

BMI 500: mHealth informatics



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Interim Chair BMI

Honorary Professor, University of Oxford

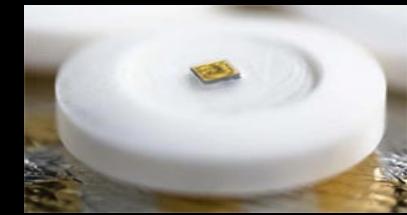
Adjunct Prof., Morehouse School of Medicine

Distinguished Guest Prof., Tsinghua University

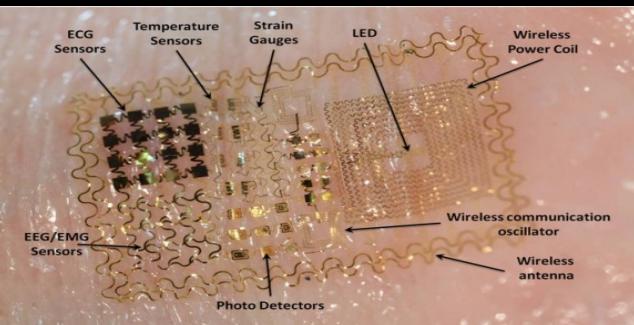
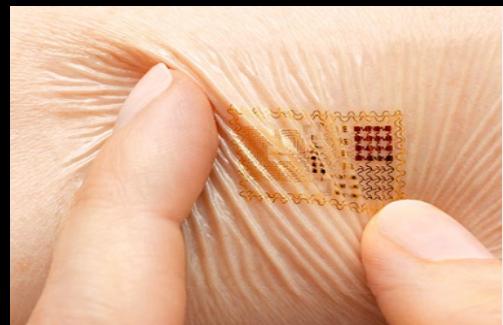
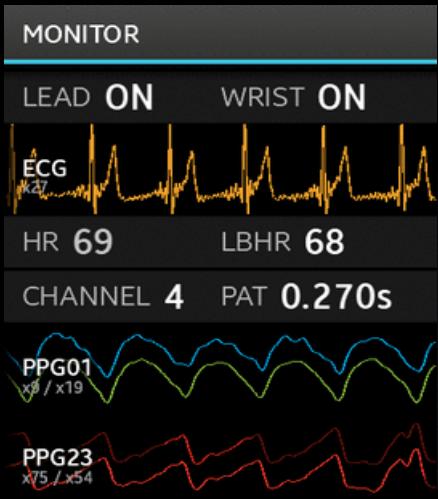
**Deputy Editor, Journal of Physiological Measurement,
Institute of Physics.**

mHealth taxonomy

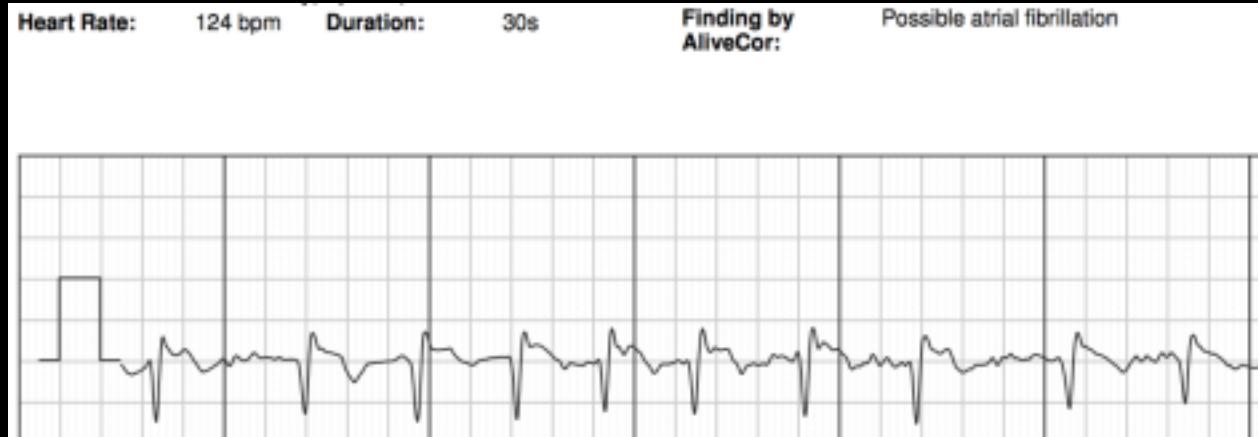
- Low hanging fruit (limited)
 - Text message reminders (not particularly effective)
 - Surveys
 - Making a standard device wirelessly connect to your phone (e.g. glucometer, BP cuff) to track data
- Taking advantage of the phone
 - Using onboard sensors (microphone for snoring, accelerometer for movement, video camera for sleep)
- Adding sensors designed for the phone
 - ECG (arrhythmias), lenses (cataracts), location bands (Alzheimer's), contact lenses (diabetes), smart pills (compliance) ...



The Next Generation of Wearables



How do we use this information to detect changes in health?

