Francesco Tonin

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taralloc.github.io

Machine Learning Researcher

I research **deep generative models** (e.g., VAE, GAN, Transformer) from the point of view of **deep kernel machines**, applying them to real-world problems such as **multi-modal clustering** and **anomaly detection**, and **explainaible AI** through **disentanglement**.

RESEARCH AND WORK EXPERIENCE

2024 - Present

Postdoctoral researcher in Machine Learning, EPFL

Lausanne, Switzerland

- Advisor Prof. Volkan Cevher in the LIONS group.
- Keywords: deep learning, generative models, Transformers, adversarial attacks, privacy, Large Language Models (LLMs).

2019 – 2023

Ph.D. in Machine Learning, KU Leuven

Leuven, Belgium

- Advisors Prof. Panos Patrinos and Prof. Johan Suykens (ESAT department).
- Keywords: kernel methods, deep learning, generative models, Transformers, Lagrangian duality, multi-modality, disentanglement, anomaly detection.
- Swiss National Supercomputing Centre (ETH Zurich/CSCS)'s Summer School on Effective High-Performance Computing & Data Analytics with GPUs: GPU architectures, C\C++ GPU programming in CUDA and OpenACC, Python HPC libraries (Numpy/SciPy/Dask/Numba), PyTorch.

2009 - 2016

Freelance Software Developer

Worked with multiple clients from all over the world on many projects, including:

- Created program to organize hundreds of PDF documents with OCR libraries, achieving in seconds an unfeasible task for a human being.
- Developed C# tools to calculate compound interest and to store clients' bank account details for a tax services office, making their workflow easier.
- Wrote code breaker for Vigenère cipher in efficient C code.

EDUCATION AND TRAINING

2017 – 2019

MSc in Engineering: Computer Science, KU Leuven

Leuven, Belgium

- Graduated *summa cum laude*.
- Specialization in Artificial Intelligence.

Projects

- Resolved a conflict during a group project about how to satisfy a non-functional requirement in a software architecture.
- Designed a smart heuristic to improve search in a Constraint Programming assignment, more than halving the number of backtracks.
- Worked with a teammate using Agile practices to efficiently complete demanding weekly assignments.

Dissertation

- Scheduled meetings with my advisors to discuss progress and attended seminars about research in the DTAI group.
- Topic: Most important locations on a large road map from GPS traces. Coded in Julia.

2014 – 2017

BSc in Computer Engineering, Politecnico di Torino

Turin, Italy

- Relevant coursework: Linear Algebra, Numerical Analysis, Complex Analysis, Signal Processing, Structures and Algorithms, Computer Architecture, Automatic Control, Databases, Object Oriented Programming.

PUBLICATIONS AND PREPRINTS

- **Tonin, F.**, Pandey, A., Patrinos, P., & Suykens, J. (2021). Unsupervised Energy-based Out-of-distribution Detection using Stiefel-Restricted Kernel Machine. In *IJCNN 2021*.
- **Tonin, F**., Patrinos, P., & Suykens, J. (2021). Unsupervised learning of disentangled representations in deep restricted kernel machines with orthogonality constraints. *Neural Networks*, 142, 661-679.
- Tao, Q., **Tonin, F.**, Patrinos, P., & Suykens, J. (2022). Tensor-based Multi-view Spectral Clustering via Shared Latent Space. Preprint.
- **Tonin, F*.**, Lambert, A.*, Patrinos, P., & Suykens, J. (2023). Extending Kernel PCA through Dualization: Sparsity, Robustness and Fast Algorithms. In *ICML 2023*.
- **Tonin, F**., Patrinos, P., & Suykens, J. (2023). Combining Primal and Dual Representations in Deep Restricted Kernel Machines Classifiers. In *ECML-PKDD 2023 SCEFA Workshop.*
- Chen, Y.*, Tao, Q.*, **Tonin, F**., & Suykens, J. A. (2023). Primal-Attention: Self-attention through Asymmetric Kernel SVD in Primal Representation. In *NeurIPS 2023*.
- Tao, Q.*, **Tonin, F.***, Patrinos, P., & Suykens, J. (2023). Nonlinear SVD with Asymmetric Kernels: feature learning and asymmetric Nyström method. Preprint.
- **Tonin, F.**, Tao, Q., Patrinos, P., & Suykens, J. (2024). Deep Kernel Principal Component Analysis for Multi-level Feature Learning. *Neural Networks*, 170, 578-595.
- Achten, S., **Tonin, F.**, Patrinos, P., & Suykens, J. (2024). Semi-Supervised Classification with Graph Convolutional Kernel Machines. In *AAAI 2024*.
- Chen, Y.*, Tao, Q.*, **Tonin, F**., & Suykens, J. A. (2024). Self-Attention through Kernel-Eigen Pair Sparse Variational Gaussian Processes. Preprint.

Invited reviewer for *JMLR*, *IEEE TPAMI, IEEE TNNLS*.

SELECTED TALKS

- EPFL LIONS (Lausanne) - November 2023. *Asymmetric Kernels Meet Transformers: A Primal-Dual Approach to Self-Attention through Kernel Singular Value Decomposition*
- Leuven.AI scientific workshop (Leuven) - June 2022. *Unsupervised Energy-based Out-of-distribution Detection using Stiefel-Restricted Kernel Machine*
- Bioinformatics and AI Seminars (University Hospital UZ Leuven) - May 2022. *Multi-view Spectral Clustering and Generation from a Shared Latent Space*

TEACHING

I am a **Teaching Assistant** for the following master courses:

- Data Mining and Neural Networks (Sep 2020- Dec 2023)
- Support Vector Machines: Methods and Applications (Feb 2020 – Jul 2023)

I (co-)supervised the following **master thesis** students:

- *Multiway spectral clustering with Stiefel-Restricted kernel machines*, by Edward Vandercruysse for MsC in Mathematical Engineering (AY 2021-2022).

- *A non-local similarity framework for the denoising of textured meshes*, by Guillaume Roy for MsC in Statistics and Data Science (AY 2020-2021).

SCHOLARSHIPS

2020	Fondazione Agnelli doctoral scholarship (6000€)
2015	Fiat Chrysler Automobiles (FCA) scholarship (2000€)

LANGUAGES: Italian (Mother Tongue), English (Level C1), French (Level A1), Dutch (Level A1).