Mobile Application (Design and) Development

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Welcome!

- Goals of this course:
  - Help you learn about mobile app development and best practices
  - Help you learn about mobile interaction design and rapid prototyping strategies
  - Provide you with the tools, knowledge, and excuse to create a **novel** mobile app that helps solve a serious problem that strengthens your programming portfolio

Who am I?

- BSE in CSE from Penn
- Ph.D. from MIT (computer vision)
- "Home of the Future" and architects
- Health and House_n
- Northeastern! (Sep 2011)
  - New Ph.D. Personal Health Informatics)
  - Interests: mobile health, games for health, mobile and home sensing and pattern recognition, UI design, AI

Mobile Applications

- What are they?
  - Any application that runs on a "mobile device"
- Types (and evolution)
  - Web apps: run in a web browser
    HTML, JavaScript, Flash, server-side components, etc.
  - **Native: compiled binaries for the device**
    Not cross-platform, but more interesting options
- **This class: Android phones**

Native development environments

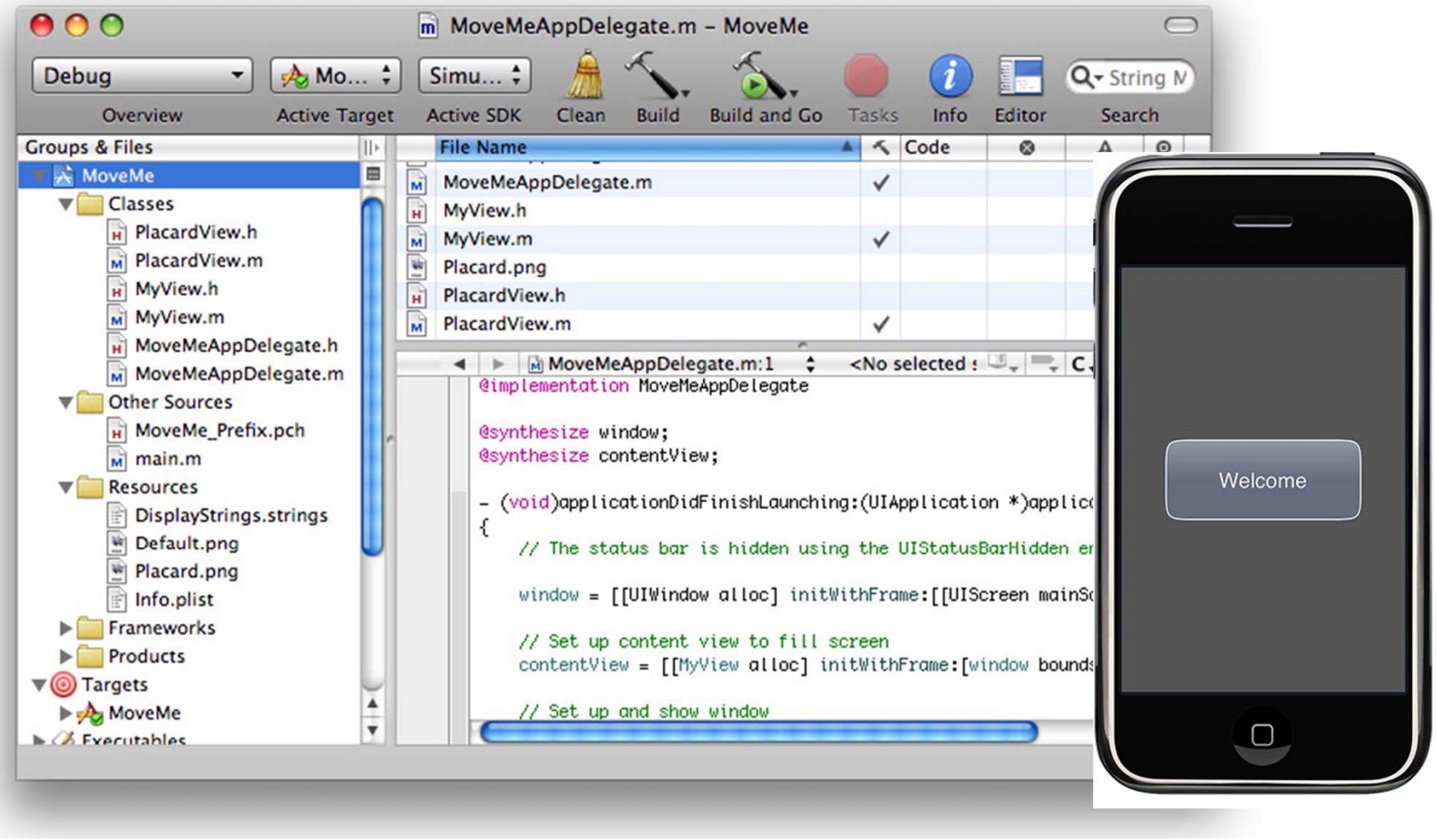
- Options
  - Java ME
  - .NET Compact Framework (C++, C#, VB.NET) for Windows Mobile
  - Qualcomm's BREW (C or C++)
  - Symbian (C++)
  - BlackBerry (Java)
  - Android (Java)
  - iPhone (Objective-C)

Is having so many choices and so much industry turmoil/competition a good thing?

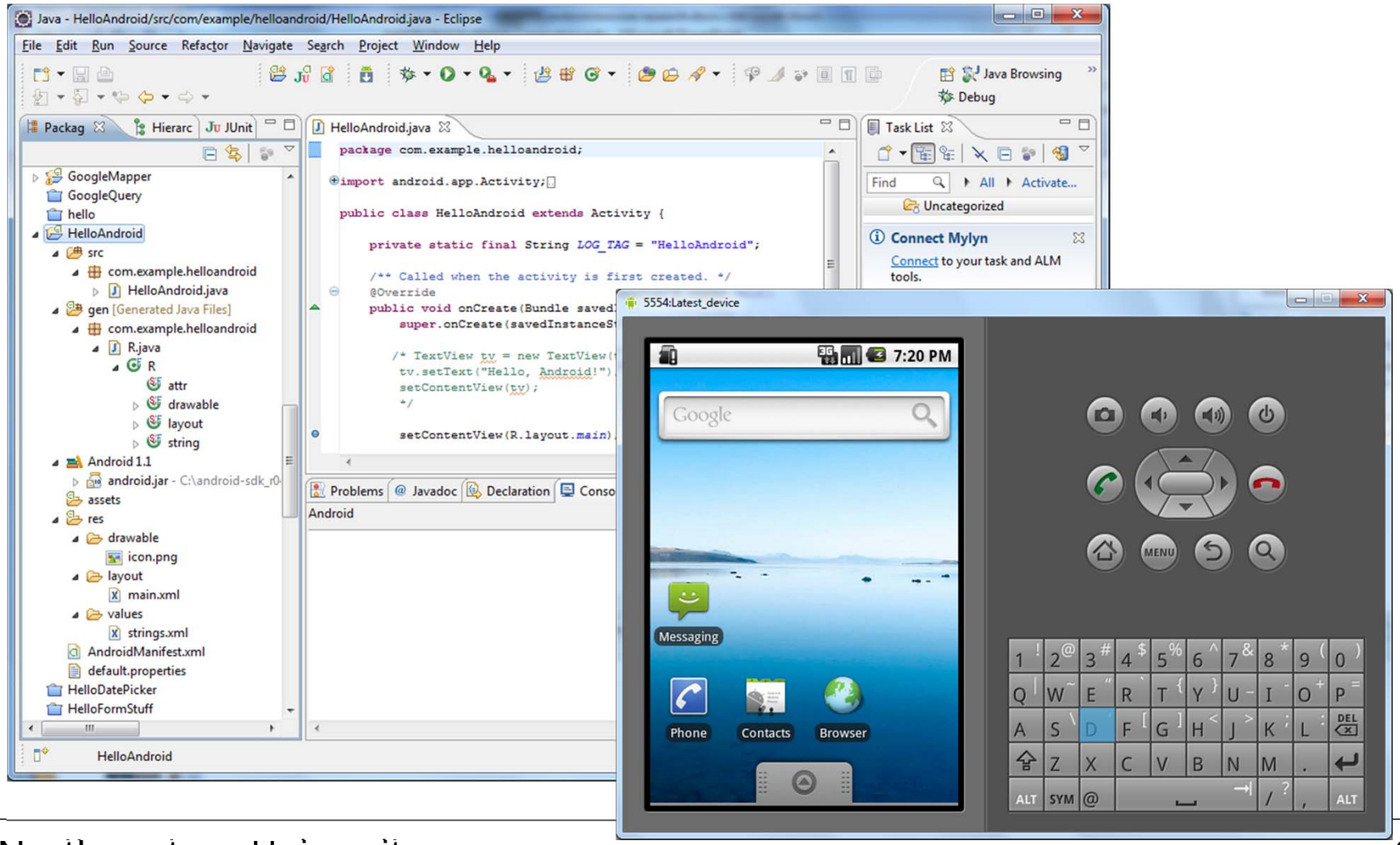
Development Environments

- Most platforms have an SDK that you can download and build against
- Every platform has an emulator that you can use to test your apps
- Most emulators are configurable to match a variety of mobile devices
  - Various screen sizes, memory limitations, tablets, etc.
  - In practice, emulators quite limited

xCode IDE & iPhone Emulator



Eclipse and Android Emulator



Why a special course?

- There is a **growing demand** for experts
- **Mobile computing is transformative**
- It's **easier to learn** with a group
- Mobile app interaction design offers **unique challenges and opportunities**

Mobile devices – the good

- **Always with the user**
- Increasingly powerful devices
- Typically GPS capable
- Typically have accelerometer
- Designed for communication
- 2+ types of wireless connections
- Many apps are free or low-cost

Mobiles – the not-so-good

- Limited processor speed
- Limited battery life
- Limited and slow network access
- Limited screen size
- Limited or awkward input
  (none great: soft keyboard, phone keypad, touch screen, stylus, speech)
- Inconsistent platforms across devices
- Warning: Blackberry thumb

Primary design challenges

- Short bursty interactions
- User expectations for simplicity
- Interruptions!
- Limited input modality
- Data reliability (and multiple points of desired data access)
- Standing out in a crowd
- Aggressive operating systems
- In the future: security/privacy

How will the course work?

- 7 week, intensive, immersive Android programming experience. Are you ready?
- Focus on both **DESIGN** and **DEVELOPMENT**, with some user testing thrown in.
- Syllabus (in progress) online: http://www.ccs.neu.edu/home/intille/teaching/MobileApplicationDevelopment2011Syllabus.htm

Project

- Sudoku
- Boggle
- Something that helps people with health behavior change that is addictive, innovative, and useful and uses the phone's unique capabilities ... that is designed by you and turns heads

Project contest

- Everyone in the class will try/critique apps from other teams
- At end of the course we will vote for the Top App, along with a small group of invited expert judges
- Small prize awarded and bragging rights

More on project options

- Plug-in for the CITY project
- Innovative use of motion sensor for encouraging physical activity or less sedentary behavior

  (Advanced: could use Wockets)

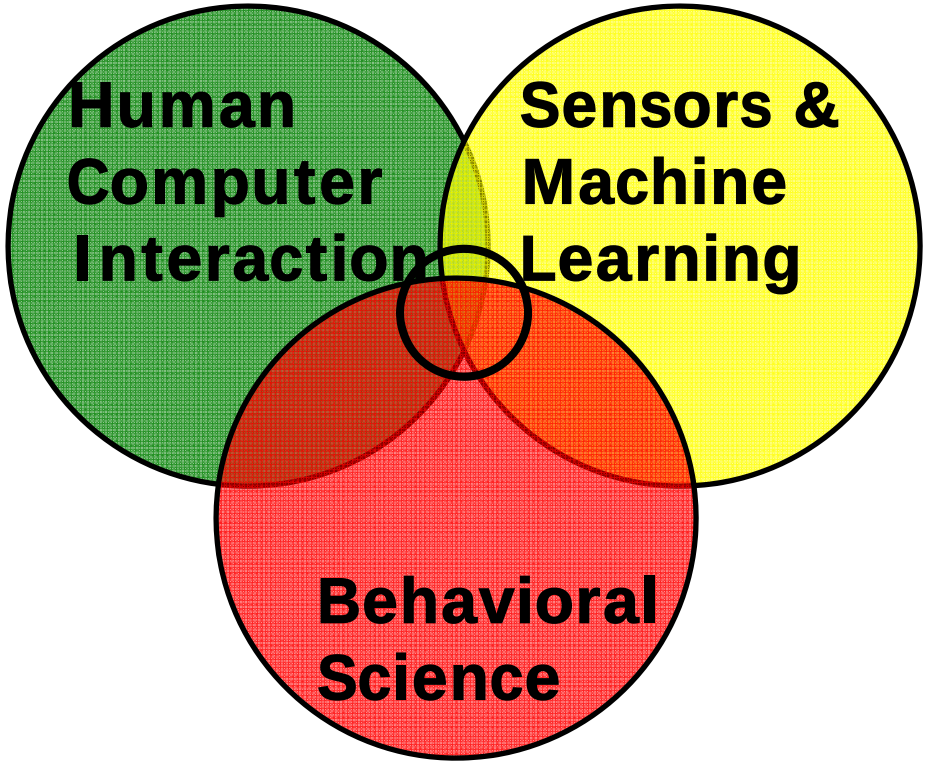
Demo: CITY App

- http://www.dukecitystudy.org

Let's start thinking creatively...