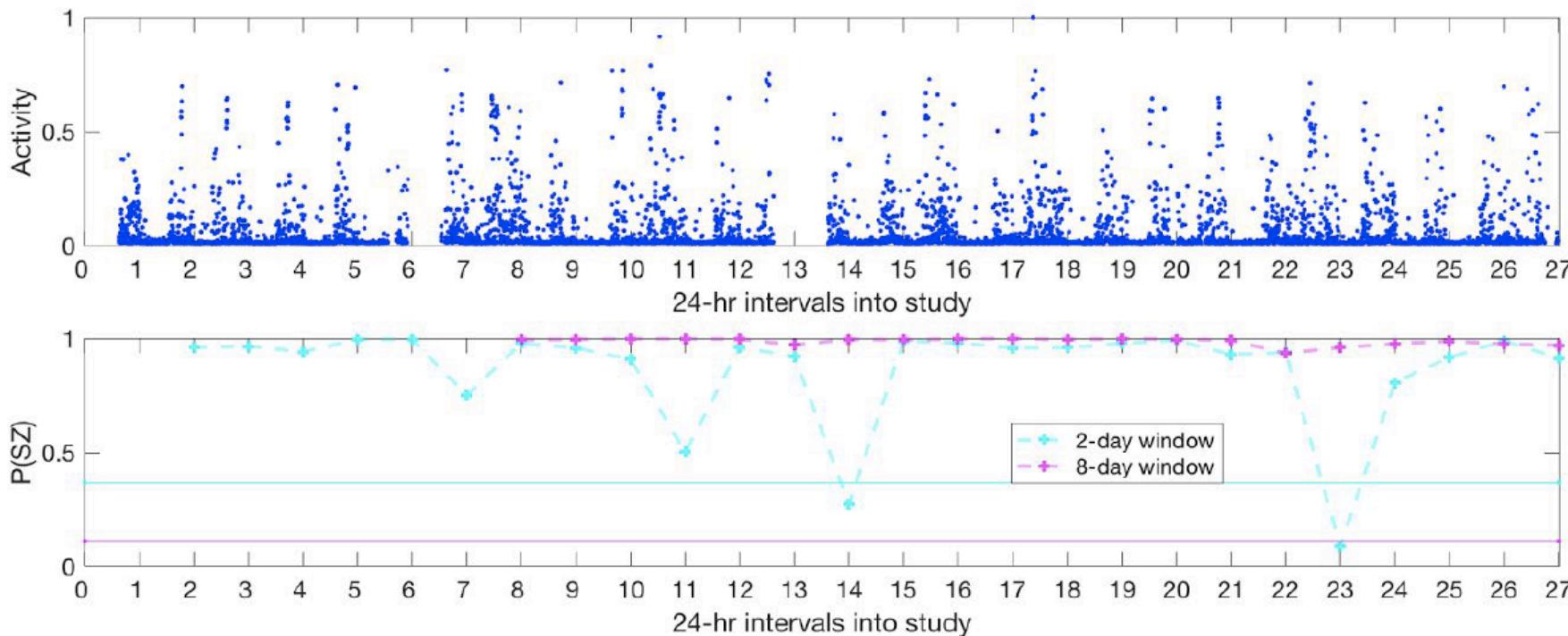


Objective identification and analysis of physiological and behavioral signs of schizophrenia.

Osipov M¹, Behzadi Y², Kane JM³, Petrides G³, Clifford GD¹.

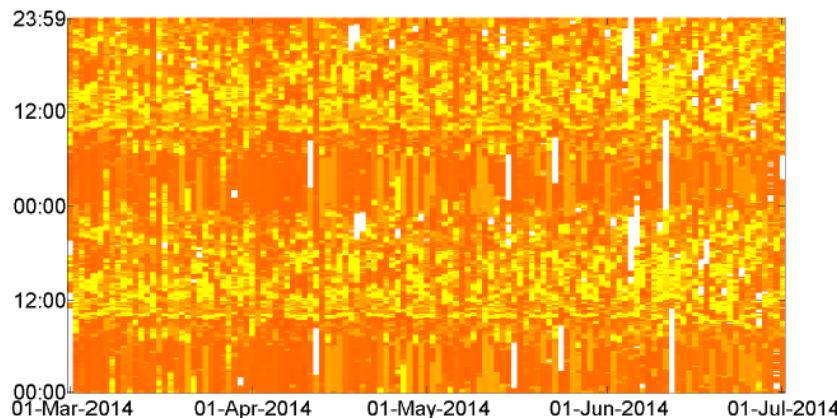
⊕ Author information

Abstract

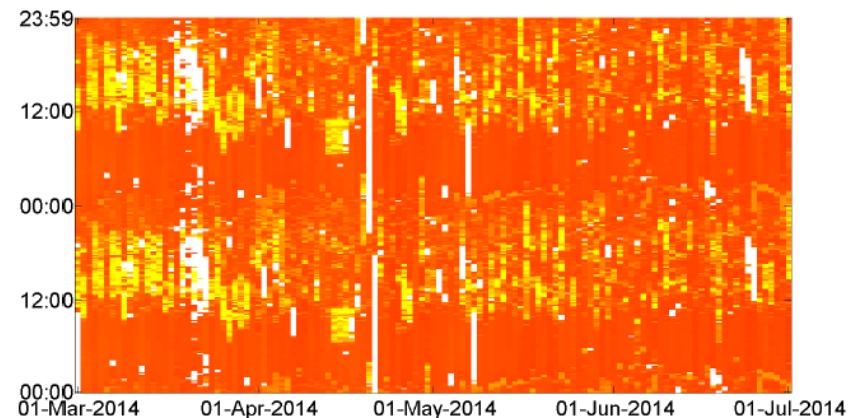


What about other mental health issues?

Borderline personality disorder ...

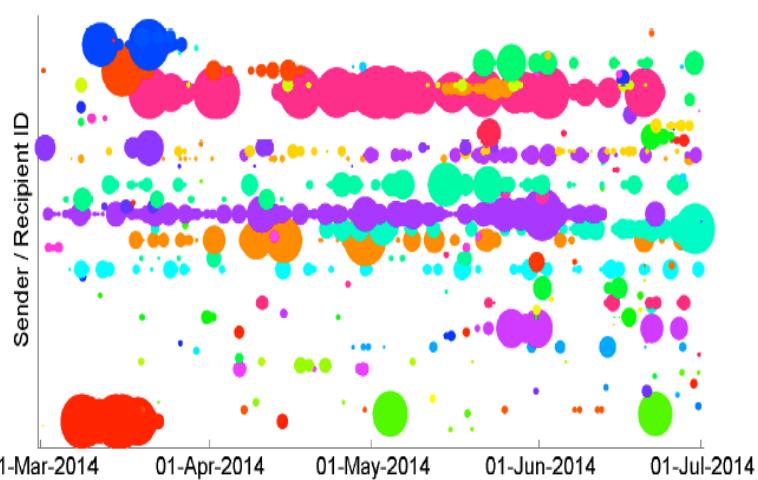


(a) Actigraphy levels (healthy control).

