

PRAVEEN VENKATESH

Shanahan Foundation Fellow
Allen Institute & University of Washington

(he/him)
<https://praveenv253.github.io>

I am an information theorist and computational neuroscientist, interested in developing mathematical models and computational tools to explain how biological and artificial neural systems process information. In particular, I develop new measures of stimulus-specific information flow and information interaction between brain regions.

EDUCATION

Carnegie Mellon University, Pittsburgh, PA [2014–21]
M.S., Ph.D., Electrical & Computer Engineering

Indian Institute of Technology Madras, Chennai, India [2010–14]
B.Tech. (Honors), Electrical Engineering

RESEARCH EXPERIENCE

Shanahan Foundation Fellow at the Interface of Data and Neuroscience [2021–present]
Allen Institute & University of Washington, Seattle, WA
Mentors: Adrienne Fairhall, Stefan Mihalas, Christof Koch

- Designed algorithms to quantify redundant and synergistic information between brain regions about a stimulus, in high-dimensional settings, via Gaussian Partial Information Decompositions (GPIDs).
- Currently applying GPID and information flow to explore information processing in the mouse visual system.

Graduate Research Assistant [2015–21]
Carnegie Mellon University, Pittsburgh, PA
Advisor: Pulkit Grover ◦ *Thesis:* “Information Flow in Neural Circuits”
Committee: Robert E. Kass, Cosma R. Shalizi, Todd P. Coleman, José M.F. Moura

- Devised a framework to detect and quantify the information flow about specific messages within neural circuits; demonstrated how this framework can explain (and guide interventions in) an artificial neural network.
- Developed a biomarker of the efficacy of Responsive Neurostimulation (RNS) by quantifying changes in seizures.
- Examined fundamental limits of, engineered, and experimentally validated new high-density EEG systems.

AWARDS & HONORS

- Inaugural recipient of the *Shanahan Foundation Fellowship at the Interface of Data and Neuroscience* [2021–24] at the Allen Institute and the University of Washington, Seattle
- Selected to the *Summer Workshop on the Dynamic Brain* at Friday Harbor, [2021] hosted by the Allen Institute and the UW Center for Computational Neuroscience
- Lecturer for the Tutorial on “*Information Theory for Neural Inference*” [2021] at the 2021 IEEE International Symposium on Information Theory, Melbourne, Australia
- A recipient of the *ITA Sun Award*, the gold prize for Graduation Day talks [2020] at the 2020 Workshop on Information Theory and its Applications, San Diego
- An inaugural recipient of the *CMLH Fellowship in Digital Health* [2017–18] from the Center for Machine Learning and Health at Carnegie Mellon University
- A recipient of the *Dowd Fellowship* [2016–17] from the College of Engineering at Carnegie Mellon University
- An inaugural recipient of the *Henry L. Hillman Presidential Fellowship* [2015–16]
- A recipient of the *Carnegie Institute of Technology Dean’s Fellowship* [2014–15]

PUBLICATIONS

Ph.D. Thesis

Praveen Venkatesh, “Information Flow in Neural Circuits”, *Carnegie Mellon University*, 2021

Preprints

2. S. Dutta, **P. Venkatesh**, P. Grover, “Quantifying Feature Contributions to Overall Disparity Using Information Theory”, (*preprint*), Presented at the AAAI-22 Workshop on Information-Theoretic Methods for Causal Inference and Discovery
1. **P. Venkatesh**, S. Cheng, P. Grover, “A Synergistic Perspective on Information Flow and Encoding”, (*in prep*)

Journal papers

6. S. Dutta, **P. Venkatesh**, P. Mardziel, A. Datta, P. Grover, “Fairness Under Feature Exemptions: Counterfactual and Observational Measures”, *IEEE Transactions on Information Theory*, August 2021
5. **P. Venkatesh**, D. Sneider*, M. Danish*, N. D. Sisterson, N. Zaher, A. Urban, P. Grover, R. M. Richardson, V. Kokkinos, “Quantifying a Frequency Modulation Response Biomarker in Responsive Neurostimulation”, *Journal of Neural Engineering*, March 2021, *Equal contribution
4. **P. Venkatesh**, S. Dutta, P. Grover, “Information Flow in Computational Systems”, *IEEE Transactions on Information Theory*, April 2020
3. A. Chamanzar, S. George, **P. Venkatesh**, M. Chamanzar, L. Shutter, J. Elmer, P. Grover, “An Algorithm for Automated, Noninvasive Detection of Cortical Spreading Depolarizations Based on EEG Simulations”, *IEEE Transactions on Biomedical Engineering*, August 2018
2. A. Robinson, **P. Venkatesh**, M. Boring, M. Tarr, P. Grover, M. Behrmann, “Very High Density EEG Elucidates Spatiotemporal Aspects of Early Visual Processing”, *Scientific Reports*, November 2017
1. P. Grover, **P. Venkatesh**, “An Information-theoretic View of EEG Sensing”, *Proceedings of the IEEE*, December 2016