- **Timing of delivery of tailored information** important for behavior change
- Mobile devices with real-time feedback create novel (and engaging?) options that *can't be achieved without the technology*
- There are some design and technical challenges, but they can be overcome with more research

Opportunity



Leverage:
Consumer electronics
Mobile technologies

Focus:
Body
Home
Workplace
Community
} **Personal**

Big opportunities at the intersection using real-time, cost-effective feedback … Some "killer apps" yet to be built.

Engineering getting closer...

- Phone sensors
  - Accelerometer
  - GPS
  - Others...
- Wearable sensors
  - Wockets (accelerometers)
  - Heart rate monitors
- Self-report on phone

machine learning algorithms

- Physical activity
  - Activity type
  - Intensity
  - Duration
  - Location
- Other behaviors
- Physiological state
- Self-reported state

health applications

Detect **change** in activity;
Motivate behavior changes;
Info at teachable moment

Inspiration

- Suppose a person visits the doctor and the doctor recommends more physical activity

- Scenario 1:
  - Doctor gives a lecture with suggestions
  - Hands out some reading material

- Scenario 2:
  - Person hires a (good) personal trainer

Inspiration

Timing of information delivery is powerful & could dramatically improve intervention

- Scenario 1:
  - Doctor provides a pedometer
  - At end of a day, 1500 more steps to goal
- Scenario 2:
  - Doctor provides "just-in-time" phone app
  - *When walking*, notifies 1500 more steps to goal

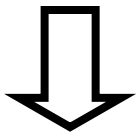
New opportunity

- Context-sensitive just-in-time content delivery at points of decision, behavior, or consequence [Fogg 99]

- Exploit the sensor-enabled mobile devices and personal computers people are acquiring for entertainment and communication ... and their sensing and processing power

Strategy

- Simple messages
  (points of decision/behavior/consequence)
- Right time ← Requires computational sensing
- Right place ← Requires portable computing
- Tailored, non-disruptive ← Requires attention to interface design
- Repeated and consistent ← Requires patience
  (computers excellent at this)



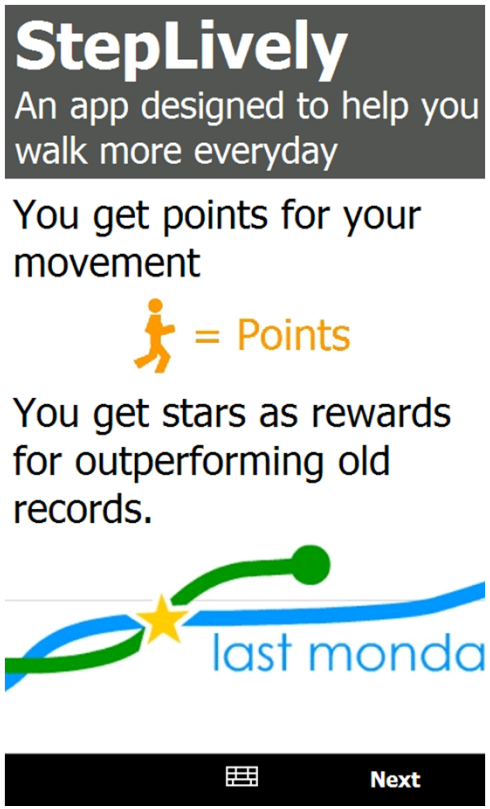
- Impact on behavior change?

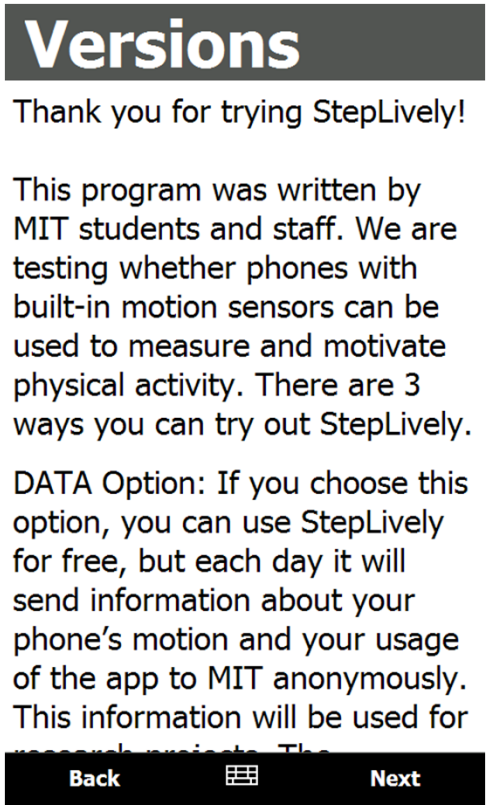
Does just-in-time work?

Example 1: StepLively

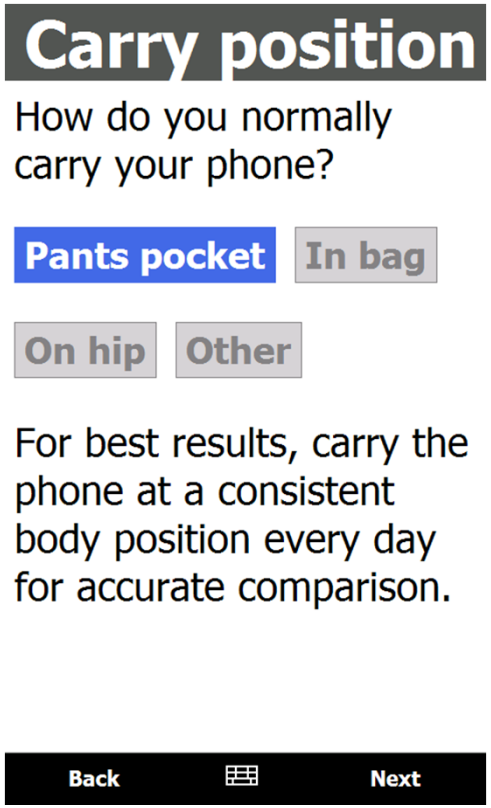
- Based on operant conditioning
- Uses positive, just-in-time reinforcement
- Multi-level (day, week) goal setting against own behavior that is continuously and automatically measured using phone motion sensor
- Provides pleasant audio reinforcers based on **current behavior**

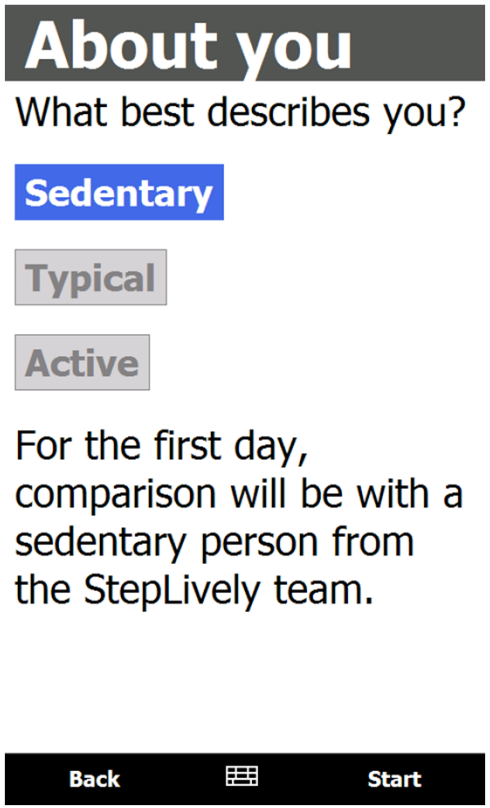
Standard phone app (Windows Mobile 6.x version)

