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RESEARCH INTERESTS	My general research interest is to discover mechanisms by which networks of cells compute to produce behaviour in animals (rats, mice, zebrafish, etc), using computational and experimental tools. <i>Keywords</i> : Neuroscience, Computation, Imaging, Cognitive Science, Machine Learning.	
EDUCATION	Sorbonne Université Laboratoire Jean Perrin, École Doctorale Physique en Île-de-France ZENITH Neuroscience PhD program	September 2020 - present
	École polytechnique fédérale de Lausanne (EPFL) Master of Science, Life Sciences and Technology	September 2016 to August 2018
	Indian Institute of Technology Kanpur (IIT Kanpur) Bachelor of Technology, Computer Science and Engineering	July 2012 to July 2016
EMPLOYMENT	Sainsbury Wellcome Centre, University College London (UCL) Research Assistant, Learning, Inference and Memory Lab of Dr. Athena Akrami	January 2019 - August 2020
	Centre for Digital Education, École polytechnique fédérale de Lausanne (EPFL) Social Media Manager, EPFL Neuroscience on Facebook	September 2017 to October 2018, part time
	ArtLab, École polytechnique fédérale de Lausanne (EPFL) Junior Curator, 'Mental Work', Exhibition on Brain Computer Interfaces	September 2017 to February 2018, part time
PUBLICATIONS	• S. Bhattacharjee; S. Chatterjee ; A. Banerjee; T. Y. Ho; K. Chakrabarty; B. Bhattacharya, "Adaptation of Biochemical Protocols to Handle Technology-Change for Digital Microfluidics", IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, 2016. DOI : 10.1109/TCAD.2016.2585622	
RESEARCH PROJECTS	Learning, Inference and Memory Laboratory, SWC, UCL Learning of statistical structure of sensory inputs <i>Mentored by Athena Akrami</i>	January 2019 - present
	<ul style="list-style-type: none">- The objective of this work is to investigate how animals can update their sensory representations to optimise reward output- I use a high-throughput semi-automated behavioural protocol to train animals (rats presently, and eventually mice) on a delayed match to sample auditory task- I manipulate the statistical distribution of the sensory samples to test how this affects the priors formed in the animal's brain and how this is used in working memory and decision making- I am constructing a mathematical (normative) model based on a Bayesian framework to analyse and predict the behaviour of the animal.	
	Laboratory of Sensory Processing, Brain Mind Institute, EPFL Sensitivity to perturbation in computational models of the barrel column	

- The objective of this work is to investigate computationally, the sensitivity to perturbation of network activity in a neuronal network model of a barrel column (C2) in the mouse primary somatosensory cortex.
- I use published data from the laboratory as well as optimise for other parameters not available to best fit the known properties of the biological tissues, yet generalise well enough.
- It turns out that the dynamics changes appreciably (measured by a defined sensitivity measure) to even the addition of a single spike in the network.
- I found out that one certain class of cells (L4 fast spiking neurons) are the most important factor in the runaway dynamics, and also investigated the important role of thalamic input in preserving spike timing consistency in the presence of perturbation.

Aging and Vision in Action Lab, Institut de la Vision, Paris, France
Calculating ego-motion, path integration and depth from optic flow

Mentored by Denis Sheynikhovich, under Angelo Arleo

May - August 2017

- The objective of the work was to deal with estimating an observer's self-motion, depth perception as well as path integration from what the observer sees as changing intensity pattern on their retina (called optic flow).
- Several algorithms were tested and the simplest as well as most biologically plausible was selected and implemented to test the results in terms of optic flow processing.
- Based on the processing, hypotheses regarding the change of processing with age were suggested in tandem with experiments on optic flow on young and aged people.

Laboratory of Computational Neuroscience, Brain Mind Institute, EPFL
Sequences reproduce cortical bidirectional connectivity statistics

Mentored by Aditya Gilra and Marco Lehmann, under Wulfram Gerstner

March - May 2017

- The objective of the work was to investigate the nature of information storage in neural networks.
- I simulated modified neural networks with connected single neurons and compared the statistics of their weights during storing attractors, a sequence of correlated patterns and finally a set of sequences of correlated patterns.
- We found out correlation in sequences do not affect the connectivity, but a set of correlated patterns reproduces connectivity statistics from experiments when it is optimised to store such sets. This might be thought of as a different 'type' of information being stored in such models.
- A report for the project can be found [here](#).