Conference papers

12. K. Gurushankar, **P. Venkatesh**, P. Grover, “Extracting Unique Information Through Markov Relations”, *Allerton Conference on Communication, Control, and Computing*, September 2022 (*to appear*)
11. **P. Venkatesh***, G. Schamberg*, “Partial Information Decomposition via Deficiency for Multivariate Gaussians”, *International Symposium on Information Theory (ISIT)*, June 2022, *Equal contribution
10. **P. Venkatesh**, S. Dutta*, N. Mehta*, P. Grover, “Can Information Flows Suggest Targets for Interventions in Neural Circuits?”, *Neural Information Processing Systems (NeurIPS)*, December 2021, *Equal contribution
9. **P. Venkatesh**, S. Dutta, P. Grover, “How else can we define Information Flow in Neural Circuits?”, *International Symposium on Information Theory (ISIT)*, June 2020
8. S. Dutta, **P. Venkatesh**, P. Mardziel, A. Datta, P. Grover, “An Information-Theoretic Quantification of Discrimination with Exempt Features”, *AAAI Conference on Artificial Intelligence (AAAI): Oral presentation*, February 2020
7. A. Gangrade, **P. Venkatesh**, B. Nazer, V. Saligrama, “Efficient Near-Optimal Testing of Community Changes in Stochastic Block Models”, *Neural Information Processing Systems (NeurIPS)*, December 2019
6. **P. Venkatesh**, S. Dutta, P. Grover, “How should we define Information Flow in Neural Circuits?”, *International Symposium on Information Theory (ISIT)*, July 2019
5. Z. Ahmed, J. Reddy, K. Deshpande, A. Krishnan, **P. Venkatesh**, S. Kelly, P. Grover, M. Chamanzar, “Flexible Ultra-resolution Subdermal EEG Probes”, *Biomedical Circuits and Systems Conference (BioCAS)*, October 2018

4. A. Krishnan, R. Kumar, **P. Venkatesh**, S. Kelly, P. Grover, “[Low-cost Carbon Fiber-based Conductive Silicone Sponge EEG Electrodes](#)”, *Engineering in Medicine and Biology Conference (EMBC): Oral presentation*, July 2018
3. **P. Venkatesh**, P. Grover, “[Lower Bounds on the Minimax Risk for the Source Localization Problem](#)”, *International Symposium on Information Theory (ISIT)*, June 2017
2. **P. Venkatesh**, P. Grover, “[Is the Direction of Greater Granger Causal Influence the Same as the Direction of Information Flow?](#)”, *Allerton Conference on Communication, Control and Computing*, September 2015
1. P. Grover, J. A. Weldon, S. K. Kelly, **P. Venkatesh**, H. Jeong, “[An Information-theoretic Technique for Harnessing Attenuation of High Spatial Frequencies to Design Ultra-High-Density EEG](#)”, *Allerton Conference on Communication, Control and Computing*, September 2015

