Searching for Suitable Datasets:

Focus on Empatica-based Labelled Data

1. Overview

Convolutional Neural Networks (CNNs) are widely used in processing time-series data in applications such as emotion recognition, stress detection, and health monitoring. A 1D-CNN, in particular, processes 1-dimensional signals such as physiological and bio signals. When selecting datasets for training and validating a 1D-CNN, it is crucial to find data that matches the application area, such as physiological data collected from wearable devices like **Empatica**.

Empatica provides several key sensors for physiological measurements, including:

- **Electrodermal activity (EDA)** for stress response.
- **Photoplethysmography (PPG)** for heart rate.
- **Temperature** and **movement (accelerometer)** sensors for activity recognition.

The datasets should ideally be **labelled**, allowing for supervised learning, and contain **multi-modal** sensor data relevant to health or emotional states.

1.1 Dataset Selection Criteria for 1D-CNN

When searching for appropriate datasets for training and validation, consider the following criteria:

1. **Sensor Compatibility:**
   - The dataset should include data from Empatica devices or similar sensors (e.g. E4, Embrace Plus).
   - Look for data from multi-modal signals like EDA, PPG, accelerometer, and temperature

2. **Data Format:**
   - **1D time-series data** should be in a format that is easy to preprocess (e.g., CSV, MAT, or directly downloadable sensor files).

3. **Labelled Data:**
   - Data should be **labelled** with information about stress, emotional state, activity level, or other health indicators.
   - Classified events or timestamps should be present for accurate segmentation and validation.

4. **Data Volume:**

- The dataset should provide sufficient data for both training and validation.
- Larger datasets with diverse subjects are preferred to reduce overfitting and improve generalisation.

5. **Public Availability:**
   - The dataset should ideally be publicly available for research purposes and come with clear usage documentation.

WESAD (Wearable Stress and Affect Detection)		
Description:	WESAD is a dataset for stress detection using physiological and motion data recorded from the **Empatica E4** and a **RespiBan** device. It contains labelled stress, amusement, and baseline conditions.	
Sensors:	Electrodermal Activity (EDA)	
	Photoplethysmography (PPG)	
	Accelerometer (ACC)	
	Temperature (TEMP)	
Labels:	- Stress - Baseline - Amused	
Availability:	WESAD dataset	
	WESAD paper	
Usage:	Ideal for training stress detection models.	

AMIGOS		
Description:	**Shimmer 2R** platform extended with a GSR and ECG modules board. **Emotiv EPOC Neuroheadset** 40 healthy individuals (13 female, 27 male) aged between 21 and 40 (mean age 28.3). 37 conducted the experiment (participant 8, 24, 28 were not available). In the individual setting, 17 participants performed the experiment alone. In the group setting, 20 participants performed the experiment together with 3 other participants (5 groups of 4 people). In order to maximize interactions, groups were formed to include people that knew each other, being either friends, colleagues, or people with similar cultural background. During the recording sessions, the participant(s) were led to the recording room. While the different sensors were set up, experimenters explained the differences of the protocol compared to the short videos experiment. The experiment consisted of the display of 4 long videos in random order. Videos were shown in two recording sub-sessions, each consisting of: (1) initial self-assessment (45s) of arousal, valence, dominance and selection of basic emotions. (2) the display, in two trials of two long videos, each followed by (3) self-assessment (45s) of arousal, valence, dominance, liking and familiarity, and selection of basic emotions. After the first sub-session followed a break of 15 minutes where participants were offered refreshments. After, sensors' signals were checked and the second recording sub-session started, after which the session ended. After the long videos experiment, participants were asked to fill in as soon as possible, on-line forms with Personality Traits and PANAS questionnaires. Participants took **2 days on average to fill in the questionnaire**. Once they filled in all required forms, they were given mugs and university gadgets in return for their participation.	
Sensors:	Electroencephalogram (EEG)	128 Hz, 14-bit resolution
	Electrocardiogram (ECG)	256 Hz, 12-bit resolution

	Galvanic Skin Response (GSR)	128 Hz, 12-bit resolution
Labels:	-	
Availability:	Dataset	
	Dataset summary	
	Experiment Paper	
Usage:	Not usable. A questionnaire that has two days to be filled in by all participants is rather inaccurate. People tend to forget about it, or just fill it in after a few days. If it was done after the experiment or a few minutes after, it was more suitable.	

