Ubiquitous and Mobile Computing CS 528: Sandra Helps You Learn: the More You Walk, the More Battery Your Phone Drains

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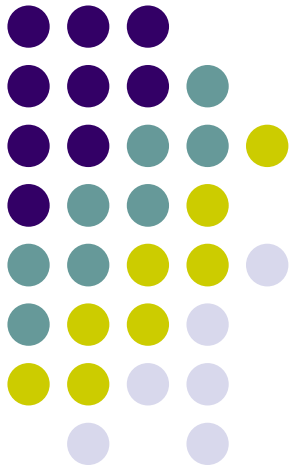
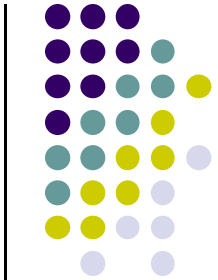
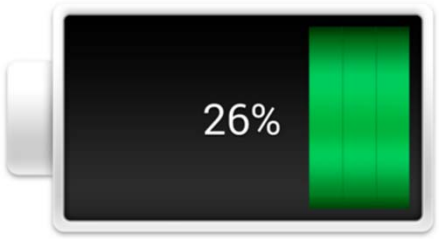


Outline



- Motivation and Introduction
- Related Work
- Methodology
- Evaluation
- Limitations and Discussion
- Conclusion
- References

Motivation

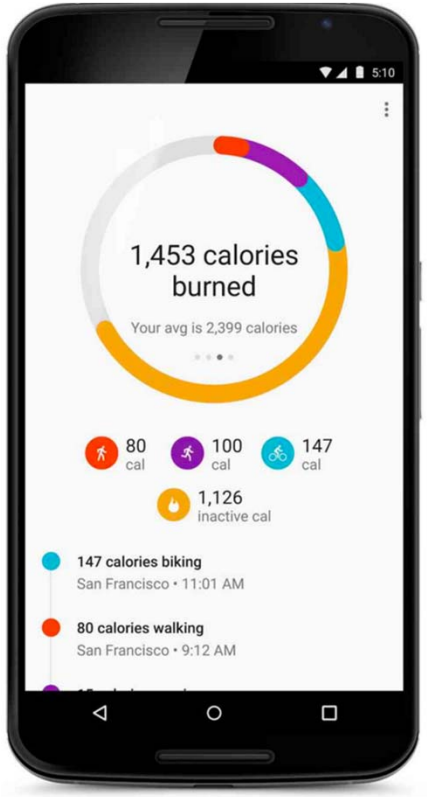


Power saver
Optimize battery life
OFF

Extreme power saving mode
Put phone in extreme power saving mode to extend battery life
OFF

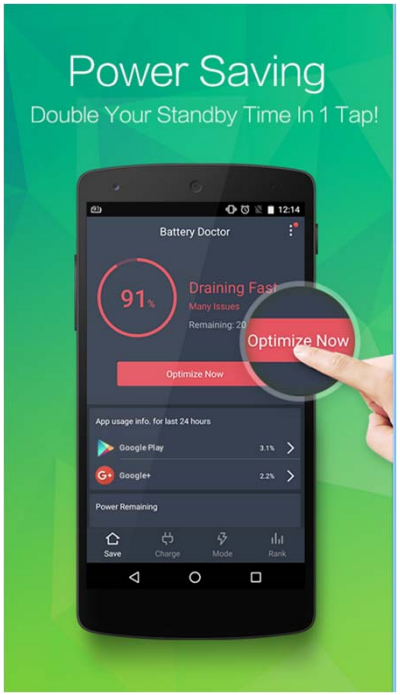
Usage
View battery usage details

History
23h 23m 42s on battery



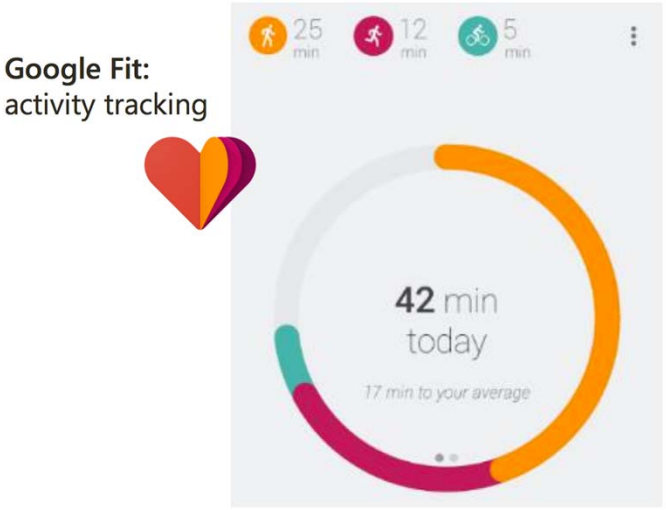
Why?

