Anmol Kagrecha

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Research Interests

Learning Theory, Optimization, Stochastic Modelling, and Information Theory

Education

Indian Institute of Technology Bombay (2015-Present)
B.Tech and M.Tech in Electrical Engineering
Specialization: Communication and Signal Processing
GPA: 9.63 / 10.0 (2^{nd} among 78 students)

Publications

- Distribution oblivious, risk-aware algorithms for multi-armed bandits with unbounded rewards
  A.K., Jayakrishnan Nair and Krishna Jagannathan
  To appear in *Advances in Neural Information Processing Systems 2019 (NeurIPS 2019)*
- "Please come back later": Benefiting from deferrals in service systems
  A.K. and Jayakrishnan Nair
  To appear in *International Conference on Communication Systems & Networks (COMSNETS 2020)*

Research Projects

Distribution oblivious, risk-aware algorithms for multi-armed bandits Jan'19 to Nov'19
Advisors: Prof. Jayakrishnan Nair & Prof. Krishna Jagannathan *EE, IIT Bombay & EE, IIT Madras*

Introduction: We consider a fixed budget best-arm identification stochastic multi-armed bandit problem where the objective is to find the arm which minimizes a linear combination of the expected loss and a risk-sensitive metric Conditional Value at Risk (CVaR). The loss distributions could be unbounded or even heavy tailed. The algorithms should be distribution oblivious, i.e., unaware of any information about the distributions.

- Proposed novel estimators for the CVaR of unbounded random variables (potentially heavy tailed) and proved concentration inequalities for the proposed estimators.
- Provided two classes of distribution oblivious multi-armed bandit algorithms with provable upper bounds on the probability of misidentification of the arm optimizing the linear mean-CVaR objective.
- Proved a matching lower bound on the probability of misidentification for any oblivious algorithm.

Modelling and analysis of deferral based queues July'18 to Dec'18
Advisor: Prof. Jayakrishnan Nair *EE Department, IIT Bombay*

Introduction: We consider the performance benefits arising from the possibility of deferring customers who cannot be served upon arrival. Specifically, we consider an Erlang B type loss system where the system operator can, subject to certain constraints, ask a customer arriving when all servers are busy, to come back at a specified time in the future.

- We propose a simple state-dependent policy for determining the rearrival times of deferred customers and characterize its long run fraction of customers dropped.
- We also analyze a relaxation of the problem where the deferral times are bounded in expectation.
- Via extensive numerical evaluations, we demonstrate the superiority of the proposed state-dependent policy over naive state-independent deferral policies.

Semidefinite programming (SDP) based decoder for binary linear codes May'18 to July'18
Advisor: Prof. James Saunderson *ECSE Department, Monash University*

Introduction: Maximum likelihood decoding for several classes of codes is a provably hard problem. Practical decoding algorithms usually work well, but lack rigorous guarantees on performance. Formulating decoding as a convex optimization problem, we aim to provide efficient algorithms and provable guarantees on performance.

- Formulated a SDP relaxation of maximum likelihood decoding of binary linear codes and found the explicit optimality conditions for the SDP based decoder.
- Proved that the SDP based decoder is at least as good as linear programming (LP) based decoder, i.e., whenever LP based decoder succeeds, so does the SDP based decoder.
- Simulations show that the SDP based decoder performs marginally better than the LP based decoder.

Modelling translation in *Plasmodium falciparum* Aug'17 to Dec'17
Advisor: Prof. Swati Patankar *Biosciences and Bioengineering Department, IIT Bombay*

Introduction: *P. falciparum* is a malaria causing parasite & its genome is highly AT-rich, with AT content as high as 90% in the intergenic regions. Hence, a high number of upstream start codons & upstream open reading frames are found on the mRNAs, making the translation process of coding regions difficult to understand.

- Reviewed literature on translation in *P. falciparum* & identified important features governing the mechanism.
- Developed a Markovian model to predict the translational efficiency based on the identified features and the data from *in vitro* experiments conducted in the lab.

Scholastic Achievements and Awards

- Awarded the Electrical Engineering Department's Roll of Honour for academic year 2018-19.
- Awarded the Institute Academic Prize for standing 1^{st} (out of 70) in academic year 2017-18.
- Awarded a Travel Grant by Google to attend NeurIPS 2019.
- Awarded AP grades for distinctive performance in Image Processing, Control Systems and Biology.
- All India Rank 546 in JEE Advanced 2015 out of 150,000 shortlisted candidates.

