Using smartphones for population research

Prof. Vassilis Kostakos
School of Computing and Information Systems
University of Melbourne

31 May 2017
Talk given at the Melbourne School of Population and Global Health
University of Melbourne

~

What your phone knows about you

~

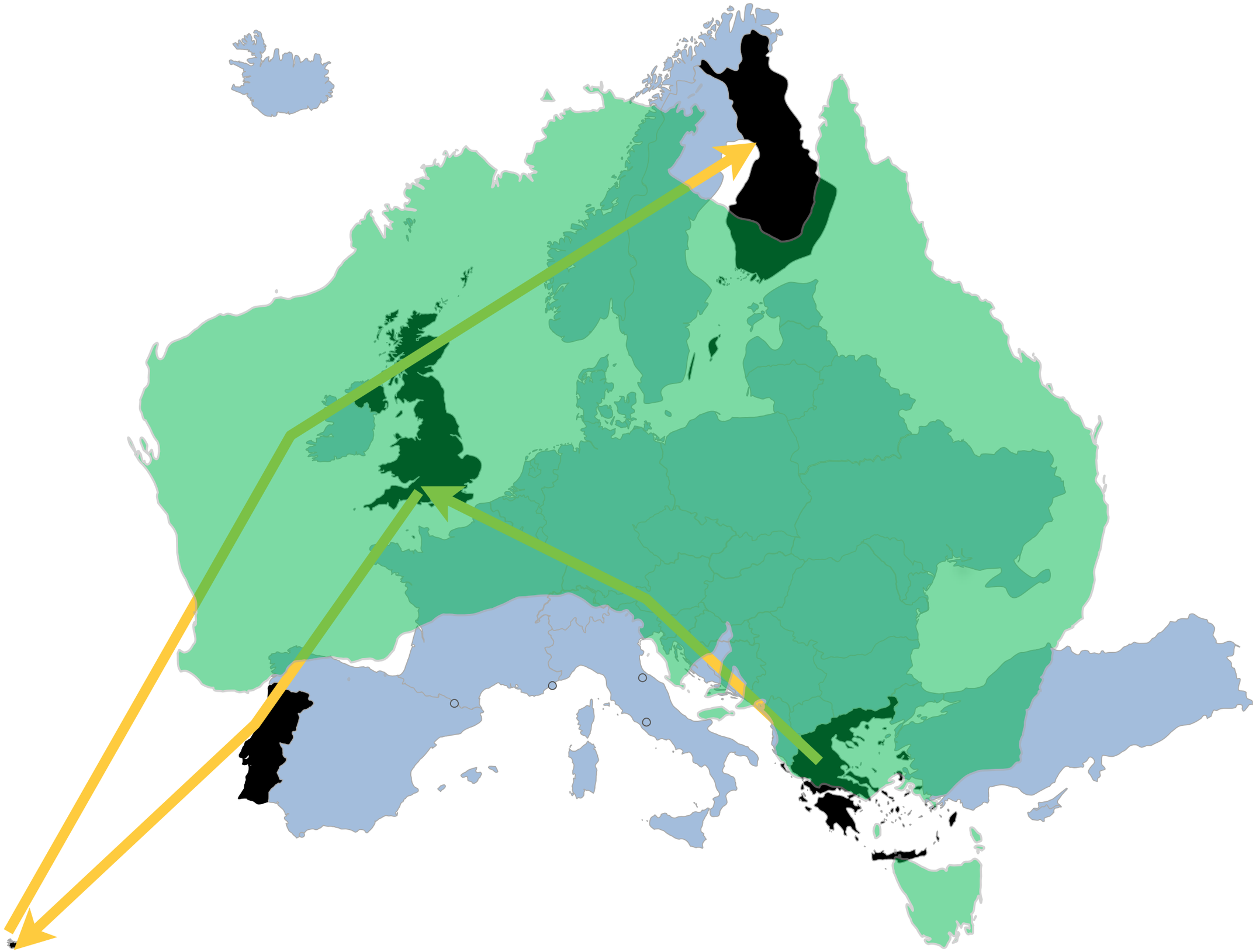
Computer scientists are not (just) programmers

~

Do not hire developers to build research apps

~

Let's collaborate!



Brief history of computing

1960’s

1980’s

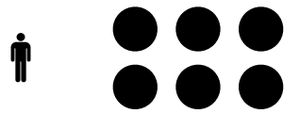
2000’s

3 “Waves” of computing

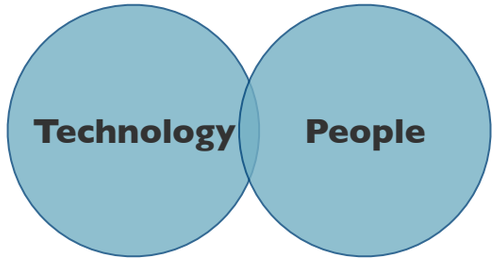
Capabilities

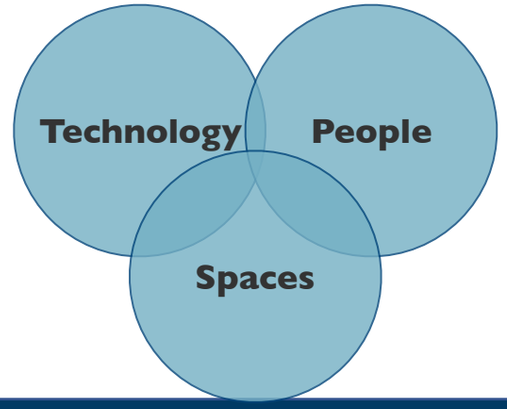
Size

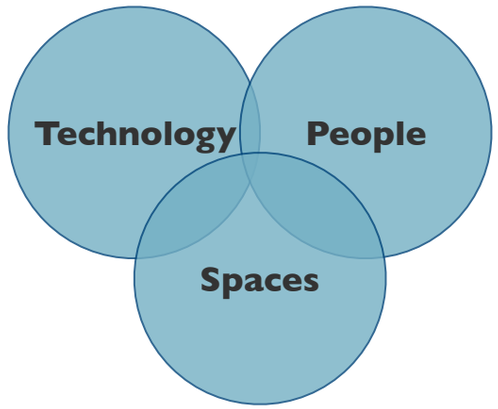
Usage



Research





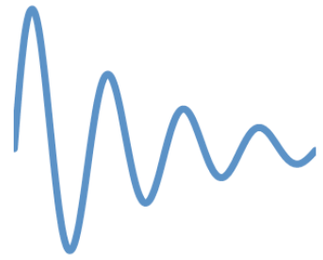


Understand people -> build better technology

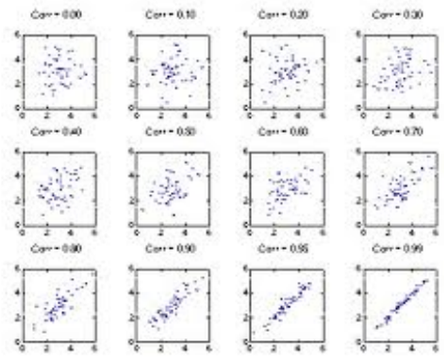
Study technology -> better understand people

Modus operandi

Smartphone/Facebook data

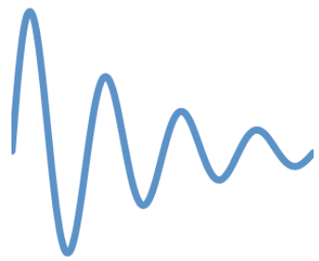


Calculate metrics



Establish correlations
Describe behaviour

Behaviour, attitudes, questionnaires, etc.



