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BEYOND MEAN FIELD IN FINITE CONNECTIVITY SPIN GLASSES

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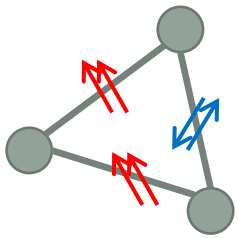
Brief introduction



- Fully connected spin glasses: mean field solutions available (e.g. Sherrington Kirkpatrick model, spherical model)

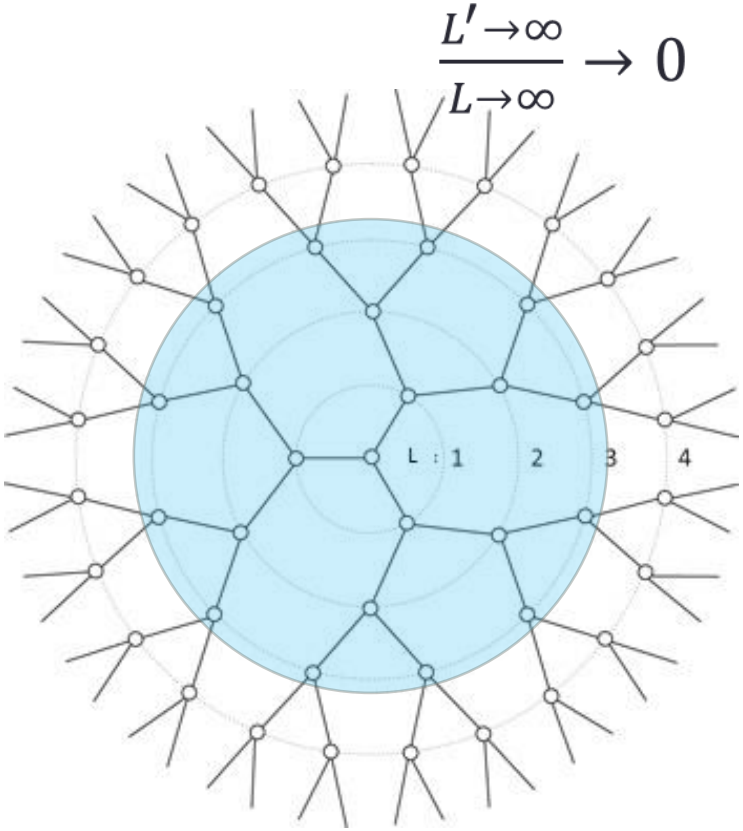
- Finite connectivity spin glasses: no mean field exact solution (basically due to lack of huge number of small interactions: unability to use the central limit theorem)

A particular type of lattices: tree-like lattices

- High temperatures: replica symmetric (RS) stable solution.

- Low temperatures: One step RSB (replica symmetry breaking) analytical solution available, at every disorder distribution and temperature.

[M. Mezard, G. Parisi, Bethe lattice spin Glass revisited, 2001]



Past and current projects:

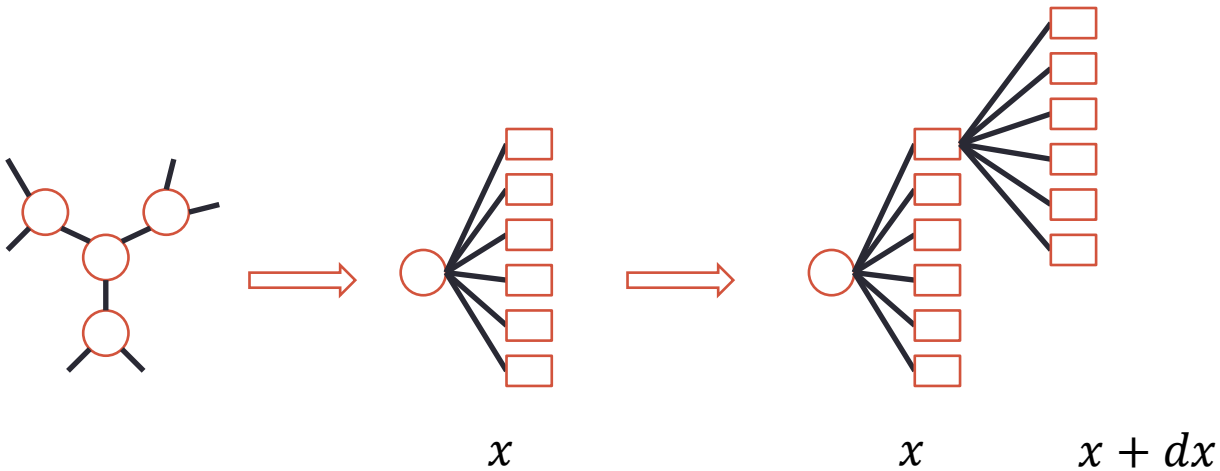
- Start point: a numerical extension up to two steps of RSB of the 1 RSB solution.