- Empirical practices help users develop battery model
- Research prototypes and commercial apps supplement the model



Why?

- CSAs (Continuous Sensing Apps) introduce new major factors governing phones' battery consumption
- Nontrivial persistent battery drain
- Mobility-dependent battery drain

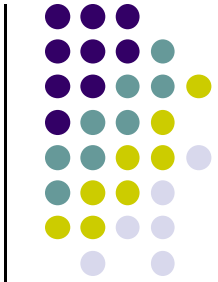


Moves: activity/place tracking

Accupedo: pedometer

Dieter: pedometer

Related Work



- Battery Interface

Found and provided useful battery information

Not focusing on background-running CSAs

- Battery Management

Proposed battery management strategy

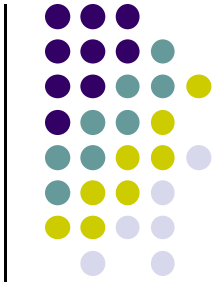
Not aiming to help CSA users manage battery by themselves

- Battery Diagnosis

Detected abnormal battery drain and its causes

Not letting users aware of the impact of mobility conditions

Key Research Questions



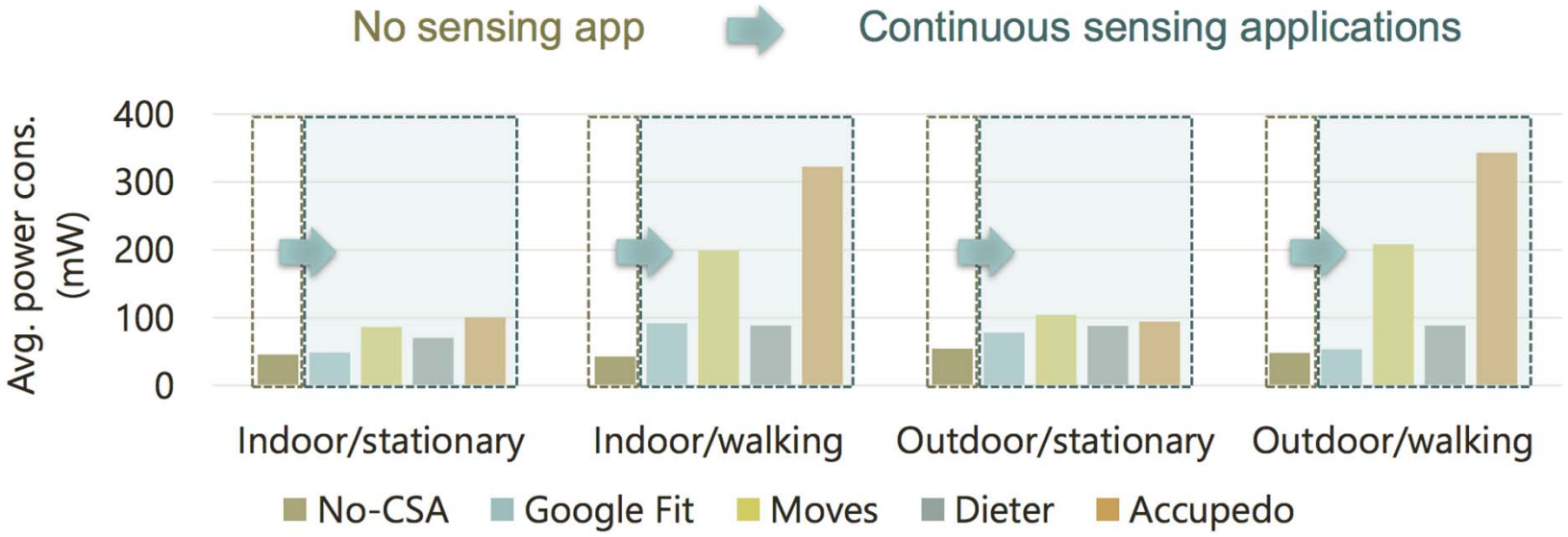
- Why do CSAs make current practices no longer effective?
  1. Quantitative impact: Nonlinear battery drains of CSAs
  2. User perceptions with CSAs' battery behaviors

- How can we help users' battery management?

