Feedback and Proxy

Lessons From Engineering a Weight Controller

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Simplify Calorie Counting

How?

Calorie Reduction Works

493 studies over 25 years [1]

[1] Miller WC, Koceja DM, Hamilton EJ. A meta-analysis of the past 25 years of weight loss research using diet, exercise or diet plus exercise intervention. Int J Obes Relat Metab Disord. 1997;21(10):941-7.

Calorie Counters

- Calorie Limit: Formula
- Calorie Measurement: Database

Let’s try to improve on both of these.

Calorie Counters: Biased

- Formula residual [1]: ~200 Calories
- User Underreporting [2]: ~18%

Both biases vary from user to user. Thus, comparing user's calories to formula's calories is not "apples-to-apples".
Net bias can result in (i) overeating: won't lose weight, (ii) undereating: will be hungry (making it more difficult to sustain the diet)
Also, would like to avoid tracking "calories out", which includes activity and various other things

[1] Institute of Medicine of the National Academies. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. 2002, 2005
[2] Mertz W, Tsui JC, Judd JT, et al. What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. Am J Clin Nutr. 1991;54(2):291-5.

Calorie Counters: Tedious

- Is this apple *medium* or *large*?
- How many tbsp of melted butter is on this fish?
- How many oz of chicken is that?
- Do I enter *every single ingredient*?

Searching DB takes time, even with an app
Estimating measurements (oz, tbsp, etc) is difficult
Guessing ingredients is difficult
After many days of three meals with several ingredients, one can easily get tired of this

Improvements

- **Feedback: Remove bias**
- Proxy: Simplifies calorie measurement

Feedback: Thermostat

- Target temperature
- Thermometer
- Too hot? Turn on AC
- Too cold? Turn on heater

Feedback controller
Keeps temperature near target
Simple but effective
Use a temp noise band to avoid turning heater/AC on/off too frequently
Don’t need deep understanding of thermodynamics
Don’t need sophisticated or precise measurements

Feedback: Weight Controller

- Pick a target weight
- Bathroom scale
- Overweight? Eat less
- Underweight? Eat more

Eat less than you have been instead of using a formula; “apples-to-apples” comparison now
Informal interviews with personal trainers and dieters suggests this procedure is applied, if informally: Not losing weight? Lower calorie target manually, irrespective of formula.
Feedback does not require deep understanding of system dynamics.

Improvements

- Feedback: Remove bias
- **Proxy: Simplifies calorie measurement**

Ex proxy: activity monitor clearly doesn’t count steps b/c it’s on your arm; it’s a proxy
Ex proxy: BMI is a proxy for body fat; skin calipers take much more effort

Proxy

- Easy / cheap estimate, E
- Correlated with measurement, M

Ex: step tracker
E = shaking of accelerometer in phone
M = steps counted by a researcher

Proxy

- Restaurant, packaged, homemade food
- No measuring device
- Trade precision for ease-of-use

Restaurant, packaged, homemade
Estimation lowers precision, but is easier than DB lookups
Ease-of-use means more use, we hope

Proxy

- Time?
- Weight?
- Volume?

Fundamental physical units: time, mass, length

Proxy: Volume

- Technique from portion control:
  - Compare to closed fist
- Calories = (Calories/Volume) * Volume
- Is it a good signal?

always have your fist with you (no device)
works with any kind of food
doesn’t capture variation in calorie density (Calories/Volume)
simplify: only use one measurement method (i.e., no palms, thumbs, thumbtips)

Mechanical Turk

- N=28
- 7-day record of *food, calories, fists*
- correlation = **.59**

df = fists(7) / meanFists(1:6) - 1
dc = calories(7) / meanCalories(1:6) - 1
correlation(df, dc) = .59
fists(7) = # fists on the seventh day
meanFists(1:6) = mean of # fists over fist 1-6 days
See http://www.pertinacity.org/blog/2014/2/12/dynamics
So .59 … is this any good?

