Computer Science > Information Theory

# Achieving a vanishing SNR-gap to exact lattice decoding at a subexponential complexity

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The work identifies the first lattice decoding solution that achieves, in the general outage-limited MIMO setting and in the high-rate and high-SNR limit, both a vanishing gap to the error-performance of the (DMT optimal) exact solution of preprocessed lattice decoding, as well as a computational complexity that is subexponential in the number of codeword bits. The proposed solution employs lattice reduction (LR)-aided regularized (lattice) sphere decoding and proper timeout policies. These performance and complexity guarantees hold for most MIMO scenarios, all reasonable fading statistics, all channel dimensions and all full-rate lattice codes.
In sharp contrast to the above manageable complexity, the complexity of other standard preprocessed lattice decoding solutions is shown here to be extremely high. Specifically the work is first to quantify the complexity of these lattice (sphere) decoding solutions and to prove the surprising result that the complexity required to achieve a certain rate-reliability performance, is exponential in the lattice dimensionality and in the number of codeword bits, and it in fact matches, in common scenarios, the complexity of ML-based solutions. Through this sharp contrast, the work was able to, for the first time, rigorously quantify the pivotal role of lattice reduction as a special complexity reducing ingredient.
Finally the work analytically refines transceiver DMT analysis which generally fails to address potentially massive gaps between theory and practice. Instead the adopted vanishing gap condition guarantees that the decoder's error curve is arbitrarily close, given a sufficiently high SNR, to the optimal error curve of exact solutions, which is a much stronger condition than DMT optimality which only guarantees an error gap that is subpolynomial in SNR, and can thus be unbounded and generally unacceptable in practical settings.

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