Nicholas Guilbeault

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Summary

Research Software Engineer building real-time machine learning systems and open-source scientific software. Core maintainer of **Bonsai.ML** and author of 20+ packages with 40,000+ downloads, with a PhD in computational neuroscience and a track record of turning research needs into reliable, documented, tested tools used by labs worldwide. Strong focus on **low-latency streaming inference, cross-platform .NET and Python engineering, computer vision, and hardware integration**.

Skills

- **Languages:** Python, C#/.NET, Bonsai, Nix, R, GLSL, Bash.
- **Machine learning:** PyTorch, JAX, TorchSharp, scikit-learn, ML.NET, ONNX; state-space models (Kalman filters, HMMs, Bayesian decoders), deep learning, reinforcement learning, online and batch learning, benchmarking.
- **Computer vision:** OpenCV, real-time tracking and pose estimation, multi-camera calibration, bundle adjustment, 3D reconstruction, high-speed camera acquisition.
- **Systems and performance:** low-latency streaming inference, GPU Direct, CUDA, profiling, real-time closed-loop pipelines.
- **Engineering and hardware:** unit and integration testing, CI/CD (GitHub Actions), Docker, Linux and Windows, NuGet and PyPI packaging; Harp devices, Arduino, Raspberry Pi, embedded ML (Google Coral).

Experience

Research Software Engineer, NeuroGEARS Ltd – London, UK 03/2026–Present

- Built 3D pose tracking for animals and humans from multi-camera video: multi-camera calibration, bundle adjustment, and a JARVIS-based tracking pipeline.
- Implemented GPU Direct RDMA to stream high-bandwidth camera data straight to GPU memory, bypassing host memory, for real-time processing.
- Maintained Aeon, a platform for continuous, long-term behavioural monitoring of animals, including 2D pose tracking, hardware, Neuropixels 2.0 and ONIX ephys acquisition workflows.
- Contributed to Harp and microharp hardware for synchronised acquisition and control, including VertiGate, a Harp-compatible gate controller, with firmware releases, documentation, Python packaging, and CI/CD.

Senior Research Software Engineer, Gatsby Computational Neuroscience Unit, UCL – London, UK 12/2023–03/2026

- Primary developer of Bonsai.ML, the machine learning library for Bonsai, a visual reactive programming language: shipped 12 open-source packages with 16,000+ downloads.
- Built and deployed ML models for online, streaming data (Kalman filters, HMMs, Bayesian decoders, deep networks) with online and batch learning, for low-latency neural decoding, kinematic tracking, forecasting, and receptive field mapping.
- Released PointProcessDecoder, 7 NuGet packages with 23,000+ downloads, decoding spike-train and clusterless neural data with sub-millisecond latency for closed-loop experiments, including online spike detection.
- Created repeatable benchmarking and evaluation harnesses (offline replay and online monitoring) to compare models and prevent regressions across releases.
- Worked with experimental scientists, ML researchers, and engineers to translate research needs into software, and helped organise the inaugural Bonsai Conference (2024) with 30+ researchers from the Allen Institute, Janelia, MIT, and UCL.

Research Software Engineer, NeuroGEARS Ltd – London, UK. Consulting on real-time experimental control and analysis software for two research groups. 09/2023–12/2023

Graduate Researcher, Thiele Lab, University of Toronto – Toronto, Canada 09/2016–09/2023

- Developed BonZeb, an open-source toolkit for kinematic tracking, behavioural analysis, and closed-loop stimulation, adopted as a tracking method in publications in Nature, Cell, and Current Biology, with 50+ citations.
- Built supervised and unsupervised ML pipelines for image processing, pose estimation, clustering, and regression, increasing data throughput by 20% and reducing analysis time by 50%.
- Supervised 5 undergraduate and 2 graduate researchers in software development and experimental neuroscience, resulting in presentations at 15+ conferences.

Education

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

BSc (Hons), Behaviour, Cognition, and Neuroscience, University of Windsor 2012–2016

Selected Open-Source Software

- **Bonsai.ML**: Core maintainer (700+ commits). Deep learning via TorchSharp, Kalman filters, HMMs, online Bayesian regression, and neural decoding, with Python.NET and ML.NET interoperability, a documentation site, an examples repository, and a reinforcement learning demo built on Bonsai.ML.Torch.
- **PointProcessDecoder**: Bayesian state-space neural decoder with point-process and marked point-process observations. CPU and CUDA builds for Linux and Windows, with a Bonsai.ML integration.
- **BonZeb**: Kinematic tracking, closed-loop stimulation, and behavioural analysis for high-speed (500+ FPS) real-time experiments.
- **Bonsai on Linux and hardware**: bonsai-nix (Nix flake with patched Wine and CUDA support), a Docker base image, and Bonsai packages for Teledyne DALSA and Euresys cameras.

Selected Publications

- **Guilbeault, N. C.**, Westbrook, M. E., Krishna, V. S., Ansari, R., Keth, A., Arrenberg, A. B., Juntti, S. A., Thiele, T. R. (2026). Complex pectoral-fin-driven locomotion underlies refined visuomotor behavior in the cichlid *Astatotilapia burtoni*. iScience, 29(9), 117136. doi: 10.1016/j.isci.2026.117136
- Cai, L. T., Krishna, V., Hladnik, T. C., **Guilbeault, N. C.**, et al. (2023). Spatiotemporal visual statistics of aquatic environments in the natural habitats of zebrafish. Scientific Reports, 13(1), 12028. doi: 10.1038/s41598-023-36099-z
- **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), 8148. doi: 10.1038/s41598-021-85896-x

Selected Talks and Teaching

Workshop, Bonsai: Wiring the World into Sound and Image, Peckham Digital, Festival of Creative Computing, London, UK 10/2026 (upcoming)

Course Instructor, Build-a-Brain, No Black Boxes Foundation, London AI Campus, London, UK. Computing from transistors to embedded ML for high school students. 01/2026–04/2026

Course Instructor, Neuroinformatics, PhD Programme, Sainsbury Wellcome Centre, London, UK 03/2024, 03/2025

Bonsai.ML Workshop, Bonsai Conference, Sainsbury Wellcome Centre, London, UK 12/2024

Invited Talk, Integrating Machine Learning into Bonsai for Real-time Experimental Neuroscience, Janelia Research Campus, USA 11/2024