

USING MACHINE LEARNING TO SCORE POWERLIFTING MEETS



SOPHIA WILSON

WHAT IS POWERLIFTING?

- Based on 1 Rep Max
- Given 3 attempts on 3 lifts:
Squat, Bench and Deadlift
- 3 judges decide if each attempt is Good/Failed
- Highest attempt judged “Good” in each lift is added to Total
- Scored/Ranked on Total



photograph courtesy of Jakes Adei: @strength_in_chiropractic

HOW IS POWERLIFTING SCORED?

- Ranked Within Age (Division)
+Weight+Equipment Classes
- “Best Lifter” is awarded across weight classes
 - however separate across Age Classes/ Equipment/Gender
 - (so there will be a few “Best Lifter” awards per meet)
- How to determine “Best Lifter” poses a challenge
- Which brings us to....



photograph courtesy of Demi Durkin @demileighd_

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ABSOLUTE VS RELATIVE STRENGTH

WHICH LIFTER LIFTS THE MOST?



Ray Williams: 182.26 kg (401.81 lbs)

1105 KG (2436.1 LBS)
BWX = 6.06



Heather Connor: 46.53 kg (102.58 lbs)

375.5 KG (827.8 LBS)
BWX = 8.08

ABSOLUTE VS. RELATIVE STRENGTH

WHICH LIFTER LIFTS THE MOST?-RELATIVE TO THEIR BODYWEIGHT?



$$8.08 \times 182.26 = 1472.66\text{KG (}3239.85\text{LBS)}$$

- 1079 lbs a lift
- ACROSS ALL FEDERATIONS:
- World Record in bench 755 lbs
- World Record in deadlift 931 lbs
- World Record in squat 1113.3 lbs

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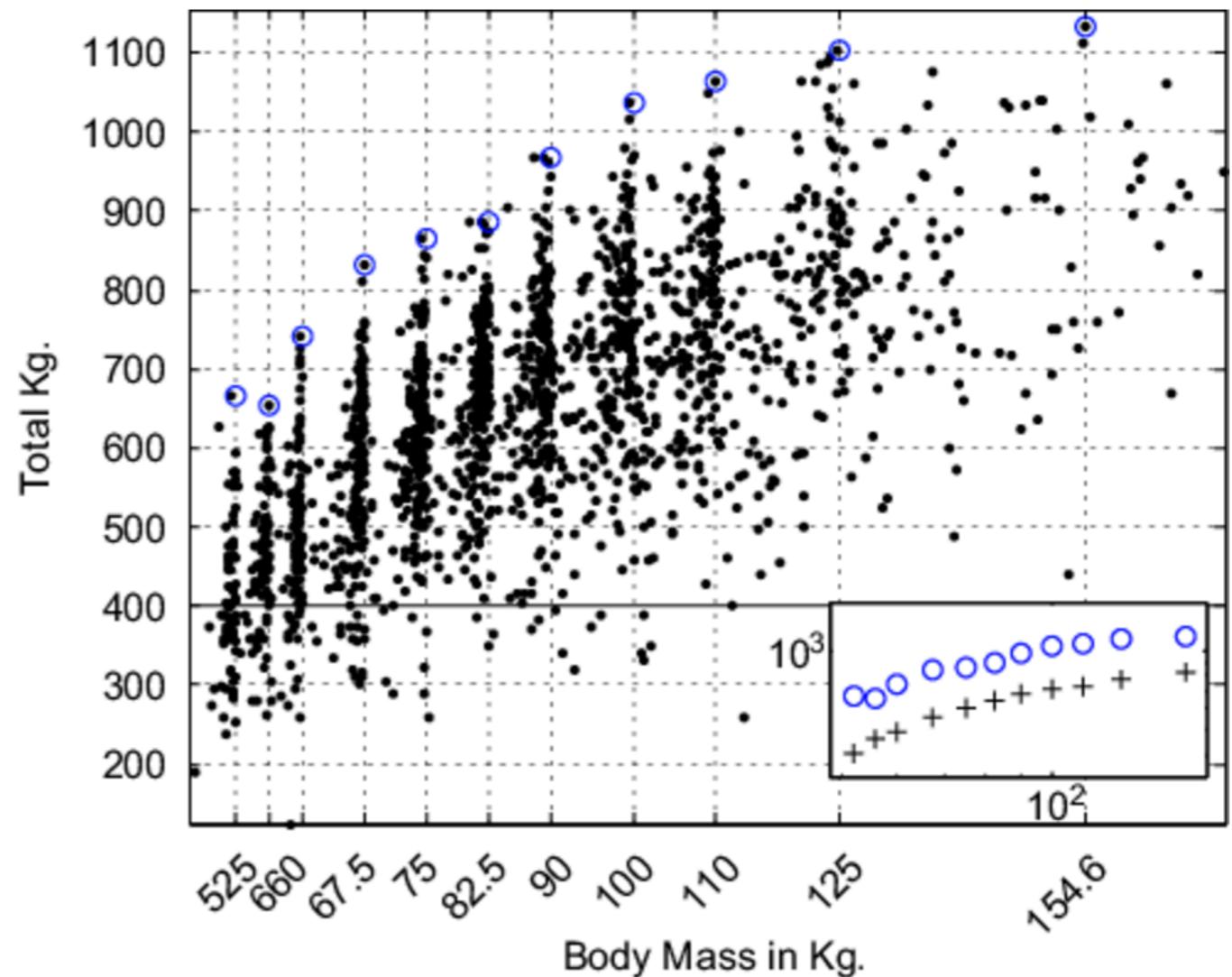
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1105 KG (2436.1 LBS) **ALLOMETRY**
BWX = 6.06

