# 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

# Wearables

## Research


## Consumer

# 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

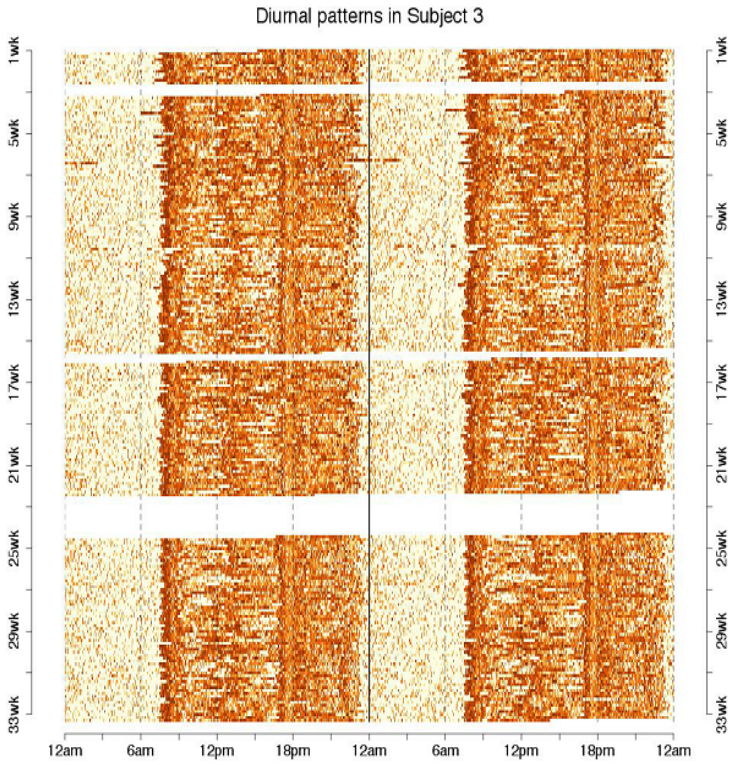
# Epidemiological Studies and Clinical Trials

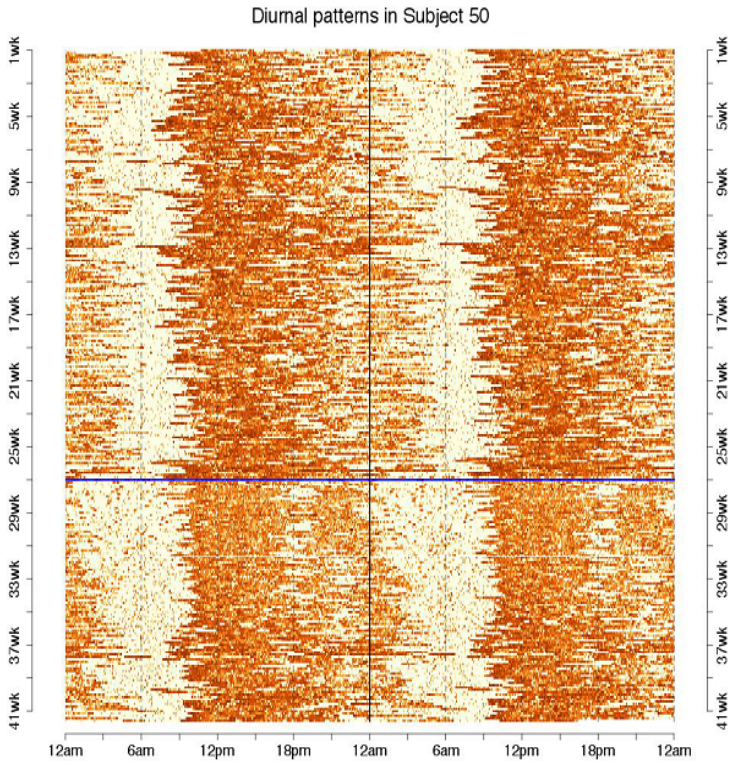
- Epidemiological studies:
  - Cross-sectional/one visit: 7 -14 days per
  - Age, Sex, BMI,…
  - Nutrition, Heart Diseases, Mood Disorders, …

