

Stefano Crotti

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About

I am a PhD student at the [Statistical Physics and Interdisciplinary Applications](#) group at Politecnico di Torino, Italy. We use techniques from the statistical physics of complex systems to study optimization and inference problems across various domains: biology, computer science, epidemic modelling, and more.

Research interests

Approximation techniques for high-dimensional probability distributions: theory and implementation

- Algorithms on graphs: message-passing and other physics-inspired techniques
- Tensor Networks as an approximation tool: expressive power and limitations
- Scientific programming: leveraging the power of modern programming languages as well as techniques such as automatic differentiation to produce efficient software and speed up research

Education

- PHD in [Physics](#), Politecnico di Torino
- 2021 DIPLOMA from [Alta Scuola Politecnica](#) (multidisciplinary honour program)
- 2020 MSc in [Mathematical Engineering](#), Politecnico di Milano (double degree)
- 2020 MSc in [Physics of Complex Systems](#), Politecnico di Torino
- 2018 BSc in [Electronic Engineering](#), Politecnico di Torino

Publications

- 2023 **S. Crotti**, A. Braunstein, *Matrix Product Belief Propagation for reweighted stochastic dynamics over graphs*, Proceedings of the National Academy of Sciences, 120 (47) ([PNAS](#), [arxiv](#))
- 2022 A. Braunstein, L. Budzynski, **S. Crotti**, F. Ricci-Tersenghi, *Closest-vector problem and the zero-temperature p-spin landscape for lossy compression*, Physical Review E 106 (5) ([APS](#), [arxiv](#))

Projects

- 2022 - **Stochastic dynamics on graphs** - Estimating observables of conditioned stochastic dynamics is in general a hard problem. For example, given a model for the spread of a disease on a network of contacts and data from sparse medical tests, the goal is to reconstruct the state of the unobserved individuals. We look for good Bayesian, physics-inspired approximations.
- 2020 - 22 **Closest vector problem** - A classic in discrete optimization with potential applications to cryptography and a strong link to information theory. We studied it for a certain random ensembles of parameters, through a mapping to a generalized Ising model from the statistical physics of disordered systems.
- 2019 - 21 **PN Relay** - Graduation project for Alta Scuola Politecnica: design of an electronic device to classify peripheral nerve signals. I worked in the signal processing / machine learning team.

Posters and presentations

- 2023 *Matrix Product Belief Propagation for reweighted stochastic dynamics over graphs*
Lipari School workshop "Complex networks", Lipari, Italy - Contributed talk
The Beg Rohu Summer School, St. Pierre Quiberon, France - Poster
Yough in High Dimensions, Trieste, Italy - Poster

Teaching

Algorithms for optimization, inference and learning (2022/23, 2023/24), prof. Alfredo Braunstein, Politecnico di Torino - Teaching Assistant

Programming skills

Julia, git: advanced
MATLAB, Python: intermediate

Open source software

I am the author of a few Julia packages

- [IndexedGraphs.jl](#) - Sparse matrix-based graphs with efficient access to edge properties. Used as the basic building block for message-passing algorithms
- [TensorTrains.jl](#) - A lightweight library for tensor trains (a.k.a. matrix product states in physics). It efficiently performs computation of observables and sampling
- [UniformIsingModels.jl](#) - Efficient computation of observables for fully-connected Ising models

Languages

Italian: mother tongue

English: proficient

French: fluent

Spanish: intermediate