

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?



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 lowresolution 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 finetuning, similarity matching, and post-hoc optimization.



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:

$$d_{ij} = \frac{1}{4} \frac{(\mu_i - \mu_j)^2}{\sigma_i^2 + \sigma_j^2} + \frac{1}{2} \ln\left(\frac{\sigma_i^2 + \sigma_j^2}{2\sigma_i \sigma_j}\right),$$
 (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 Every-DAY DATA where only 31% of data is labeled as stress.

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	Baseline		
	Transferred		

- 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.



- Baseline: Level 1-2 are trained with LABORATORY DATA for the whole population and decision thresholds are chosen.
- \bullet 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.
- $\bullet \, \text{Transferred} + \mathrm{PO}$: We apply PO after model transfer.

The authors acknowledge the support by the German Federal Ministry of Education and Research through the Cello project under the project number: 16SV8590.