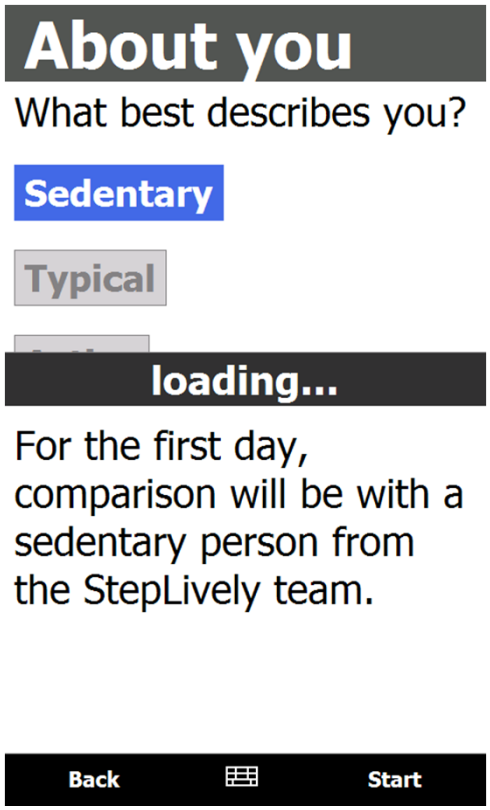




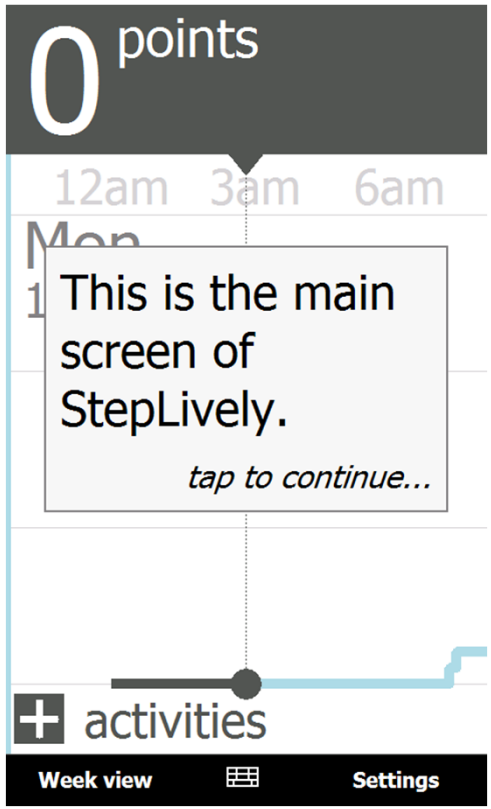
Simple startup

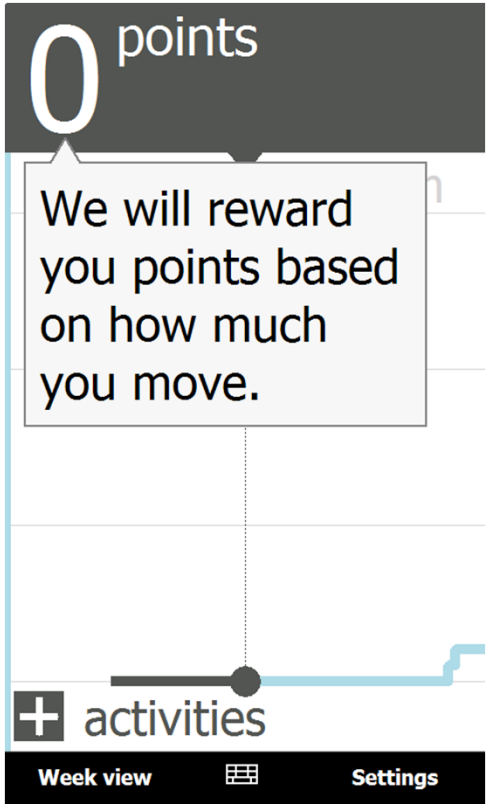


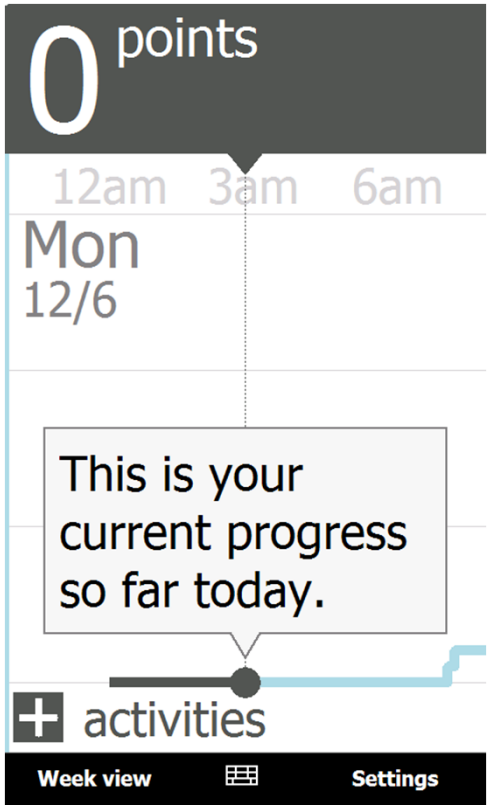




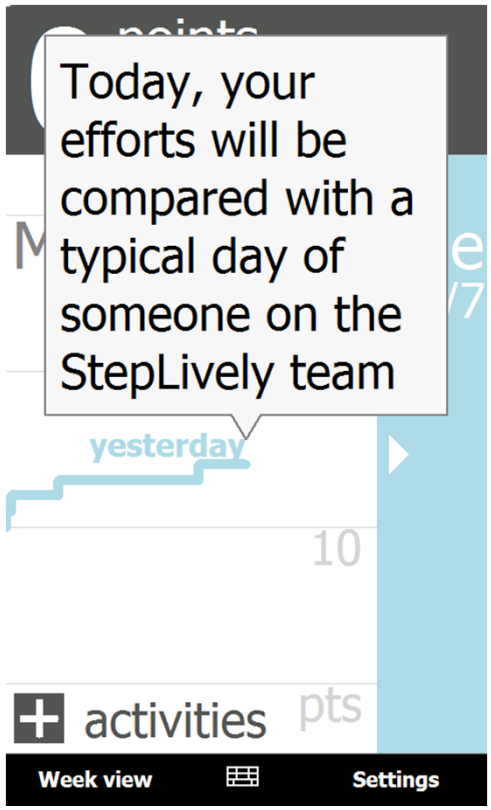
Tutorial

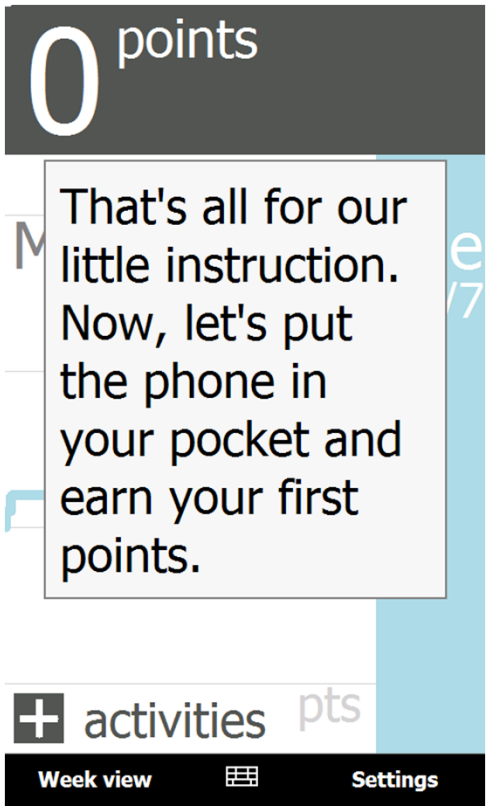

0 points
12am 3am 6am
This is the main screen of StepLively.
tap to continue...
activities
Week view
Settings


0 points
We will reward you points based on how much you move.
activities
Week view
Settings

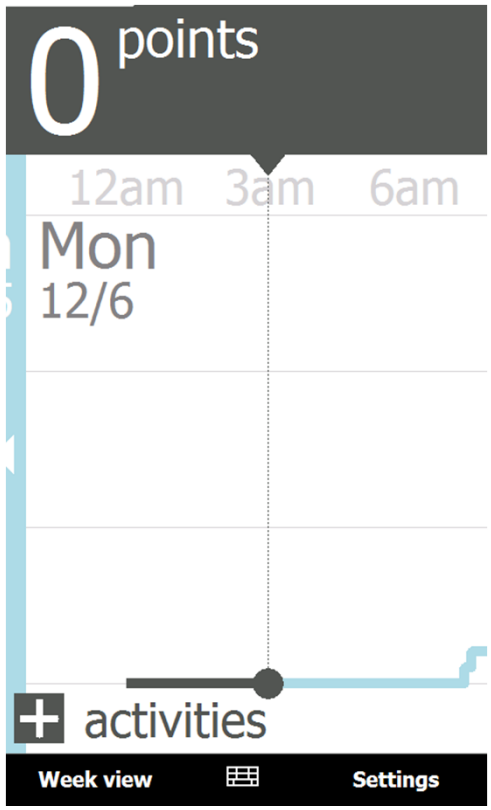

0 points
12am 3am 6am
Mon
12/6
This is your current progress so far today.
activities
Week view
Settings

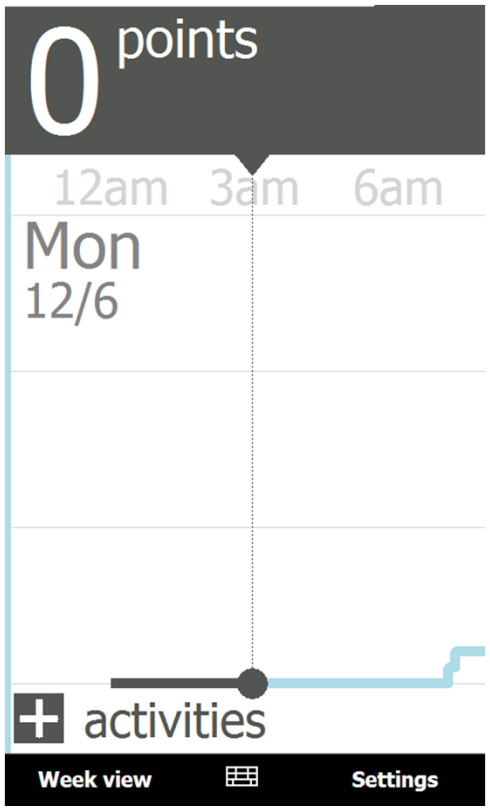
Tutorial


Today, your efforts will be compared with a typical day of someone on the StepLively team
yesterday
10
activities
pts
Week view
Settings

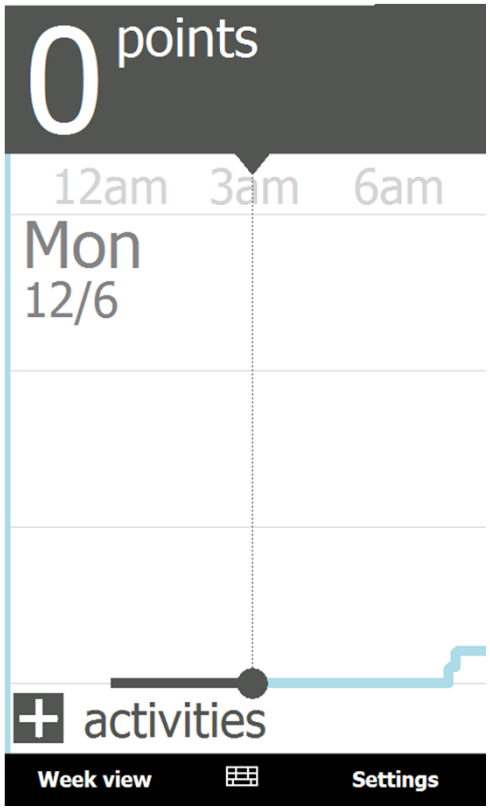

0 points
That's all for our little instruction. Now, let's put the phone in your pocket and earn your first points.
activities
pts
Week view
Settings

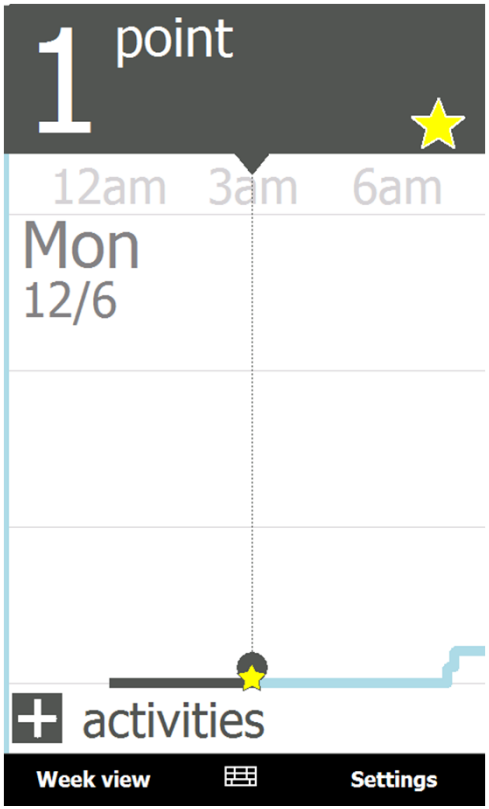
Starting motion (grad student at 3AM!)