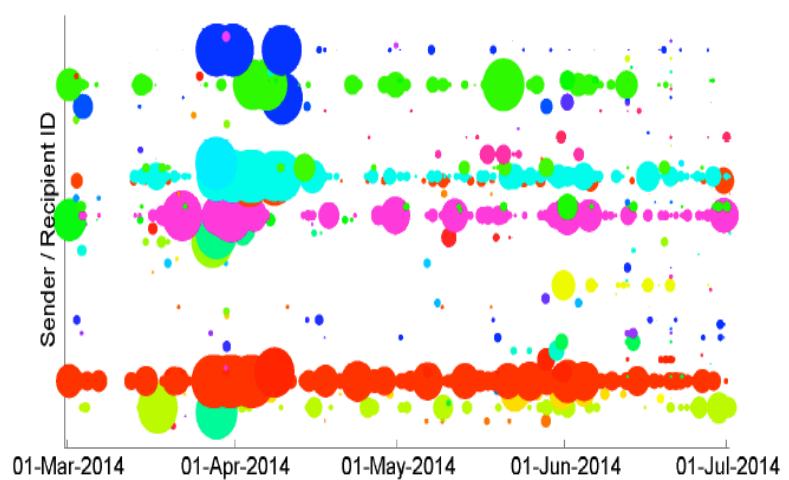


(b) Actigraphy levels (borderline personality disorder).

Bipolar Patients



(c) Social network activity levels by contact (healthy control).

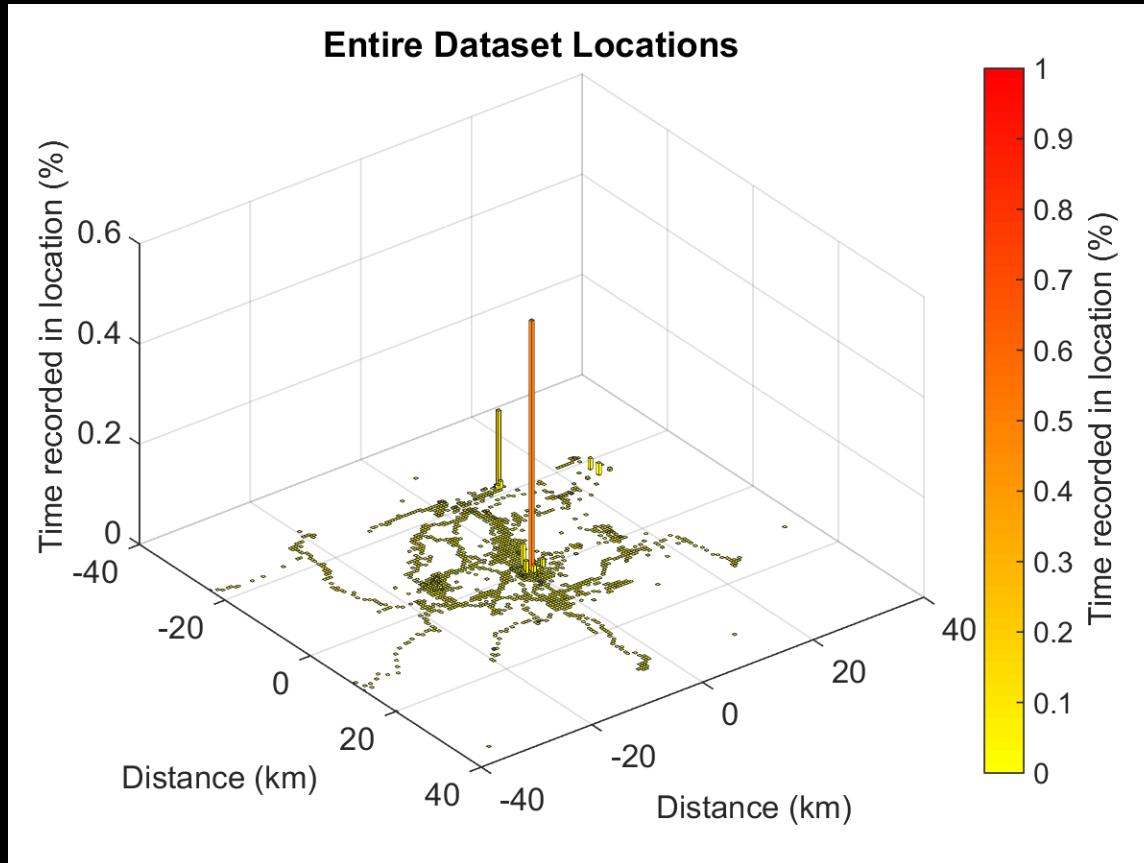


(d) Social network activity levels by contact (bipolar).

