

# smartphone sensing



## how are you feeling android?

Andrew T. Campbell, Dartmouth College

Workshop on Using Smartphones as Mobile Sensing Devices: A Practical Guide for Psychologists to Current and Potential Capabilities, SPSP 2012



OS	Percentage
Android	43%
Symbian	22%
Apple	18%
RIM	12%
Other	2%
Other	2%

The App Store is about to hit 10 billion downloads.

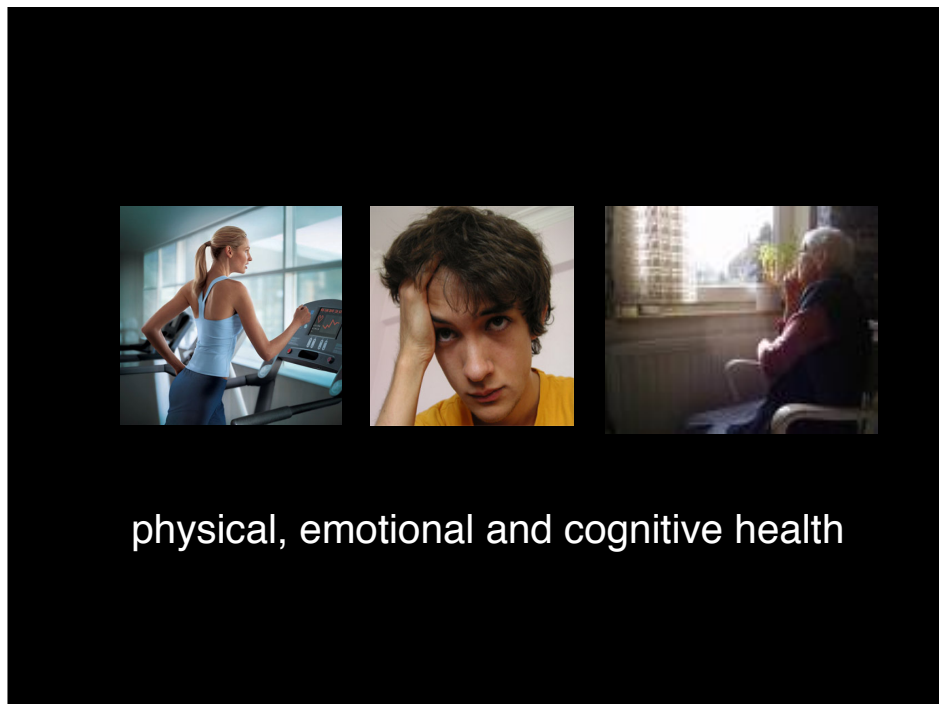
9 9 5 2 0 4 9 1 5 4

# smartphone madness

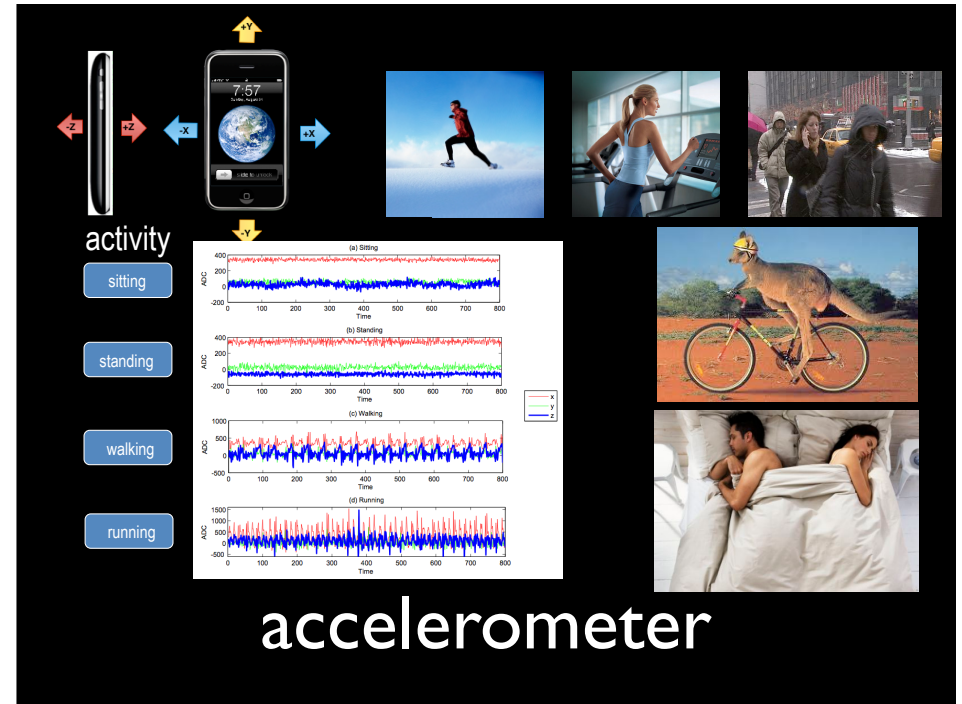
- SST SST25VF080B 1 MB Serial Flash
- NATIONAL SEMICONDUCTOR LM2512AA Display Interface
- BROADCOM BCM5974 Touchscreen Controller
- WOLFSON WM6180C Audio Codec
- INFINEON PMB2525 Hammerhead II GPS
- SAMSUNG Application Processor and DDR SDRAM
- ST MICROELECTRONICS LIS331 DL Accelerometer
- INFINEON SMP31 SMARTI Power Management IC
- LINEAR TECHNOLOGY LTC4088-2 Battery Charger/USB Controller
- SKYWORKS SKY77340 Power Amp. Module
- INFINEON UMTS Transceiver
- TRIQUINT TQM666032 WCDMA/HSPA Power Amp.
- TRIQUINT TQM676031 WCDMA/HSPA Power Amp.
- TRIQUINT TQM616035 WCDMA/HSPA Power Amp.
- NUMONYX PF38F3050M0Y0CE 16 MB NOR + 8 MB Pseudo - SRAM
- INFINEON Digital Baseband Processor
- NXP Power Management