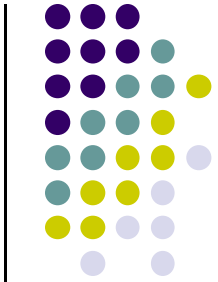
  Sandra

Standby powers under different mobility conditions

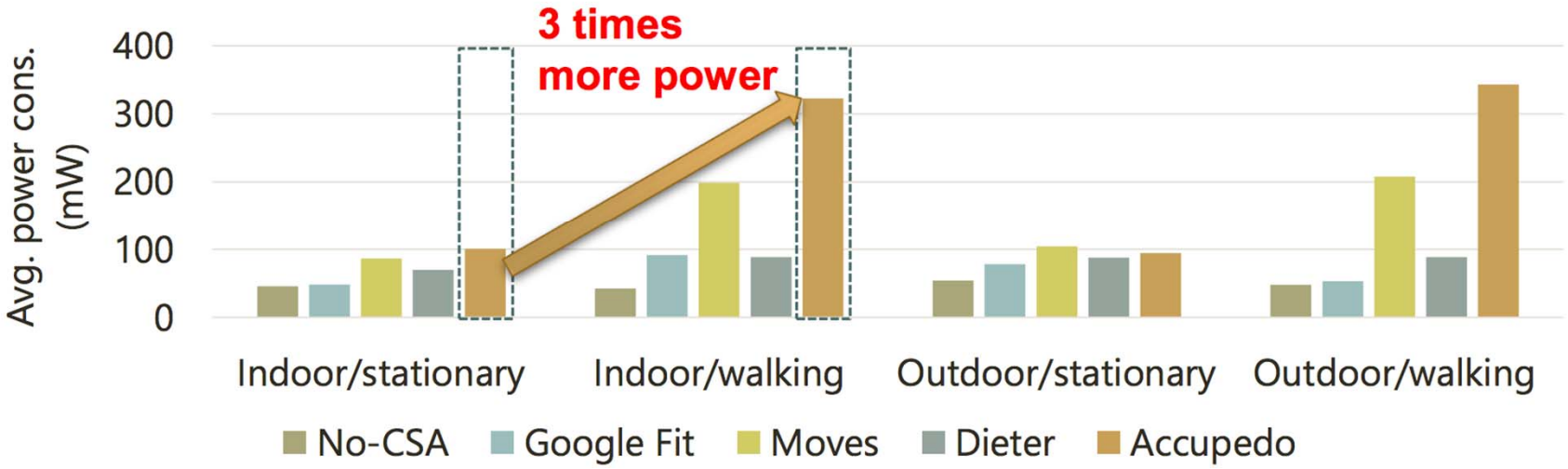
- CSAs drain extra stand-by power
- Average increment: 171% compared to No-CSA



Standby powers under different mobility conditions

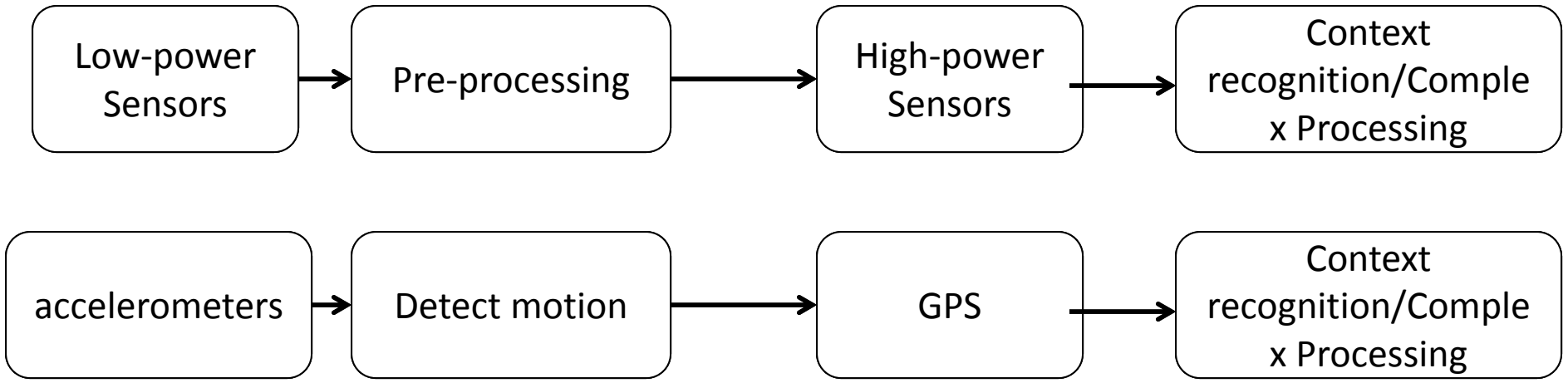


- CSAs drain extra stand-by power
- Average increment: 171% compared to No-CSA
- Extras vary depending on user's mobility condition

