The Missing Numerator: Towards a Value Measure for Smartphone Apps

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Mobility Is **The** Important Feature


MY IPHONE SPENDS THAT MUCH TIME ON CHARGE
IT MIGHT AS WELL BE A FRIGGIN LANDLINE
memegenerator.net

Energy Management Is A Well Researched Field

eDoctor: Automatically Diagnosing Abnormal Battery Drain Issues on Smartphones
Ma, X., Huang, P., Jin, X., Wang, P. *et. al.*

Where is the Energy Spent Inside My App?: Fine Grained Energy Accounting on Smartphones with Eprof
Pathak, A., Hu, Y. C., Zhang, M.

Energy management in mobile devices with the cinder operating system
Roy, A., Rumble, S. M., Stutsman, R., Levis, P., Mazie and Zeldovich, N.

V-edge: Fast self-constructive power modeling of smartphones based on battery voltage dynamics
Xu, F., Liu, Y., Li, Q., and Zhang, Y.

AppScope: Application Energy Metering Framework for Android Smartphones Using Kernel Activity Monitoring.
Yoon, C., Kim, D., Jung, W., Kang, C., and Cha, H.

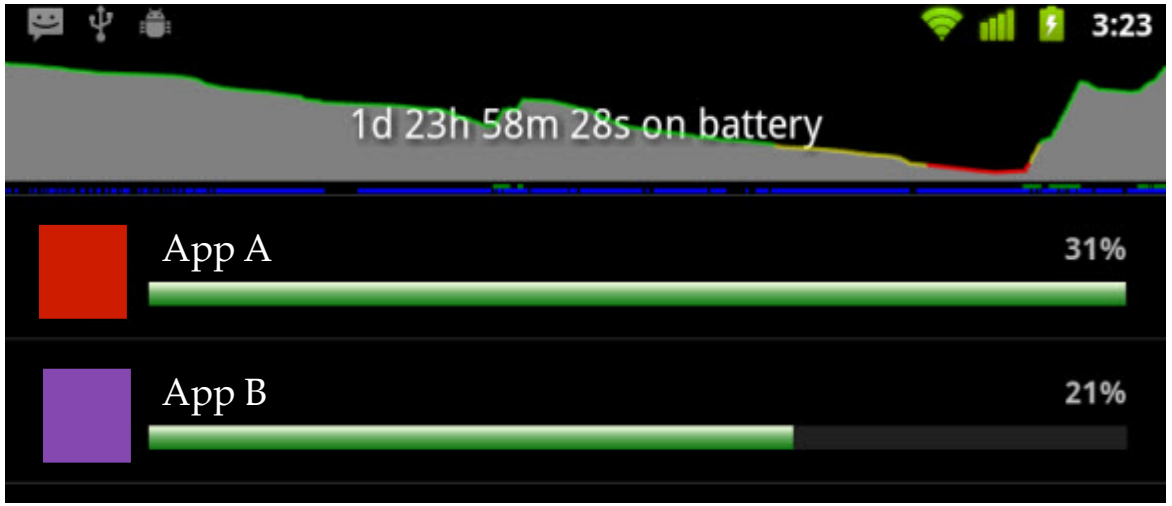
Currentcy: a unifying abstraction for expressing energy management policies
Zeng, H., Ellis, C. S., Lebeck, A. R., and Vahdat, A.

Quanto: Tracking energy in networked embedded systems
Fonseca, R., Dutta, P., Levis, P., and Stoica, I.

Carat: collaborative energy diagnosis for mobile devices
Oliner, A. J., Iyer, A. P., Stoica, I., Lagerspetz, E., and Tarkoma, S.