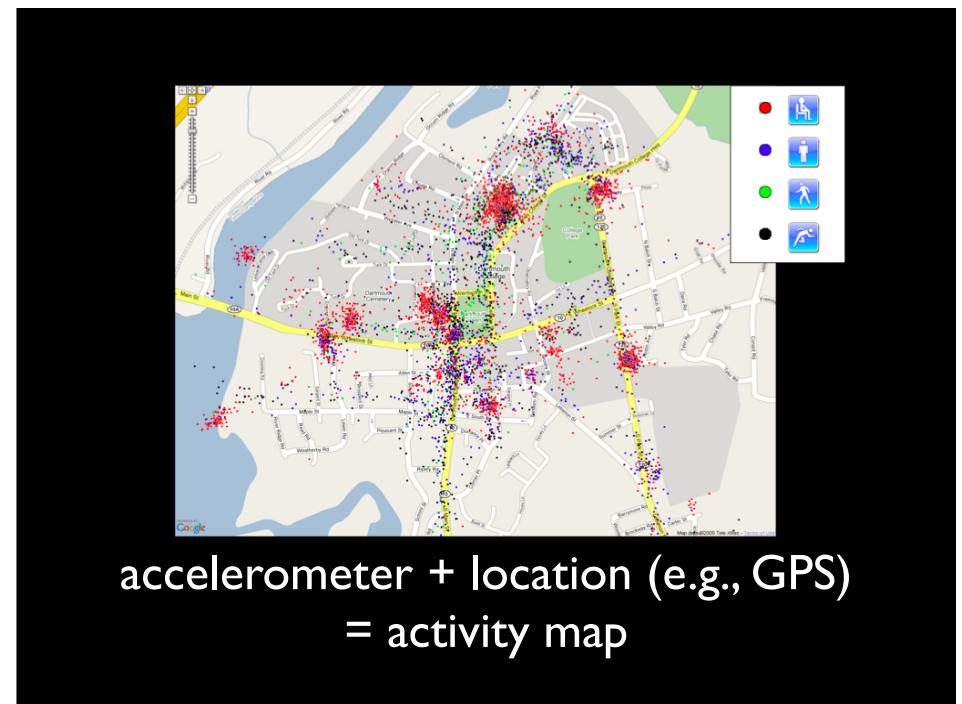
why is this important to us?

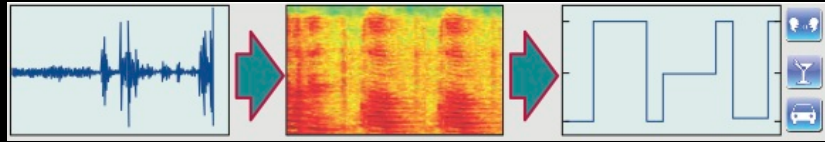


let's look at the capability  
of a single sensor



what is the influence of  
location on people?





