Joel T. Kaardal

Leveraging data and machine learning to build smart products and make discoveries.

Education

2017 **Ph. D. Physics**, *University of California*, San Diego, *GPA: 3.5*.
2013 **M. S. Physics**, *University of California*, San Diego, *GPA: 3.5*.
2010 **B. S. Physics & B. S. Chemistry**, *University of Minnesota*, Minneapolis, *GPA: 3.8*.

Experience

2018– **Data scientist/software engineer**, *The Markov Corporation (DBA Level)*, Palo Alto, CA.

- Designed the LEVEL oven's image classification system that infers the suggested identity of over 100 different foods with >95% precision and leverages customer feedback to continuously improve. Composed for quick inference, the classifier computes on the oven's mobile GPU and is optimized on a GPU/Spark cluster.
- Conceptualized and implemented an experimental apparatus to generate pixel-precision ground truth depth data to train a deep stereo vision model in TensorFlow. A robot was designed to generate high-precision data while minimizing sample collection time.
- Wrote software to optimize and evaluate food detection and generative semantic segmentation models that locate food to pixel precision within the oven. Managed crowdsourced annotation of detection and segmentation data reducing the costs of building a quality dataset.
- Developed the first production version of the of the LEVEL oven's backend software in python. The backend software handles the oven's perception, cooking logic, and overall control flow. The software's modular design makes for ease of experimentation with new features/algorithms.
- Generally, research responsibilities include proposing, planning, and executing research projects to improve and expand on the capabilities of the LEVEL oven. Software engineering responsibilities focus on translating research results into product features.

2011–2018 **Post-doctoral/graduate student researcher**, *Salk Institute for Biological Studies*, La Jolla, CA.

- Designed a new dimensionality reduction technique that addressed an important standing problem in the analysis of the subunits that make up deep biological neural networks.
  - Technique was published in a journal article[1] and was presented at the 2016 Computational and Systems Neuroscience conference (COSYNE).
  - Led to novel insights into how neurons deep in the auditory system make decisions based on multiple inputs. The method predicted responses of neurons to new stimuli better than prior dimensionality reduction methods for nearly all 50 neurons in the data set.
- Developed a model and algorithm for decoding the computations underlying the responses of sensory neurons.
  - Method was published in a computational neuroscience journal[2] and presented in a talk at the 2012 Society for Neuroscience meeting and the 2013 COSYNE conference.
  - Independently reproduced the expected biological inputs of retinal neurons and newly discovered that these neurons compute a particular type of logical operation.

2011– **Other activities**.

- Authored nonlinear constrained optimization algorithms including a GPU capable interior-point method in python and augmented Lagrangian in MATLAB both of which are top search results on GitHub. The interior-point method was used in a publication[1].
- Constructed a residual neural network to teach a computer to play tic-tac-toe via reinforcement learning. After training, the computer won 95% of games against a random opponent.
- Wrote software to optimize convolutional autoencoders in MATLAB that is a top search result on Google. Code was used to compress spectrograms of audio files.
- Simulated the existence of a phase transition between steady-state and chaos for simulated Hodgkin-Huxley recurrent neural networks as a function of synaptic gain consistent with predictions.

✉ jkaardal@gmail.com • joelkaardal.com
github.com/jkaardal • www.linkedin.com/in/joelkaardal

Skills

Machine learning	Experience with supervised, unsupervised, and reinforcement learning, deep learning architectures, generative adversarial networks, and computer vision. Experience working with big datasets on compute clusters and testing results for significance.
Mathematical optimization	Experience with both heuristic and deterministic, global and local optimization algorithms. Familiar with integer, linear, semidefinite, nonlinear programming methods and matrix completion.
Programming languages	*Fluent* in Python (TensorFlow, Keras, Theano), MATLAB/Octave; *Conversational* in C/C++, Java, Spark, SQL, ElasticSearch; *Tourist* in HTML/CSS, JavaScript.
Mathematics	Proficient in mathematics including probability theory, probabilistic graphical models, information theory, multivariate calculus, partial differential equations, and linear algebra.

Publications

[1] J. T. Kaardal, F. E. Theunissen, and T. O. Sharpee, "A low-rank method for characterizing high-level neural computations," *Frontiers in Computational Neuroscience*, vol. 11, p. 68, 2017.

[2] J. Kaardal, J. D. Fitzgerald, M. J. Berry, and T. O. Sharpee, "Identifying functional bases for multidimensional neural computations," *Neural computation*, vol. 25, no. 7, pp. 1870–1890, 2013.

[3] J. T. Kaardal, *Decoding the computations of sensory neurons*. PhD thesis, UC San Diego, 2017.

✉ *jkaardal@gmail.com* • *joelkaardal.com*

github.com/jkaardal • *www.linkedin.com/in/joelkaardal*