Bring in the noise

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One of the apparent contradictions of information theory is the fact that most codes are good and yet finding codes is challenging. In fact, it has been co-designing error-correcting codes and, most importantly, their generally complex decoders that has proven difficult, particularly when these decoders must be amenable to implementation in efficient, dedicated and customized chips.

In this talk we describe "Guessing Random Additive Noise Decoding," or GRAND, by Duffy, Médard and their research groups, which renders universal, optimal, code-agnostic decoding possible for low to moderate redundancy settings. GRAND enables a new exploration of codes, in and of themselves, independently of tailored decoders, over a rich family of code designs, including random ones. Surprisingly, even the simplest code constructions, such as those used merely for error checking, match or markedly outperform state of the art codes when optimally decoded with GRAND.

GRAND relies on the fact that in most channels of interest noise entropy is far inferior to the entropy of the messages. By taking into account probabilistic information about the noise, for example conditional probabilities based on soft information, or noise correlation, GRAND can use the fact that conditioning or correlation reduce entropy to improve throughput. Simple constructions such as product codes, when component codes are decoded with GRAND, can outperform LDPCs when we consider codes with high redundancy.

Without the need for highly tailored codes and bespoke decoders, we can envisage using GRAND to avoid the issue of limited and sub-optimal code choices and instead have an open platform for coding and decoding. Moreover, recent work with Duffy, Médard, Yazicigil and their groups has demonstrated that such decoding can be implemented with extremely low latency and record-breaking low energy in silicon.