

# ILYES KHEMAKHEM

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**Profile** — I'm a driven PhD student and researcher whose primary interest is to study the identifiability of statistical models, in particular deep learning models. My objective is to apply my analytical skills to interesting real-world datasets and use my theoretical knowledge to tackle quantitative finance challenges.

## EDUCATION

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**Gatsby Computational Neuroscience Unit, UCL** **Sep 2017 - present**  
*PhD in Machine Learning* *London, UK*

Advisor: Aapo Hyvärinen.

Research focus: unsupervised representation learning, theory and algorithms for nonlinear ICA, learning identifiable representations, causal discovery.

Published papers: “Variational autoencoders and nonlinear ICA: a Unifying Framework”, “ICE-BeeM: Identifiable Conditional Energy-Based deep Models” and “Causal Autoregressive Flows”.

**École Normale Supérieure** **Oct 2016 - Aug 2017**  
*MSc in Maths, Vision and Machine Learning (MVA)* *Saclay, France*

Major in mathematics applied to computer vision and machine learning.

MSc Thesis: Wasserstein Dynamic Time Warping — Advisor: Marco Cuturi

**École polytechnique** **Sep 2013 - Aug 2017**  
*Engineering degree* *Palaiseau, France*

Major in computer science (Data science, data mining, parallel computing and computer vision) and applied mathematics (statistics, machine learning)

**IPEST** **Sep 2011 - Jun 2013**  
*Classe préparatoire* *La Marsa, Tunisia*

Two years of preparation to the highly competitive entrance exam to French engineering schools. Accepted at École polytechnique, France's top engineering school.

## EXPERIENCE

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**Cambridge Spark** **Sep 2020 - present**  
*Teaching fellow* *London, UK*

Taught and tutored for Cambridge Spark, a leader in data science and AI training, career development and progression.

**University College London** **Sep 2018 - Sep 2020**  
*Teaching assistant* *London, UK*

Prepared and taught tutorials for the “Probabilistic and Unsupervised Learning” and “Advanced Topics in Machine Learning” courses.

**CREST, ENSAE** **Apr 2017 - Sep 2017**  
*Research intern* *Saclay, France*

Proposed a new loss function for time-series based on dynamic time warping (DTW) and optimal transport (OT) distances.

**Kaiko** **Mar 2016 - Aug 2016**  
*Data science intern* *Paris, France*

Bitcoin and blockchain data analysis: produced a first of a kind report on bitcoin market and exchanges. Worked on bitcoin price prediction, and developing new indicators for bitcoin.

**RCAST, University of Tokyo**

*Research intern*

**Jul 2015 - Aug 2015**

*Tokyo, Japan*

Triple-junction solar cells' characterisation: programmed a curve fitter to extract cell parameters from experimental results. Measured single cell response from a triple junction solar cell and quantified the photon heating effect.

## RESEARCH PROJECTS

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**IK**, RP Monti, R Leech, A Hyvärinen, “Causal Autoregressive Flows”, in *The 24th International Conference on Artificial Intelligence and Statistics*, 2021.

Made explicit a connection between causal discovery and normalizing flow models: affine autoregressive flows define an identifiable causal model that generalizes additive noise models, and can be used in conjunction with exact likelihood ratio tests for causal discovery.

**IK**, RP Monti, DP Kingma, A Hyvärinen, “ICE-BeeM: Identifiable Conditional Energy-Based Deep Models based on Nonlinear ICA”, in *Neural Information Processing Systems (spotlight)*, 2020.

Proposed identifiable architectures for EBMs in addition to an identifiable latent variable model that relaxes and generalizes the independence assumption in nonlinear ICA.

**IK**, DP Kingma, RP Monti, A Hyvärinen, “Variational Autoencoders and Nonlinear ICA: A Unifying Framework”, in *The 23rd International Conference on Artificial Intelligence and Statistics*, 2020.

Made explicit the connection between nonlinear ICA and the framework of VAEs: one can use the theory of nonlinear ICA to train identifiable VAEs, and use VAEs to estimate the nonlinear ICA

RP Monti, **IK**, A Hyvärinen, “Autoregressive flow-based causal discovery and inference”, *ICML INNF workshop*, 2020.

Highlighted the similarities between autoregressive flow models and structural equation models (SEMs), and showed that flows are suitable for a wide range of causal applications from causal discovery to answering interventional and counterfactual statements.

**IK**, M Cuturi, “Wasserstein Dynamic Time Warping”, *MSc Thesis*.

Presented a new loss function for time series of non-negative measures by combining the Wasserstein Fisher Rao metric and the soft-dynamic time warping loss as an alternative to the LDDMM framework with no mathematical constraints.

## SKILLS

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**Programming** (proficient) — Python, LaTeX.

**Programming** (working knowledge) — Shell scripting, C, C++.

**Languages** — French (native), Arabic (native), English (full proficiency), Japanese (elementary).

## INVITED TALKS

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**Facebook AI Research** — (2021).

**Max Planck Institute for Intelligent Systems, Tübingen** — (2021).

**Inria Paris-Saclay** — (2019, 2020).

## OTHER RESEARCH EXPERIENCE

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**Reviewer** (2020 - present):

- Machine learning conferences: AISTATS 2020, UAI 2021, AISTATS 2021, NeurIPS 2021.
- Journals: Computational Statistics and Data Analysis, Expert Systems With Applications.

**Seminar organizer** (*2020 - present*):

- DeepMind/CSML Research Seminars, *UCL* — Weekly research seminars in Machine Learning jointly organized with UCL Computer Science and Statistics departments.
- Machine Learning Journal Club, *Gatsby Unit* — Weekly departmental research seminars to discuss new papers, review standard material and host guest speakers.

**Teaching assistant** — Machine Learning Summer School, London (*July 2019*).