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 mathematical theories and algorithms modelling how brains can learn. Demonstrated effectiveness on **large-scale datasets**, surpassing prior theories by 88%, and published at **Top ML conferences** (NeurIPS '22, ICLR '24), with application to low-power analog AI hardware.
- Designed theories for AI explainability of self-supervised deep learning. Based on new understanding, designed a model showing improved empirical robustness on large-scale vision settings, published at NeurIPS '23.

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× 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.