StressBal:

Personalized Just-in-time Stress Intervention with Wearable and Phone Sensing

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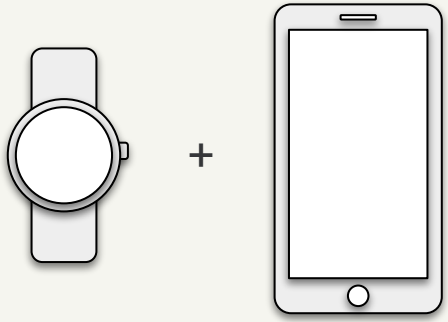
Stress Management System



- Physiological signals and Behavioral data for detection
- Mobile applications and Interfaces for alleviating

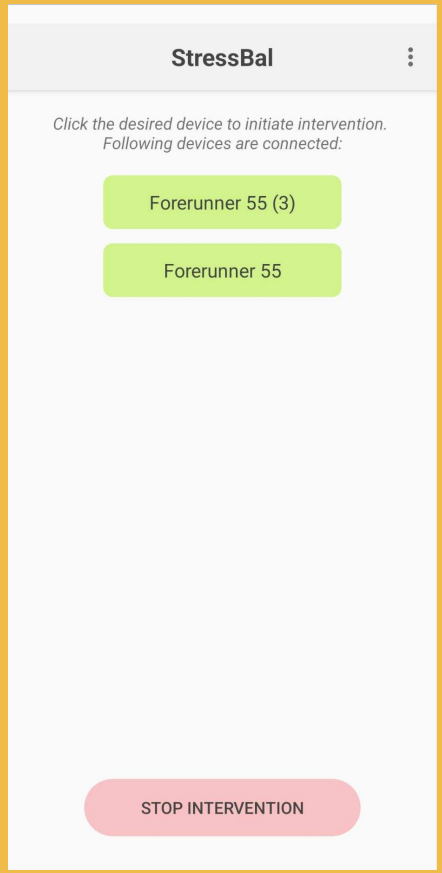
Real-time System

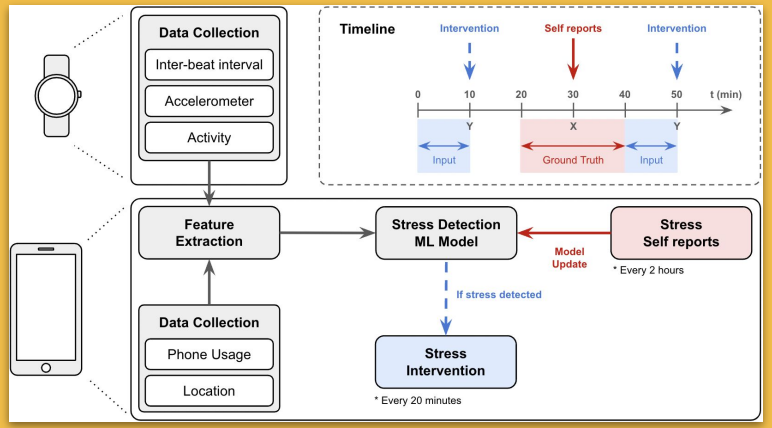
StressBal,

Detects daily stress and
Provides just-in-time intervention,
Using multimodal data and ML algorithm

StressBal

- ✓ Use of commercial off-the-shelf wearable device
- ✓ Implementation of an adaptive stress recognition module
- ✓ Localized data processing enabled by complete on-device operations





