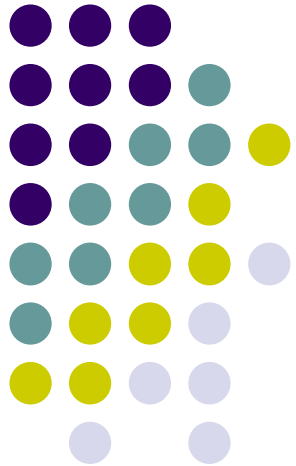
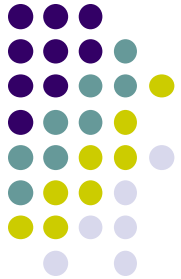
Warfighter Analytics for Smartphone Healthcare (WASH) User Study

WPI WASH Team

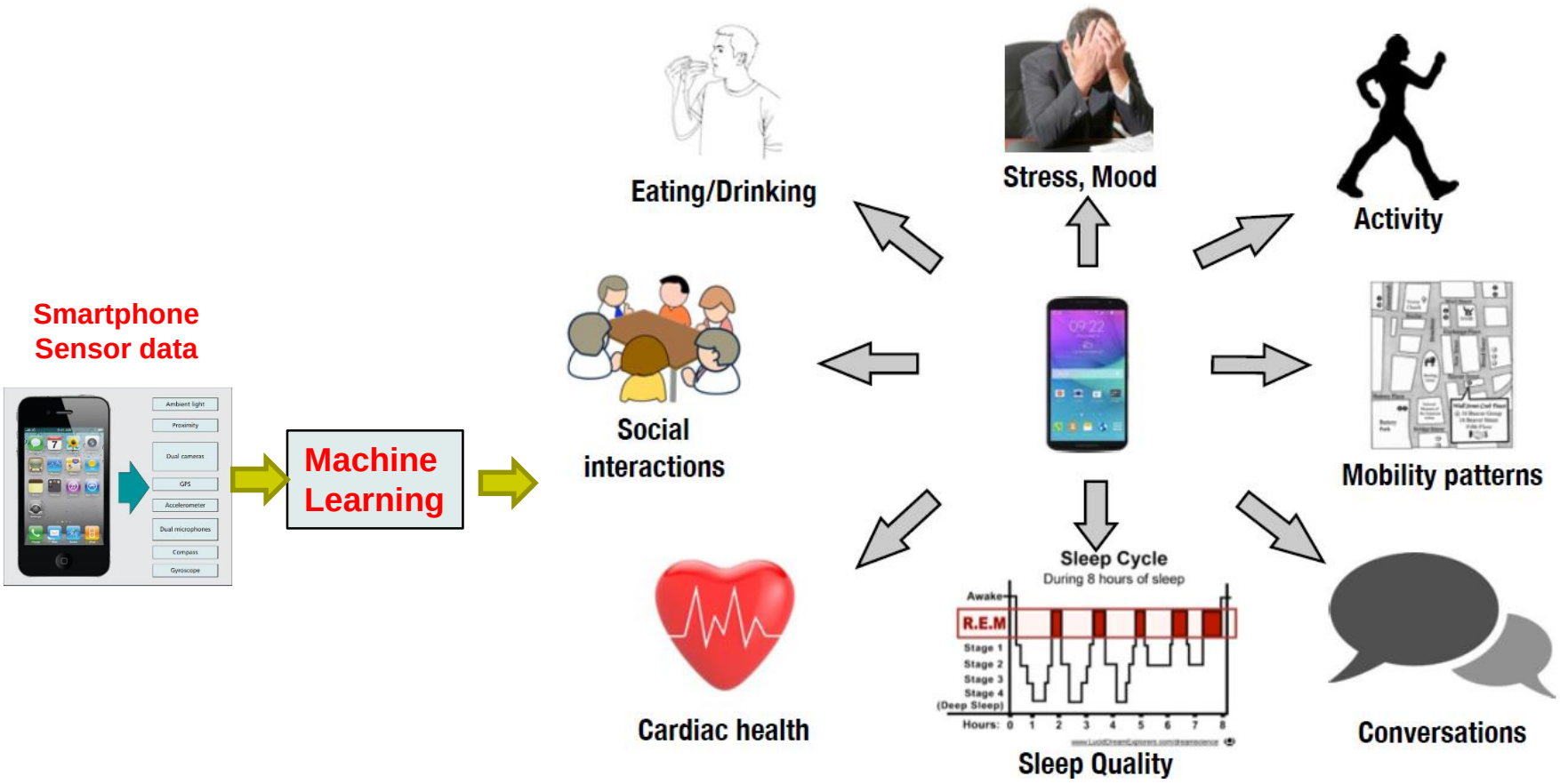




Project Background

Background: Smartphone Sensing

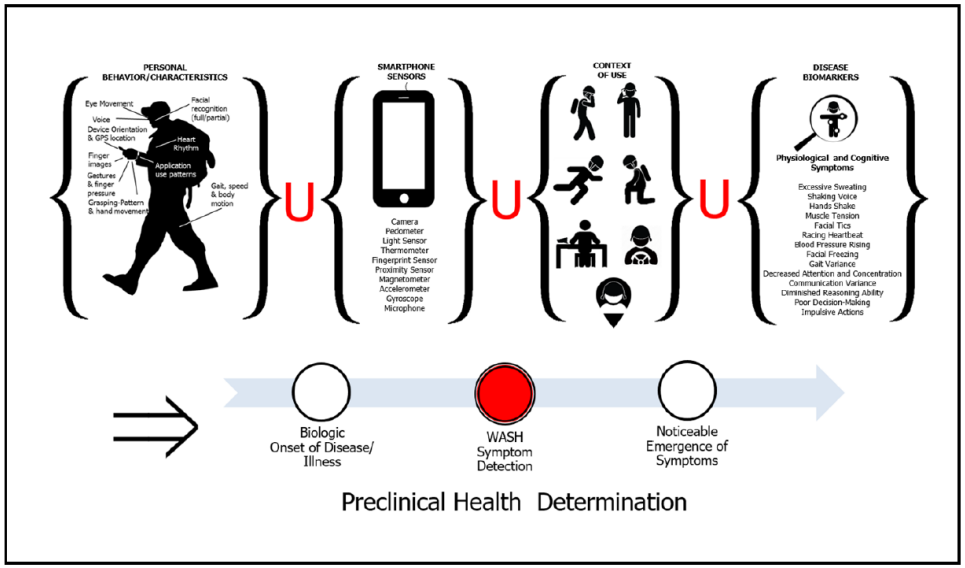
- Smartphones have many (20+) sensors
  - accelerometer, compass, GPS, microphone, camera, proximity
- Can sense physical world, detect user behaviors, sick smartphone user, etc



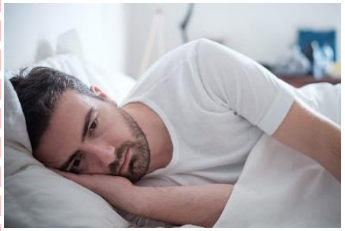
Smartphone BioMarkers to Improve Warfighter Health

PI: Agu, co-PI: Rundensteiner

- US military want early signs of warfighter ailment:
  - Traumatic Brain Injury (bomb blasts, explosions, fall, etc)
  - Infectious diseases (E.g. tuberculosis, pneumonia, measles, meningitis, malaria, Ebola, cholera and influenza)
