Data 8 Connector: Sports Analytics

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02/20/18

Course Stuff

➔ Homework due Thursday (OH today 2-4pm if you need help)
➔ Project proposals: Go over them next week
➔ Homework grades on bCourses (HW1 everyone got 100% so no worries for now)
➔ Today's demo in a Piazza post just sent
➔ Any questions?

Review

RE24

$$RE24 = \text{Run Potential End State} - \text{Run Potential pre event} + \text{Runs Scored}$$

➜   Change in run potential plus runs scored

➜   Impact of the event on expected run scoring

LWTS & wOBA

What's the goal? Run creation

➜   BA, OBP, and SLG didn't explicitly work to estimate run creation, just something close (a proxy)

We want a linear metric

$$\text{Linear Metric} = w_{1B} \cdot 1B + w_{2B} \cdot 2B + \cdots + w_{BB} \cdot BB + \cdots$$

They're elegant and fairly robust:

➜   Gather positive and negative contributions

➜   Weight by importance

➜   Sum

LWTS & wOBA

But what weights to use?

LWTS: If you hit a single, how much runs above average will that single produce?
   →   Use RE24 values to get average run impact of a single

Why LWTS and wOBA are so great: use the game and its data to inform how you
should value outcomes

LWTS & wRAA

LWTS: expected values of events (average RE24 per event)

Event_Type	Double	Error	Fielder's choice	Generic out	Hit by pitch	Home run	Intentional walk	Interference	Single	Strikeout	Triple	Walk
RE24	0.778	0.512	-0.308	-0.283	0.336	1.379	0.17	0.481	0.461	-0.288	1.081	0.306

How to interpret LWTS:
➔ Two teams, A's and Yankees have all stats are the same
➔ Except: Yankees have 100 more singles than the A's
$100 \cdot 0.46 = 46$ more runs expected for the Yankees (~4.5 wins)
➔ Or: A's have 33 more HRs.
$33 \cdot 1.38 = 45.5$ more runs expected for the A's (1 HR equal to about 3 singles)

LWTS & wRAA

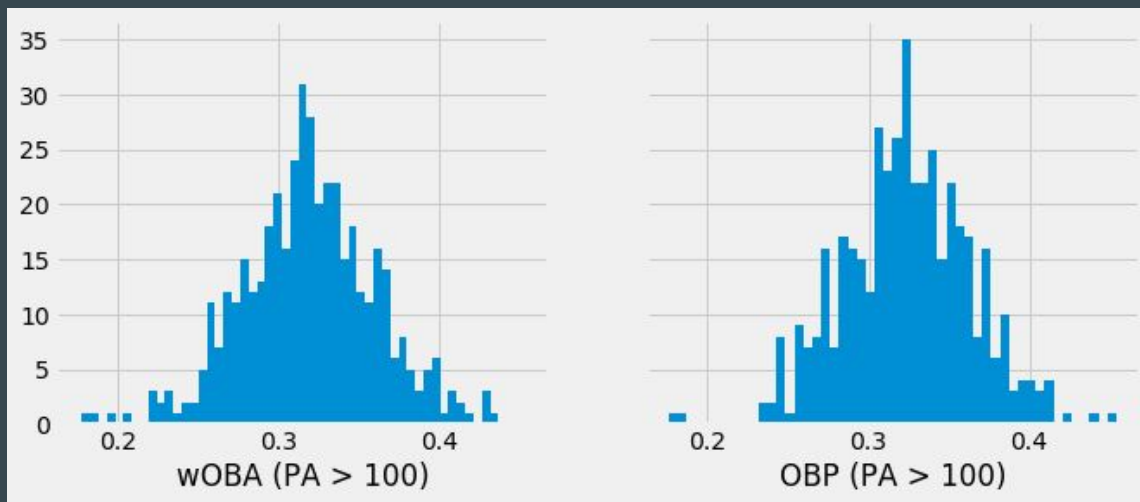LWTS for players: called wRAA on Fangraphs
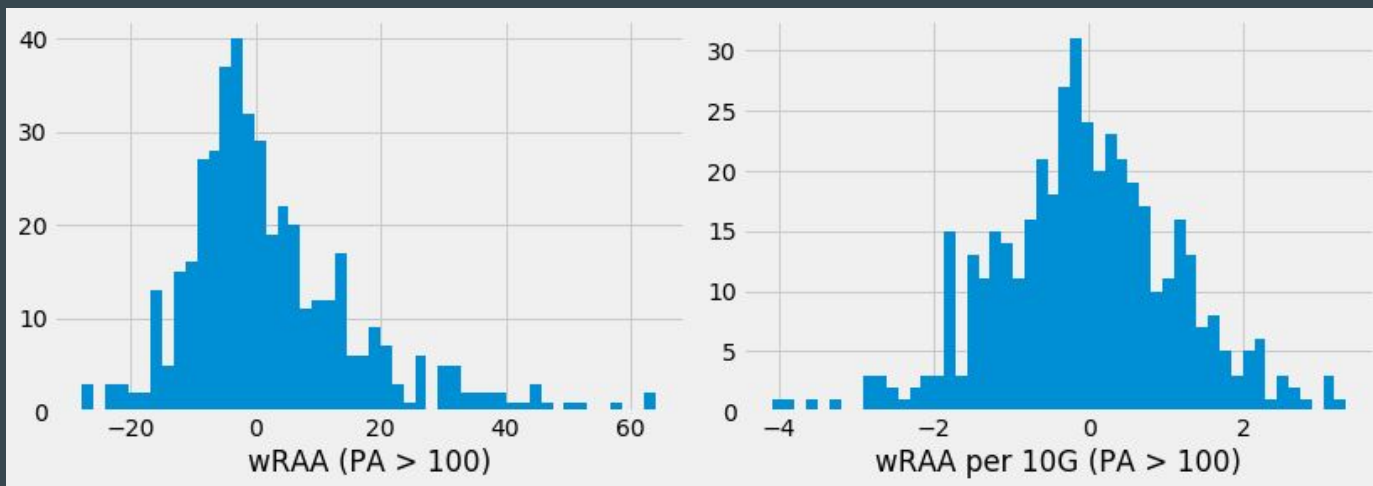
wOBA