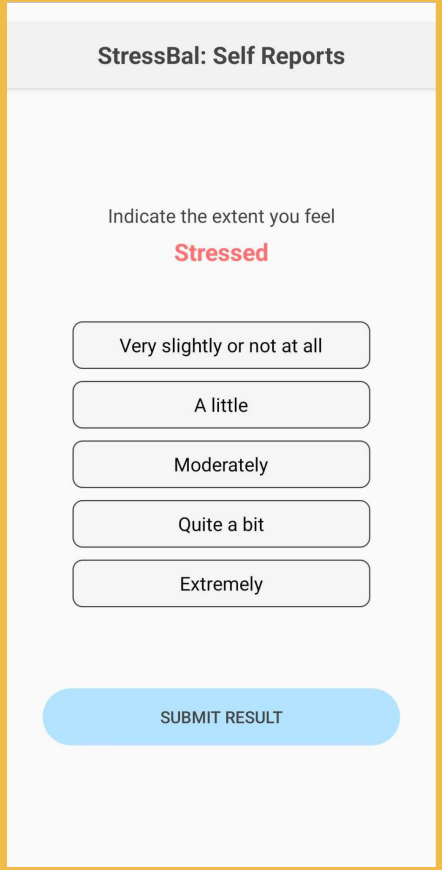
1. Data Collection
2. Feature Extraction
3. Just-in-time Intervention
4. Model Update

android

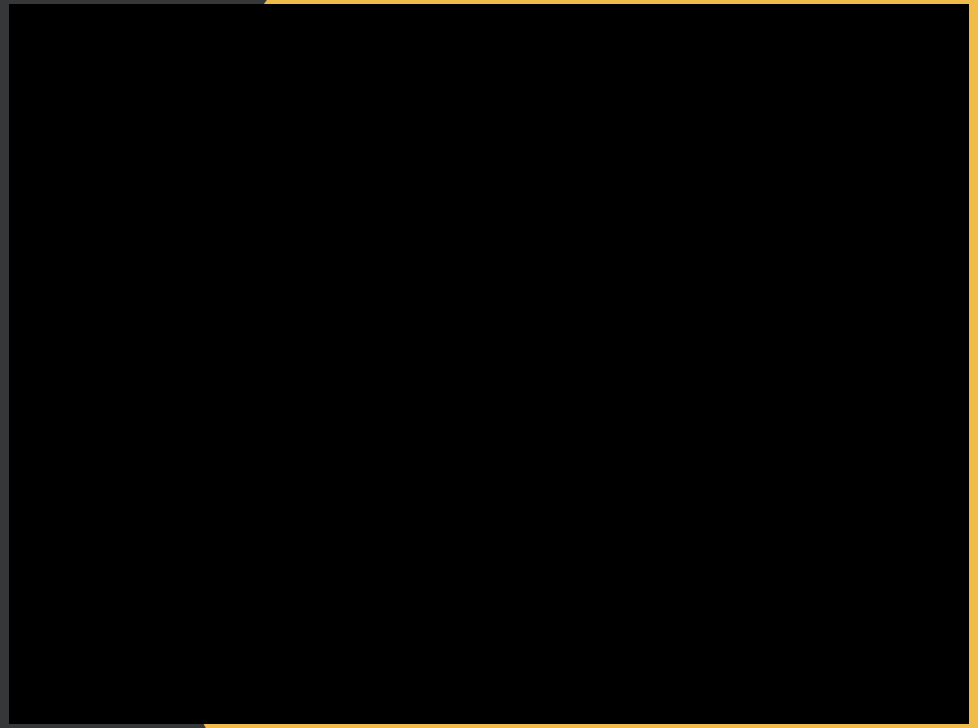
1. Data collection

- Smartwatch
  - Inter-beat Interval (IBI)
  - 3-axis accelerometer (ACC)
  - Activity
    - Step counts
    - Distance moved
- Mobile Phone
  - Location
  - Phone usage

- Ecological Momentary Assessments (EMAs)
  - Every 2 hours
  - Answers are binned
    - Quite a bit & Extremely
      → *Stressed*
    - Very slightly or not at all & A little & Moderately
      → *Not stressed*
  - Used as ground truth