ALLOMETRY

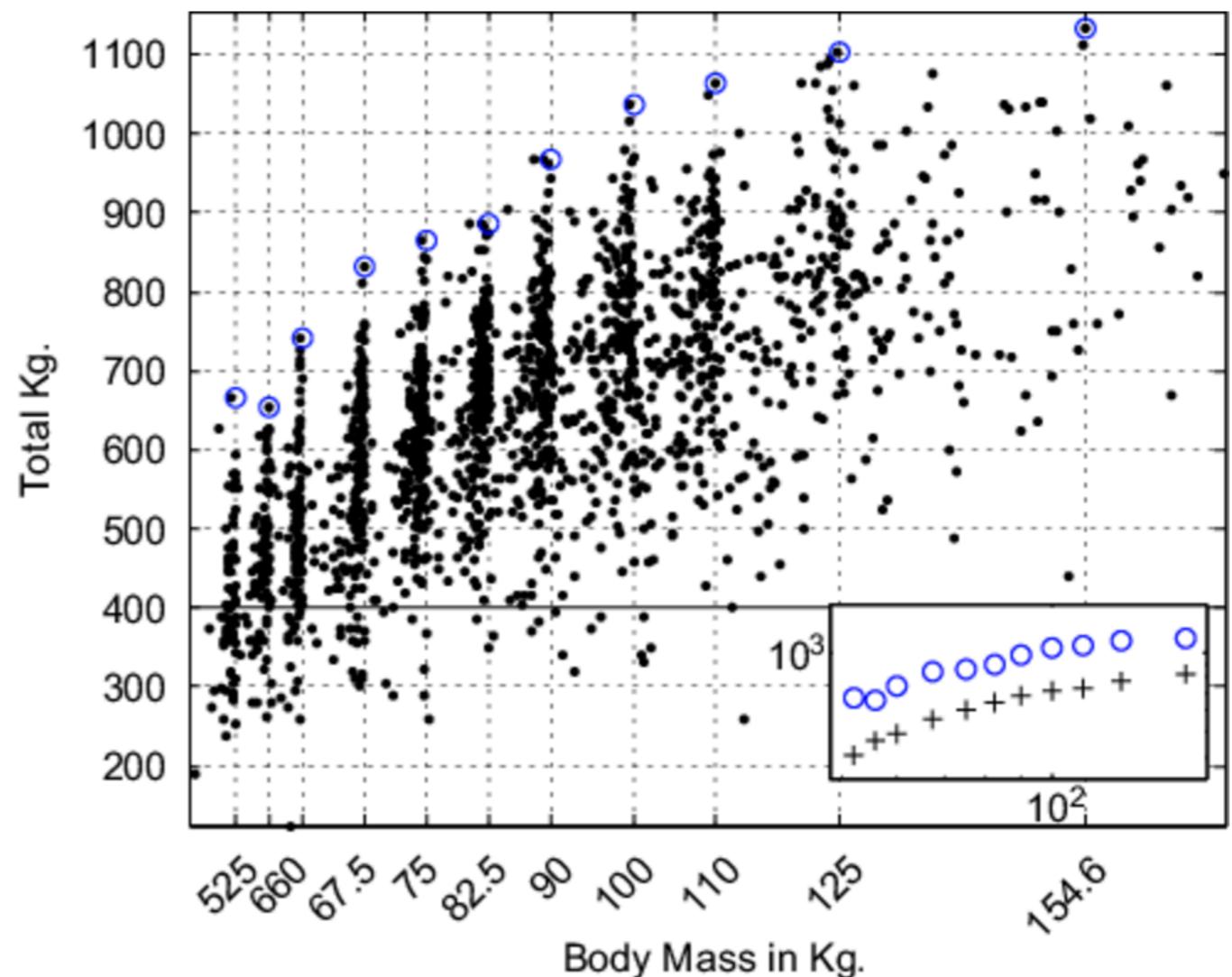
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- Body mass increases faster than strength



graph found from [this article](#)

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SO...WHAT IS USED INSTEAD?

THE WILKS COEFFICIENT

- Very little information about its creation
- Created in 1994 by Robert Wilks (CEO of Powerlifting Australia)
- Based off top performers
- Compare male and female lifters
- Compare across bodyweights

“It looks like he just played around with numbers until he found some that worked”

$$Coeff = \frac{500}{a + bx + cx^2 + dx^3 + ex^4 + fx^5}$$

x is the body weight of the lifter in kilograms

Values for *men* are:

a=-216.0475144
b=16.2606339
c=-0.002388645
d=-0.00113732
e=7.01863E-06
f=-1.291E-08

Values for *women* are:

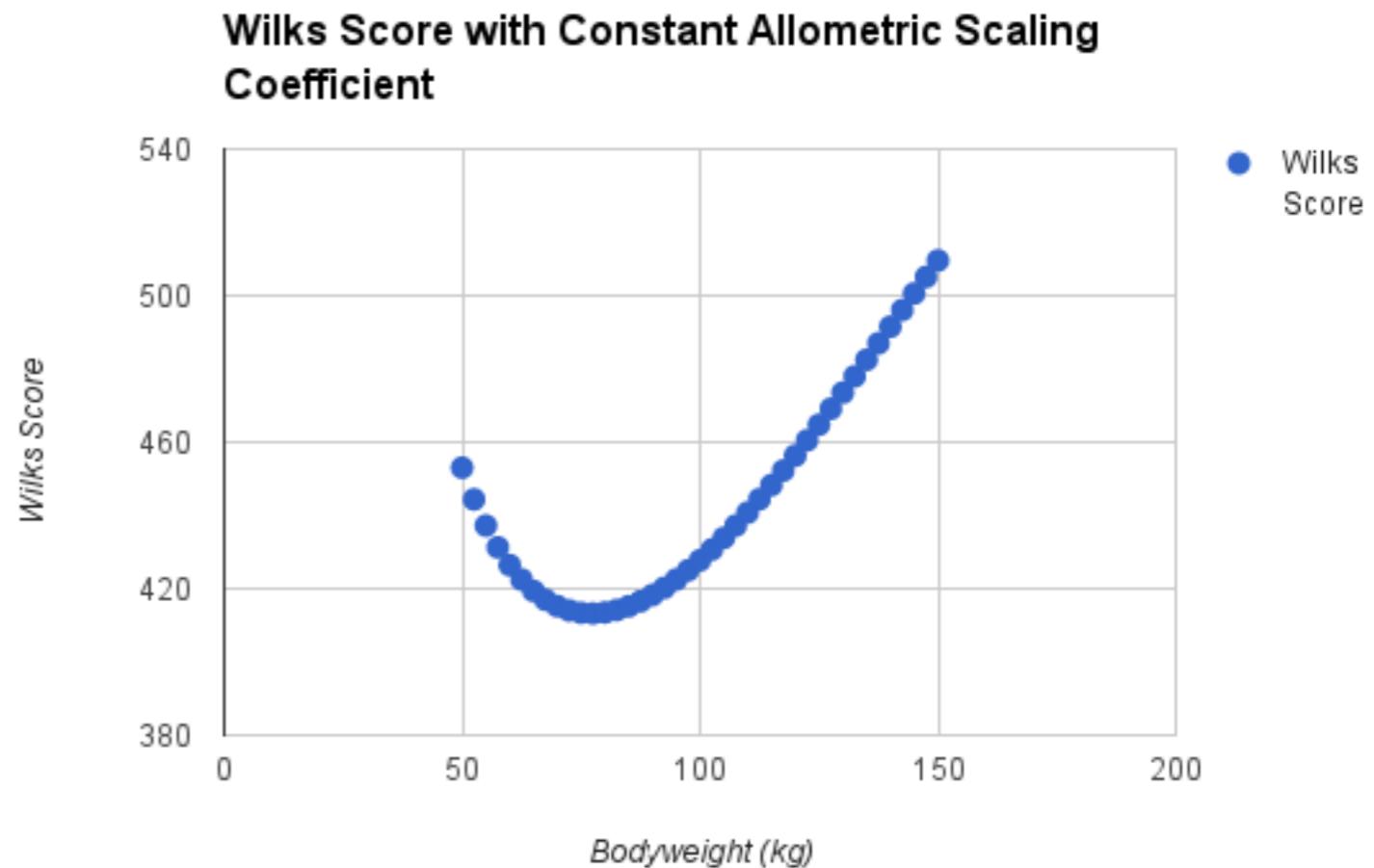
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b=-27.23842536447
c=0.82112226871
d=-0.00930733913
e=4.731582E-05
f=-9.054E-08

screenshot from [wikipedia](#)