Moving … eventually get point

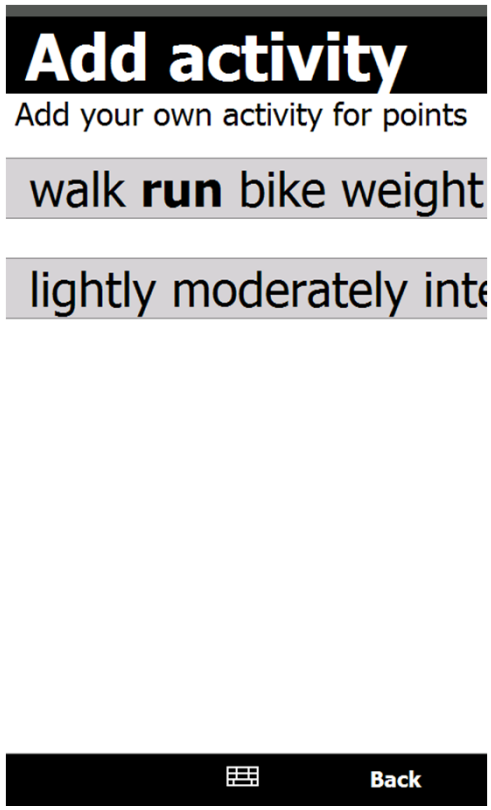


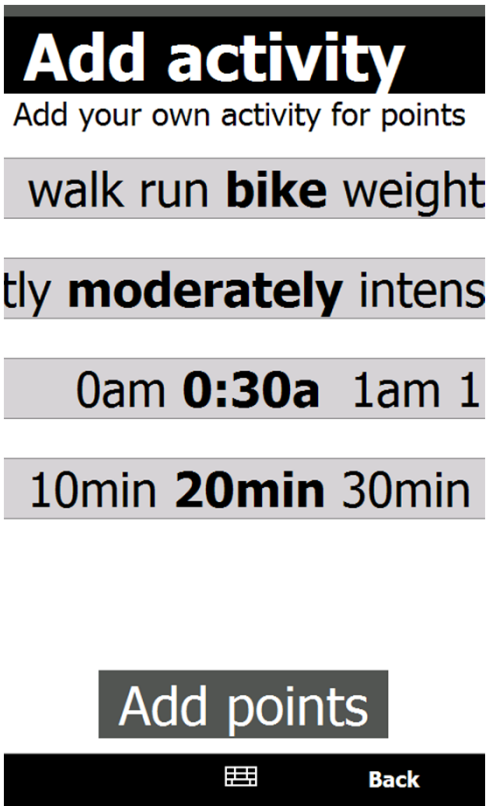


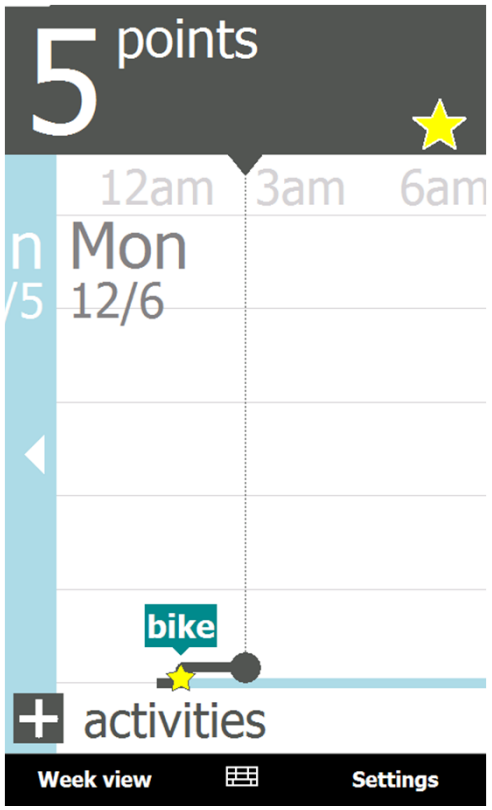
No movement at 3AM from prior time so "get ahead" and receiver reinforcement (sound + star)

Goal: say ahead of the past

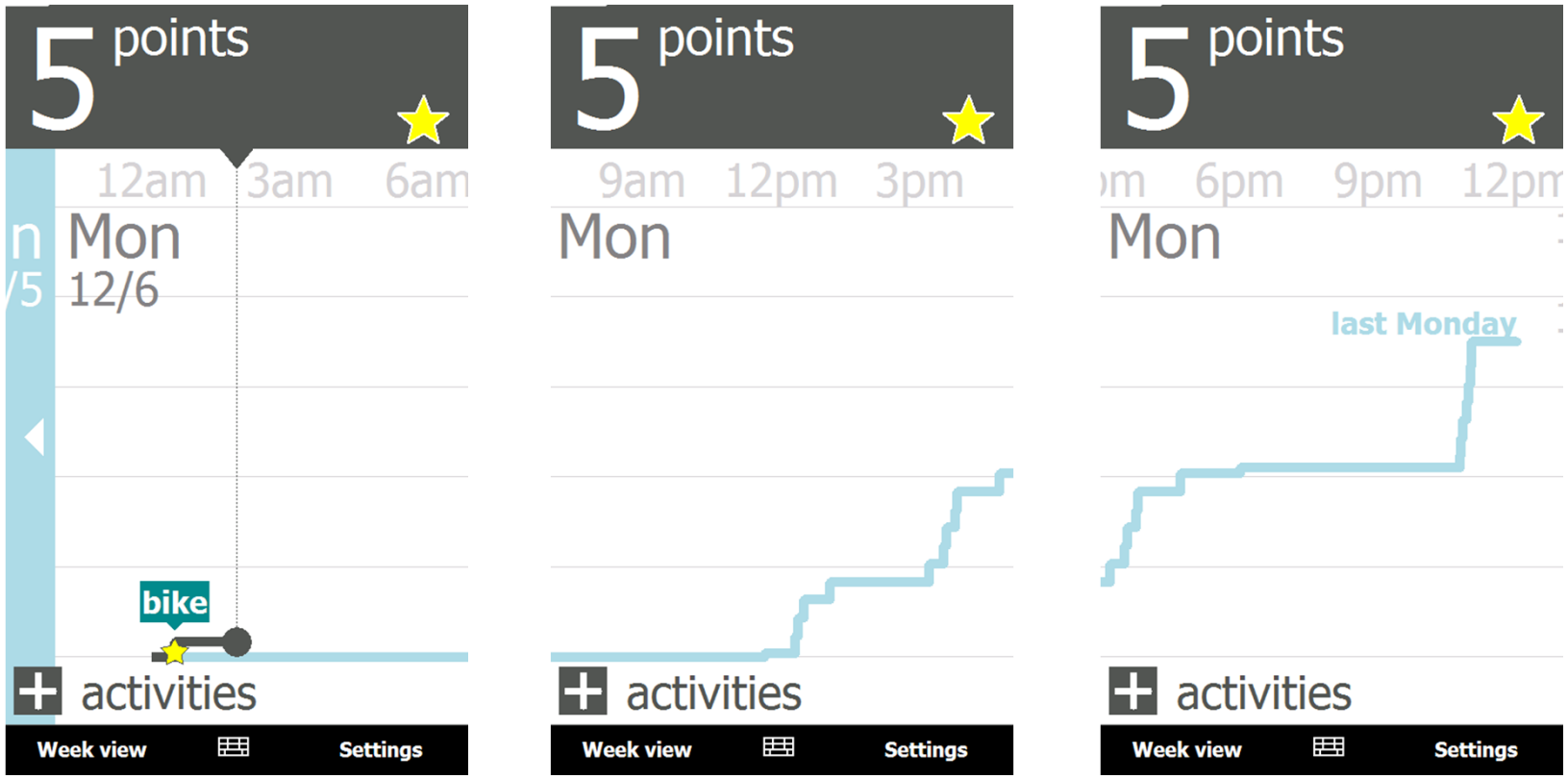
Fill in gaps via self report



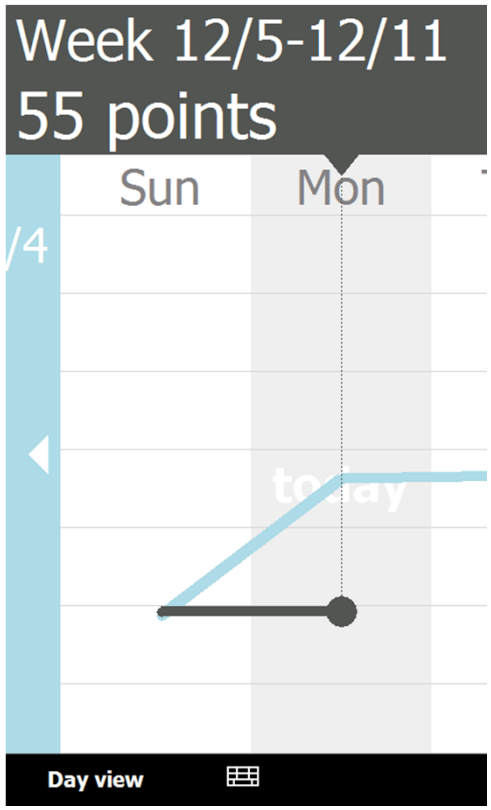


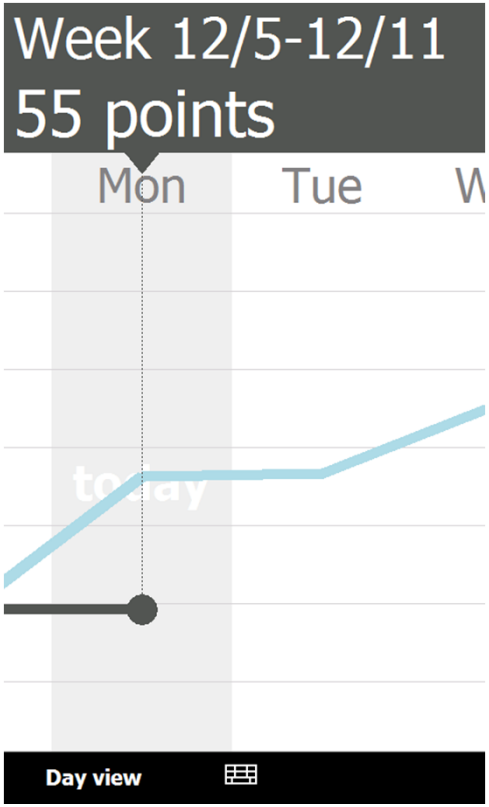


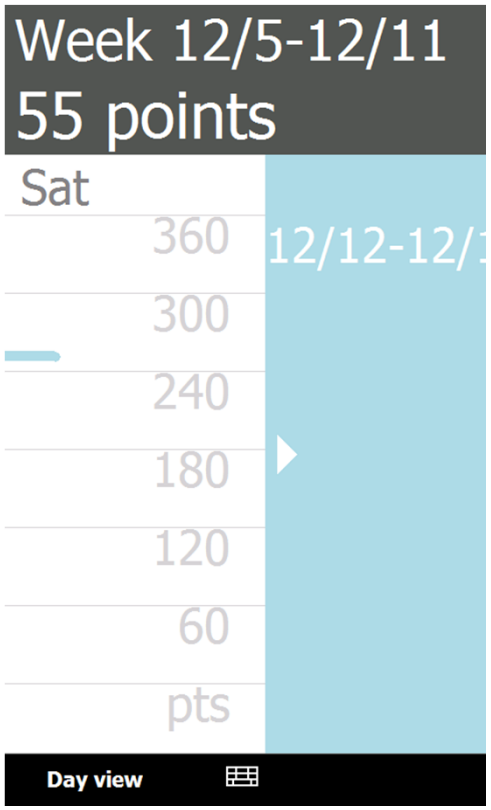
Navigate to see goal



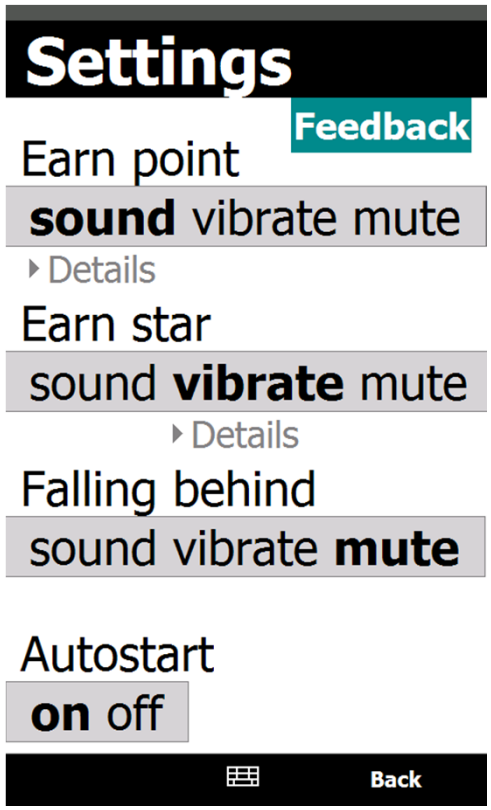
Day goal and week goal (then reset)