Workshops Attended

- Advances in Applied Probability (PAAP), International Centre for Theoretical Sciences, August 2019
- JTG & IEEE Information Theory Society Summer School, IIT Madras, June 2019
- Workshop on Stochastic Optimization in Networks and Related Topics, IIT Bombay, March 2019
- Workshop on Games on Networks and Queues, IIT Bombay, January 2019
- Workshop on Learning Theory, Tata Institute of Fundamental Research, January 2019

Technical Projects

Generating Random Graphs without Short Cycles Spring '19
Random Graphs under Prof. Nikhil Karamchandani

Studied and presented an algorithm for generating random graphs without short cycles, that nearly uniformly samples from possible candidate graphs and has a polynomial time complexity in expectation.

Alleviating Trade-off between Temporal and Spatial Resolution of Videos Spring '19
Recent Topics in Analytical Signal Processing under Prof. Animesh Kumar

Implemented an algorithm to reconstruct a video from its coded exposure using dictionary learning (K-SVD) and a sparse reconstruction algorithm (OMP). Empirically studied the effects of changing the hyper-parameters of the algorithm like the sampling strategy to form coded exposure and the size of dictionary.

Experiments with Differentiable Neural Computers Spring '19
Advanced Machine Learning under Prof. Sunita Sarawagi

Studied two neural network models: Neural Turing Machines (NTM) and Differentiable Neural Computers (DNC), capable of performing fundamentally algorithmic tasks. Trained and evaluated DNC on top-k sort, shortest-path and connectedness tasks.

Parameter Estimation in Heat Shock Response of *E. coli* Autumn '18
Estimation and Identification under Prof. Debraj Chakraborty

Implemented Hybrid Extended Kalman Filter (HEKF) for parameter estimation in a model of heat shock response of *E. coli*, used a a-posteriori identifiability test to check reliability of the estimates and used a model selection algorithm to discriminate between two competing models of the mechanism.

Heavy Tails in Engineering Systems Autumn '18
Heavy Tails: Properties, Emergence and Identification under Prof. Jayakrishnan Nair

Surveyed and presented generative models for heavy tailed behaviour arising in engineering systems, viz., the internet, language and firebreaks. Reviewed the theoretical analysis of the following models: Heuristically Optimized Trade-offs, Zipf's Law and Highly Optimized Tolerance.

Applications of Semantic Web in Health Care and Medicine Summer '17
Advisor: Dr. Dinesh Siddu *Philips Research, Bengaluru*

Developed a Python module to convert files of a medical file format DICOM to files of semantic web format RDF for improved sharing of data and easier analysis by SPARQL query language. Optimized queries on Semantic Web Access Policy Application that reduced the query time by a factor of 50.

Mentoring and Tutoring

Coordinator, Department Academic Mentorship Program (April'18 to April'19)
Mentor, Department Academic Mentorship Program (April'17 to Present)

- Co-headed a team of 22 hand-picked mentors who guided over 35 academically under-performing students.
- Assisted 8 students over 2 years to overcome academic & personal issues that they encountered.

Teaching Assistant, Data Analysis & Interpretation (July'19 to Present)
Involved in correction of exams and conducting fortnightly tutorials, aimed at addressing conceptual doubts and problem solving for a class of 140 sophomore students.

Mentor, Summer of Science, Maths and Physics Club (May'17 to July'17)
Provided guidance to a sophomore student to learn the basics of Game Theory and reviewed his final report, which is published on the Club's blog.

Relevant Coursework & Programming Skills

- **Probability & Statistics**: Online Learning, Markov Chains & Queuing Theory, Fundamentals of Heavy Tails, Machine Learning (Introductory & Advanced), Random Graphs, Estimation & Identification, Advanced Stochastic Processes
- **Communication & Signal Processing**: Information Theory, Error Correcting Codes, Communication Networks, Image Processing, Analytical Signal Processing, Digital Signal Processing
- **Miscellaneous**: Optimization, Real Analysis, Game Theory, Matrix Computations, Control Systems, Partial Differential Equations, Linear Algebra, Complex Analysis, Data Structures & Algorithms
- **Programming Languages**: Python, C/C++, MATLAB, Mathematica, Julia, VHDL

Extra-Curricular Activities

- **Technical Color** for academic year 2017-18 from Hostel 2.
- Learning **Level A1 French** language under International Relations Office, IIT Bombay.
- **Cultural Special Mention** for academic year 2016-17 from Hostel 2.
- Completed **B Certification** of **National Cadet Corps** (NCC), IIT Bombay.

References

Prof. Jayakrishnan Nair
Electrical Engineering
IIT Bombay
website

Prof. James Saunderson
Electrical & Computer Systems Engineering
Monash University
website

Prof. Krishna Jagannathan
Electrical Engineering
IIT Madras
website