# Zacharie Garnier-Cuchet

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## Experience

- **LAMA-WeST Lab, Polytechnique Montréal / Mila [][]** *Sept. 2024 – Present*
  *Graduate Research Assistant — Legal NLP (funded by Lexum [])* Montréal, Canada
  - Developing a pipeline for automatic detection and disambiguation of legal references within judicial decisions, in collaboration with Lexum, a leading legal information company.
  - Constructed a dataset of annotated Canadian court decisions; paper submitted to **EMNLP 2026**.
  - Built **LeREaDLabelizer [][]**, a semantic annotation platform deployed for legal experts to label judicial decisions at scale.
  - Designed the complete **LAMA-WeST Lab website [][]**, serving as the lab's public research presence.
  - Supervised by Professor Amal Zouaq, Mila affiliate and director of the LAMA-WeST Lab.

- **Polytechnique Montréal []** *2025 – Present*
  *Teaching Assistant — Natural Language Processing (INF8460)* Montréal, Canada
  - Assisted in the Master's-level NLP course, supporting students in implementing neural models and foundational NLP algorithms.
  - Designed and corrected assignments involving Word2Vec, SGNS, GPT, and PyTorch implementations.
  - Guided student projects and provided technical feedback on model performance and reproducibility.

- **Polytechnique Montréal []** *Summer 2026*
  *Teaching Assistant — Introduction to Databases (INF3270)* Montréal, Canada
  - Supporting an undergraduate course covering relational database design, SQL (DDL, DML, DCL), entity-relationship modeling, functional dependencies, and normal forms.
  - Topics include embedded SQL, concurrency control, transaction management, indexing, and hashing structures.

- **Mila — Québec AI Institute []** *2025 – Present*
  *Member, Equity Diversity and Inclusion (EDI) Committee* Montréal, Canada
  - Contributing to Mila's institutional efforts to build a more equitable and inclusive research environment.
  - Participating in the design and evaluation of EDI initiatives across the institute's community of researchers and students.

- **Université de Technologie de Compiègne (UTC) []** *2022 – 2024*
  *Mathematics Teaching Assistant* Compiègne, France
  - Taught calculus, linear algebra, and probability to students with disabilities, adapting methods to diverse learning needs.
  - Provided personalized academic support, improving student success and autonomy.

- **Bombardier Produits Récréatifs (BRP) []** *Sep 2023 – Feb 2024*
  *Industrial Engineering Intern (New Product Development)* Valcourt, Québec, Canada
  - Automated industrial processes for Can-Am vehicle development by streamlining project deliverables and data workflows.
  - Developed tools improving data traceability and reducing manual processing time.
  - Contributed to new product development pipelines in a fast-paced engineering environment.

- **IBM Quantum []** *Feb 2023 – 2023*
  *Quantum Computing Intern* Remote
  - Conducted introductory research in quantum computation under IBM Quantum mentorship.
  - Explored quantum circuits and algorithms, gaining hands-on experience with cloud-based quantum hardware.

- **Focal-JMlab []** *Jan 2021 – Feb 2021*
  *Manufacturing and Industrial Operations Intern* La Talaudière, France
  - Worked in production workshops and logistics warehouses, learning practical industrial processes.
  - Assisted with supply chain workflows and quality control tasks.

## EDUCATION

- **Polytechnique Montréal / Mila – Québec AI Institute [🌐]** *Sept. 2024 – July 2026*
  *M.Sc.A. (Research) in Computer Engineering – Artificial Intelligence* Montréal, Canada
  - GPA: 4.0/4.0
  - Coursework: Natural Language Processing, Deep Learning Dynamics, Reinforcement Learning, Representation Learning, Stochastic Processes, Data Science.
  - Research focus: Legal NLP, reference extraction and disambiguation, dataset construction, trustworthy AI.

- **Université de Technologie de Compiègne (UTC) / Sorbonne University Alliance [🌐]** *Sept. 2020 – June 2024*
  *Engineering Degree (Master-level) in Mathematics, Physics, and Mechanical Engineering* Compiègne, France
  - GPA: 5.0/5.0
  - Coursework: Thermodynamics, Fluid Mechanics, Mechanical Vibrations, Structural Optimization.

