Master Thesis

Parametric Alternating Information Bottleneck Approach for the Gaussian CEO Problem

Description:

Distributed technical systems for monitoring and control rely heavily on communication capabilities. Sensing, communication, and signal processing have to be jointly optimized to optimally infer the desired information. In this thesis, distributed sensors communicate over capacity-limited links with a common receiver. The measurements are noisy which is widely known as remote sensing problem. In order to ensure reliable transmission from each sensor to the common receiver the measurements have to be compressed and FEC encoded. These compressed measurements shall contain as much information as possible about the measured physical quantity. The Chief Execution Officer (CEO) problem addresses the estimation of a common relevant signal from its quantized noisy measurements. In the CEO scenario a rate region describes the set of feasible rates for which a desired minimal distortion can be achieved.

Tishby et al. introduce the Information Bottleneck (IB) framework as an information theoretic approach to optimize quantizers. Since the given scenario does not allow the communication between sensors, optimal vector quantization is not applicable. The sub-optimality of independently optimized scalar quantization can be overcome by jointly designing these scalar quantizers using the statistics of the other quantizers as side-information. Therefore, the Alternating Information Bottleneck (AIB) algorithm was introduced, which successively designs each quantizer, given the statistics of all other quantizers as side-information while dealing with individual rate constraints.
In this thesis, the relevant signal $x$ is assumed to be Gaussian distributed. In the scalar case, i.e. just one sensor is considered, the parametric version of the Information Bottleneck (PIB) approach can be applied. This approach shall be extended to the distributed optimization problem. Therefore, both algorithms (AIB and PIB) have to be combined. Moreover, the PIB approach exploits that some distributions used in the calculations are Gaussian. It has to be investigated, whether this also holds for the distributed case.

The required tasks for this thesis are:

- Literature review on the CEO problem and the Information Bottleneck method, especially the PIB and AIB approach.
- Familiarize yourself with the current implementation of the AIB algorithm in Python
- Derive and implement a parametric version of the AIB algorithm in Python
- Analyse its performance in contrast to the original AIB algorithm

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