AUTOMATIC DETECTION OF MIND-WANDERING USING FACIAL EXPRESSIONS

Radek Kargul r.kargul@studet.tudelft.nl
Supervisors: Bernd Dudzik, Xucong Zhang, Hayley Hung

TU Delft

1. Definitions

Mind-wandering (MW) – "when mind-wandering occurs, the executive components of attention appear to shift away from the primary task [1], not due to external factors or the person interacting with the external environment"

Mementos dataset – "a first multimodal corpus for computational modelling of affect and memory processing in response to video content" [2]

Facial Action Coding System (FACS) – a system that describes any facial movements

Action Units (AUs) – parametric descriptions (intensity scale 1-5)

2. Background

- ❑ Detection in combination with other data
- ❑ Self-reports indicating when MW happens
- ❑ Data collection rather cost-intensive (e.g. in labs)

Research Question: *Can automatic MW detection using only facial expressions from Mementos dataset perform better than by chance?*

3. Mementos Dataset

- ❑ Reactions to music videos
- ❑ Participants with multiple responses
- ❑ **1995** curated samples total

Labelling

- ❑ Groups of 3 and 2 (5 in difficult cases)
- ❑ Major part of peer work
- ❑ **549** annotated videos (**27.5%**)

Indicators

- ❑ **Smile**
- ❑ **Looking up / Rolling Eyes**
- ❑ **Squinting Eyes**
- ❑ **Sound**
- ❑ **Frowning**

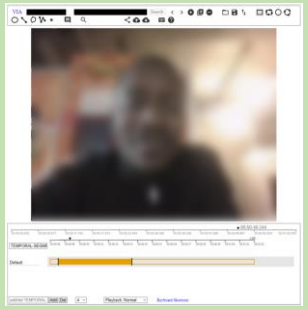

Figure 1: Example of annotating with VGG Annotator [3]

4. Methodology

Annotated Data
- ❑ **30** frames per second videos
- ❑ **50-70** second-long

Data pre-processing

AUs (features) extraction — OpenFace 2.0 [4] tool
17 facial features (AUs)

Frames segmentation
- ❑ Encoding frames into segments
- ❑ Capturing temporal information

Time series feature extraction — Tsfresh [5] tool
10 temporal features

Machine Learning

Data splitting
- ❑ **70%** training / **30%** testing sets
- ❑ Participants' responses not shared

Models preparation
- ❑ **Baseline** (majority classifier)
- ❑ **Algorithm-level approach** (class-weighted SVM*)
- ❑ **Data-level approach** (SVM* + SMOTE*)

Classification & evaluation
- ❑ SVM hyper-parameter tuning
- ❑ Evaluation on **100 classifications**
- ❑ Score metrics insensitive to imbalanced data

***SVM** = Support Vector Machine
***SMOTE** = Synthetic Minority Oversampling Technique

Baseline Classifier

Metric	Average	Median	Min	Max	SD
Precision	0.0	0.0	0.0	0.0	0.0
Recall	0.0	0.0	0.0	0.0	0.0
F1-Score	0.0	0.0	0.0	0.0	0.0
PR-AUC	0.505	0.505	0.503	0.508	0.001

*Table 1: Results from 100 **baseliner** classifications*

SVM Classifier (class-weighted)

Metric	Average	Median	Min	Max	SD
Precision	0.516	0.535	0.132	0.75	0.147
Recall	0.646	0.667	0.111	0.9	0.15
F1-Score	0.55	0.571	0.19	0.762	0.127
PR-AUC	0.583	0.588	0.266	0.778	0.102

*Table 2: Results from 100 **algorithm-level approach** classifications*

SVM Classifier (SMOTE technique)

Metric	Average	Median	Min	Max	SD
Precision	0.546	0.561	0.146	1.0	0.16
Recall	0.624	0.638	0.053	0.9	0.169
F1-Score	0.556	0.587	0.1	0.821	0.135
PR-AUC	0.587	0.6	0.202	0.822	0.114

*Table 3: Results from 100 **data-level approach** classifications*

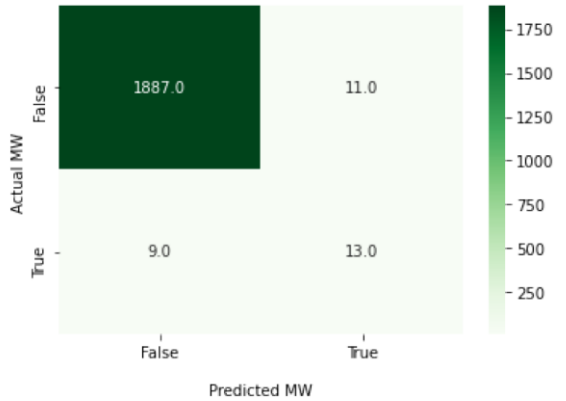

Figure 2: Example of a confusion matrix with 1898 not-MW samples and 22 MW samples ~ 86:1 ratio

5. Results

- ❑ Baseline (majority) classifier only classifies to the not-MW class, resulting in **0 P/R/F1**
- ❑ **Large variance** across the classification scores
- ❑ On average, the algorithm-level approach outperforms the data-level by **+0.04 (PR-AUC)** and **+0.06 (F1-Score)**
- ❑ **59%** TP vs **99.4%** FN

6. Conclusion & Future Work

- ❑ Data unsuitable for MW detection (difficult to evaluate at 86:1 sample ratio)
- ❑ No success in balancing the dataset
- ❑ Changing approach / labelling more data
- ❑ Other feature extraction method could be used
- ❑ MW detection not possible with the current setup

7. References

[1] J. Smallwood & J. W. Schooler (2006). The restless mind. Psychological bulletin, vol. 132, no. 6, 946–958.
[2] Dudzik, B., Hung, H, Neerincx, M., & Broekens, J. (2021). Collecting Mementos: A Multimodal Dataset for Context-Sensitive Modeling of Affect and Memory Processing in Responses to Videos
[3] https://www.robots.ox.ac.uk/~vgg/software/via/
[4] T. Baltrusaitis, A. Zadeh, Y. C. Lim, and L.-P. Morency, "Openface 2.0: Facial behavior analysis toolkit," in 2018 13th IEEE international conference on automatic face & gesture recognition (FG 2018). IEEE, 2018, pp. 59–66.
[5] M. Christ, N. Braun, J. Neuffer, and A. W. KempaLiehr, "Time series feature extraction on basis of scalable hypothesis tests (tsfresh–a python package)," Neurocomputing, vol. 307, pp. 72–77, 2018.