Q. Tyrell Davis
www.github.com/rivesunder

Summary

I'm an experienced machine learning software engineer and scientist who specializes in developing cross-disciplinary tools to solve challenging problems. I have a broad and diverse background including molecular biology, inverse problem solving, differentiable programming, deep learning, and complex systems. In particular I am enthusiastic about applying the latest advances in large language and diffusion models to understanding and engineering biological sequences and structures.

Selected skills/tools (links to public examples): Programming languages: Rust (clica), Julia (Cyto.jl), R (Coursera), Python; PyTorch (yuca), SciKit-Learn (ramann-metrics), Hugging Face/transformers (mybrary), biosequence embeddings (JAKInhibition), graph neural networks (graphnn), reinforcement learning (DockRL, neural cellular automata (SRNCA).

See my GitHub portfolio for a longer list of hobby project examples.

Work Experience

- **Research Scientist (Complex Systems Simulation)** 2023.

  In the past year I have been pursuing a project examining the effects of discretization on self-organizing pattern formation in simulations of continuously valued complex systems. My investigation is primarily focused on constructed systems: cellular automata, artificial chemistry, and neural networks, but has potential lessons for natural systems simulated in computers, *e.g.* weather, molecular dynamics, and protein folding. A manuscript describing my experiments was recently accepted to the journal *Innovations in Machine Intelligence*.

- **Writer (Machine Learning and Molecular/Structural Biology)** 2018 to 2023.

  I write tutorials, practical reviews of ML topics, and summaries of state-of-the-art research for hardware and software companies and research non-profits involved in machine learning and high-performance computing.

- **Post Doctoral Associate**, University of Vermont Morphology, Evolution, and Cognition Lab. 2021 to 2022.

  As a post-doc I co-advised a PhD research project evaluating large language models for symbolic regression, predicting mathematical models (equations) from numerical data. I also had the good fortune to mentor a motivated high school student in their project using neural cellular automata to model plant patterning (their write-up here). Lastly, I published four first-author papers of my own research.

- **Senior Scientific Software Engineer** Macromoltek, Inc. 2021.

I led a comprehensive overhaul of the machine learning codebase applied to the problem of computational design of therapeutic antibodies. Highlights include introducing a cohesive unit testing framework; establishing best practices for programming style, code review and documentation; and completing significant data, data handling, and model audits. I supervised work on ML projects and contributed to non-ML engineering by participating in code review and providing senior engineering leadership.

- **Machine Learning Microscopy Data Scientist**, Oxford Nano Imaging. 2019.

  I developed neural and physics-based models for label-free imaging in a bench-top super-resolution microscope. I also contributed general image processing and computer vision expertise, such as tools for eliminating super-resolution artifacts using Fourier filtering. I had supervisory responsibilities for a junior colleague contributing 50% of their time to my projects. In addition to technical contributions, I was involved in every aspect of the hiring process for our team.

- **Postdoctoral Researcher in Optical Microscope Development**, University of Oxford, Dynamic Optics and Photonics Group. 2018 to 2019.

  I developed a test-bed instrument for developing adaptive optics for microscopy based on experimental, electronically addressable liquid lenses (provided by our collaborators). My responsibilities also included technical and mentorship support for PhD students in the lab. I believe that my instrument went above and beyond the standard for laser safety in research microscopes, achieved without hindering access to the instrument by incorporating a gull-wing clamshell enclosure in the design.

- **Marie Curie Early Stage Researcher**: PHOtonic tools for Quantitative imaging in tissUeS (PHOQUS), University of Dundee. 2014 to 2018.

  I designed, built, and performed experiments with a custom optical tweezers microscope for studying the biophysics of microtubule-protein interactions. I developed a major innovation in microtubule visualization: using defocus to compute label-free images, avoiding the intrinsic phototoxicity of fluorescence imaging and eliminating the need for acquiring many empty images for background subtraction as in video-enhanced differential interference contrast microscopy. I published my technique as an arXiv pre-print: TIE Microscopy for Dynamic MTs.