Laboratory of Computational Neuroscience, Brain Mind Institute, EPFL
Multisensory integration with stochastic variational learning in spiking networks

Mentored by Aditya Gilra and Johanni Brea, under Wulfram Gerstner

May - August 2015

- The objective of the work was to try and test the possibility of multisensory integration being feasibly modeled by recurrent spiking networks with more biologically plausible learning rules.
- Worked under my post-doctoral guides to implement the said model architecture based on Python.
- Developed an insight into the different steps and challenges of the modeling process.
- Acquired a fair understanding of the issues in designing and testing working models, apart from core issues in the physics and neuroscience behind the models.

Nanotechnology Research Triangle, Indian Statistical Institute, Kolkata, India
Digital Microfluidic Protocols

Mentored by Sukanta Bhattacharjee, under Bhargab B. Bhattacharya

May - August 2014

- The objective of the work was to suggest new ways to deal with technology enhancement like processor speed increases in the context of digital microfluidic biochips (DMFB).
- Tried out various methods to avoid a complete re-synthesis of the given architecture (which would be a trivial solution), under the guidance of Sukanta Bhattacharjee

- Developed a method, based on symbolic encoding and SAT solvers, added with rich graph-theoretic procedures, to intelligently use the existing action sequences and save costly resources.
- Continued development on the project that culminated in the publication of the work in 2016.

TEACHING
EXPERIENCE

- ***Unsupervised and Reinforcement Learning in Neural Networks*** (Teaching Assistant) *February - July 2018*
Am responsible in helping students in the exercises of the course offered to master's students at EPFL.
- ***Data Structures and Algorithms*** (Teaching Assistant) *August - November 2016*
Was responsible for teaching, clearing doubts, preparing and grading questions as well as smoothly conducting the course organised by the Department of Computer Science and Engineering, IIT Kanpur.
- ***Introduction to Machine Learning*** (Instructor) *Summer 2016*
Taught a course for a group of undergraduate and postgraduate students at IIT Kanpur, organised by the Association of Computing Activities. It was meant to introduce people to the field of machine learning, its practice and some of the theory behind it.

SKILLS

- ***Computational Tools:*** MATLAB, GNU Octave, Theano, Brian2, NeuroLucida
- ***Bioinformatics Tools:*** BLAST, ClustalW2, HMMER, MEME suite
- ***Programming Languages:*** C, C++, Python, R, Java, Javascript
- ***Natural Languages:*** Bengali (native), Hindi/Urdu (proficient), English (proficient), French (conversational), Sanskrit

COURSE
PROJECTS

Visualising Cancer Data

Mentored by Kirell Benzi, EPFL

September 2017 - present

- Used visualisation techniques to represent cancer genomic data on an interactive graph using the information from The Cancer Genomic Atlas, with clusters based on a novel distance measure. The method was developed by Rachel Jeitziner at the [Briskin Lab](#) of EPFL.
- Presented a poster on it at Google Research Day 2018 at EPFL.
- A dedicated website on the project may be accessed [here](#). It is presently being improved.

Predicting the probability of Parkinson's disease from fMRI data

Mentored by Robert West, EPFL

September 2017 - January 2018

- Used a variety of techniques on the PPMI data (Parkinson's Progression Marker's Initiative) which consists of resting state fMRI of controls and Parkinson's patients, to classify them into diseased and non-diseased patients
- Received best presentation at Applied Machine Learning Days 2018 conference, Lausanne, Switzerland.
- A dedicated website on the project may be accessed [here](#). It is presently being improved.

Predicting the movement of a robotic arm via neural spikes

Mentored by Ricardo Chavarriaga, EPFL

September - November 2016

- Used a variety of machine learning techniques to reduce the dimension of the data, sort spikes, and apply regression analysis to predict the motion of a robotic arm controlled by a monkey.

