GeNoMe: Generating Anomalies in Medical Imaging

1. General Info

Project Title: GeNoMe: Generating Anomalies in Medical Imaging

Contact Person: Yousef Yeganeh, Azade Farshad

Contact Email: y.yeganeh@tum.de, azade.farshad@tum.de

2. Project Abstract

In most cases, anomalies are shown as deformed segments in the image. Even non-experts can easily recognize them; therefore, in the next step, we aim to produce anomalies that are often hidden from the untrained and even trained eyes in the next step. At the end of this project, our goal is to acquire a general understanding of inpainting models, and we to investigate and tune these models to become specialized in such tasks.

3. Background and Motivation

Recently, generative models, such as DALL-E[2], present remarkable results in inpainting[1] tasks. Unlike GANs or other generative models, these approaches do not aim to generate complete synthetic images. Still, they modify an existing image based on its underlying data distribution or an input. These manipulations are conducted so that the generated synthetic parts conform to the context of the image and its surroundings. This technique, along with other generative models, introduces anomalies in healthy medical imaging data. The number of pathological images is often limited, and a technique to create anomalies from healthy images that are often easily obtainable is very valuable for the medical community. We aim to analyze and learn about these manipulations and apply them in the medical setting according to the project abstract presented in the previous section.

4. Technical Prerequisites

- You need to have a strong background in deep learning to read the related papers and discuss them in the weekly meetings and with your teammates
- You must be able to use repositories that are mostly written in pytorch and python and modify them

5. Benefits:

- Weekly supervision and discussions
- Practicing writing and presentation
- Possibility of using the chair students' room
- Extra office hours for problem-solving for enthusiastic students
- Possibility of novelty and publication
- Possibility of further collaboration with the team in the form of HiWi, guided research, IDP and thesis

6. Students' Tasks Description

- Understanding the techniques and methodology
- Implementation of the codes and modifying them in a clear way in a shared repository
- Writing weekly reports and presenting them in the weekly meetings

- Active discussions with the teammates and tutors
- Running the evaluation metrics on a medical imaging dataset
- Testing and documentation.

7. Work-packages and Time-plan:

	Description	#Students	From	To
WP1	Familiarizing with the literature.	4	05.05	12.05
WP2	Familiarizing with the required frameworks. Come up with a detailed time-plan (gantt)	4	12.05	19.05
WP3	Evaluation of inpainting technique on synthetic data	4	19.05	02.06
WP4	Adapting inpainting technique for medical imaging data	4	02.06	16.06
WP5	Evaluation of the implemented methods on anomalies	4	16.06	23.06
M1	Intermediate Presentation II	4	23.06	
WP6	Improving anomaly generation	4	23.06	01.07
WP7	Comparison to other anomaly generation techniques	4	01.07	14.07
WP8	Testing and Documentation	4	14.07	28.07
M2	Final Presentation	4	28.07	

References

1. Yu, J., Lin, Z., Yang, J., Shen, X., Lu, X. and Huang, T.S., 2018. Generative image inpainting with contextual attention. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 5505-5514).
2. Ramesh, A., Pavlov, M., Goh, G., Gray, S., Voss, C., Radford, A., Chen, M. and Sutskever, I., 2021, July. Zero-shot text-to-image generation. In *International Conference on Machine Learning* (pp. 8821-8831). PMLR.
3. Nichol, A., Achiam, J., & Schulman, J. (2018). On first-order meta-learning algorithms. arXiv preprint arXiv:1803.02999.
4. Laptev, N. (2018). AnoGen: Deep Anomaly Generator. In Outlier Detection De-constructed (ODD) Workshop. Available online: https://research. fb. com/publications/anogen-deep-anomaly-generator/(accessed on 20 August 2018).
5. Salem, M., Taheri, S., & Yuan, J. S. (2018, November). Anomaly generation using generative adversarial networks in host-based intrusion detection. In 2018 9th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON) (pp. 683-687). IEEE.

6. Kim S, Kim B, Park H. Synthesis of brain tumor multicontrast MR images for improved data augmentation. Med Phys. 2021 May;48(5):2185-2198. doi: 10.1002/mp.14701. Epub 2021 Mar 22. PMID: 33405244.
7. Suvorov, R., Logacheva, E., Mashikhin, A., Remizova, A., Ashukha, A., Silvestrov, A., ... & Lempitsky, V. (2022). Resolution-robust Large Mask Inpainting with Fourier Convolutions. In Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (pp. 2149-2159).