
Play-by-play era: 500MB per season



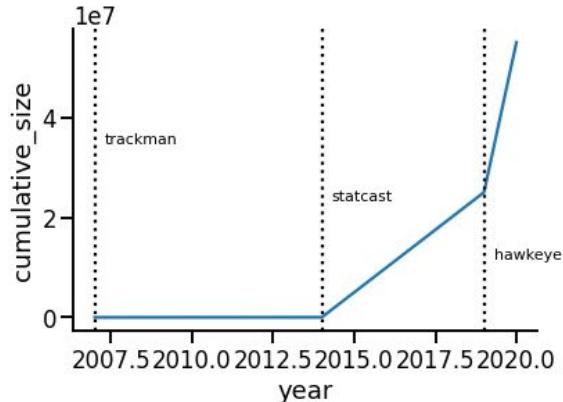
TrackMan era: 4.5GB per season

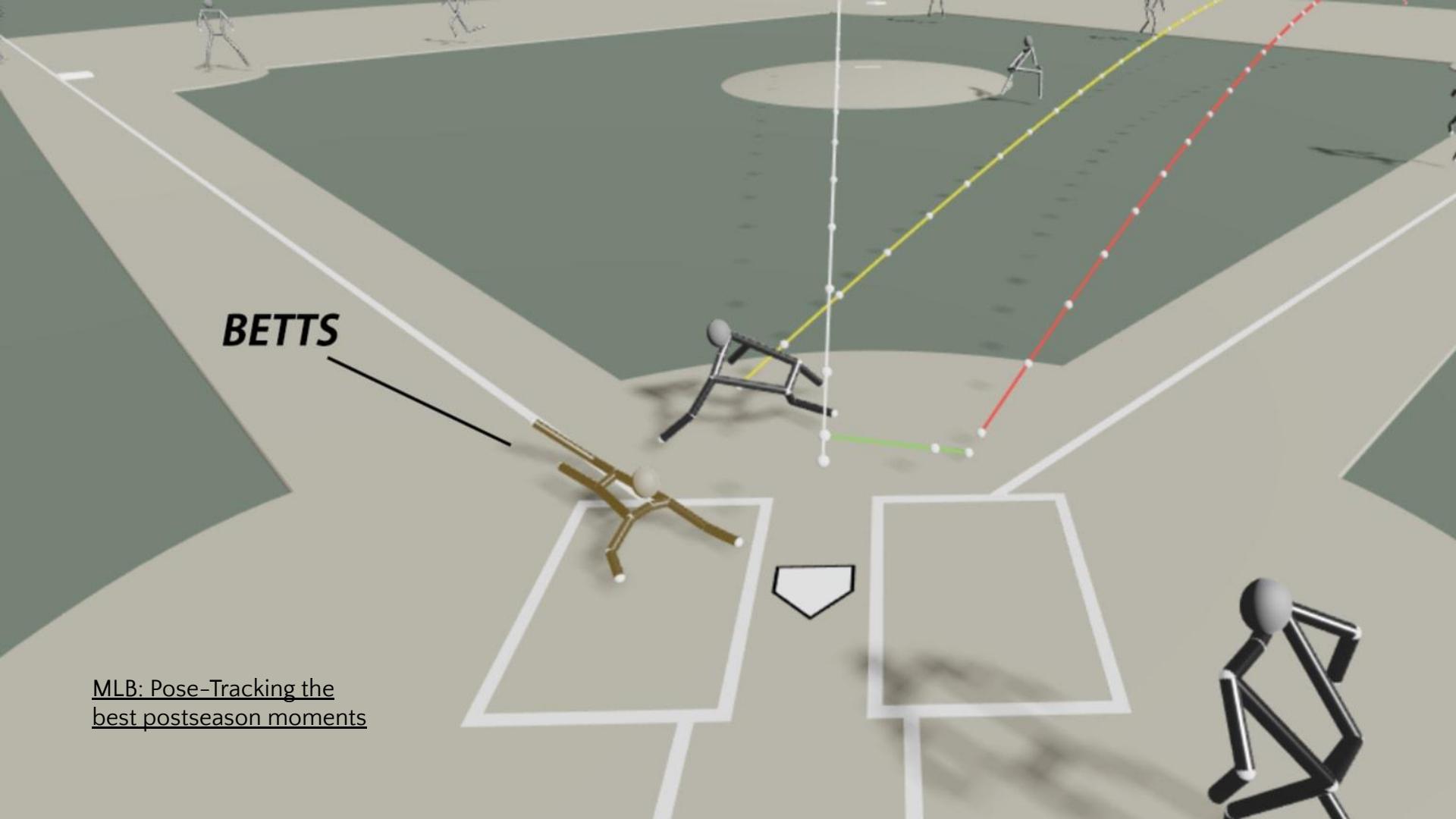


Statcast era: 5TB per season



Statcast (Hawk-Eye) era: 30TB per season



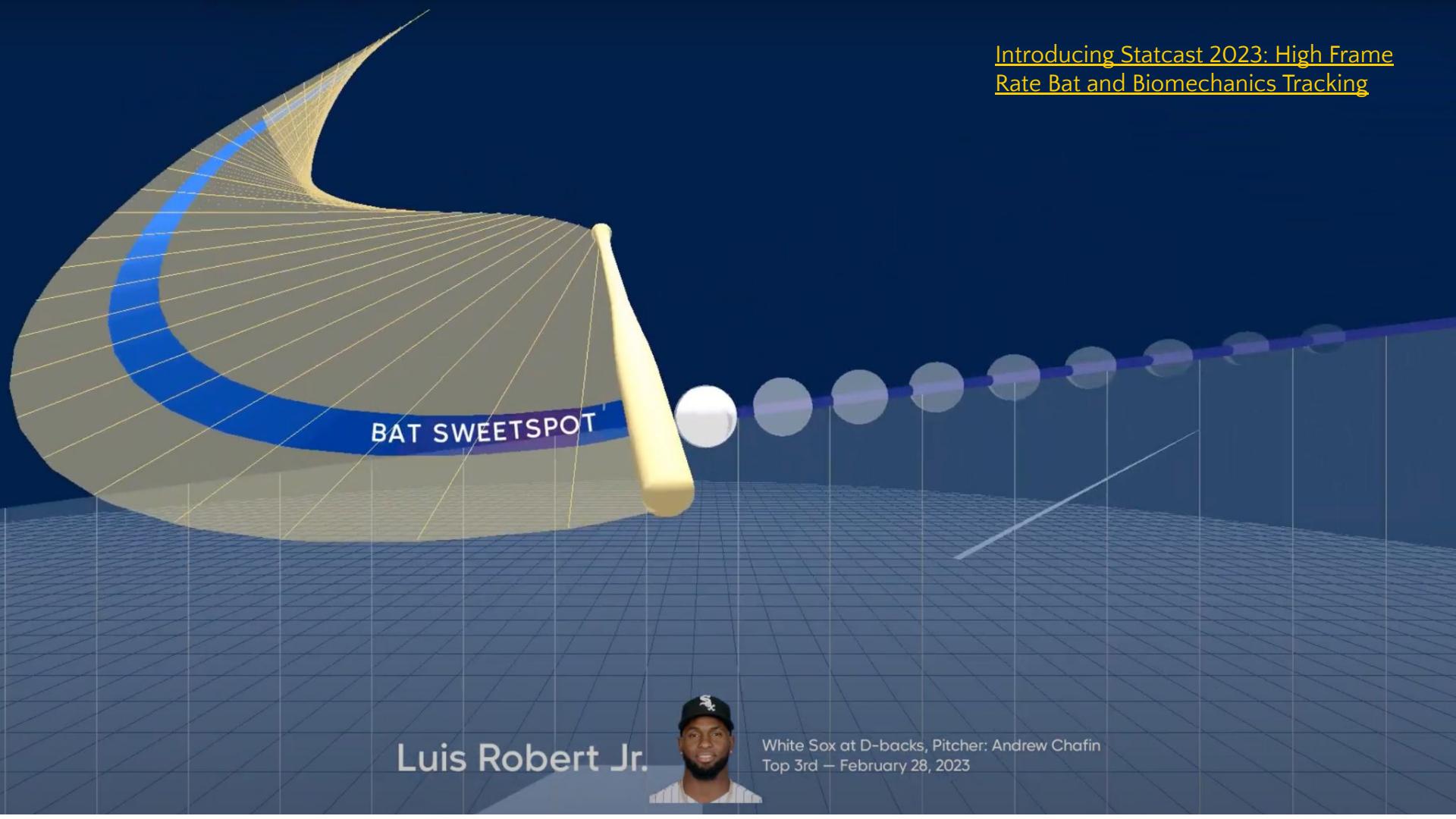


BETTS

A 3D rendering of a baseball field showing a player's trajectory. The player, labeled 'BETTS', is shown in three stages of a swing. A yellow line with white dots shows the path from home plate towards the pitcher's mound. A red line with white dots shows an alternative path or a different player's movement. The field includes bases, a pitcher's mound, and a fence. Other players are visible in the background.

MLB: Pose-Tracking the
best postseason moments

Introducing Statcast 2023: High Frame
Rate Bat and Biomechanics Tracking



Luis Robert Jr.



White Sox at D-backs, Pitcher: Andrew Chafin
Top 3rd — February 28, 2023



1. What in the world is a good swing?

- Change in pitching quality of competition makes minor-to-majors hitting translations more difficult
 - Weakness exploitations in MLB (e.g. high fastball)
- Aaron Judge v José Altuve batting mechanics
- Educated guesses v pure reaction
- Physical movement variance
 - Clutch hitting!?



2. Reimagining pitcher roles

- Woolner: Determining optimal pitcher usage strategies.
- Opener to match up against best 3 hitters