So we should be able to answer some simple energy consumption questions

Comparing Apps



App A consumes more energy than App B

Comparing Apps

App A

App B

Comparing Apps

App A

App B

Comparisons Are Hard

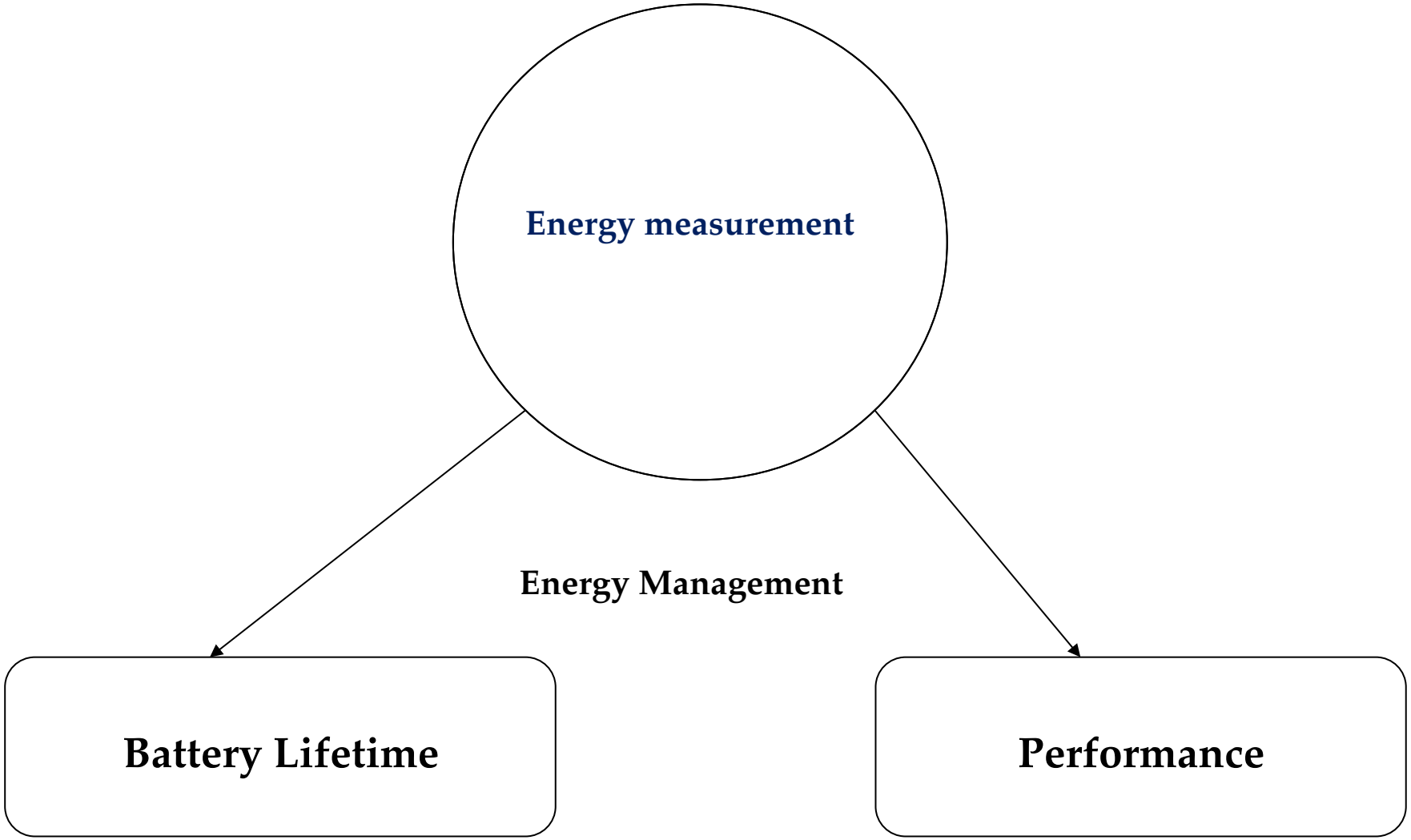
- Different apps from different categories
- Different apps from same category
- Same app on different users / devices
- Same app on same user / device for different time instances

Disconnect between researchers and real world users


A-W-E-
S-O-M-E


My dissatisfaction
is immeasurable.