- 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

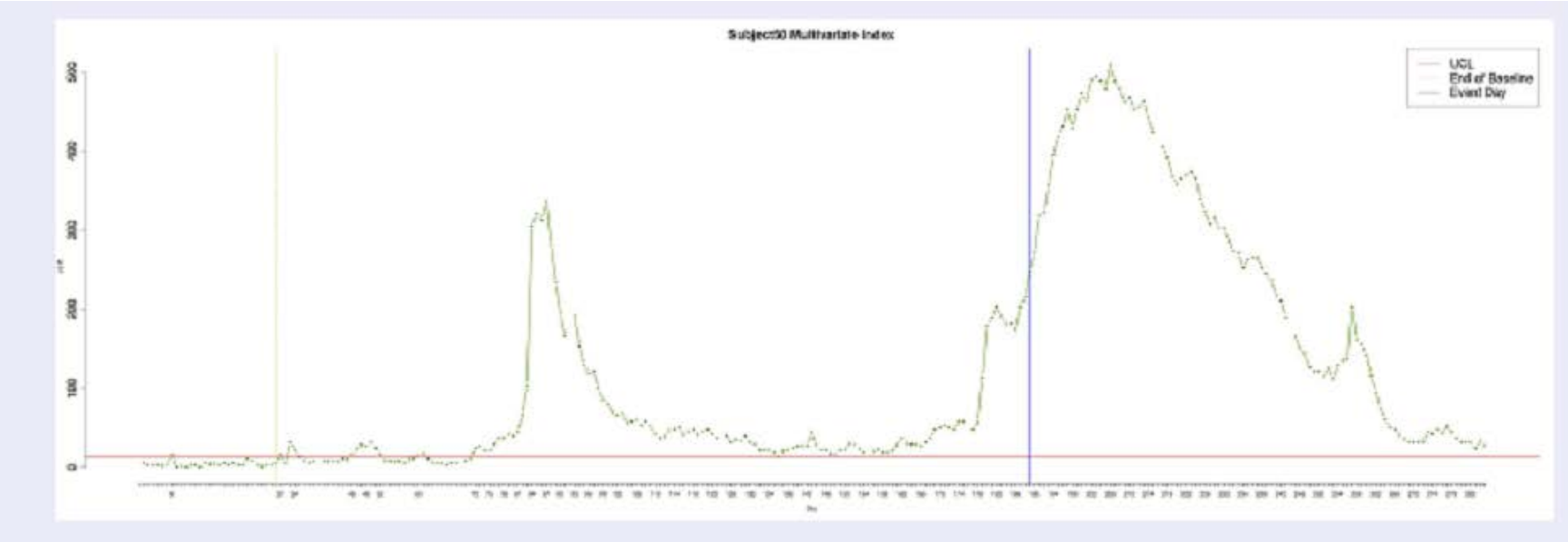


# Congestive Heart Failure

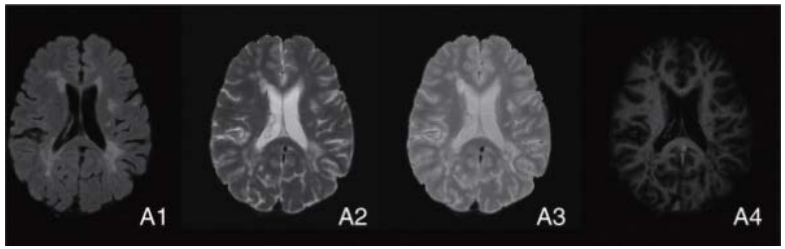
Mobile monitoring of a daily Physical Activity index

