ASU College of Health Solutions
Arizona State University

EMBEDDED MACHINE INTELLIGENCE LAB

Wearable AI Systems for Health Promotion and Disease Management

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EMIL

EMBEDDED MACHINE INTELLIGENCE LAB

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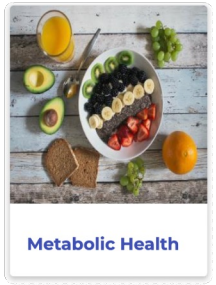
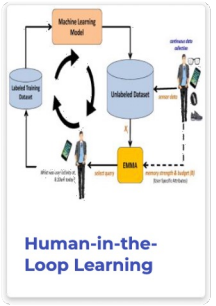
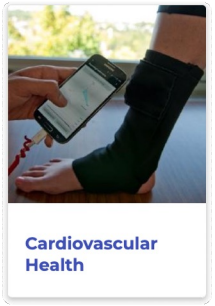
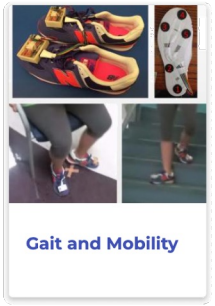
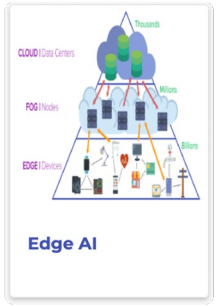
Research Projects

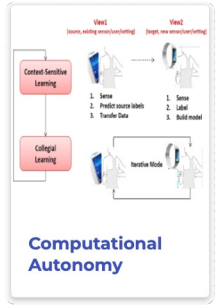










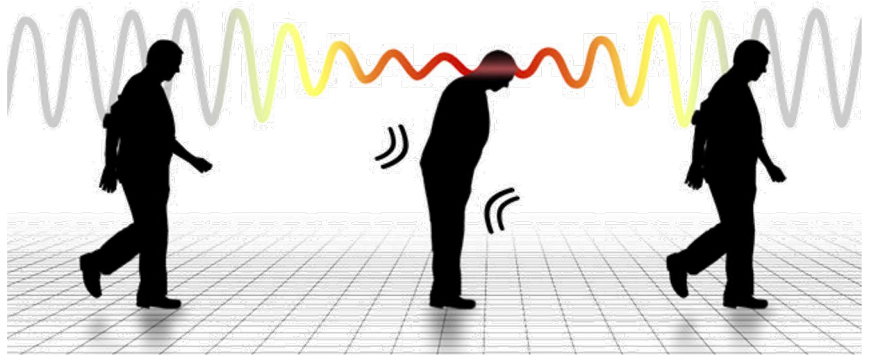


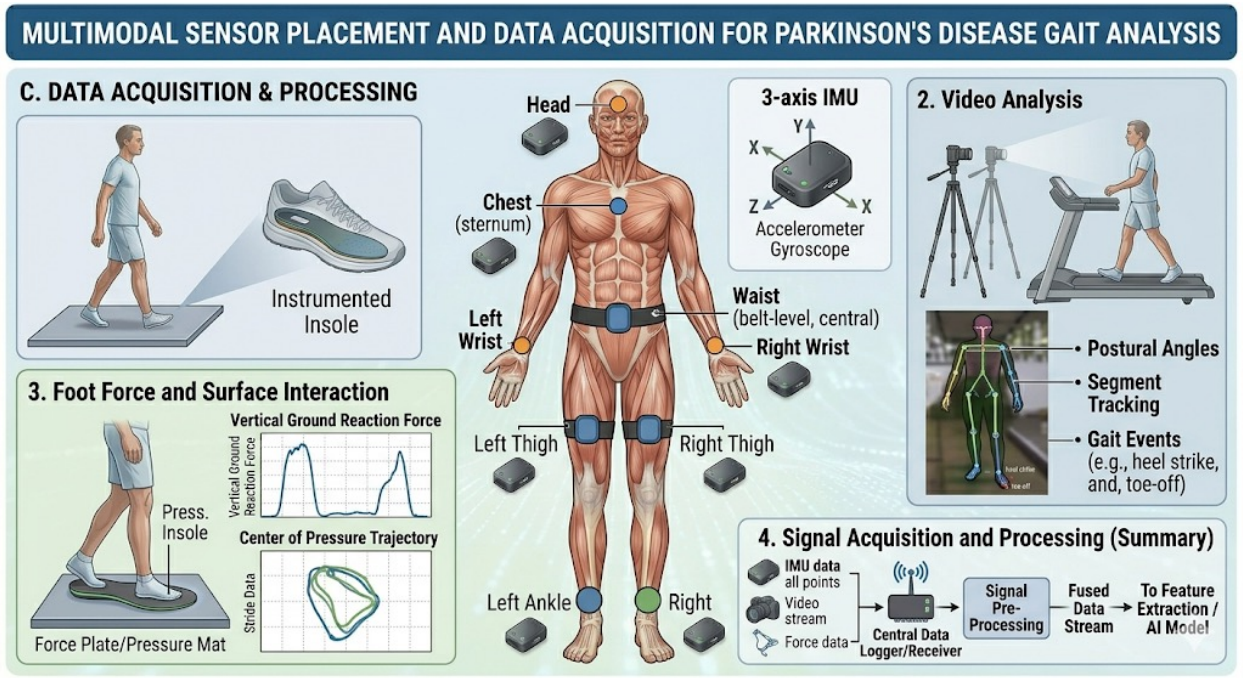
- 9 PhD students (4 BIDS, 4 CS, 1 CE)
- 4 BMI undergrad
- **Research area:** AI, wearable sensors, digital health, metabolic health, nutrition, Parkinson, mental health (sleep & stress), heat

