CS 4518 Mobile and Ubiquitous Computing

Computing

Lecture 19: ActivPass & Sandra

Emmanuel Agu

Announcement
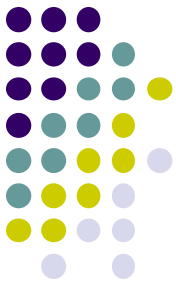
Final Project Pitches

- **Remember:** Thursday (3/2) and Friday (3/3) this week

ActivPass

ActivPass

S. Dandapat, S Pradhan, B Mitra, R Choudhury and N Ganguly, ActivPass: Your Daily Activity is Your Password, in Proc CHI 2015

- Passwords are mostly secure, simple to use but have issues:
  - Simple passwords (e.g. 1234): easy to crack
  - Secure passwords hard to remember (e.g. $emime)$@(*$@)9)
  - Remembering passwords for different websites even more challenging
  - Many people use same password on different websites (dangerous!!)

Google

Having trouble signing in?

- I forgot my password

  To reset your password, enter the username you use to sign in to Google. This can be your Gmail address, or it may be another email address you associated with your account.

  Email address

- I forgot my username
- I'm having other problems signing in

Continue

ActivPass

- Unique human biometrics being explored
- **Explicit biometrics:** user actively makes input
  - E.g. finger print, face print, retina scan, etc
- **Implicit biometrics:** works passively, user does nothing explicit to be authenticated.
  - E.g. unique way of walk, typing, swiping on screen, locations visited daily
- Also smartphone soft sensors as biometrics: unique calls, SMS, contacts, etc
- **Advantage of biometrics:** simple, no need to remember anything

ActivPass Vision

- **Observation:** rare events are easy to remember, hard to guess
  - E.g. Website visited this morning that user rarely visits

- **Idea:** Authenticate user by asking questions about user's outlier (rare) activities
  - What is caller's name from first call you received today?
  - Which news site did you not visit today? (CNN, CBS, BBC, Slashdot)?

ActivPass Vision
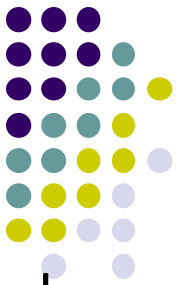
- Authentication questions based on outlier activities generated from:
  - Call logs
  - SMS logs
  - Facebook activities
 - Browser history

ActiviPass

ActivPass Envisioned Usage Scenarios

- Prevent password sharing.
  - E.g. Bob pays for Netflix, shares his login details with Alice

- Replace password hints with Activity questions when password lost

- Combine with regular password (soft authentication mechanism)

How ActivPass Works

- Activity Listener runs in background, logs
  - Calls, SMS, web pages visited, etc

- When user launches an app:
  - Password Generation Module (PGM) creates n password questions based on logged data
  - If user can answer k of password questions correctly, app is launched!
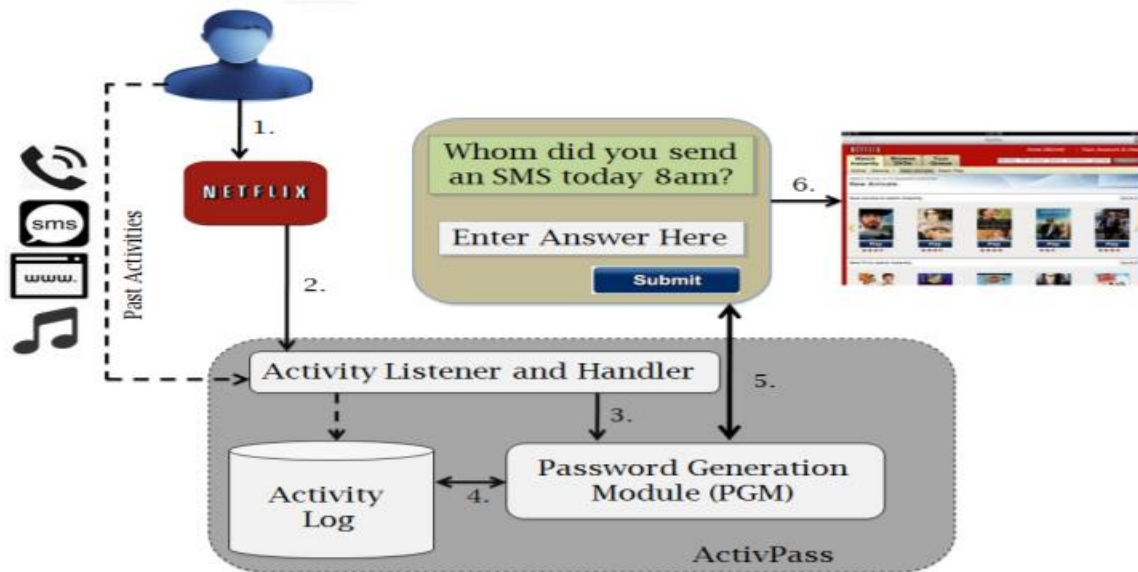
ActivPass Vision