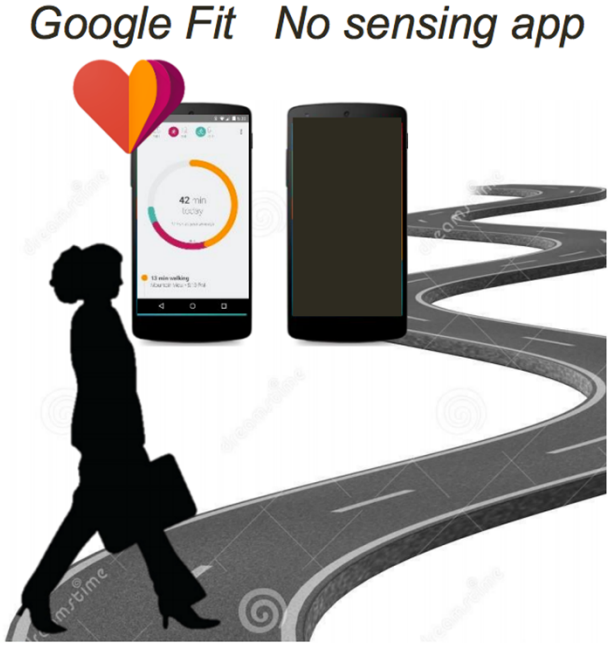


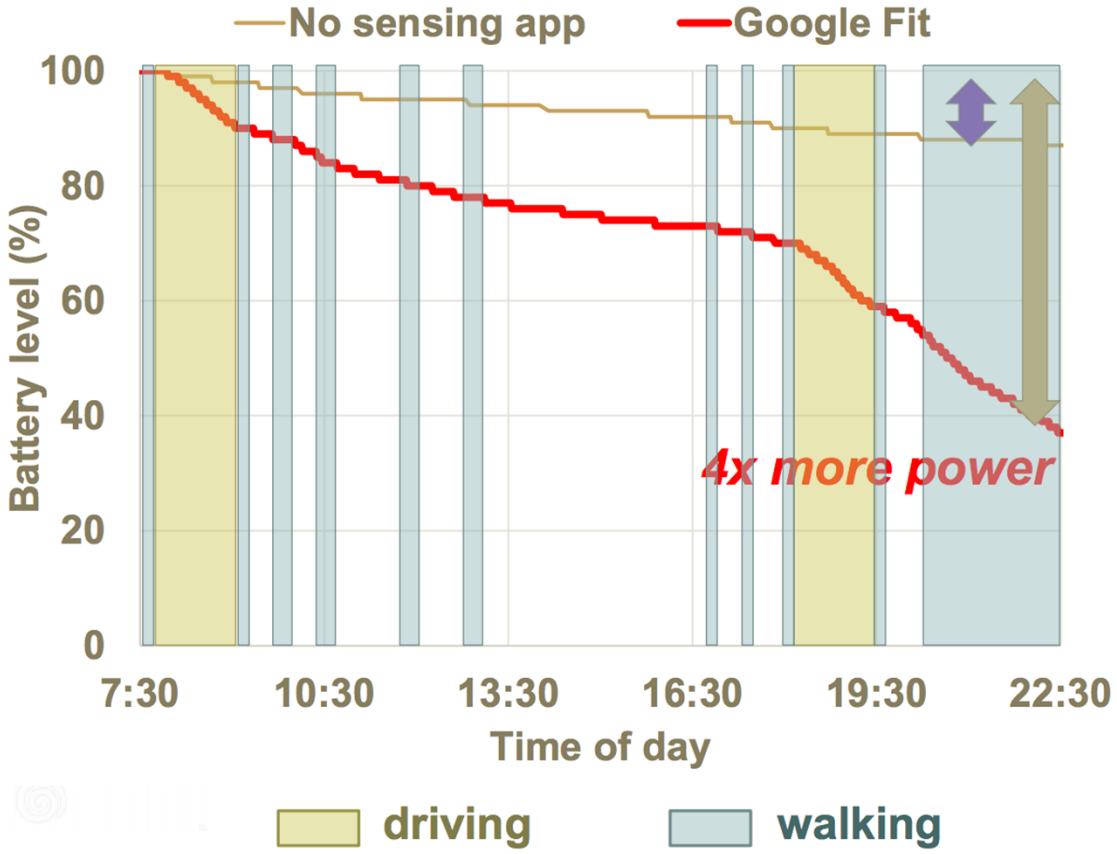
Why mobility-dependent?