ghasemzadeh.com

Parkinson Project

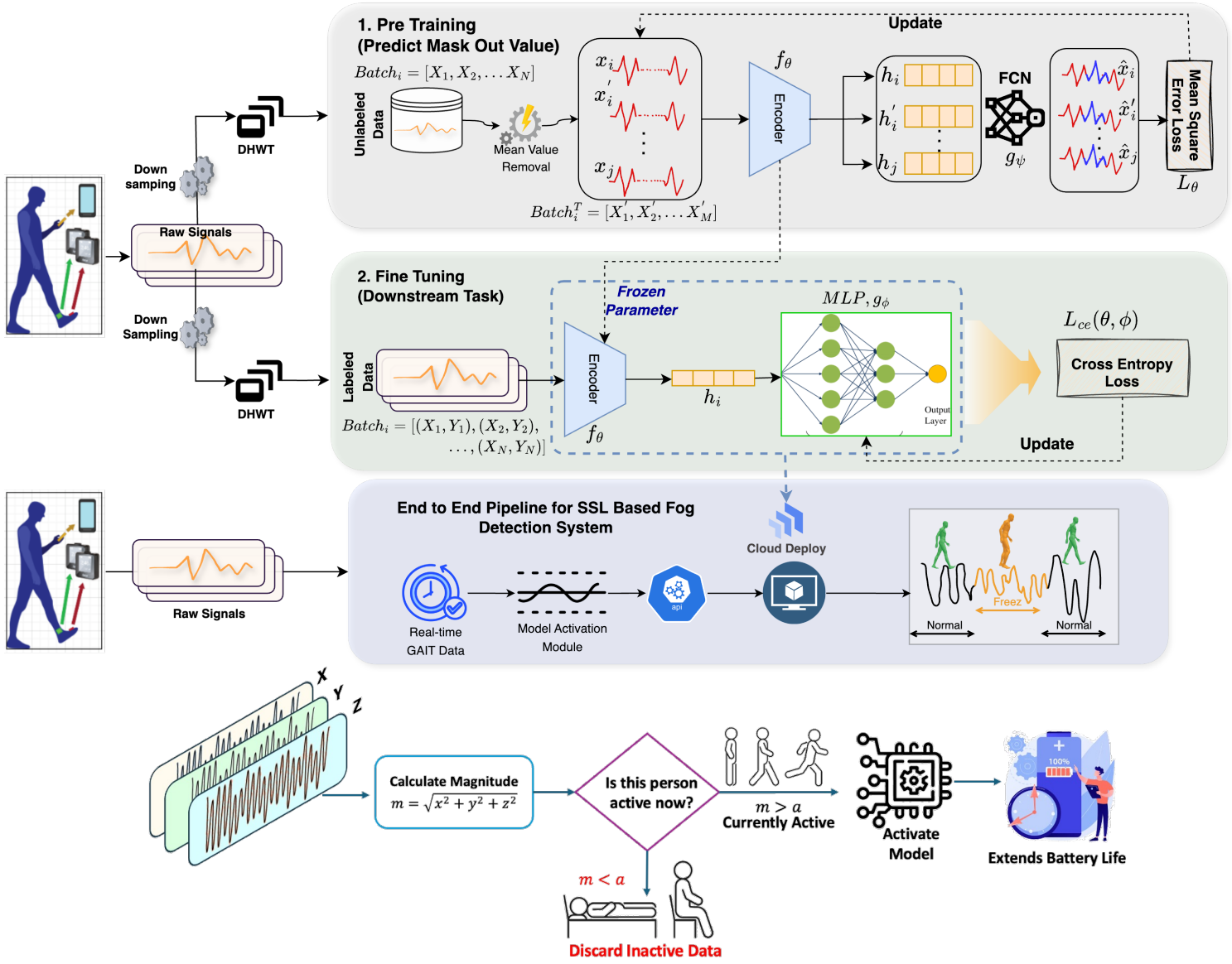
- PD is a chronic neurodegenerative condition characterized by motor symptoms
- **Freezing of Gait (FoG):** Sudden, episodic inability to step forward, often described by patients as feeling like their "feet are glued to the floor.
  - Patients often perform better in a clinical setting due to focused attention
  - highly unpredictable and often triggered by environmental factors
- Inertial sensors (accelerometers) capture movement patterns 24/7.
- AI models can detect FoG events automatically
  - Clinical labels are scarce and expensive
  - Power efficient for longer battery life





