

# VIBHOR KUMAR

Github: <https://github.com/veezbo/>

LinkedIn: <https://linkedin.com/in/kumarvibhor/>

Email: [vibhor@caltech.edu](mailto:vibhor@caltech.edu)

Phone: +1 (513) 293-1138

## EDUCATION

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**California Institute of Technology [Caltech]**, *B.S. Computer Science, 3.8/4.0*      *Sep. 2012 - Dec. 2015*

- **Biological Neuroscience and Cognition:** Introduction to Neuroscience (Bi/CNS 150), Optogenetic Methods in Experimental Neuroscience (Bi/CNS/BE 230), Cognitive Neuroscience Tools (CNS/Psy 115)
- **Computational Neuroscience:** Neural Computation (Bi/CNS/CS 187), Human Brain Mapping: fMRI Theory and Practice (CNS 251), Individual Project in Computational Neuroscience (CNS 180)
- **Psychology:** Frontiers in Behavioral Economics (Ec/Psy 109), Current Issues in Philosophical Psychology (HPS/Pl 134), Frontiers in Neuroeconomics (Psy/CNS 105)
- **Computer Graphics and Computer Vision:** Introduction to Computer Graphics (CS/CNS 171), GPU Programming (CS 179), Introduction to Computer Graphics Research (CS 176), Computer Graphics Research Project class (CS 174), Individual Project in Computer Graphics (CS 81), Discrete Differential Geometry (CS 177), Advanced Robotics: Motion and Vision (ME/CS 132)
- **Other Computer Science:** Machine Learning - Theory and Practice (CS 156ab), Functional Programming (CS 115), Mathematical and Computational Linguistics (Ma 191), Data Structures and Algorithms (CS 38), Decidability and Tractability (CS 21), Introduction to Computing Systems (CS 24)
- **Mathematics and Physics:** Single and Multivariable Calculus (Ma 1ac), Linear Algebra (Ma 1b), Differential Equations (Ma 2a), Probability and Statistics (Ma 2b), Discrete Mathematics (Ma 6a), Classical Mechanics and Electromagnetism (Ph 1abc), Waves, Quantum Mechanics, and Statistical Mechanics (Ph 2ab)
- **Foreign Language:** Japanese - Advanced (L106abc, L107abc, L108abc)

## WORK AND EXPERIENCE

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**Janelia Research Campus (HHMI)**, *Research Consultant*      *October 2015 - Present*

- Using raw visual data of the brain, collected from electron microscope scans of the fly brain, to learn about the physical structures and connectivity of the networks of neurons in the brain.
- Developing project-specific improvements to pre-existing Convolutional Neural Network libraries for increased efficiency and accuracy.

**Tokyo Institute of Technology**, *Research Exchange Student*      *June 2015 - August 2015*

- Explored Cognitive Neuroscience from the perspective of Computer Science by carefully analyzing fMRI data using standard statistical and Machine Learning techniques.
- Worked with Professor Akama to design language tasks, run the fMRI experiments, and subsequently analyze and interpret the data to derive conclusions about the neural bases of language switching.
- Devised a novel Machine Learning paradigm to apply the technique of MVPA to our unique dataset.
- Continuing research by exploring possible resting-state fMRI analyses that can be done, made possible by the unique design of the original experiment.

**Apple**, *Platform Architecture - Graphics Research Intern*      *June 2014 - September 2014*

- Worked with the exploratory graphics team to provide recommendations for future graphics hardware based on research results.
- Developed novel, in-house graphics software algorithms, corroborated by recent research, to demonstrate efficient and visually appealing improvements over the prior pipeline and pre-existing techniques.

**Samsung Mobile R&D**, *Software Engineering Intern*      *July 2013 - September 2013*

- Developed testing suites for enterprise security applications and their derivatives by working with Android testing tools and bash/python scripting for full automation.
- Worked alongside my team by handling automation and development, and created test cases for various parts of the overall testing suite, including optimizing a UI interface for internal use.
- Fixed errors with testing tools, involving careful manipulation of the Android source code, while additionally ensuring compatibility with Samsung's current and future internal modifications.