- Expansion around the 1RSB point.

- Extension of the 2RSB algorithm to an arbitrary number of symmetry breaking steps.

- Investigation of the zero temperature properties in field.

Past and current projects
2 RSB expansion over 1 RSB point

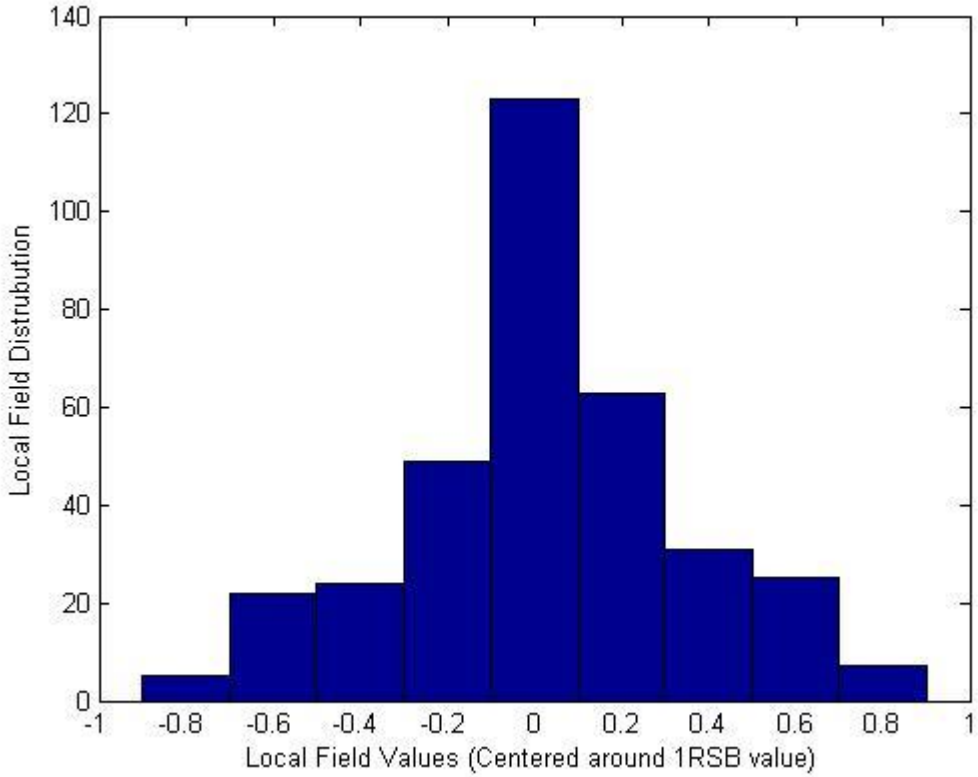


If we fix the 2RSB parameter aroud the value of the 1RSB one, we might be able to perform an analytical expansion for the distribution of the 2RSB states, knowing the one for the precedent level