Weighted On-Base Average

$$wOBA = (0.696 \cdot BB + 0.732 \cdot HBP + 0.879 \cdot 1B + 1.254 \cdot 2B + 1.613 \cdot 3B + 1.965 \cdot HR)/PA$$

Beauty of wOBA: powerful and easy to use/interpret (think of it like OBP)

wOBA

wOBA for players: similar scale to OBP

wOBA

|	Name	Team	Age	G	PA	AVG	OBP	SLG	OPS	wOBA ▾	wRAA	wRAAper10G
36	Mike Trout	Angels	25	114	507	0.306	0.442	0.629	1.071	0.437	49.6	3.33
38	Aaron Judge	Yankees	25	155	678	0.284	0.422	0.627	1.049	0.43	62.5	3.13
37	J.D. Martinez	- - -	29	119	489	0.303	0.376	0.69	1.066	0.43	45.1	3.14
39	Joey Votto	Reds	33	162	707	0.32	0.454	0.578	1.032	0.428	64	3.08
41	Rhys Hoskins	Phillies	24	50	212	0.259	0.396	0.618	1.014	0.417	17.2	2.76
42	Bryce Harper	Nationals	24	111	492	0.319	0.413	0.595	1.008	0.416	39.4	2.72
43	Charlie Blackmon	Rockies	31	159	725	0.331	0.399	0.601	1	0.414	57.2	2.68
45	Matt Olson	Athletics	23	59	216	0.259	0.352	0.651	1.003	0.411	16.4	2.58
47	Giancarlo Stanton	Marlins	27	159	692	0.281	0.376	0.631	1.007	0.41	52.3	2.57
48	Freddie Freeman	Braves	27	117	514	0.307	0.403	0.586	0.989	0.407	37.3	2.47

