To Lift Heavy or Not To Lift Heavy

A Case Study in Olympic Weightlifting Strategy

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King of JuCo, Eric Sim (The Athletic)

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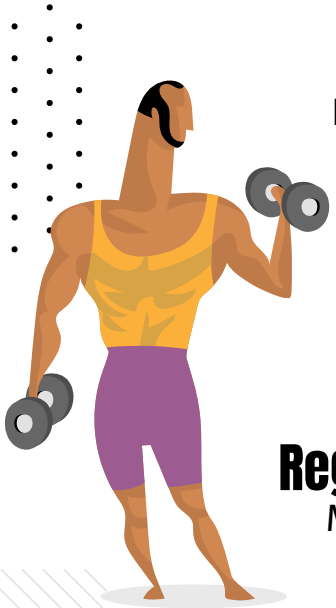


Previous Research

- “Bayesian modelling of elite sporting performance with large databases” by Jim E. Griffin, Laurenţiu C. Hinoveanu and James G. Hopker
- Analyzed 100m sprinting and weightlifting
- Constructed a Bayesian model of individual performance progression, fitted by Markov chains Monte Carlo
- Specifically analyzed age of peak performance between men and women

Competition Rules

- Broken down by weight classes
- Two different lifts, totals added together
  - snatch
  - clean and jerk
- Three attempts per lift, heaviest lift counts
- If you fail all three, you do not qualify

Caine Wilkes, Team USA

Caine Wilkes (AKA The Dragon)

- 36 year old American weightlifter from North Carolina
- Competes in the heaviest weight class (109kg+)
- Competed in the 2020 Tokyo Olympic games (finished 9th)
- Three time Pan-American champion
- Hopes to compete in Paris in 2024...

Caine Wilkes, Team USA

Data

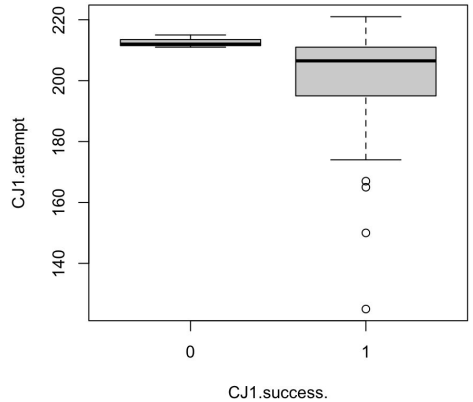
Data from the International Weightlifting Results Project (iwrp.net)

Date	Event type	Place	Nation	B.W	Snatch				Cl&Jerk						Sincler
					1	2	3		1	2	3				
2024-03-31	XX	Phuket	THA	160.08	170.0	~~175.0~~	~~175.0~~	18	208.0	214.0	~~221.0~~	11	384.0	11	388.4
2023-12-04	GP	Doha	QAT	158.62	168.0	171.0	~~180.0~~	8	203.0	213.0	~~218.0~~	6	384.0	7	388.8
2023-09-04	WC	Riyadh	KSA	156.32	165.0	170.0	175.0	18	203.0	211.0	~~216.0~~	17	386.0	16	391.6
2022-07-24	PAC	Bogota	COL	148.20	168.0	~~173.0~~	~~174.0~~	5	205.0	~~210.0~~	~~211.0~~	3	373.0	4	381.5
2021-07-23	OG	Tokyo	JPN	151.15	173.0	~~178.0~~	~~180.0~~	12	212.0	217.0	~~224.0~~	8	390.0	9	397.6
2021-04-18	PAC	Santo Domingo	DOM	151.05	170.0	175.0	176.0	2	205.0	212.0	~~219.0~~	2	388.0	2	395.6
2019-09-18	WC	Pattaya	THA	146.25	175.0	181.0	~~187.0~~	15	215.0	222.0	~~227.0~~	18	403.0	16	407.4

iwrp.net Caine Wilkes

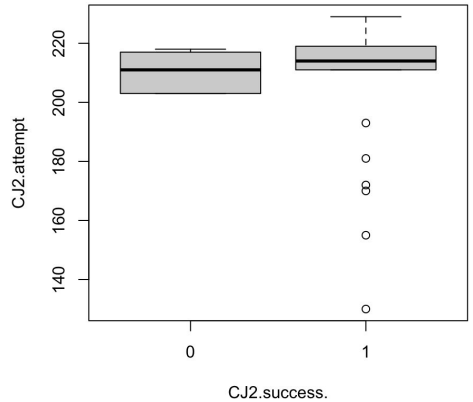
EDA- Clean and jerk attempt 1

CJ1.success.	min	median	max	mean	sd	n
0	211	212.0	215	212.6667	2.081666	3
1	125	206.5	221	198.3571	22.413974	28