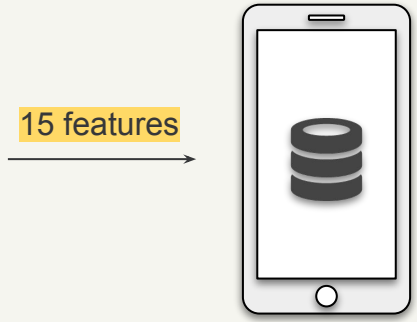


DEMO



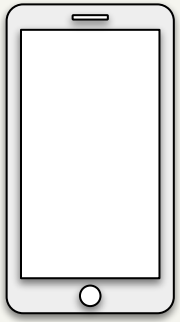
2. Feature extraction

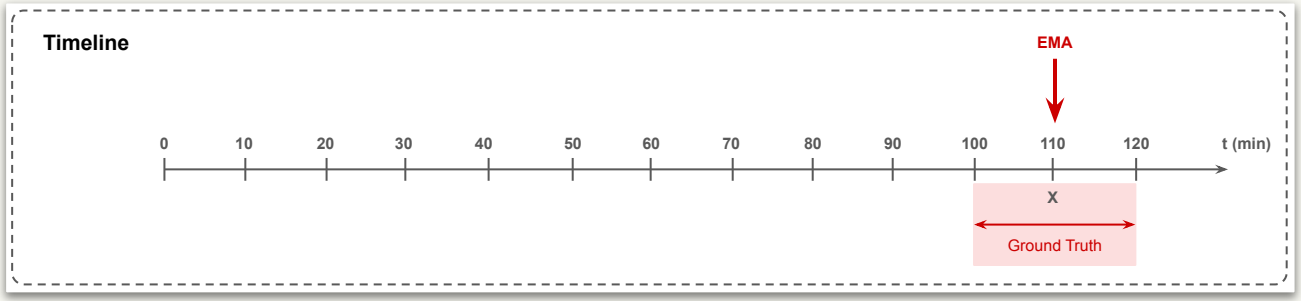
- Each time watch data is transmitted
  - i.e. Every 5 minutes
- Numerical
  - Heart rate variability (HRV)
  - Mean, Std, Mag for each axis
  - # of steps
  - Phone usage time
- Categorical
  - Moved / Not Moved
  - At home / At work



3. Just-in-time Intervention

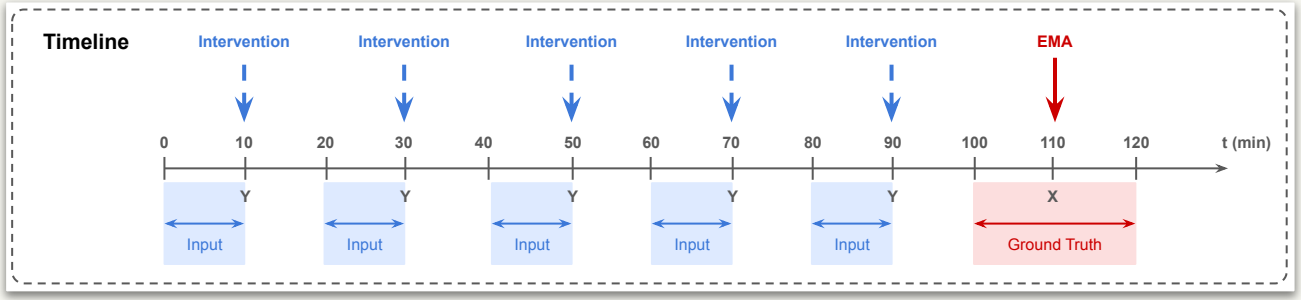
- ML-based stress detection model
  - Pre-training
    - Baseline model with individual data
    - EMA data labeling





3. Just-in-time Intervention

- ML-based stress detection model
  - Intervention
    - Every 20 min
      - Predicts user's stress status
    - Guidelines of the existing peripheral breathing exercise