PROBLEMS WITH THE WILKS COEFFICIENT

as told by Greg Nuckols (and me)

1. It's biased against middleweights
2. It's based off of mixed raw/equipped data (with no way to account for it)
3. It's overcomplicated for a relationship just between bodyweight/weight lifted (one might say its **overfit**)
4. It hasn't been updated since its creation (while new world records have been set)
5. *mine* Only captures the relationship between bodyweight and total (what about age)



Nuckols, Greg, et al. "Who's The Most Impressive Powerlifter? • Stronger by Science." *Stronger by Science*, 30 Aug. 2016, www.strongerbyscience.com/whos-the-most-impressive-powerlifter/. Accessed 14 Sept. 2017.

THE MACHINE LEARNING SOLUTION: “THE RESIDUALS SCORE”

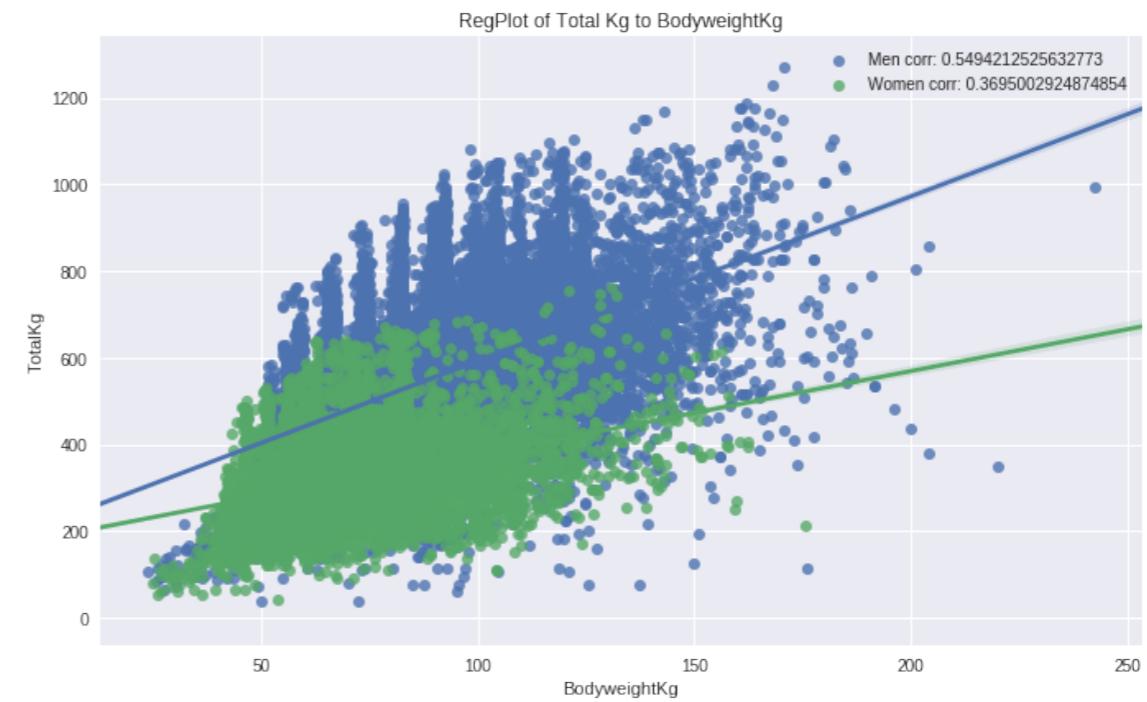
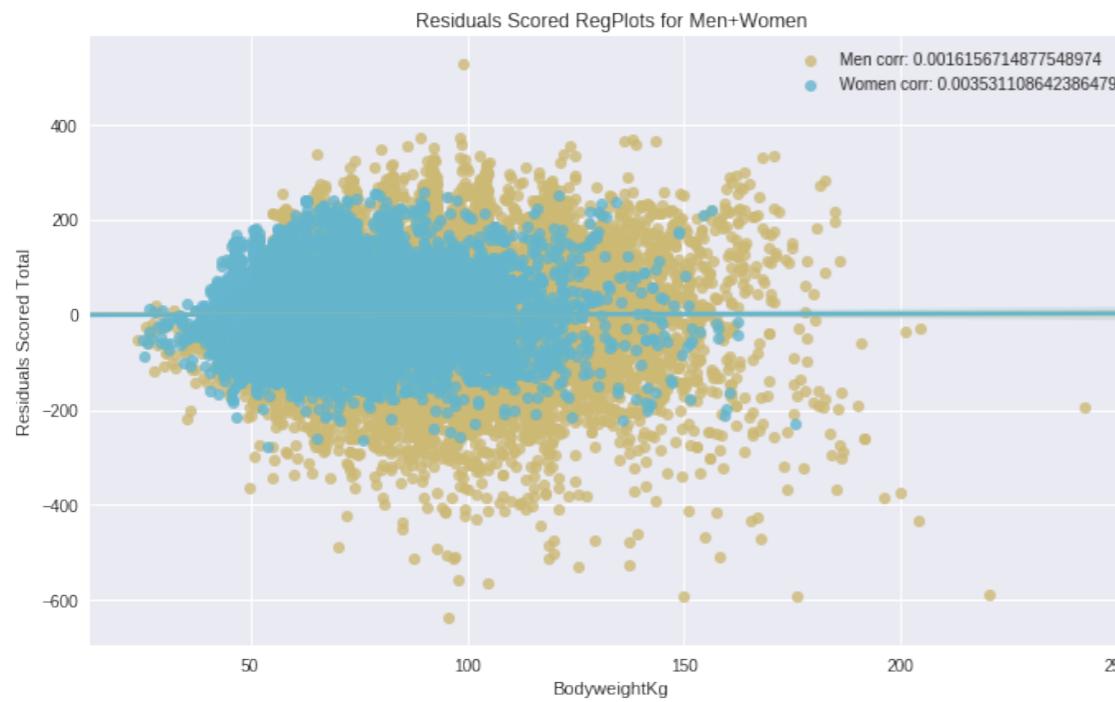
Computer allows us to transcend the limitations of human calculation

