Designing collaborative smart pervasive sensing systems to improve health outcomes for individuals and communities.

Emre Ertin

The Ohio State University

MD2K
Center of Excellence for
Mobile Sensor
Data-to-Knowledge

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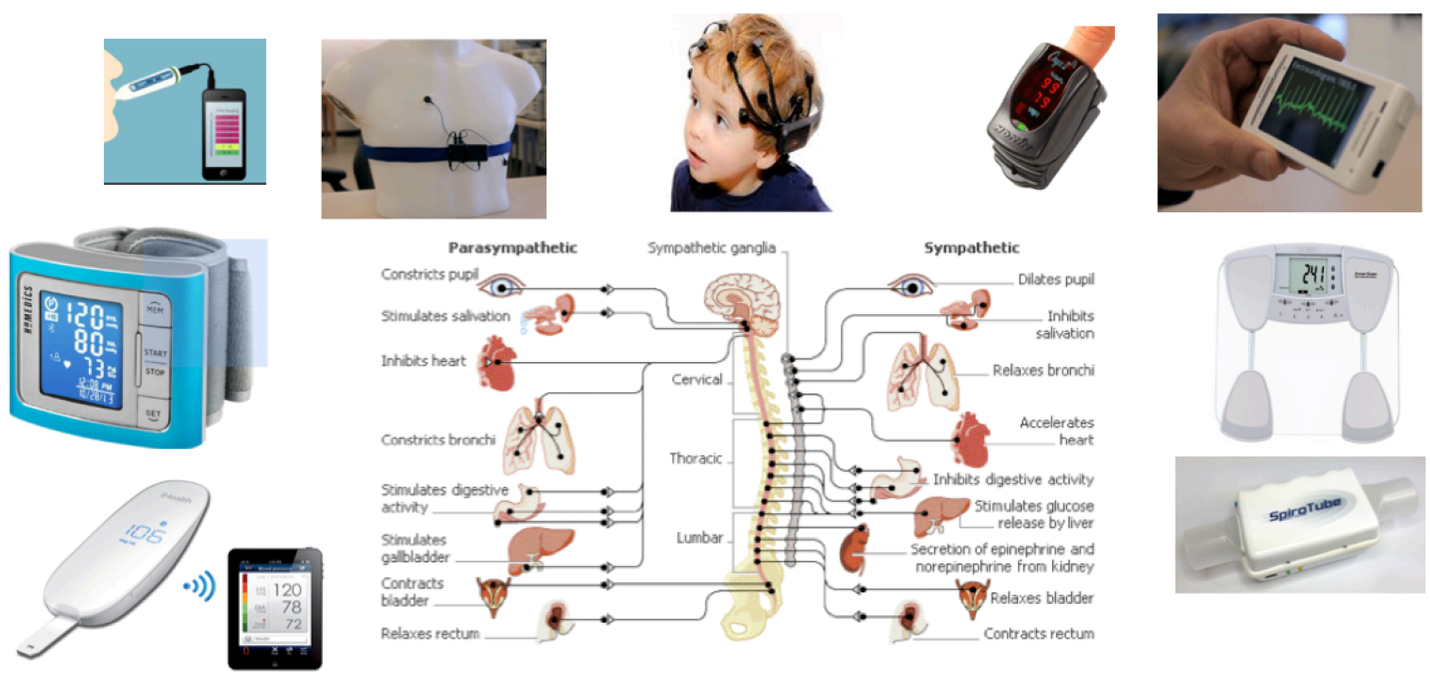
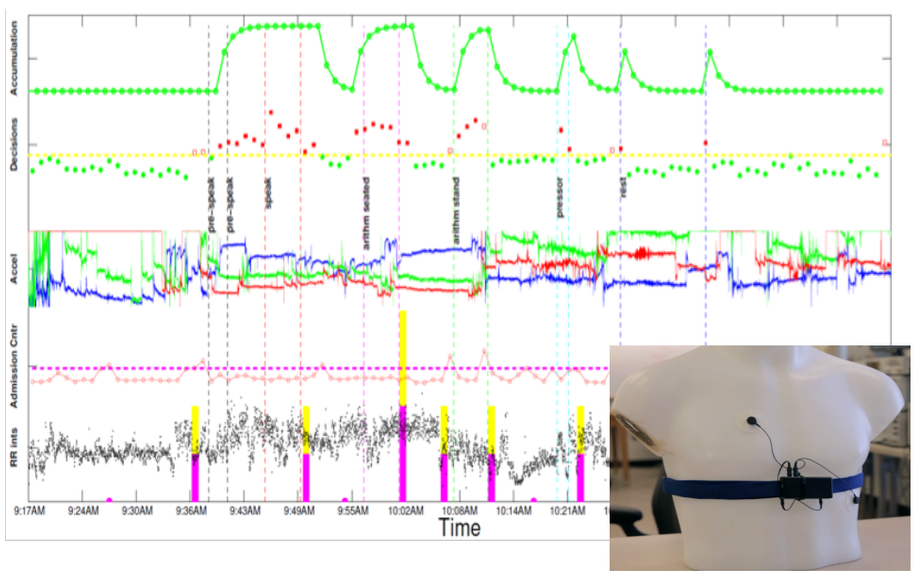
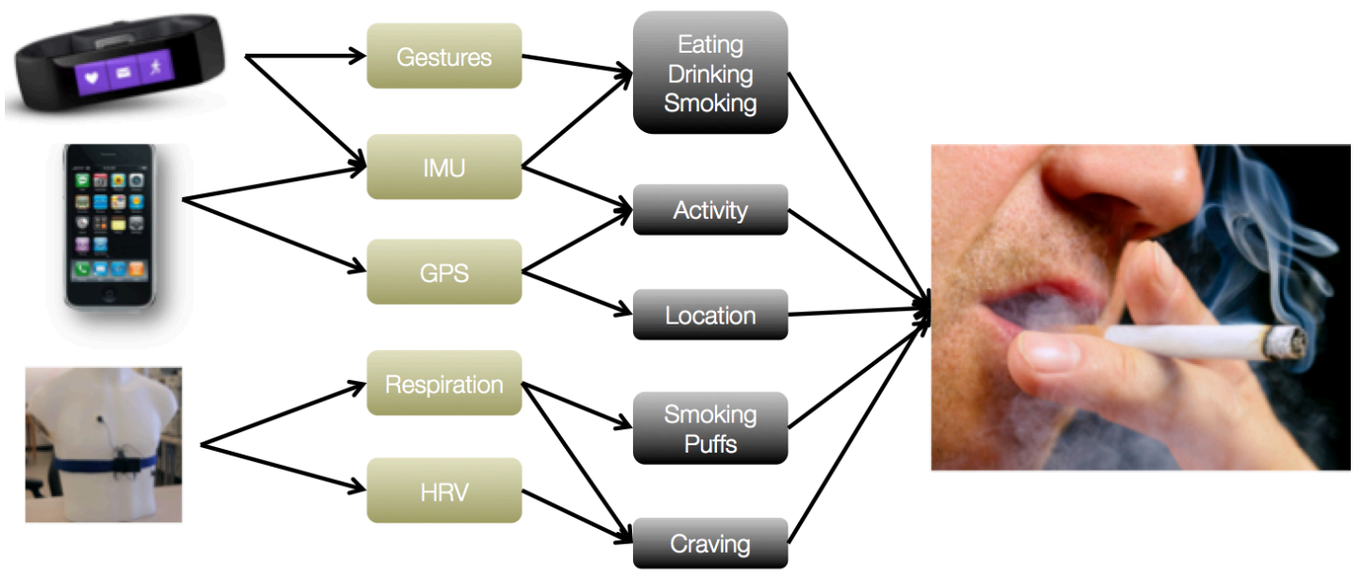
mHealth Research