**Caltech, Teaching Assistant and Tutor**

*Various*

- *Tutor for L106 and L107*: Beginner and Intermediate Japanese. Helping students with specific questions about Japanese, in addition to directing focused self-study as necessary. Available to students as a resource for working through complex sentences in encountered native texts. (*September 2015 - Present*)
- *Teaching Assistant for Ma 191/CS 101*: Mathematical and Computational Linguistics. Assisted Professor with the design of the class and grading of the final projects. (*January 2015 - April 2015*)
- *Teaching Assistant for CS 171*: Introduction to Computer Graphics. Responsibilities included holding occasional recitation sessions, weekly office hours, and grading student assignments. Additionally designed study guides to help students finish the assignments. (*September 2013 - January 2014*)

**ChoiceFork, Researcher**

*April 2013 - June 2013*

- Built up from scratch the logistics of improving decision making on the internet as the sole researcher and developer. The resulting methodology was grounded in Natural Language Processing.

**Vora Labs, Testing and Software Development**

*Summer 2012*

- Created unit tests with JUnit for all parts of the development on the backend, while additionally developing various backend and frontend tasks as needed, including product search recommendations.

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## SELECTED RESEARCH PROJECTS

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**Neuronal Tracing in the Entire Drosophila Brain using Vision-based Convolutional Neural Networks, Janelia Research Campus**

*October 2015 - Present*

- Analyzing raw electron-microscope scans of the entire Drosophila fly brain using Convolution Neural Networks in a Computer Vision framework to efficiently and accurately determine the structure and connectivity of thousands of neurons, and the millions of connections between them.

**Investigating the Neural Basis of Trialwise Language Switching in Late Japanese-English Bilinguals, Research at Tokyo Tech**

*Jun. 2015 - September 2015*

- Analyzing fMRI data collected from Japanese-English bilinguals during a language-switching task to confirm involved brain regions, and to study underlying patterns using machine learning to simultaneously understand the neural basis of semantic representation of objects and bilingual language-switching.

**Determining brain connectivity and modulation involved in decision making using Dynamic Causal Modeling, CNS180 Research**

*Jan. 2015 - Jun. 2015*

- Using Dynamic Causal Modeling (DCM) to gauge the likelihood of selected models across the space of connectivities and modulations involved in five critical regions in the brain playing a part in decision making.

**Prevalence and Recoverability of Syntactic Parameters in Sparse Distributed Memories (Kanerva Networks), Ma 191 Research**

*Jan. 2015 - Apr. 2015*

- Studying the robustness of syntactic parameters from the Principles and Parameters paradigm using SDM. When adding noise, we found that, in some instances, we were able to recover the original data using Kanerva Networks, indicating dependency relations between syntactic parameters.

**Studying and Manipulating the Boundary Conditions of Mesh Conformal Parametrization, CS176 Research**

*Dec. 2013 - April 2014*

- Investigating boundary conditions involved in conformal parametrization of meshes, and finding alternatives to the de-facto Von Neumann boundary conditions in mesh processing.

**Edge-Preserving Linear-Time Smoothing Optimization, CS174 Research**

*March 2013 - June 2013*

- Optimizing an edge-preserving linear-time smoothing filter algorithm (Gastal, Oliveira; SIGGRAPH 2011), and implementing both a CPU and GPU version with novel improvements.

**Automated Inbetweening of Noisy Keyframes, CS81 Research**

*Dec. 2012 - March 2013*

- Using ideas from both Computer Graphics and Applied Math to develop a generalized method that can automatically generate artist-drawn keyframes in a way that is faithful to the artist's intent.

## SKILLS AND AWARDS

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**Skills:** C/C++, Python, Java, Haskell, R, Caffe, OpenGL, GLSL, CUDA, OpenCV, Octave, Matlab, Mathematica, Android (ADT), ANTLR, Bash Scripting, L<sup>A</sup>T<sub>E</sub>X, Markdown, Git and Github (**see above**)

**Awards:** Tokyo Institute of Technology International Research Opportunities Program (TiROP): Caltech Representative (*Summer 2015*), Stauffer Scholarship (Caltech, *Fall 2015, Winter-Spring 2014*), Marion Gene Vincenti Scholarship (Caltech, *Spring 2013*), Frances and Howard Vesper Scholarship (Caltech, *Spring 2013*), 1st place Google Games Coding Competition (*Spring 2013*), 11th Place Regional ACM Collegiate Programming Contest (*Winter 2012*), Association for Computing Machinery Membership, (*Spring 2013*), Top 5 in Silver Division on USA Computing Olympiad US Open Contest (*Spring 2012*), Honda-OSU Math Medal (*Spring 2012*), 1st Place American Computer Science League Contest (*Spring 2012*)