raw sensor  
data

extracted  
features

classification  
inference

making sense of data

machine learning is key to building  
robust, personalized behavioral models

learning, big data, mining,  
apps



- sensing
- feature extraction
- inference
- learning/adaptation
- app specific
- privacy

we want to push  
intelligence to the  
phone



density leads to big data



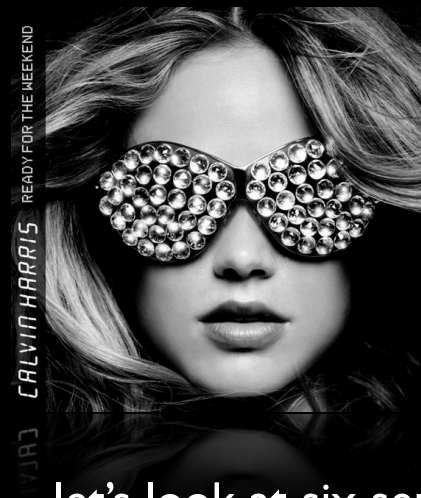
where is this leading?





smartphones are getting smarter;  
at some point they will:

- understand our behavioral patterns, emotional and mental state
- anticipate our every move
- help us navigate our day
- become integrated into the fabric of our lives
- new apps in health, social science, psychology
- radically change how we study human, community and population behavior



social networks app  
sound diary app  
well-being app  
stress app  
safety app  
neural app

let's look at six sensing apps developed  
with Tanzeem Choudhury (Cornell)

**cence***me*

facebook

twitter

myspace  
a place for freedom

cenceme web

"Sensing Meets Mobile Social Networks: The Design, Implementation and Evaluation of the CenceMe Application", *ACM SenSys 2008*

two microphones

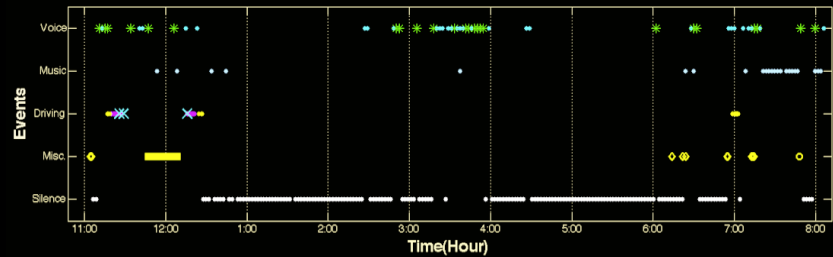
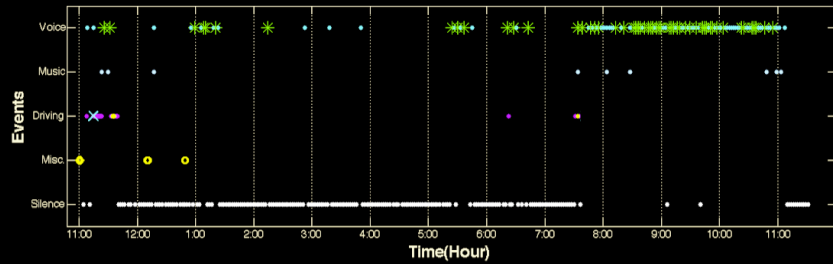
how do social "conversation networks" evolve?

Voice


SoundSense

Hong Lu, Wei Pan, Nicholas D. Lane, Tanzeem Choudhury, Andrew T. Campbell

## SoundSense diary: discovering life patterns



Too many people lead unhealthy, **unbalanced** lifestyles

Even health conscious people have a **narrow** view of healthy behavior

## BeWell App

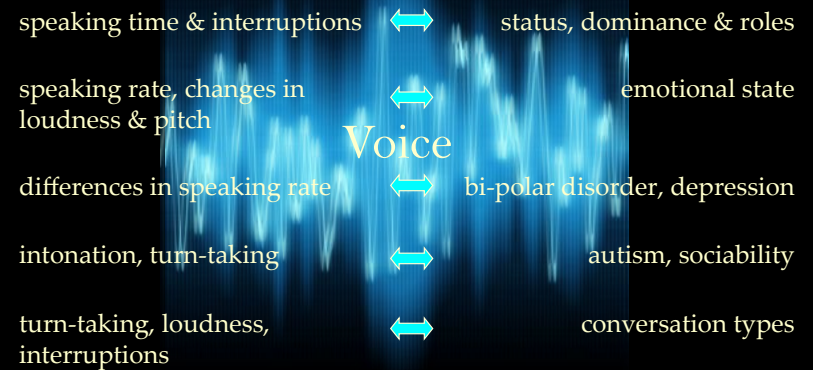


Poor

Fair

Excellent

## Infer meaningful attributes of interaction



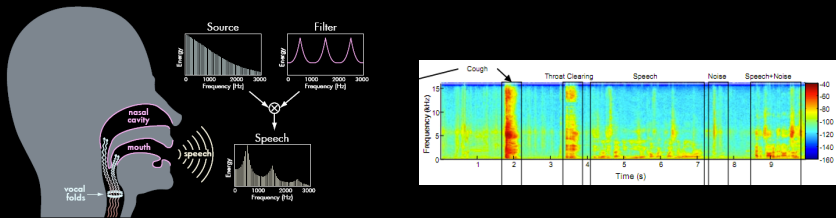


# StressSense: stress from voice



Pitch plays a prominent role

Other important features are those using energy and spectral slope



front and back cameras

# WalkSafe:

a pedestrian safety app for mobile users who walk and talk while crossing roads

Tianyu Wang, Giuseppe Cardone,  
Antonio Corradi, Lorenzo Torresani,  
Andrew T. Campbell