- use more data (every available USAPL/IPF meet recorded going back to the 80s-instead of just highest performers)
- use more information, or **features** (Age, Bodyweight, Gender, Equipment -instead of just Bodyweight)
- let the computer take this information and use it to predict the total kg a person will lift (aka build a **model**)
- lifters are scored based on the difference between what they lifted and what the model predicted they would lift (this is called a **residual**)
- model will churn out a formula that can be spread and easily used by meet directors all over the world



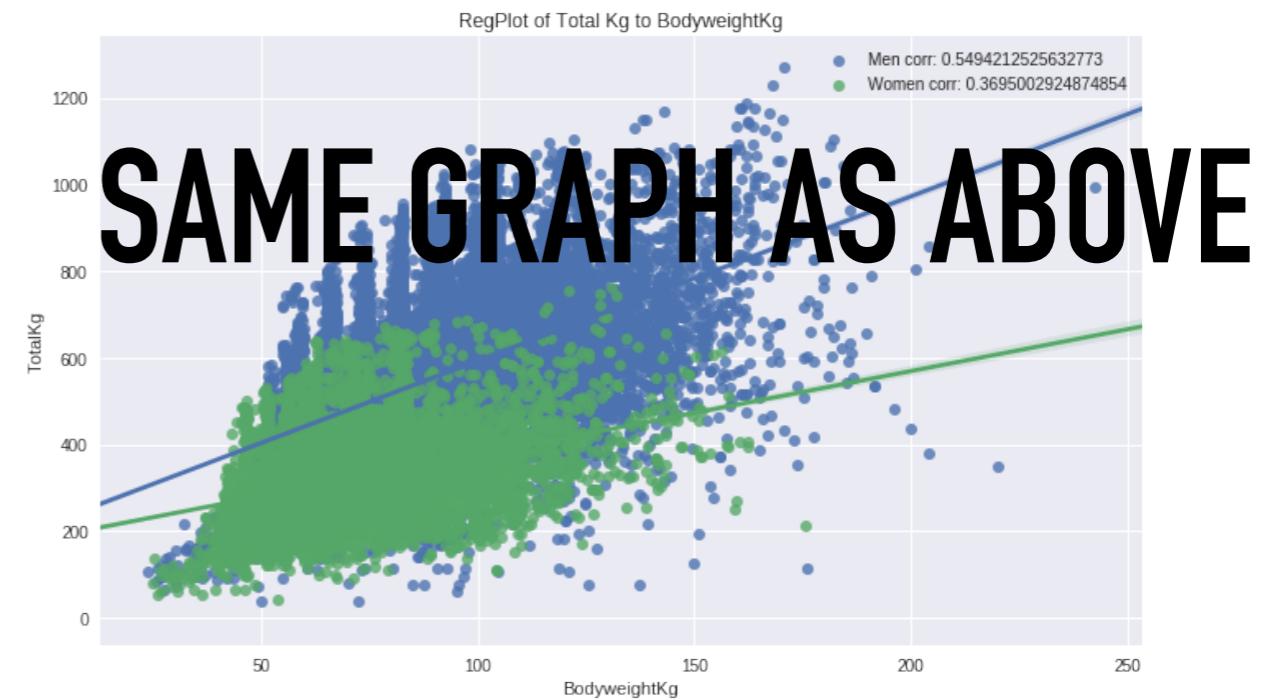
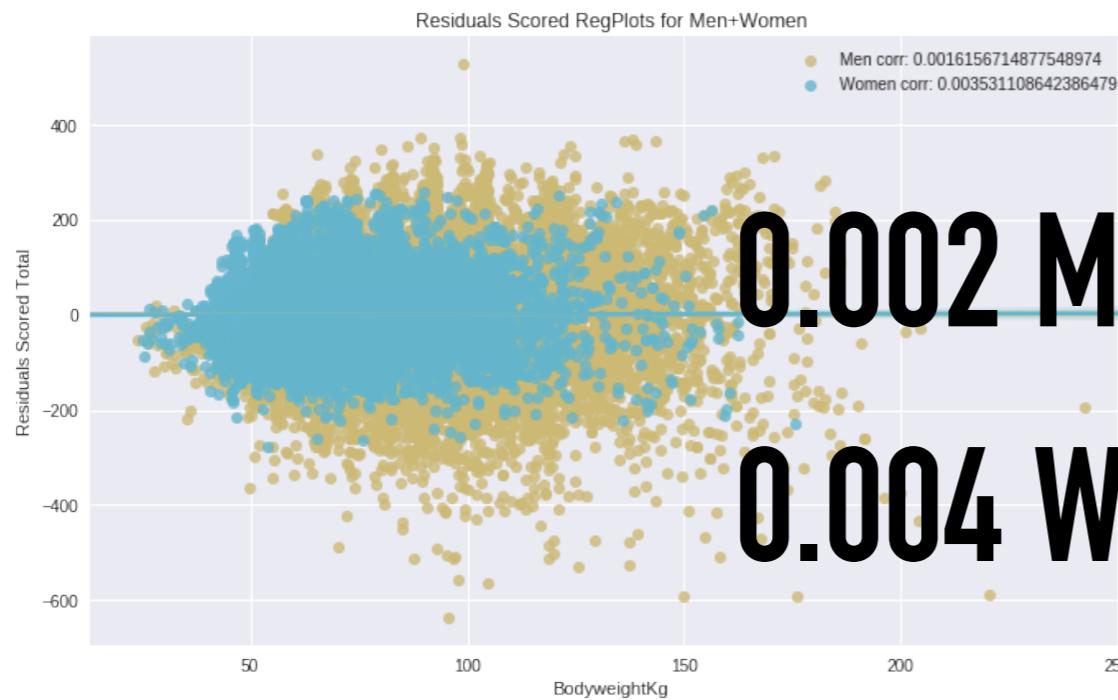
photograph courtesy of Alan Le @depth_before_dishonor

KEY METRICS/VALIDATION-COMPARISON TO WILKS



Recreation of VANDERBURGH, P. M. and A. M. BATTERHAM. Validation of the Wilks powerlifting formula. *Med. Sci. Sports Exerc.*, Vol. 31, No. 12, pp. 1869-1875, 1999.