- **WASH Concept:** Smartphone-sensable biomarkers may manifest first
  - E.g. reduced mobility, sedentary, sleep problems, stay close to home
- WPI received $2.8 from DARPA (military) to research smartphone biomarkers for TBI and infectious diseases

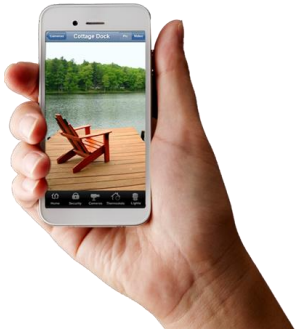


Examples of TBI, Infectious Disease Biomarkers Detectable by Smartphone

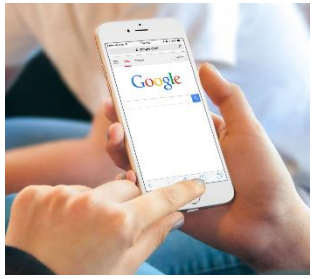


Sleep problems

Pupils dilated



Hands shaking



Slow phone interactions

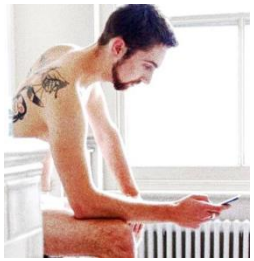
Avoiding light

Slurred speech

Traumatic Brain Injury (TBI) Smartphone Biomarkers

Walking Problems

Coughing



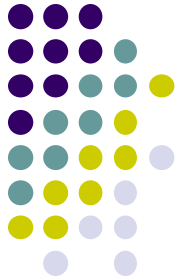
Increased Bathroom usage

Sneezing

Infectious Disease Smartphone Biomarkers

Note: Specific tests (e.g. hands shaking) in specific situations (e.g. user holding phone)