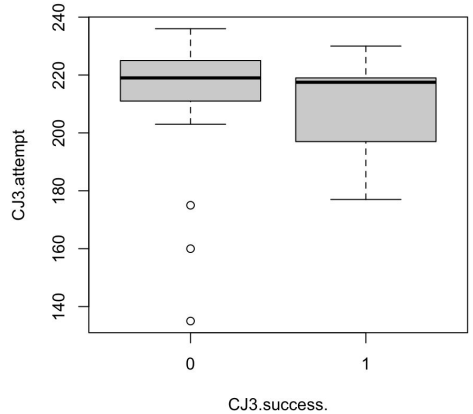
EDA- Clean and jerk attempt 2

CJ2.success.	min	median	max	mean	sd	n
0	203	211	218	210.50	6.534524	6
1	130	214	229	204.88	24.381209	25



EDA- Clean and jerk attempt 3

CJ3.success.	min	median	max	mean	sd	n
0	135	219.0	236	211.4762	25.20837	21
1	177	217.5	230	209.9000	17.36823	10



Logistic Regression

Logistic Regression Results

- Best model: Clean and Jerk Att. 3 Success
  - For Caine: 10 successes, 21 failures
  - Includes Att. weights and Success for CJ1 and CJ2
- ‘Significant’ Improvements!
  - Age at 99.9% level
  - Bodyweight at 99% level
- Are these sensible?
  - Highly technical movements
  - For UHW class, strategic advantage to higher BW

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.67458    1.26822  -1.320  0.19968
CJ2a         0.08098    0.06750   1.200  0.24250
CJ2s         0.00546    0.25759   0.021  0.98327
CJ1a        -0.04345    0.06410  -0.678  0.50461
CJ1s        -0.48089    0.52633  -0.914  0.37037
CJ3a        -0.04074    0.03169  -1.285  0.21142
Age         -0.12622    0.04322  -2.921  0.00769 **
BW           0.04714    0.01990   2.369  0.02659 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
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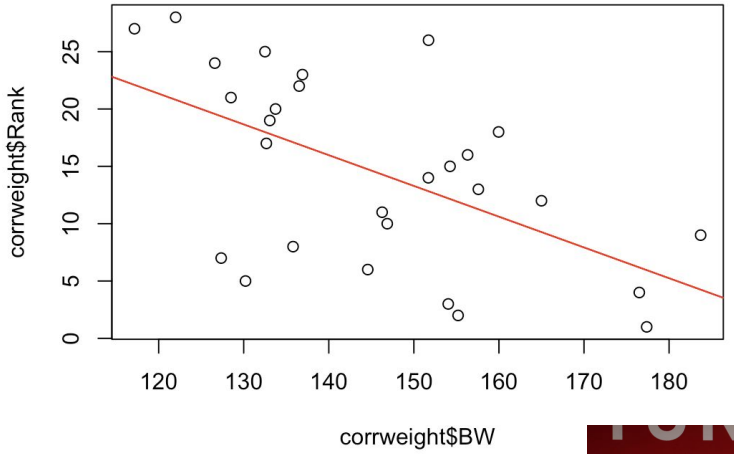
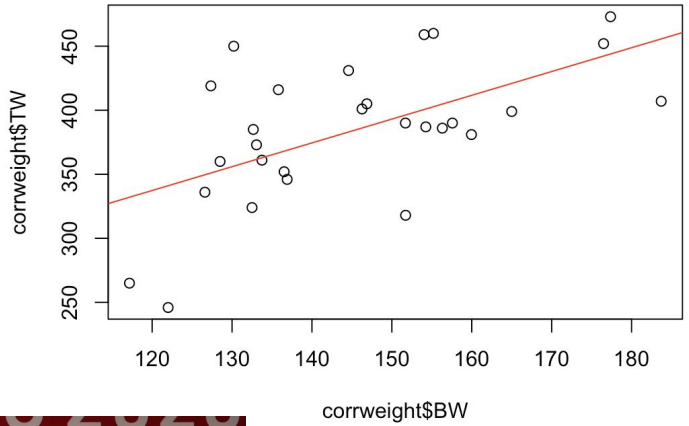
Caine Wilkes, Getty Images