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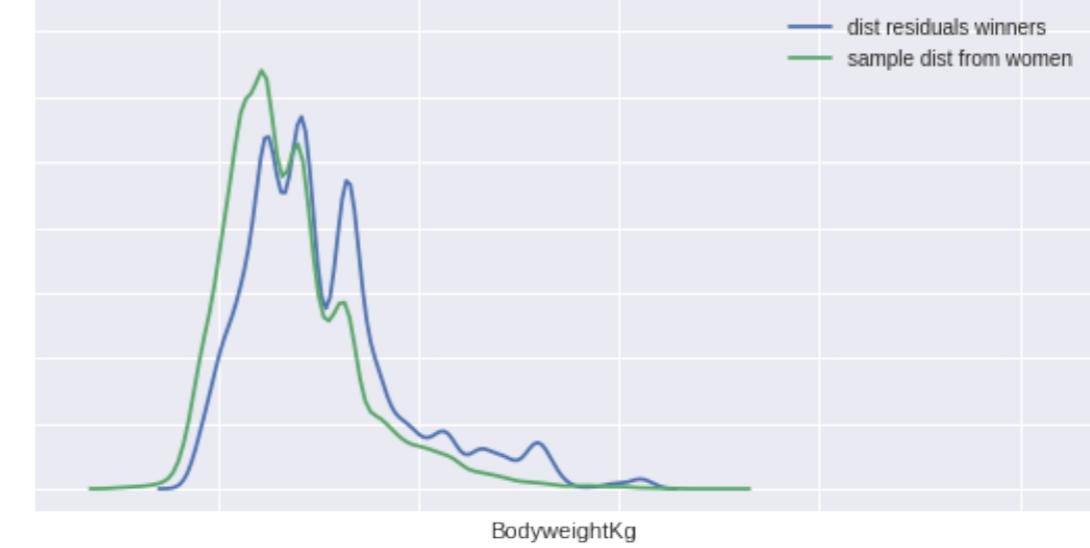
KEY METRICS/VALIDATION-COMPARISON TO WILKS

Distributions with 10,000 Simulated meets

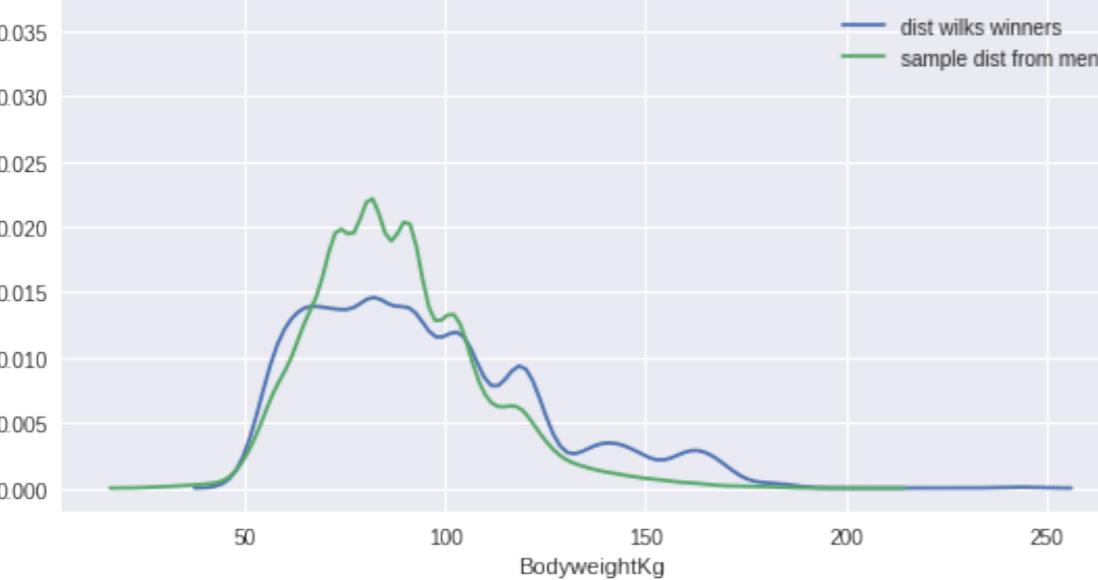
Bodyweight Distribution of Best Lifter--Residuals Model (Men)



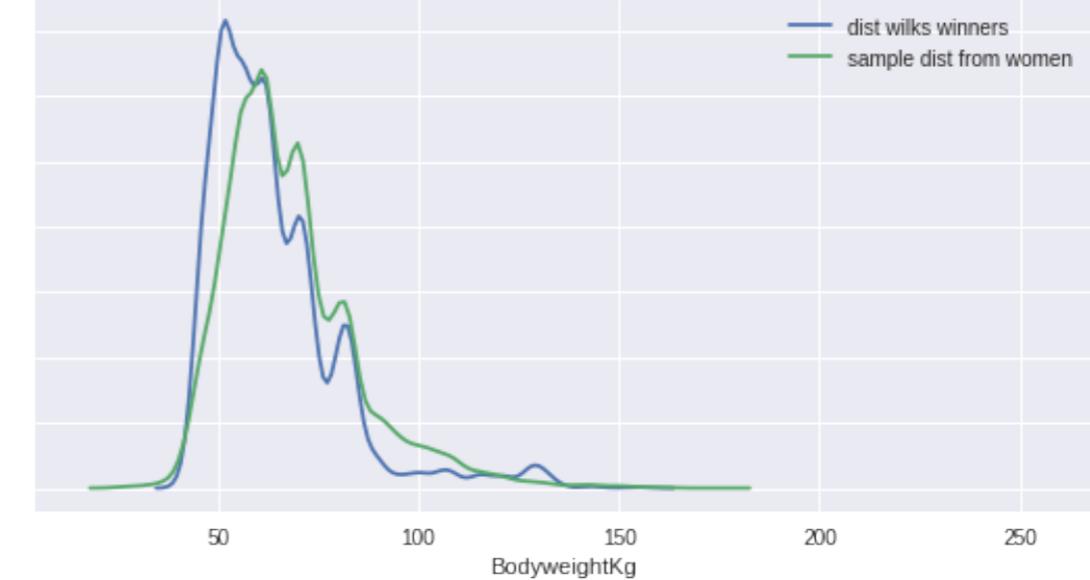
Bodyweight Distribution of Best Lifter--Residuals Model (Women)



Bodyweight Distribution of Best Lifter-Wilks Score (Men)

