

PhD Course of Marc Mézard:

Statistical Mechanics and Methods for Complex Systems

This course introduces the modern concepts and methods developed for the study of statistical physics of disordered systems, including the replica method, the cavity method, and message passing. It shows how the conceptual framework of statistical physics can be applied to a wide range of problems arising in various branches of science.

The aim is that students with different backgrounds, including those who have not been exposed to statistical physics should be able to understand the relevance of this approach and use it in various problems, ranging from spin glasses to constraint satisfaction problems, average case complexity, information theory, machine learning, statistical inference.

Chapter I: Introduction to Statistical Physics

Chapter II: Ising model

Chapter III: Disordered systems

Chapter IV: The random energy model

Chapter V: Belief propagation

Chapter VI: Introduction to the cavity method: Ising models on random graphs with finite degree

Chapter VII: The 1RSB Cavity Method

Chapter VIII: Random K-Satisfiability: the 1RSB solution. Survey propagation