Calculate metrics

Sources

Social Media

Smartphone use

Smart city

Interaction

Insights

Happiness

Personality

Habits

Exposure

Methods

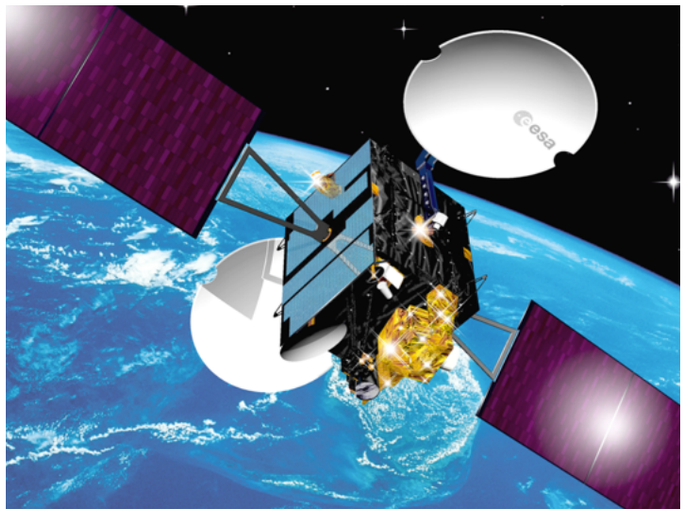
Smartphone instrumentation

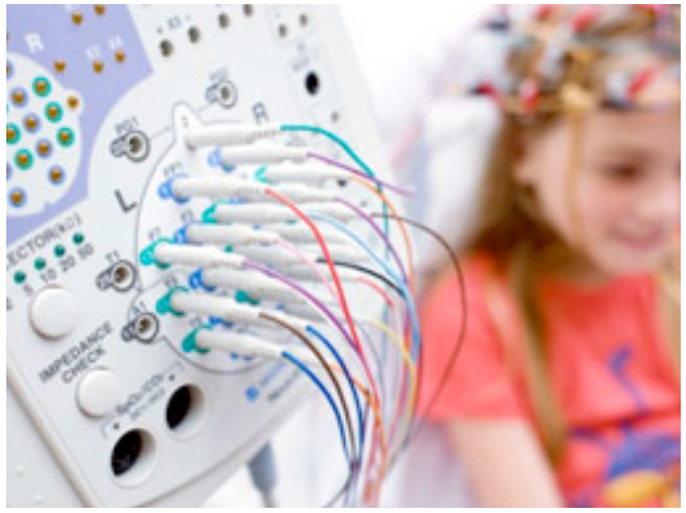
Crowdsourcing

In-the-wild methods

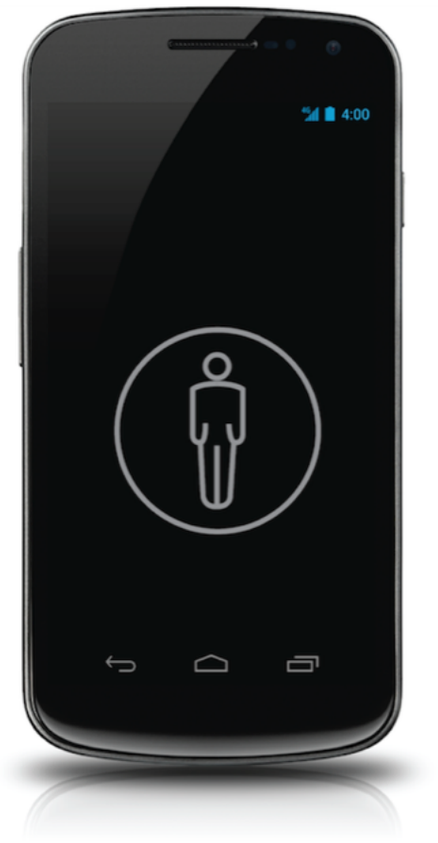
Smartphones for science

Scientific instruments

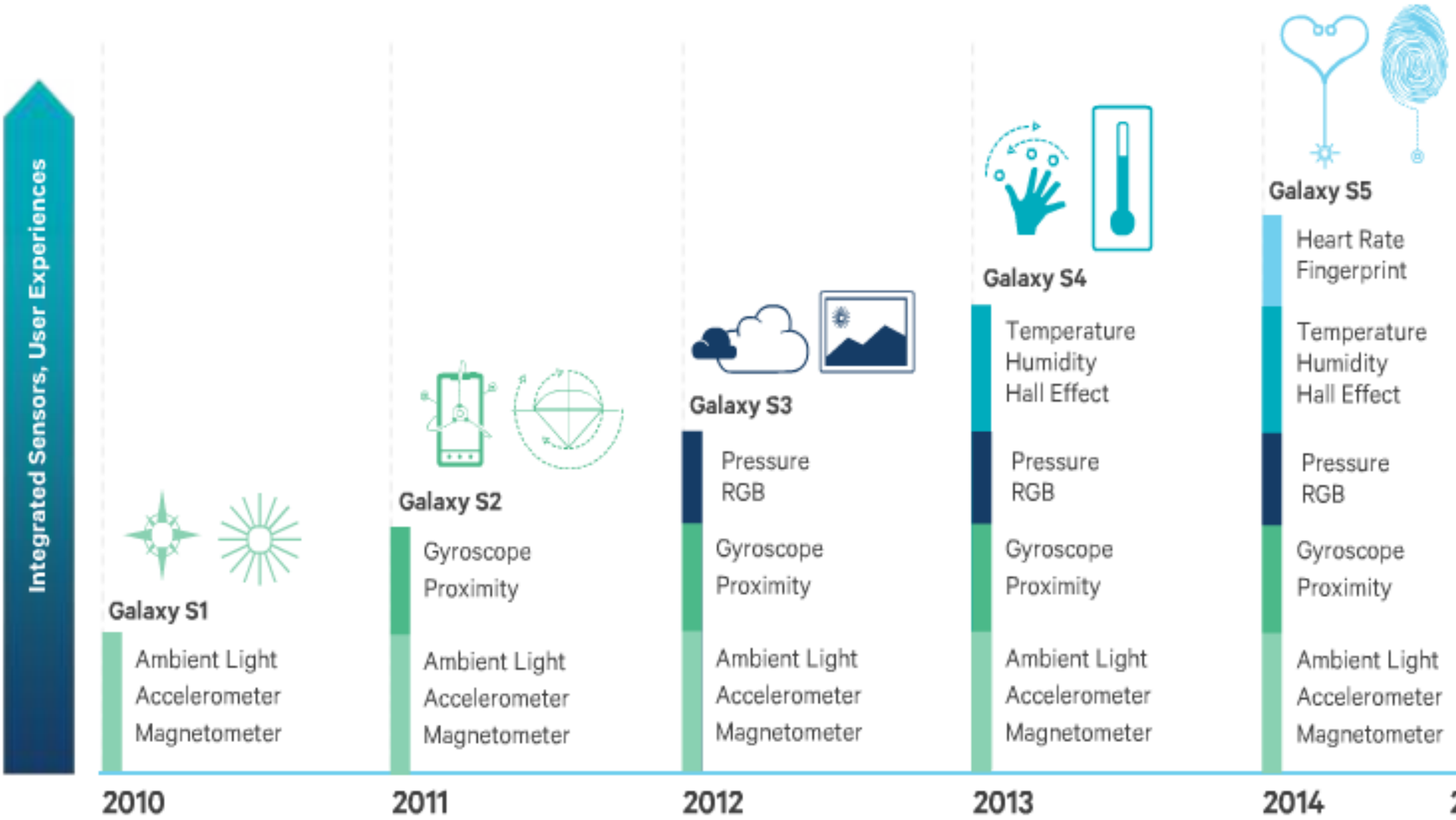




Non-invasive sensing



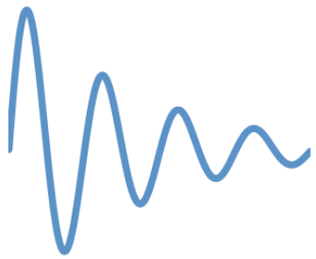
Sensor growth in smartphones

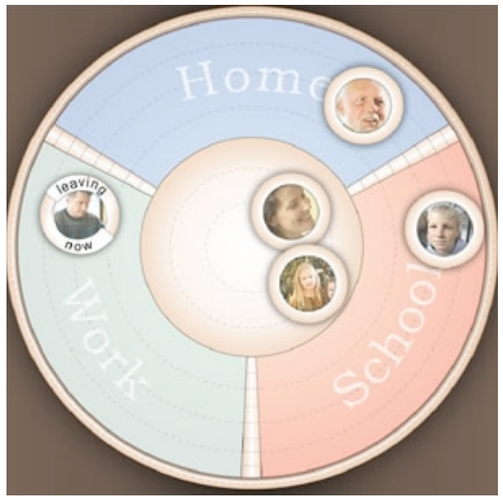


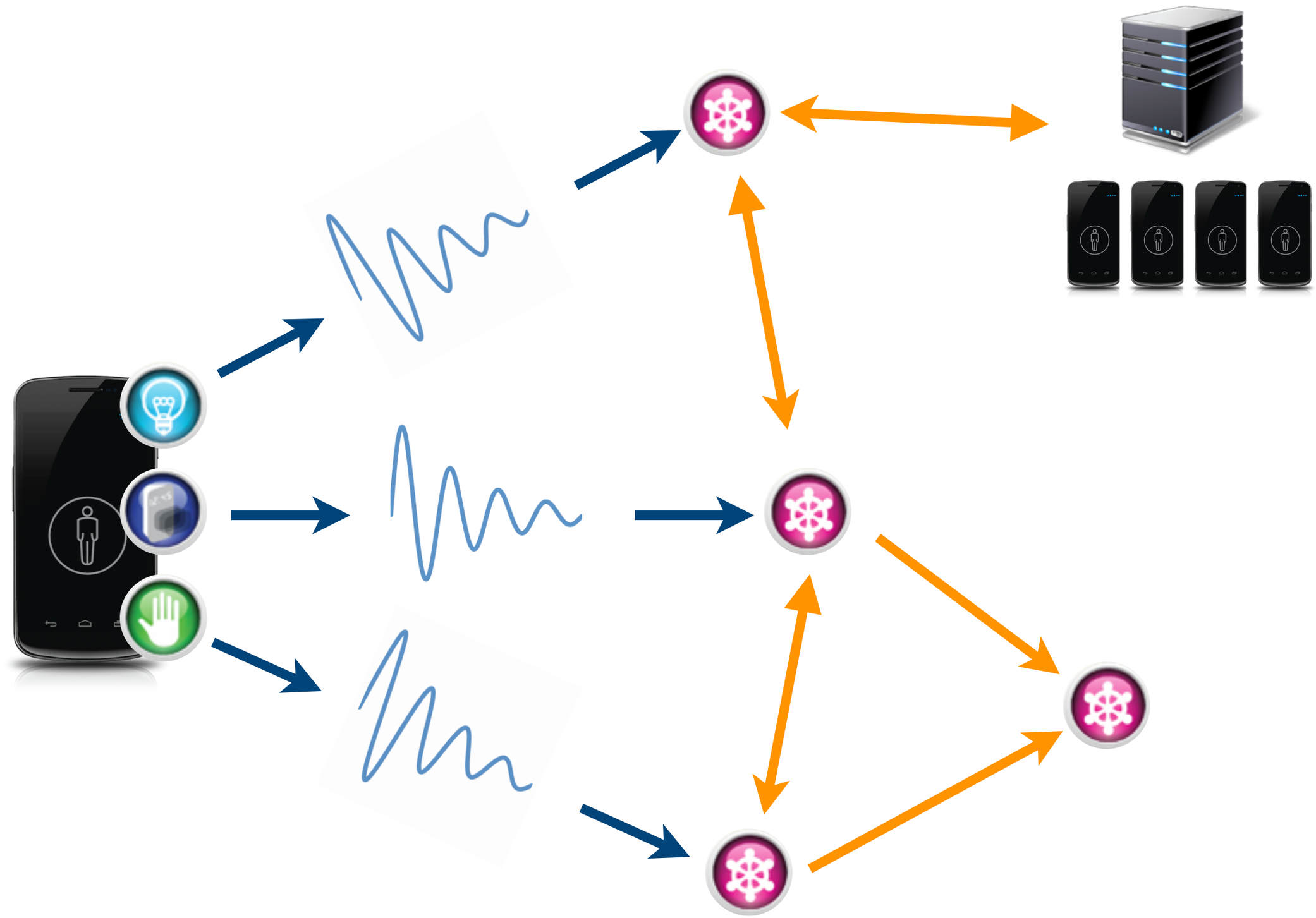
What to analyse?

How to analyse?