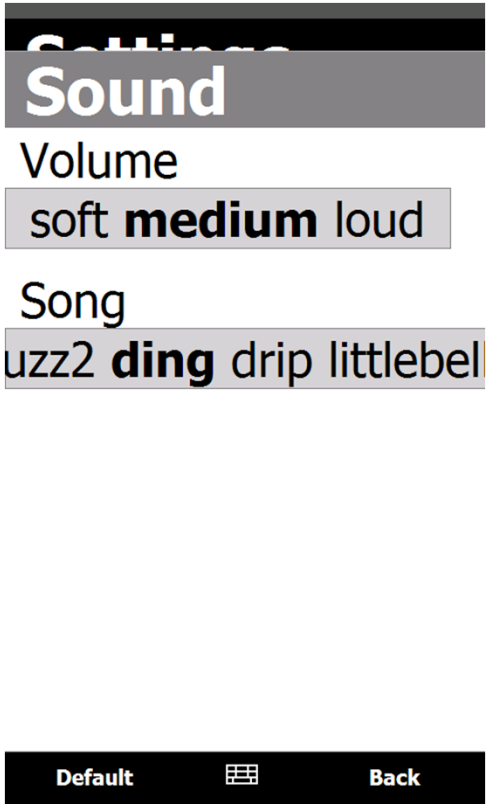


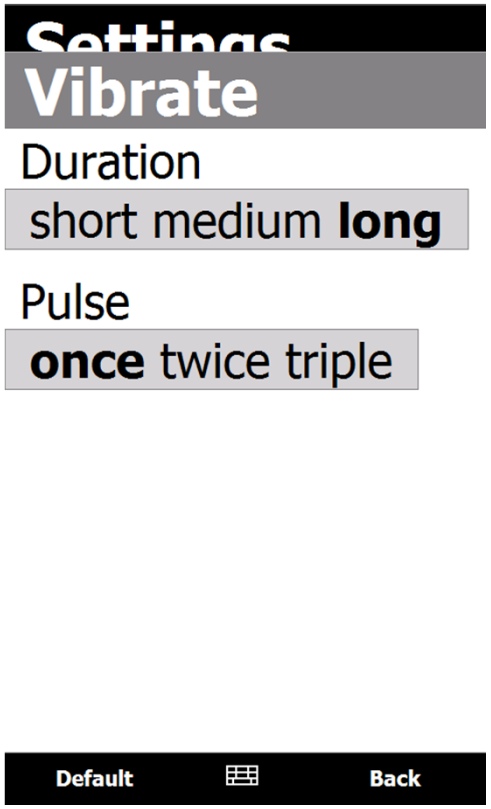




Customize reinforcement



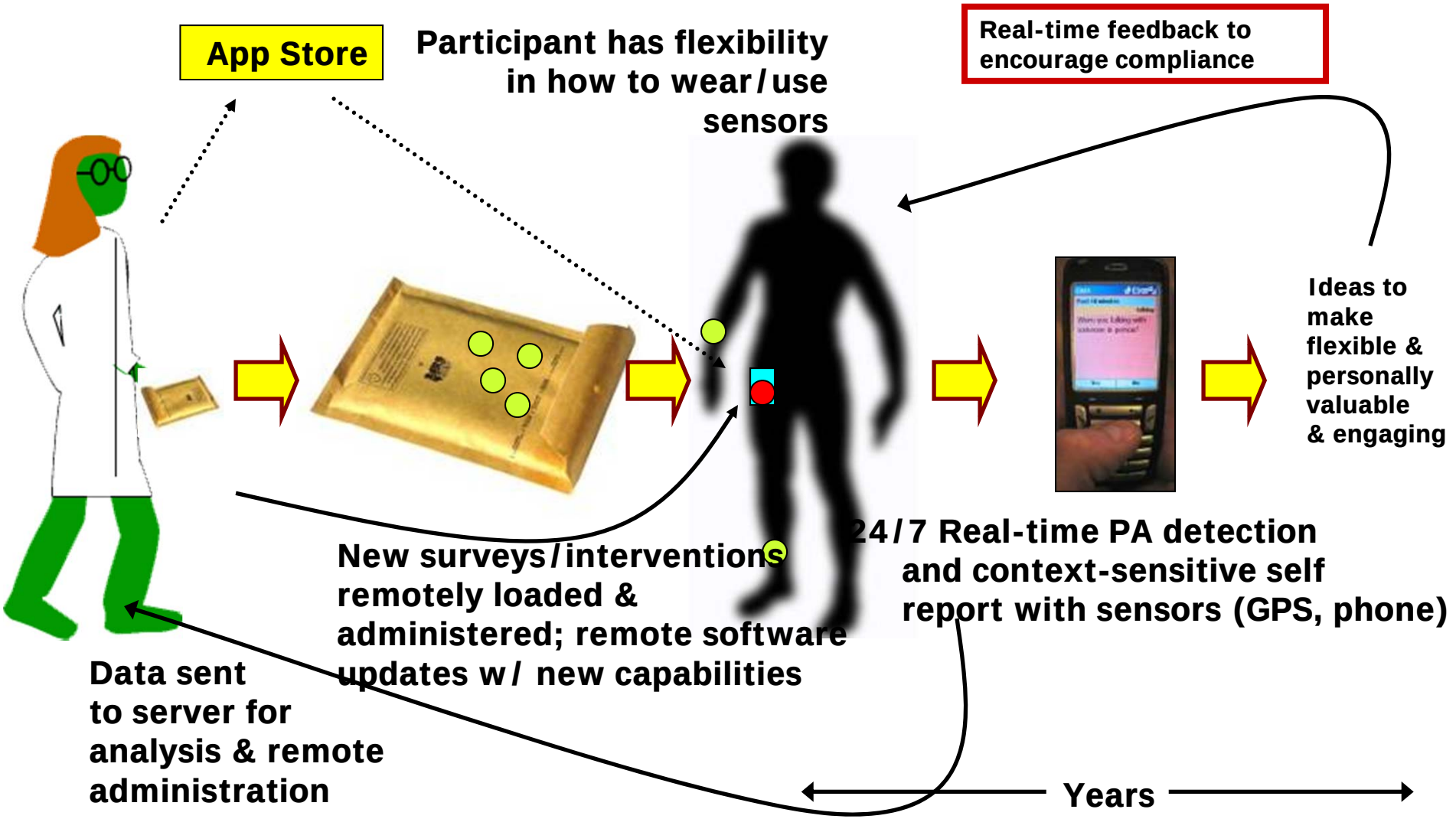




Example 2: Wockets

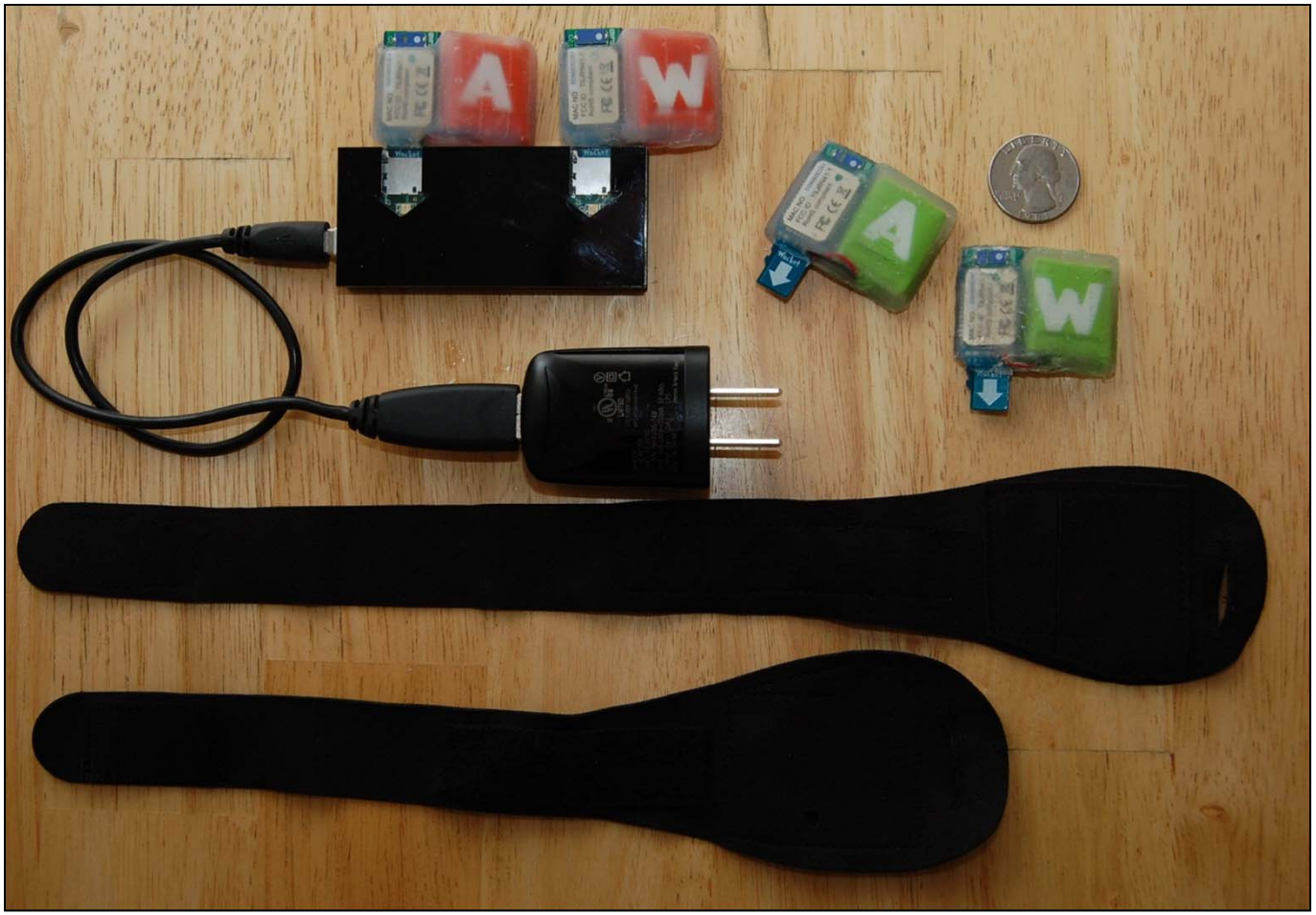
- Goal
  - 24/7 measurement of physical activity of
    - Type
    - Intensity
    - Duration
    - Location
  - For months+
  - Keep cost low so suitable for cohort studies
    - Exploit consumer phone technologies
    - All open source

Vision: population-scale



Wocket "kit" (+ phone)