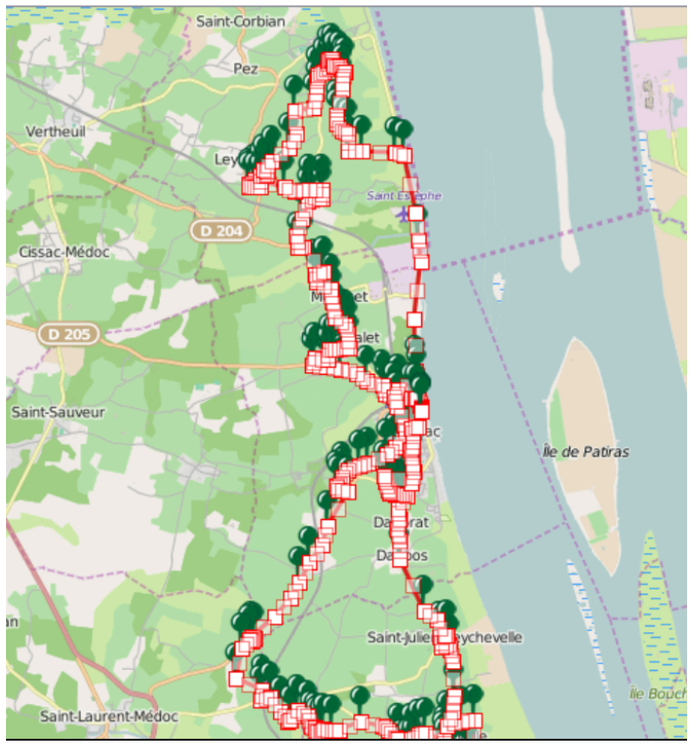
- Long term monitoring of physiology and behavior of subjects in their natural environment to improve health outcomes, healthcare delivery and health research.
- Vertically engineered systems for measuring physiology with links internal states and correlate with measurable risky/healthy behaviors
- Models of behavior incentive systems are personalized but mostly static and very limited set of carefully defined external factors and context