Start from scratch





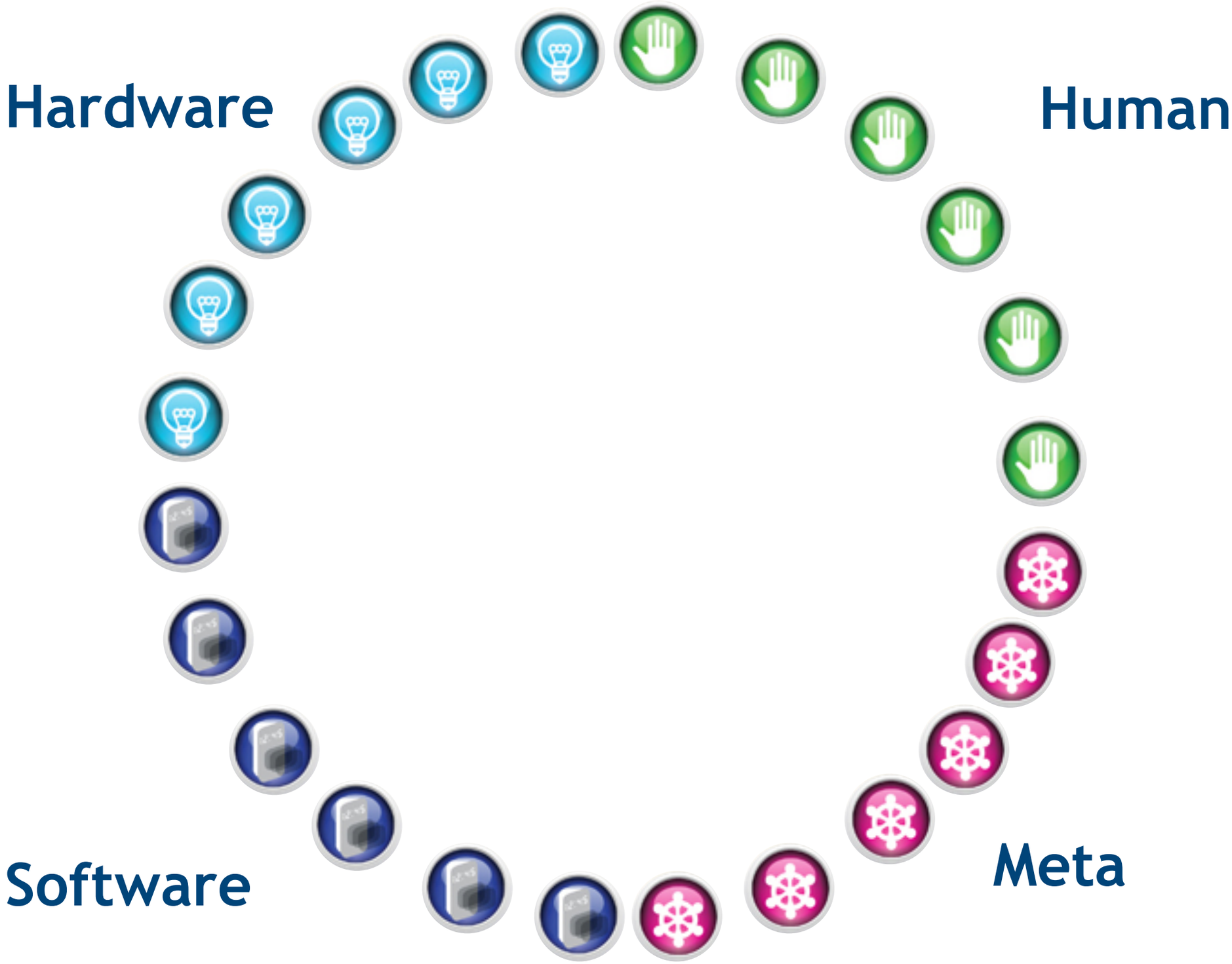


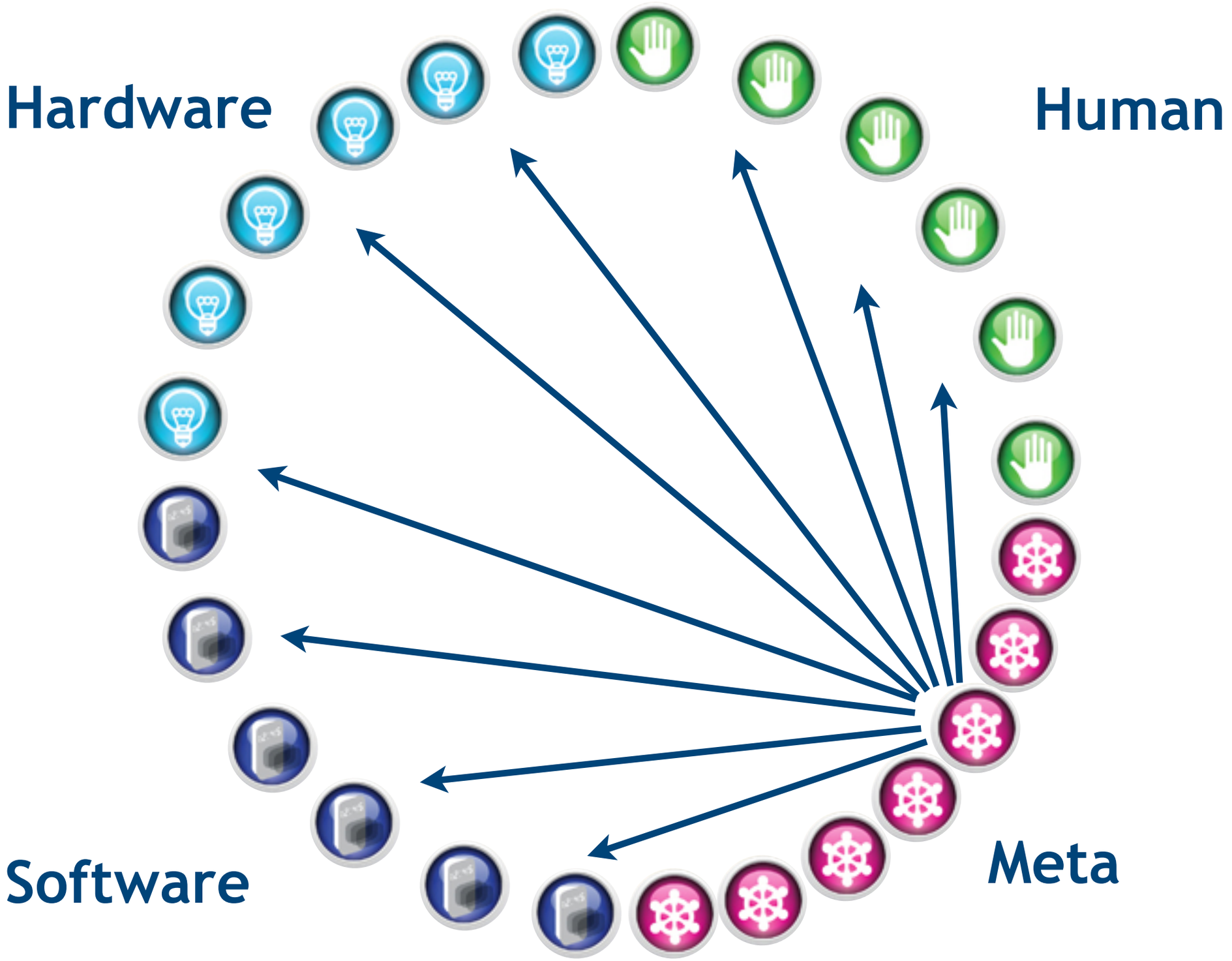
Hardware

Software

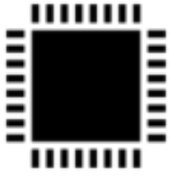
Human

Meta


Hardware
Human
Software
Meta


Hardware
Human
Software
Meta

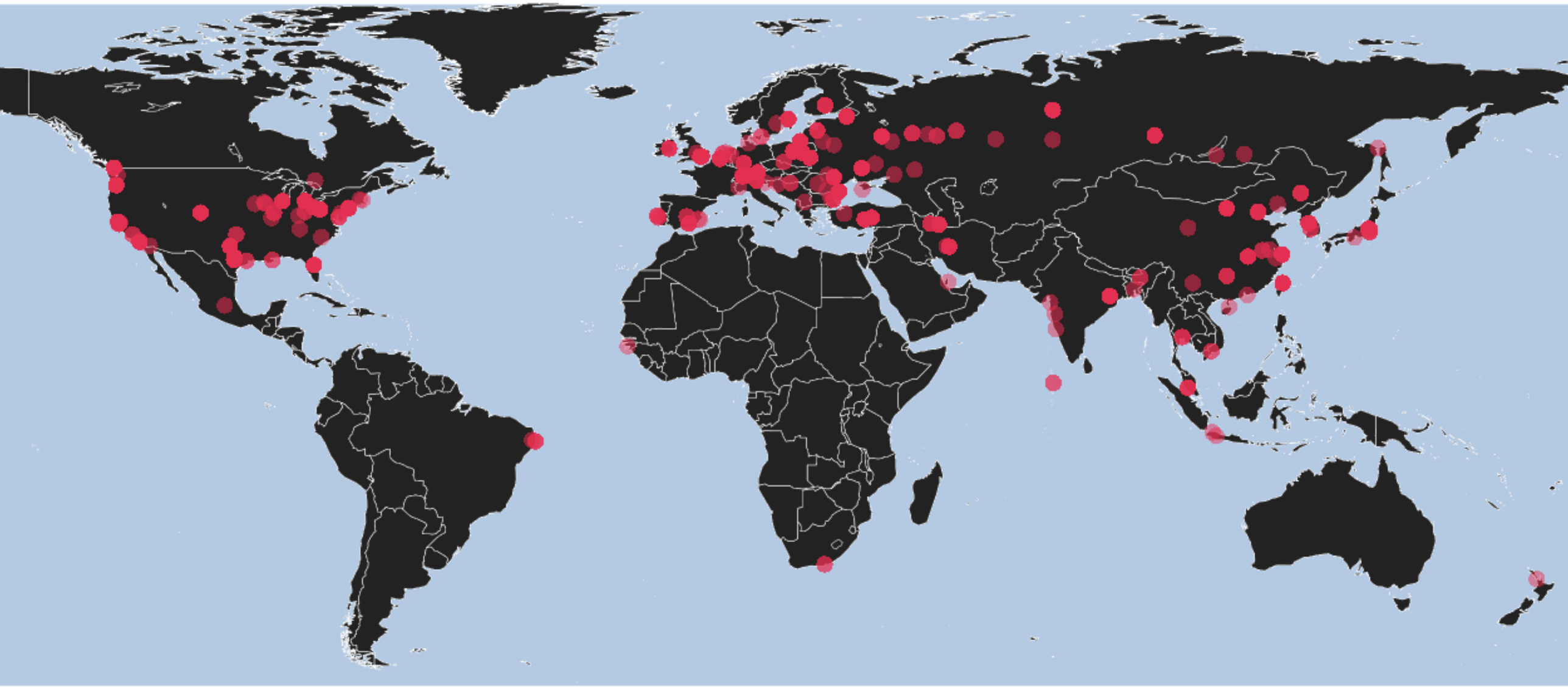
Hardware



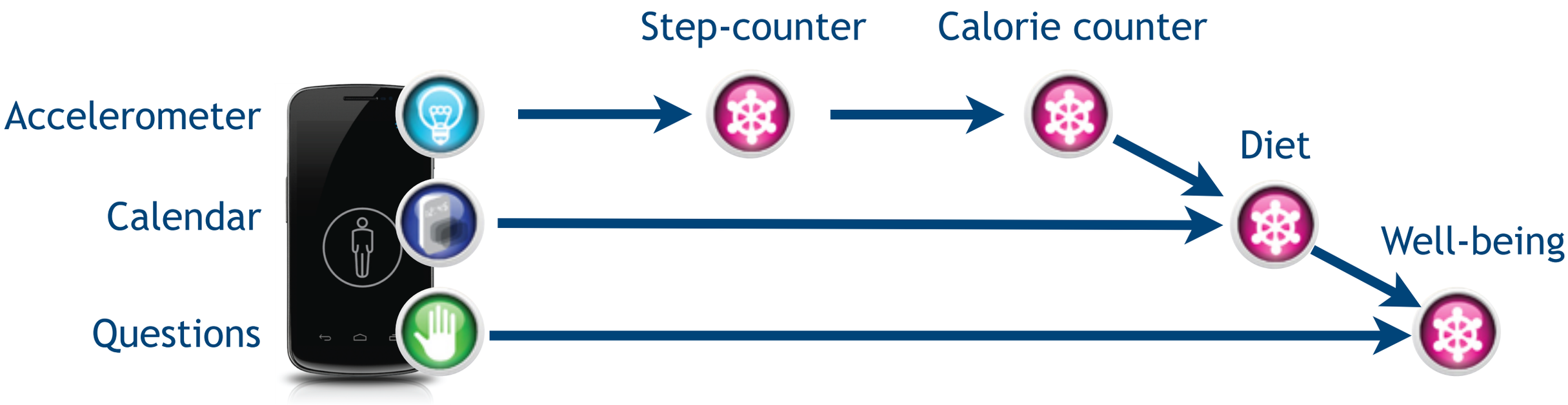
Software

Human

Kostakos, V., & Ferreira, D. (2015). The Rise Of Ubiquitous Instrumentation. **Frontiers in ICT**, 2(3), 1-2.