OPS

OPS: On-Base Plus Slugging

$$OPS = OBP + SLG$$

Also powerful: but the value is meaningless and not data-driven

Use wOBA if you have it

wOBA vs OPS
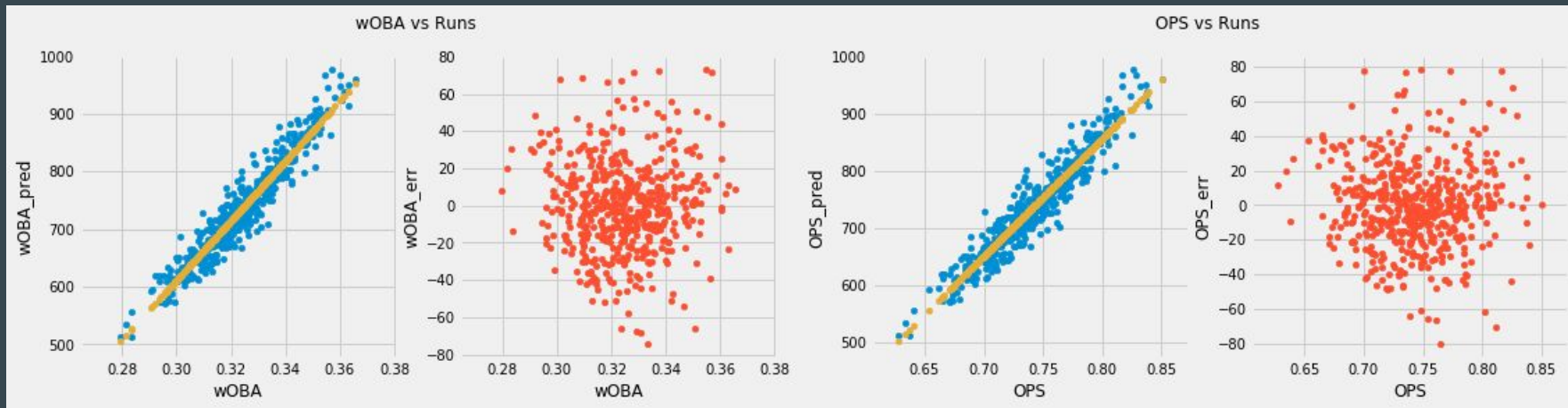
OPS: Corr with R: 0.955   Std dev of errors (in Runs): 24.9   (SLG was 34.1!!)

wOBA: Corr with R: 0.956   Std dev of errors (in Runs): 24.6

OPS and wOBA Corr: 0.996

What about base running?

Base running

There are three fundamental components to baserunning

➔ Stolen bases (easy)
➔ Double plays (easy)
➔ Advancement (hard)

FanGraphs' comprehensive stat: *Base Running (BsR)*

➔ Sum three components

$$BsR = wSB + wGDP + UBR$$

So what are the three components?

Base running

Why the variability in difficulty of measuring?

The situations and mechanisms for SB and DP are simple
    Basically just runner on first (< 2 outs for DP)
    Collect opportunities and measure extra outs created (vs extra bases for SB)

Advancement is trickier
    A single to left field will (almost) never lead to a runner going first to third
    To do it right, you need to know a fair amount about the hit ball to create an expected outcome for the runner

wSB

Stolen base runs

$$\text{Total Stolen Base Runs} = SB \cdot \text{Run Value of } SB + CS \cdot \text{Run Value of } CS$$

$$\text{Run Value of } SB = 0.2, \quad \text{Run Value of } CS = -(2 \cdot \text{Runs per Out} + 0.075)$$

Remember, these are totals, not above or below average.

wSB

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Why 0.2 always? Not sure. Seems to be a decent value to use if you look at RE

CS value:
- You cost the team the runs due to your out
- And you cost the team for removing yourself from the base paths (it's like you never got on so your value from your on-base event needs to be downgraded)

wSB

League average stolen base runs per opportunity (use league totals)

$$lgwSB = \frac{SB \cdot \text{Run Value of } SB + CS \cdot \text{Run Value of } CS}{1B + BB + HBP - IBB}$$

Stolen base runs above average (use player values now)

$$wSB = \text{Total Stolen Base Runs} - \text{Expected runs given } SB \text{ opportunities}$$
$$= SB \cdot \text{Run Value of } SB + CS \cdot \text{Run Value of } CS - lgwSB \cdot (1B + BB + HBP - IBB)$$