- User can customize
  - Number of questions asked, what fraction must be answered correctly
 - Question format
  - Activity permissions

Question formats	Example questions asked
Binary	Have you received a call from Alice at around 10 pm on 19/09/2014?
MCQ	Please write the options of the links you visited,this week in comma separated way (Ex: A, B): A. CNN; B. BBC; C. SKY News; D. Reuters
Text	Whom did you call at around 7 pm on 17/09/2014 ? Hint: (Al*)

- Paper investigates ActivPass utility by conducting user studies

How ActivPass Works

- Periodically retrieves logs in order to classify them using **Activity Categorization Module**
  - Tries to find outliers in the data. E.g. Frequently visited pages vs rarely visited web pages

  - Erases any "irrelevant" logs. E.g. calls from "unknown number"
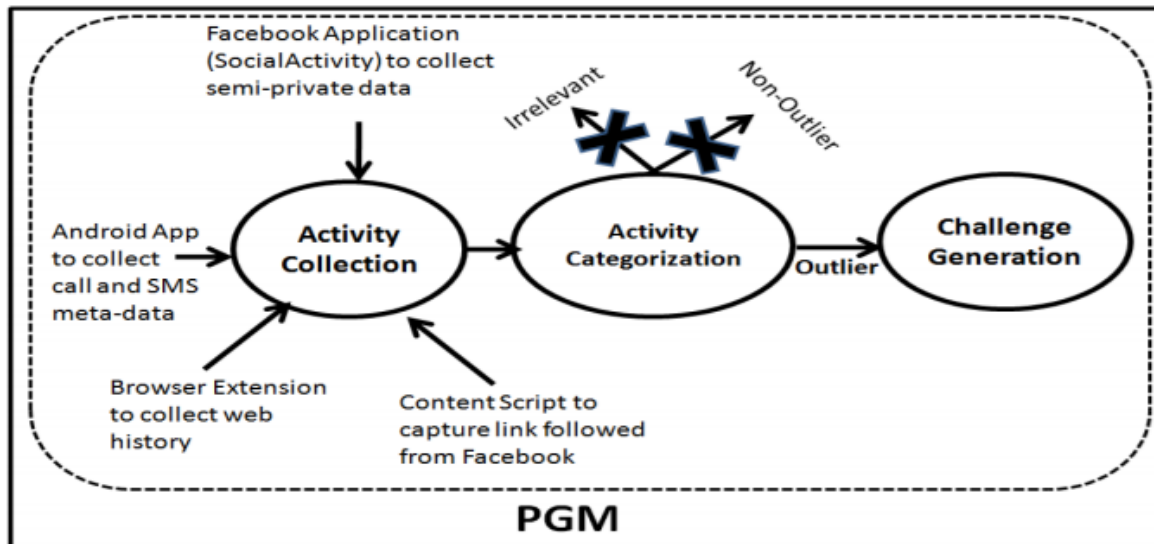
ActivPass: Types of Questions Asked & Data Logged

	Range of questions asked
Facebook	1) Profiles visited by the user. 2) Groups the user is a member of. 3) A person with whom user had a chat.
Web	1) Titles of the web-pages visited by the user.
Call	1) A person whom the user called. 2) A person who called the user.
SMS	1) A person whom the user sent an SMS. 2) A person who sent an SMS to the user.
Audio	1) The tune/tone used by the user as an alarm. 2) The tune/tone used by the user as her ring-tone. 3) The audio files downloaded by the user.

Source	Details of data collected
SMS	Time, Receiver/Sender Name
Call	Time, Type (incoming, outgoing), Name of other person, Duration
Audio	Title of Music added in this week, Alarm tone, Ring tone
Web	URL, Time of visit
Link visited from Facebook	URL, Time of visit
Facebook Group	Name of Private (secret and closed) groups
Facebook Pages	Name of pages created by user
Facebook Profile	Name of Facebook friends of user
Facebook Message	Time (in milliseconds from epoch), Name of other person, Msg Id, Thread Id

ActivPass: Evaluation

- Over 50 volunteers given 20 questions:
  - Average recall rate: 86.3% ± 9.5
  - Average guessability: 14.6% ± 5.7

- Devised Bayesian estimate of challenge given n questions where k are required

- Tested on 15 volunteers
  - Authenticates correct user 95%
  - Authenticates imposter 5.5% of the time (guessability)

n	k	Authentic user	Impostor
4	4	0.554	0.0004
4	3	0.906	0.011
4	2	0.989	0.1043
4	1	0.998	0.468
3	3	0.642	0.0031
3	2	0.948	0.0577
3	1	0.996	0.3771
2	2	0.745	0.0213
2	1	0.981	0.2707