Workshops and Conference abstracts

18. **P. Venkatesh**, G. Schamberg, A. Fairhall, S. Olsen, S. Mihalas, C. Koch, “[Gaussian Partial Information Decomposition: Quantifying Inter-areal Interactions in High-Dimensional Neural Data](#)”, *Computational and Systems Neuroscience (Cosyne)*, March 2022
17. **P. Venkatesh**, M. Danish*, D. Sneider*, N. D. Sisterson, P. Grover, R. M. Richardson, V. Kokkinos, “[Quantifying Frequency Modulation in Seizures of Patients Undergoing Responsive Neurostimulation](#)”, *American Epilepsy Society annual meeting*, December 2020, *Equal contribution
16. **P. Venkatesh**, P. Grover, “[Understanding Encoding and Redundancy in Grid Cells Using Partial Information Decomposition](#)”, *Computational and Systems Neuroscience (Cosyne)*, February 2020
15. **P. Venkatesh**, S. Dutta, P. Grover, “[Information Flow in Neural Circuits: Formal Definition and Required Neuroengineering](#)”, *Information Theory and Applications Workshop (ITA): Graduation Day Talk*, February 2020, **Winner of the ITA Sun Award:** the gold prize for graduation day talks
14. **P. Venkatesh**, V. Kokkinos, R. M. Richardson, P. Grover, “[An automated and configurable seizure segmentation tool for tracking the evolution of seizures](#)”, *American Epilepsy Society Annual Meeting (AES)*, December 2019
13. **P. Venkatesh**, P. Grover, “[Relating Information Flow and Causal Interventions in Neural Circuits](#)”, *SfN Neuroscience*, October 2019
12. **P. Venkatesh**, P. Grover, “[Revealing Information Paths in the Brain using Synergistic Information](#)”, *CNS*2019 Workshop on Methods of Information Theory in Computational Neuroscience*, July 2019
11. **P. Venkatesh**, P. Grover, “[An Information-theoretic Framework for Examining Information Flow in the Brain](#)”, *28th Annual Computational Neuroscience Meeting (CNS*2019)*, July 2019
10. S. M. Haigh, A. Chamanzar, **P. Venkatesh**, P. Grover, M. Behrmann, “[Cortical Hyper-Excitability in Migraine to Chromatic Patterns](#)”, *Optical Society of America Fall Vision Meeting*, September 2018
9. K. Deshpande, Z. Ahmed, J. Reddy, A. Krishnan, **P. Venkatesh**, S. Kelly, P. Grover, M. Chamanzar, “[Flexible, Ultra-resolution, Subdermal EEG Probes](#)”, *SfN Neuroscience: Nanosymposium*, November 2018
8. A. Chamanzar, S. George, **P. Venkatesh**, M. Chamanzar, J. Elmer, L. Shutter, P. Grover, “[Automated Algorithm and System for Noninvasive Detection of Worsening Brain Injuries](#)”, *Military Health System Research Symposium*, August 2018
7. R. Kumar, **P. Venkatesh**, R. Sun, G. Mohankumar, A. Antony, R. M. Richardson, P. Grover, “[Ultra-high-density scalp EEG outperforms localized invasive ECoG grids in inferring depth of seizure foci](#)”, *31st International Congress of Clinical Neurophysiology*, May 2018
6. R. Sun, P. Grover, R. Morina, M. Bremner, **P. Venkatesh**, A. Bagic, R. M. Richardson, J. Pan, A. Urban, N. Zaher, A. Antony, “[Analysis of cortical stimulation data to localize intracranial electrodes using simultaneous scalp and stereo EEG recordings](#)”, *American Epilepsy Society annual meeting*, December 2017
5. **P. Venkatesh**, A. Krishnan, J. Weldon, S. Kelly, P. Grover, “[Ultra-resolution Subdermal EEG: Long-term Minimally-invasive Brain Monitoring](#)”, *SfN Neuroscience*, November 2017

4. **P. Venkatesh**, P. Grover, “[High Density EEG: Information-theoretic Limits and Algorithms](#)”, *International Symposium on Information Theory (ISIT)*, *Recent Results*, June 2017
3. A. Chamanzar, S. George, **P. Venkatesh**, W. Ding, P. Grover, “Systematic and Automated Algorithms for Detecting Cortical Spreading Depolarizations Using EEG and ECoG to Improve TBI Diagnosis and Treatment”, *12th World Congress on Brain Injury*, March 2017
2. **P. Venkatesh**, W. Ding, P. Grover, “[Data Processing for Reliable Detection of Cortical Spreading Depolarizations Using High-density EEG](#)”, *American Epilepsy Society annual meeting*, December 2016
1. **P. Venkatesh**, P. Grover, “[Is the Direction of Greater Granger Causal Influence the Same as the Direction of Information Flow?](#)”, *Sfn Neuroscience*, October 2015

TEACHING

IEEE International Symposium on Information Theory (ISIT 2021)

- Lecturer for the Tutorial on *Information Theory for Neural Inference* [Summer, 2021]
 - Conceptualized, designed and delivered one part of a three-part tutorial on the applications of information theory to neuroscience and neuroengineering.