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

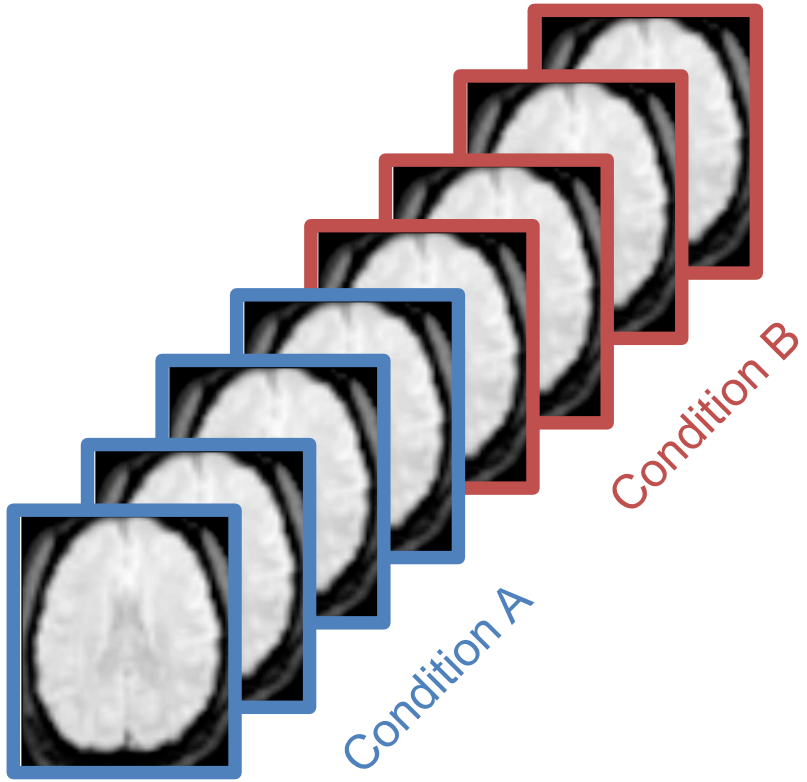


# Neuroimaging

Structural



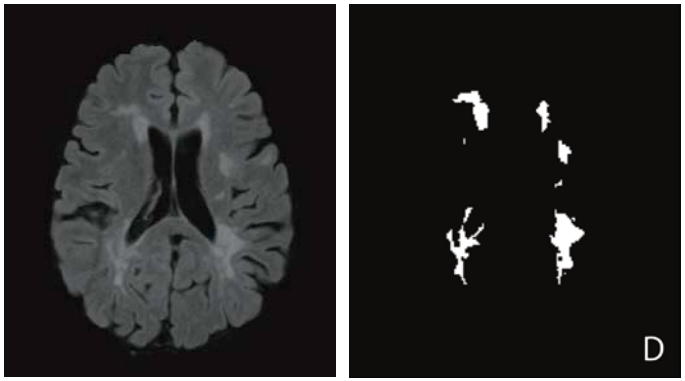

Functional

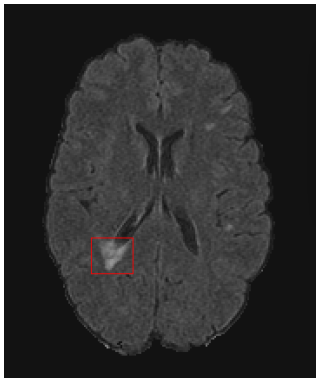


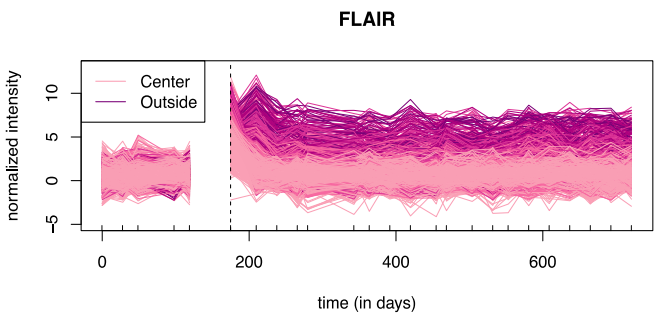
# MS Lesion Segmentation

- 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.