Ultra Heavyweight (109+ KG) Class

Bodyweight vs Rank



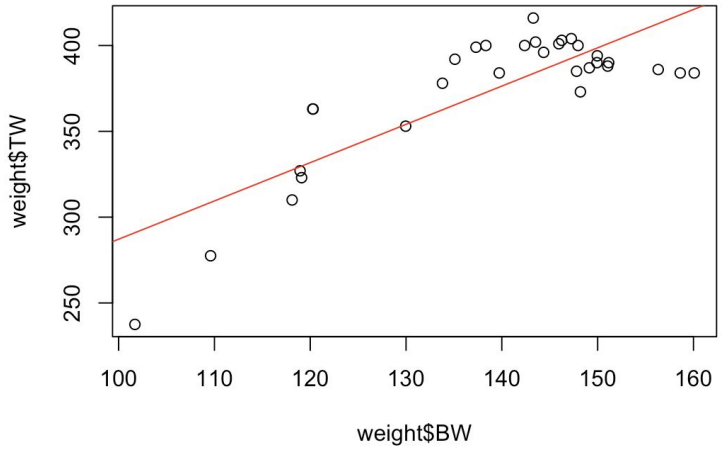
Bodyweight vs Total Weight Lifted



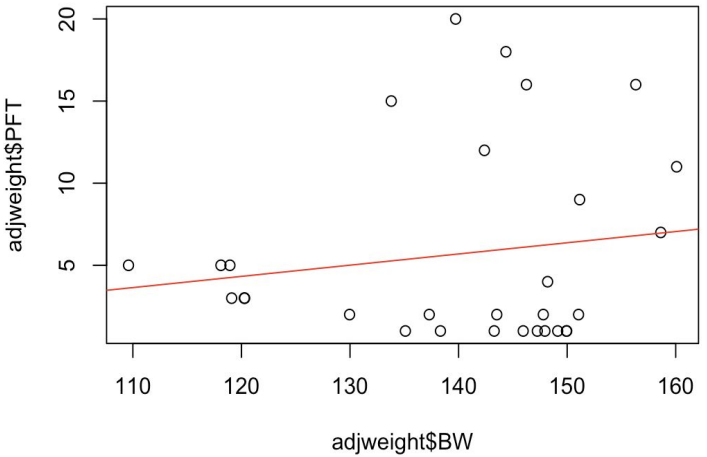
Lasha Talakhadze

How does Caine Wilkes compare?

Caine's BW vs TWL



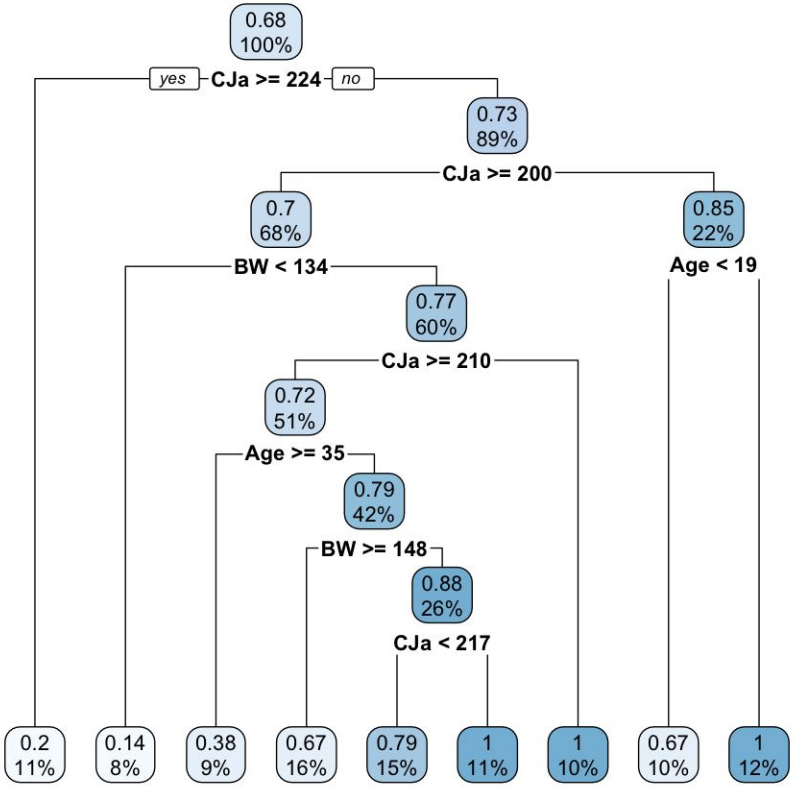
Caine's BW vs Place Finished (Rank)