Dartmouth College

University of Bologna

while out jogging on day ...

can brain signals drive  
smart phones?



## Brain to Mobile Phone Interface


Andrew T. Campbell, Tanzeem Choudhury, Shaohan Hu, Hong Lu,  
Matthew K. Mukerjee\*, Mashfiqui Rabbi, Rajeev D. S. Raizada

"NeuroPhone"

\* Contact Author

we need a new smartphone tool for  
social and psychological experiments

some of the pieces exist



# PACO

The Personal Analytics Companion

**What is PACO?**  
*It's a tool for building your own Personal Science experiments - in minutes!*  
(On Android devices! On iOS 5 devices someday.)

Join the announcement list for an invitation to the beta trial.  
 Email:

[Learn More about PACO](#)

**What is PACO good for?**  
**Many types of mobile experiments!**

**Quantified Self**  
 Ever wonder how happy you are? Whether your weight is trending up or down? Do you want one place to manage the data and reminder scheduling for all your mobile exercise trackers, weight trackers, baby's bowel movement trackers, fuel consumption trackers (is that the same as the previous one?)?

**Mobile Population Studies - Wellness, Corporate environment, or Whatever**  
 Ever want to design, iterate, and deliver a social science experiment or mobile wellness intervention to a group of people on Android mobile phones in a matter of minutes? (You social and behavioral scientists out there know who you are.)

**User Control of Data**  
 Do you want to be able to correlate your data across multiple trackers?  
 Do you want your data kept private and under your control? With informed consent about what you are sharing and with whom?

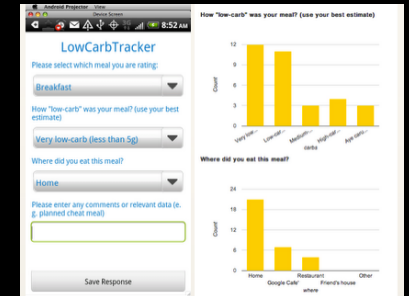
If you answered yes to any or all of these questions, then, Paco is the tool for you! Though we are still building a lot of these features, so don't be too judgmental just yet - instead [click in some of our own 2015 stats](#).

<http://www.pacoapp.com/>

creation of experimental trackers and interventions

experiential sampling (ESM)

allows users to explore and ask questions about their data



**fünf**  
 Open Sensing Framework

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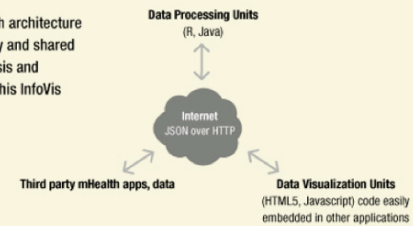
sensor collection and data analysis

# Open mHealth

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A quality open mHealth architecture depends on modularity and shared components for analysis and visualization. We call this InfoVis



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Email Address \*

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FUNDERS



This work is based on work supported by the above named

Open mHealth at the mHealth Summit 2011

Posted on [December 9, 2011](#) by [admin](#)

On Monday, December 5th the Open mHealth team (Ida Sim, Deborah Estrin and David Haddad) presented at the 2011 mHealth Summit. You can check out the presentation below or watch the video here: [Open mHealth-mHealth Summit Presentation](#) View more presentations ... [Read more](#) →

# what is missing?

open source, robust behavior models for phones

feed back, intervention mechanisms and data visualization

data analysis tools and data repository

phone issues

-- energy, robustness, scaling, privacy

SDK for putting it all together (has to be easy)



societal scale sensing

## Many people to thank

**Students:** Emiliano Miluzzo, Nicholas D. Lane, Hong Lu, Matt Mukerjee, Michela Papandrea, Ye Xu, Tianyu Wang, Wei Pan, Shane Eisenman, Mirco Musolesi, Mashfiqui Mohammod, Mu Lin, Xiaochao Yang

**Faculty:** Tanzeem Choudhury (CS), Ethan Berke (Medical School), Rajeev Raizada (Neuroscience)

**Sponsors:** NSF, Nokia, Intel, MSR