Eric Christiansen, PhD

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Software engineer experienced in AI research and infrastructure.
See emchristiansen.com for details.

Work and research

High-frequency crypto arbitrage

Solo Entrepreneur — *2022 July – Present*

Created a market-neutral high-frequency cryptocurrency arbitrage business with >$300K profit on >$10M volume.

- Wrote CUDA code for fast traversal of the Curve25519 elliptic curve, running 1000× faster than CPU SOTA. Read textbooks, reference implementations, and current math research to find the best algorithm.
- Designed a dynamic-programming algorithm, also used to order transactions in new blocks, reducing optimization time from seconds to tens of milliseconds.
- Generalized trading strategies into a differentiable flow model, implemented in JAX and bound to Rust via PyO3. Found trades not discoverable by prior heuristics.
- Used Typescript, OCaml, Rust, Python, CUDA, Kubernetes, JAX, and TiDB. Code is available for in-meeting review upon request.

Google Research

Mountain View, CA

Senior Software Engineer — *2014 April – 2022 July*

Work split between AI research and internal infrastructure.

- ***In Silico* Labeling**: Used deep learning to predict fluorescence images from transmitted-light images of unlabeled cells. It gives life scientists many of the benefits of fluorescence labeling without most of the costs; see this blog post and this editorial for context.
  - Led an 18-person team across Google, Verily, Harvard, and Gladstone which developed this seminal AI computational microscopy technique, published in *Cell* [1], the Google Blog, and open sourced.
  - Work ranged from wetlab experimental design, to large scale distributed image processing, to model development.
  - Developed a novel image-to-image model with a 25% improvement in loss and qualitatively better results than the SOTA.
  - Patented [2] and led to the creation of two new projects at Verily. Later work automated quality control in similar pipelines [3].
  - Used C++, Golang, Python, Flume, and TensorFlow.
- **Hyperparameter tuning API**: Created Google's first hyperparameter tuning API for deep learning, by providing a convenient interface to black box optimizers and infrastructure to manage experiment lifecycles. This was the first version of what became the Vertex AI hyperparameter tuner. Used C++ and Python.
- **Example selection**: Built a system that trains deep networks faster by dynamically adjusting the train set data distribution (*cf.* curriculum learning) using a concurrently-trained helper model.
  - Provided a nearly free 30% training speedup on tasks with imbalances in example difficulty, such as image classification.
  - Engineered to saturate TPUs (e.g. 80K images / second on ImageNet).
  - Final code was a distributed system consisting of 50K lines of C++, Python, and SQL.
- **Miscellaneous**
  - Published on neural architecture search [4] and model calibration and ensembling [5].
  - Maintained and developed TensorFlow and JAX libraries for calibration and ensembling, nondifferentiable optimization, and tensor manipulation.
  - Hosted 3 successful interns, interviewed 100s of candidates, earned designations for cross-team collaboration and technical expertise, got readability for Golang, C++, and Python, and finished my PhD [6].

Note, I quit six months before the first layoffs in 2023.

Willow Garage Menlo Park, CA
PhD Intern *2012 – 2013 (9 months)*

- Developed two local image descriptors designed for speed on mobile devices [7] (C++ and Scala).
- Created an open-source evaluation framework for local descriptors (Scala).
- Added Java support to OpenCV.
- Taught fitness classes and organized company-wide daily lunches.

Google Mountain View and Los Angeles, CA
PhD Intern *2010 and 2011 Summers (6 months)*

- Worked on Google Goggles research and backend infrastructure, including adding the first high-dimension log-time nearest-neighbor method to the scalable matching service.
- Helped the webcrawler to detect and appropriately handle auto-generated websites.

Education

University of California, San Diego La Jolla, CA
PhD in CS *2008 – 2018*

PhD in computer science, with foci in computer vision and machine learning.

- Published in ML theory [8], computer vision [9, 10, 11, 12, 7], and deep learning [1].
- TA'd undergrad computability, graduate algorithms (2x), graduate data mining, and graduate computer vision. Mentored Google Summer of Code student for OpenCV.
- Started a free food program for my lab, funded by grants, which I believe significantly improved lab morale and communication.

Swarthmore College Swarthmore, PA
BA in Math (honors) with CS minor *2004 – 2008*

Code projects

During my PhD, I kept sane by working on a number of side-projects, for example:

- PersistentMap: A type-safe, boilerplate-free, key-value store for Scala.
- salve: A macro and template library for adding some functional programming ideas to C++.
- sbt-latex: A build management tool for LaTeX (Scala).
- CharikarLSH: An implementation of Moses Charikar's method for approximate nearest neighbor retrieval. Note, techniques like this are how vector databases work (C++).
- mbtree: An implementation of metric-ball trees for nearest neighbor search (Scala).
- DistanceLSH: An implementation of a metric hashing for nearest neighbor search (Haskell).