At Carnegie Mellon University

- Teaching Assistant and Co-instructor for *18-753: Information Theory* [Spring, 2020]
 - Contributed to the redesign of this introductory course, to focus on information measures, causality, partial information decomposition, and fairness in machine learning.
 - Delivered lectures on introductory information theory and information flow in neuroscience.
 - Advised students’ course projects at the intersection of information theory and neuroscience.
- Teaching Assistant and Co-instructor for *18-898: Introduction to Data Science with Applications to Clinical Neural Data* [Spring, 2017]
 - Contributed to curriculum design and developed new course material and homework assignments.
 - Delivered lectures on statistics and source localization, and oversaw projects in collaboration with clinicians.
- Teaching Assistant for *18-290: Signals and Systems* [Spring, 2015]
 - Changed course perceptions and induced more students to pursue the signals stream: won course an award.

At the Indian Institute of Technology, Madras

- Teaching Assistant for *EE4371: Introduction to Data Structures and Algorithms* [Spring, 2014]
 - Served as the first ever undergraduate TA in the department; received commendation for exceptional work.

INVITED TALKS

17. “Information Flow and Interaction between Brain Regions”, *NeuroAI Seattle*, September 2022.
16. “Quantifying Inter-areal Interactions using the Gaussian Partial Information Decomposition”, *UW Neural Computation and Engineering Connection*, May 2022.
15. “Information Flow and Representation in Neural Circuits”, *University of Oregon*, April 2022.
14. “———”, *Mount Sinai School of Medicine*, April 2022.
13. “———”, *Institut de Neurosciences de la Timone*, April 2022.
12. “———”, *Allen Institute*, August 2021.
11. “———”, *Harvard University*, December 2020.
10. “———”, *Center for Science of Information (CSoI) Fall seminar series*, October 2020.
9. “———”, *Georgia Tech*, September 2020.
8. “———”, *Columbia University*, September 2020.

7. “——”, *University of Washington*, September 2020.
6. “Information Flow in Neural Circuits”, *Carnegie Mellon University*, June 2020.
5. “——”, *Information Theory and Applications Workshop (ITA)* graduation day talk, February 2020.
Won the ITA Sun award: the gold prize for graduation day talks.
4. “——”, *Carnegie Mellon University*, May 2019.
3. “Revealing Information Paths in the Brain using Synergistic Information”, in the *Information Theory Workshop at the 28th Annual Computational Neuroscience Conference*, July 2019.
2. “Ultra-resolution EEG: Fundamental limits, algorithms, instrumentation and experiments”, *Center for Machine Learning and Health Fellowship Seminar*, October 2017. *Voted best talk at the fellowship seminar.*
1. “Is the direction of greater Granger Causal influence the same as the direction of information flow?”, *Carnegie Mellon University*, March 2015.

MENTORSHIP

Undergraduate students

- Woohyeuk Chang, Undergraduate in Computational Neuroscience, CMU [2020–present]
- Susan Cheng, Undergraduate in Physics, CMU; Research Assistant in ECE, CMU [2019–present]
- Daniel Sneider, Undergraduate in ECE, CMU [2019–21]
- Alankrita Bhatt, Undergraduate from IIT, Kanpur [Summer 2015]
- Wanqiao Ding, Undergraduate in ECE, CMU [2015–17]

Masters students

- Mohammed Danish, Masters in ECE, CMU [2020–21]
- Revanth Banala, Masters in ECE, CMU [2020–21]
- Ritesh Kumar, Masters in BME, CMU [2017–18]

SKILLS

Programming: Python, MATLAB, C, C++, SQL, Bash shell scripting, \LaTeX

Frameworks: Numpy, Scipy, Scikit-learn, Pandas, CVXPY, PyTorch, EEGLAB, Brainstorm, Fieldtrip, Freesurfer

Github: <https://github.com/praveenv253>

RELEVANT COURSEWORK (CMU)

- Real Analysis
- Lebesgue Integration
- Neural Data Analysis
- Information Flows: Communication, Computational and Neuronal
- Estimation, Detection and Identification
- Intermediate Statistics
- Compressive Sensing and Sparse Representations
- Information Theory
- Error Control Coding
- Convex Optimization
- Information Processing and Learning
- Computational Neuroscience (at IIT Madras)