Funded Mobile Projects in Healthcare Sensing and Imaging

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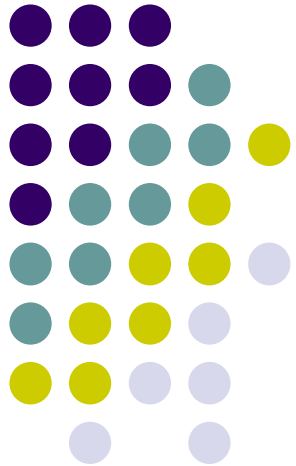
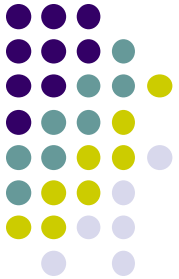




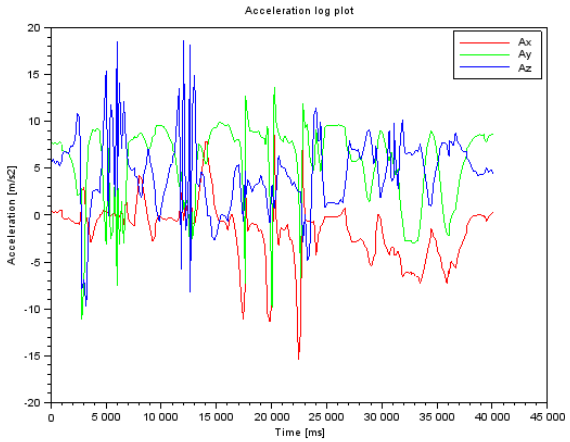
Project 1: AlcoGait Intoxication Sensing

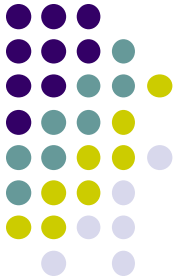
1 Masters student: Spring + Summer

AlcoGait: Intoxication Detection

- Can we test drinker's before DUI? Prevent it?
  - **Vision:** Test gait at party, during walk to car
- How? Alcogait smartphone app:
  - Samples accelerometer, gyroscope
  - Extracts accelerometer and gyroscope features
  - Classify features using Machine Learning

    (SVM, naïve Bayes, Random Forest, etc)
  - Notifies user if they are too drunk to drive
- Video: https://www.youtube.com/watch?v=pwZaoKmfq8c





Project 2: SmartPhone Wound Imaging

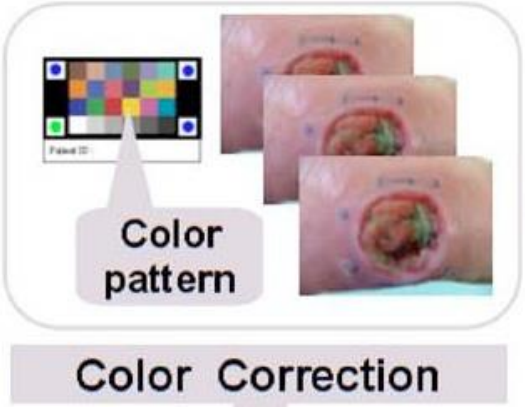
3 PhD Students

Sugar Diabetes App

PI: Strong, co-PIs: Tulu, Agu, Pedersen UMASS: Harlan, Pagoto, Ignotz, Dunn
ECE PhD Student: Lei Wang (wound analysis)

- **NSF-SCH funded project:** smartphone app
  - Diet, blood glucose, exercise, weight
  - Analyzes wound healing from pictures
    - Wound boundary detection
    - Generates wound healing score
  - Behavior change (reminders, goal-setting)
- Funding: $1.2 million, 2011-2015


Wound image acquisition



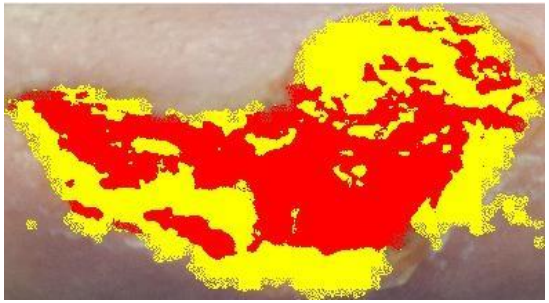
Color Correction


Unsupervised Segmentation

Sugar Wound Assessment: Sample Steps

Wound Image

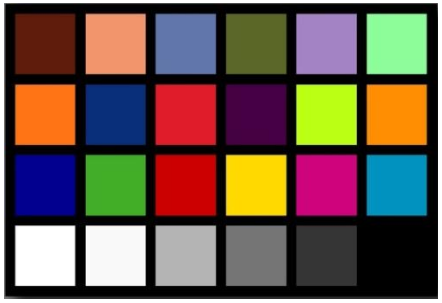
Wound boundary determination
(Conditional Random Fields)