- Adopting conditional sensing pipelines for energy saving

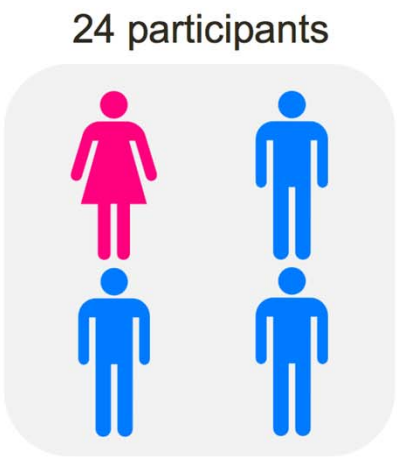


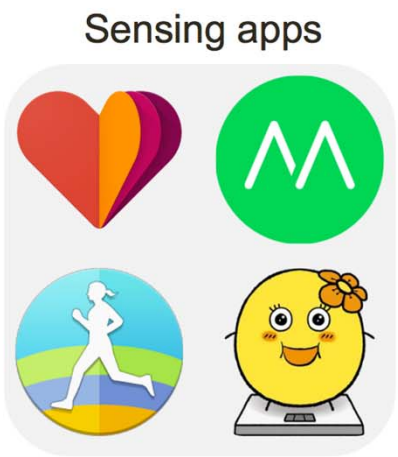
Day-long battery drains under real life mobility variations





User perceptions with CSAs' battery behaviors



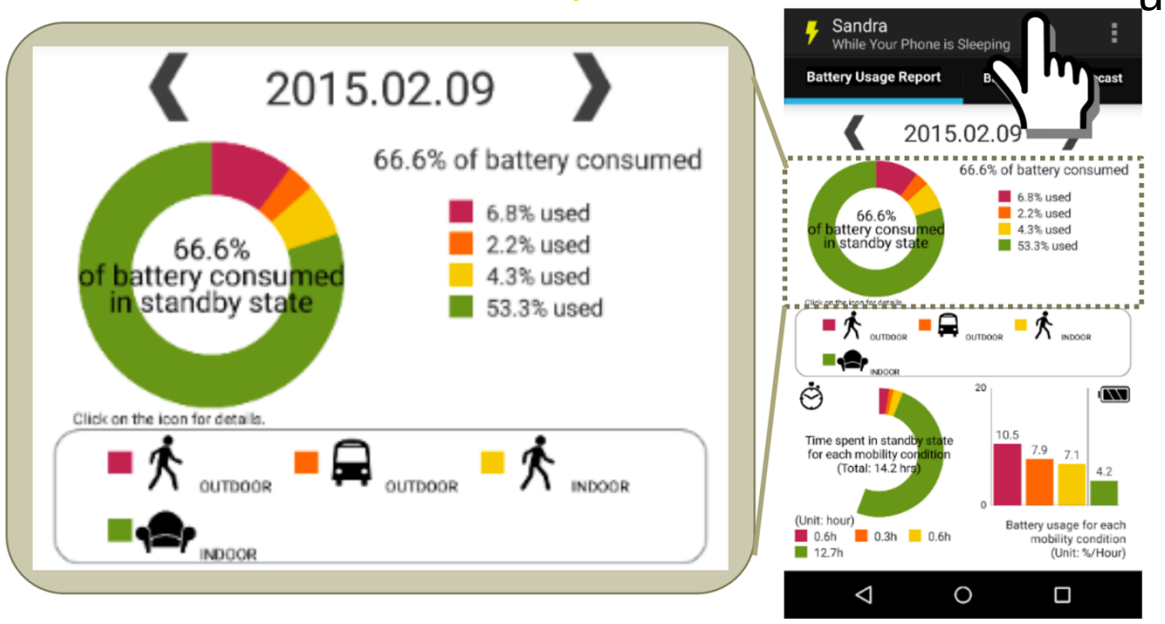


- Limited understanding about CSA's operation and battery drains
- Suspicion of erratic battery drains, but don't know why

Design

- Purposes
  - Make users understand mobility-dependent power behavior
  - Help users take necessary actions in advance
- Interfaces

