

# Eric Crawford, PhD

SENIOR DEEP LEARNING ENGINEER

San Francisco, California, USA

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## Experience

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### Senior Deep Learning Engineer

San Mateo, California, USA

SKYDIO

Dec 2021-Present

- Using OpenCLIP and pgvector, developed a system enabling semantic search over 10s of millions of aerial photographs, now the primary tool used by deep learning team to scrape data for training models on new classes of objects and for iteratively improving existing models.
- Trained and deployed efficient and accurate anchor-free instance segmentation neural networks for real-time, on-drone tracking of people and vehicles, in both visible and infrared spectra. For visible-spectrum detection, adopted new network architecture and augmentation scheme, improving detection performance by 5% while significantly reducing inference latency. Built infrared detection from the ground up, including data collection, de-duplication and annotation, as well as model selection, training and evaluation. Adapted both networks to run on higher-resolution images on new NVIDIA Jetson Orin platform, improving visible-spectrum small-object f1-score from 0.1 to 0.65.
- Designed distillation-based technique for training instance segmentation networks to predict vectors describing the appearance of each detected object, facilitating migration from a complex multi-stage training pipeline to simple single-stage training, while improving object re-identification performance by 10%. Developed extensive evaluation and visualization tools for verifying quality of learned appearance vectors.
- Owned deep learning team's instance segmentation infrastructure, including model training, metrics, datasets, annotations and visualization.
- Prototyped techniques for using open-source visual foundation models (primarily CLIP and Segment Anything) to automatically pseudolabel high-resolution images for instance segmentation, with novel classes specified by text-based prompts.
- Developed and deployed int8-quantized instance segmentation networks on NVIDIA Jetson Orin using TensorRT, reducing end-to-end inference latency by 35% and GPU compute time by 40%, while reducing f1-score by < 1%.

### Computer Vision Intern

Vancouver, BC, Canada

UNITY TECHNOLOGIES

May 2021-Aug 2021

- Performed large-scale training experiments aimed at finding ways to improve instance segmentation performance using simulated data.
- Developed recipes for training Mask-RCNN on simulated data, aiming to reduce the number of hand-labeled examples required.
- Implemented robust and scalable infrastructure for managing large numbers of simultaneous training jobs using Google Cloud Platform (GCP).

### Machine Learning Consultant

San Francisco, California, USA

PERSONA IDENTITIES INC.

July 2019-Oct 2019

- Developed cloud-based object detection system with TensorFlow and GCP, enabling new forms of identity document verification.
- Performed extensive model selection and hyperparameter tuning to find the optimal balance between inference speed, precision and recall.

### Lead Developer

Waterloo, Ontario, Canada

COMPUTATIONAL NEUROSCIENCE RESEARCH GROUP, UNIVERSITY OF WATERLOO

2010-2014

- Designed and implemented CUDA and MPI backends for the Nengo neural simulation package.
- Reduced network simulation times by several orders of magnitude using high-performance clusters, allowing networks containing hundreds of thousands of realistic spiking neurons to be simulated in real-time.

### Research Assistant

Philadelphia, Pennsylvania, USA

DEPARTMENT OF OTORHINOLARYNGOLOGY, UNIVERSITY OF PENNSYLVANIA

2011

- Implemented computational methods for identifying neural receptive fields based on neurophysiological data.

## Education

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### Doctor of Philosophy, Computer Science

Montreal, Quebec, Canada

MCGILL UNIVERSITY / MILA

09/2014-08/2021

- Cumulative GPA: 4.0/4.0
- Member of Reasoning and Learning Lab

### Master of Mathematics, Computer Science

Waterloo, Ontario, Canada

UNIVERSITY OF WATERLOO

09/2012-08/2014

- Cumulative GPA: 91.80%
- Member of Computational Neuroscience Research Group

### Bachelor of Mathematics, Honors Computer Science, Co-op, CogSci Option

Waterloo, Ontario, Canada

UNIVERSITY OF WATERLOO

09/2007-08/2012

- Cumulative GPA: 88.07%
- Dean's Honors List with Distinction

# Publications

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## CONFERENCE / JOURNAL ARTICLES