- Starters pitch much more than relievers
 - Way more valuable: Median 5th SP - Top-end 3th RP
- In-season build-up:
 - 21-22: Ranger Suarez, Drew Rasmussen, Jeffrey Springs
 - 23: Michael King, Cole Ragans, Zack Littell
- 1993 Tony La Russa: Three innings every third day



3. Non-Stuff Pitching

- The industry hasn't been able to understand the residual between results and stuff very well
 - Location and command
 - Arsenal and pitch selection and sequencing:
 - Predictability v using your best pitch
 - Esteban: Just throw your best pitch more!
 - Deception beyond movement



4. Coaching and player development with data

- Trade Offs:
 - Improvement v injury risk
 - When to make a coaching intervention
 - Short-term v long-term
- Injury proneness, and its relationship to workload
- Better understanding the times through the order effect
 - Familiarity, fatigue, pitch selection entropy
- Pitcher availability and usage, given recent workload



5. You have the analytics! Now what?

- Data-driven decision making under uncertainty
 - How do you build a data culture?
- Team context v team neutral
 - Team-specific economic assumptions
 - Time-dependent even within the team!
 - Roster-aware player impact
 - Padres: Suppose we play 9 SS in the field...



Thank you!

Any *questions* ?

Find me at

- estebanng.github.io
- [@EstebanNG_](https://twitter.com/EstebanNG_)