Tissue composition analysis
(Red-Black-yellow model)
K-means Clustering

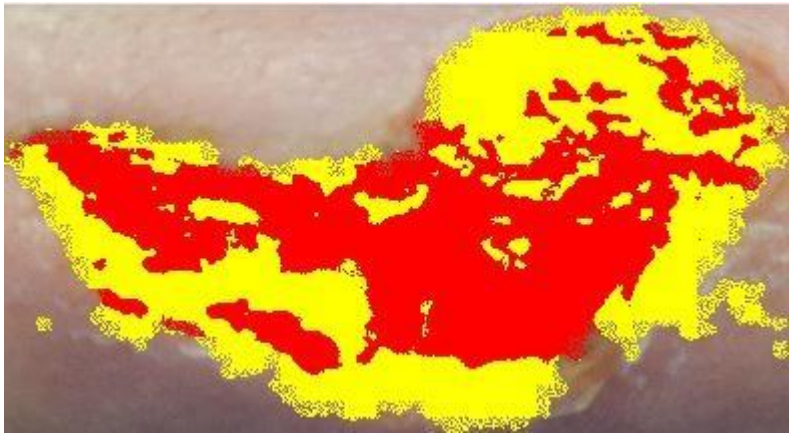
3 Versions of Wound Detection Algorithm

- **Version 1:** Mean-shift segmentation + footbox
- **Version 2:** 2-stage Cascaded SVM + no footbox
- **Version 3:** Associative Hierarchical Random Field (AHRF) + calibration patch



Healing Score

- Weighted proportion of red, yellow and black tissue

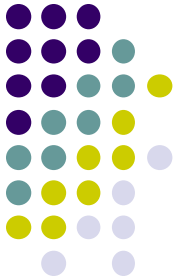


$$S_n = 1 - \frac{WA_n - WA_0}{WA_0} * G = (1+G) - G\frac{WA_n}{WA_0}$$

- High level of agreement with physician-assessments
- Krippendorff's Alpha Coefficient ranging from 0.42 to 0.81