- **Crawford, E.**, and Pineau, J. (2020). Exploiting Spatial Invariance for Scalable Unsupervised Object Tracking. *AAAI*.
- **Crawford, E.**, and Pineau, J. (2019). Spatially Invariant Unsupervised Object Detection with Convolutional Neural Networks. *AAAI*.
- Dong, Y, Shen, Y., **Crawford, E.**, van Hoof, H., and Cheung, J.C.K. (2018). BanditSum: Extractive Summarization as a Contextual Bandit. *EMNLP*.
- Kroger, B., **Crawford, E.**, Bekolay, T., and Eliasmith, C. (2016). Modeling interactions between speech production and perception: speech error detection at semantic and phonological levels and the inner speech loop. *Frontiers in Computational Neuroscience*.
- **Crawford, E.**, Gingerich, M., and Eliasmith, C. (2015). Biologically plausible, human-scale knowledge representation. *Cognitive science*.
- **Crawford, E.**, Gingerich, M., and Eliasmith, C. (2013). Biologically plausible, human-scale knowledge representation. *Conference of the Cognitive Science Society*.

## WORKSHOPS AND PREPRINTS

- **Crawford, E.**, and Pineau, J. (2020). Learning 3D Object-Oriented World Models from Unlabeled Videos. *ICML Workshop on Object-Oriented Learning*. **Outstanding Paper Award**.
- **Crawford, E.**, and Pineau, J. (2019). Spatially Invariant, Label-free Object Detection. *NeurIPS Workshop on Perception as Generative Reasoning*. **Spotlight**.
- Venkattaramanujam, S., **Crawford, E.**, Doan, T., and Precup, D. (2019). Self-supervised Learning of Distance Functions for Goal-Conditioned Reinforcement Learning. *arXiv preprint arXiv:1907.02998*.
- **Crawford, E.**, and Pineau, J. (2018). Spatially Invariant Attend, Infer, Repeat. *NeurIPS Workshop on Modeling the Physical World*.
- **Crawford, E.**, Rabusseau, G. and Pineau, J. (2017). Sequential Coordination of Deep Models for Learning Visual Arithmetic. *arXiv preprint arXiv:1809.04988*.
- Voelker, A., **Crawford, E.**, and Eliasmith, C. (2014). Learning large-scale heteroassociative memories in spiking neurons. *Unconventional Computation and Natural Computation*.

## THESES

- **Crawford, E.** (2021). Learning Object-Oriented Models of the Visual World. PhD Thesis, McGill University.
- **Crawford, E.** (2015). Biologically plausible, human-scale knowledge representation. Master of Mathematics Thesis, University of Waterloo.

## SOFTWARE

- **Crawford, E.** (2013-2015). MPI backend for the Nengo neural simulator. <https://github.com/nengo/nengo-mpi>.
- **Crawford, E.** (2010-2015). Contributions to Nengo neural simulator core library. <https://github.com/nengo/nengo>.

## Awards & Scholarships

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<b>Alexander Graham Bell Canada Graduate Scholarship - Doctoral - \$70,000</b> - NSERC	09/2016-08/2018
<b>David R. Cheriton Graduate Scholarship - \$20,000</b> - University of Waterloo	09/2012-08/2014
<b>Alexander Graham Bell Canada Graduate Scholarship - Masters - \$17,000</b> - NSERC	09/2012-08/2013
<b>President's Graduate Scholarship - \$10,000</b> - University of Waterloo	09/2012-08/2013
<b>Ontario Graduate Scholarship - \$15,000 (Declined)</b> - Gov. of Ontario	09/2012-08/2013
<b>Computational Neuroscience Summer Program - \$4,000</b> - University of Pennsylvania	05/2011-07/2011
<b>Undergraduate Student Research Award - \$4,500</b> - NSERC	01/2011-04/2011
<b>Undergraduate Student Research Award - \$4,500</b> - NSERC	01/2010-04/2010
<b>Industrial Undergraduate Student Research Award - \$4,500</b> - NSERC	09/2008-12/2008
<b>President's Scholarship - \$2,000</b> - University of Waterloo	09/2007-12/2007

## Skills

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- Object Detection and Instance Segmentation with Deep Neural Networks
- Semantic Text/Image Search Using OpenCLIP and pgvector.
- Synthetic Data for Instance Segmentation
- NVIDIA Jetson DNN Acceleration: Quantization, Sparsity, and Deep Learning Accelerator
- Unsupervised Object Detection and Tracking
- Variational Autoencoders
- PyTorch, TensorFlow, ONNX, TensorRT, OpenCV
- AWS & GCP
- Linux, Git, CUDA, MPI, SQL
- Languages: Python, C/C++, Java, Scheme, LaTeX