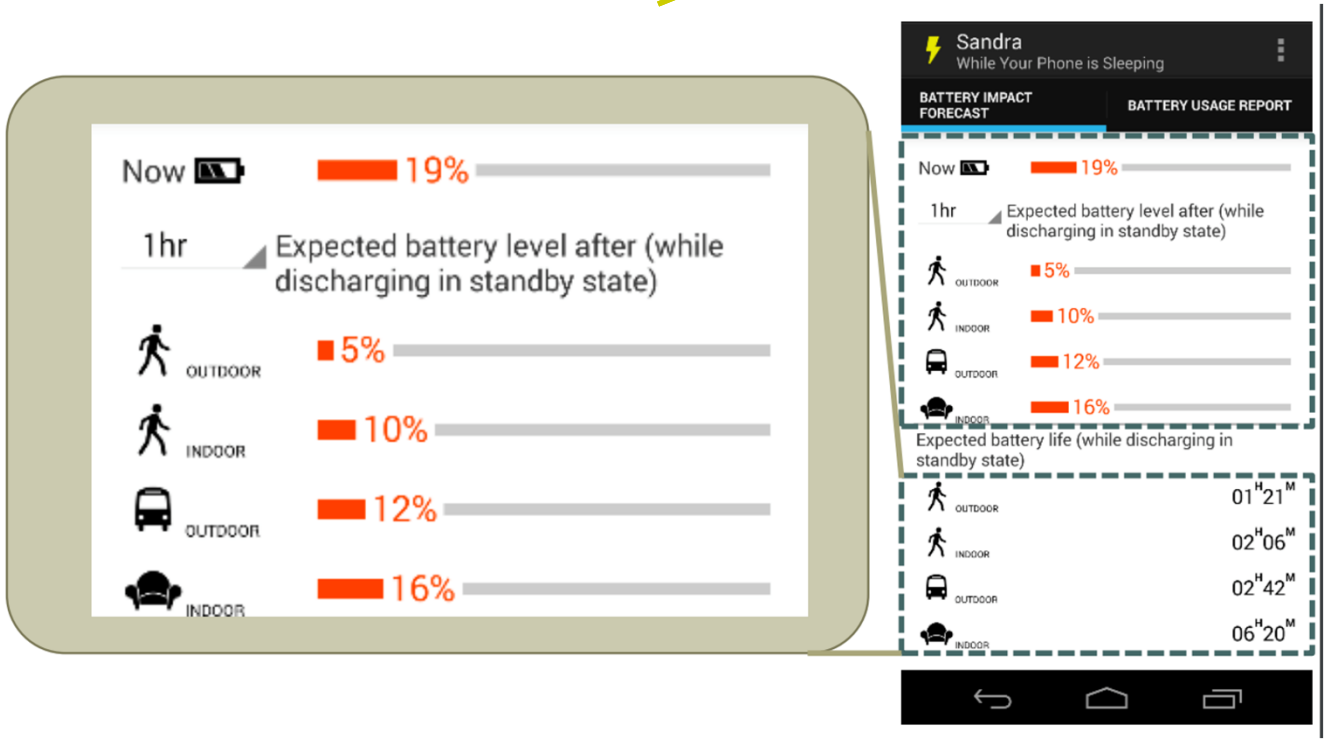
Provides a retrospective battery use summary