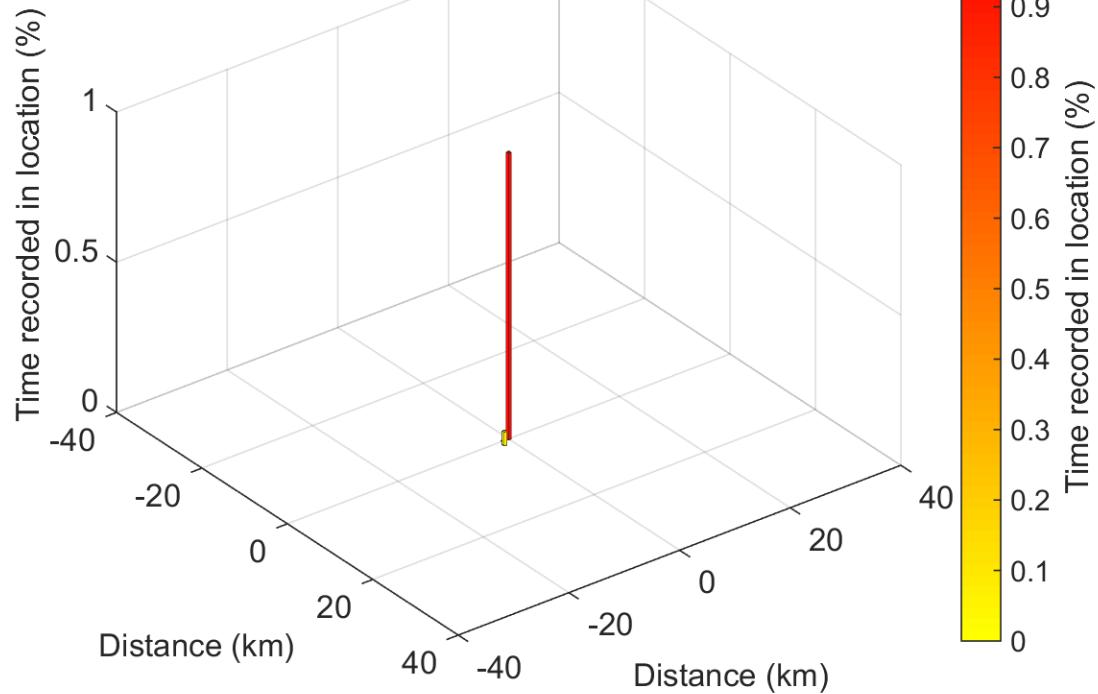
↑social network & ↓activity = physical illness

↓social network & ↓activity = mental illness

Location: Context is essential



Night Locations



Weekday Locations

Time recorded in location (%)

0
0.2
0.4
0.6

-40

0

20

Distance (km)

-20

0

20

Distance (km)

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Time recorded in location (%)

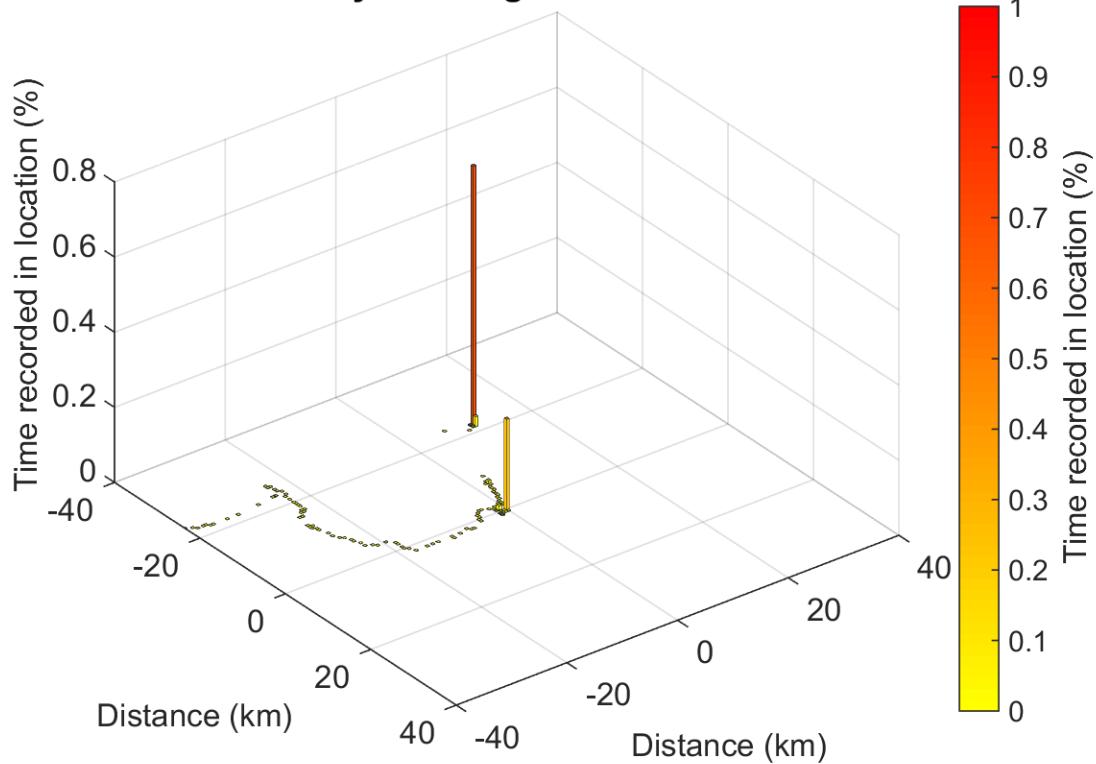
40

0

20

Distance (km)

Weekday Working Time Locations



Weekend Locations

Time recorded in location (%)

0.8
0.6
0.4
0.2
0

-40 0 20 40 -40 0 20

Distance (km) Distance (km)

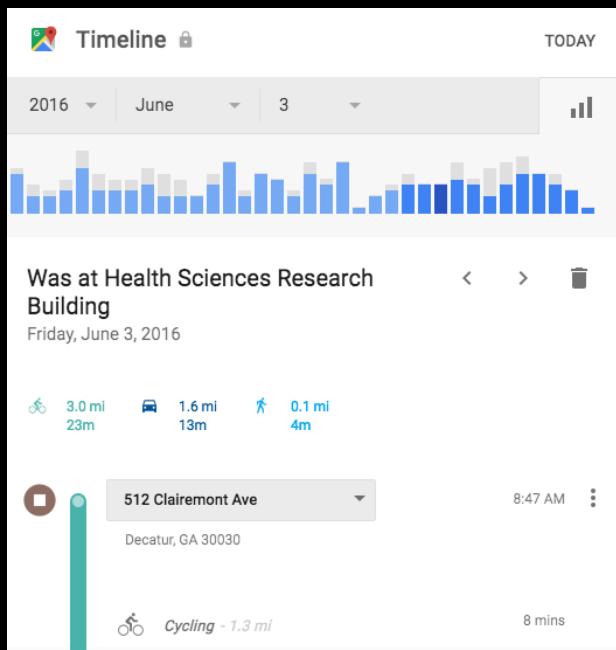
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Time recorded in location (%)