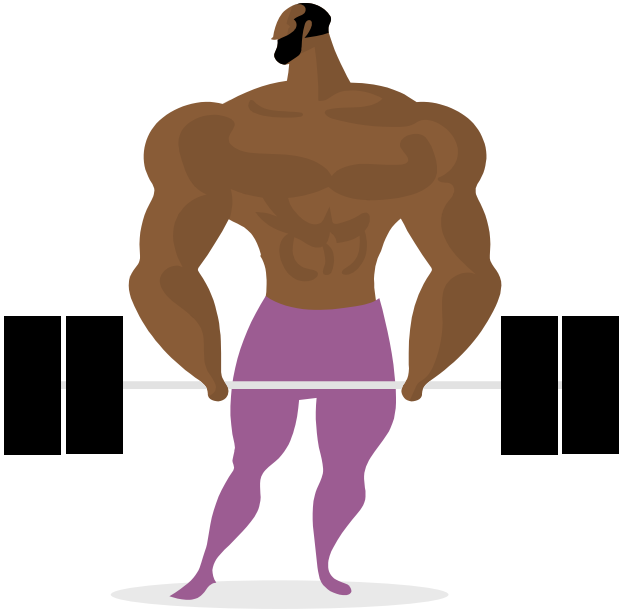


Decision Tree

Decision Tree Results

- Only 3 variables taken into account:
  - Age (years)
  - Body weight in kilograms (BW)
  - Weight attempted in kilograms (CJa)
- Does not consider previous lifts that day, so attempt 1 is treated the same as attempt 3





Markov Chains

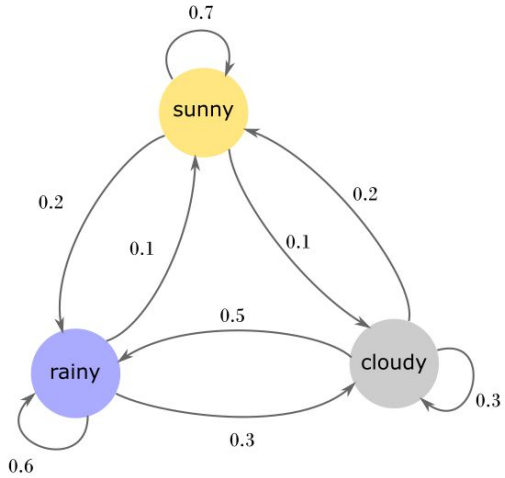
What is a Markov chain?

- Probabilistic modeling where the current state depends completely on the one previous state
- Can be represented as a matrix or as an image
- To calculate the probability distribution after *n* steps, take the initial position of the system, multiplied by the transition matrix to the power of *n*
  - The initial position is just which state you start in
- With initial position *x* and transition matrix *P*, you calculate the probability distribution after *n* steps with:

