# Spencer J. Kent

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## Education

**Ph.D.** | Electrical Engineering and Computer Sciences — Aug. 2015 - Dec. 2020
University of California, Berkeley – Berkeley, CA
Advisor: Bruno Olshausen

**B.S.** | Electrical and Computer Engineering — Aug. 2011 - May 2015
Rice University – Houston, TX
*with Distinction in Research*

## Research

**Interests**

Theoretical Neuroscience, Computer Vision, Machine Learning, Abstract Algebra, Information Theory

**Projects**

Resonator Networks for factoring high-dimensional vectors
May 2017 - *Present*
Developed a theory of factorization in high dimensional neural circuits which is fundamental to Vector Symbolic Architectures and, possibly, perception in the brain. Currently working on extensions and applications in the domain of visual scene analysis.

Visual scene transformation and analogy with Vector Symbolic Neural Networks
Nov. 2016 - *Present*
Developing a framework for representing visual scenes that combines neural networks with Vector Symbolic Algebras in order to capture complex compositional structure within a single distributed scene representation. This is a first step toward a unified scene description language that can be consumed and modified by neural networks.

Neural coding models and lossy image compression
Nov. 2017 - *Present*
Exploring models of neural coding for advanced image compression, with special emphasis on nonlinear analysis transforms that produce sparse distributed codes. We believe that such transforms enable a scheme that beats state-of-the-art lossy image compression standards.

A convolutional sparse-coded point process model for exploratory neural data analysis
Jan. 2016 - Jun. 2016
Proposed a point process formulation of convolutional sparse coding that can be used as a tool for exploratory data analysis. Framework can uncover structure in a variety of multivariate point process datasets, which we demonstrated on tetrode recordings from cat visual cortex.

**Journal Papers**

Frady, E. P., Kent, S. J., Olshausen. B. A., & Sommer, F. T. (2020). Resonator networks, 1: an efficient solution for factoring high-dimensional, distributed representations of data structures. *Neural Computation, 32(12), 2311-2331. https://doi.org/10.1162/neco_a_01331.*

Kent, S. J., Frady, E. P., Sommer, F. T., & Olshausen, B. A. (2020). Resonator networks, 2: factorization performance and capacity compared to optimization-based methods. *Neural Computation, 32(12), 2332-2388. https://doi.org/10.1162/neco_a_01329*.

**Preprints**

Kleyko, D., Davies, M., Frady, E. P., Kanerva, P., Kent, S. J., Olshausen, B. A., Osipov, E., Rabaey, J., Rachkovskij, D. A., Rahimi, A., & Sommer, F. T. (2021). Vector symbolic architectures as a computing framework for nanoscale hardware. *arXiv preprint (2021), arXiv: 2106.05268.*

**Conference Talks**

Maudgalya, N., Olshausen, B. A., & Kent, S. J. (2020). Vector symbolic visual analogies. In *AAAI Symposium on Conceptual Abstraction and Analogy in Natural and Artificial Intelligence*.

**Conference Posters**

Frady, E. P.*, Kent, S. J.*, Kanerva, P., Olshausen, B. A., Sommer, F. T. (2018). Cognitive neural systems for disentangling compositions. In *Cognitive Computing 2018*.

Frady, E. P.*, Kent, S. J.*, & Olshausen, B. A. (2018). A recurrent neural network model for factoring distributed representations. In *Computational and systems neuroscience (CoSyNe '18)*.

Kent, S. J., & Olshausen, B. A. (2017). A vector symbolic approach to scene transformation. In *Cognitive computational neuroscience (CCN '17)*.

# Experience

**Kozu Inc.** | Co-Founder

Mar. 2022 - *Present* | Remote

Code, business development, and design.

**The NiVACK Group** | Consultant

Nov. 2021 - *Present* | Remote

Currently advising the NiVACK Group on data science and enterprise data warehousing.