Soumma et al. Self-Supervised Learning and Opportunistic Inference for Continuous Monitoring of Freezing of Gait in Parkinson's Disease (ACM Health 2025, Impact Factor: 8.0)

Self-supervised Learning & Opportunistic Inference



a. Pretext Task: Raw signals $X \in \mathbb{R}^{N \times T}$

Masked window, $\hat{X} = mask(X, m)$

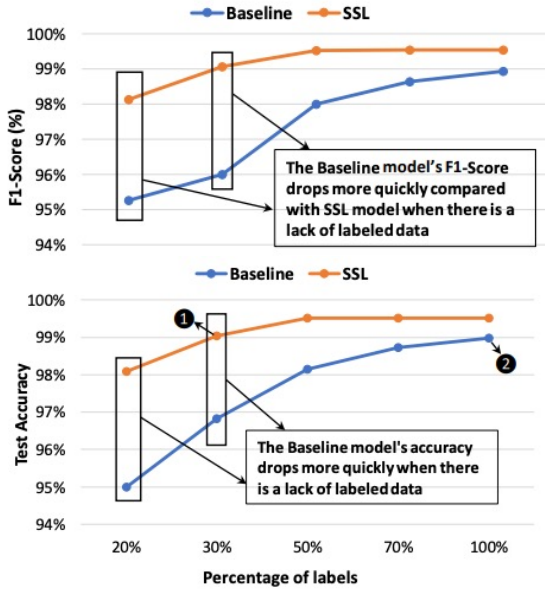
Trained Pretext Model, f_θ

$$\frac{1}{N_m} \sum_{j=1}^{N_m} (\hat{x}_j - x_{p(j)})^2$$

b. Down Stream Task: MLP on top of pretext model

$$\hat{Y} = h_{\theta,\phi}(X) = g_\phi(f_\theta(X))$$

$$L_{ce}(\theta, \phi) = -\frac{1}{N} \sum_{i=1}^{N} [y_i \log(\hat{y}_i) + (1 - y_i) \log(1 - \hat{y}_i)]$$



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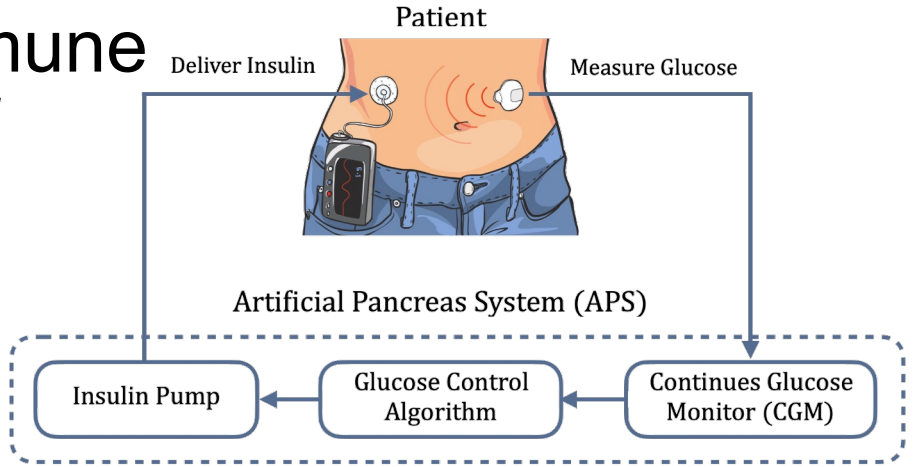
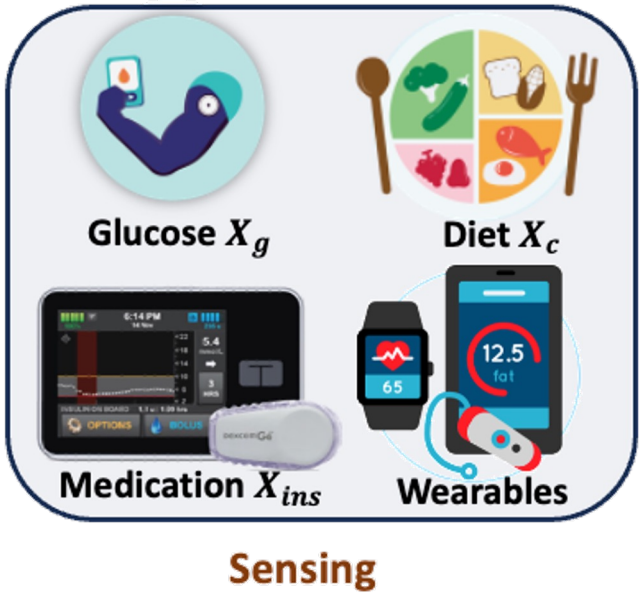
Nutrition/Diabetes Project