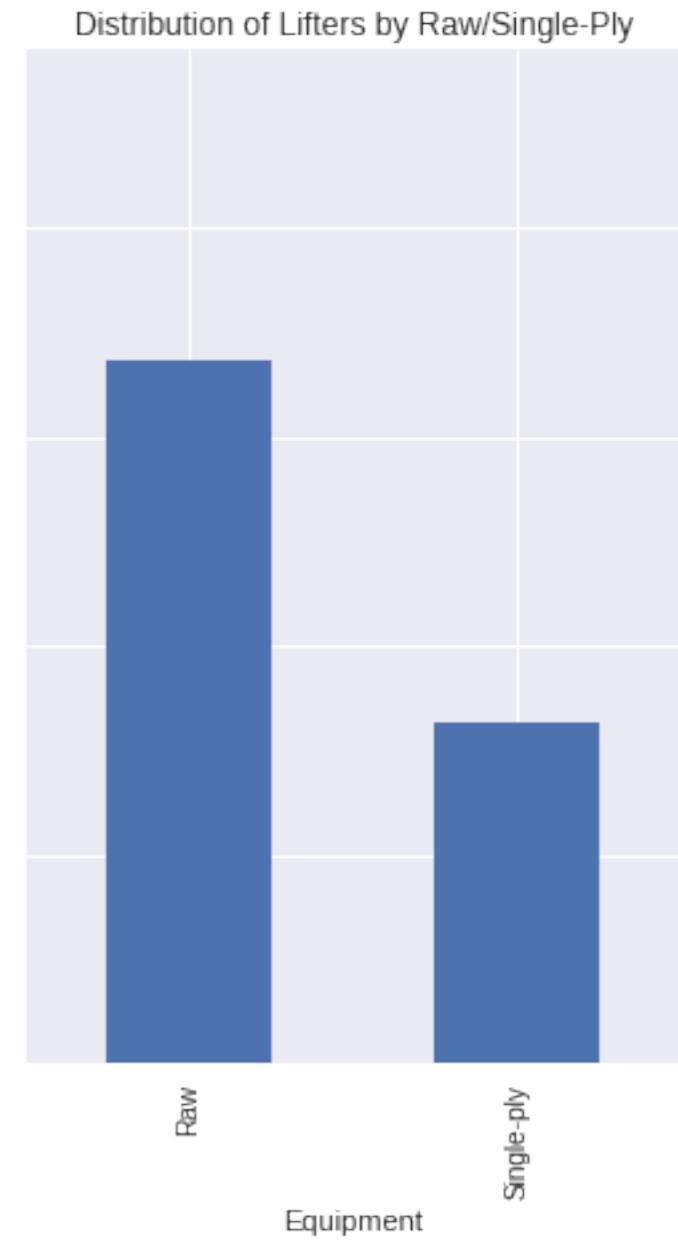
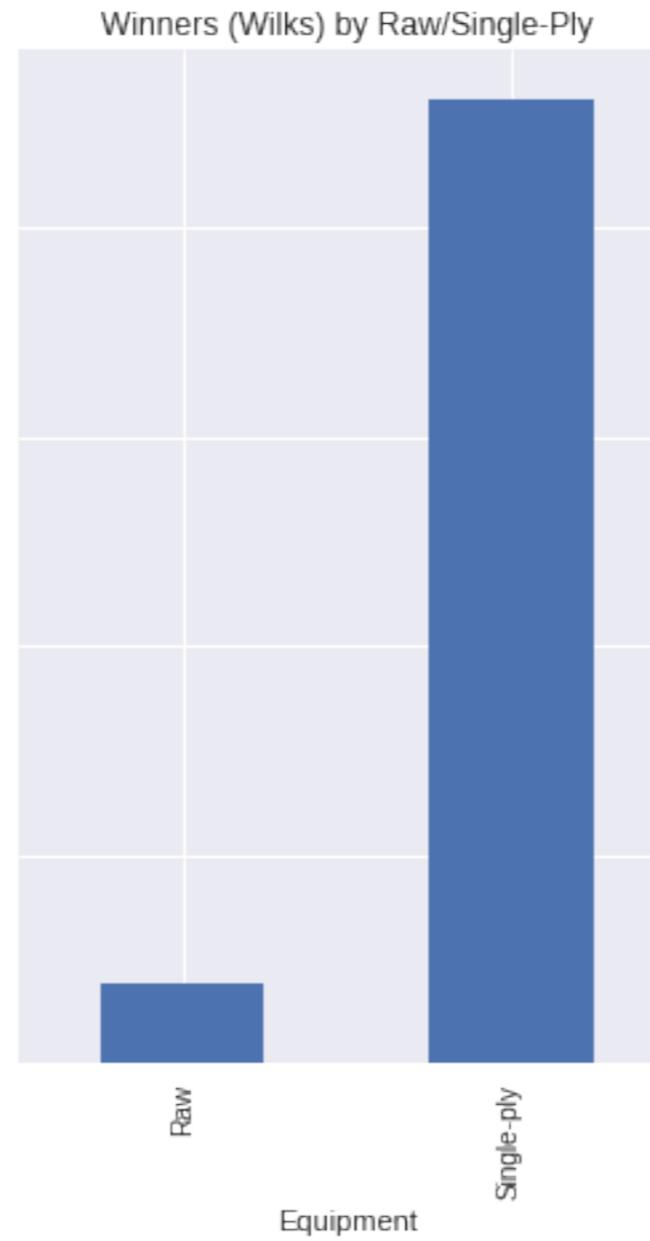
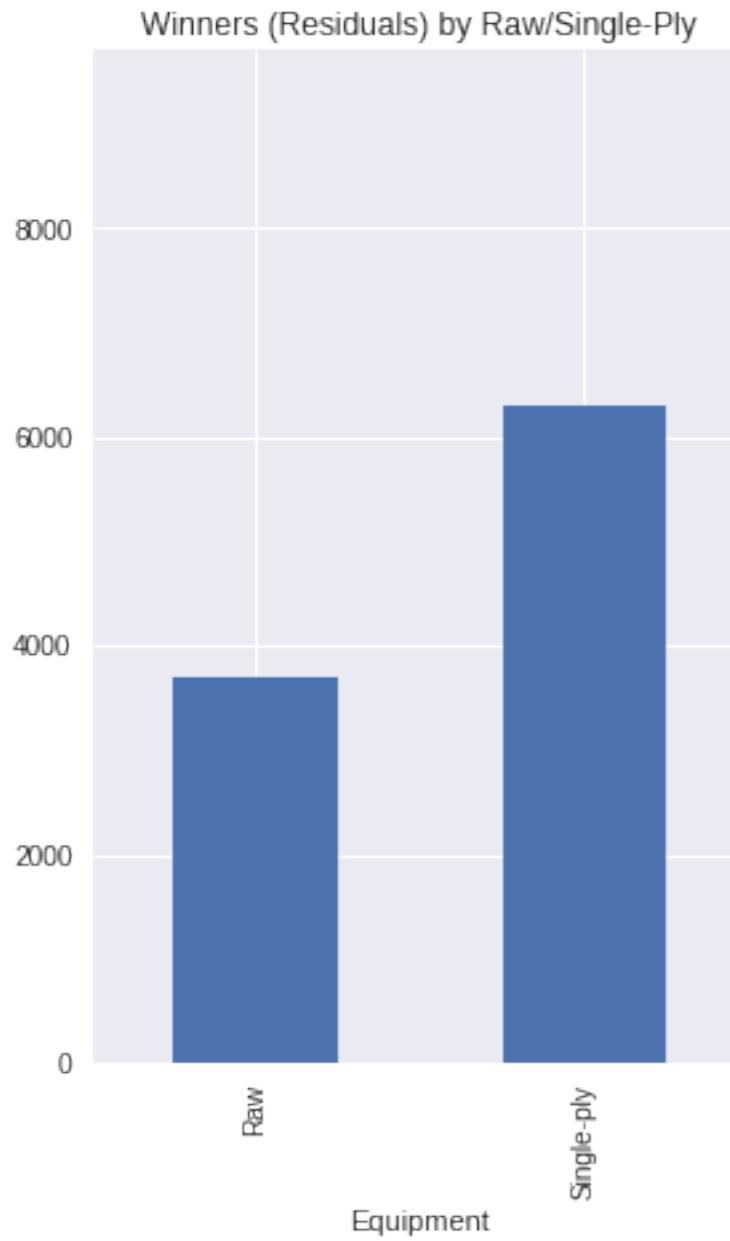