“LEGO” - context



Individuals: Record your own data

No programming skills are required. The mobile application allows you to enable or disable sensors and plugins. The data is saved locally on your mobile phone. Privacy is enforced by design, so AWARE does not log personal information, such as phone numbers or contacts information. You can additionally install plugins that will further enhance the capabilities of your device, straight from the client.

Scientists: Run studies

Running a mobile related study has never been easier. Install AWARE on the participants phone, select the data you want to collect and that is it. If you use the AWARE dashboard, you can request your participants' data, check their participation and remotely trigger mobile ESM (Experience Sampling Method) questionnaires, anytime and anywhere from the convenience of your Internet browser. The framework does not record the data you need? Check our tutorials to learn how to create your own plugins, or just contact us to help you with your study! Our research group is always willing to collaborate.

Developers: Make your apps smarter

Nothing is more stressful than to interrupt a mobile phone user at the most unfortunate moments. AWARE provides application developers with user's context using AWARE's API. AWARE is available as an Android library. User's current context is shared at the operating system level, thus empowering richer context-aware applications for the end-users.

Demo (online)

Earthquake_japan

Status: Closed Open

Join study: https://api.awareframework.com/index.php/webservice/index/63/dRWYUlt4
Show QRcode

Description: Earthquake sensing using smartphone accelerometer.

Sensors:

- Accelerometer
  - Status accelerometer
    True or false to activate or deactivate accelerometer sensor.
  - Frequency accelerometer: 200000
    Non-deterministic frequency in microseconds (dependent of the hardware sensor capabilities and resources), e.g., 200000 (normal), 60000 (UI), 20000 (game), 0 (fastest).
- Ambient Noise
- Android Wear
- Applications
- Barometer
  - Status barometer
    True or false to activate or deactivate sensor.
  - Frequency barometer: 200000
    Non-deterministic frequency in microseconds (dependent of the hardware sensor capabilities and resources). You can also use a SensorManager sensor delay constant.
- Battery
- Bluetooth
- Communication
- Device Usage
- **ESM**
  - Status esm
    True or false to activate or deactivate ESM sensor.
- Google Activity Recognition
- Gravity
- Gyroscope
- Installations
- Light
- Linear Accelerometer
- Locations
- Lux Meter
- Magnetometer
- MQTT
- Network
- NTPtime
- OpenWeather
- Processor
- Proximity
- Rotation
- Screen
  - Status screen
    True or false to activate or deactivate sensor.

Owner: Kostakos, Vassilis

Co-researchers: Ferreira, Denzil ✖ Gonçalves, Jorge ✖ Pandab, Pratyush ✖ Add co-researcher

Database name: Kostakos_63

Created: 23 May 2014

API key: dRWYUlt4

Visualization: *Date:*

Type	*Total records*
accelerometer	**171653610**
magnetometer	169680505
esms	111
battery	1

Devices:

Devices: Search devices

Displaying 1-8 of total 8 devices. Total of 0 devices selected.

Select all	*Device ID*	*Label*
	00b9246d-8ce0-4c9e-b92b-547244b17446	kolabtab13-v2
	2601c4be-8934-4bf6-9668-bc289996d87d	kolobtab13
	5e704f7b-23bd-4d2b-80fb-60dc84bd77ef	
	6a0a257b-8af6-4a53-b58d-8613310b8483	
	6c2210d3-601b-4623-b9d4-0e2378eb3690	kolobtab14
	ab17f1b5-c65a-4016-872d-3957475ac3b6	kolobtab14-v2
	b95da1f5-7038-4e6f-948e-27a7b5da862d	Denzil phone
	bf3940fb-2767-4ac7-9ae1-9f1fd116eda2	kolobtab14-v3

Displaying 1-8 of total 8 devices. Total of 0 devices selected.

Send to device(s):

ESM | Broadcasts | Configure | Custom

Message type: Free text

Title: ESM Freetext

Instructions: The user can answer an open ended question

Time to answer: Unlimited

ESM Queue

Type	*Title*
Your ESM queue is empty.	

Add to queue | Send ESM(s)

MQTT history:

Search from MQTT history

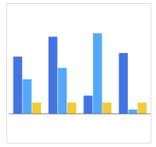
Date	*Topic*	*Title*
26 June 2014	esm	How are you?
18 June 2014	esm	Hello Tokyo
11 June 2014	esm	Testing
26 May 2014	broadcast	ACTION_AWARE_SYNC_DATA
26 May 2014	broadcast	ACTION_AWARE_SYNC_DATA

Show more

Studies » Battery Drainer Game » Visualizations » New chart

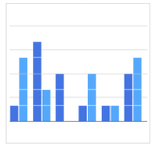
1. Choose a chart

Column chart



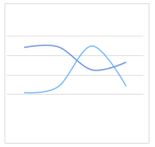
Pie chart

Histogram



Scatter chart

Line chart



Box chart

Cancel | Fine Tuning | Next

Studies » Battery Drainer Game » Visualizations » New chart

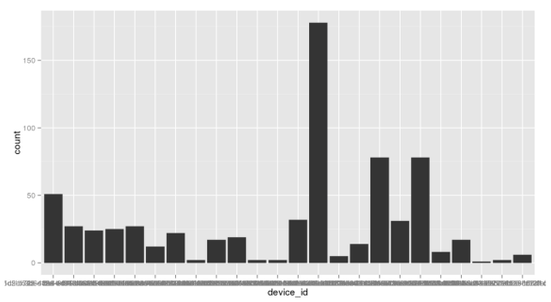
1. Choose a chart | 2. Data selection

Column chart

Select a table : battery_charges

Grouping variable :

Stacking variable :



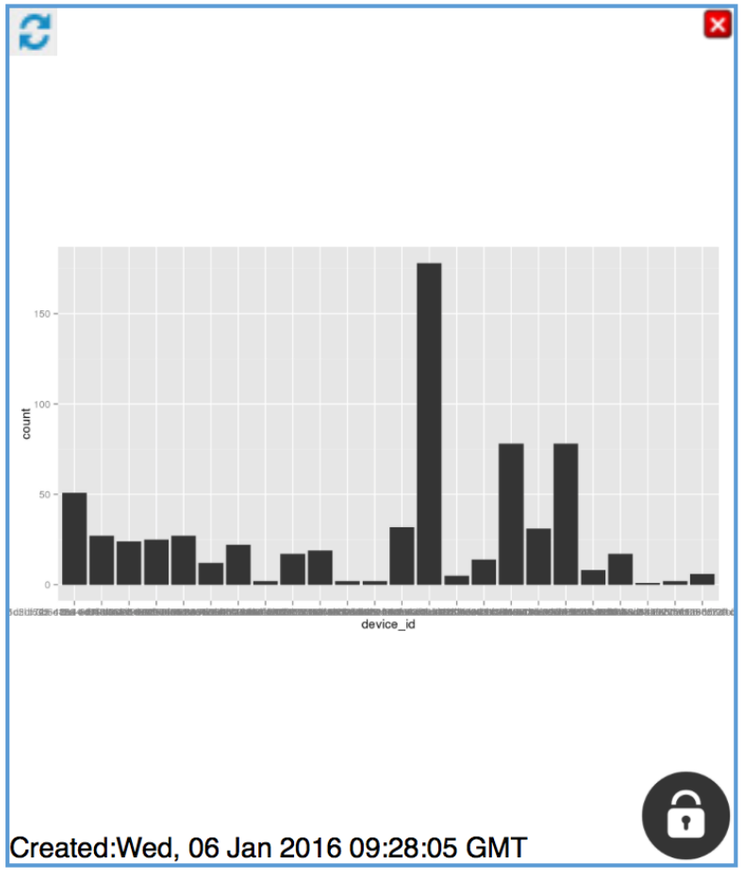
Select x-axis variable : device_id

Cancel | Fine Tuning | Save

DEVELOPER RESEARCHER MANAGER

Studies » Battery Drainer Game » Visualizations

Public page link: https://api.awareframework.com/index.php/visualizations_public/235



