

Axel Laborieux

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PROFESSIONAL EXPERIENCE

Friedrich Miescher Institute (affiliated to Novartis)

Basel, Switzerland

Postdoctoral researcher in AI and neuroscience.

Oct 2021–Present

- Designed a learning algorithm modelling how the brain can learn locally through neuronal oscillations. Demonstrated effectiveness on large-scale image recognition surpassing prior theories by 88%, and leading to several **contributions at Top ML conferences** (NeurIPS 2022, ICLR 2024).
- Gained mechanistic understanding of how self-supervised deep learning avoids the collapse of learned representations. Designed a new model which translated into improved robustness on large-scale vision settings, accepted at NeurIPS 2023.

SKILLS

Computer: Python, Shell, Git, Slurm, Scientific programming. **Libraries:** PyTorch, NumPy, JAX, Flax, Haiku, Pandas.

Deep learning: Equilibrium models, self-supervised and continual learning, sequence modelling. Experience with ConvNets, ResNets, Transformers. **Mathematics:** Linear algebra, probability, statistics, real and complex analysis.

EDUCATION

Paris-Saclay University

Palaiseau, France

Ph.D. in Physics.

Sep 2018–Sep 2021

Title: “Bio-inspired continual learning and credit assignment for neuromorphic computing”

Main topic: **software-hardware co-design for Edge AI**.

- Created a **continual learning** algorithm dedicated to binarized neural network accelerators for continuously learning from incoming data while matching deep learning baselines.
- Improved by $7\times$ the performance of an **on-chip local learning** algorithm dedicated to analog neural networks on natural images by designing a better gradient estimator.
- Upgraded a physical memory device based on resistive RAM technology from binary to ternary **quantization**, increasing model performance without circuit overhead.

Output: **6 first-author contributions** (3 journal publications, 3 conference acceptances) spanning machine learning, physics and neuroscience.

Ecole Normale Supérieure

Paris, France

M.Sc. in Statistical and Quantum Physics.

Sep 2017–Sep 2018

Ecole polytechnique (France’s top engineering school)

Palaiseau, France

B.Sc. and M.Sc. in applied Mathematics and Computer Science.

Sep 2014–Sep 2017

SELECTED PUBLICATIONS (Google Scholar: 272 citations, h-index 7)

- Laborieux, A.**, & Zenke, F. (2024). Improving equilibrium propagation without weight symmetry through Jacobian homeostasis. *ICLR* (accepted, main conference)
- Halvagal, M. S.*, **Laborieux, A.***, & Zenke, F. (2023). Implicit variance regularization in non-contrastive SSL. *NeurIPS* (* equal contribution)
- Laborieux, A.**, & Zenke, F. (2022). Holomorphic equilibrium propagation computes exact gradients through finite size oscillations. *NeurIPS*, 35, 12950-12963. **Oral (top 7%)**
- Laborieux, A.**, Ernoult, M., Hirtzlin, T., & Querlioz, D. (2021). Synaptic metaplasticity in binarized neural networks. *Nature communications*, 12(1), 2549. **(Covered in press by Tech Xplore)**

AWARDS

- Swiss National Science Foundation postdoctoral fellowship. Leading a two-years research project aimed at modelling cortical computation (CHF190k+, **top 9%** applications).
- **Best thesis award** for 2021 from the Engineering Sciences Graduate School of Paris-Saclay (€2k).
- **NeurIPS 2022 scholar award**, was granted hotel and travel tickets for attending NeurIPS.
- Google TPU Research Cloud fellow.

INVITED TALKS AND SEMINARS

- Kenyon Lab, **Los Alamos National Laboratory**, “*Computing local gradients with Holomorphic EqProp*”.
- Contributed talk at the workshop “*Recent advances in understanding artificial and biological neural networks*” at **Les Houches school of physics**, France.
- **CEA Grenoble**, Vianello Lab. “*Credit assignment through neural oscillations*”.
- Forschungszentrum Jülich, Neftci Lab. “*Credit assignment through neural oscillations*”.
- Machine Learning seminar at **IBM Zürich**.
- Cognitive Machine Learning (CoML) team led by Prof. Dupoux at **Ecole Normale Supérieure Paris**.

ADDITIONAL EXPERIENCE AND SKILLS

Reviewer: NeurIPS, ICLR, ICML, Frontiers, IEEE TCAS, ISCAS.

Languages: French (native), English (fluent), Mandarin (fluent).

Leadership: Served in the French police force for a 4-month military service program.

Hobbies: Sinology, Calligraphy, Baking, Travelling, Hiking, Motorcycle.