40

Can Google help?

www.google.com/maps/timeline



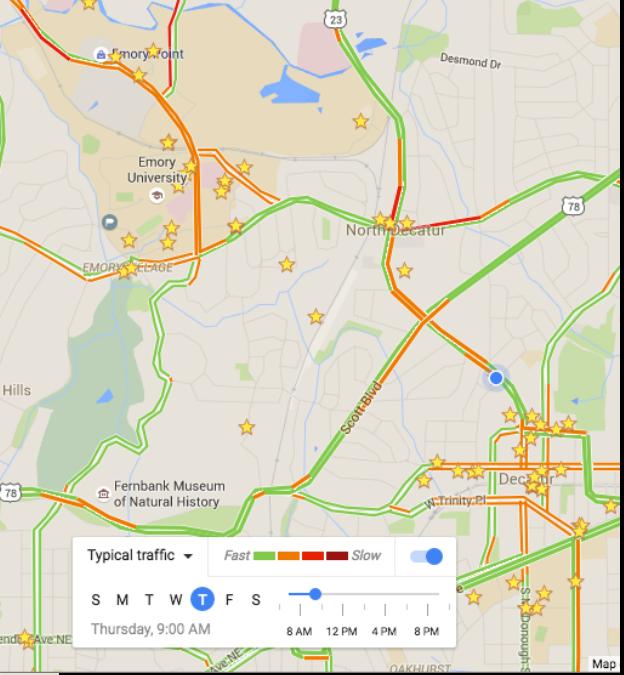
Google Maps APIs

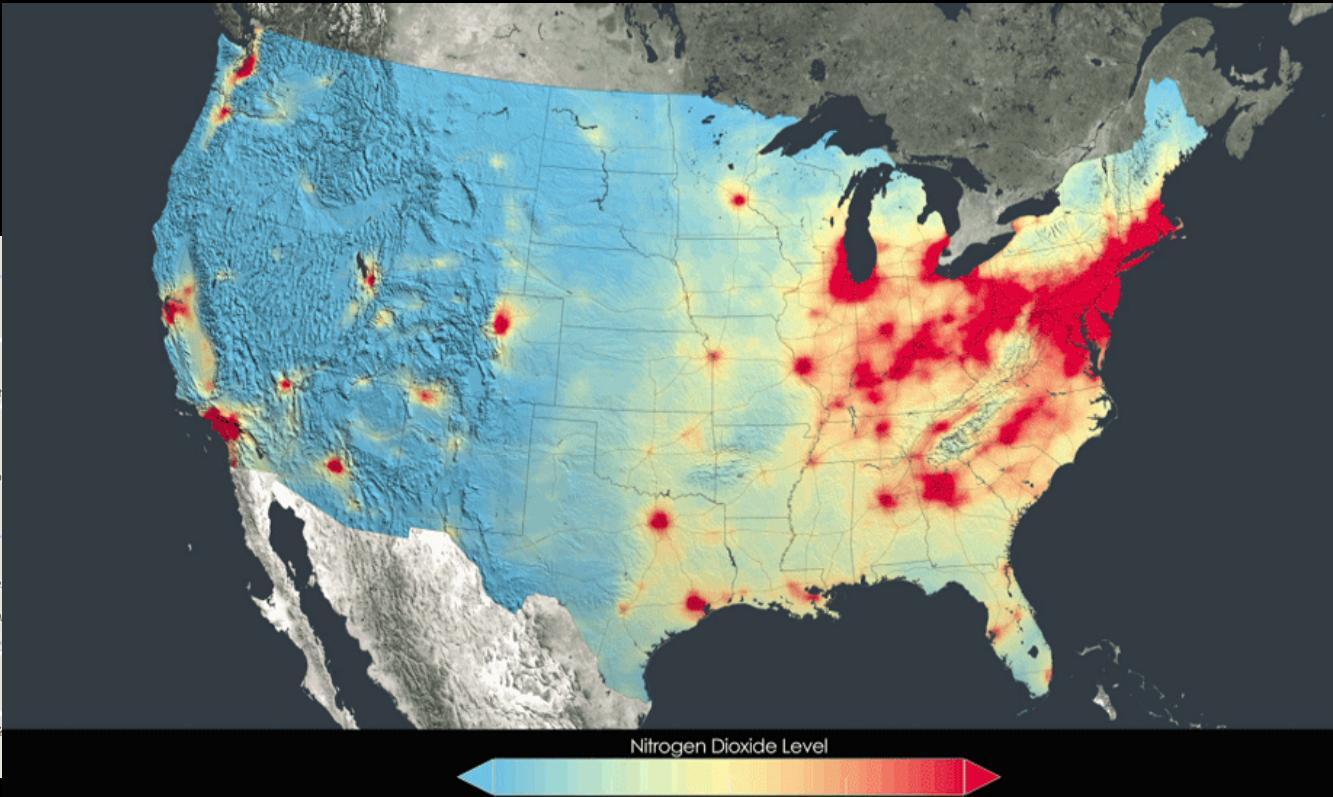
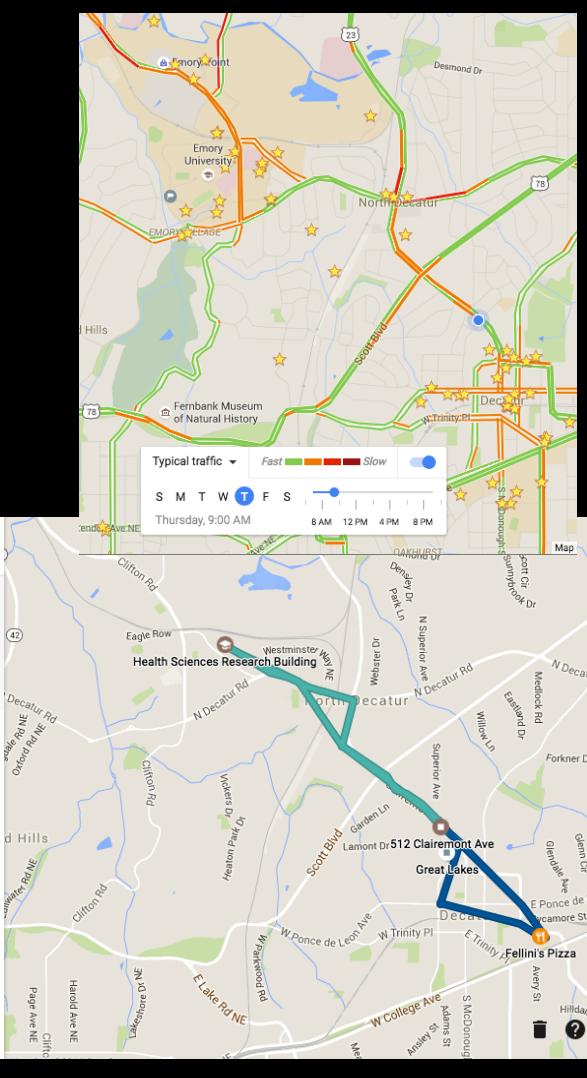
Web > Maps JavaScript API

