

# Nicholas Guilbeault

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## Summary

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Driven **Research Software Engineer** specializing in real-time machine learning applications for neural data analysis. Bringing **2+ years** of professional software development (C#/.NET, Python) and **7+ years** of academic research experience, including leading the development of Bonsai.ML and BonZeb. Looking to build scalable, cutting-edge technology to drive innovation in *artificial intelligence* and *neurotechnology* sectors.

## Experience

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**Research Software Engineer**, Gatsby Computational Unit, UCL – London, UK 12/2023 – Present

- *Lead Developer – Bonsai.ML*: Spearheaded the design and implementation of Bonsai.ML, integrating machine learning tools (PyTorch, TensorFlow, ML.NET, ONNX) into the Bonsai-Rx visual reactive programming language (C#/.NET). Developed a total of 7 C#/.NET packages, with 3 real-time inference models (Kalman filter, hidden Markov model, point-process decoder) applied to neural and behavioural data.
- *Neural Decoder*: Built and optimized a Bayesian state-space point-process decoder in C#/.NET using TorchSharp. Developed methods for online learning of latents from spike-train or clusterless data and achieved sub-millisecond decoding latency. Adopted in 2 labs, enabling novel real-time experiments.
- *Leadership & Team Work*: Leveraged interdisciplinary communication skills to collaborate with diverse teams of scientists and engineers, effectively translating research requirements into efficient software solutions for data analysis and Bonsai.ML. Delivered 2 talks and 1 workshop, including topics on Bonsai.ML, software engineering practices, and online machine learning methods. Played a key role in bridging the gap between computational researchers, software engineers, and experimenters to achieve project goals.

**Research Software Engineer**, NeuroGEARS – London, UK 09/2023 – 12/2023

- *Consulting*: Engaged with stakeholders to deliver custom software solutions for real-time experimental control, data acquisition, and automated data analysis pipelines, satisfying stakeholder needs across 2 distinct research groups and completing project requirements on schedule.

**PhD Researcher, Neuroscience**, University of Toronto – Toronto, Canada 09/2016 – 09/2023

- *Open-Source Development – BonZeb*: Developed a software suite for tracking kinematics, analyzing behavioural data, and performing closed-loop neural perturbation experiments. Software used by numerous international research labs as evidenced by 12+ GitHub stars and 25+ citations on Google Scholar.
- *Data Analysis with Machine Learning*: Employed supervised and unsupervised ML techniques, including convolutional neural networks for animal pose estimation, CNMF and image registration for calcium imaging analysis, and hierarchical clustering for uncovering behavioural motifs. Automated analysis pipelines proved useful to others, resulting in 100% increase in data throughput and 10x reduction in analysis time compared to prior manual methods.
- *Interdisciplinary Research*: Deployed hardware for autonomous imaging platform and architected software solutions for videography, data annotation, and analysis of statistics of natural vision, exemplifying the ability to work effectively in large teams of 12+ researchers and apply technical skills across domains.
- *Leadership & Communication*: Led a small team of 5 undergraduate and 2 graduate student researchers in building software and conducting neuroscience experiments. Reviewed results and coordinated software development with experimental needs. Presented findings at 10+ conferences to diverse audiences.

**Cofounder, Startup Web3 Developer**, Ledger Macro Inc. – Wyoming, USA 05/2022 – 03/2023

- *Fast-Paced Development*: Prototyped an Ethereum-based cryptogaming platform which subscribed to ERC-721/1155 smart-contract events and triggered in-game actions by submitting and monitoring on-chain transactions with web3.py. Designed and implemented a custom generative art algorithm that streamed SVG

assets from a cloud repository and batch-rendered 10000+ unique NFT assets in under five minutes.

## Education

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**PhD, Department of Cell and Systems Biology**, University of Toronto, Canada 2016 – 2023

- GPA: 4.0/4.0. Dissertation focused on real-time pose estimation, kinematic tracking, interactive sensory environments, neural recording/stimulation, and sensorimotor assays.

**BSc, Behaviour, Cognition, and Neuroscience**, University of Windsor, Canada 2012 – 2016

- GPA: 3.89/4.0; Co-authored publication: Testing a novel treatment for Alzheimer's disease.

## Technical Skills

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- *Programming*: Python, C#/.NET, Bonsai-Rx, Julia, R, MATLAB, C, JavaScript, Solidity.
- *Machine Learning Methods*: Bayesian statistics, state-space models, linear models, computer vision, pose estimation, online data streams, time series analyses, deep neural networks, reinforcement learning.
- *Machine Learning Frameworks*: PyTorch, TensorFlow, Scikit-learn, ONNX, ML.NET, OpenCV
- *Tools*: Bash, Git, GitHub, Windows/Linux development, Docker, VirtualBox, Hyper-V, Jupyter notebooks, JSON schemas, HPC, cloud computing, data visualization (Matplotlib, Plotly, OxyPlot), UI frameworks (WinForms, PyQt), documentation frameworks (docfx, sphinx).
- *Soft Skills*: Collaborative, team leadership, interdisciplinary communication, managing cross-functional teams, agile development, proficient in technical writing.

## Publications

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- Cai, L. T., Krishna, V., Hladnik, T. C., **Guilbeault, N. C.**, Vijayakumar, C., Arunachalam, M., Juntti, S. A., Arrenberg, A. B., Thiele, T. R., Cooper, E. A. Spatiotemporal visual statistics of aquatic environments in the natural habitats of zebrafish. *Scientific Reports*, 13(1), 12028. doi: <https://doi.org/10.1038/s41598-023-36099-z>
- Alexander, E., Cai, L. T., Fuchs, S., Hladnik, T. C., Zhang, Y., Subramanian, V., **Guilbeault, N. C.**, Vijayakumar, C., Arunachalam, M., Juntti, S. A., Thiele, T. R., Arrenberg, A. B., Cooper, E. A. (2022). Optic flow in the natural habitats of zebrafish supports spatial biases in visual self-motion estimation. *Current Biology*, 32(23), P5008-5021.E8. doi: <https://doi.org/10.1016/j.cub.2022.10.009>
- **Guilbeault, N. C.**, Guerguiev, J., Martin, M., Tate, I., Thiele, T. R. (2021). BonZeb: Open-source, modular software tools for high-resolution zebrafish tracking and analysis. *Scientific Reports*, 11(1), 1-21. doi: <https://doi.org/10.1038/s41598-021-85896-x>
- Muthukumaran, K., Kanwar, A., Vegh, C., Marginean, A., Elliot, A., **Guilbeault, N.**, . . . , Pandey, S. (2018). Ubisol-Q10 (a nanomicellar water-soluble formulation of CoQ10) treatment inhibits Alzheimer-type behavioral and pathological symptoms in a double transgenic mouse (TgAPeswe, PSEN1dE9) model of Alzheimer's disease. *Journal of Alzheimer's Disease*, 61(1), 221. doi: <https://doi.org/10.3233/JAD-170275>

## Awards

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Ian Brown Graduate Student Paper of the Year Award, University of Toronto Scarborough 06/2022

Alexander Graham Bell Postgraduate Scholarships, Natural Sciences and Engineering Research Council of Canada 09/2017 - 08/2021

Vietnamese-Canadian Community Graduate Award In Zoology, Faculty of Arts & Science, University of Toronto 01/2021

Best Poster Presentation Award, Interdisciplinary Graduate Research & Discovery Conference, University of Toronto Scarborough 04/2019

Yoshio Masui Prize in Developmental, Molecular, or Cellular Biology, Faculty of Arts & Science, University of Toronto 12/2018