Energy management != Energy Measurement

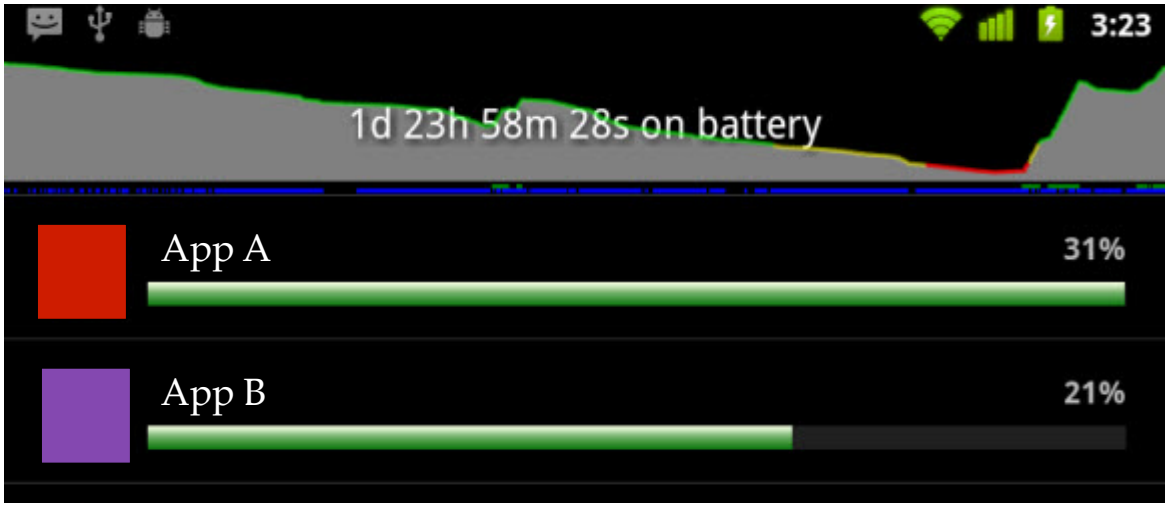


Missing Numerator

$$\text{Energy Efficiency} = \frac{\text{App ?Value}}{\text{Energy Consumption}}$$

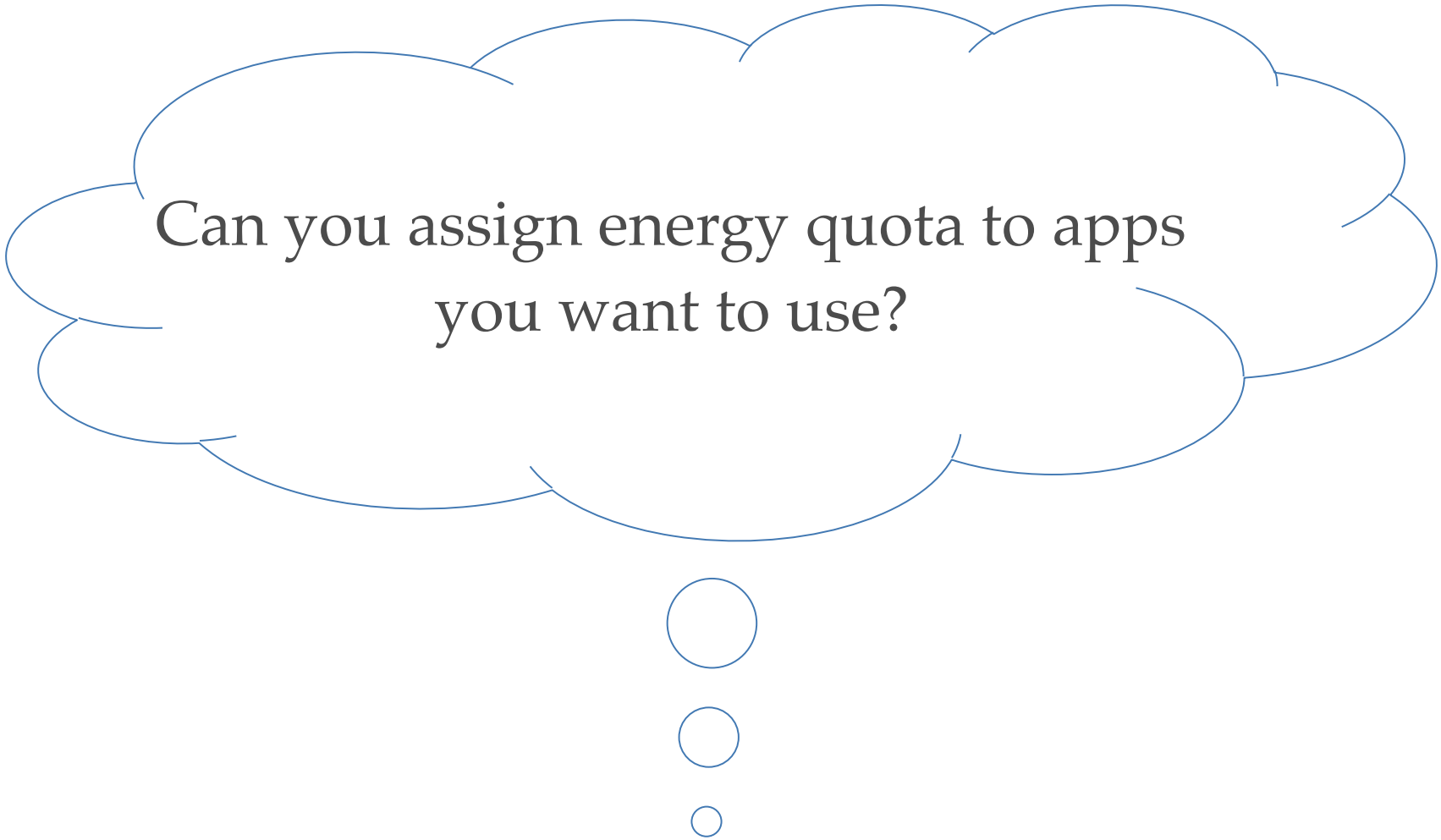
How will this **numerator** help?