Design

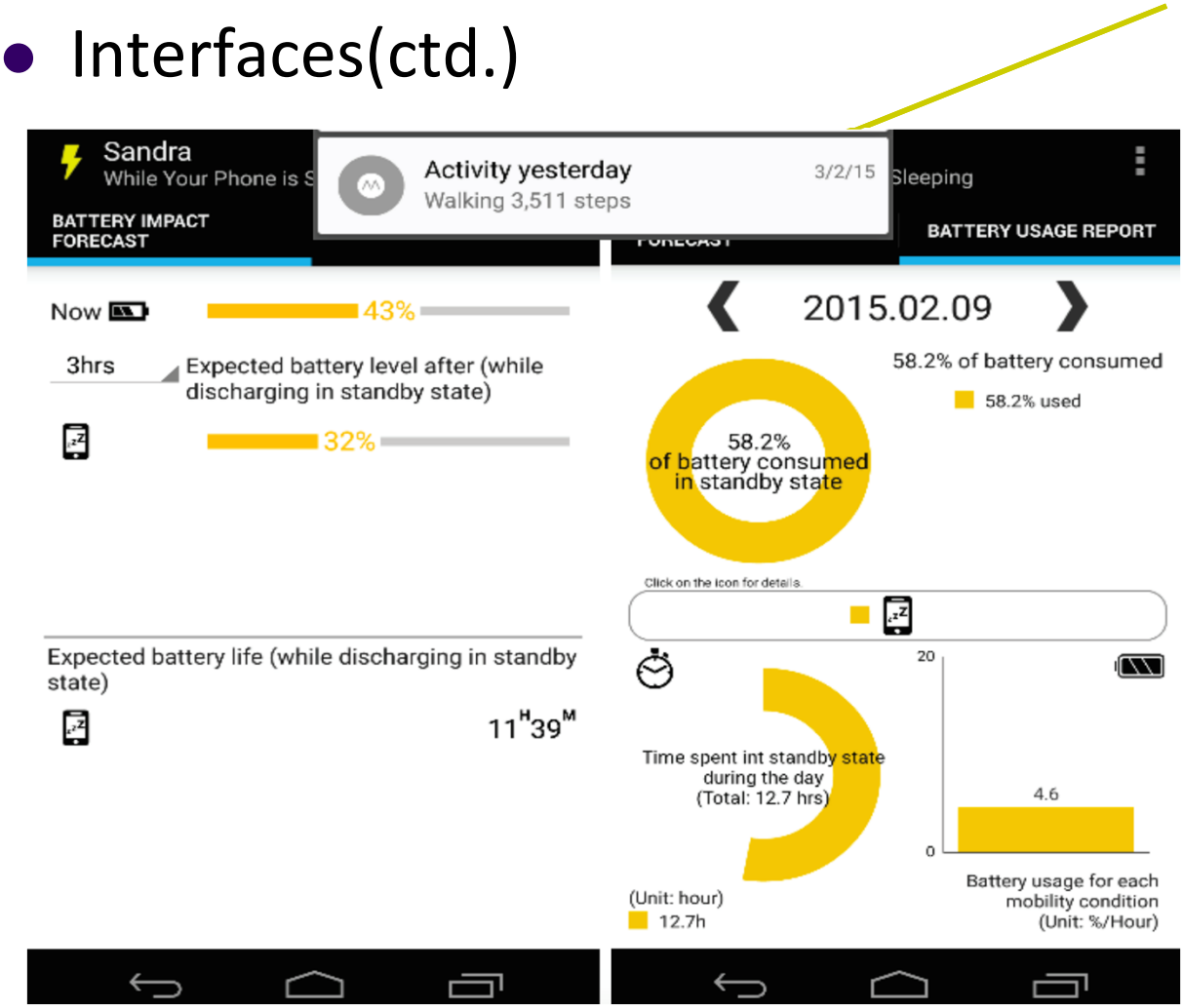
- Interfaces(ctd.)

Provides expected standby times for a set of commonly occurring mobility conditions



Design

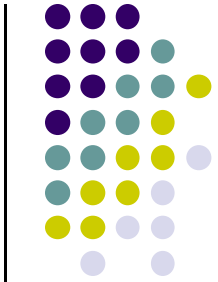
- Interfaces(ctd.)



Sandra-lite

- Downgraded Sandra
- Single standby life expectation
- Without per-mobility breakdown

Implementation



- Mobility Condition Monitoring
  - Leverage context information generated by continuous sensing applications by using open APIs
- Calculation of battery drains
  - Drain rate(%hour): average decrease in battery levels per hour= total battery decrease/total duration(for a mobility condition)
- One concern: Sandra overhead
  - Incurs only a marginal cost(Power overhead: only 3-7 mW), so not a big deal

Evaluation

- Experimental Setup

24 participants

30-day deployment

18 Google Fit,
6 Moves

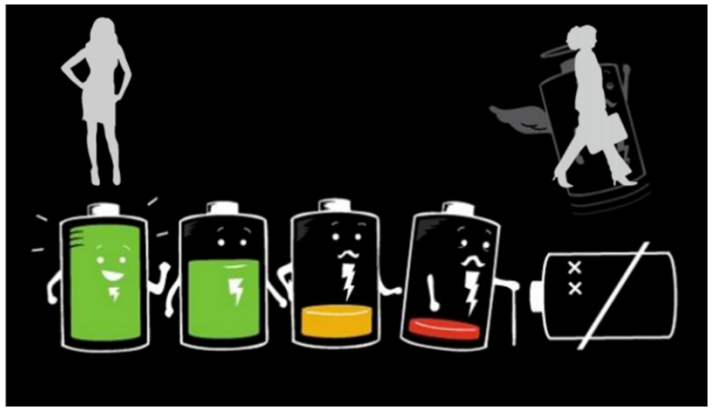
Real devices

- Conduct two questionnaires for using Sandra and Sandra-lite in a 5-point Likert-scales(Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

