Adjacent-Bits-Swapped Polar codes: A new code construction to speed up polarization

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Abstract

Polar codes were proposed by Arıkan and shown to achieve capacity on all binary memoryless symmetric (BMS) channels. The construction of polar codes with code length $n = 2^m$ involves m layers of polar transforms. We observe that after each layer of polar transforms, one can swap certain pairs of adjacent bits to accelerate the polarization process. More precisely, if the previous bit is more reliable than its next bit under the successive decoder, then switching the decoding order of these two adjacent bits will make the reliable bit even more reliable and the noisy bit even noisier. Based on this observation, we propose a new family of codes called the Adjacent-Bits-Swapped (ABS) polar codes. We add a permutation layer after each polar transform layer in the construction of the ABS polar codes. In order to choose which pairs of adjacent bits to swap in the permutation layers, we rely on a new polar transform that combines two independent channels with 4-ary inputs. This new polar transform allows us to track the evolution of every pair of adjacent bits through different layers of polar transforms, and it also plays an essential role in the Successive Cancellation List (SCL) decoder for the ABS polar codes. Extensive simulation results show that ABS polar codes consistently outperform standard polar codes by 0.15dB–0.3dB when we use CRC-aided SCL decoder with list size 32 for both codes. The implementations of all the algorithms in this paper are available at https://github.com/PlumJelly/ABS-Polar. This talk is based on joint work with Guodong Li and Min Ye.

Keywords: Polar codes; Successive Cancellation List (SCL) decoder

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