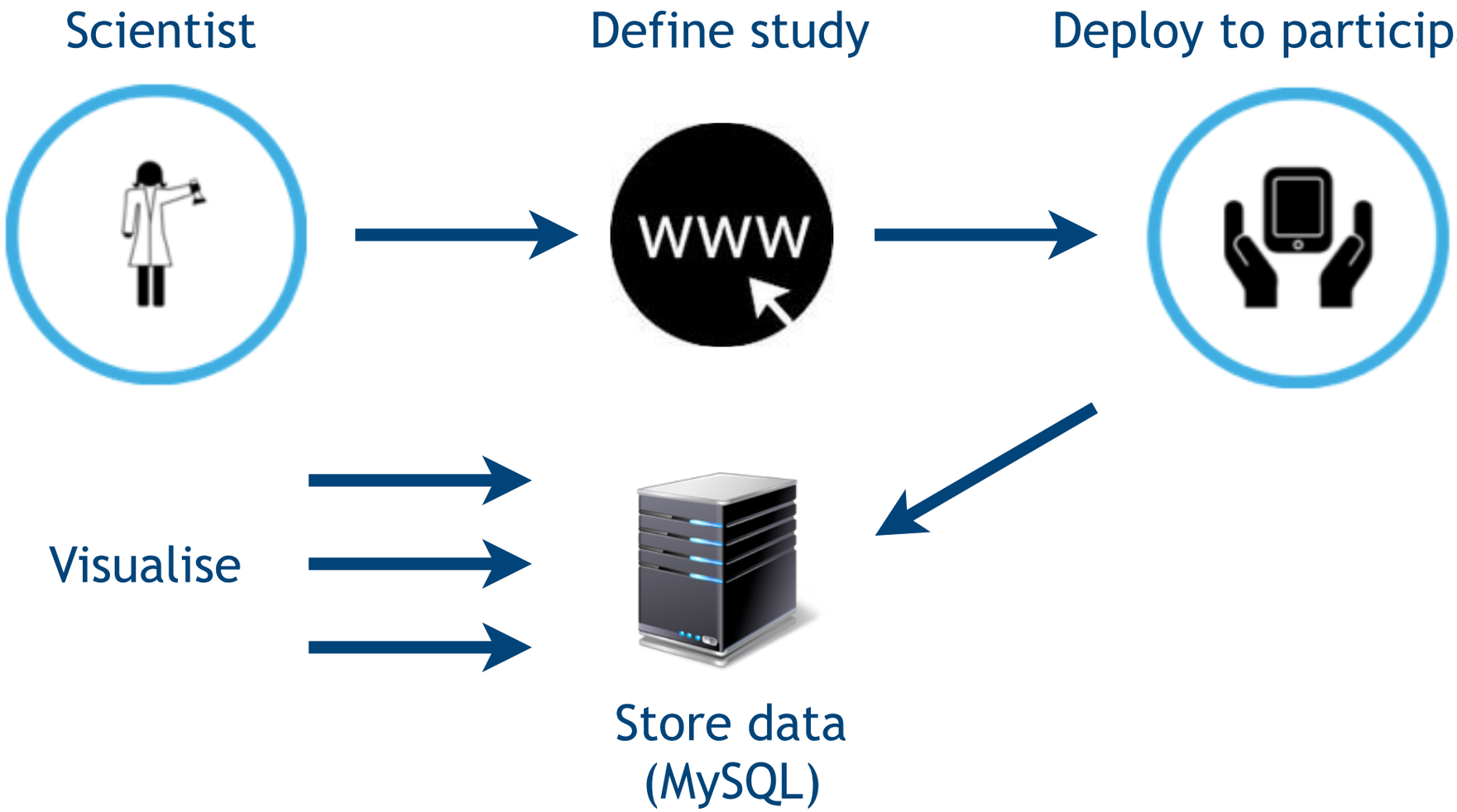
Created:Wed, 06 Jan 2016 09:28:05 GMT

Create a new chart.

Instrumentation scale

Data diversity	Micro	Meso	Macro
Sensors			
Hardware	Computational behavioural science	Computational social science	Engineering social systems
Software	Personal informatics	Community behavior	Cultural imaging
Human	Personal diagnosis	Intermittent cohorts	Global cohorts

Ubiquity


Scientist
Define study
Deploy to participants
www
Visualise
Store data
(MySQL)

Scientific instrument

Experience Sampling Method

Passive sensor collection

Behavioural studies
(Personality prediction)

Medical studies
(Parkinson’s / Cancer / Pain)

Environmental exposure studies
(Urban mobility)

Transport engineering
(Crowd simulation, queue modelling)

Economics
(Power consumption modelling)

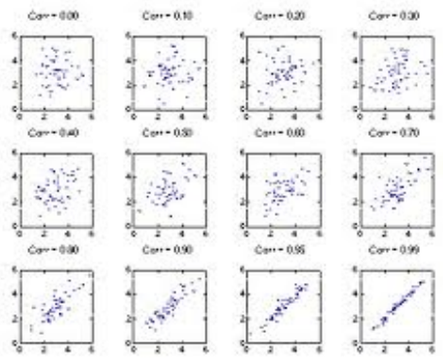
Role of UbiComp Scientists?

- We need scientists who can build market-ready technology
  - Our software is deployed into the hands of patients/users/ consumers
- Who have experience with human-subjects studies
  - Our software is used on a daily basis, in-situ
- Who can "speak" the language of other disciplines
  - Large multidisciplinary teams
- Who can understand the nuances of interaction
  - Separate "noise" from "valuable" data