Publications

[1] E. Christiansen, S. J. Yang, D. M. Ando, A. Javaherian, G. Skibinski, S. Lipnick, E. Mount, A. O'Neil, K. Shah, A. K. Lee, P. Goyal, W. Fedus, R. Poplin, A. Esteva, M. Berndl, L. L. Rubin, P. Nelson, and S. Finkbeiner, "In silico labeling: Predicting fluorescent labels in unlabeled images," *Cell*, vol. 173, no. 3, pp. 792–803.e19, 2018.

[2] P. C. Nelson, E. Christiansen, M. Berndl, and M. Frumkin, "Processing cell images using neural networks," May 15 2018, US Patent 9,971,966.

[3] S. J. Yang, M. Berndl, D. M. Ando, M. Barch, A. Narayanaswamy, E. Christiansen, S. Hoyer, C. Roat, J. Hung, C. T. Rueden, A. Shankar, S. Finkbeiner, and P. Nelson, "Assessing microscope image focus quality with deep learning," *BMC Bioinformatics*, vol. 19, no. 1, pp. 77:1–77:9, 2018.

[4] C. Ying, A. Klein, E. Christiansen, E. Real, K. Murphy, and F. Hutter, "NAS-Bench-101: Towards reproducible neural architecture search," in *International Conference on Machine Learning*, 2019, pp. 7105–7114.

[5] X. Wang, D. Kondratyuk, E. Christiansen, K. M. Kitani, Y. Movshovitz-Attias, and E. Eban, "Wisdom of Committees: An Overlooked Approach To Faster and More Accurate Models," in *The Tenth International Conference on Learning Representations, ICLR 2022, Virtual Event, April 25-29, 2022*. OpenReview.net, 2022.

[6] E. Christiansen, "From local descriptors to in silico labeling," Ph.D. dissertation, University of California, San Diego, 2018.

[7] E. Christiansen, V. Rabaud, A. Ziegler, D. Kriegman, and S. Belongie, "Match-time covariance for descriptors," in *British Machine Vision Conference, BMVC 2013, Bristol, UK, September 9-13, 2013*, 01 2013, pp. 12.1–12.11.

[8] E. Christiansen, "An upper bound on prototype set size for condensed nearest neighbor," *arXiv preprint arXiv:1309.7676*, 2013.

[9] T. Winlock, E. Christiansen, and S. J. Belongie, "Toward real-time grocery detection for the visually impaired," in *IEEE Conference on Computer Vision and Pattern Recognition, CVPR Workshops 2010, San Francisco, CA, USA, 13-18 June, 2010*. IEEE Computer Society, 2010, pp. 49–56.

[10] A. Ziegler, E. Christiansen, D. J. Kriegman, and S. J. Belongie, "Locally Uniform Comparison Image Descriptor," in *Advances in Neural Information Processing Systems 25: 26th Annual Conference on Neural Information Processing Systems 2012. Proceedings of a meeting held December 3-6, 2012, Lake Tahoe, Nevada, United States*, P. L. Bartlett, F. C. N. Pereira, C. J. C. Burges, L. Bottou, and K. Q. Weinberger, Eds., 2012, pp. 1–9.

[11] E. Christiansen, I. S. Kwak, S. Belongie, and D. Kriegman, "Face box shape and verification," in *Advances in Visual Computing*, G. Bebis, R. Boyle, B. Parvin, D. Koracin, B. Li, F. Porikli, V. Zordan, J. Klosowski, S. Coquillart, X. Luo, M. Chen, and D. Gotz, Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, 2013, pp. 550–561.

[12] A. Flores, E. Christiansen, D. J. Kriegman, and S. J. Belongie, "Camera distance from face images," in *Advances in Visual Computing - 9th International Symposium, ISVC 2013, Rethymnon, Crete, Greece, July 29-31, 2013. Proceedings, Part II*, ser. Lecture Notes in Computer Science, G. Bebis, R. Boyle, B. Parvin, D. Koracin, B. Li, F. Porikli, V. B. Zordan, J. T. Klosowski, S. Coquillart, X. Luo, M. Chen, and D. Gotz, Eds., vol. 8034. Springer, 2013, pp. 513–522.

[13] M. H. Tong, A. D. Bickett, E. Christiansen, and G. W. Cottrell, "Learning grammatical structure with echo state networks," *Neural Networks*, vol. 20, no. 3, pp. 424–432, 2007.

[14] J. P. McCleery, L. Zhang, L. Ge, Z. Wang, E. Christiansen, K. Lee, and G. W. Cottrell, "The roles of visual expertise and visual input in the face inversion effect: Behavioral and neurocomputational evidence," *Vision Research*, vol. 48, no. 5, pp. 703–715, 2008.

Miscellaneous

Things I do sometimes

- CrossFit
- Running
- Burning Man
- AIDS/LifeCycle

Books I liked

- Harry Potter and the Methods of Rationality
- The Traitor Baru Cormorant
- The Selfish Gene
- Sapiens

Non-research interests

- Ethereum
- Tezos
- Rust