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Assignment #01
CSYS 300:Principles of Complex Systems
Collaborators: None
Github Code

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1. Weight lifting models

   (a) How well does 2/3 scaling hold up?
   The β estimates for the men and women are slightly above and below the 2/3 or .6667 scaling relationship. For men they range from .616 to .633 and for women from .714 to .727. However, when considering a 95% confidence interval for β, each of the estimates contain .6667.

Sex	Event	β Estimate
Men	Clean & Jerk	0.616 [0.532, 0.699]
Men	Snatch	0.619 [0.469, 0.769]
Men	Total	0.633 [0.530, 0.736]
Women	Clean & Jerk	0.719 [0.592, 0.846]
Women	Snatch	0.714 [0.583, 0.845]
Women	Total	0.727 [0.585, 0.868]

   (b) Who holds the overall, re-scaled world record?
   With normalized scores of 107.697, 107.630, 106.677 for the Total, Snatch, and Clean & Jerk respectively, Lasha Talakhadze holds the normalized world record across Men and Women for all three events.

2. Probability distribution, power-law.

   (a) Determine c.
   We need to find a normalizing constant that makes the following true by the definition of a probability mass function:

$$\int_a^b cx^{-\gamma} dx \ = 1$$

   In order to do this, we can find the integral of the above equation without c (the sum of the area under the curve) from a to b, and then set c as the reciprocal of that term. This way, area under the curve from a to b is normalized to add to 1.

$$\int_a^b x^{-\gamma} dx \ =$$

Taking the anti-derivative and applying the FOC:

$$\frac{b^{1-\gamma}}{1-\gamma} - \frac{a^{1-\gamma}}{1-\gamma} =$$

$$\frac{b^{1-\gamma} - a^{1-\gamma}}{1-\gamma}$$

Taking the reciprocal:

$$c = \frac{1-\gamma}{b^{1-\gamma} - a^{1-\gamma}}$$

If you take b to ∞., the first term from the top of the page becomes zero where $\gamma > 1$.

$$0 - \frac{a^{1-\gamma}}{1-\gamma} =$$

$$\frac{a^{1-\gamma}}{\gamma - 1}$$

Taking the reciprocal gives us:

$$c = \frac{\gamma - 1}{a^{1-\gamma}}$$

(b) Why can't γ be ≤ 1?
If γ is equal to 1, the probability function will be zero everywhere and thus the area under the curve will not sum to one (there is no area under the curve), making it an invalid probability function. You can see this by looking at the numerator in the answer for c above when b goes to ∞. If it is less than one, it will be negative and probability functions cannot be negative.