OVERVIEW GUIDES REFERENCE

Fusion Tables layer

- Fusion Tables queries
- Fusion Tables heatmaps
- Fusion Tables styling
- GeoRSS layers
- Traffic layer
- Transit layer
- Bicycle layer



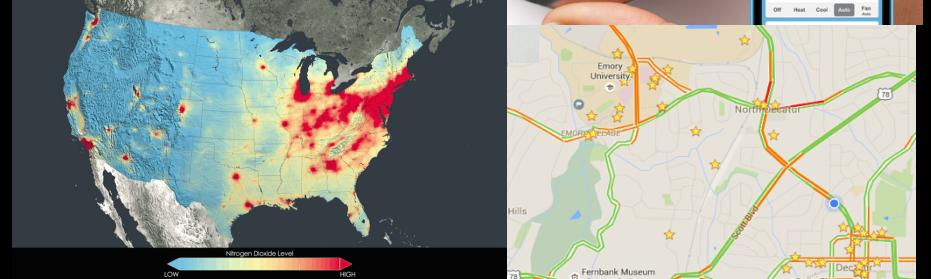
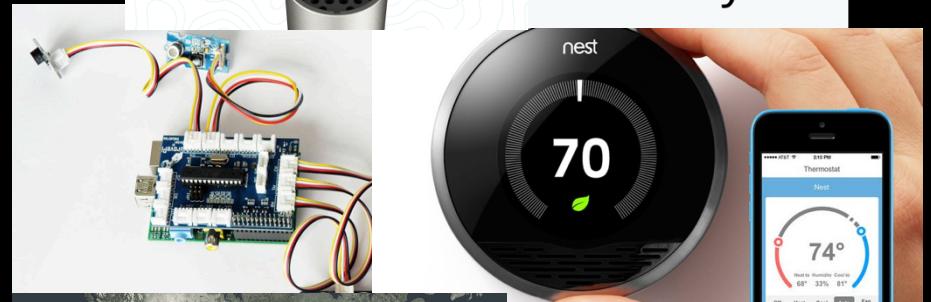
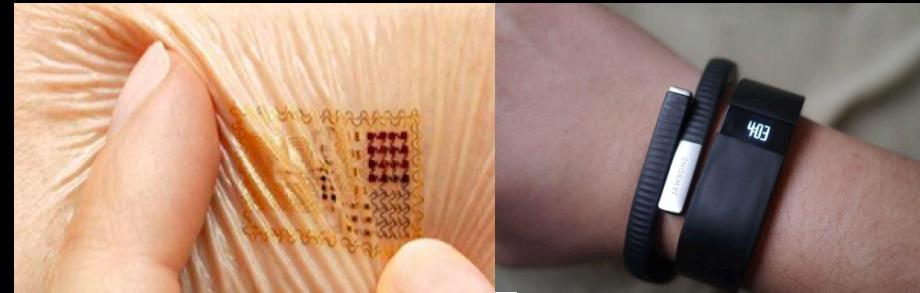


The Future is now: 'Big' mHealth ...

Use physiology patches and actigraphy meters –
Jawbone, Simband, Pebble, etc

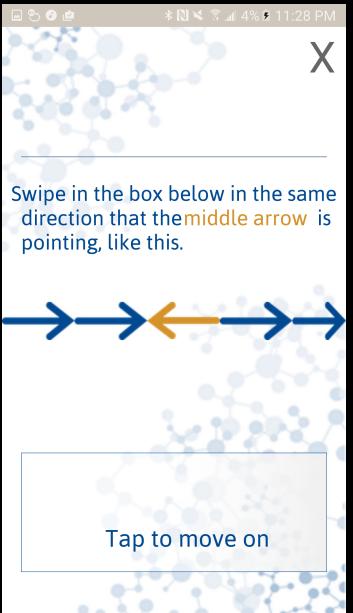
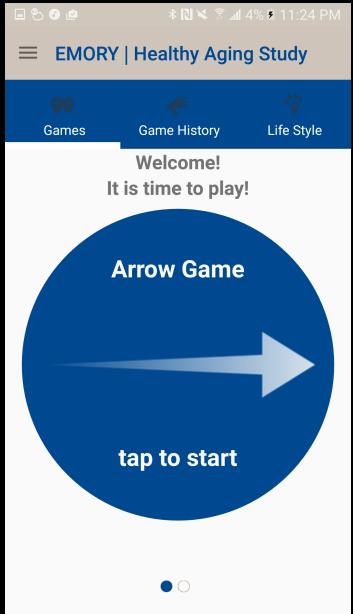
Natural behavioral data scraping
Smartphone (accelerometer, gyro, GPS, SMS)
Telecom records (H1N1)

'Off body' sensors
Video cameras – sleep, gait, activity
'Exposomes' – Pollution from sensors
Google – Traffic exposure, activity, food deserts?
Satellite data - Pollution



Healthy Aging Study

- 100,000 patients ...



healthyaging.emory.edu

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EMORY | Healthy Aging Study

[Click here to join the study.](#)

Welcome to the **Emory Healthy Aging Study**, your opportunity to partner with leading physicians at Emory University and help make discoveries that will change our understanding of aging and age-related diseases for generations to come. It's easy. It's historic. It's one for the ages.