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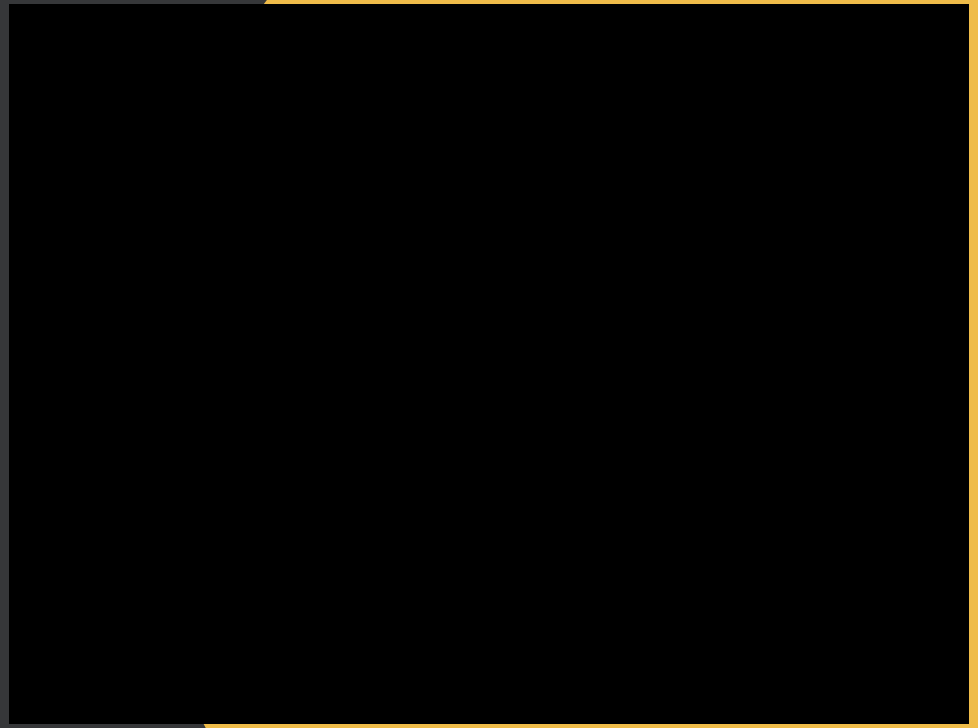

4. Model Update

- Nightly Update TensorFlow Lite
  - On-device
  - More accurate and personalized detection

Future Work

- Evaluating system in a specific environment and target user
- Improving the detection algorithm

Open Platform!

Thank you!

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Stress of daily life

Identify stressful situations and
Manage stress in the early stage

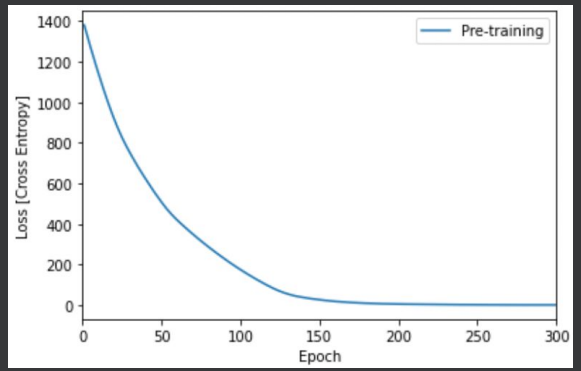
Extracted Features

Time	HRV	meanX	stdX	magX	meanY	stdY	magY	meanZ	stdZ	magZ	step	distance	home	work	screenTime
00:00 →	43.32	-159.08	4.54	1591.45	456.4	34.12	4576.74	-945.37	15.45	9454.96	0	0	0	1	0
00:05 →	32.91	-121.16	1.36	1211.68	93.55	1.65	935.65	-1055.42	1.62	10554.21	0	0	0	1	0
00:10 →	32.49	-753.74	18.33	7539.63	630.17	76.01	6347.37	-230.89	118.18	2593.76	0	0	0	1	13.802
00:15 →	36.88	58.77	115.35	1294.6	479.15	67.98	4839.49	-948.19	42.6	9491.47	0	0	0	1	13.802
00:20 →	30.32	-621.45	4.46	6214.66	762.49	7.44	7625.26	-284.07	12.05	2843.26	0	0	0	1	318.749

Pre-training

Result

- Training Loss



Test Accuracy: 0.667