Optimal *n, k* →

Maximize   **Minimize**

Sandra: Battery Drain of Continuous Sensing Applications

Problem: Continuous Sensing Applications Drain Battery Power

C Min *et al,* Sandra Helps You Learn: the More you Walk, the More Battery Your Phone Drains, in Proc Ubicomp '15

- Battery energy is most constraining resource on mobile device
- Most resources (CPU, RAM, WiFi speed, etc) increasing exponentially *except* battery energy (ref. Starner, IEEE Pervasive Computing, Dec 2003)
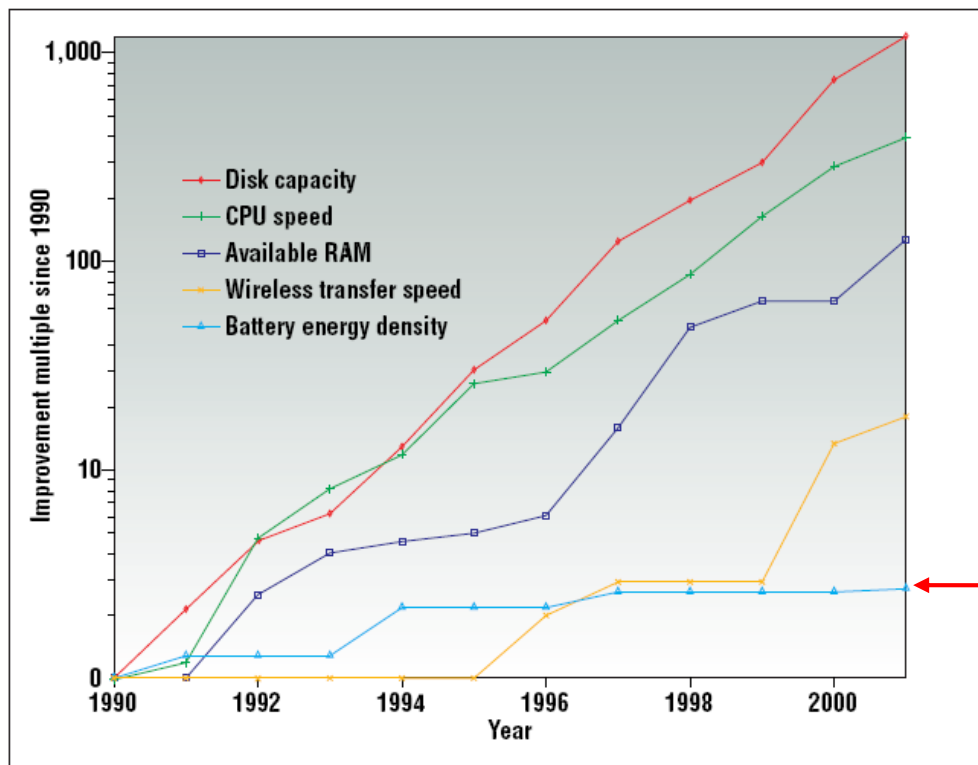

Battery energy density barely increased

Figure 1. Improvements in laptop technology from 1990–2001.

Problem: Continuous Sensing Applications Drain Battery Power

C Min *et al,* Sandra Helps You Learn: the More you Walk, the More Battery Your Phone Drains, in Proc Ubicomp '15

- CSAs (Continuous Sensing Apps) introduce new major factors governing phones' battery consumption
  - E.g. Activity Recognition, Pedometer, etc
- How? Persistent, mobility-dependent battery drain
  - Battery drain depends on user's activities
  - E.g. batter drains more if user walks more

26%
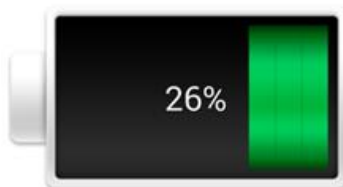
Google Fit:
activity tracking

25 min 12 min 5 min

42 min
today
17 min to your average
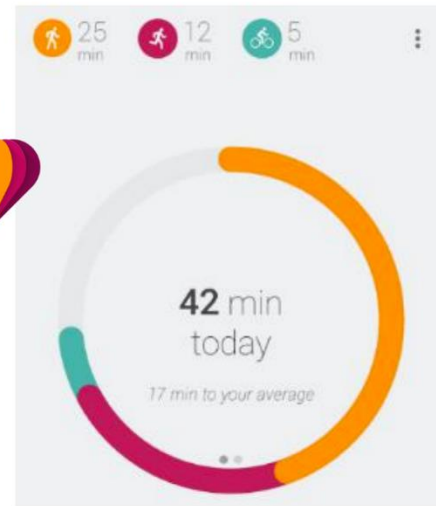
Moves: activity/place tracking

Accupedo: pedometer

Dieter: pedometer

Sandra: Goal & Research Questions

- E.g. Battery at 26%. User's typical questions:
  - How long will phone last from now?
  - What should I do to keep my phone alive until I get home?