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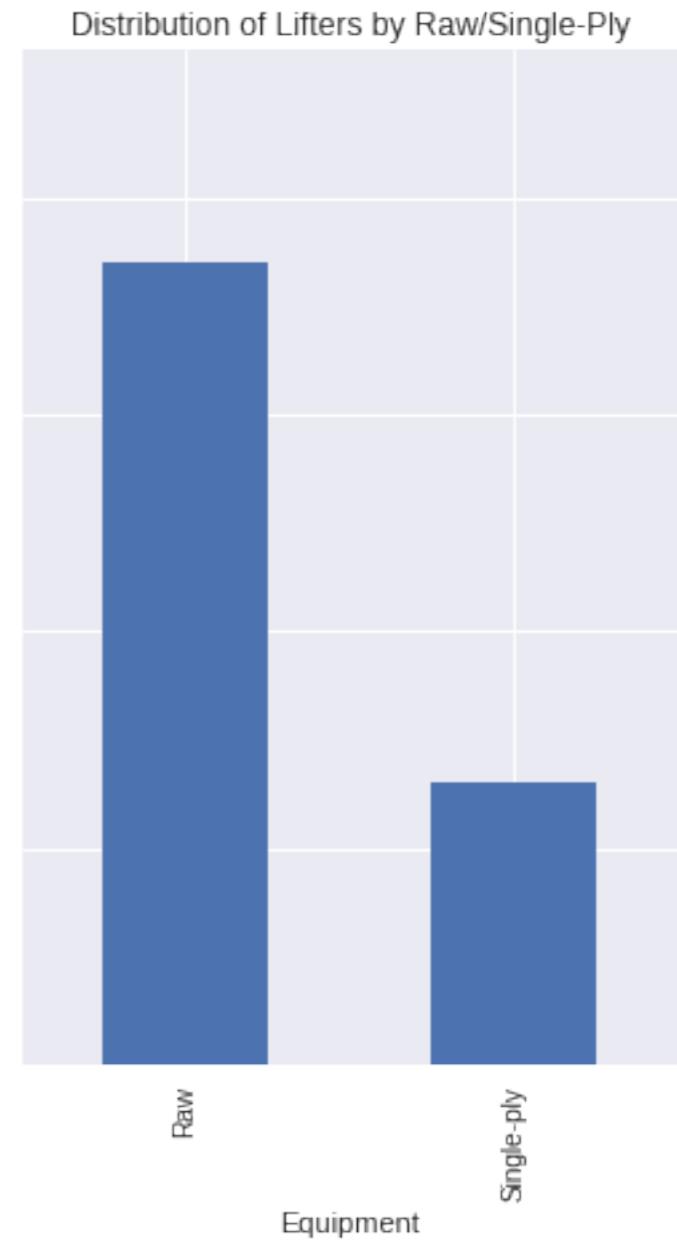
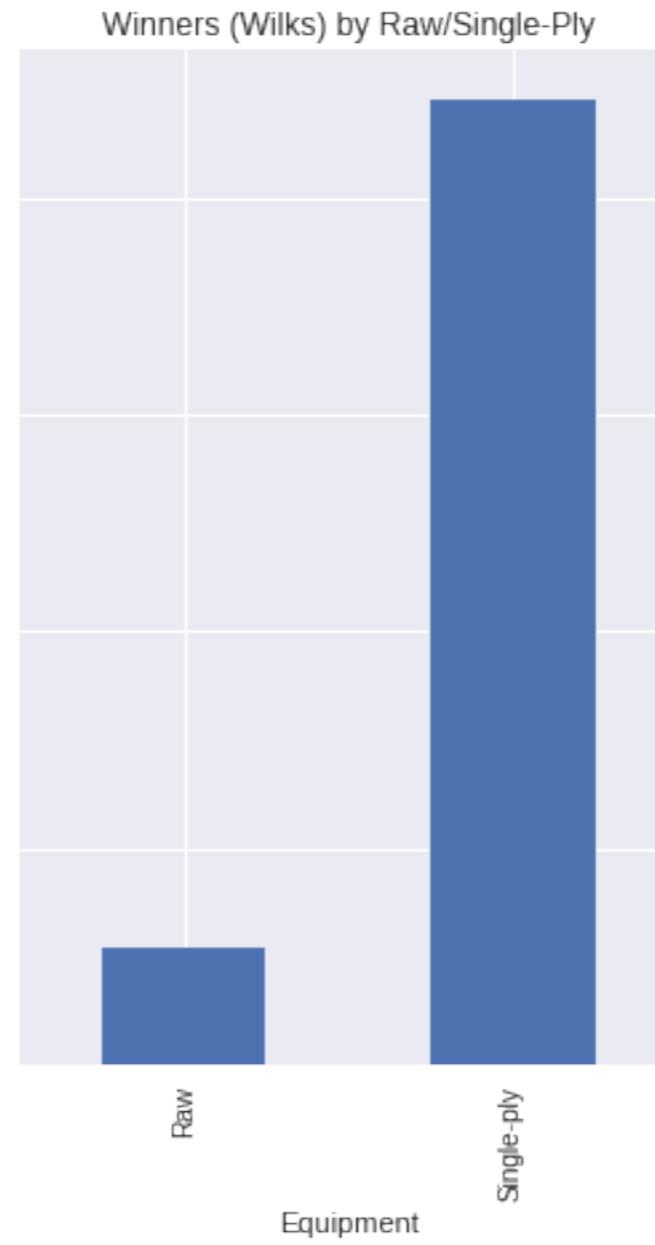
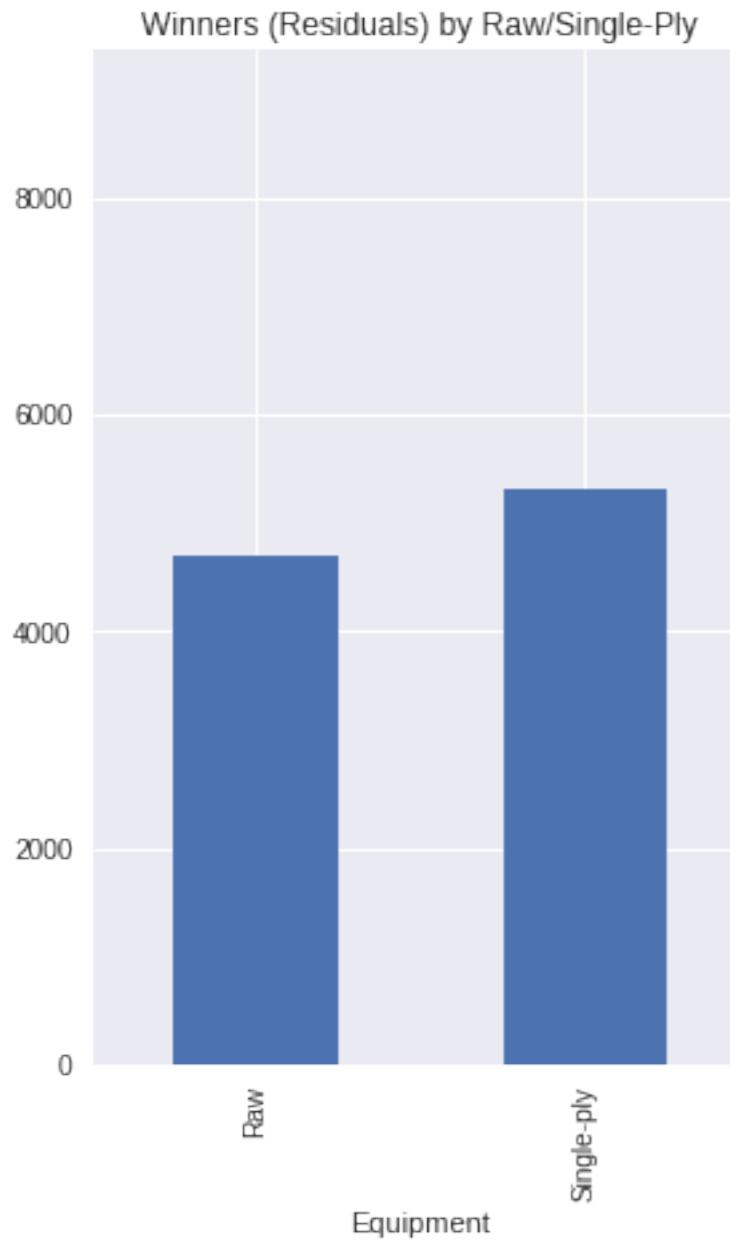
KEY METRICS/VALIDATION-COMPARISON TO WILKS

