PRASHANT RANGARAJAN

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EDUCATION

Birla Institute of Technology and Science, Pilani, Pilani Campus (2015 –)
Expected Degree (in 2020): BE (Honors) in Computer Science and MSc (Honors) in Mathematics. Current CGPA: 9.6 out of 10 (**first rank** among Dual Degree students)

PUBLICATIONS

Rangarajan P and Rao RP (2019). Estimation of vector autoregressive parameters and Granger causality from noisy multichannel data, *IEEE Transactions on Biomedical Engineering,* **66**, 2231-2240. DOI: 10.1109/TBME.2018.2885812 (**Impact Factor: 4.5**).

Rangarajan P, Mody SK, and Marathe M (2019). Forecasting dengue and influenza incidence using a sparse representation of Google Trends, electronic health records, and time series data, *PLOS Computational Biology,* **15**, e1007518. DOI: 10.1371/journal.pcbi.1007518 (**Impact Factor: 4.4**).

RESEARCH PROJECTS

Learning vector autoregressive models and causal inference from noisy multichannel data
Project with Prof. Rajesh Rao, Computer Science, University of Washington, Seattle (2017–18)
Time series data is usually modeled using autoregressive processes. Since most observed time series data is contaminated with noise, it is important to study denoising algorithms that enable learning of autoregressive model parameters in such cases. We proposed a new method, the *nonlinear Cadzow method*, for learning vector autoregressive parameters from noisy multichannel data, using optimization techniques. We showed that this method gives better results than the existing state-of-the-art methods. We applied this method to infer Granger causal relations from noisy biological data and again obtained superior results compared to existing methods. Since Granger causality is often used to build causal graphs, our denoising method permits accurate construction of such graphs from noisy data.

Forecasting dengue and influenza incidence using a sparse representation learnt from Google Trends, electronic health records, and time series data
Project with Prof. Madhav Marathe, Computer Science, University of Virginia (2018–19)
Dengue and influenza are leading causes of viral infection in the world and hence it is important to develop accurate methods for forecasting their incidence. We proposed a computationally efficient method, the *Autoregressive Likelihood Ratio method*, that learns a sparse (non-lasso) representation of multivariate time series data. We demonstrated that this method performs better than the lasso method for synthetic data. Further, for the case at hand, the time complexity of our algorithm was shown to be better than that for lasso. Using Google Trends, electronic health records, and disease incidence time series data, this sparse representation was then used to forecast dengue and influenza incidences for multiple countries. We showed that this method outperforms existing state-of-the-art method by an average of 18% (in terms of the forecasting error).

Cross-lingual embeddings using matrix factorization
Project with Dr. Martin Jaggi, Computer Science, EPFL, Lausanne (May – July 2018)
We worked on obtaining word embeddings for low-resource languages since such embeddings are critical to developing machine translation tools. We obtained cross-lingual embeddings, with the goal of obtaining a document-level embedding for a parallel corpus of Wikipedia articles present in different languages. We used factorization of a sparse, low-rank matrix and stochastic gradient descent to improve the embeddings of two low-resource languages which have documents in common by using a third resource-rich language which also has documents in common with the other two. We experimented with different loss functions in order to obtain the optimal loss function, which leads to maximum improvement as compared to baseline embeddings.

Active Learning for Graph Convolutional Networks (GCNs)
Project with Dr. Partha Talukdar, Computational and Data Science, Indian Institute of Science, Bangalore (July 2019 - present)
It is important to be able to predict properties of nodes in a graph since this has applications in a wide variety of areas such as NLP and biological networks. Utilizing labels for a small subset of nodes and the graph structure, GCNs are able to successfully predict label scores for the rest of the nodes in the graph. In this ongoing work, we are formulating models that incorporate both active learning and confidence scores within a single GCN framework.

STUDY PROJECTS

Machine Learning and Optimization
Project with Dr. Partha Talukdar, Indian Institute of Science, Bangalore (May – July 2016)
I studied two important machine-learning problems: matrix sensing and matrix completion. I studied one type of alternating minimization in depth: the maximum block improvement method.

Advanced Probability and Mathematical Finance
Project with Prof. Mrinal Ghosh, Indian Institute of Science, Bangalore (May – July 2017)
I studied advanced concepts in probability theory including martingales, convergence theorems and stopping times. I applied these concepts to mathematical finance for pricing various options.

Hamiltonian Graphs
Project with Prof. Rajiv Kumar, BITS, Pilani, Pilani Campus (August – December 2017)
I studied necessary and sufficient conditions for certain classes of graphs to be Hamiltonian. I also obtained bounds on the number of Hamiltonian cycles on graphs.

Visual Question Answering
Project with Prof. Poonam Goyal, BITS, Pilani, Pilani Campus (January – April 2019)
I studied the problem of Visual Question Answering using a combination of deep neural networks and LSTMs that was trained and tested on the standard VQA and COCO datasets.

HONORS AND ACHIEVEMENTS

- One of 50 students selected from across India and across all disciplines for the prestigious Indo-US S.N. Bose Scholarship program (2019).
- Selected for the competitive Canadian Mitacs Globalink 2019 Research Internship from undergraduate applicants worldwide (declined).
- One of 64 students selected from around 3500 applicants worldwide for EPFL's paid 2018 summer Internship program in Computer Science.

- Recipient of the prestigious KVPY scholarship with an All India Rank 67 out of 150,000 candidates. Offered admission by the Indian Institute of Science, Bangalore based on this performance.
- Recipient of the prestigious National Talent Search Examination scholarship (one of 1000 candidates who qualified out of 1,000,000 who wrote the examination from all over India).
- Passed the IIT JEE Advanced Examination 2015 (ranked in the main merit list).
- Awarded the Indian Academy of Sciences (IASc-INSA-NASI) Summer Research Fellowship 2018 (declined).
- Eligible for Merit Scholarship in multiple semesters at the Birla Institute of Technology and Science, Pilani for being ranked within top 9 of the entire batch of 900 (cutting across all branches/majors).
- Passed both the entrance examination and interview for admission to the B. Stat. program of the Indian Statistical Institute.
- Eligible for INSPIRE Scholarship (top 1% in the All India CBSE 12^{th} Board examinations).
- Ranked 52 in engineering among 150,000 who appeared for Karnataka Common Entrance Test.
- Passed the Regional Mathematical Olympiad.
- First in the state in the New South Wales Mathematics examination in 2014-15.

PROFESSIONAL ACTIVITY

- Reviewer for IEEE Transactions on Signal Processing (Publon Verified).

SKILLS/COURSES

Software
Proficient in Python and Matlab. Experienced with C.

Courses

- **Computer Science:** Logic in Computer Science, Object Oriented Programming, Data Structures and Algorithms, Database Systems, Microprocessors and Interfacing, Theory of Computation, Operating Systems, Computer Architecture, Principles of Programming Languages, Data Mining, Information Retrieval, Design and Analysis of Algorithms, Compiler Construction, Computer Networks, Neural Networks and Fuzzy Logic.
- **Mathematics:** Linear Algebra, Multi-Variable Calculus, Probability and Statistics, Real Analysis, Algebra, Measure and Integration, Functional Analysis, Differential Geometry, Differential Equations, Discrete Mathematics, Graph Theory and Networks, Optimization, Nonlinear Optimization, Operations Research, Applied Stochastic Processes.

Online courses
Machine Learning (Coursera course from Stanford University); Python Programming (edX course from MIT).

Courses audited at the Indian Institute of Science
Foundations of Data Science (Ravi Kannan), Numerical Optimization.