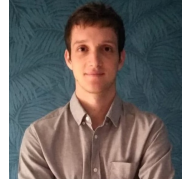# Théo BEUZEVILLE

*Postdoctoral researcher in Computer Science and Applied Mathematics specializing in Numerical Analysis for algorithms in Artificial Intelligence*

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## Education

**2021–2024**  **Ph.D. in Computer Science**, *University of Toulouse*, Toulouse, France.

Title:  Backward error analysis of artificial neural networks with applications to floating-point computations and adversarial attacks.

Keywords:  Artificial neural networks, floating-point arithmetic, error analysis, adversarial attacks, rounding errors, backward error.

**2017–2020**  **Engineering Degree in Computer Science – French Grande École**, *Toulouse INP–ENSEEIHT*, Toulouse, France.

Major in Applied Mathematics and Computer Science, specialising in High-Performance Computing and Big Data, which includes courses in deep learning, distributed systems, high-performance scientific computing, optimisation and statistics.

**2019–2020**  **Research Master's Degree: Performance in Software, Media and Scientific Computing**, *University of Toulouse*, Toulouse, France.

Training in Machine Learning (PyTorch, TensorFlow), distributed and parallel computing (MPI, OpenMP) and data analysis (Python, Matlab).

**2014–2017**  **Higher school preparatory classes for French Grande Écoles**, *Lycée Carnot*, Dijon, France.

Preparation for the entrance examinations to the Grandes Écoles d'ingénieurs. Intensive scientific training in Mathematics, Physics and Engineering Sciences.

## Research Experience

**2024–2025**  **Research and Teaching Assistant**, *Toulouse INP–ENSEEIHT - IRIT*, Toulouse, France.
- Ongoing research expanding Ph.D. work on backward error analysis of neural networks.
- Research findings presented in several academic seminars.
- 200 hours of teaching in the department of Computer Science at undergraduate and master's levels in an engineering school, combining theoretical foundations and practical programming.
- Courses taught include Optimisation, Machine Learning, Linear Algebra, High Performance Computing, and programming in C.

**2021–2024**  **Ph.D. in Computer Science**, *University of Toulouse - Atos*, Toulouse, France.

This thesis develops theoretical and experimental methods to analyse and predict the sensitivity of neural networks to perturbations, using numerical linear algebra concepts such as conditioning and backward error. It introduces adversarial attacks based on parameter perturbations, provides a theoretical analysis of rounding errors, and derives error bounds in floating-point arithmetic, offering guarantees of robustness and guidelines for deep learning architectures.

Supervisors:  Alfredo BUTTARI, CNRS research director, *CNRS - IRIT*, Théo Mary, CNRS researcher, *CNRS - LIP6*, and Serge Gratton, Professor, *Toulouse INP–ENSEEIHT*.

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|---|---|
| March 2020–October 2020 | **Research Internship**, *Artificial and Natural Intelligence Toulouse Institute (ANITI) - Airbus*, Toulouse, France.<br>Title: Rounding errors and accuracy in artificial neural networks.<br>○ Study of computational robustness for embedded neural networks in safety-critical systems.<br>○ Study comparing the numerical errors of different implementations of neural network computations.<br>○ Study of libraries for assessing the numerical robustness of codes (CADNA, FLUCTUAT) using interval or stochastic arithmetic.<br>○ Theoretical bounds on forward error propagation through neural network layers.<br>○ Experimental validation of theoretical results. |
| Supervisor: | Alfredo BUTTARI, CNRS research director, *CNRS - IRIT*. |
| January 2020–March 2020 | **Object Detection and Tracking in Video**, *Picsellia*, Toulouse, France.<br>Title: Implementation of an image and video annotation tool.<br>○ Motion tracking in video using Robust Principal Component Analysis (RPCA).<br>○ Analysis of RPCA limitations: sensitivity to camera motion and dynamic backgrounds (e.g., foliage, water).<br>○ Study and experimentation with B-SSSR algorithm to improve the baseline method.<br>○ Initial implementation of a self-supervised R-CNN for class learning in automatic tracking. |
| June 2019–July 2019 | **Research Internship**, *University of Florence*, Florence, Italy.<br>Title: Performance analysis of an optimisation algorithm for training artificial neural networks.<br>○ Literature review of optimisation algorithms for neural network training.<br>○ Study and implementation of an adaptive regularisation algorithm with inexact evaluations, developed by the research team.<br>○ Application to neural network training on benchmark datasets.<br>○ Comparative performance analysis against state-of-the-art methods. |
| Supervisor: | Stefania BELLAVIA, Professor, *University of Florence, Department of Industrial Engineering*. |

## Scientific Publications

### Ph.D. Thesis

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| 2024 | Théo Beuzeville. Backward error analysis of artificial neural networks with applications to floating-point computations and adversarial attacks, June 2024. URL : `https://theses.hal.science/tel-04622129`. |

### Publications

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|---|---|
| 2022 | Théo Beuzeville, Alfredo Buttari, Serge Gratton, Theo Mary, and Erkan Ulker. Adversarial attacks via Sequential Quadratic Programming, August 2022. URL : `https://hal.science/hal-03752184`. |
| 2021 | Théo Beuzeville, Pierre Boudier, Alfredo Buttari, Serge Gratton, Théo Mary, and Stéphane Pralet. Adversarial attacks via backward error analysis, December 2021. URL : `https://hal.science/hal-03296180/`. |

### In preparation or submitted

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|---|---|
| In press | Théo Beuzeville, Alfredo Buttari, Serge Gratton, and Theo Mary. Deterministic and probabilistic rounding error analysis of neural networks in floating-point arithmetic. *IMA Journal of Numerical Analysis*. Oxford University Press (OUP), In press. |

### Patents

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|---|---|
| 2025 | Théo Beuzeville, Alfredo Buttari, Serge Gratton, Theo Mary, and Nicolas Winckler. Method for training an artificial intelligence model and associated computer program, US 2025/0232224A1, July 2025. URL : `https://hal.science/hal-05219822`. |
| 2023 | Théo Beuzeville, Alfredo Buttari, Serge Gratton, and Stéphane Pralet. Method, computer program and device for quantizing a deep neural network, US 2023/0334301, October 2023. URL : `https://hal.science/hal-04268862`. |

## Scientific skills

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|---|---|
| Programming | Python (PyTorch, TensorFlow), Julia, C, Matlab, OpenMP, MPI. |
| Research interests | Machine Learning, Artificial Neural Networks, Numerical Error Analysis, Mixed and Low-Precision Computations, Floating-Point Arithmetic. |
| Tools | Git, LaTeX, Jupyter, VSCode, Linux environment. |
| Languages | French (native), English (fluent — scientific writing and presentations — TOEIC 980), Spanish (intermediate level). |

## Other Activities

Over 20 years of competitive athletics experience, with several regional titles in sprinting and javelin throw.