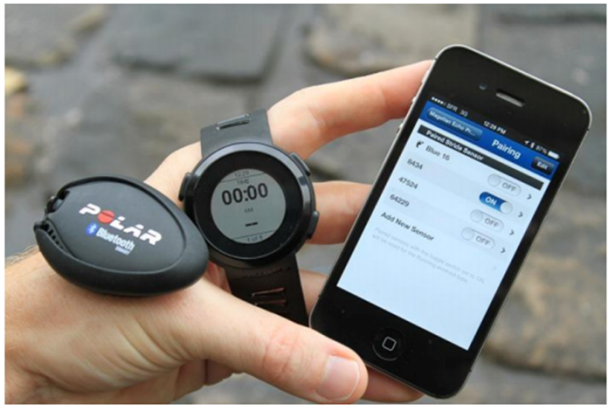
Evaluation

- Q1: “Dis it bring changes to your existing understanding about your phone’s stand-by battery drain? ”

- C



Realizing that the phone consumes different power



Positive impact on sensing applications

Mo

understanding(p-value 0.023)

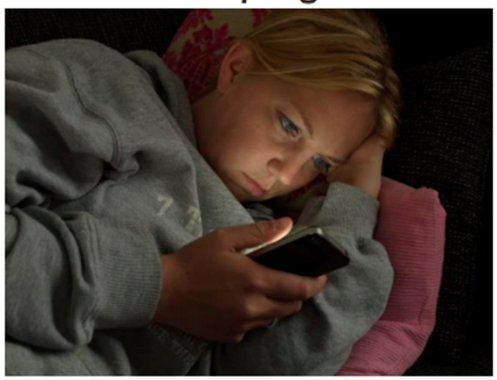
Evaluation

- Q3: “Did you find it helpful in managing your phone’s

In-situ arrangement:
Recharging the phone

Acquiring
new everyday practices:
Turning off GoogleFit on driving

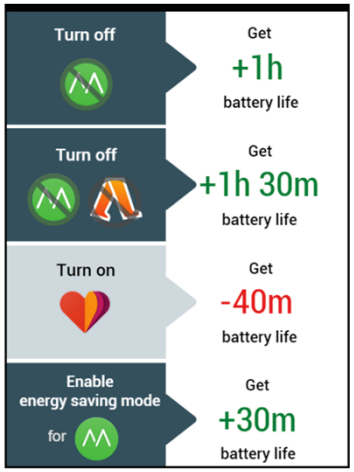
Feeling less nervous
under limited battery:
Before sleeping

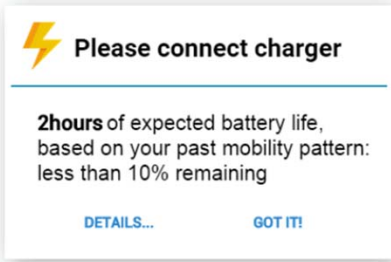


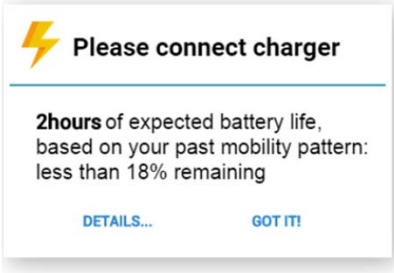
Mobility-aware battery information was perceived as useful (p-value= 0.005)

Limitations and Discussions

- Limitations
  - Study Limitation of Target Participants
  - Other Factors that Affect Nonlinear Battery Drain
- Extensions
  - Notify expected increase of a phone's battery
  - Future mobility pattern-based battery advisor
  - Context-dependent recharge alert



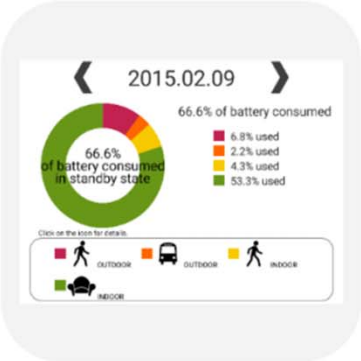




Conclusion

Mobility-dependent battery drain

Real devices, real users, real-life situations



Sandra

Usefulness of mobility-aware battery information

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