Chair of Communications Engineering
TUM Department of Electrical and Computer Engineering
Technical University of Munich

Master's Thesis

Group testing techniques based on sparse graphs for large-scale population screening

Group testing is a combinatorial technique (developed by R. Dorfman in 1943) which allows to detect infected individuals by running “pooled” tests on (blood) samples. More specifically, by merging the samples of a subset of individuals into a pool, a test is carried out to verify the positivity (or negativity) of the pool. By repeating the test on different subsets, it is eventually possible to detect the individuals carrying the infection, possibly with very few tests compared with the test population. The approach is currently scouted to speed-up the testing in the context of the COVID-19 pandemic (see https://www.nature.com/articles/d41586-020-02053-6 and [1-2]). The technique admits a description which shares several similarities with the syndrome-based error correction problem via linear block codes. It is not a surprise that major contributions in the area of group testing have been given by coding and information theorists.

The scope of the thesis is to investigate the adoption of capacity-approaching codes based on sparse graphs (e.g., low-density parity-check codes) to attack the group testing problem. The use of sparse-graph codes for this purpose has been already envisaged in [3-4]. In this work, we will address the design of adaptive/non-adaptive and quantitative/non-quantitative group testing techniques based on sparse graphs, under various detection algorithms (belief propagation, as well as combinatorial orthogonal matching pursuit).

[1] Mutesa, Leon, et al. "A strategy for finding people infected with SARS-CoV-2: optimizing pooled testing at low prevalence." arXiv preprint arXiv:2004.14934 (2020). [2] Narayanan, Krishna R., Anoosheh Heidarzadeh, and Ramanan Laxminarayan. "On Accelerated Testing for COVID-19 Using Group Testing." arXiv preprint arXiv:2004.04785(2020). [3] K. Lee, R. Pedarsani and K. Ramchandran, "SAFFRON: A fast, efficient, and robust framework for group testing based on sparse-graph codes," 2016 IEEE International Symposium on Information Theory (ISIT), Barcelona, 2016 - available at https://arxiv.org/abs/1508.04485 [4] Aldridge, Matthew, Oliver Johnson, and Jonathan Scarlett. "Group testing: an information theory perspective,: NOW Published, 2020 - available at https://arxiv.org/pdf/1902.06002.pdf

Prerequisites

The student should have successfully passed the Channel Coding course and should exhibit a good understanding of probability theory. The Channel Codes for Iterative Decoding and Information Theory courses are plus.

Contact

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Advisors

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