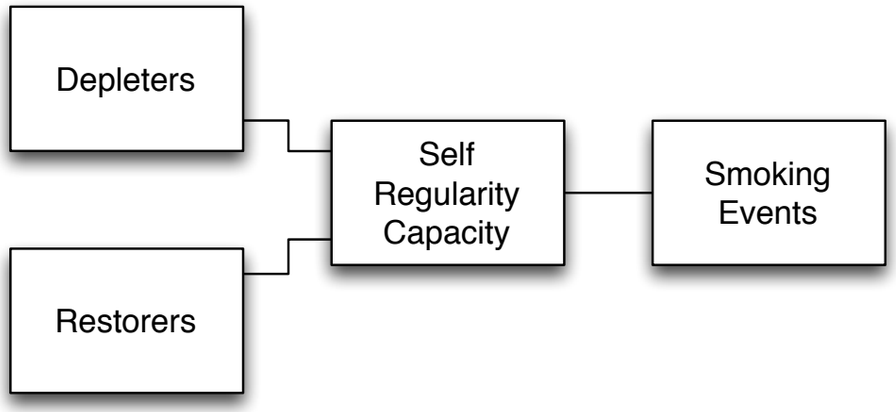


mHealth Research









mHealth Research Opportunities

- We have access to data from variety of sensors: wearables, mobile devices, IoT and other infrastructure sensors, health records and social media,
- Build smart *collaborative* pervasive sensing systems that can not only monitor physiology of individuals but also how individuals interaction with each other and the environment modulates their physiology and behavior.

