SURVEY OF AFFECT REPRESENTATION SCHEMES IN PHYSIOLOGICAL AUTOMATIC AFFECT RECOGNITION: A SYSTEMATIC LITERATURE REVIEW

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1. Background

- **Affect** is a term used for defining all categories of mental state: emotions, moods, attitudes, interpersonal stances, and affect disposition [1]
- **Automatic Affect Recognition (AAR)** is a field of affective computing that aims to recognize these affective states based on different modalities (visual, physiology)
- **Physiological signals** include all internal conditions in the human body (EEG, RSP, Body Temperature) [2]
- **Affect Representation Scheme (ARS)** is a way of defining affective states and a crucial element of AAR

happy   sad   disgust

fear   surprise   anger

Arousal

Valence

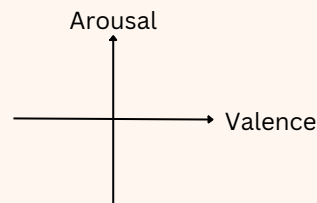Figure 1: Ekman's six emotions [3] - example of a categorical ARS

Figure 2: Russel's valence/arousal [4] - example of a dimensional ARS

2. Research Question

What Affect Representation Schemes are used in Physiological-signal-based Automatic Affect Recognition systems that are described in the existing literature?

Topics that will be covered to answer the main question:
- type of input data (signals) used
- target affective states (emotion, mood, etc.)
- type of ARS(s) used and motivations for them
- the popularity of types of ARS over time
- correlation between the choice of the scheme and target affection states and input signals

3. Methodology

- **A Systematic Literature Review** is recommended for research where the same information from different studies is extracted, aggregated, and compared [5]
- Report structured according to PRISMA guidelines [6]
- Engines: IEEExplore, Scopus, Web of Science, ACM DL
- Include Computer Science papers in English that introduce an AAR system using at least one physiological signal.
- 3 terms were identified for query construction: **affect, recognition, physiological signal**
- 2 additional filters for feasibility: year of publication 2020-2023, benchmarking dataset

4. Results & Findings

Search results: The search resulted in 610 records after removing duplicates. Filtering by title and abstract reduced this number to 220. Due to time constraints, only 129 papers were assessed for eligibility on full text. In the end, **115 papers were included in the review**.
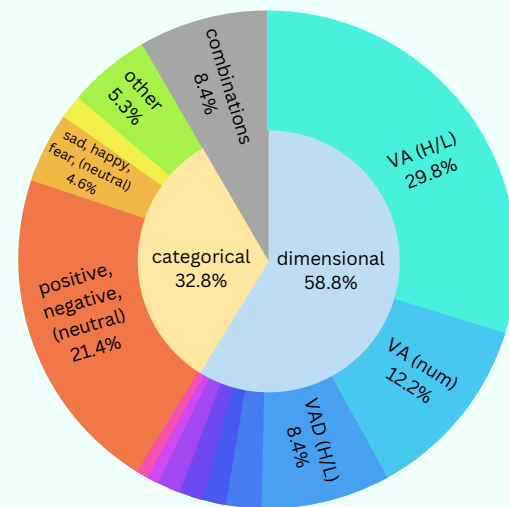
combinations 8.4%

other 5.3%

sad, happy, fear, (neutral) 4.6%

positive, negative, (neutral) 21.4%

categorical 32.8%

dimensional 58.8%

VA (H/L) 29.8%

VA (num) 12.2%

VAD (H/L) 8.4%

Figure 3: ARSs used in the reviewed papers. H/L - High/Low, V - Valence, A - Arousal, D - Dominance

Input signals:
- the majority (108/115) of papers used EEG
- 93/115 papers used only EEG
- Other physiological signals were usually used in multimodal systems
- no correlation between input signals and ARS was found

Affect categories:
- 108/115 paper target emotion
- 9 of them target emotion in a specific context (e.g., user emotion)
- systems that target emotion in a specific context are more likely to use a categorical ARS

Popularity over time:
- among the categorical models, the ones with more categories have become more popular in the last 2 years
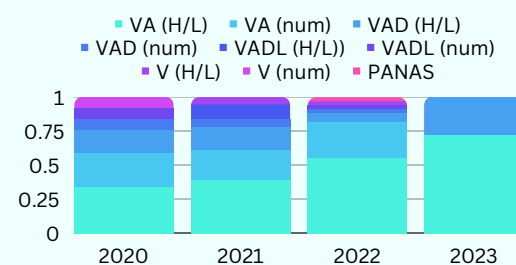- H/L representations are gaining popularity

ARS:
- **Combination ARSs** have characteristics of both categorical and dimensional ARS
- Reducing dimensional models to quadrants (High/Low) a is common practice
- 20 papers use multiple ARSs for experiments on multiple datasets

Motivations:
- Dimensional ARSs are often mentioned to be better as they represent more states
- VA (Valence/Arousal) model is usually motivated by its popularity, other ARSs were rarely motivated
- only 49/115 papers cite psychological papers

VA (H/L)   VA (num)   VAD (H/L)
VAD (num)   VADL (H/L)   VADL (num)
V (H/L)   V (num)   PANAS

2020   2021   2022   2023

Figure 4: Dimensional ARSs in the reviewed papers over time H/L - High/Low, V - Valence, A - Arousal, D - Dominance, L - Liking

positive, negative, (neutral)
sad, happy, fear (neutral)
sad, happy, fear, disgust, (neutral)
other
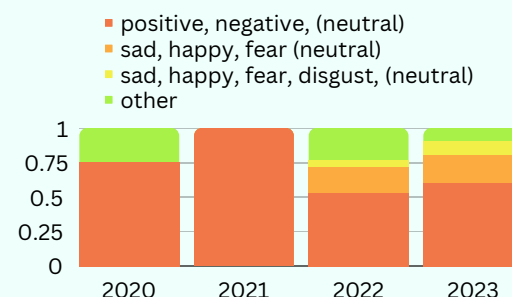
2020   2021   2022   2023

Figure 5: Categorical ARSs in the reviewed papers over time

5. Conclusion

- Authors often modify the dimensional ARS from the datasets, but further research is required to research whether these transformations are based on psychological theories and how they influence the results of experiments
- The results for the popularity of the categorical ARS are highly influenced by the datasets, however, there might be a tendency towards datasets that consider more categories
- Authors have to provide more motivation and background for ARS to increase the reliability of their work

6. Limitations

- The additional year of publication constraint limited the answer to the popularity of ARSs over time question, however, we still managed to provide some insights, and the results can be utilized in the complete review
- The dataset constraint had an impact on all results, however, it allowed to explore how researchers utilize these datasets.
- Due to the lack of representatives of systems using other signals than EEG and targeting affective states other than emotions, the results should be considered for the EEG-based emotion recognition systems. We believe a full review would fill in this gap.
- The review was performed by only one researcher which imposes the risk of bias and errors.

7. Future Work

- Performing a full review without the feasibility filters
- More detailed investigation of the datasets and their motivations for ARS
- Exploring the correlation between the dataset and ARS and the modifications authors apply to the dataset's ARS
- Expanding the research on the alignment of ARSs with psychological theories, in particular, the modifications applied to ARS

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[6] Page M J, McKenzie J E, Bossuyt P M, Boutron I, Hoffmann T C, Mulrow C D et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews BMJ 2021; 372 :n71 doi:10.1136/bmj.n71