

# **FROM BAYESIAN INFERENCE TO NEURAL NETWORKS: AN INTRODUCTION TO DATA SCIENCE**

(By S. Goldt, A. Laio, J. Barbier, R. Trotta)

## **I Basics of Bayesian inference [R. Trotta]**

Introduction to inference: what is it? Why do we need it?

Frequentist probability vs bayesian probability

Confidence levels, posterior distributions, priors and the difference between all those

If time allows: classical hypothesis testing vs Bayesian model comparison

## **II An introduction to random matrix theory [J. Barbier]**

The Wigner ensemble and the semi-circular law

Wishart Ensemble and Marcenko–Pastur law

Spiked matrix models and the BBP transition

## **III Introduction to unsupervised learning and dimensional reduction**

### **[A. Laio]**

PCA

Multidimensional scaling and kernel methods

Intrinsic dimension estimates

## **IV Neural networks [S. Goldt]**

Neural networks 101: types and applications + some open theoretical problems

Learning dynamics: empirical phenomena and theoretical predictions

The impact of data structure

Unsupervised learning: from Hebbian learning to independent components