- Users currently informed on well-known factors draining battery faster
  - E.g. frequent app use, long calls, GPS, brighter screen, weak cell signal
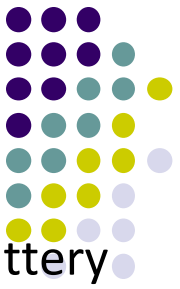
Sandra: Goal & Research Questions

- Users currently don't accurately include CSAs in their mental model of battery drain

  - CSA energy drain sometimes counter-intuitive
  - E.g. CSA drain is **continuous** but users think drain only during activity (e.g. walking)
  - Battery drain depends on activities performed by user

- Paper makes 2 specific contributions about energy drain of CSAs

  1. **Quantifies CSA battery impact:** Nonlinear battery drains of CSAs

  2. Investigates/corrects **user's incorrect perceptions** of CSAs' battery behaviors

Sandra: Goal & Research Questions

- **Battery information advisor (Sandra):**
  - Helps users make connection between battery drain (including CSAs) and their activities
  - Forecasts battery drain under different **future** mobility conditions
    - E.g. (stationary, walking, transport) + (indoor, outdoor)
  - Maintains a history of **past** battery use under different mobility conditions

First Step: Measure Battery Consumption of 4 CSAs

- **Google Fit:**
  - Tracks user activity continuously (walking, cycling, riding, etc)
- **Moves:**
  - Tracks user activity (walking, cycling, running), places visited and generates a storyline
- **Dieter:**
  - Fitness tracking app in Korea
- **Accupedo:**
  - Pedometer app

