From Laboratory to Everyday Life: Personalized Stress Prediction via Smartwatches

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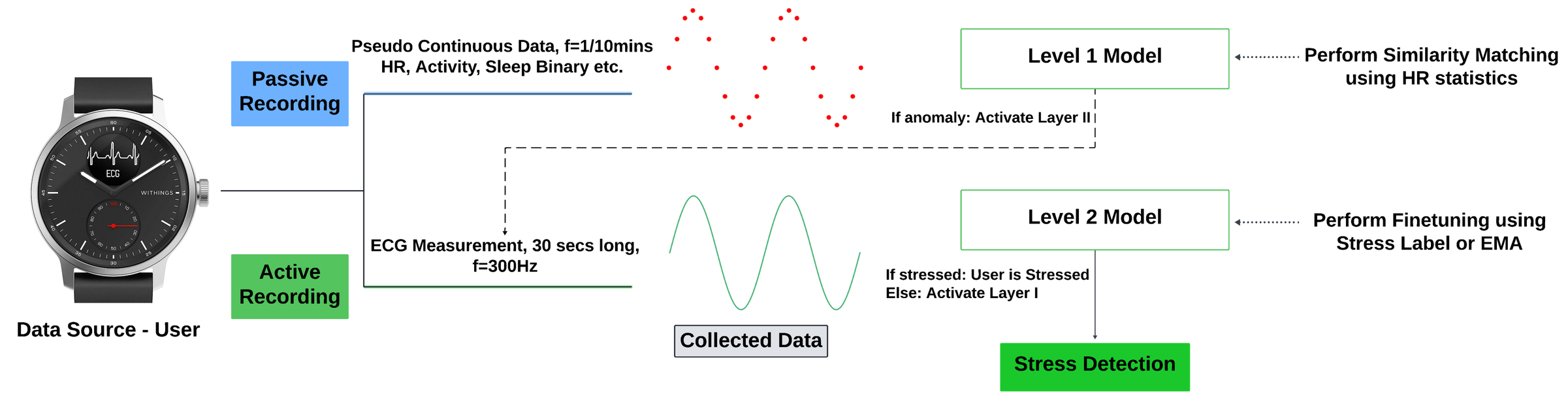
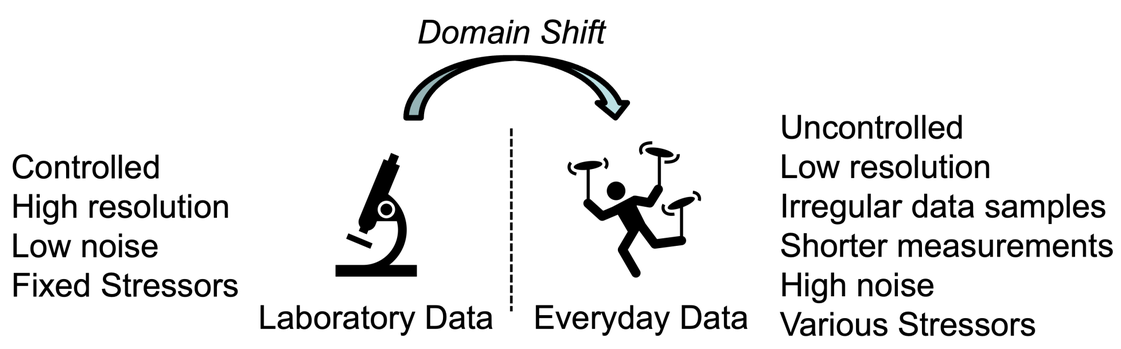
Can we transfer laboratory data to offer personalized stress prediction in everyday life?