**Fourthbrain.ai, Inc.** | Machine Learning Instructor and Subject Matter Expert

July 2021 - Dec. 2021 | Remote

Designed course content and delivering weekly lectures in an intensive 16-week bootcamp for Machine Learning Engineering.

**CTRL-Labs, Inc.** | Research Scientist Intern

May 2019 - Sep. 2019 | New York, NY

Surface electromyography research. Design and execution of two projects, one involving hand gesture classification with very small amounts of labeled training data, the other involving feature engineering and classical signal processing of multivariate time series.

**Google, Inc.** | Software Engineering Intern, Google[X]
Jun. 2015 - Aug. 2015 | Mountain View, CA
Built software on the radar development team for the self-driving car project. The radar qualification software I wrote (mainly in C++) controlled diverse physical hardware, collected massive amounts of raw data, and analyzed radar performance in real-time.

**Google, Inc.** | Hardware Engineering Intern, Google[X]
May 2014 - Aug. 2014 | Mountain View, CA
Worked on the smart contact lenses project where I wrote software (Python, LabVIEW, and Verilog) to test and debug low-power RF devices. I also led a rapid prototyping effort which involved CAD design (Solidworks) antenna design and simulation (HFSS), fabrication, and testing in the field.

**Hewlett Packard Company** | Hardware Engineering Intern
May 2013 - Aug. 2013 | Houston, TX
Worked on the drive qualification team where I built test infrastructure (primarily in Python) and did verification of new 12Gbps SAS hardware using various application, link, and physical layer tools. My project led to a new, more-automated process for qualifying drives used in enterprise servers.

**Sandia National Laboratories** | SIP Summer Technical Intern
May 2012 - Aug. 2012 | Albuquerque, NM
Worked on two different projects, one involving nuclear weapons failsafes (software and hardware robustness) and the other involving software-defined radio (primarily 802.15.4 ZigBee).

## Software

**Programming and Markup Languages**
Python • C/C++ • SQL • HTML/CSS/PHP (e.g. I designed and built *https://redwood.berkeley.edu*)
Verilog • LaTeX

**Software/Frameworks**
PyTorch • TensorFlow • Python scientific computing stack: NumPy, Pandas, scikit-learn, Dask, etc.
MATLAB • Caffe • OpenCV • AWS • Git • LabVIEW • Solidworks • Altium Designer • Blender

## Teaching

**Designing Information Devices and Systems I** | Discussion Section & Content Development TA
University of California, Berkeley
June 2020 - Aug. 2020
A broad introduction to electrical engineering and computer sciences at Berkeley. Topics included linear algebra, circuit analysis, and statistical learning.

**Fundamentals of Electrical and Computer Engineering** | Content Development TA
Rice University
Jan. 2015 - May 2015
The first course in ECE at Rice, which gives a broad but rigorous treatment of digital logic and computer architecture.

**Discrete Time Signal Processing** | TA and forum moderator (edX MOOC)
Rice University
Jan. 2014 - May 2014
A Massive Online Open Course (MOOC) version of the main signal processing course at Rice.

## Service

**UC Berkeley EE Graduate Student Association** | Chair, student rotations committee
Nov. 2017 - Dec. 2020

**IEEE** | President, Rice University student chapter
May 2014 - May 2015

**Rice University Admissions Office** | Senior Undergraduate Interviewer
Aug. 2015 - May 2015

## Honors & Awards

2015 | NSF Graduate Research Fellowship
2015 | UC Berkeley Chancellor's Fellowship
2015 | Rice Engineering Design Showcase First Place
2015 | Rice Engineering Alumni Association Willy Revolution Award
2015 | Rice ECE Affiliates Design Showcase First Place Undergraduate Project
2015 | Chevron Scholarship in Engineering
2014 | Eta Kappa Nu
2014 | Rice Engineering Alumni Association Merit Award in Electrical Engineering
2011 | Rice Trustee Distinguished Scholarship