Energy Consumed by CSAs under different mobility conditions

- CSAs drain extra stand-by power

- Average increase in battery drain: 171% vs No-CSA

- Drains 3x more energy when user is walking vs stationary
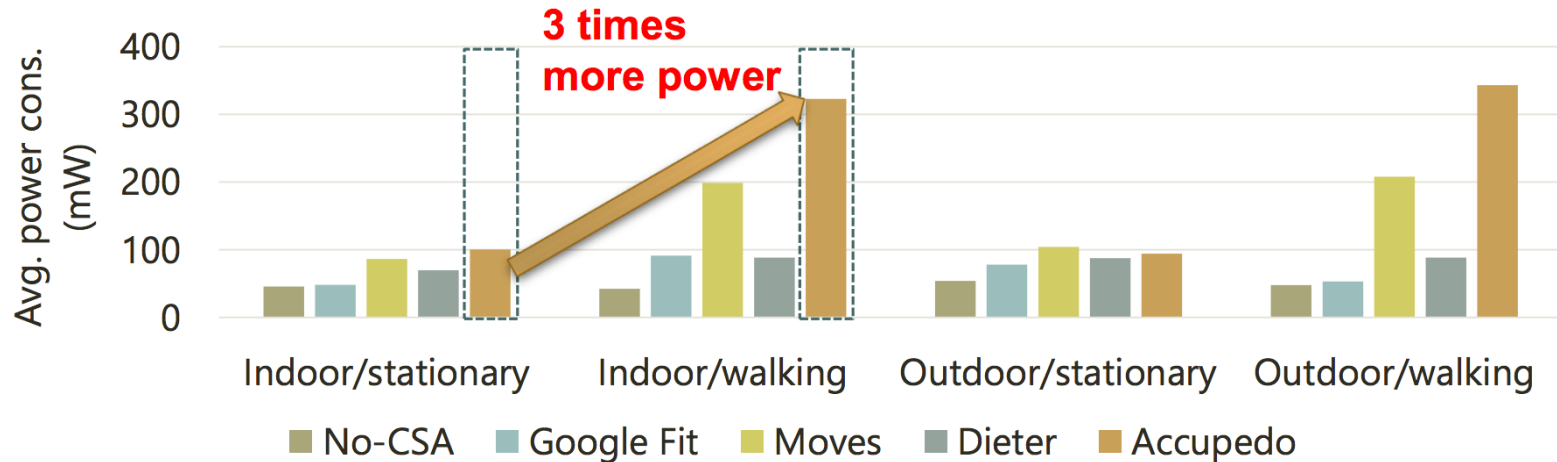
Day-long Battery Drain under real Life Mobility
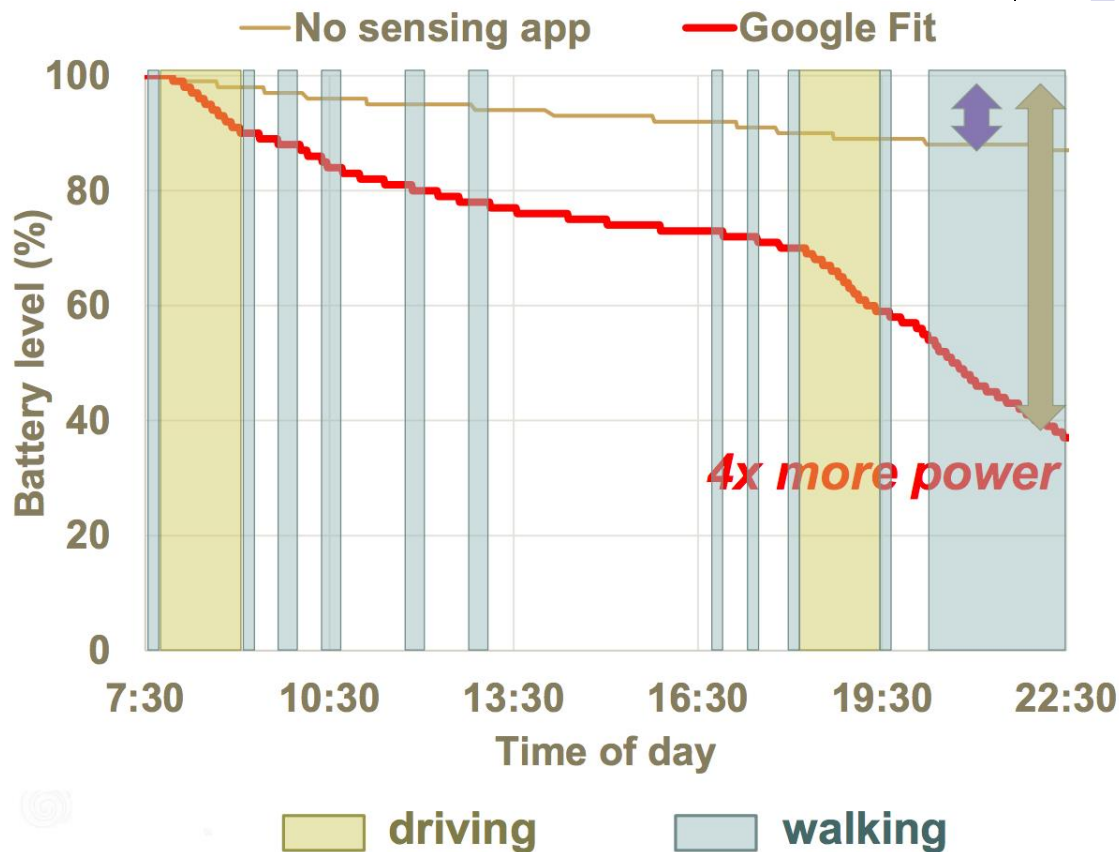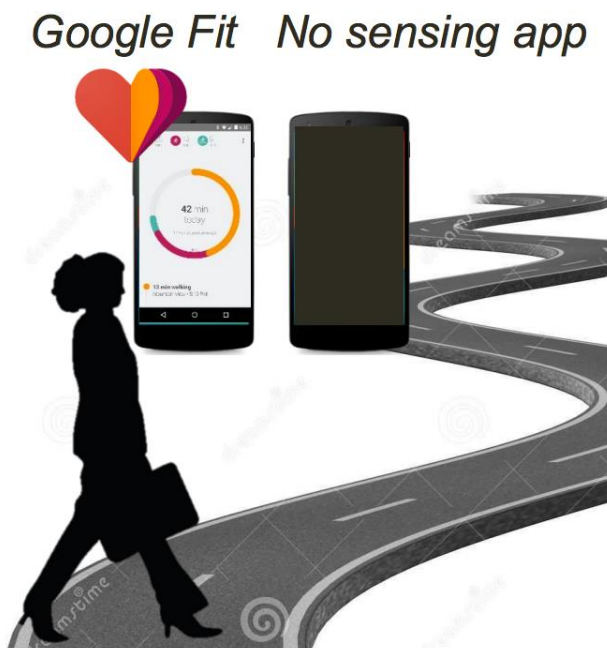
Also steeper battery drain when user is walking

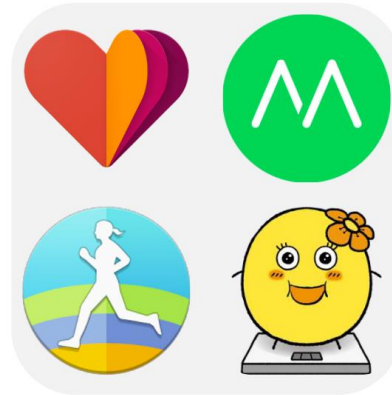**Users may focus on only battery drain caused by their foreground interactions**

Next: Investigate User perceptions of CSAs' Battery Consumption

24 participants   Sensing apps   1:1 Interview

- Interviewed 24 subjects to understand factors influencing phone's battery life

- Questions included:
  - Do you feel concerned about phone's battery life?
  - Have you suspected that CSAs reduce battery life?