Learning fast kernels

Mentored by Harish Karnick, IIT Kanpur

September - November 2015

- Acquired a fair understanding of the prevalent issues and techniques in learning of fast kernels, useful in ubiquitous kernel learning methods. Implemented the Fastfood based approach and proposed a possible technique, based on the *À la carte* algorithm.

Billion word imputation

Mentored by Harish Karnick, IIT Kanpur

January - April 2015

- Implemented an approach based on N-grams based to predict missing words in English language sentences. This was followed by implementing a recurrent neural network (RNN) based approach (T. Mikolov *et al.* 2010) that accounts for context generated by the preceding part of the sentence

while predicting the missing word, by using the network output as an input to the neural network.

Hallucinations in Garden Path sentences -

Mentored by Amitabha Mukerjee, IIT Kanpur

August - November 2014

- Analyzed the processing of garden path sentences, true and hallucinated, through empirical data and designed self-paced reading based experiments as well as gaze-tracking experiments for the same. Tested hypotheses in the field (R. Levy *et al* 2011) of sentence-processing through human cognition models using collected data.
- Awarded second-best course project for the semester.

Linguistic profiles of the Lamkang language

Mentored by Chaithra Puttaswamy, IIT Kanpur

August - November 2014

- Carried out a detailed study of the grammar, vocabulary, phonology and morphology of the Lamkang language, spoken in Manipur in north-east India. Identified and discussed points of contact and convergence with local Meitei and Bishnupriya languages, as well as with Indo-Aryan languages like Bengali and Assamese.
- Awarded an A*, given only for exceptional performance.

RHadoop Server

Mentored by Arnab Bhattacharya, IIT Kanpur

August - November 2014

- Aim of the project was to set up a Hadoop Cluster on IBM Blade server and configure RHadoop packages on it to allow distributed computing of R map reduce programs on this cluster.
- Understood and made usable the IBM blade server which was an unused resource in the CSE Department for the past 5 years. Selected as the best course group project among 30 others.

POSITIONS OF RESPONSIBILITY

- **Academic Delegate, SV MA4, AgePoly, EPFL**, working as a link between the student body and the governing body of EPFL. (*February 2018-July 2018*).
- **Student Nominee, Department Undergraduate Committee**, working as a link between the student body and the governing body of IIT Kanpur. (*2014-15*)
- **Academic Mentor** with the Counselling Service, IIT Kanpur during the academic year 2013-14, to guide juniors and classmates in their academics, particularly for the courses **Mathematics-I, Introduction to Electrodynamics** and **Introduction to Biology**. (*2013-14*)
- **Coordinator, NERD (Notes on Engineering, Research and Design), IIT Kanpur**, responsible for organizing lectures on popular science and science communication, publishing and editing the student research magazine on science and technology and keeping the campus updated on latest news on science and technology, as a part of the NERD team. (*2013-15*).
- **Co-Editor, Vox Populi, IIT Kanpur**, responsible for maintaining and editing the campus newspaper as a part of a vibrant team. (*2014-15*).

SCHOLASTIC ACHIEVEMENTS

- Two time recipient of the **Certificate of Merit for Academic Excellence**, awarded by IIT Kanpur for the academic years 2012-13 and 2013-14.
- Awarded the **Ram Parkash Chopra Memorial Scholarship** for the academic years 2014-15 and 2015-16, given to students for academic performance and aptitude.
- Awarded the **KVPY (Kishore Vaigyanik Protsahan Yojna) Fellowship** for students interested in basic sciences for 2011 and 2012 by the Government of India.

REFERENCES

- **Dr. Athena Akrami**, Group Leader, Sainsbury Wellcome Centre, University College London, United Kingdom. *Email : athena.akrami@ucl.ac.uk*
- **Prof. Carl Petersen**, Professor, Brain Mind Institute, EPFL, Switzerland. *Email : carl.petersen@epfl.ch*
- **Dr. Angelo Arleo** Director of Research, Institut de la Vision, Sorbonne University, Paris, France. *Email : angelo.arleo@inserm.fr*