- **Technische Universität Berlin (TUB) / Berlin University Alliance [🌐]** *Mar. 2022 – Aug. 2022*
  *Academic Exchange Semester – Mechanical Engineering* Berlin, Germany
  - Coursework: Linear Algebra, Probability & Statistics, Applied Physics, Mechanical Engineering fundamentals.
  - Completed an intensive German language program and explored international research perspectives.

## PROJECTS

- **LeREaDLabelizer – Semantic Annotation Platform** *2024 – Present*
  *Tools: JavaScript, HTML/CSS, Python;* 🌐 *tool* | *GitHub* Research / EMNLP 2026
  - Built from scratch to support annotation of judicial decisions for the LAMA-WeST legal NLP dataset.
  - Deployed and used in production by legal domain experts; designed for non-technical annotators.
  - Supports semantic tagging, reference highlighting, and structured label export.

- **LAMA-WeST Lab Website – Research Lab Web Presence** *2024 – Present*
  *Tools: Jekyll, GitHub Pages, HTML/CSS;* 🌐 *site* | *GitHub* Research infrastructure
  - Designed and developed the complete website for the LAMA-WeST Lab from scratch.
  - Covers team pages, publications, research projects, and news; maintained as lab grows.

- **AP ArchiGroup – Architecture Studio Website** *2024 – Present*
  *Tools: Jekyll, HTML/CSS;* 🌐 *site* | *GitHub* Freelance / ongoing
  - Maintaining and extending a professional client-facing website for a Paris-based architecture studio.
  - Collaborating with non-technical stakeholders to translate design requirements into web solutions.

- **Applying RLHF to Humor Generation – Reinforcement Learning Course Project** *Sept. 2024 – Dec. 2024*
  *Tools: PyTorch, TRL, PPO, Phi-3-Instruct, BERT Reward Model* [🌐]
  - Implemented a full RLHF pipeline to align a language model toward humorous dialogue generation.
  - Trained a BERT-based reward model to evaluate humor quality and guide policy optimization.
  - Applied Proximal Policy Optimization (PPO) via the TRL library to fine-tune Microsoft Phi-3.

- **Dynamic Analysis of Taipei 101 – Structural and Modal Vibrations Study** *Mar. 2024 – Aug. 2024*
  *Tools: MATLAB, Python, Finite Element Methods* [🌐]]
  - Modeled the Taipei 101 tower using Rayleigh–Ritz formulations and finite element abstractions.
  - Computed eigenmodes, modal frequencies, and compared them with theoretical expectations.
  - Analyzed the efficiency of passive mass dampers and their impact on structural response.

- **Optimal Wordle Solver – Independent Algorithmic Project** *Mar. 2022 – Jun. 2022*
  *Tools: Python, Information Theory;* 🌐 *tool* | *GitHub*
  - Built a Wordle-solving algorithm based on entropy reduction and constraint filtering.
  - Reduced runtime from hours to seconds through optimized data structures and pruning.
  - Analyzed quadratic complexity and implemented improvements for near real-time inference.

- **N-SAT Solver – Independent Algorithmic Project** *Summer 2022*
  *Tools: Python, Backtracking, Heuristics*

- Designed and implemented a solver for generalized N-SAT problems with custom heuristics.
- Applied the solver to real combinatorial tasks (Sudoku, Nonograms) with successful results.
- Explored pruning strategies and partial assignments to reduce exponential branching.

- **Text Decoder via Stochastic Key Search – Independent Project** *2021*
  *Tools: Python, Randomized Algorithms, Heuristic Search*
  - Developed a decoder for a substitution-based encoding system assigning unique integers to characters.
  - Designed a stochastic exploration algorithm to navigate the space of possible keys.

- **Nim Game with Intelligent Agent – Independent Project** *Jan. 2024 – Feb. 2024*
  *Tools: Google Sheets, Combinatorial Game Theory*
  - Implemented an intelligent adversary for the Nim game using winning-position theory (XOR heap invariants).
  - Logged game histories for post-hoc analysis of strategy effectiveness.