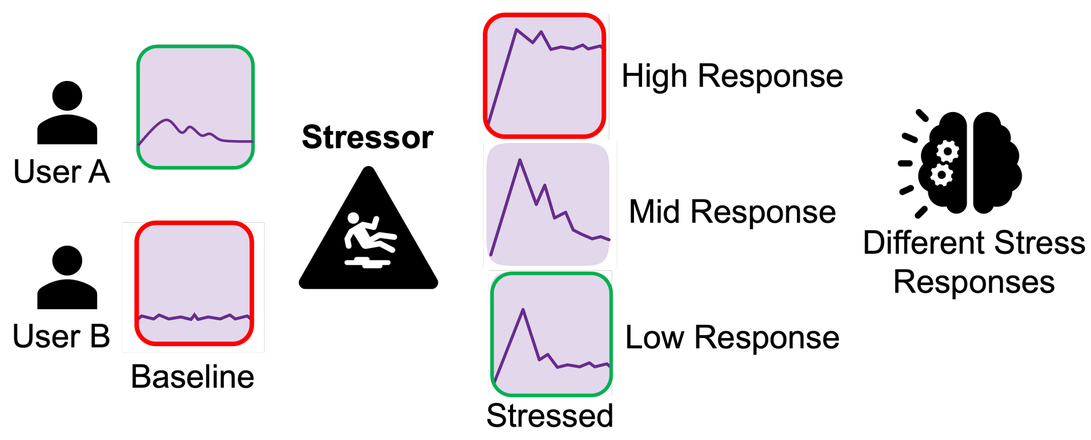
Motivation and Contributions

Chronic stress can lead to serious health issues like **cardiovascular diseases, depression, and anxiety.** In this work, we

1. Propose **Multi-level Stress Predictor, (MuStP), a two-level ML pipeline that can operate with low-resolution HR and high-resolution ECG measurements for stress prediction.**
2. Transfer **the model trained in laboratory environment to everyday environment.**



3. Perform **personalized stress prediction** with model fine-tuning, similarity matching, and post-hoc optimization.



4. Operate **with low-resolution heart rate (HR) signals in default mode**, e.g. suitable to run with incoming data from commercial smartwatches.
5. Require **minimum active participation of the user** for real-time stress prediction in everyday life setting.

MuStP

MuStP is trained with LABORATORY DATA and **transfer them to everyday environment using** EVERYDAY DATA.

- Level 1: Uses an isolation forest-based anomaly detector for HR measurements over 30 minutes. Personalized through **similarity matching** (SM), selecting model of user with minimum distance:

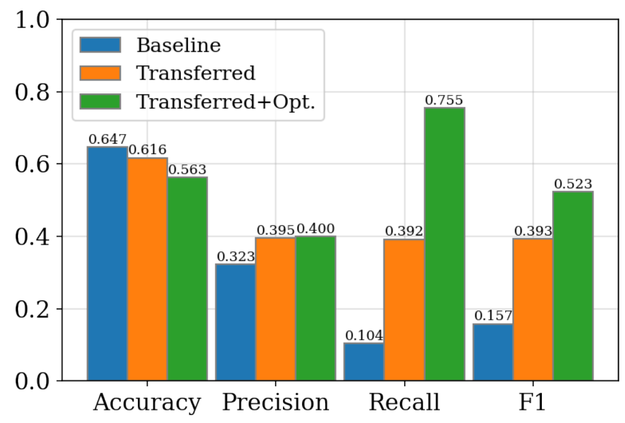
$$d_{ij} = \frac{1}{4}\frac{(\mu_i - \mu_j)^2}{\sigma_i^2 + \sigma_j^2} + \frac{1}{2}\ln\left(\frac{\sigma_i^2 + \sigma_j^2}{2\sigma_i\sigma_j}\right), \quad (1)$$

  where μ and σ statistics of baseline HR measurements, i and j are indices of query and key users, respectively.
- Level 2: Utilizes a Convolutional LSTM network which classifies 30-second ECG signals into stress and non-stress. The last layer can be **Fine-tuned** (FT).

We perform post-hoc optimization (PO) to user decision thresholds by maximizing F1 score on held-out data.

Results

We present our results of MUSTP model with 60% of EVERYDAY DATA where only 31% of data is labeled as stress.



- Baseline: Level 1-2 are trained with LABORATORY DATA for the whole population and decision thresholds are chosen.
- Transferred: In Level 1, for each everyday user, the model is decided with SM. In Level 2, we apply FT by using 40% of everyday user data collected over time.
- Transferred + PO: We apply PO after model transfer.

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