

# Parul Jain

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📄 <https://paruljainneuro.github.io/>

## Education

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### Ph.D. Candidate

Physiology, Biophysics, and Systems Biology  
Weill Cornell Medical College (WCMC), New York, NY

*Aug 2017 - March 2023 expected*

### Bachelor of Technology

Computer Science and Engineering, with minor in Computational Biology  
Indian Institute of Technology Delhi

*Jul 2012 - May 2016*

## Research Projects

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### Detecting low-level language processing in severely brain-injured patients

*Drs. Jonathan D. Victor and Nicholas D. Schiff, WCMC*

*Apr 2018 -*

Current methods for assessing residual cognitive skills in severely brain-injured patients include bedside tests, which require motor function, and motor imagery tests based on correlates of neural response, such as fMRI/EEG, which require sustained attention. In addition, both methods rely on language comprehension, a high-level function. In doing so, they fail to identify patients with partial language processing skills. Taking advantage of the hierarchical nature of language, I developed tools to analyze EEG for identifying low-level language processing markers in severely brain-injured patients. This method does not require motor function or sustained attention. I identified patients with behavioral responses using Coma Recovery Scale-Revised (CRS-R) and patients with covert cognition using fMRI and EEG response to motor imagery commands. I analyzed language processing at two levels: tracking the natural speech envelope and the differentiation of phonemes classes based on the manner of articulation. Results indicate that all studied patients have EEG evidence of language processing at both levels. That said, patients with evidence of language comprehension via CRS-R or EEG/fMRI-based motor imagery tests had responses with shorter latency. The project promotes assessing these patients' cognitive skills at all levels, which can assist in prognostication and rehabilitation.

### Application of Hermite-based measure of non-Gaussianity to normality tests and ICA

*Dr. Jonathan D. Victor, WCMC, and Bruce W. Knight Jr., The Rockefeller University*

*Aug 2018 -*

Measures of non-Gaussianity have a dual role in data analysis: as tests of normality for validating model assumptions and as contrast functions of Independent Component Analysis (ICA) for separating meaningful signals. There are many normality tests and ICA contrast functions, but none take into account the distribution's shape. As a result, their sensitivity to certain types of deviations from normality is low. To bridge this gap, I explored the use of Hermite functions, a family of orthonormal functions that form a basis set, as a measure of non-Gaussianity. Unlike other methods, the new measure approximates the shape of the distribution directly. I used simulated datasets, including realistic EEG datasets, to assess the sensitivity of the new method to different types of deviations from Gaussianity (modality, weight in tails, symmetry). I compared its performance to standard normality tests and ICA contrast functions included in a standard ICA package. The findings indicate that as a normality test, the new measure is more sensitive to specific distribution shapes and is more robust than many standard normality tests. As an ICA contrast function, these advantages are limited to datasets with small sample sizes.

### Network inferencing in neuronal circuits in zebrafish

*Dr. Mark Goldman, UC Davis, and Dr. Emre Aksay, WCMC*

*Aug 2016 - Dec 2017*

This project aimed to model the oculomotor neural integrator in zebrafish to understand the working of short-term memory. I developed new tools for the simultaneous recording and stimulation of the oculomotor system in larval zebrafish were developed. Specifically, I processed real-time images from two-photon microscopy via MATLAB-based image analysis routine for automatic neuron identification. The output was linked to a python-based analysis pipeline for model fitting, which compared negative derivative feedback models to conventional positive feedback models. The python-based analysis sent feedback to MATLAB based on sensitivity analysis for controlled stimulation.

### Causality in gene regulatory networks

*Dr. Sumeet Agarwal, Dr. Parag Singla, and Sahil Loomba, IIT Delhi*

*Jul 2015 - May 2016*

To understand the dynamics of gene-regulatory networks (GRNs), we used simulated mRNA concentrations in multiple subject data and across time series data. We compared standard information theory techniques such as Granger causality and transfer entropy to novel methods like convergent cross maps and manifold learning.

### **Android device benchmarking**

*Dr. Sorav Bansal, IIT Delhi*

*December 2014*

We implemented a standalone android performance benchmarking application in Java. The SPEC CPU2000 benchmarking suite was made compatible with android and wrapped in Java to create a simple application that tested the performance of android devices on features such as memory, computational speed, and graphics.

### **Quantum mechanical simulations**

*Dr. Kushal Shah, IIT Delhi*

*May 2014 - Jul 2014*

Asymptotic bounds of energy of a second-order Fermi accelerator were estimated using a simple kinetic model of a trapped particle in a box with an externally controlled oscillating wall. I implemented various models of the Fermi accelerator in C++. Bounds on energy were estimated using Monte-Carlo simulations on high-performance GPU clusters.

## **Publications**

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### **Low-level language processing in severely brain-injured patients**

**P. Jain, M. M. Conte, H. U. Voss, J. D. Victor, N. D. Schiff.**

*Under review*

### **Application of Hermite-based measure of non-Gaussianity to normality tests and ICA**

**P. Jain, J. D. Victor, B. W. Knight.**

*Submitted*

## **Presentations**

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### **Society for Neuroscience Conference, Chicago, Nov 2019**

**Poster**

**P. Jain, M. M. Conte, J. D. Victor, N. D. Schiff.** EEG evidence of phonemic processing in severely brain-injured patients.

### **Vincent du Vigneaud Research Symposium, WCMC, Apr 2022**

**Talk**

**P. Jain, M. M. Conte, H. U. Voss, J. D. Victor, N. D. Schiff.** EEG evidence of phoneme processing in severely brain-injured patients.

### **Society for the Neurobiology of Language, Philadelphia, Oct 2022**

**Poster**

**P. Jain, M. M. Conte, H. U. Voss, J. D. Victor, N. D. Schiff.** EEG evidence of phoneme processing in severely brain-injured patients.

## **Teaching Experience**

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- Teaching Assistant, Applied Quantitative Techniques for the Biological Sciences, headed by Dr. Diane Lane, WCMC, Sep - Oct 2021
- Teaching Assistant, Dynamic Models in Biology, taught by Dr. Trine Krogh-Madsen, WCMC, Sep - Dec 2018 and 2019

## **Work Experience**

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### **Zolve (educational platform for student query redressal)**

*Chief Technical Officer*

*Oct 2015 - May 2016*

Developed string algorithms, machine learning based performance evaluations, and web security methods for the platform. Optical character recognition was implemented for parsing mathematical expressions in student queries. Additional responsibilities included database management, server maintenance, and web product design.

**Microsoft, India***Software Development Intern**May 2015 - Jul 2015*

Developed a prototype SDK library for OneNote Services. The library serves as an API and facilitates the development of android applications that use OneNote at the backend by handling data transfer, representation, and storage.

**Technical Skills**

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MATLAB, python, L<sup>A</sup>T<sub>E</sub>X, R, C++, Java

**Awards and Honors**

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- Kishore Vaigyanik Protsahan Yojana Fellow, 2010
- National Talent Search Scheme Scholar, 2008