- Type 1 diabetes (T1D) is a chronic autoimmune disease characterized by the destruction of pancreatic beta cells
- Lifelong dependency on exogenous insulin therapy
- Requires continuous monitoring and precise insulin administration to maintain blood glucose levels
- CGM devices provide real-time readings,
  - Enabling patients and healthcare providers to monitor glycemic trends and respond to fluctuations more effectively

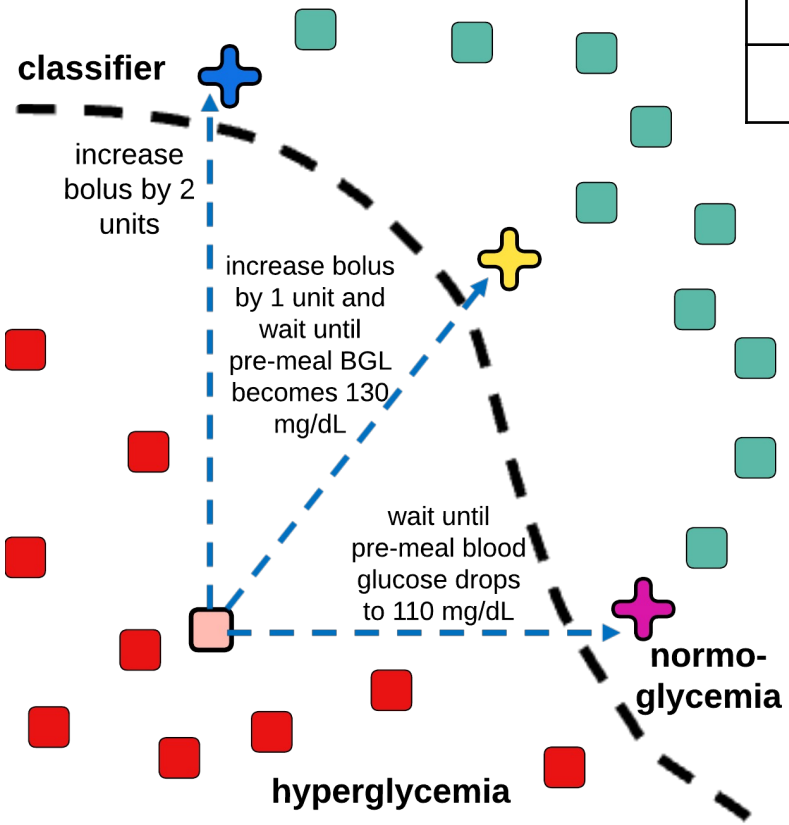


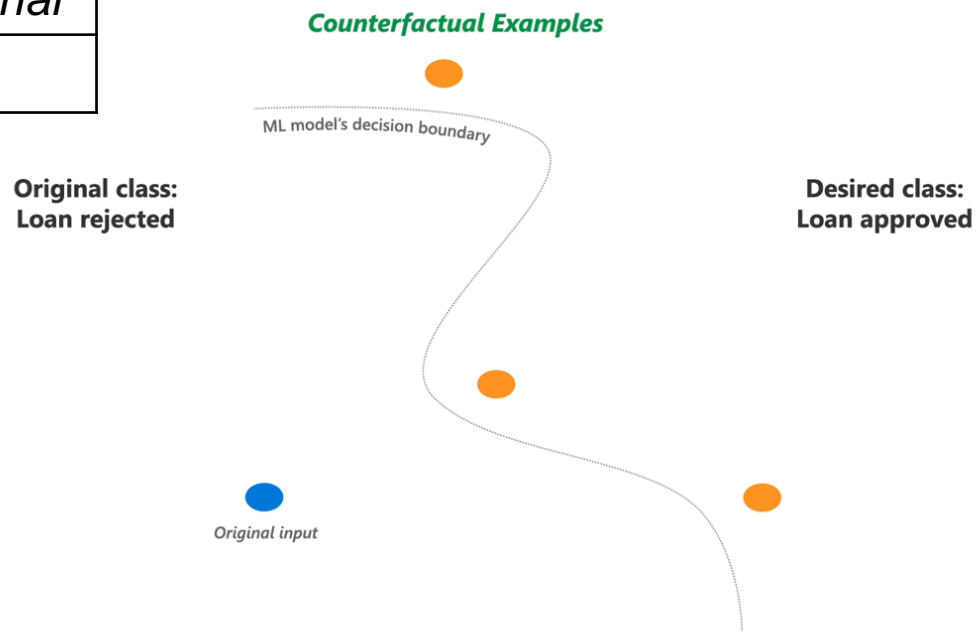


Introduction to Counterfactual Explanations

Counterfactual explanation (CF) is a type of XAI method that helps understand model decisions by showing how **small**, meaningful changes to the input could have led to a **different outcome**.