SmartPhone Biomarkers for TBI/Infectious Diseases
2 PhD Students

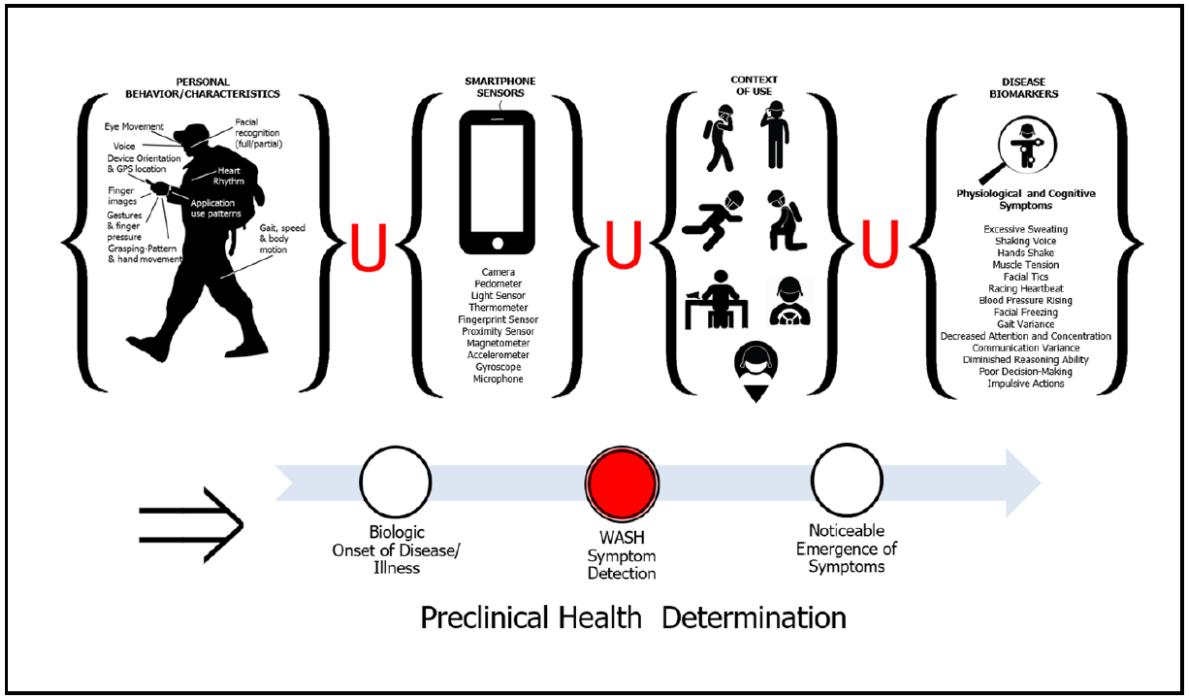
Smartphone BioMarkers



- Smartphone biomarker
  - Smartphone-sensable user behaviors that can reliably indicate the health status, ailment symptoms and condition of the smartphone user.
- **Example:** depressed smartphone users:
  - Fewer step count per day
  - Smaller radius away from home
  - Fewer conversations
  - Difficulty sleeping at night
- All signs above can be sensed with a smartphone

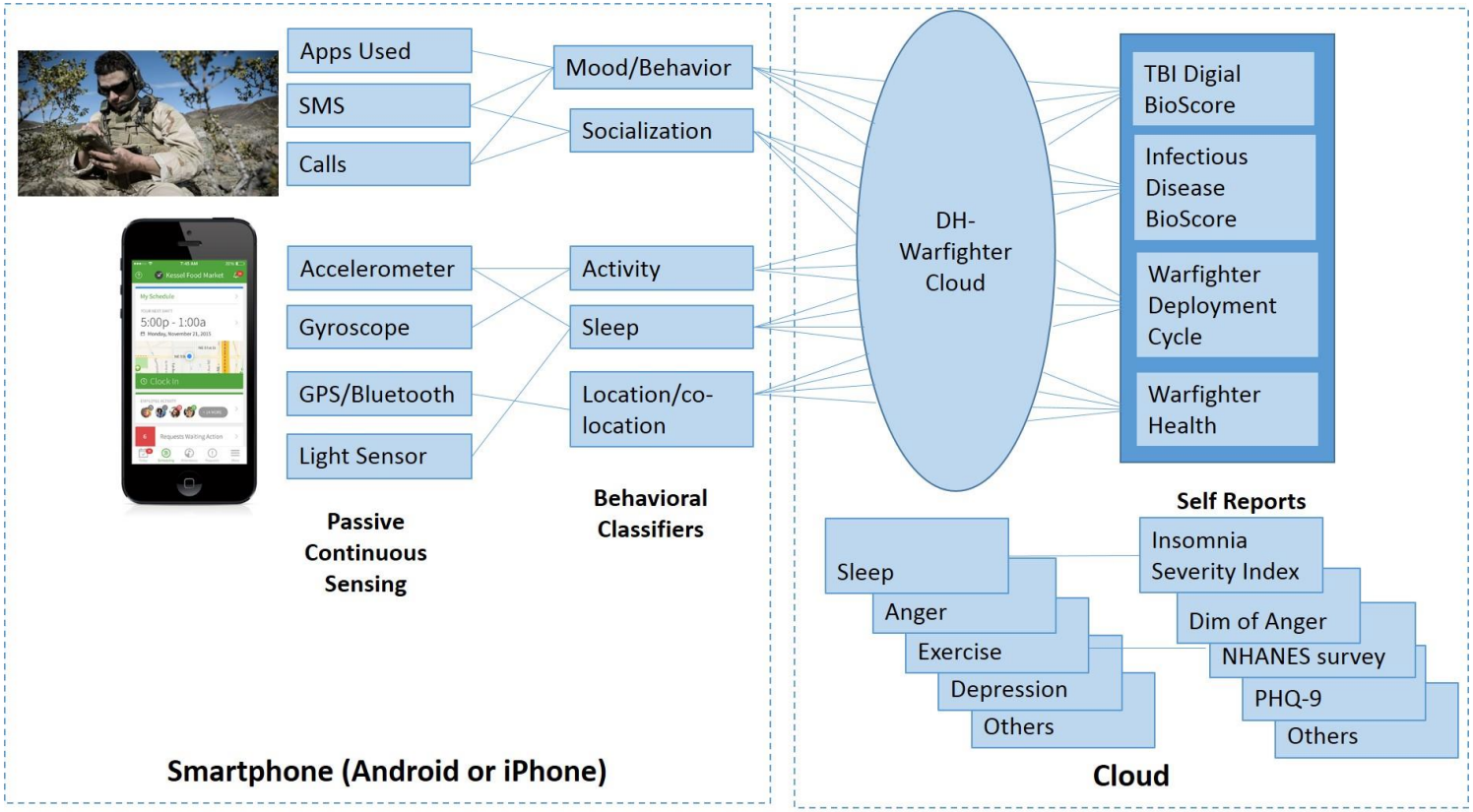
TBI & Infectious Disease Smartphone BioMarkers