Comparing Apps

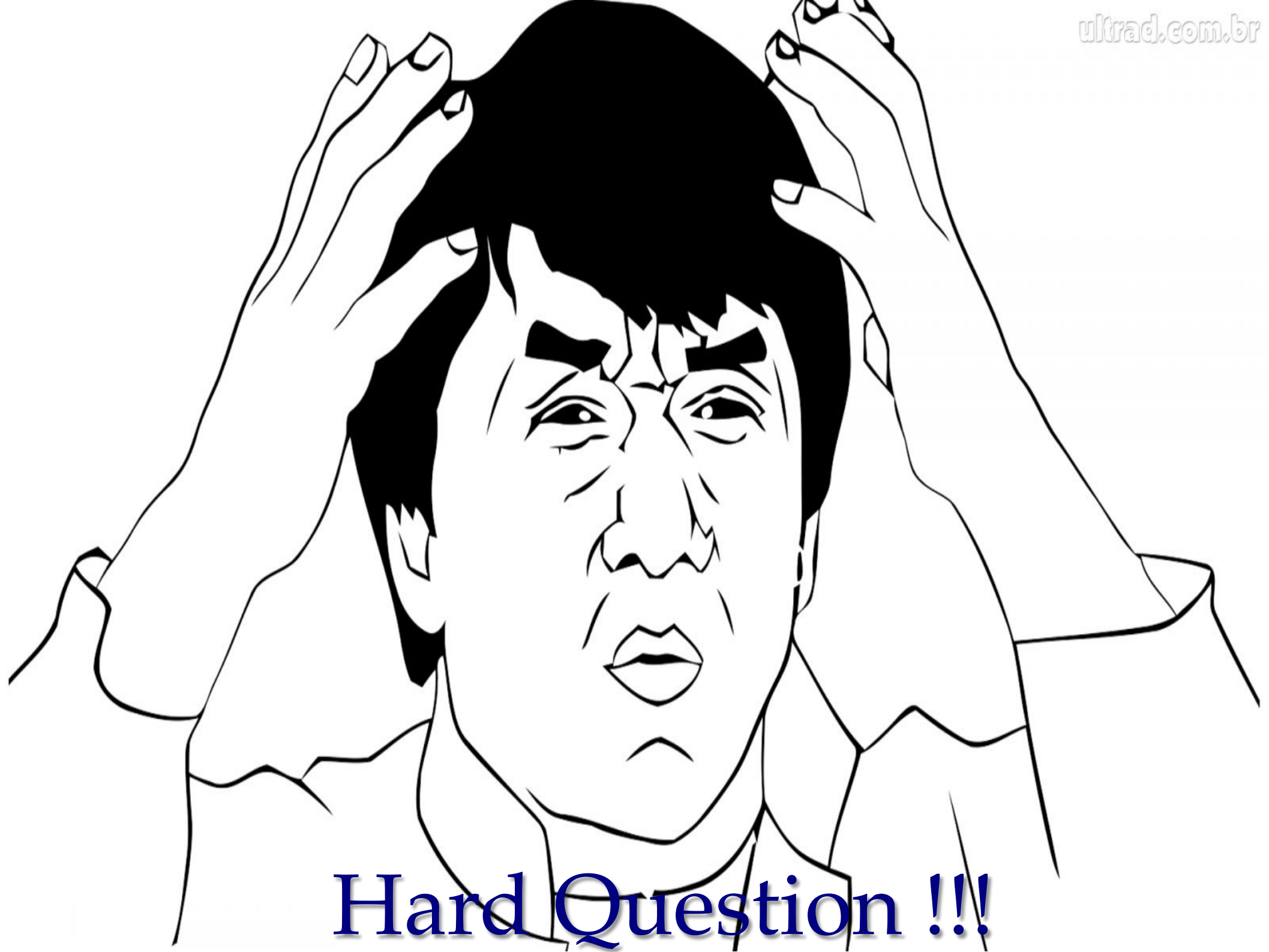


Does **value** exist?

