

Private generative models for the synthesis of ECG data

This master thesis aims to train general adversarial networks with privacy guarantees for the generation of synthetic ECG data.

In order to protect the privacy of patients, synthetic data can be used instead of or additionally to real medical data in research and education. Generative models such as General Adversarial Networks (GANs)[1] or Variational Autoencoders (VAE)[2] have successfully been used to generate new data, even complex time series such as ECGs[3][4]. To ensure that the generated data is in fact preserving the privacy of the patients represented in the training data, differential privacy[5] can be applied. While GANs have already been trained under privacy conditions [6], it has not yet been combined with the generation of ECG data. Therefore this master thesis aims to combine existing generative models for ECG data with privacy constraints.

Students interested in this thesis should already have knowledge about deep learning and experience with Python. Further skills in the field of time-series or generative models are nice-to-have but optional.

Related literature

- [1] Creswell, A., White, T., Dumoulin, V., Arulkumaran, K., Sengupta, B., & Bharath, A. A. (2018). Generative adversarial networks: An overview. *IEEE signal processing magazine*, 35(1), 53-65.
- [2] Kingma, D. P., & Welling, M. (2013). Auto-encoding variational bayes. *arXiv preprint arXiv:1312.6114*.
- [3] Upreti, R. (2023). Conditional Deep Generative Models for Generating Synthetic Electrocardiograms (Master's thesis, Oslomet-storbyuniversitetet).
- [4] Beetz, M., Banerjee, A., & Grau, V. (2022). Multi-domain variational autoencoders for combined modeling of MRI-based biventricular anatomy and ECG-based cardiac electrophysiology. *Frontiers in physiology*, 13, 886723.
- [5] Dwork, C. (2006, July). Differential privacy. In *International colloquium on automata, languages, and programming* (pp. 1-12). Berlin, Heidelberg: Springer Berlin Heidelberg.
- [6] Jordon, J., Yoon, J., & Van Der Schaar, M. (2018, September). PATE-GAN: Generating synthetic data with differential privacy guarantees. In *International conference on learning representations*.

Medical assistance systems ranging from robots to smart home devices and apps provide support for people in physical and cognitive tasks. Based on a deep understanding of social interaction and human cognition, we develop effective intelligent assistance systems with the flexibility to co-construct interaction with different user groups (patients, relatives, doctors, nurses, etc.). This is achieved through a consistent *user-centered co-design*. Our goal is to support people in their well-being and participation through *studies and technology development* so that they can live autonomously and healthily.

More information is available at: <https://www.uni-bielefeld.de/fakultaeten/medizin/fakultaet/arbeitsgruppen/assistenzsysteme/>

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