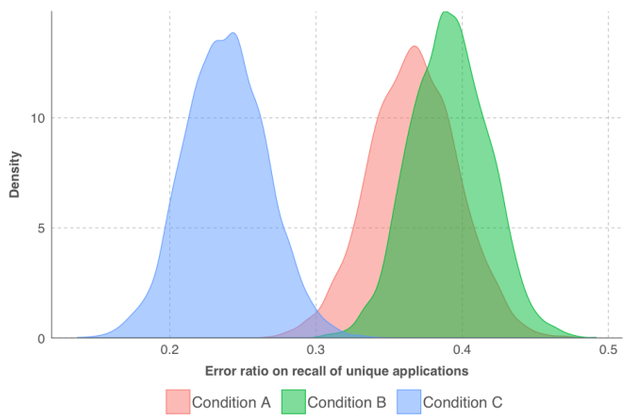
Measurement

Phenomena

Sample data



Analysis/Statistics

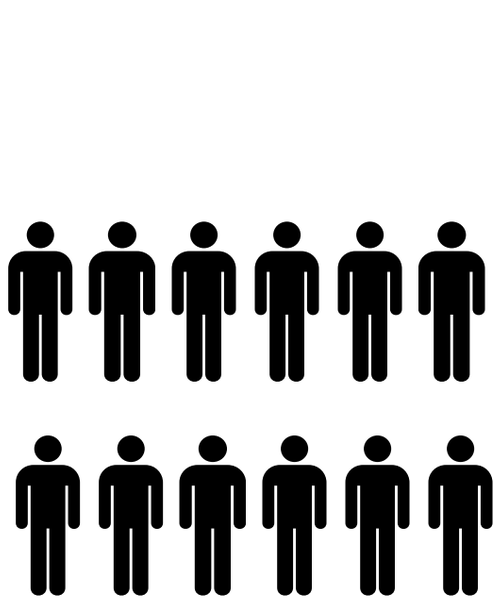


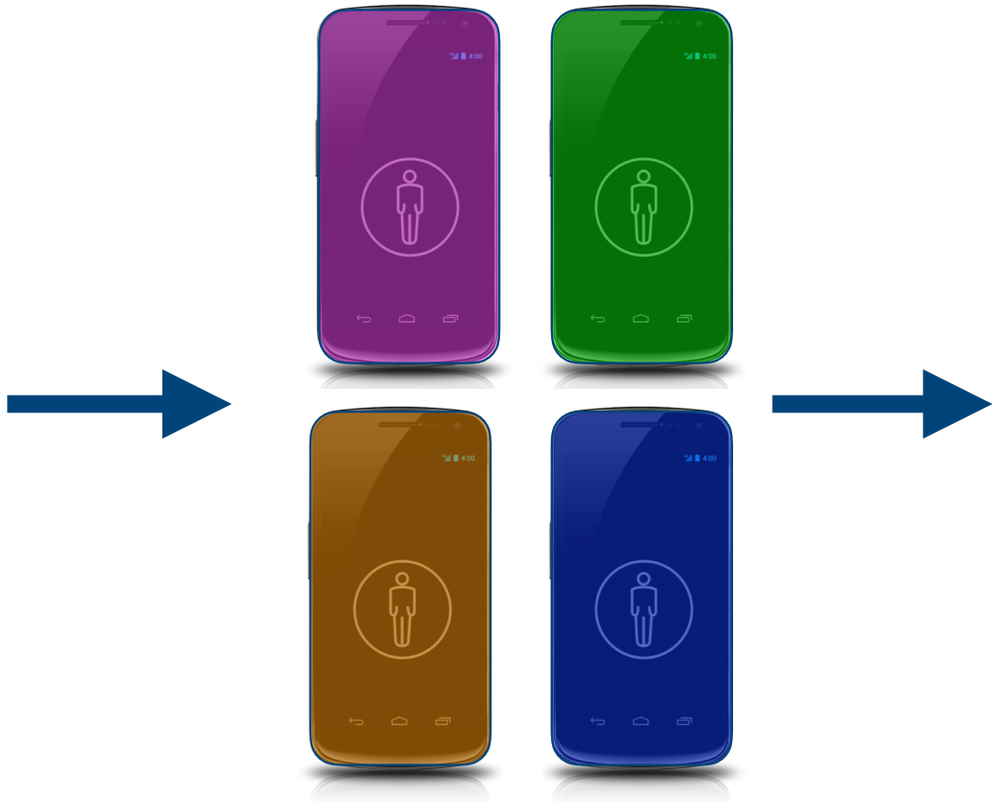
Measurement instrument

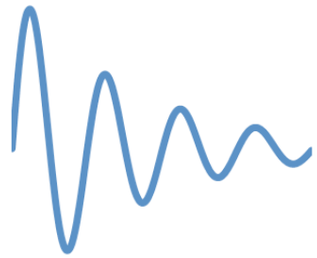
- Bias
- Reliability
- Transparency
- Repeatability