DRIVE dataset	
Description:	Twenty-four drivers participated in a real-world driving experiment in Boston. They were equipped with four sensors (Electrocardiogram, electromyogram, skin conductance and respiration) and went driving for at least fifty minutes. They used features from five minutes intervals during rest, highway and city driving conditions to distinguish three levels of driver stress. The result of this study was that for most drivers the skin conductivity and heart rate metrics were mostly correlated with the driver stress level. *Measurement sensor device is unknown.*
Sensors:	Electrocardiogram (ECG)
	Electromyography (EMG)
	Electrodermal Activity (EDA)
	Respiration
Labels:	- Low stress - Medium stress - High stress
Availability:	Dataset
	Paper
Usage:	This dataset can be used to study driver stress, analyse physiological data related to driving conditions, and machine learning model for stress detection based on sensor data. It is especially useful for research in physiological monitoring, human factors in driving, and stress recognition applications.

Continuously Annotated Signals of Emotion (CASE) dataset		
Description:	This dataset consists of synchronized physiological recordings (1000Hz, 16-bit ADC) that were acquired by Thought Technology sensors. The dataset consists of physiological and annotation data from 30 participants 15 male, 15 female, who watched several video-stimuli. They showed the participants several movie-fragments that are categorised as genres (Action, comedy, documentary, nature). And showed the fragments for (min: 101 – max: 197 seconds). The data is mapped as (col 1: time, col 2-9: ECG, BVP, EDA, Respiration, skin temperature, EMG-zygomaticus, EMG-corrugator, EMG-trapezius). After viewing, participants answered a questionnaire.	
Sensors:	Electrocardiogram (ECG)	1000Hz
	Electrodermal Activity (EDA)	1000Hz
	Blood Volume Pulse (BVP)	1000Hz
	Electromyogram (EMG)	1000Hz
	Skin Temperature	1000Hz
	Respiration	1000Hz
	Electrocardiogram (ECG)	1000Hz
	Electrodermal Activity (EDA)	1000Hz
Labels:	Labelled as video-segments. During that period, the person should experience amusing, boring, relaxing or scary.	
Availability:	Paper	
	Dataset	
Usage:	This dataset is ideal for research in emotion detection, physiological signal analysis, and developing machine learning models focused on emotional responses.	

The violin plots shown in Figure 1, shows comparison of physiological measurements (HR, skin conductance, respiration, EMG, and emotional ratings) across four video types: amusing (red), boring (grey), relaxing (green), and scary (blue).

- **Heart rate (HR)**: Higher for amusing and scary videos.
- **Respiration rate (RR)**: Elevated in amusing and scary conditions.
- **EMG (Corrugator)**: Amusing videos lead to lower activity (linked to smiling), while scary increases frowning.
- **Valence**: Amusing videos elicit positive emotions, while scary ones are more negative.
- **Arousal**: Scary videos have the highest arousal.