- **Exploration of the Syracuse (Collatz) Conjecture – Independent Math Project** *2020*
  *Tools: Python, Discrete Dynamical Systems*
  - Investigated structural properties of the Syracuse sequence and constructed analyzable variants.
  - Applied numerical experimentation to study density and stopping-time behaviors.

## Patents and Publications

C=Conference, J=Journal, P=Patent, S=In Submission

**[C.1]** Z. Garnier-Cuchet, et al. (2025). **Revisiting the Goldilocks Zone in Inhomogeneous Networks**. In *ICML 2025 Workshop on High-Dimensional Learning Dynamics (HiLD)*. Jun. 2025.

**[S.1]** Z. Garnier-Cuchet, et al. (2026). **Legal Reference Extraction and Disambiguation in Canadian Judicial Decisions**. Manuscript under review at *EMNLP 2026*.

## Technical Skills

- **Machine Learning & Deep Learning:** PyTorch, JAX, HuggingFace Transformers, Lightning, Weights&Biases, Optuna; contrastive learning, metric learning, retrieval models, reinforcement learning, sequence modeling, representation learning.
- **NLP & Information Retrieval:** Tokenization (BPE, SentencePiece), SGNS/Word2Vec, GloVe, BM25, ColBERT, LLM-based encoders, cross-encoders, rerankers, long-context models, legal NLP, citation retrieval, sequence-to-sequence models.
- **Scientific Programming & Data:** Python, C, R; NumPy, Pandas, Scikit-learn; data processing at scale, vector stores, approximate nearest neighbors (FAISS).
- **Databases & Backend:** SQL (DDL, DML, DCL), relational modeling, entity-relationship design, normal forms, indexing, transaction management; NoSQL basics.
- **Web Development:** HTML, CSS, JavaScript; Jekyll, GitHub Pages; full-stack prototyping and deployment of research tools and professional websites.
- **Mathematics & Statistics:** Probability theory, stochastic processes, Monte-Carlo methods, numerical optimization, convex analysis, high-dimensional geometry, linear algebra, statistical modeling.
- **Software & Engineering:** Linux, Git, Docker, SLURM/HPC; API design, profiling, testing; version-controlled research pipelines.
- **Cloud & Deployment:** AWS (EC2, S3), GCP, Compute Canada.
- **Research Skills:** Experimental design, ablation studies, reproduction of baselines, dataset construction, annotation guidelines, metric analysis, error analysis, LaTeX for scientific writing.

## Leadership & Professional Experiences

- **Leadership & Service**
  - **EDI Committee Member, Mila** (2025–Present) — Contributing to equity, diversity, and inclusion initiatives across the institute.
  - **President, BRP Intern Committee** (2023) — Represented 100+ interns; coordinated events and communication with upper management.
  - **Class Representative** (France, 3 years) — Academic mediation, conflict resolution, and cohort coordination.
  - **Activities Lead, Student Association (UTC)** — Managed events, logistics, and student engagement.
- **Professional Experience**
  - **Cook & Logistics Manager**, Pizzeria (Ireland) — Paid position following Workaway; managed kitchen operations, supply chain, and service (Jun–Sept 2023).
  - **Café Service & Operations Assistant**, Local Café (Montréal) — Customer service and daily operations (Jan–Mar 2023).

## Additional Information

- **Languages:**
  - French (native)
  - English — daily use; learned at school and during stay in Ireland
  - German — multiple travels; 10+ years learning at school
  - Spanish — travel in South America; self-taught and one formal course
- **Sports:**
  - Marathon: Paris 2023 (3:05), Petit Train du Nord 2024 (1st in category), Montréal 2025 (pacer)
  - Half marathons: Montréal 2023–2024
  - Trail: Mont-Tremblant 2025 (14/300)
  - Other: Tennis (15/3), climbing, handball, soccer
- **Music:**
  - Trombone (11 years), Piano (5 years), Jazz improvisation, Composition
  - Member of jazz Big Band and various ensembles
  - Former conservatory student; performer in a symphonic orchestra