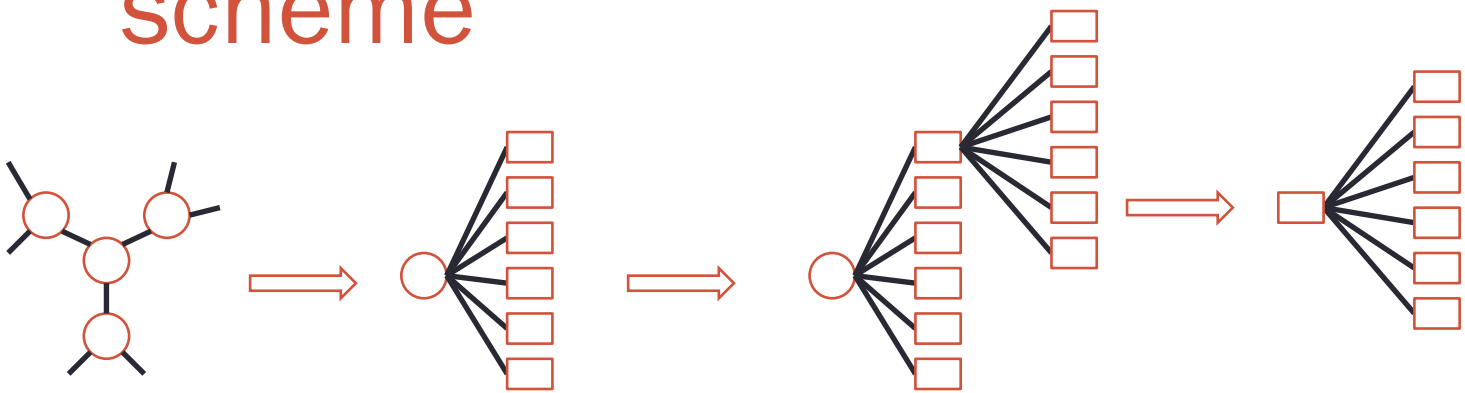
Past and current projects
2 RSB expansion over 1 RSB point

Numerical investigations have been performed so far, suggesting that actually the 2RSB fields distribution might have a Gaussian shape.

An analytical approach to this expansion will be performed in the following period.

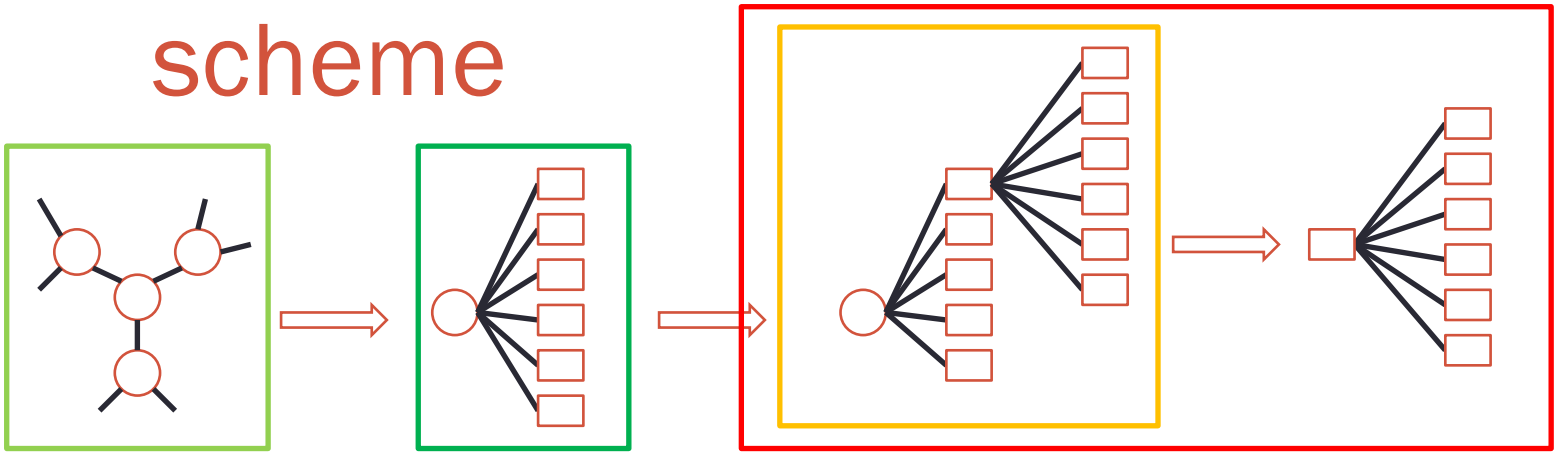


Past and current projects: Automatized iteration of RSB scheme



- Due to the tree structure of the distribution of states, it has been possible to develop a recursive algorithm, capable of performing the required procedures at every desired step of RSB.

Past and current projects: Automatized iteration of RSB scheme



RS: Easy to perform, even in high level development environments.