Called wSB on FanGraphs

Double Plays

Double plays: same idea

$$wGDP = \text{Run Value of an Out} \cdot (\text{Player } GDIP -$$
$$\text{League } GDIP \text{ Rate} \cdot \text{Player } GDIP \text{ Opportunities})$$

➔ GDIP Opportunities: man on first, < 2 outs.
➔ Penalize for the extra outs above and beyond what's expected

Comprehensive Stats

Sometimes they're incorporated into complete models

Total Average: Really just counts total bases per outs including SB and CS
➔ Old and not really advanced. Suffers from the "Bases fallacy"

Linear metrics like eXtrapolated Runs, etc
➔ Like LWTS but including SB and CS
➔ wOBA used to have SB and CS: separated out so it's only a batting metric

Advancement

Deeper models for advancement

UBR (Ultimate Base Running) from FG
➔ Uses batted ball zone data to divy up advancement value between runner and fielder

openWAR: tries to divy up RE24 on an event between advancement and hitter value
➔ Interestingly, openWAR uses MLBAM location data but not for baserunning

UBR: A Toy Example

Runner on second and one out: ground ball is hit to SS

On average:
➔ Runner safe at 3rd and batter thrown out: 20% of the time
➔ Runner stays at 2nd and batter thrown out: 70% of the time
➔ Runner out at 3rd: 5% of the time
➔ Runner beats throw at 3rd: 5% of the time
Average base/out run expectancy of those results is .25 runs

UBR: A Toy Example

Runner advances and the batter is thrown out: new RE is .5 runs

➔ Runner gets credit for .25 runs (.5 minus .25).

Runner stays put: new RE is .23 runs

➔ Runner gets docked -.02 runs

Runner gets credit for the difference in resultant and expected run value of the situation
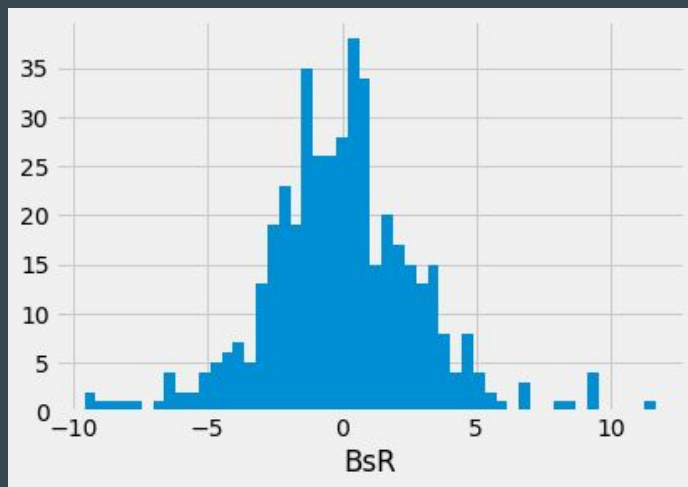
Need to do this for a lot of other base runner situations

How Many Runs from Base Running?

Rating	BsR
Excellent	8
Great	6
Above Average	2
Average	0
Below Average	-2
Poor	-4
Awful	-6

How Many Runs from Base Running?

How Many Runs from Base Running?

Top 2 highest Career BsR all time (and over 100)

Ricky Henderson
➔ BsR: 144.4
➔ wRAA: 509.4

Tim Raines
➔ BsR: 100.6
➔ wRAA: 318.9

Top 5 Career wRAA:
➔ Babe Ruth, Ted Williams, Barry Bonds, Ty Cobb, Lou Gehrig, Stan Musial
➔ All over 1000 runs above average

Offensive Metrics Overview

Offensive Metrics

➔   Classic Stats
➔   Advanced: OPS
➔   Run Estimation: wRAA (and sort of wOBA)
➔   BsR = wSB + wGDP + UBR

Classic stats are good starters

OPS is good if you have nothing else, wOBA better

wRAA and BsR end up as components of WAR (Wins Above Replacement)
    Also tougher at first: quoted in runs, not a natural or usual unit

What about other sports?