- Privacy
- Battery life
- Convenience

Repeatability: automated testing

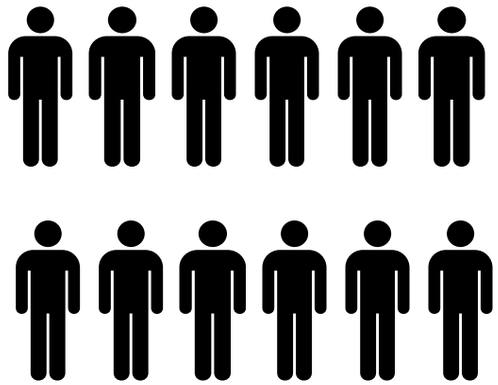


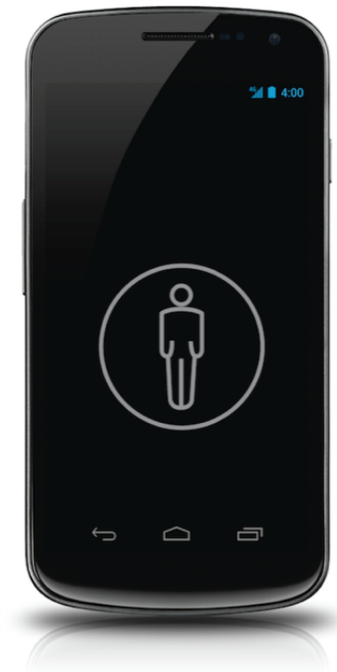


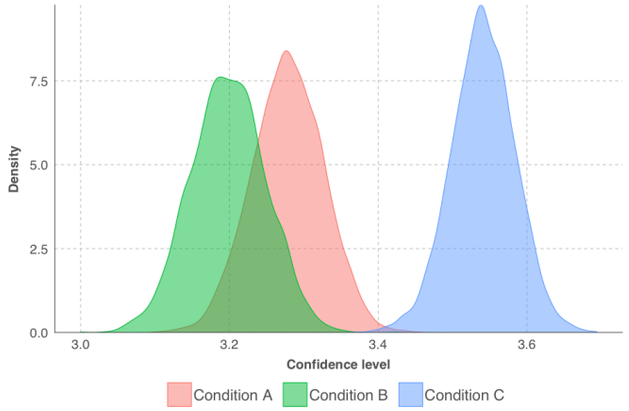


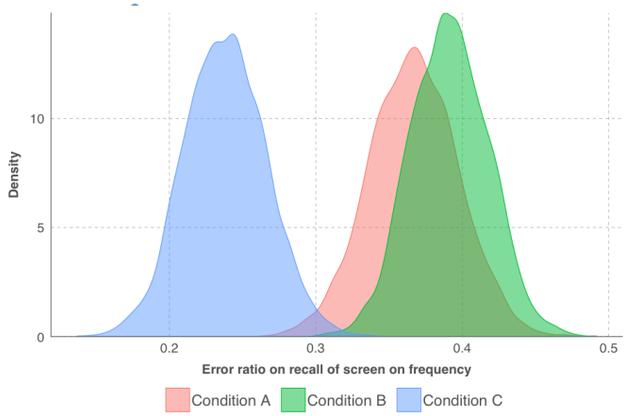
Calculate metrics

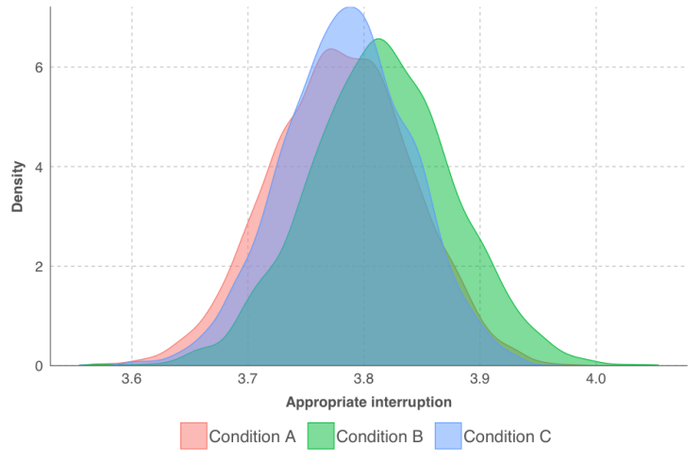
Reliability: ESM/EMA accuracy



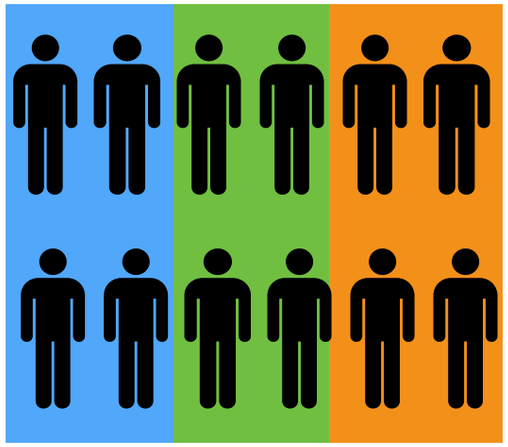


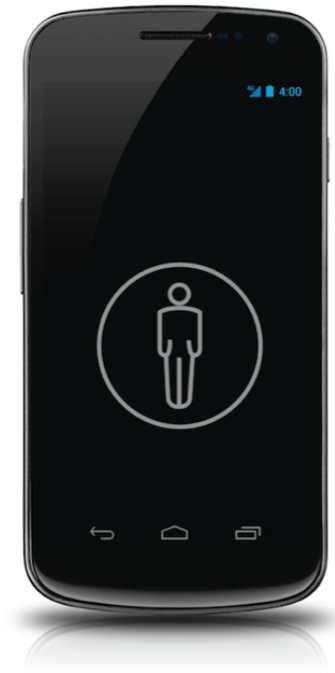


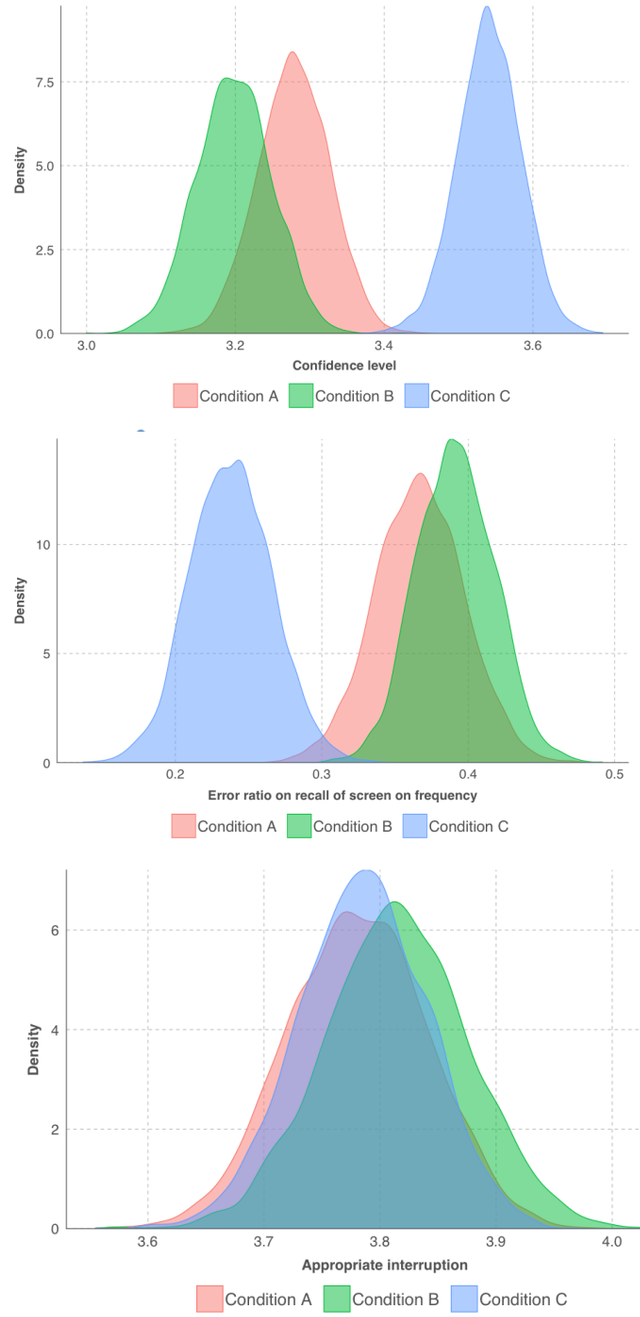




Reliability: situational impairments