Our Research Approach



- We now have specific list of 30 contexts in which we will run 14 specific TBI/infectious disease tests
- **Research Question 1:** Can smartphone detect when a smartphone user is in one of our specific contexts?
- Methodology:
  - Recruit 100 subjects
  - Run a scripted user study
  - Subjects using smartphone, enter each of 32 contexts
  - Gather smartphone data continuously in background
  - Later: analyze data (machine learning)
    - Research Question: Can user situations be reliably detected from smartphone data

Context: Definition & Final List of Contexts

Context = (User Activity, Phone Prioception, App Category, Social)

Sitting
Standing
Walking
Lying down
Sleeping
Awake/not sleeping
Interacting with phone
Coughing
Exercising
Running
Sneezing
Sitting down
Lying down
Standing up
Talking into phone

Phone in Hand
Phone facing down
Phone on table
Trouser pocket
In bag
Briefcase
Jacket pocket

Games
- Video game

Media & Video
- Video Chat
- Video streaming

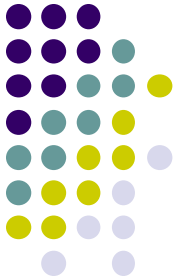
Communication
- Messaging

Social
- Messaging

Entertainment
- Video streaming

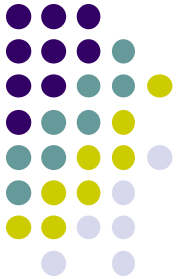
Alone
2 or more speakers
More than 2 speakers
Busy place

30 Contexts Needed for Our Tests



1	<interacting with phone, phone in hand, *, *>
2	<*, phone in hand, *, *>
3	<lying down, *, *, *>
4	<sitting, *, *, *>
5	<standing, *, *, *>
6	<sleeping, *, *, *>
7	<awake, *, *, *>
8	<walking, in pocket, *, *>
9	<walking, in hand, *, *>
10	<walking, in bag, *, *>
11	<*, phone on table, *, *>
12	<*, phone facing down, *, *>
13	<talking into phone, *, *, *>
14	<*, *, *, more than 2 speakers>
15	<Coughing, *, *, *>

16	<Coughing, *, *, in busy place>
17	<Toilet, *, *, *>
18	<Toilet, Phone in pocket, *, *>
19	<sleeping, phone on table, *, 0>
20	<exercising, phone in hand, *, 0>
21	<exercising, phone on table, *, 0>
22	<exercising, *, *, more than 2 speakers>
23	<Sneezing, *, *, 2 or more speakers>
24	In noisy/bust place
25	<lying down, phone on table, *, *>
26	<Sneezing, *, *, alone>
27	<Sitting up, *, *, *>
28	<Standing up, *, *, *>
29	<Sitting down, *, *, *>
30	<Lying down, *, *, *>



WASH User Study Overview

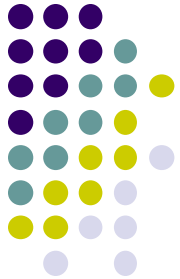
Context Collection Study: Overview

- Scripted, on-campus study to cover the majority of identified contexts
- Each subjects completes a carefully planned circuit, timed
- Each subject given same Essential Android phones to ensu consistent data
- Mobile app automatically gathers sensor data, labels entered manually with timestamps

Context Data Study: Route @ WPI

1. Fuller Labs
   - Briefing
2. Recreation Center
   - Walking, running
   - Bathroom
3. Morgan Hall
   - Phone call
   - Water break
   - Being in a busy place
4. Fuller Labs
   - Lying down
   - Sitting down
   - Standing up

Context Collection Study: Sensors

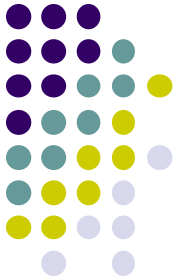


Standard:

- Gyroscope
- Accelerometer
- Barometer
- Magnetometer
- Location Services
  - Speed
  - Distance traveled over a period of time

Experimental:

- Audio
  - Feature extraction on phone to mitigate privacy concerns
- Ambient light
- Proximity
- Discrete sensors
  - Is the phone charging?
  - Are they interacting with it?



Main Steps for Subject

Steps for Study Subjects

- Go to this link to sign up
  - https://docs.google.com/spreadsheets/d/1marttdu2zJxTzboOPhNW1XGaMKMVrKF2iTgQA0WkvuI/edit?usp=sharing
- At the time you select, go to Fuller Labs Room 319, ask to meet Luke Buquicchio and WASH students
- Student researchers will:
  - Meet you there
  - Explain the study protocol to you
  - Get your signed consent as a study participant
  - Run the study (at most 1 hour)
  - **Note:** You will receive study phones and all material for this study
- If you have questions, email Luke Buquicchio (ljbuquicchio@wpi.edu)