Karlsruher Institut für Technologie

Communications Engineering Lab (CEL)
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Machine Learning-based optimization of a Decoder for Tail-Biting Convolutional Codes

Bachelor's Thesis

Project

Convolutional Codes require *termination*, i.e. insertion of bits to "flush" out the remaining bits from the internal state. While this is not a significant problem for long-running stream communications, in cases where short packets of data need to be decoded individually (e.g. IoT/5G low latency), this comes at a rate loss, and thus with a penalty.

Tail-Biting Convolutional Codes counter that by using the beginning as termination (or the end as initialization), and thus combine the ease of decoding of convolutional codes with the benefits of block decoding.
However, not having a known termination sequence, makes it desirable to have sensible hypothesis for what the initial state is, before the decoding begins and potentially runs into expensive mis-speculation based on an incorrect initial estimate.

Due to the finite memory length of a convolutional code, it's possible to formulate the problem of finding the most likely initial state as an estimation problem for a vector of scalars. Compared to trying all reasonable state candidates, employing neural networks promises to reduce the complexity of the problem at hand.

You'll be tasked with finding a neural network to estimate the optimal initial state candidate. This requires design of the neural network itself, as well as a training fixture. Your thesis will contribute a fundamental contribution to the theory and application of robust low-latency, low-power communications, and thus might enable high-performance small-packet communication networks of the future.

Deliverables

1. Become acquainted with tail-biting convolutional codes and neural networks
2. Implementation of a training framework for the neural network
3. Training and evaluation of the neural network

Requirements

- ✓ (optimally) working knowledge of Python
- ✓ Interest in working on channel decoders and neural networks as means for optimization

Institute

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