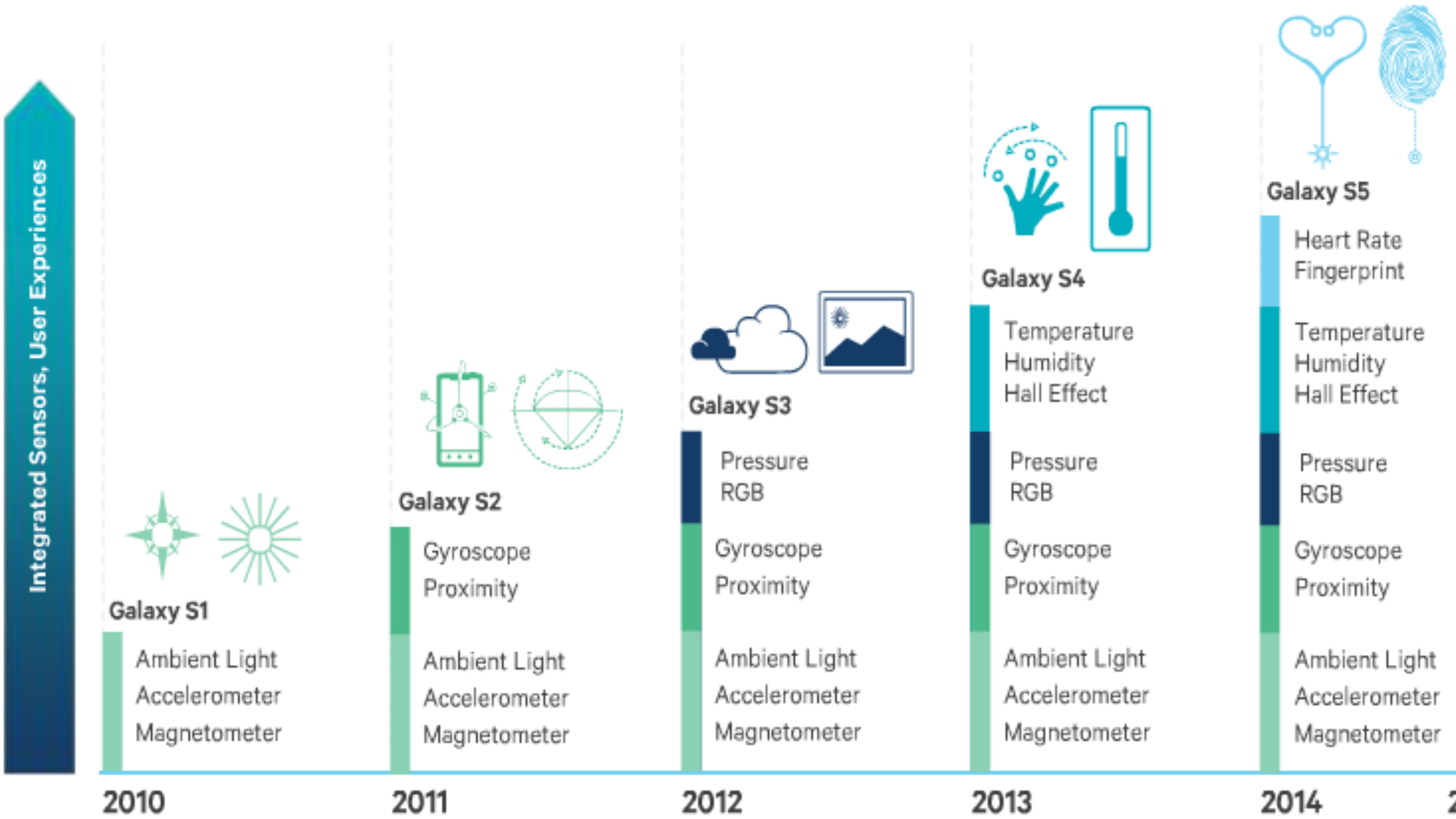






Privacy: on-board inference

Sensor growth in smartphones

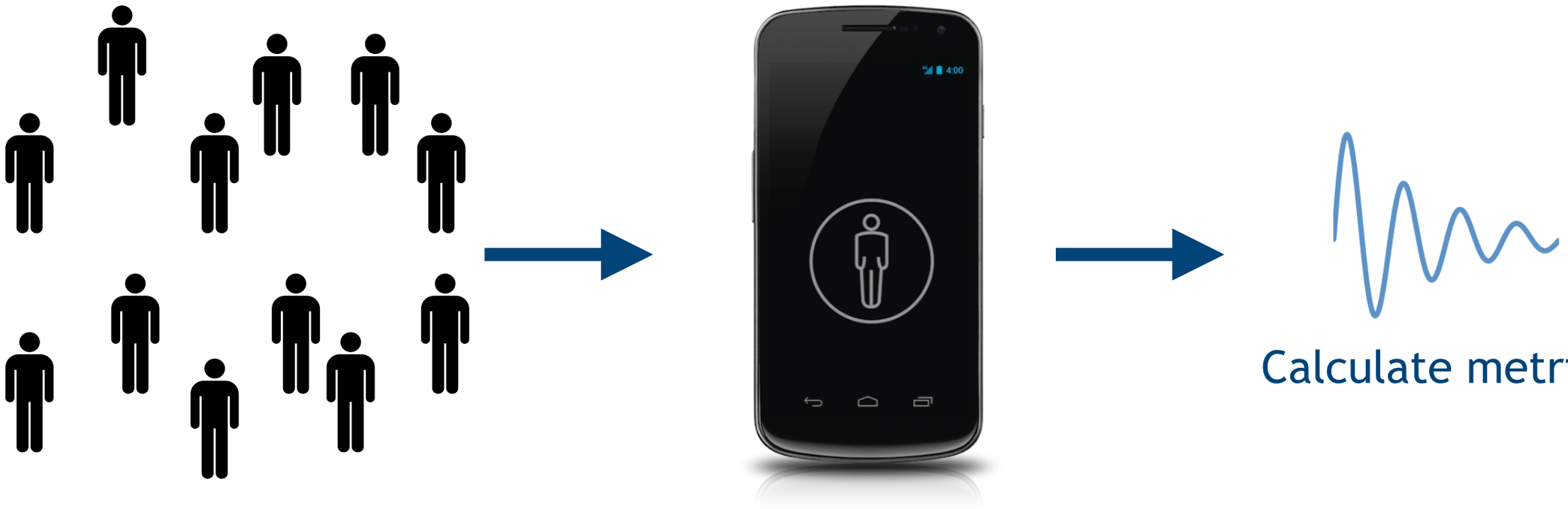


Convenience: gamification

Calculate metrics

Convenience: crowdsourcing

Convenience: crowdsourcing



Keeping our eyes on the future

NIRS: Near Infrared Spectroscopy

The end!

Prof. Vassilis Kostakos
vassilis.kostakos@unimelb.edu.au

School of Computing and Information Systems
University of Melbourne

http://awareframework.com