Statistical Methods and Applications for Research in Technology

Vadim Zipunnikov, PhD
SMART Working Group

Methods for new technologies: **wearables** and **brain imaging**

> 30 master, PhD, and post-doctoral students

> 30 collaborators at JHU and > 30 collaborators outside of JHU

**Brian Caffo**  
**Ciprian Crainiceanu**  
**Ani Eloyan**  
**Martin Lindquist**  
**Vadim Zipunnikov**
What do sensors offer?

• Dense measurements of Physical Activity
  – Steps or Activity Counts
  – Gait (temporal asymmetry, stride variability)
  – Energy Expenditure (calories, …)
  – Sleep (duration, the number of wakes, …)

• Heart Rate (ECG, bpm)

• Voice (Mood, Progression of Disease)

• App-based surveys (2-4 times a day)

• GPS

• Light, Temperature, others
Epidemiological Studies and Clinical Trials

• Epidemiological studies:
  – Cross-sectional/one visit: 7 -14 days per
  – Age, Sex, BMI,...
  – Nutrition, Heart Diseases, Mood Disorders, ...

• Clinical trials:
  – two visits, multiple visits, continuous monitoring
  – mobile monitoring:
    • comparative effectiveness, pre-/post- intervention
    • progression, recovery
    • early detection (CHF, Bipolar or Major Depression)
  – part of the treatment
  – compliance to treatment
  – FDA: to define endpoints at Clinical Trial of 2020
Prediction of Heart Failure Hospitalizations

- Advanced Cardiac Care Center of Columbia University Medical Center
- 62 subjects with Heart Failure followed for a year
- Adverse events: 2 died, 10 hospitalizations, 12 emergency room visits
- **Goal:** Can we predict a hospitalization or an emergency room visit
Congestive Heart Failure

Mobile monitoring of a daily Physical Activity index

– Early detection: 3-5 weeks prior to event
– Recovery: slow vs accelerated
Neuroimaging

Structural

Functional

Condition A

Condition B
MS Lesion Segmentation

- The group has developed a number of methods for automated segmentation of Multiple Sclerosis lesions.

- Another focus is studying the longitudinal behavior of these lesions.
The group has developed a number of methods for automated segmentation of lesions.
Prediction

- We have worked on methods for classifying subjects according to disease status, and predicting stimuli directly from neuroimaging data.

- The group won the "ADHD-200 Global Competition" and have helped create neurologic signature of physical pain.
Education

• The group is heavily involved in developing new massive open online courses (MOOCs) at Coursera:

  ▪ Data Science specialization (9 courses, enroll today)
  ▪ Neuroimaging specialization (coming soon)
  ▪ Statistical Analysis of fMRI Data (available now)