✓	*Interventional*
✓	*Complete*

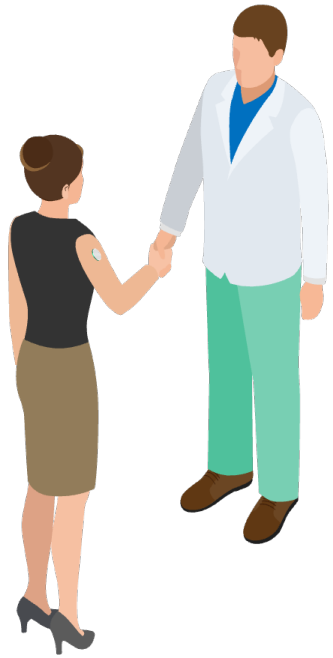




GlucoGuide System

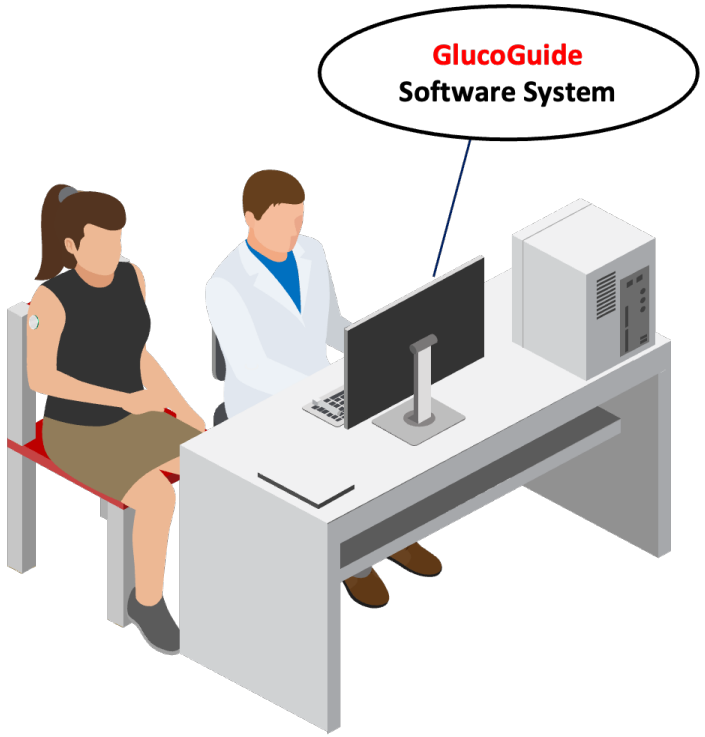
Tandem insulin pump system

Patient who is on Insulin Pump and CGM



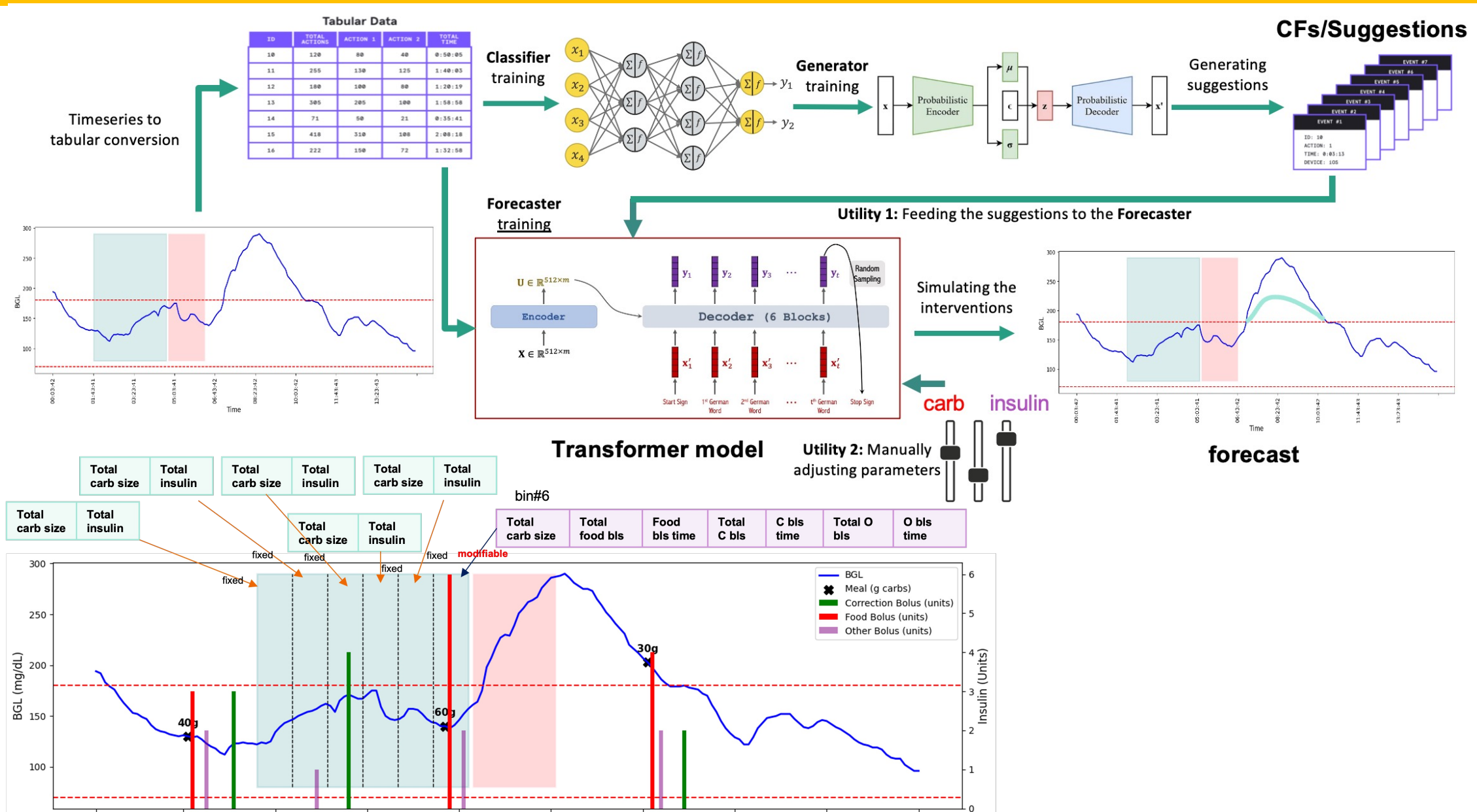
