Technische Universität München – Faculty of Informatics
Chair for Computer Aided Medical Procedures (Prof. Nassir Navab)
Practical Course: Machine Learning in Medical Imaging WS23/24

Zero-shot Disease Diagnosis from Facial Features

1 General Info

Project Title: Zero-shot Disease Diagnosis from Facial Features
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2 Background and Motivation

Disease classification from facial features is a biomedical application of computer vision that aims to diagnose diseases based on a person's face. Facial attributes describe the shape, color, texture, movement, and expression of the face, such as eyes, nose, mouth, skin, hair, etc. Different diseases can affect facial features in different ways, such as the emergence of paleness, swelling, redness, or deformity. In some cases, they can be from birth; for example, Down syndrome is a genetic disorder that causes a flattened appearance to the face, almond-shaped eyes, and a short neck or can gradually emerge as the disease progresses. Disease classification from facial attributes can have various benefits for healthcare, such as enabling early detection, disease monitoring, and patient education. However, due to ethical and legal issues, collecting and sharing facial images of patients with different diseases is challenging [2]. Moreover, the number and type of diseases that can be diagnosed from facial attributes are limited by the availability and quality of the data. Furthermore, the facial attributes of different diseases may vary depending on factors such as age, gender, ethnicity, and environmental conditions. Therefore, there is a need for novel approaches that can overcome these challenges and classify diseases from facial attributes without any prior training or knowledge of the diseases. Zero-shot learning (ZSL) is a machine learning paradigm that aims to classify instances of unseen classes from which no training data is available by utilizing the attributes of the classes.

3 Project Abstract

In this project, we aim to develop a ZSL method for disease classification from facial attributes and medical knowledge graphs [6]. The model would be evaluated against real-world face [5, 3, 4] or motion disease datasets [1, 7]. The project will include the following steps: 1) Training and evaluation of supervised baseline, 2) Zero-shot disease classification from text, 3) Caption generation for disease from the facial images, 4) Combining steps 2 and 3, 5) introduction of motion patterns to the diagnosis model, 6) Final evaluation and documentation.

4 Technical Prerequisites

- Good background in machine learning and deep learning
- Experienced in PyTorch
- Experienced in Python

5 Benefits

- Weekly supervision and discussions
- Possible novelty of the research
- The results of this work are intended to be published in a conference or journal
- Possible collaboration with Stanford

6 Work packages and Time-plan

* The dates are adopted from the previous year and are not finalized yet.

	Description	# Students	From	To
WP1	Familiarizing with the literature.	4	24.10	31.10
WP2	Implementing the baselines	4	31.10	14.11
WP3	Improving the baselines and validation on relevant datasets	4	14.11	27.11
	Midterm Presentation (Date is not finalized)	4	27.11	05.12
WP4	Implementing the model	4	05.12	19.12
WP5	Finalizing the results and evaluation	4	19.12	07.02
	Final Presentation (Date is not finalized)	4	07.02	14.02

Table 1: Project Timeline

References

[1] Andrea Bandini, Sia Rezaei, Diego L Guarín, Madhura Kulkarni, Derrick Lim, Mark I Boulos, Lorne Zinman, Yana Yunusova, and Babak Taati. A new dataset for facial motion analysis in individuals with neurological disorders. *IEEE Journal of Biomedical and Health Informatics*, 25(4):1111–1119, 2020.

[2] Castela Forte, Andrei Voinea, Malina Chichirau, Galiya Yeshmagambetova, Lea M Albrecht, Chiara Erfurt, Liliane A Freundt, Luisa Oliveira e Carmo, Robert H Henning, Iwan CC van der Horst, et al. Deep learning for identification of acute illness and facial cues of illness. *Frontiers in medicine*, 8:661309, 2021.

[3] Bo Jin. Disease-specific faces, 2020.

[4] Bo Jin. Disease-specific faces 2, 2023.

[5] Bo Jin, Leandro Cruz, and Nuno Gonçalves. Deep facial diagnosis: Deep transfer learning from face recognition to facial diagnosis. *IEEE Access*, 8:123649–123661, 2020.

[6] Alexandre Renaux, Chloé Terwagne, Michael Cochez, Ilaria Tiddi, Ann Nowé, and Tom Lenaerts. A knowledge graph approach to predict and interpret disease-causing gene interactions. *BMC bioinformatics*, 24(1):324, 2023.

[7] Tao Xu, Xinheng Wang, Xie Lun, Hang Pan, and Zhiliang Wang. Adrefv: Face video dataset based on human-computer interaction for alzheimer's disease recognition. *Computer Animation and Virtual Worlds*, 34(1):e2127, 2023.