Correlations

Ear Thermometer: .89

Jawbone UP Steps: .83

BMI: .76

Nike Fuelband Steps: .67

Jawbone UP Calories: .63

Fist Volumes: .59

SAT: .53

Fitbit Ultra Calories: .49

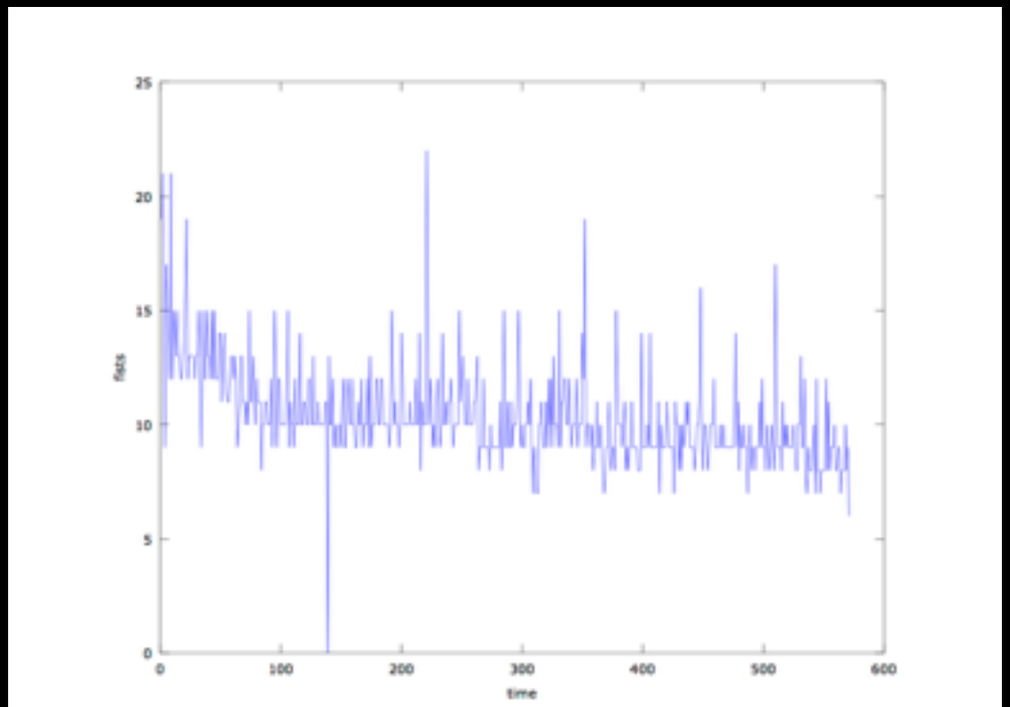
Nike Fuelband Calories: .44

GRE Verbal: .24

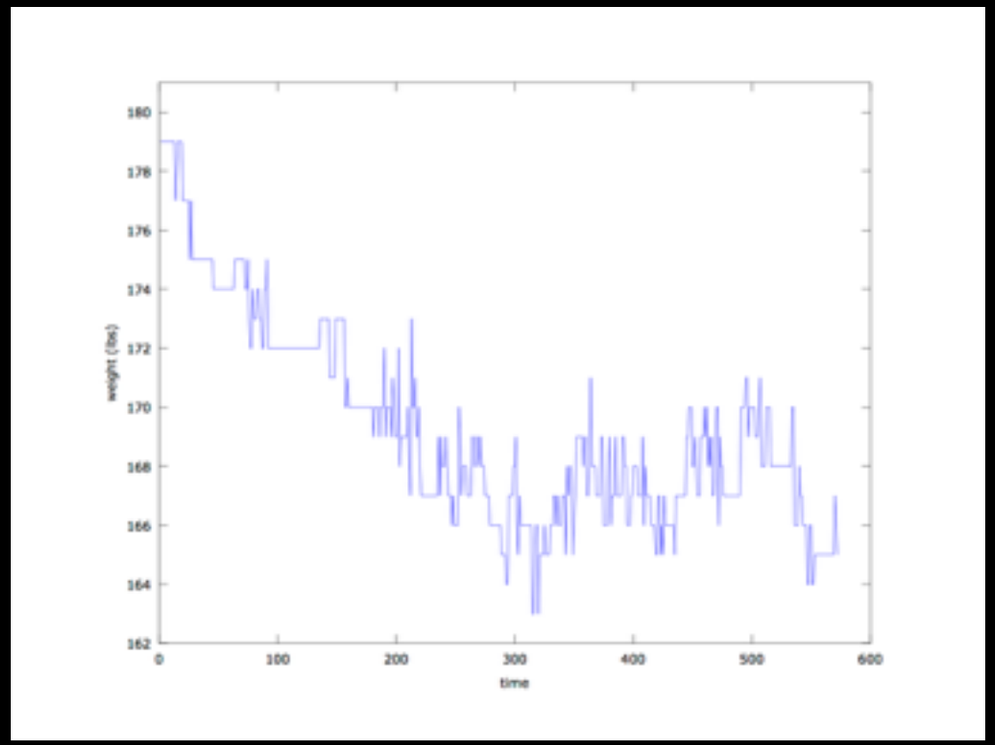
Great Stock Picker: .10

Correlation of each measurement with a more “gold standard” version of the thing it’s measuring
Better than some things, worse than others.
Full list of references: http://www.pertinacity.org/blog/2014/3/10/correlations

Fists vs. Time



Weight vs. Time



Do we need a second signal?
Nah. K.I.S.S.

Pertinacity

Of course, there's an App

Feedback and Proxy

- **Feedback**: Improves accuracy, simplifies engineering
- **Proxy**: Trades precision for ease-of-use