Charge 2



Wear 2 for 24h

Upper + lower body motion

Thin for continuous wearability

Usability critical

WRIST AND ANKLE BAND DESIGN

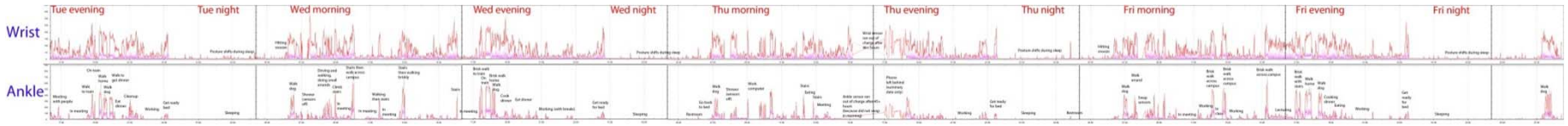


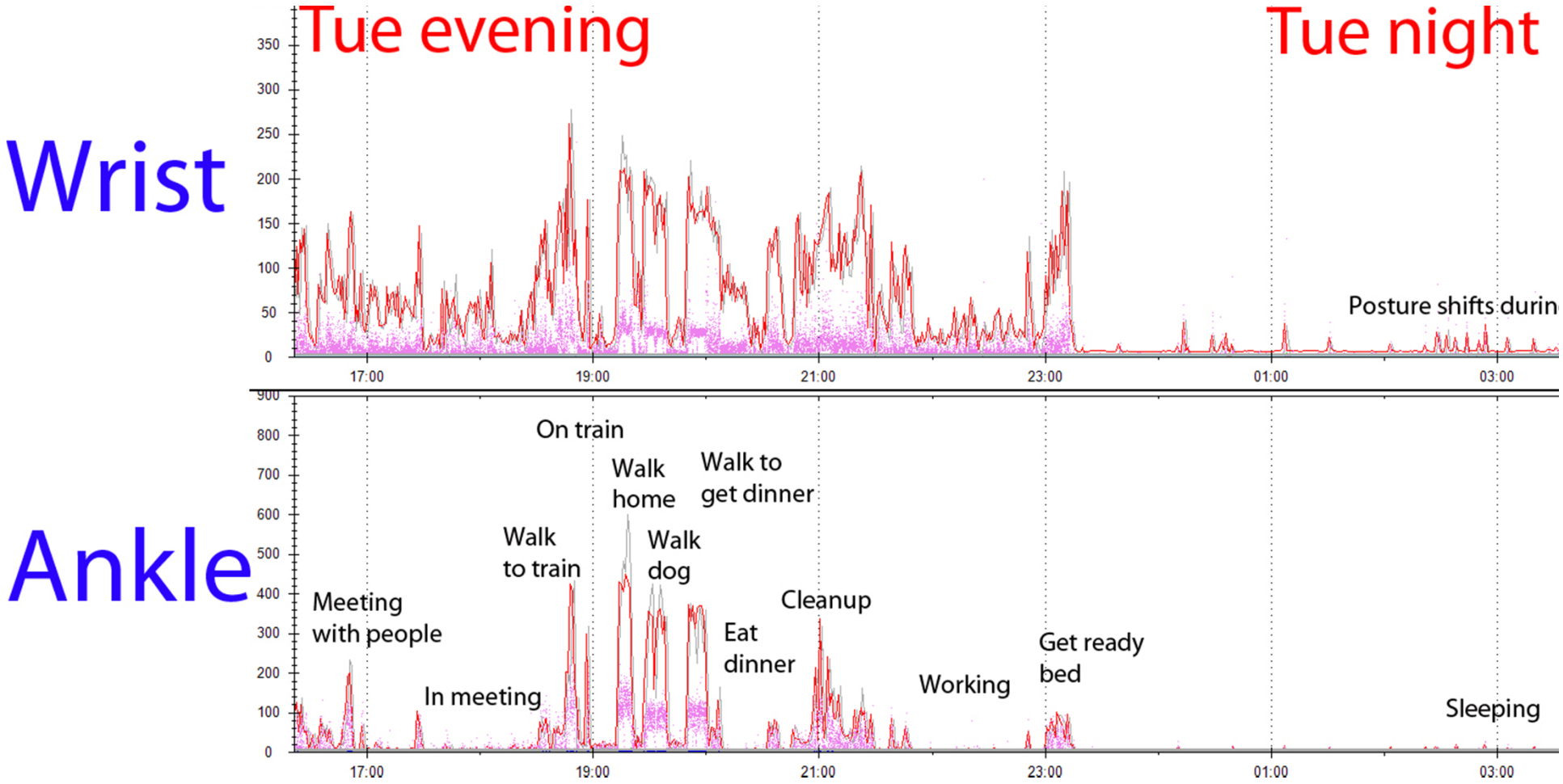

POCKET BAG DESIGN



Continuous data collection

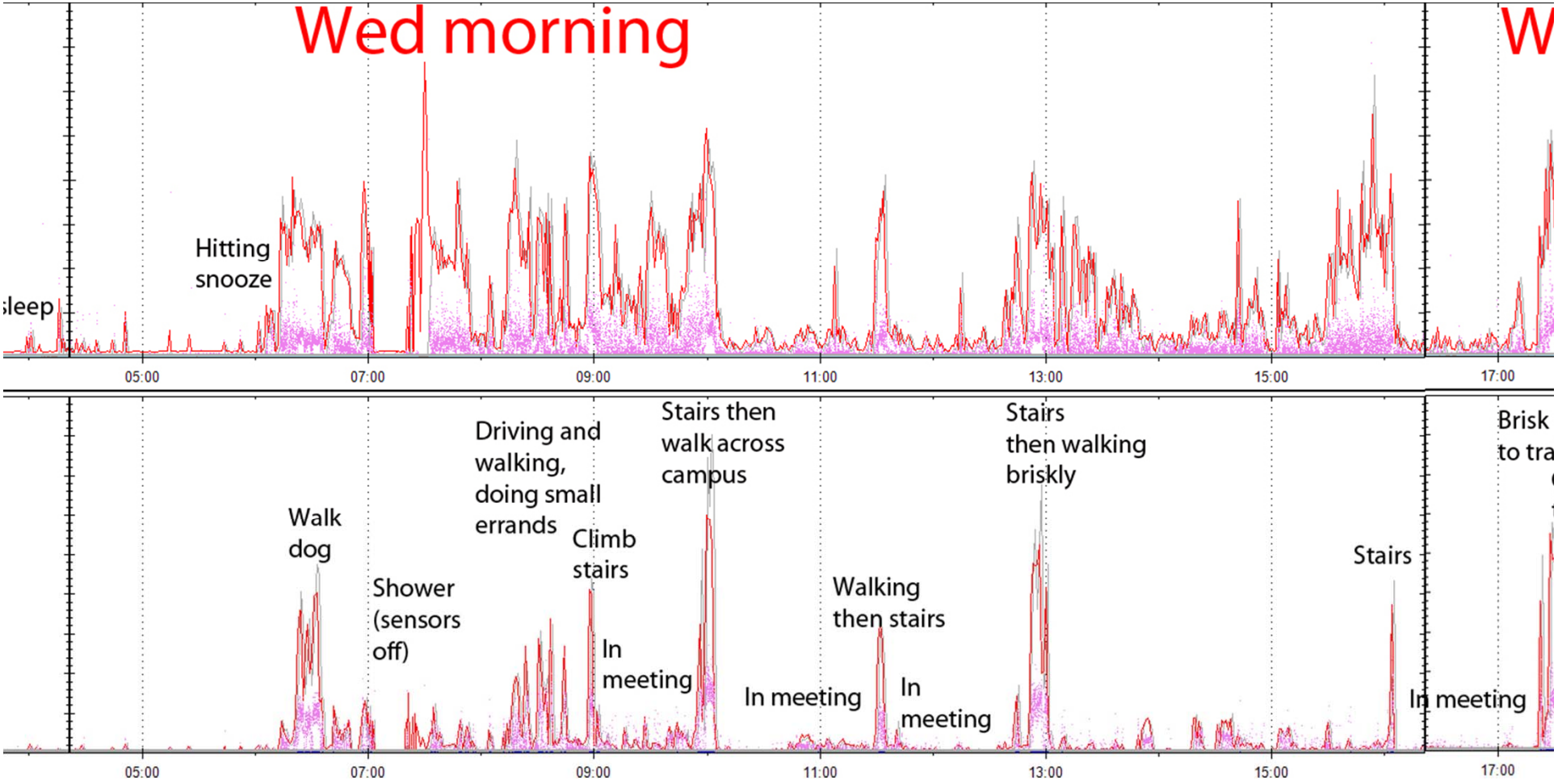
- 2 sensors wearing, 2 charging
- Summary data sent hourly to server
- Plug phone nightly (uploads raw data)
- Wockets last 42+ hours, phone waking day
- Phone detects data quality & missingness in real time and provides feedback to encourage study compliance