Let's start with football

Football: QB Passer Rating

The mythical and mysterious QB Passer Rating

It's a linear performance metric!

$$\text{QB Passer Rating} = 100 \times \frac{1}{6} \times (A + B + C + D),$$

$$A = \left(\frac{\text{COMP}}{\text{ATT}} - .3\right) \times 5, \quad B = \left(\frac{\text{YDS}}{\text{ATT}} - 3\right) \times .25,$$

$$C = \left(\frac{\text{TD}}{\text{ATT}}\right) \times 20, \qquad D = 2.375 - \frac{\text{INT}}{\text{ATT}} \times 25$$

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The good: Comp / Att, Yds / Att, TD / Att
The bad: Int / Att

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Devised in the early 1970s, it was used as a ranking system for QBs

Each of the 4 components was calibrated on data from the 60s to average 1

Overall average has grown from 66.7 to 88.6

Football: QB Passer Rating

Passer Rating misses a lot of things about QB play

➔ Rushing
➔ Sacks
➔ Fumbles
➔ Crucial situations (3rd down or 4th quarter, if this matters to you)
➔ Quality of teammates (WRs and O-Line)
➔ Attribution of performance (interceptions and yards)

Football: DVOA Rating

DVOA stands Defense-adjusted Value Over Average

...Value Over Average ... sound familiar?

DVOA is proprietary (as far as I can tell) but I will summarize the ideas

To understand it, start with the question (or Zen kōan?)

> One running back runs for three yards.
> Another running back runs for three yards.
> Which is the better run?

This will be a terse overview covering the main ideas and how they relate to what we've seen
See more here: http://www.footballoutsiders.com/info/methods

Football: DVOA Rating

Further questions you might ask

➔ What is the down and distance?
➔ Is it third-and-2 or second-and-15?
➔ Where on the field is the ball?
➔ Does the player get only three yards because he hits the goal line and scores?
➔ Is the player's team running out the clock; or down big and facing a pass defense?
➔ Is the opposing defense porous or really good?

Football: DVOA Rating

Conventional NFL stats measure performance with net yards

You really want to score points by getting in the endzone.

Yards are a means to an ends but not all yards are created equal

6 yards on 3rd and 10 isn't helpful.
> The drive still probably ended and the defense gave it to you to prevent the first down

Fantasy doesn't help: 1 yard TD run nets the same as a WR who breaks tackles to go 60 yards but stopped short of the goalline. Why does the RB get the TD credit?

Football: DVOA Rating

DVOA tries to better distribute credit for scoring points and winning games

DVOA assigns every play a value based on total yards and yards towards a first down

Based on *The Hidden Game of Football* by Pete Palmer, Bob Carroll, and John Thorn

THGF value assignments

➔ First down: play is considered a success if it gains 45 percent of needed yards
➔ Second down: play needs to gain 60 percent of needed yards
➔ Third or fourth down: only gaining a new first down is considered success

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DVOA builds on those values with fractional points and adjustments for big plays, red zone performance, and other areas of exceptional importance

Football: DVOA Rating

Return to the original question

➔ Player A gains 3 yards in a situation when an average RB gains only one yard
   Player A has value above others at his position
➔ Player B gains 3 yards in a situation when an average NFL back gains four yards
   Player B has negative value relative to others at his position.

After adjustments, we have something akin to RE24

Add up every play by a certain team or player, divide by the total of the various baselines for success in all those situations and you get Value Over Average

Football: DVOA Rating

The D in DVOA

We didn't do this with baseball but DVOA is defense-adjusted

This is far more important with an unbalanced schedule like in football

Each play is adjusted according to the defense's ability to defend that play

Defenses are also rated by the quality of the opposing offenses

 Apparently they stuck with the name defense-adjusted instead of offense-adjusted

Finally, team's are put on a scale of around +/- 30% for Off and +/- 25% for Def

 0% is average

What about basketball?

Measuring Performance

We already saw some of this with shooting percentages

Efficient shooting isn't the only part of basketball
➔ In baseball, you're usually guaranteed to get your PA and pitching/defense is considered separately due to the defined structure of the game
➔ The notion of possessions is important to bball and the way you can do things to gain/prolong possession (steals, offensive rebounds) or lose possession (turnover, dreb)

PER (Player Efficiency Rating) is a great way to explore this and PER is best introduced with a demo