1RSB: Easy to perform, computational cost still low

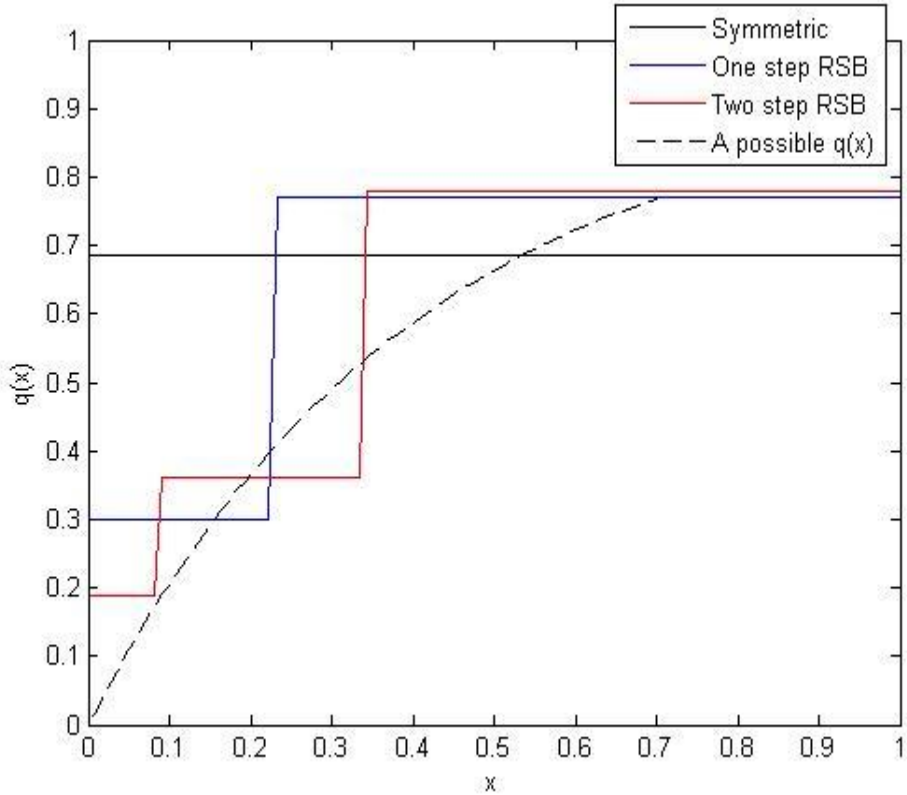
2RSB: Computational capabilities needed

>2RSB: High computational cost, an oMPI version has been implemented

Past and current projects Automatized iteration of RSB scheme

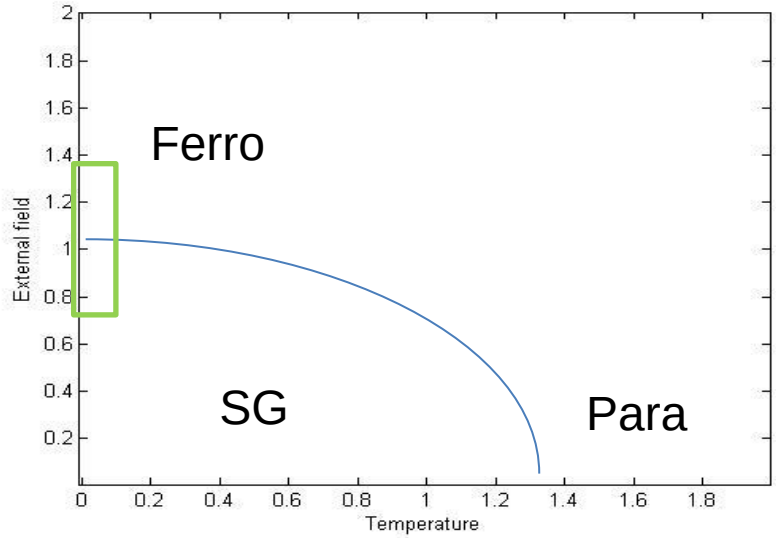
2RSB version reproduces the results obtained by the precedent version.

A 3RSB run has not been performed yet



Past and current projects: Islands of RSB in zero temperature

The last investigation performed so far deals with the transition from ferromagnetic phase to the spin glass phase, in zero temperature. Aim of this investigation is to understand if the replica symmetry breaking takes place in an uniform way in the system or if this happens "in bubbles".