  In a research placement at the Universität Tübingen, I designed and built a reflected light sheet fluorescence microscope for single molecule imaging in cells. This work was completed by my colleagues after my placement ended and published in the Journal of Microscopy.

Education

- **PhD**, University of Dundee. Thesis: "Cognitive Computational Microscopy". Awarded 2018 June

- **MSc Molecular Biology**, University of Wyoming. Thesis: "*Acanthamoeba castellanii* feeding decisions as a predictor of bacterial virulence". Awarded August 2012

- **BSc Electrical Engineering**, and **BSc Molecular Biology**, University of Wyoming. May 2010

Awards

- 2019 **10th** and **12th** place in "**NeurIPS 2019: Learn to Move - Walk Around**" (`https://bit.ly/NeurIPS2019_L2M_msft`) and "**Flatland Challenge**" (`https://bit.ly/flatland_msft`), respectively.
- 2014 to 2017 **Marie Curie Fellowship** (`https://bit.ly/phoqus_qtd`)
- 2009 to 2010 **Wyoming NASA Space Grant Consortium undergraduate research fellowship** (`https://bit.ly/qtd_ewtr`)

Selected Peer-Reviewed Publications

1. Amanda Bertschinger, **Q. Tyrell Davis**, James Bagrow, Joshua Bongard. "The Metric is the Message: Benchmarking Challenges for Neural Symbolic Regression". To be published in Proceedings of the European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases. (**2023 September**). `https://link.springer.com/chapter/10.1007/978-3-031-43421-1_10`.

2. **Q. Tyrell Davis**, Stephanie Woodman, Melanie Landesberg, Rebecca Kramer-Bottilgio, Josh Bongard. "Subtract to Adapt: Autotomic Robots". 2023 IEEE International Conference on Soft Robotics (RoboSoft). (**2023 April**). `https://doi.org/10.1109/RoboSoft55895.2023.10122102`.

3. **Q. Tyrell Davis**, Josh Bongard. "Step Size is a Consequential Parameter in Continuous Cellular Automata." Proceedings of the ALIFE 2022: The 2022 Conference on Artificial Life. ALIFE 2022: The 2022 Conference on Artificial Life. Online. (pp. 43). ASME. (**2022 July**). `https://doi.org/10.1162/isal_a_00526` `https://arxiv.org/abs/2205.12728`

4. **Q. Tyrell Davis**, Josh Bongard. "Glaberish: Generalizing the Continuously-Valued Lenia Framework to Arbitrary Life-Like Cellular Automata." Proceedings of the ALIFE 2022: The 2022 Conference on Artificial Life. ALIFE 2022: The 2022 Conference on Artificial Life. Online. (pp. 47). ASME. (**2022 July**). `https://doi.org/10.1162/isal_a_00530` `https://arxiv.org/abs/2205.10463`

5. **Q. Tyrell Davis** and Josh Bongard. "Selecting continuous life-like cellular automata for halting unpredictability: evolving for abiogenesis." In Proceedings of the Genetic and Evolutionary Computation Conference Companion (GECCO '22). Association for Computing Machinery, New York, NY, USA, 104–107. (**2022 July**). `https://doi.org/10.1145/3520304.3529037`.

6. **Q. Tyrell Davis**. "Carle's Game: An Open-Ended Challenge in Exploratory Machine Creativity." 2021 IEEE Conference on Games (CoG), pp. 01-08. (**2021 August**). `https://doi.org/10.1109/CoG52621.2021.9619011`.

7. Sven A. Szilagyi, Moritz Burmeister, **Q. Tyrell Davis**, Gero L. Hermsdorf, Suman De, Erik Schiäffer, Anita Jannasch. "Fast 3D imaging of giant unilamellar vesicles using reflected light-sheet microscopy with single molecule sensitivity." (**2020 June**). `https://doi.org/10.1101/2020.06.26.174102`

8. *See* ***`https://github.com/rivesunder/blob/master/papers.md`*** *for a list of additional research outputs*