$$xP^n$$

Markov Chain probability distribution

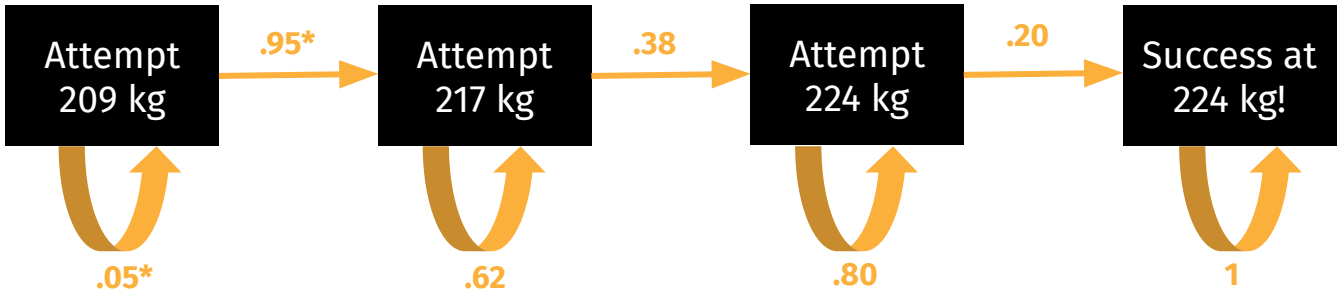
Simple Markov chain example



WEATHER TODAY	P(RAINY)	P(CLOUDY)	P(SUNNY)
rainy	0.6	0.3	0.1
cloudy	0.5	0.3	0.2
sunny	0.2	0.1	0.7

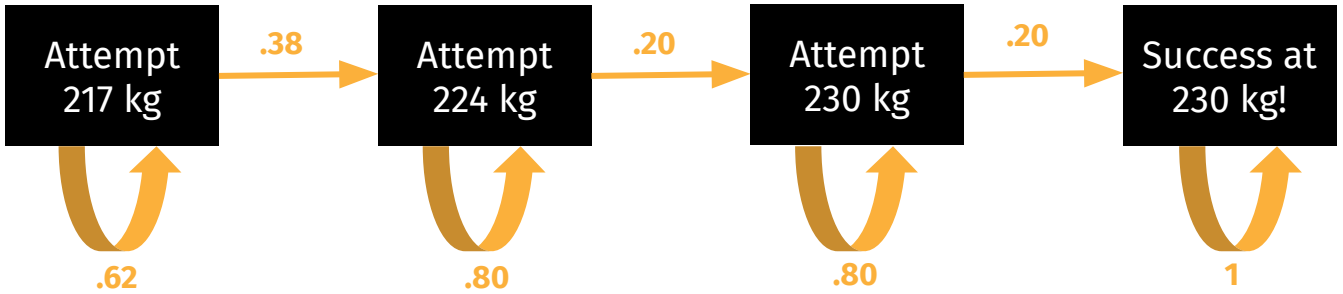
Markov chain for Caine Wilkes- current strategy

- Each state is an attempt
- Transition probabilities calculated using decision tree model
- Assuming that if he fails a rep, he will try the exact same weight again
- If there is no arrow between two states, that transition probability is zero



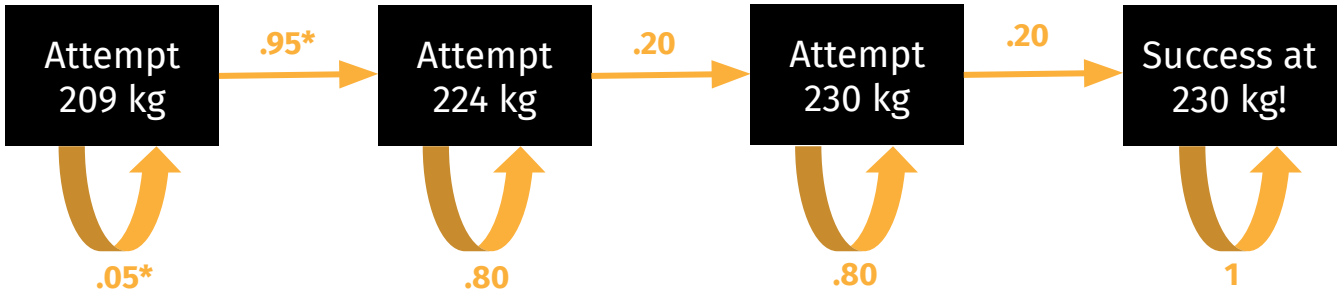
Markov chain for Caine Wilkes- more aggressive strategy