- US military would like early signs of warfighter has:
  - Traumatic Brain Injury (bomb blasts, explosions, fall, etc)
  - Infectious diseases (E.g. tuberculosis, pneumonia, measles, meningitis, malaria, Ebola, cholera and influenza)
- WASH Concept: Smartphone biomarkers may manifest first



Approach: Gather Data

- Gather up to 1 million subjects from Military cohort pools
  - Smartphone sensor data (accelerometer, GPS/Bluetooth, light, etc)
  - Medical reports (Sleep, anger, depression, pain, etc)



Extract Features + Correlation with TBI, Infectious Disease Symptoms

Ailment

TBI

Symptoms

Depression

Sleep disturbance

Irritability

Feeling Tired

Assessment Questionnaires (in HER)

PHQ-9 (depression)

Insomnia Severity Index

Short Dimension of Anger Reaction

NHANES Physical Activity Survey

Statistical Analysis (correlations, p-value)

Smartphone Features Digital Biomarkers

Max radius from home

Late night Browsing

Sleep duration, quality

Daily sedentary time

Smartphone Data

Location

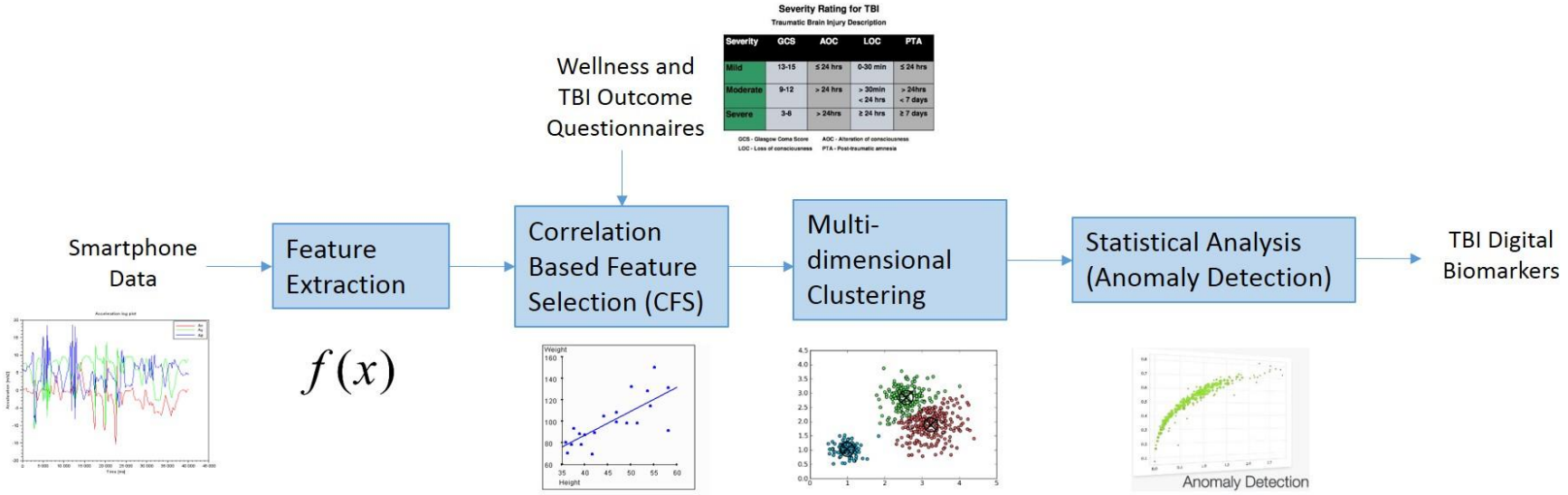
Calls (To,From, duration) App usage

Accelerometer

User Activity (e.g. sitting)

Generate TBI, Infectious Disease e-Score

- Cluster symptoms/smartphone biomarkers into disease families
- Detect anomalous warfighter behaviors



Conclusion

- I have exciting mobile sensing and imaging projects
- Currently hiring funded students for projects (to start in the spring)
  - **AlcoGait: 1 masters student for spring semester + summer**
    - (accelerometer, gyroscope, heart rate) signal processing + machine/deep learning
  - **Smartphone wound image analysis: 3 PhD students, 4 yrs**
    - algorithms for wound image analysis + machine/deep learning
    - Algorithms for decision on treatment plan
  - **Smartphone biomarkers: 2 PhD students for 4 yrs**
    - Early detection of smartphone biomarkers
    - Processing of location, mobile, smartphone sensors + machine/deep learning
- **Note:** We can discuss if you are only a Masters student