CPS: Small: Human-in-the-Loop Learning of Complex Events in Uncontrolled Environments

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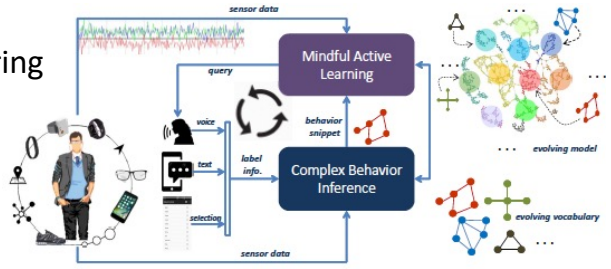
https://ghasemzadeh.com/project/human-in-the-loop-learning/

Overview

- Design a cyber physical system for human health monitoring and behavioral intervention using wearable sensors
- Take into account burden of data annotation
- Develop methods for human behavior modeling
- Integrate domain knowledge for clinical decision making



Challenge Content

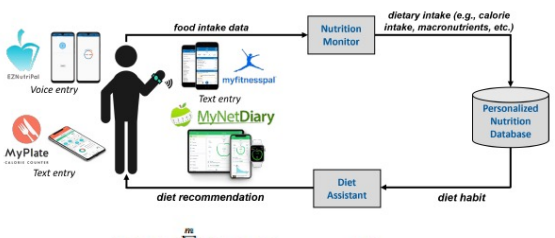
- How to gather and label sensor data in uncontrolled settings?
- How to use the gathered data to detect complex events such as human behavior?
- How to close the loop by providing adaptive clinical interventions?

Scientific Impact

- Advancing knowledge of machine learning design for CPS
- Mixed initiatives that balance human input and algorithm performance
- Closed-loop systems with physiological sensing, health assessment, and real-time feedback

Key Innovations

- Active learning algorithms to minimize burden of data labeling
- Multitask learning algorithms to enhance efficiency of the underlying machine learning models
- Predictive models to forecast health events such as treatment adherence, hyperglycemia, and stress
- Human behavior modeling using graph networks
- Sequential decision-making algorithms for real-time and adaptive clinical interventions

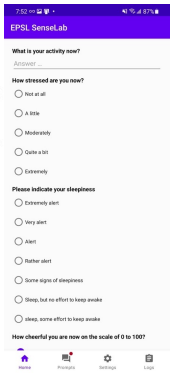


$$\text{Minimize} \quad \sum_{j=1}^{m} |p_{ij} - q_{(i-1)j}| \qquad (1)$$

Subject to:

$$\left| \sum_{j=1}^{m} p_{ij} c_j - \sum_{j=1}^{m} q_{(i-1)j} c_j \right| \geq \lambda_{min} \qquad \forall i, j \quad (2)$$

$$p_{ij} \in \{0, 1, \ldots, k_{max}\} \qquad \forall i, j \quad (3)$$



Broader Societal Impact

- Chronic disease management and prevention
- High-precision physical and mental health interventions
- Improved quality of life
- Physical activity and diet interventions in free living environments
- Access to care in rural and remote settings

Education & Outreach

- Involving undergraduate students such as REU students in research
- Holding webinars for community college students
- Visiting community colleges in the greater Phoenix area
- Mentoring high school students through ASU Science and Engineering Experience program and MET Professional Academy's Bioscience

Broader Impact

- Potential to reduce costs and improve physical and mental health outcomes
- More than 75% of all health care costs are due to chronic conditions in the US
- 6 in 10 American adults live with a chronic condition
- 1 in 5 US adults live with a mental illness

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