- Each state is an attempt
- Transition probabilities calculated using decision tree model
- Assuming that if he fails a rep, he will try the exact same weight again
- If there is no arrow between two states, that transition probability is zero



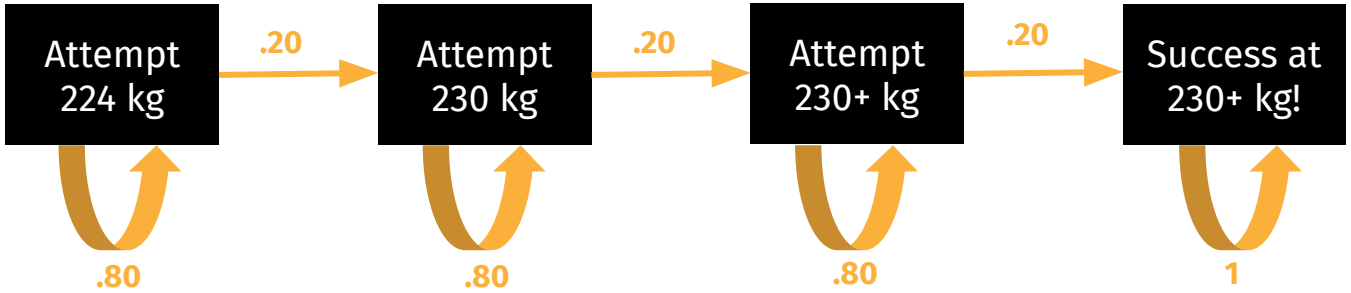
Markov chain for Caine Wilkes-hourglass strategy

- Each state is an attempt
- Transition probabilities calculated using decision tree model
- Assuming that if he fails a rep, he will try the exact same weight again
- If there is no arrow between two states, that transition probability is zero



Markov chain for Caine Wilkes- Gold medal strategy

- Each state is an attempt
- Transition probabilities calculated using decision tree model
- Assuming that if he fails a rep, he will try the exact same weight again
- If there is no arrow between two states, that transition probability is zero



Computations

- Translate the Markov Chains into the following Transition Matrices:

Current strategy

.05	.95	0	0
0	.62	.38	0
0	0	.80	.20
0	0	0	1

Aggressive strategy

.62	.38	0	0
0	.80	.20	0
0	0	.80	.20
0	0	0	1

Hourglass strategy

.05	.95	0	0
0	.80	.20	0
0	0	.80	.20
0	0	0	1

Gold medal strategy

.05	.95	0	0
0	.80	.20	0
0	0	.80	.20
0	0	0	1

- Beginning at the initial state, compute 3 iterations (3 competition attempts)

Computation Results

Weight lifted	Current Strategy	Aggressive Strategy	Hourglass Strategy	Gold medal Strategy
0 kg (failed all attempts)	0.000125	0.238	0.000125	0.512
209 kg	0.397	0	0.648	0
217 kg	0.531	0.578	0	0
224 kg	0.072	0.169	0.314	.384
230 kg	0	0.0152	0.038	0.096
230+ kg	0	0	0	0.008

Conclusions

Bigger is Better; But maybe not for Caine

For 109+ Kg weightlifters, clear benefit to increased bodyweight, Wilkes' correlation was inverse

Mr. Wilkes needs to take Game Theory

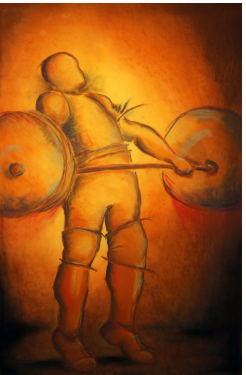
Riskier, nontraditional strategies could pay off

Plus, he was a double major in English and Art at Old Dominion. Check it out!

Future Work

Expand our analysis to all weightlifters

Caine Wilkes is a unique and interesting case study



Consider more robust strategies after rep failure

Lifters do not have to try the same weight again if they fail, they could (and usually do) increase or decrease

Look into more variables for predicting success

Our decision tree only considers age, body weight, and attempts, and ignores factors such as previous successes and failures that day

Caine Wilkes art