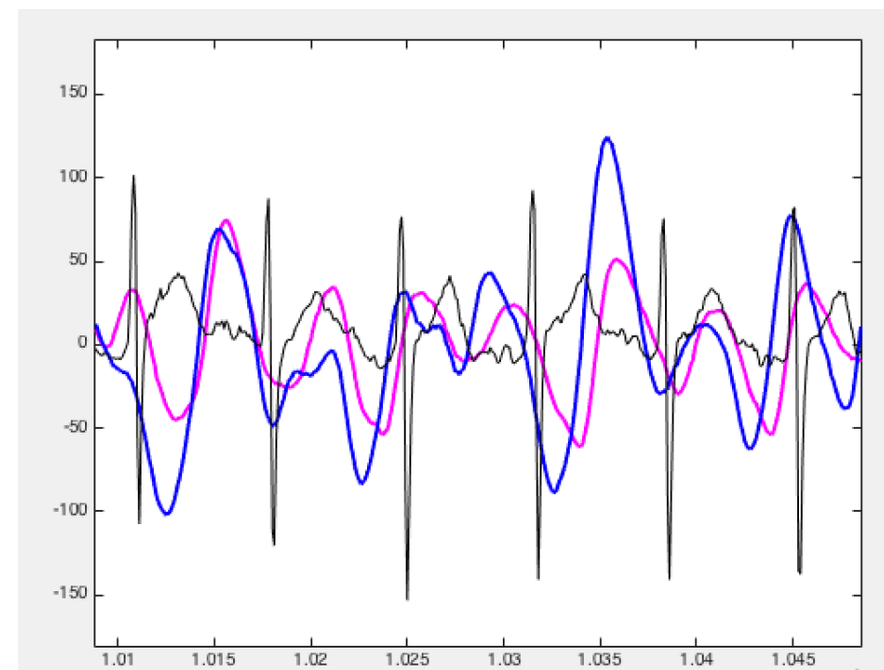
mHealth Computing Challenge

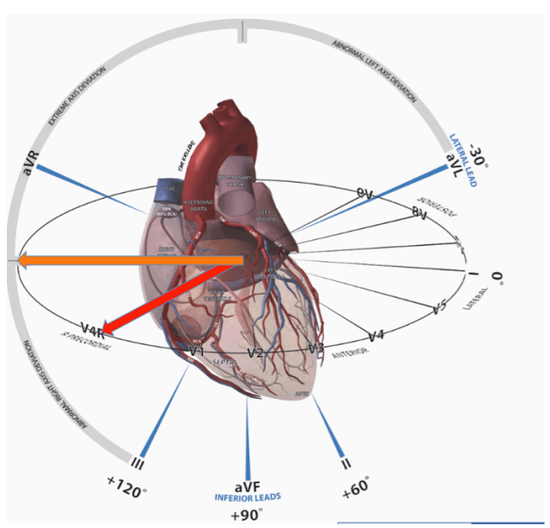
- Turning this deluge of data from heterogeneous sources with widely varying quality, resolution, and temporal availability into validated and clinically useful models of risky/healthy behavior to improve health outcomes.

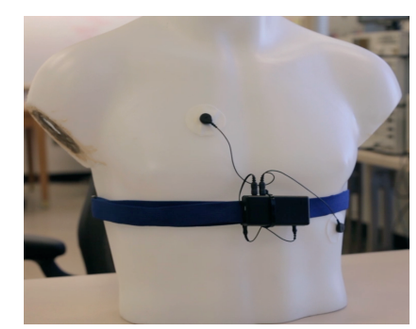
- System design have to account variability between individuals, measures and devices. Sensor placement, body composition and geometry affects measurement process. Raw output of sensors have high variability.

Quality: Accuracy and Consistency

- Cardio Monitoring: Heart Rate vs Heart Rate Variability vs ECG
  Accuracy of Beat Detection 1 msec (ECG) -20 msec (Wrist based PPG)
- Temporal Availability

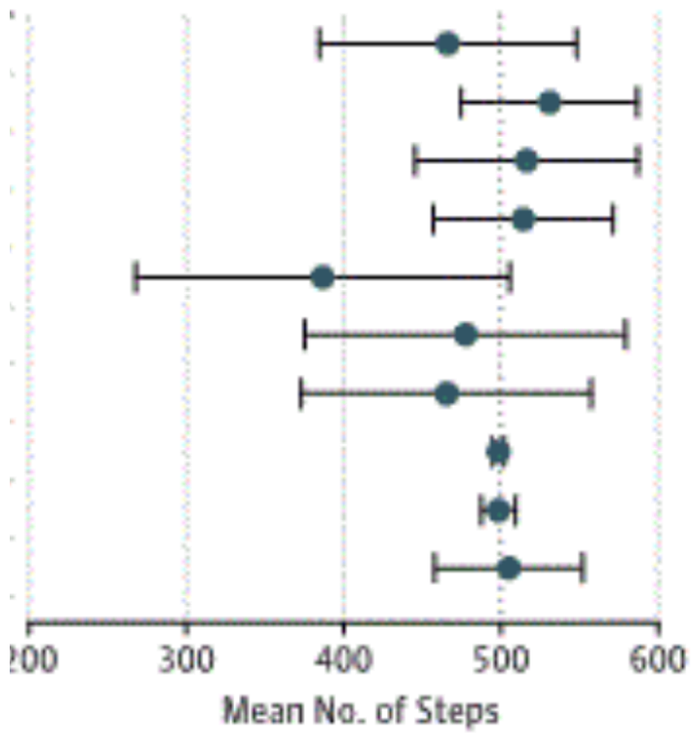






Accuracy and Consistency

- Motion Sensing: Counting Steps on Treadmill



Open Research Problems

- Building hierarchy of inferences from raw data to biomarkers to internal states that can accept inputs of varying quality, availability and resolution.

- Architectures for propagating, quality of Information, temporal uncertainty, and provenance throughout the hierarchy,

- Methods for inferring temporal alignment of data from multiple sensors observing same phenomena
  - physiological response of individuals with different sensors engaging in social interaction
  - traffic data with driver data.

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Open Research Problems

How can we build systems/sensors that can continuously improve sensor configurations, inferences and data interpretation?

What are the privacy and security implications of community data?

How we can learn and validate models of behavior appropriate for the community data ?

Rich, context switching models of individuals linking their physiology and behavior to their internal state as well as state of the environment and others in their social circle.

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