Distributions by Equipment (Women)



KEY METRICS/VALIDATION-COMPARISON TO WILKS

Distributions by Equipment (Men)

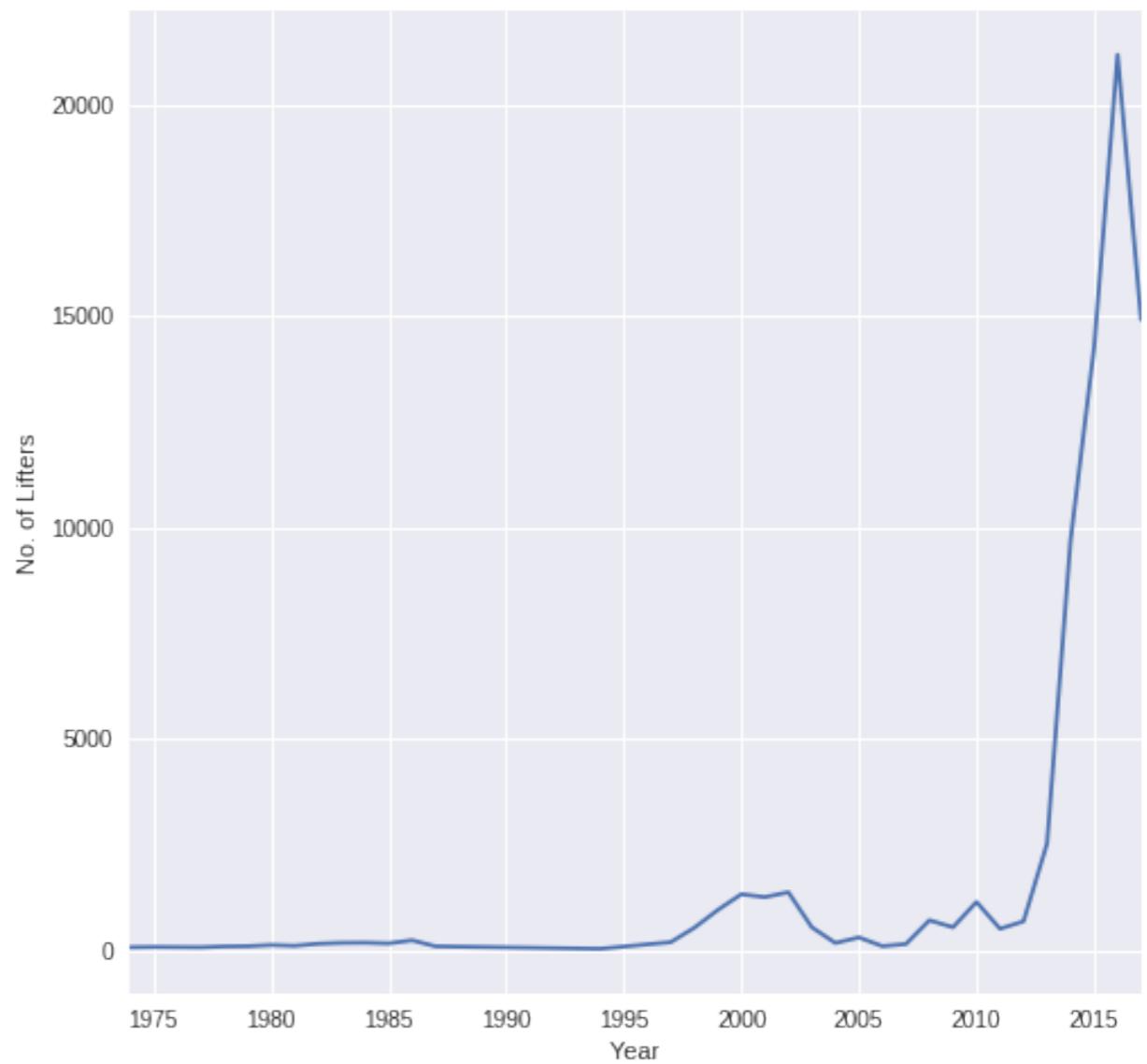


WHAT NEXT?

- ▶ The basis for predictions across disparate groups
- ▶ Not a recommendation for use yet
- ▶ Model needs some more tweaking
- ▶ The model predicts negative totals for certain groups
- ▶ More needs more validation
- ▶ What is fair? How is fair determined?

WHY SHOULD YOU CARE?

- ▶ growing popularity
- ▶ more people more money
- ▶ more money more problems





THANK YOU!