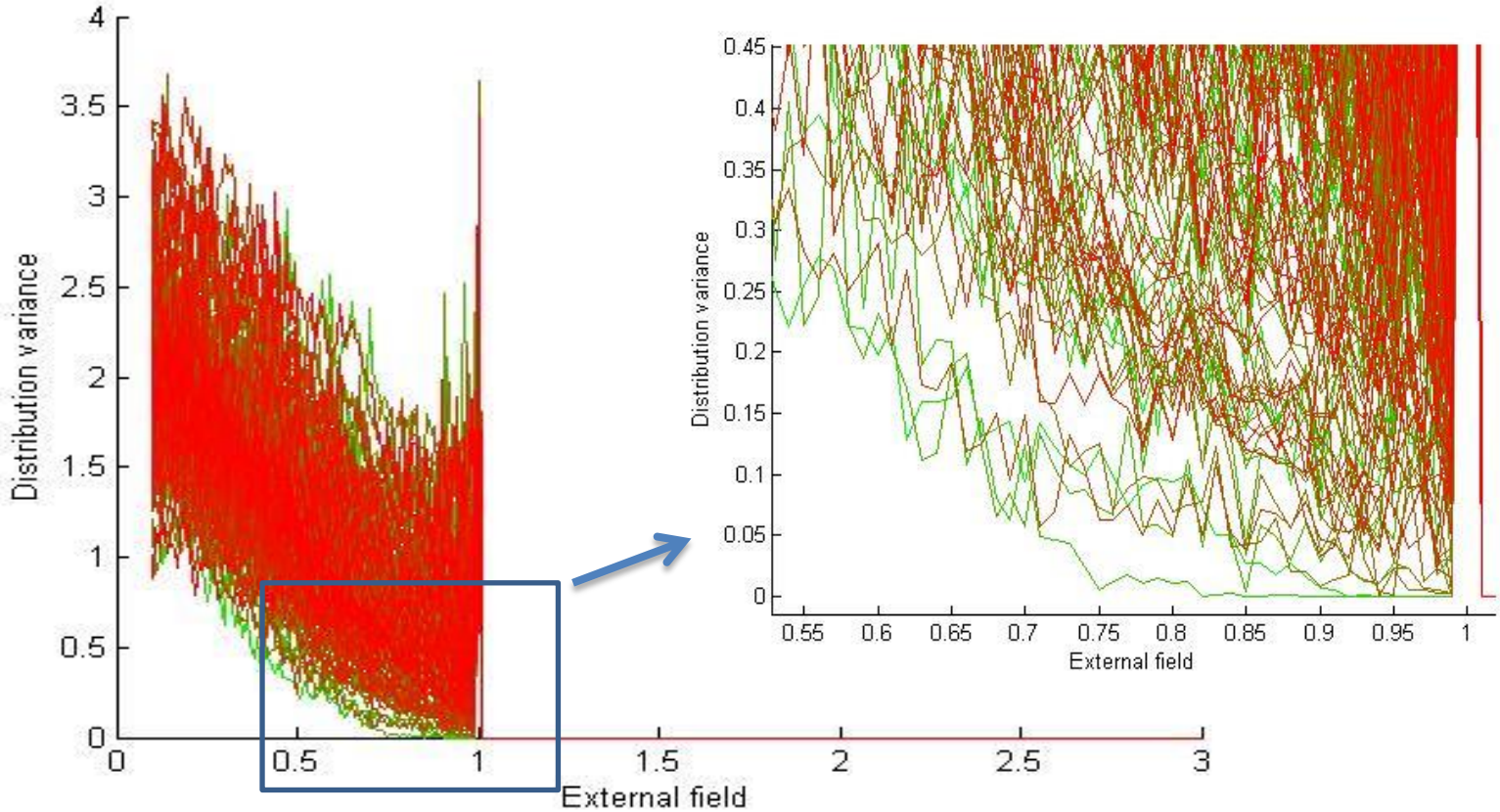
Past and current projects: Islands of RSB in zero temperature

To perform this operation a zero temperature "protected" algorithm has been implemented.

Preliminary results have been obtained using a 1RSB version.

When in RS, variance of the 1RSB fields distribution is zero. When we go in proximity of the transition point, some nodes acquire a non-zero-variance 1RSB field distribution, while some others remain unperturbed.

Past and current projects: Islands of RSB in zero temperature



Future inherent projects

- Analytical estimation of the gaussian shape in the 2RSB expansion.

- Analytical approach to full RSB for the finite connectivity SG.

Non inherent works

- Analytical investigation of the Heisenberg fully connected spin glass (in progress).

- Development of a poker playing neural network (completed).

- Development of a parallel tempered MCMC simulation for Ising p-spin glasses. Multispin coded, fast and easily portable. (completed)

Thanks for attention

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