Patient visits clinician for regular checkup

Clinician collects data from Insulin Pump and loads on his PC



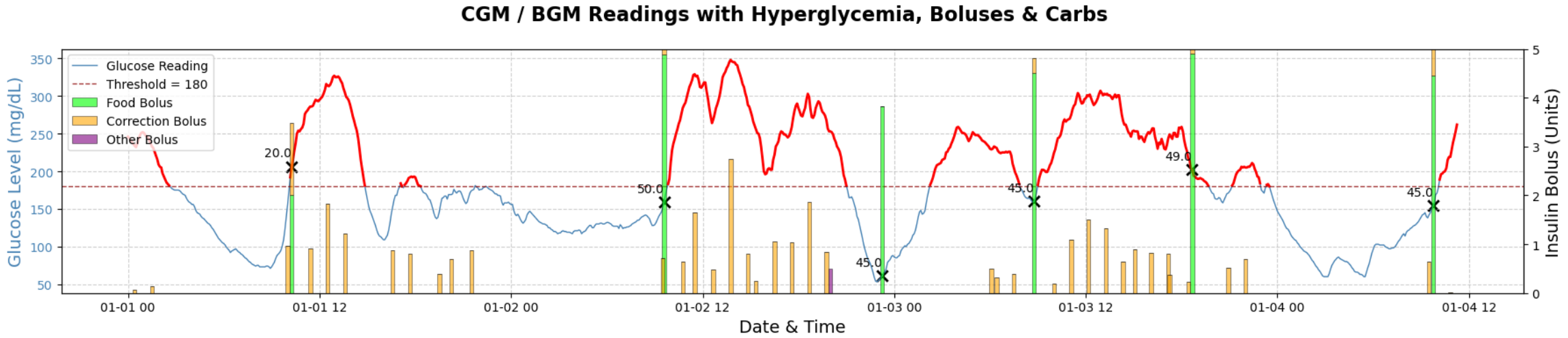
They both visualize data using GlucoGuide and explore how the patient could have done better