Allocate Energy Thought Experiment



How to measure **value**?


ultrad.com.br
Hard Question !!!

Our (Failed) Value Measure

Value = Content delivered by an app

We use screen refresh rate for measuring video content and audio bit rate for measuring audio content.

Implementation

Instrumented Android platform and distributed to PhoneLab testbed users at University at Buffalo

Comparing Four Simple Metric

Usage Based Metric

No **value**.

Power Metric

Value = Total App Running Time

Foreground Energy Efficiency Metric

Value = Screen Foreground Running Time

Content Efficiency Metric

Value = Weighted Screen Refresh Rate And Audio Bit Rate

Comparison Of App Ranks

Rank	Usage Metric	Power Metric	Foreground Eff. Metric	Content Eff. Metric
1	Android Browser	Facebook Messenger	Bank Of America	Youtube
2	Facebook	Google+	The Weather Channel	Candy Crush Saga
3	Chrome Browser	Super-Bright LED Flashlight	Skype	Bank Of America
4	Android Phone	UB Parking	Youtube	DropBox
5	Gmail	Android Music	Android Messaging	Android Messaging
6	Android Messaging	Google Search	Android Gallery	Android Gallery
7	WhatsApp Messenger	NFL Mobile	Android Calculator	Twitter
8	Google Search	Pandora	Twitter	Android Clock
9	Candy Crush Saga	Starbucks	Chrome Browser	Yahoo Mail
10	Android Gallery	Android News and Weather		

Comparison Of App Ranks

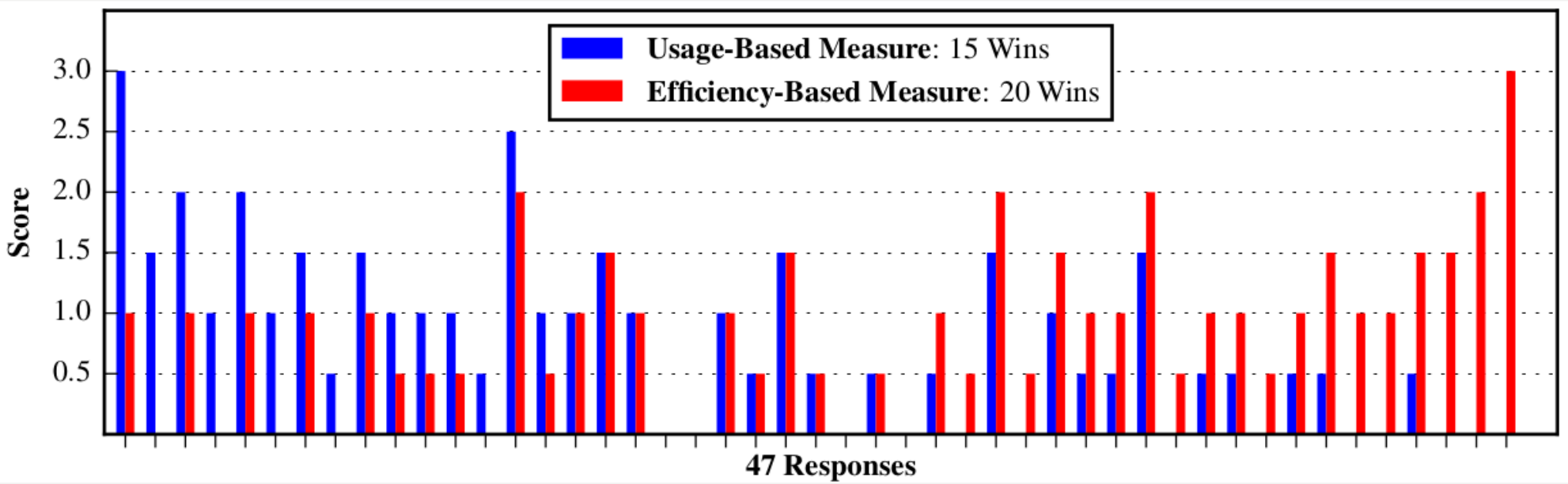
Rank	Usage Metric	Power Metric	Foreground Eff. Metric	Content Eff. Metric
10	Google+	Chrome Browser	Yahoo Mail	NFL Mobile
9	Android Calculator	WhatsApp Messenger	ESPN Sportscenter	UB Parking
8	NFL Mobile	Twitter	Google Search	Pandora
7	UB Parking	Yahoo Mail	Android Music	Facebook Messenger
6	Super-Bright LED Flashlight	Android Messaging	Pandora	Android News And Weather
5	Starbucks	Skype	Super-Bright LED Flashlight	Adobe Reader
4	Google Keep	Youtube	UB Parking	Google +
3	DropBox	ESPN Sportscenter	NFL Moblie	Android Phone
2	ESPN Sportscenter	The Weather Channel	Google+	Google Search
1	Bank Of America	Bank Of America	Facebook Messenger	The Weather Channel

Survey

Q: Which apps are you willing to uninstall to improve battery life?