Findings: Investigate User perceptions of CSAs' Battery Consumption

- Subjects
  - Already knew well-known sources of battery drain (display, GPS, network, voice calls, etc)
  - Felt battery drain should be minimal when phone is not in use
  - Were very concerned about battery life. E.g. kept multiple chargers in office, home, car, bedside, etc
  - Had limited, sometimes inaccurate understanding of details of CSA battery drain
  - Disliked temporarily interrupting CSAs to save battery life.
    - E.g. Users kill battery hungry apps, but killing step counter misses steps, 10,000 step goals

Sandra Battery Advisor Design

- **Goal:**
  - Educate users on mobility-dependent CSA battery drain
  - Help users take necessary actions in advance
- Sandra Interfaces show breakdown of past battery use
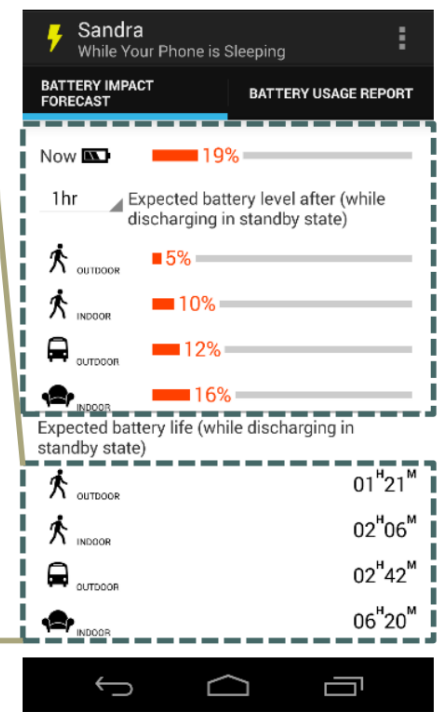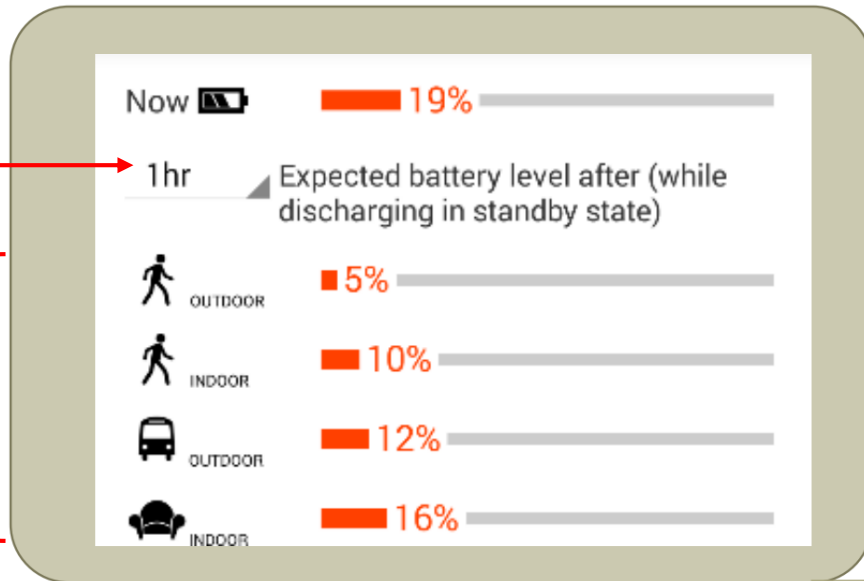- Battery usage information retrieved using Android system calls
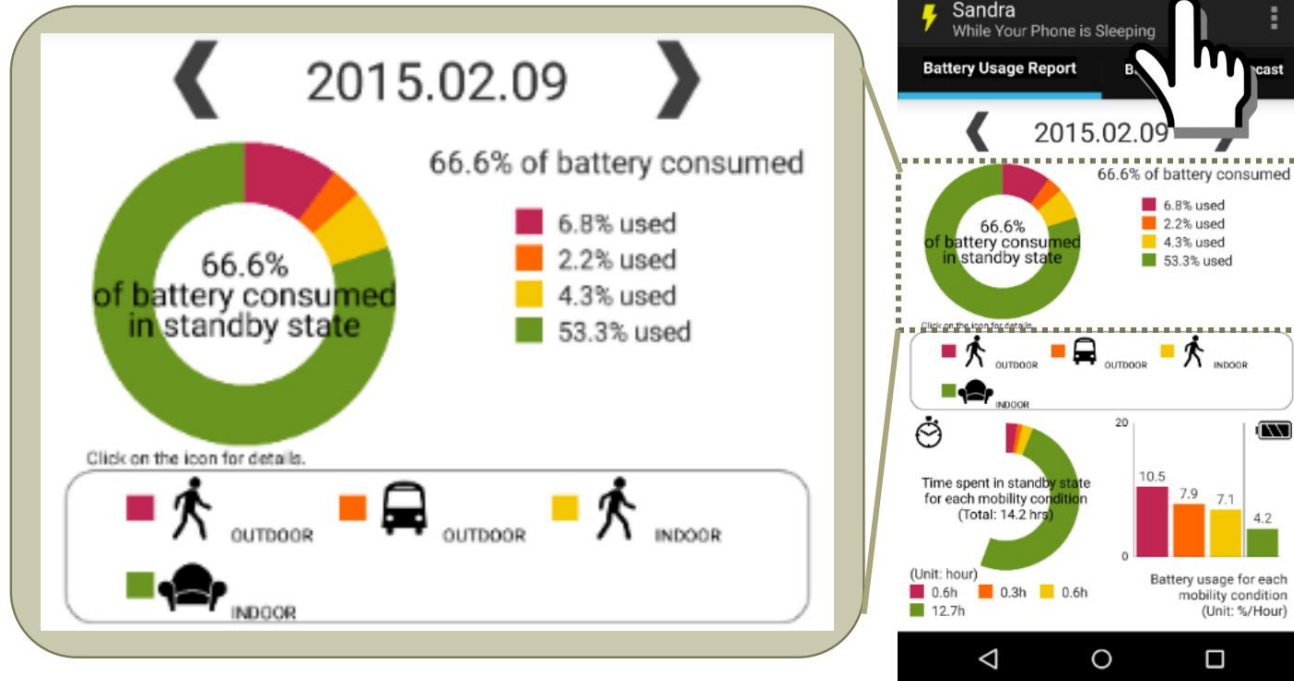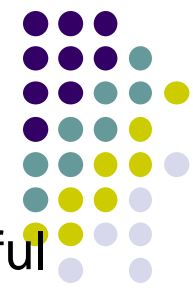
Sandra Battery Advisor Design