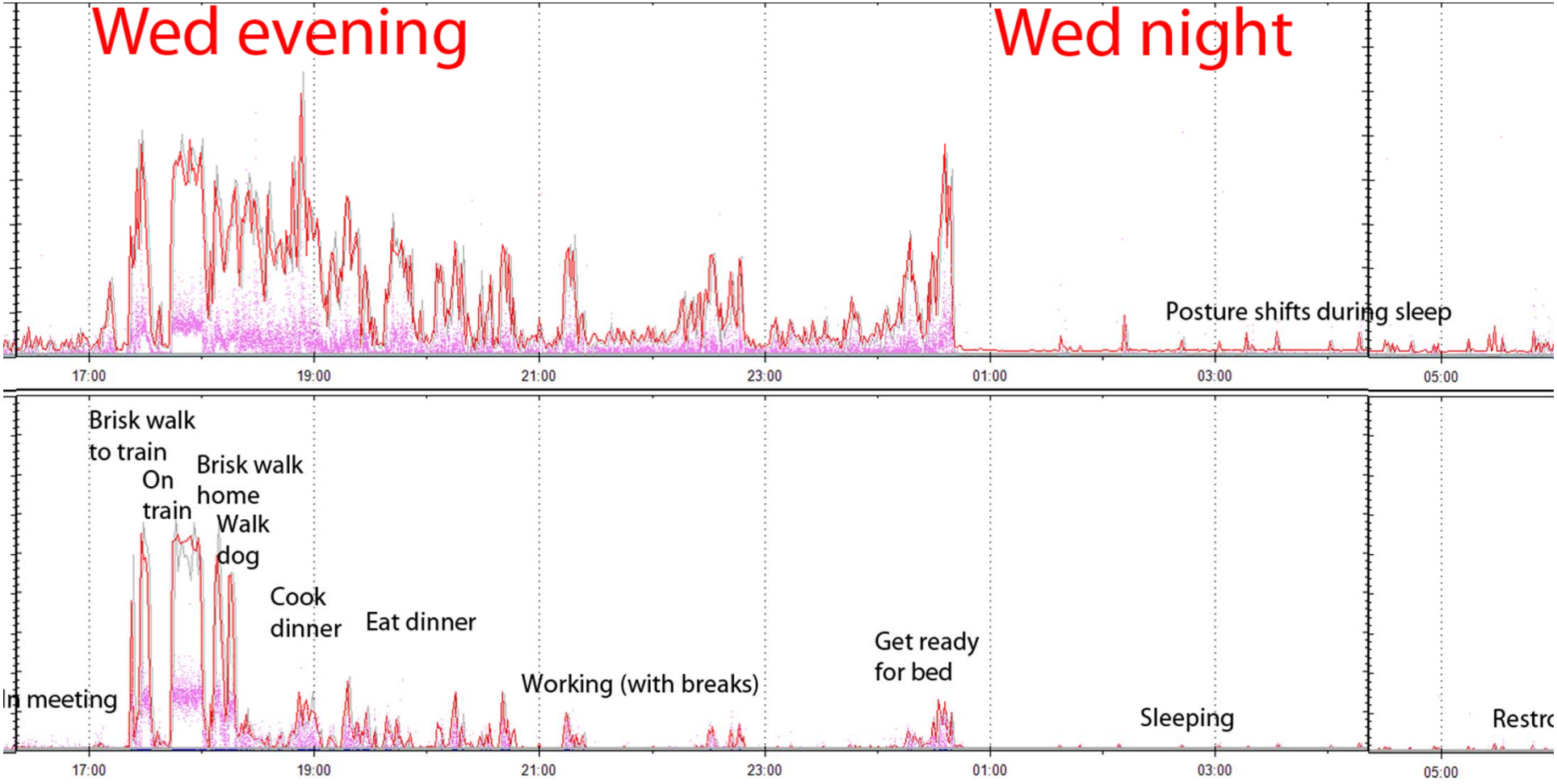


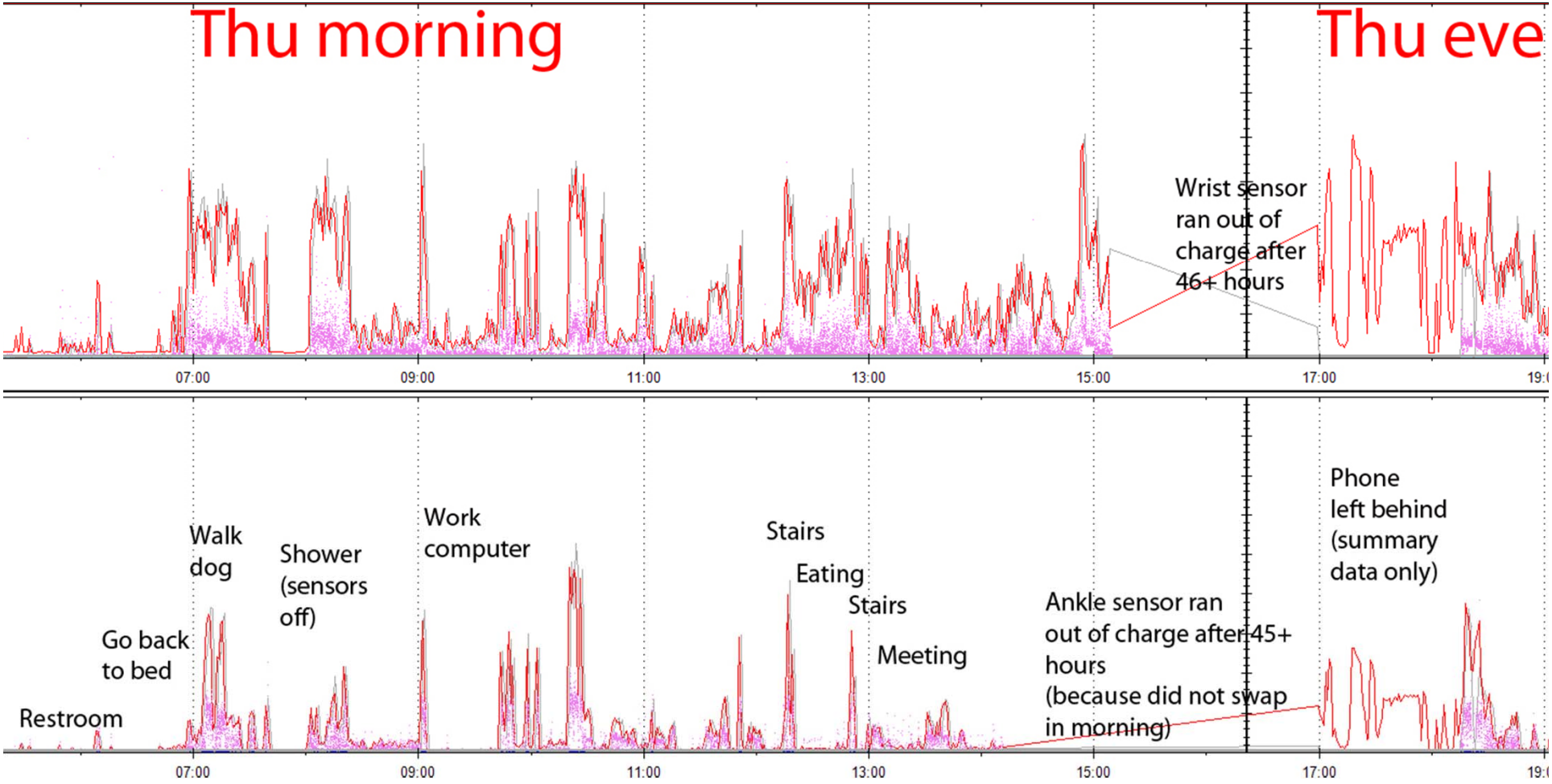


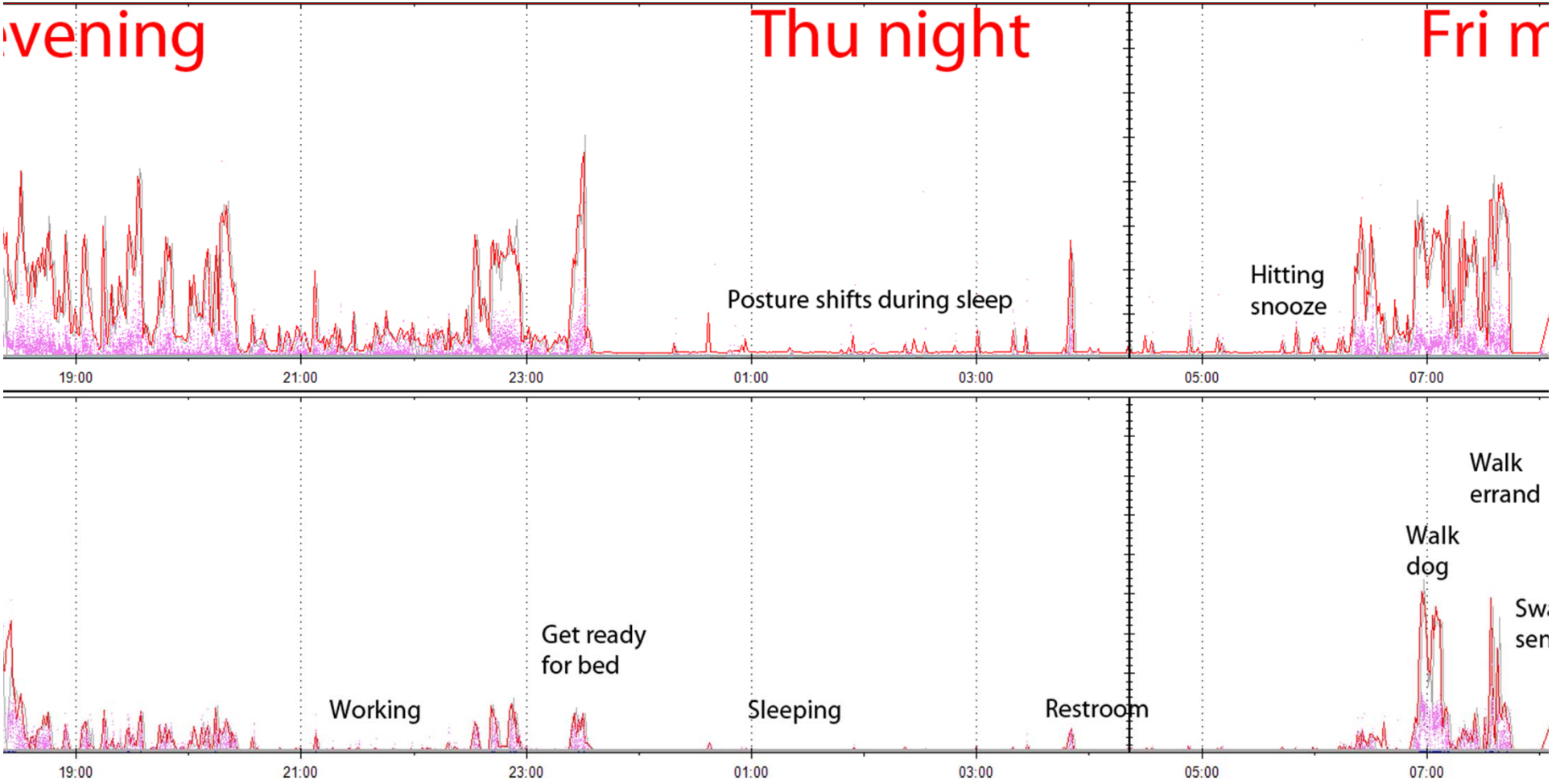
Note: Activities manually labeled ...

Working on real-time detection of some activity types and context (posture, ambulation, structure exercise, etc.)


Wed morning
W
sleep
Hitting snooze
05:00
07:00
09:00
11:00
13:00
15:00
17:00
Walk dog
Shower (sensors off)
Driving and walking, doing small errands
Climb stairs
In meeting
Stairs then walk across campus
In meeting
Walking then stairs
In meeting
Stairs then walking briskly
Stairs
In meeting
Brisk to tra


Wed evening
Wed night
Posture shifts during sleep
17:00
19:00
21:00
23:00
01:00
03:00
05:00
Brisk walk to train
On train
Brisk walk home
Walk dog
Cook dinner
Eat dinner
Working (with breaks)
Get ready for bed
Sleeping
meeting


Thu morning
Thu eve
Wrist sensor ran out of charge after 46+ hours
07:00
09:00
11:00
13:00
15:00
17:00
Restroom
Go back to bed
Walk dog
Shower (sensors off)
Work computer
Stairs
Eating
Stairs
Meeting
Ankle sensor ran out of charge after 45+ hours (because did not swap in morning)
Phone left behind (summary data only)
07:00
09:00
11:00
13:00
15:00
17:00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Walk
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Walk
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Get ready
for bed
Working
Sleeping
Restroom
19:00
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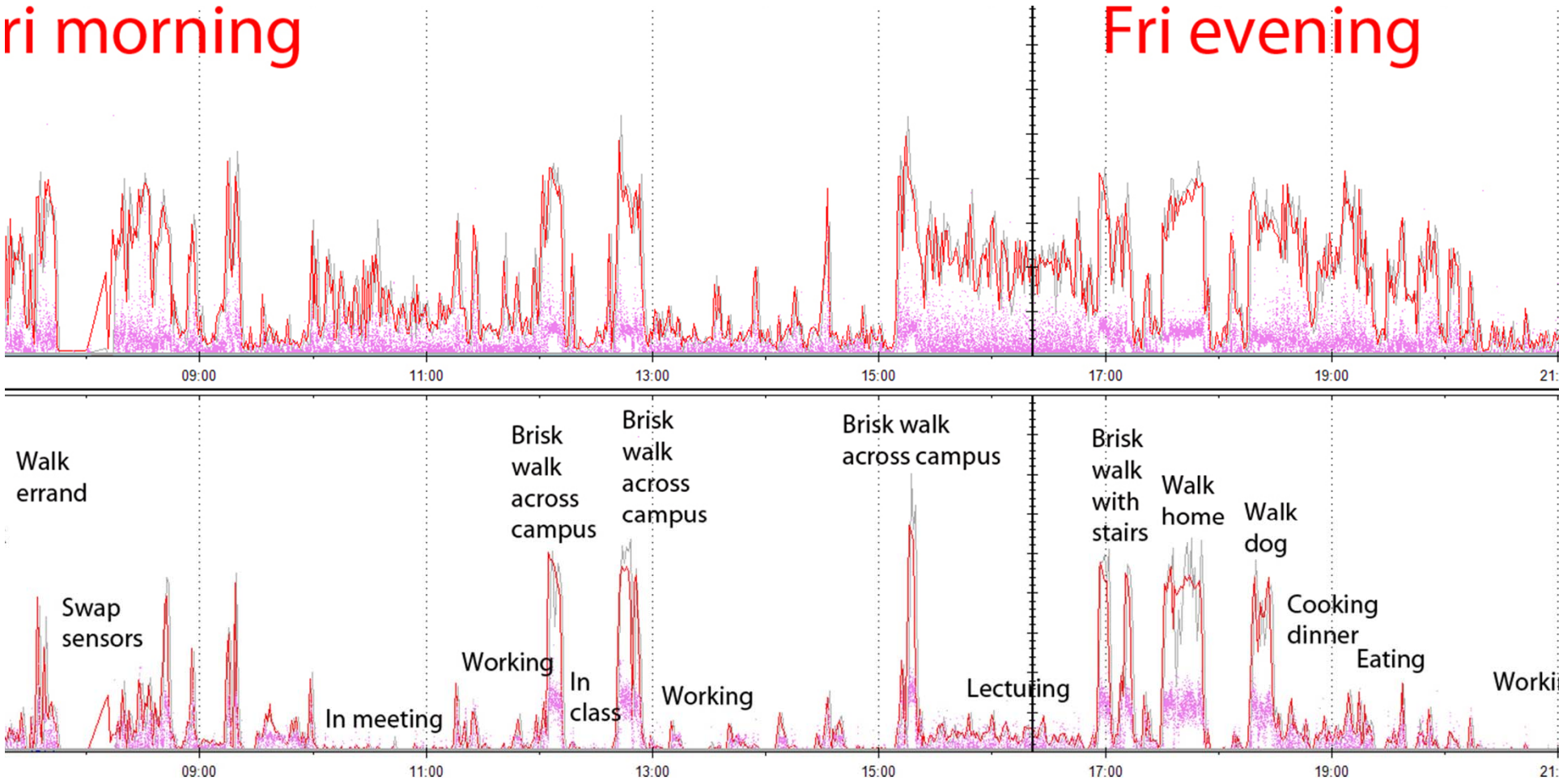
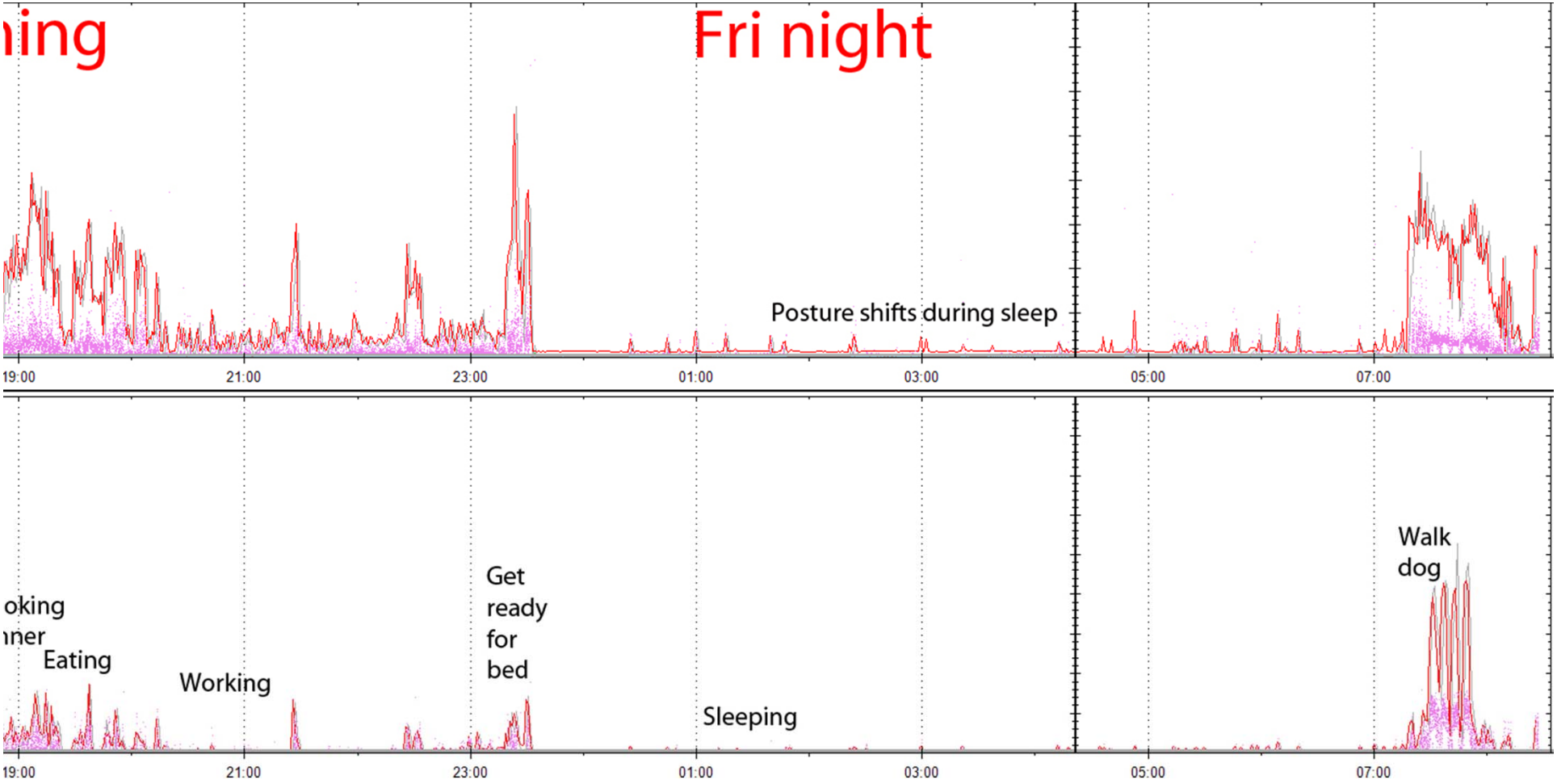

