



A Holistic View to Smartphone Energy Consumption

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Holistic understanding of smartphone energy consumption is an important open research topic. Complex interdependencies between application use, system settings, and different subsystem variables, together with a need for real-life data, make holistic energy consumption analysis challenging. Our work aims to provide techniques and methods for analyzing mobile energy use in the wild, and generating actionable recommendations for optimizing smartphone energy efficiency.



Example: Facebook

- Average energy estimate: 4.94 hours of active use
- Manual screen brightness setting, mobile network, and temperature over 30C: 4.09 hours, **-17%**
- Automatic screen brightness, Wi-Fi network, and cool battery temperature: 7 hours, **+42%**

Complex Energy Factors

Mobile devices operate in a versatile context:

- Applications: functionality, permissions, price, services, libraries etc
- System settings, e.g., network choices, screen brightness, and airplane mode
- Subsystem variables, e.g., CPU and memory loads, and network signal strength
- Sensor data, e.g., accelerometer, microphone, and inside temperature

Iterative Learning

Iterative, incremental, and fast cycle to

- Collect newest data from mobile devices to the cloud
- Use machine learning to give a deep insight to the crowdsensed environment
- Send feedback, e.g., energy suggestions and energy management plans from the analysis system back to the devices

The Carat Energy App

Carat is a research project and a mobile application that gives energy recommendations to over 850,000 Android and iOS users from 200 countries.

- The dataset has been used to analyze energy benefit of mobile applications [3] and system settings [1, 2]
- Future work to combine all the context factors to one recommendation engine of iterative learning cycles
- The Carat Context Factor Dataset is freely available at: <http://carat.cs.helsinki.fi/research>



[1] Peltonen, Lagerspetz, Nurmi, and Tarkoma. Constella: Recommending System Settings the Crowdsourced Way. Pervasive and Mobile Computing. March 2016.

[2] Peltonen, Lagerspetz, Nurmi, and Tarkoma. Energy Modeling of System Settings: A Crowdsourced Approach. IEEE PerCom 2015.

[3] Oliner, Iyer, Stoica, Lagerspetz, and Tarkoma. Carat: Collaborative Energy Diagnosis for Mobile Devices. ACM SenSys 2013.