- Sandra interfaces that forecasts expected standby times for a commonly occurring mobility conditions
  - E.g. Walking indoors/outdoors, commuting outdoors, etc

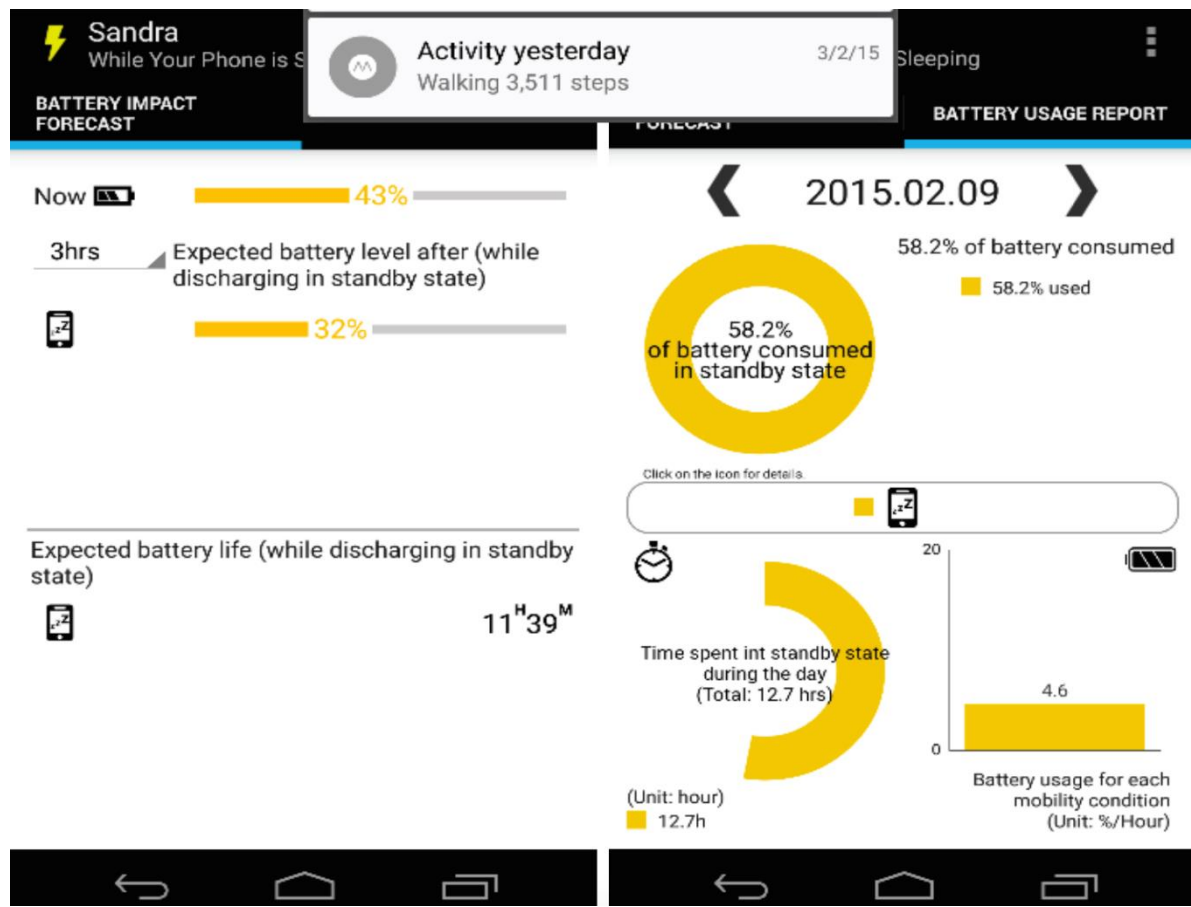Select different time intervals

CSA battery drain for different activities

Sandra Battery Advisor Design

- Sandra-lite version: investigate if mobility-specific details are useful
  - Less details
  - No mobility-specific breakdown of battery drain
  - Single standby life expectation

Forecast of Future

Breakdown of Past battery usage

Sandra Evaluation
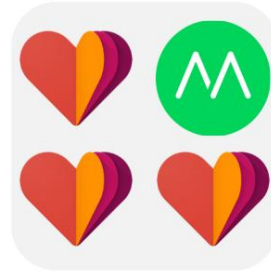
- Experimental Setup

24 participants   30-day deployment   18 Google Fit, 6 Moves   Real devices

- First 10 days Sandra just gathered information (no feedback)
- Last 20 days gave feedback (forecasts, past usage breakdown)
- Surveyed users using 2 questionnaires for using Sandra and Sandra-lite
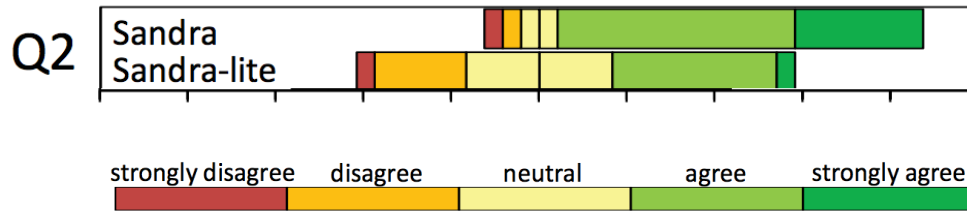 - 5-point Likert-scales (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

Sandra Evaluation

- Q1: "Did it bring changes to your existing understanding about your phone's stand-by battery drain? "

- Q2: "Do you think the provided information is useful"

Sandra vs Sandra-lite: Mobility-aware battery information of Sandra increased users' existing understanding(p-value 0.023)
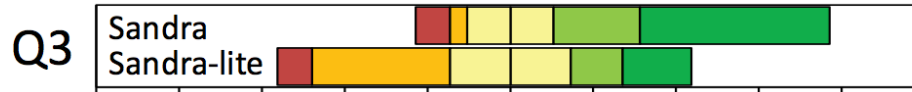

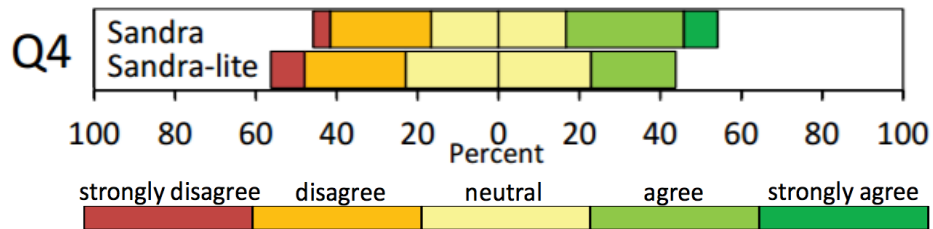Realizing that the phone consumes different power

Sandra Evaluation

- Q3: "Did you find it helpful in managing your phone's battery?"

- Q4: "Did you find it helpful in alleviating your battery concern?"

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

Acquiring
new everyday practices:
Turning off GoogleFit on driving

Feeling less nervous
under limited battery:
Before sleeping