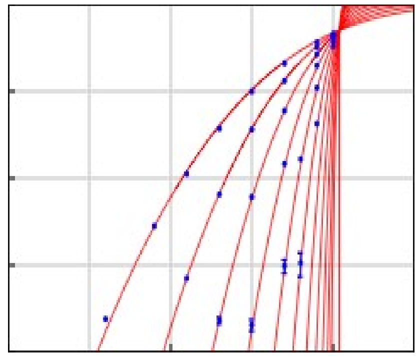
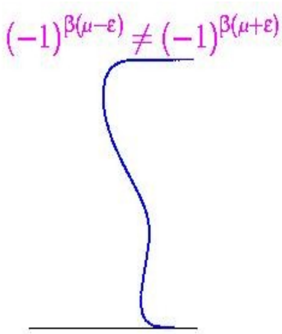
Laboratory of Communication Theory (LTHC)

Finite-Length Scaling for Iteratively Decoded LDPC Ensembles: Sparse graph codes under iterative decoding have recently attracted considerable interest due to their ability to approach the ultimate channel capacity. The asymptotic behavior of such codes is well known. Nevertheless, for any practical application, one needs to have a good finite-length approximation. It turns out that scaling laws are a good tool in order to solve this problem. The basic idea of scaling laws applied to coding theory is that all finite-length error probability curves are up to higher order terms scaled versions of a single mother curve. The ultimate goal of this work is thus to derive a efficient finite-length approximation such that one will be able to find the best suited code for any given application. The scaling law has been completely characterized for the BEC. Recently we proposed an alternative derivation of the scaling law in order to compute it for different channels (BSC, BAWGN) and algorithms (Gallager A, Decoder with Erasures, BP, Min-Sum). (*J. Ezri, A. Montanari, R. Urbanke*)





Existence of GEXIT function: EXIT function reveals a fundamental relationship between the optimal MAP decoding and suboptimal iterative decoding for transmission over the binary erasure channel. It is conjectured that such a relation exits for general BMS channels. However the EXIT function is replaced by GEXIT function. In practice, the GEXIT functions are computed by numerically computing a parameterized family of fixed point of density evolution. It is not known if such a family exists i.e. if the GEXIT function exists and whether it forms a continuous curve. Numerical simulation suggests the answer to the existence question in affirmative. Even stronger, the fixed points seem to be ordered by physical degradation. In this work, we are trying to answer these questions by using the methods in bifurcation theory. *(V. Rathi, R. Urbanke*)

For Christine

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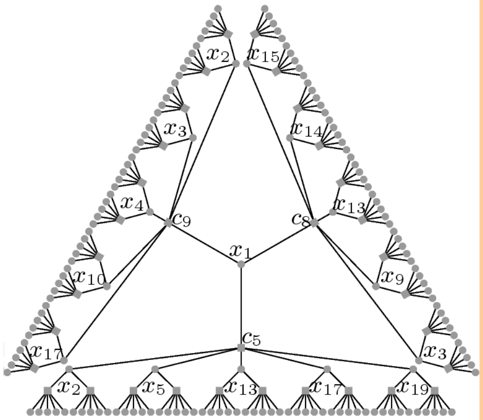
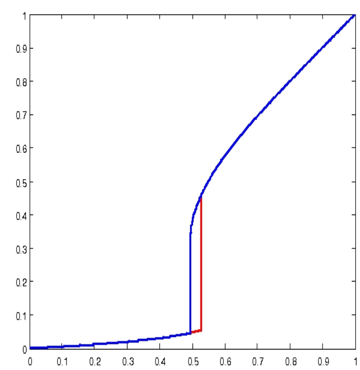


Exchanging Limits: Block Length vs Number of Iterations: Consider a code of size n transmitted through a channel and decoded using a message passing algorithm at the receiver. In practice the size of the code is fixed and we perform a large number of iterations (typically hundreds) at the receiver. The analysis of the algorithm is done assuming the size of the graph to be infinite and hence the local neighborhood is tree-like. Due to this assumption the messages seen on different edges are independent and their evolution (density evolution) can be tracked. Even though the tree assumption is only valid for a small number of iterations (O(ln n)), much smaller than the number used in practice, the predictions given by the analysis are fairly accurate already for moderate lengths. We would like to show why this is true. Mathematically the above observation corresponds to exchanging limits between block length and the number of iterations. *(S. Korada, R. Urbanke)*

ntropy of Poissonian LDPC Codes over BEC: Consider communication over a binary erasure channel with low density parity check codes and optimal maximum a posteriori decoding. It is known that the problem of computing the average conditional entropy, over such code ensembles, in the asymptotic limit of large block length is closely related to computing the free energy of a mean field spin glass in the thermodynamic limit. Tentative, but explicit, formulas for these quantities have been derived thanks to the replica method (of spin glass theory) and are generally conjectured to be exact. Using methods from statistical physics we show that the replica formulas are indeed exact in the case of Poissonian low density parity check ensembles. *(S.Korada, S. Kudekar, N. Macris)*



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