- 3 apps : least efficient by content-metric
- 3 apps: consumed most energy
- 3 apps: randomly selected

Result


Usage-Based Measure: 15 Wins
Efficiency-Based Measure: 20 Wins
Score
3.0
2.5
2.0
1.5
1.0
0.5
47 Responses

Lessons Learned

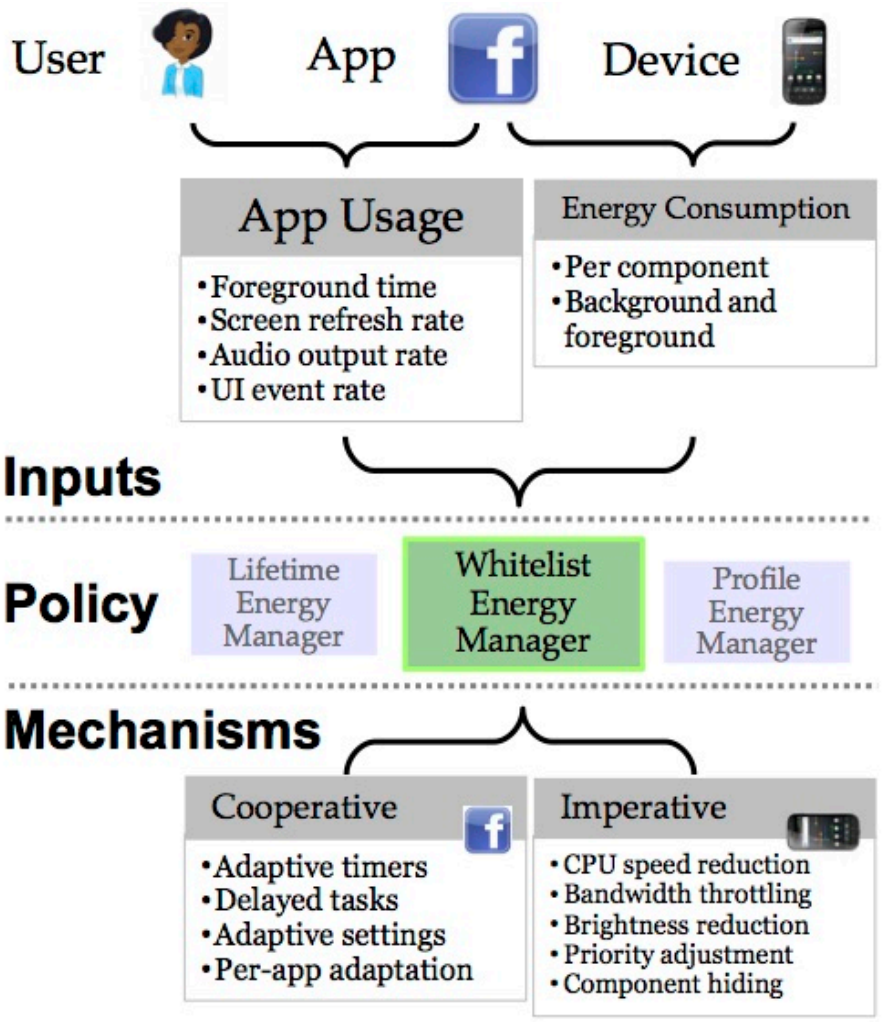
- No way to differentiate between frames which provide information from those which don't.
- Asking to uninstall apps is too extreme.
- Users are still willing to remove apps if identified correctly.
- Need better parameters to measure content.
- Simple metrics may not work.

Other Value Approaches

1. Background App Component
2. Foreground Usage
3. User Interaction

Evaluating Different Value Measures

Jouler helps to experiment with different energy management approaches.



Summary

- Energy management is more than just energy measurement.
- Per app, per user, temporally variant value measure is needed for effective energy management.
- We do not know the right way to measure value, yet.