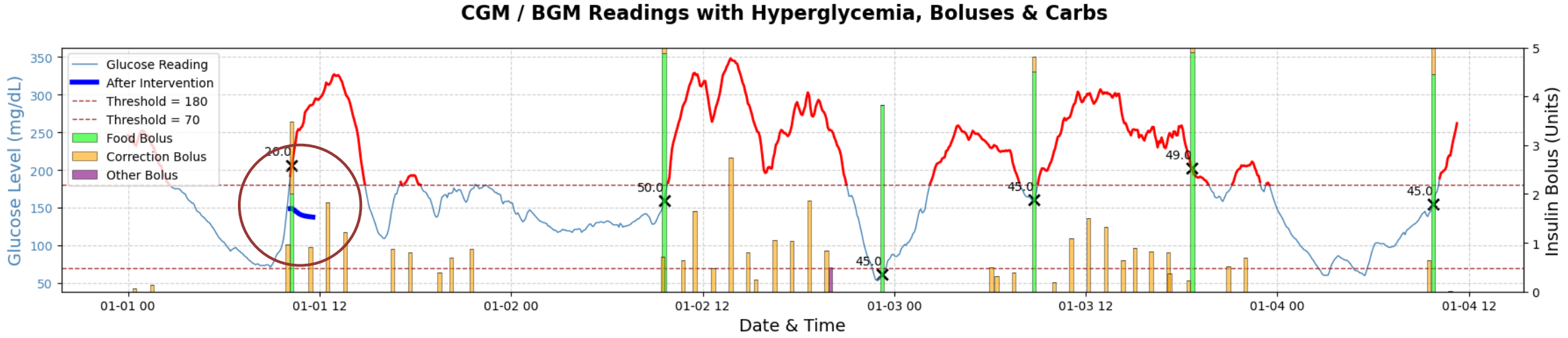
GlucoGuide System



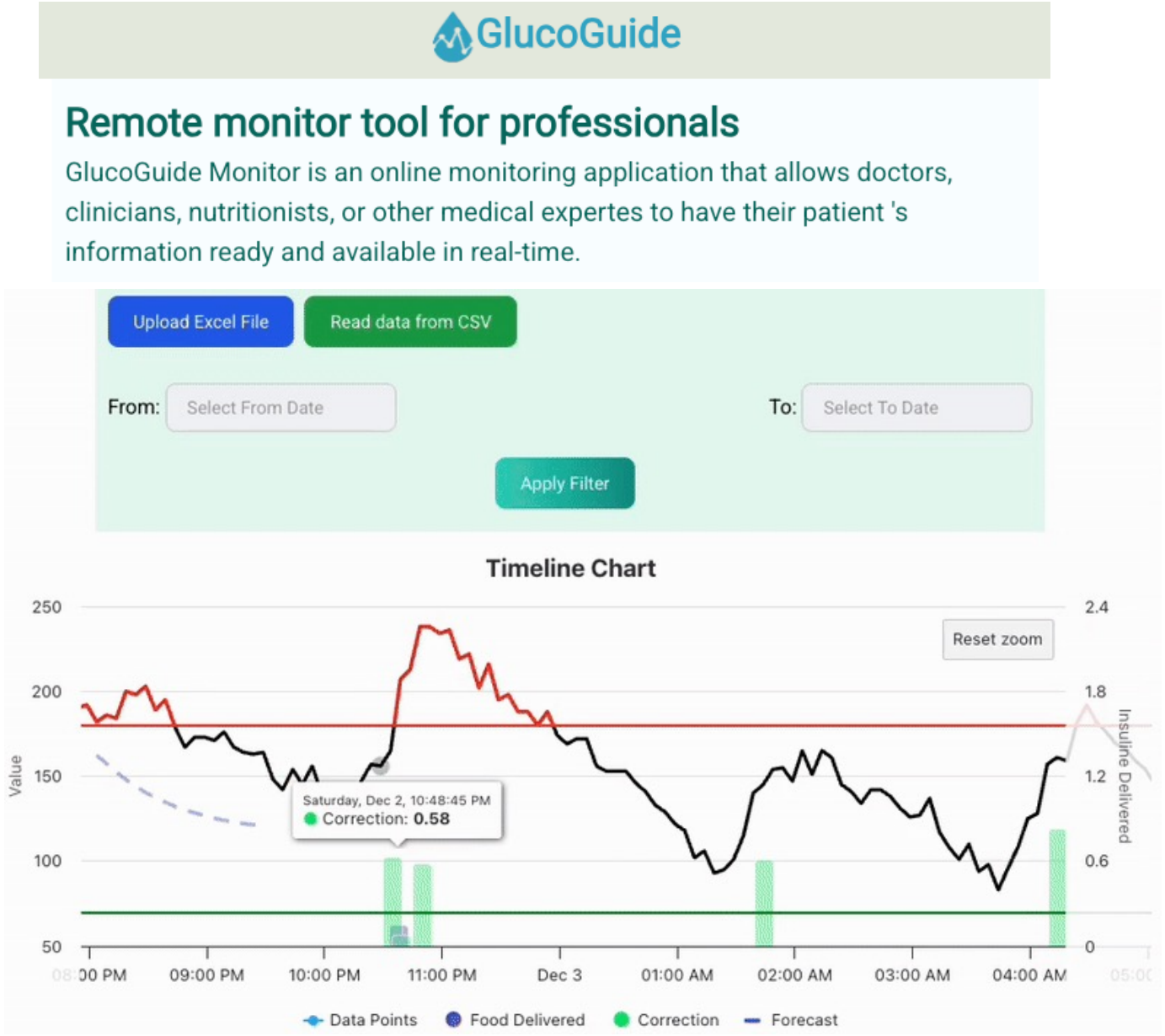
Simulation of Intervention Outcome

- This patient was having multiple hyperglycemic events. We created intervention for one and simulated the outcome after intervention





Clinical Decision Support



HeatMind

- Co-design digital health platform that provides firefighters and community organizations with the tools to objectively monitor heat-related health and provide intervention strategies to minimize risks

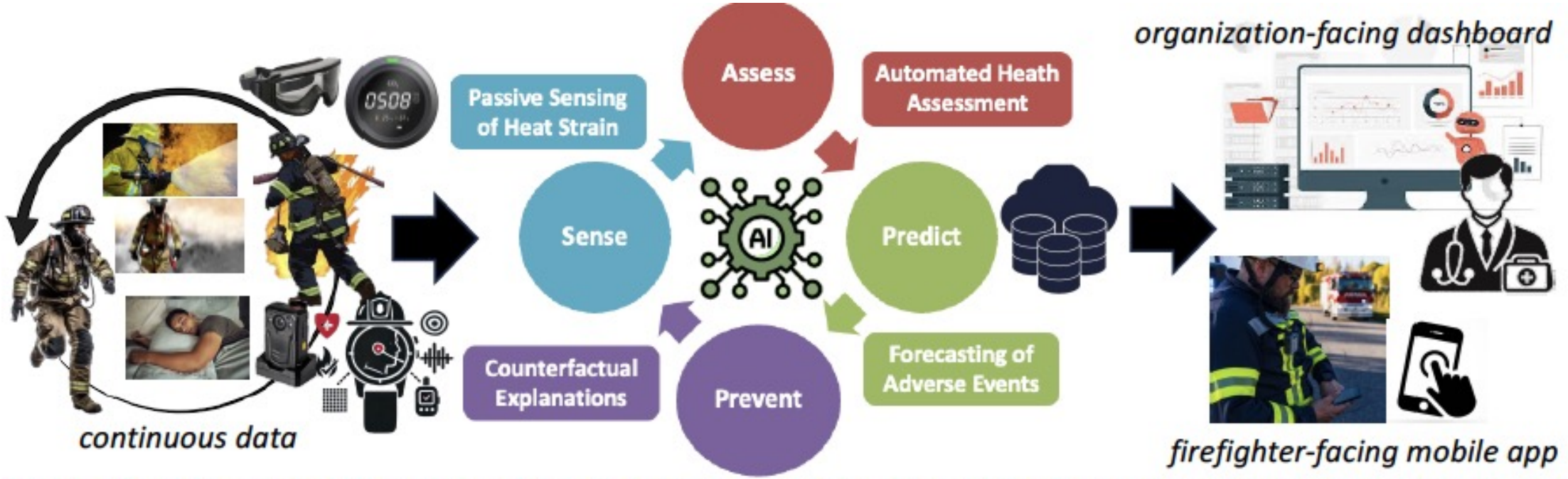


Fig. 1: HeatMind integrates wearable/environmental sensors, data, and AI to monitor key aspects of heat- and hydration-related health, assess risks, and assist in risk mitigation at both individual and community levels.

Pillar #1: Community Engagement

- Design Studio for Health

WHAT IS A DESIGN STUDIO?

Creative. Collective. Inspiring.

The design studio activates "human" expertise to generate beautiful questions. "How Might We…" questions inspiring enough that participants who frame them are excited to try it out in real life.

WHY DESIGN STUDIO?

Co-creative. Participatory. Action-oriented.

Our design studios are based on the principles of Co-Design and Participatory Action Research. The insights generated through these studios will provide the inputs and framing for the next in a co-creative, generative, participatory model.

Pillar #2: Hydration Assessment

- Design algorithms that measure hydration using passive sensing and machine learning

Pillar 3: Sensor Design

- Develop sensors / hardware that enables continuous monitoring of health and impact of excessive heat

Thank You

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