[Please join us.](#)

If you had the opportunity to change the world for the better, would you?

Increasing our knowledge about the aging process will ensure that future generations will enjoy a long and healthy life.

What it is.

How it works.

Why it matters.

FREE DOWNLOAD:
Click here for more information and receive our free PDF download:

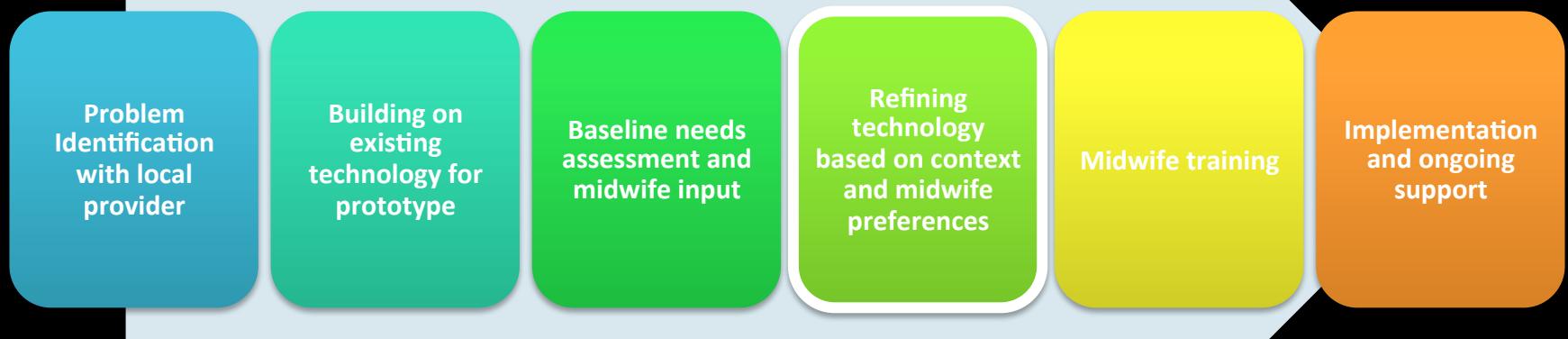
EMORY'S Top Healthy Brain Foods

But ... Issues for healthcare technology efficacy

1. Unreliable/costly supply chains & infrastructure
2. Information is not portable
3. Compliance
 - Lack of evaluation in long term
 - Humans like recreation, not health
4. High false positive rate inherent in medicine: not scalable
 - High FP rate will overwhelm healthcare system
5. Humans are fallible (medical errors ~ 20%)



Design Process



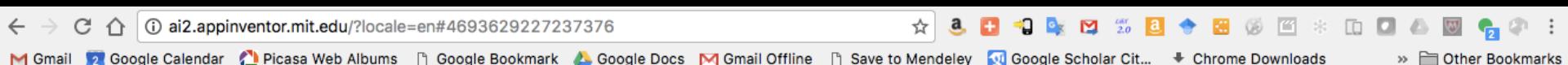
The mHealth Lab



MIT App Inventor

- [http://appinventor.mit.edu/explore/sites/all/
themes/appinventor/logo.png](http://appinventor.mit.edu/explore/sites/all/themes/appinventor/logo.png)
<http://appinventor.mit.edu/explore/about-us.html>
<http://ai2.appinventor.mit.edu/>
Use emulator or Android phone:
<http://appinventor.mit.edu/explore/ai2/setup>

MIT App Inventor interface



MIT App Inventor 2 Beta

Projects ▾ Connect ▾ Build ▾ Help ▾ My Projects Gallery Guide Report an Issue English ▾ gari.clifford@gmail.com ▾

Test Screen1 Add Screen ... Remove Screen Designer Blocks

Palette

User Interface

- Button
- CheckBox
- DatePicker
- Image
- Label
- ListPicker
- ListView
- Notifier
- PasswordTextBox
- Slider
- Spinner
- TextBox
- TimePicker

Viewer

Display hidden components in Viewer
Check to see Preview on Tablet size.

Screen1

Weight (kg)
10

Height (cm)
20

Age (months)
7

Calculate

Components

- Screen1
- weight_label
- weight
- height_label
- height
- age_label
- age
- calculate
- ans
- Canvas1

Properties

calculate
BackgroundColor
■ Default
Enabled
✓
FontBold
□
Fontitalic
□
FontSize
14.0
FontTypeface
default ▾
Height
Automatic...
Width
Automatic...
Image
None...