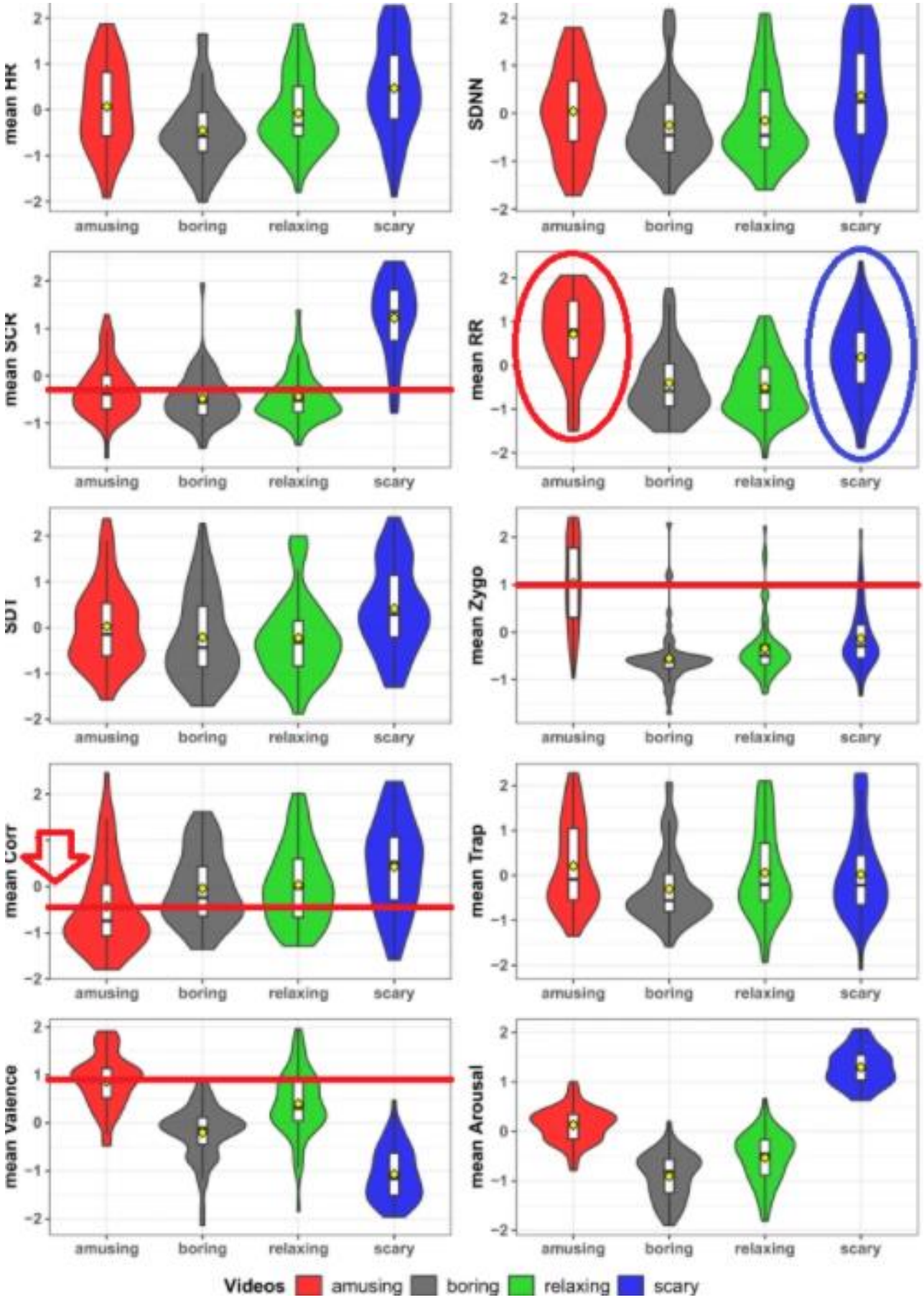

Figure 1: Sensor measurements

Affective ROAD dataset	
Description:	The AffectiveROAD dataset is designed to study driver behaviour and emotions during real-world driving scenarios. It combines physiological, behavioural, and environmental data collected from participants driving in varied conditions, capturing emotions and stress levels throughout the journey.
Sensors:	• Electrocardiogram (ECG)
	• Electrodermal Activity (EDA)
	• Heart Rate (HR)
	• Respiration
	• Skin Temperature
	• Eye-tracking
	• GPS and vehicle data
	• Electrocardiogram (ECG)
Labels:	• Emotional states (e.g., stress, calm)
	• Driving conditions (e.g., traffic, road type)
Availability:	Dataset
	Paper

DEAP dataset	
Description:	The DEAP dataset (Database for Emotion Analysis using Physiological signals) is a widely used dataset for studying human emotional states, particularly in response to visual stimuli (music videos). It was created to analyse emotions through physiological signals and facial expressions while participants watched music videos that were designed to elicit various emotions.
Sensors:	Electroencephalogram (EEG)
	Electrooculogram (EOG)
	Electromyogram (EMG)
	Galvanic Skin Response (GSR)
	Blood Volume Pulse (BVP)
	Respiration
	Skin Temperature
	Face Video
Labels:	Emotional states (e.g., valence, arousal)
	Video stimulus ratings (e.g., liking, familiarity)
Availability:	Dataset
	Paper
Usage:	The DEAP dataset can be used to study the correlation between physiological signals and emotional states, particularly for emotion recognition.

SWELL dataset	
Description:	The SWELL dataset is designed to study stress and mental workload in office-like environments. Participants completed a series of tasks (e.g., writing reports, conducting web searches) while their physiological and behavioural responses were recorded to assess stress and workload under varying conditions (e.g., time pressure, interruptions).
Sensors:	Electrocardiogram (ECG)
	Electrodermal Activity (EDA)
	Heart Rate (HR)
	Respiration
	Skin Conductance
	Facial Video
	Computer interaction logs (keyboard/mouse use)
	Eye-tracking
Labels:	Stress levels (e.g., low, medium, high)
	Task type (e.g., cognitive, browsing)
Availability:	Dataset
	Paper
Usage:	The SWELL dataset is useful for research into stress detection, mental workload analysis, human-computer interaction.