ri morning
Fri evening
09:00
11:00
13:00
15:00
17:00
19:00
21:
Walk errand
Swap sensors
In meeting
Working
Brisk walk across campus
In class
Brisk walk across campus
Working
Brisk walk across campus
Lecturing
Brisk walk with stairs
Walk home
Walk dog
Cooking dinner
Eating
Worki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Fri night
Posture shifts during sleep
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Eating
Working
Get
ready
for
bed
Sleeping
Walk
dog
19:00
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23:00
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05:00
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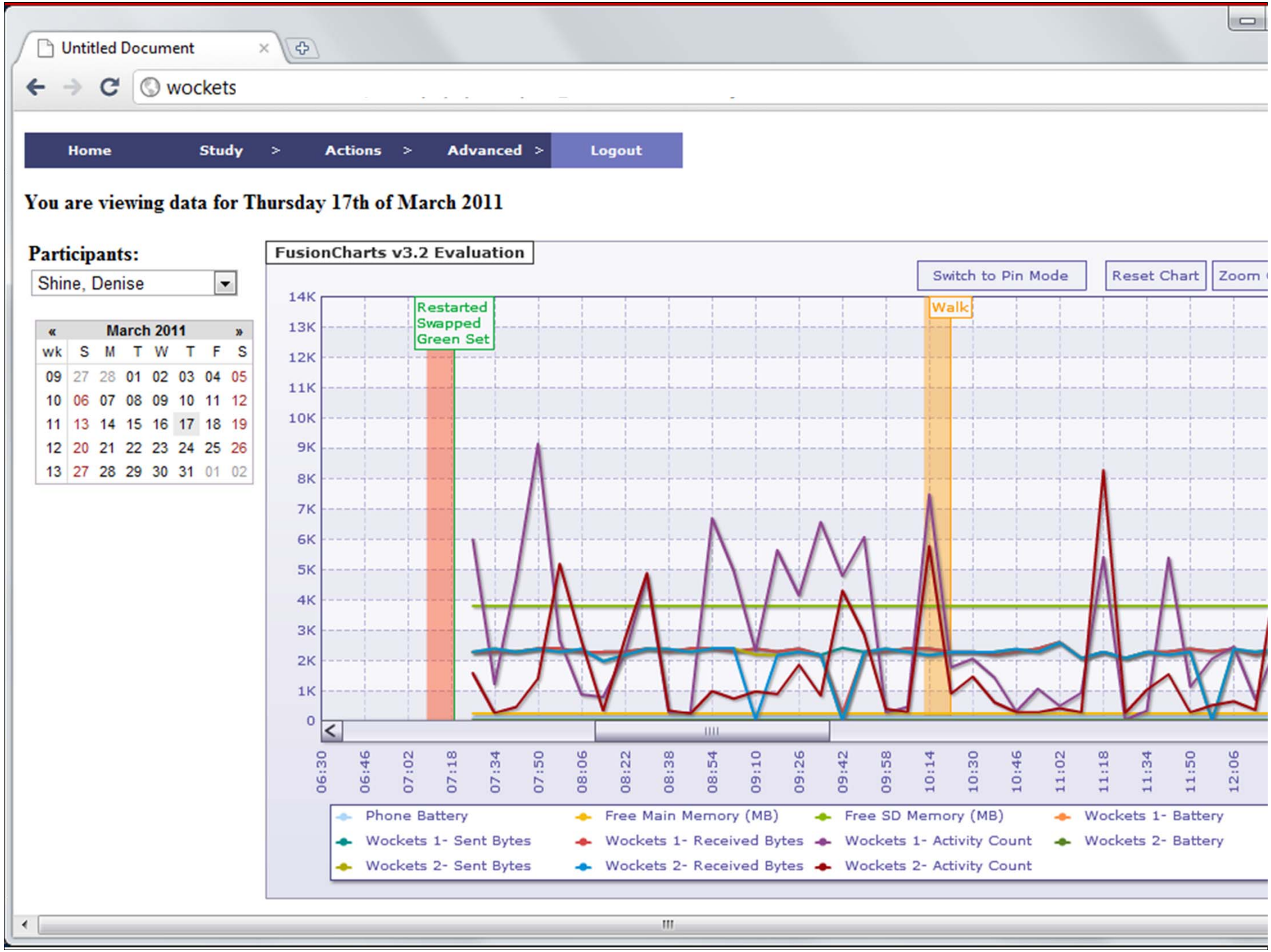
Untitled Document
wockets
Home
Study >
Actions >
Advanced >
Logout
You are viewing data for Thursday 17th of March 2011
Participants:
Shine, Denise
« March 2011 »
wk S M T W T F S
09 27 28 01 02 03 04 05
10 06 07 08 09 10 11 12
11 13 14 15 16 17 18 19
12 20 21 22 23 24 25 26
13 27 28 29 30 31 01 02
FusionCharts v3.2 Evaluation
Switch to Pin Mode
Reset Chart
Zoom
Restarted
Swapped
Green Set
Walk
14K
13K
12K
11K
10K
9K
8K
7K
6K
5K
4K
3K
2K
1K
0
06:30
06:46
07:02
07:18
07:34
07:50
08:06
08:22
08:38
08:54
09:10
09:26
09:42
09:58
10:14
10:30
10:46
11:02
11:18
11:34
11:50
12:06
Phone Battery
Free Main Memory (MB)
Free SD Memory (MB)
Wockets 1- Battery
Wockets 1- Sent Bytes
Wockets 1- Received Bytes
Wockets 1- Activity Count
Wockets 2- Battery
Wockets 2- Sent Bytes
Wockets 2- Received Bytes
Wockets 2- Activity Count

Untitled Document

wockets

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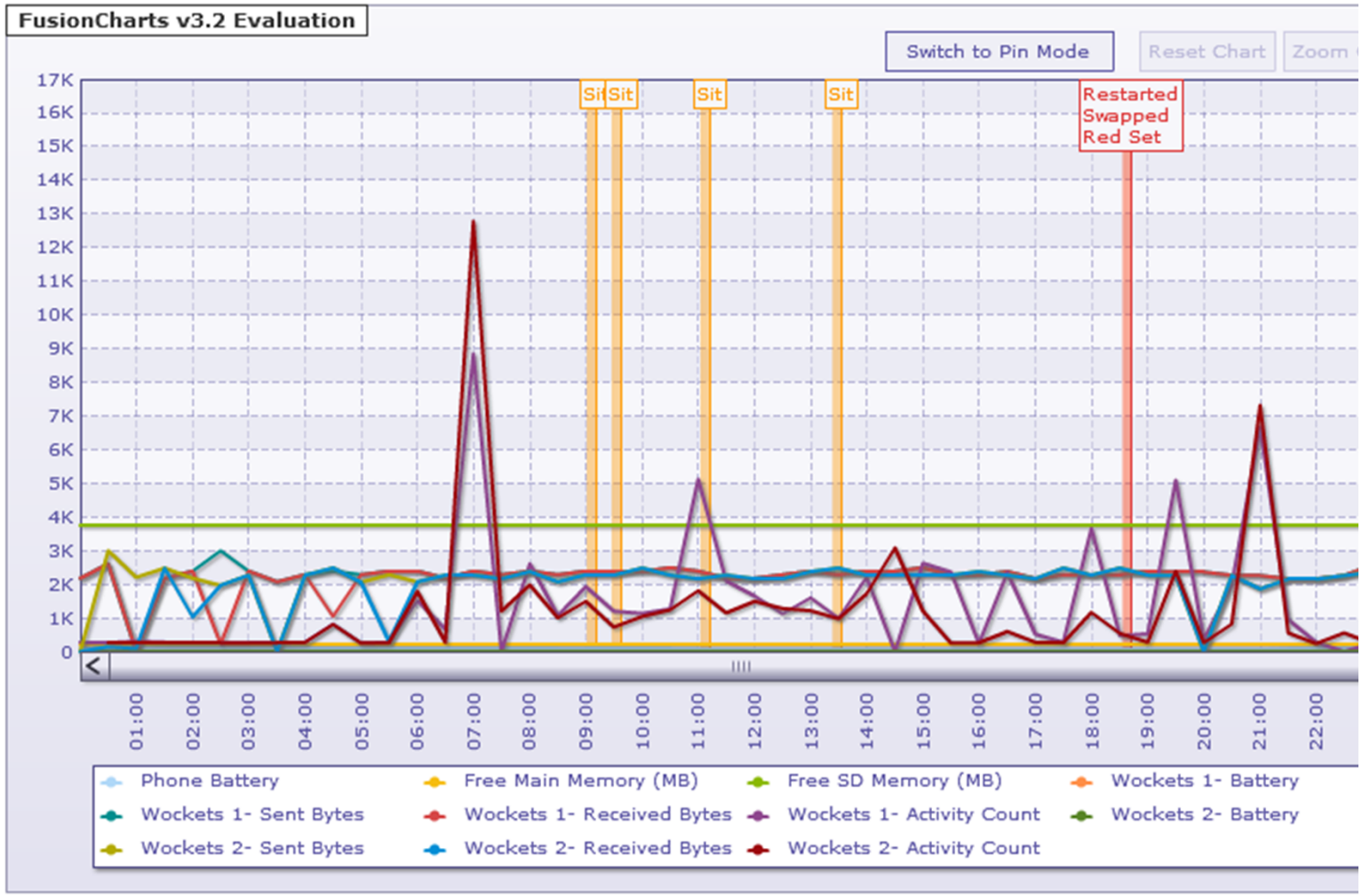
Participants:

Shine, Denise

«	March 2011						»
wk	S	M	T	W	T	F	S
09	27	28	01	02	03	04	05
10	06	07	08	09	10	11	12
11	13	14	15	16	17	18	19
12	20	21	22	23	24	25	26
13	27	28	29	30	31	01	02



Status

- Both projects went through iterative design; about to be deployed in validation studies

- Pilot testing began with research teams and friendlies
  - Identified many challenges an in both cases made major design changes
  - Next: 7 of the challenges and implications