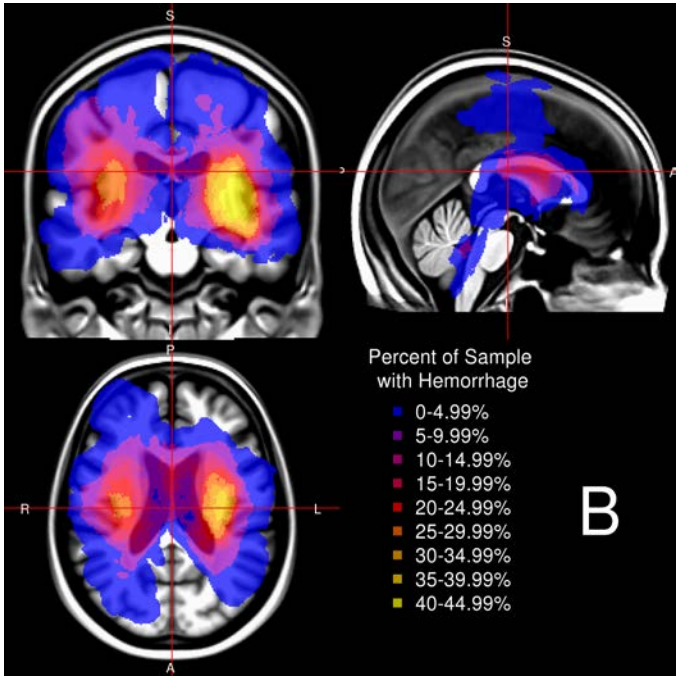


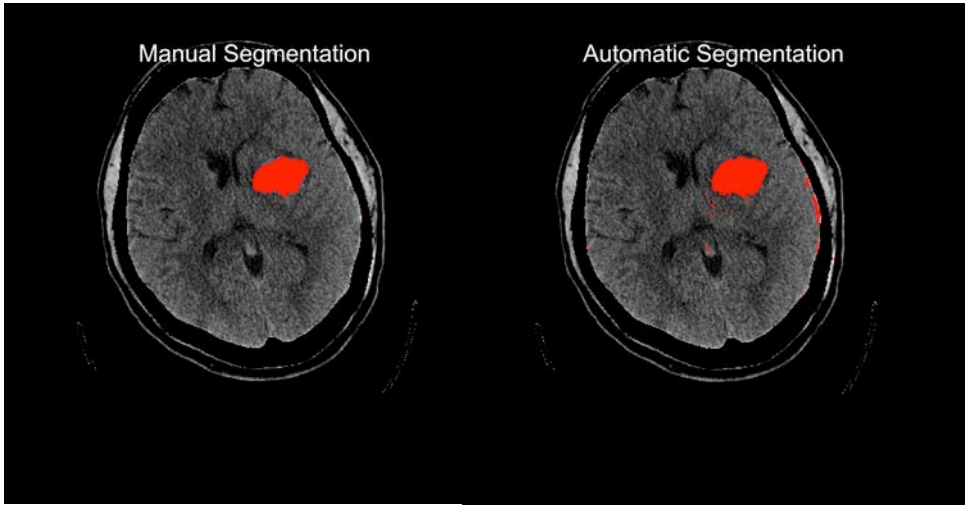


# CT Imaging

Intracerebral Hemorrhage Localization in a Population




Intracerebral Hemorrhage Prediction

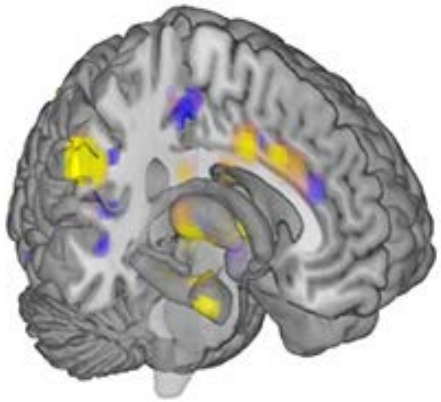



The group has developed a number of methods for automated segmentation of lesions.

# 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)