Logic Block Based Design

ai2.appinventor.mit.edu/?locale=en#4693629227237376

Gmail Google Calendar Picasa Web Albums Google Bookmarks Google Docs Gmail Offline Save to Mendeley Google Scholar Cit... Chrome Downloads Other Bookmarks

MIT App Inventor 2 Beta

Projects Connect Build Help My Projects Gallery Guide Report an Issue English gari.clifford@gmail.com

Test Screen1 Add Screen ... Remove Screen Designer Blocks

Blocks

Built-in

- Control
- Logic
- Math
- Text
- Lists
- Colors
- Variables
- Procedures

Screen1

- weight_label
- weight
- height_label
- height
- age_label
- age
- calculate
- ans

Viewer

```
when calculate .Click
do
  set ans . Text to square root weight . Text
  set Canvas1 . BackgroundColor to pink
  set Canvas1 . PaintColor to yellow
  set Canvas1 . LineWidth to 25
  set Canvas1 . Visible to true
  call Canvas1 . DrawLine
    x1 square root age . Text
    y1 square root ans . Text
    x2 age . Text
    y2 ans . Text
```

Hide Warnings

The screenshot shows the MIT App Inventor 2 Designer interface. The top navigation bar includes links for Gmail, Google Calendar, Picasa Web Albums, Google Bookmarks, Google Docs, Gmail Offline, Save to Mendeley, Google Scholar Cit..., Chrome Downloads, and Other Bookmarks. The main workspace is titled 'Test' and contains a 'Blocks' tab. On the left, a sidebar lists categories like Built-in (Control, Logic, Math, Text, Lists, Colors, Variables, Procedures) and a specific screen named 'Screen1' containing components like 'weight_label', 'weight', 'height_label', 'height', 'age_label', 'age', 'calculate', and 'ans'. The central 'Viewer' area displays a sequence of logic blocks: 'when calculate .Click' triggers a 'do' loop. Inside the loop, several 'set' blocks change properties of 'Canvas1' (BackgroundColor to pink, PaintColor to yellow, LineWidth to 25, Visible to true). A final 'call' block executes 'Canvas1 . DrawLine' with parameters derived from variables: x1 = square root of weight, y1 = square root of ans, x2 = age, y2 = ans.



MIT App Inventor

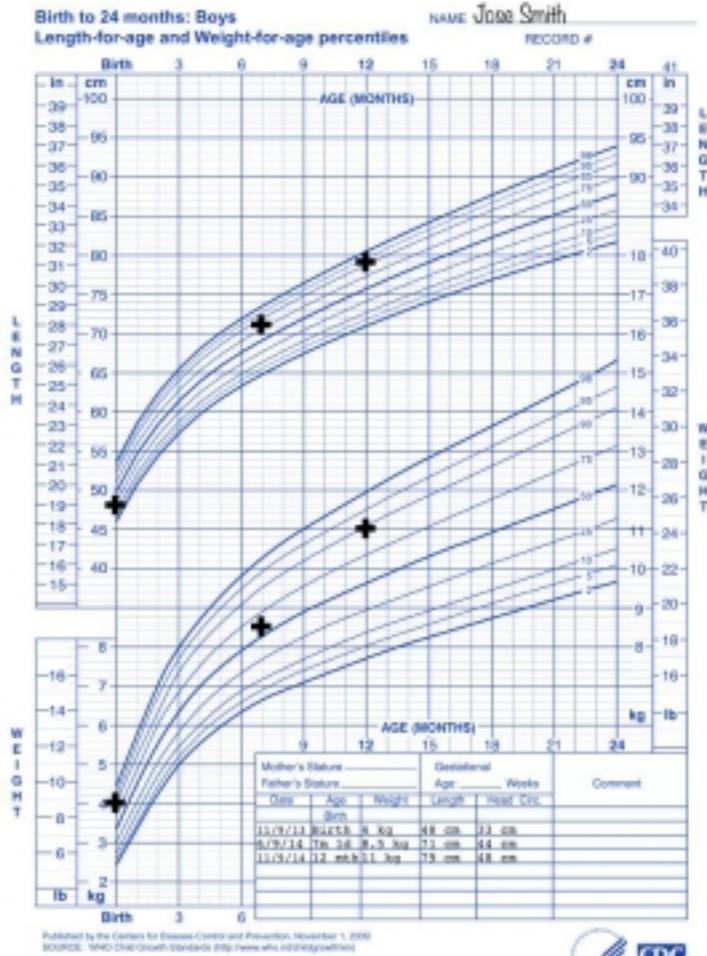
Task today: Create a z-score for pediatric growth ...

Inputs:

- Weight, height (length), head circumference, age

Outputs:

- Z score, percentile and plot on growth curve



In statistical terms, Z-scores are a special application of transformation rules. The Z-score for a measure (e.g., height or BMI), indicates how far and in what direction (positive vs. negative) a measured value deviates from the population mean, expressed in units of the population SD. It is a dimensionless quantity derived from dividing the difference between individual value (x) and the population mean (μ) by the population SD (σ). The transformed Z-scores' distribution will have a mean of zero and a SD of one (i.e., mean = 0, SD = 1). This conversion process is called standardizing or normalizing.

$$Z = \frac{x - \mu}{\sigma}$$

Z-scores are sometimes called “standard scores”. The Z-score transformation is especially useful when seeking to compare the relative standings of different measures (e.g., height vs. BMI, or the measures of boys’ vs. girls’) from distributions with different means and/or different SDs. Z-scores are especially informative when the distribution to which they refer is normal. In every normal distribution, the area under the curve between the mean and a given Z-score value corresponds to a fixed proportion of the total area (Fig. 2.3). Based on this characteristic, statisticians have created tables indicating the value of these proportions for various Z-scores.



Fig. 2.3 Z-score and the corresponding cumulative probability and percentile (proportion). For normal distribution, the Z-score of 0 divides the total area into two equal halves. Thus, the Z-score of 1 corresponds to the 84th percentile ($=0.5 + 0.34$), i.e., 84% of the population are measured lower than z-score of 1. A Z-score is calculated as dividing the difference between measured value (x) and the mean (μ) by standard deviation (σ)



MIT App Inventor

Task today: Create a z-score for pediatric growth

Deliverable:

Email gari@gatech.edu an apk called [your_name_zscore.apk] before 5pm on Friday 9th December.



MIT App Inventor

OK – get started!

<http://ai2.appinventor.mit.edu/>

Hint:

<http://www.statisticshowto.com/percentile-z-score/>