Anmol Kagrecha

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First year PhD student at the Electrical Engineering Department at Stanford University.
Interested in reinforcement learning, bandit theory, information theory, and applied probability.

Education

- **Stanford University** (2020-present)
  Robert Bosch Stanford Graduate Fellow
  PhD in Electrical Engineering
  GPA: 4.0/4.0
- **Indian Institute of Technology Bombay** (2015-2020)
  Advisor: Prof. Jayakrishnan Nair
  B.Tech and M.Tech in Electrical Engineering
  Specialization: Communication and Signal Processing
  GPA: 9.68 / 10.0

Scholastic Achievements and Awards

- Recipient of the **Robert Bosch Stanford Graduate Fellowship**
- **Institute Silver Medal by IIT Bombay** for best academic standing among the Dual Degree (B.Tech and M.Tech) students in Electrical Engineering graduating in 2020
- **Undergraduate Research Award** for exceptional work in the Dual Degree Project at IIT Bombay in 2020
- **Department Academic Mentorship Program's Certificate of Appreciation** at IIT Bombay in 2020
- **Certificate of Excellence in Teaching Assistantship** for an undergraduate course on Data Analysis and Interpretation at Electrical Engineering Department, IIT Bombay in 2020
- **Electrical Engineering Department's Roll of Honour** for academic year 2018-19 at IIT Bombay.
- **Google's Travel Grant** for attending NeurIPS 2019.

Publications

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

Preprints

- Statistically Robust, Risk-Averse Best Arm Identification in Multi-Armed Bandits
  A.K., Jayakrishnan Nair and Krishna Jagannathan
  arXiv preprint
- Constrained regret minimization for multi-criterion multi-armed bandits
  A.K., Jayakrishnan Nair and Krishna Jagannathan
  arXiv preprint
- Bandit algorithms: Letting go of logarithmic regret for statistical robustness
  Ashutosh Kumar, Jayakrishnan Nair, **A.K.**, and Krishna Jagannathan
  arXiv preprint

Research Projects

Constrained regret minimization for multi-criterion stochastic bandits Mar'20 to Jun'20
Advisors: Prof. Jayakrishnan Nair & Prof. Krishna Jagannathan *EE, IIT Bombay & EE, IIT Madras*

Introduction: We formulate a new approach to consider multiple criteria in a stochastic bandit framework. The aim is to maximize the pulls of an arm which optimizes a certain criterion while satisfying constraints on the other criteria. In particular, we look at the problem of risk-constrained loss minimization but the analysis can be easily extended to more general settings.

- Formulated the problem of CVaR-constrained expected loss minimization and defined the notion of a consistent algorithm for the proposed setting.
- Proposed a consistent algorithm, RC-LCB, and proved that the expected number of pulls of a non-optimal arm is bounded by a term logarithmic in the horizon.
- Proved an inherent tension between regret minimization and feasibility identification, i.e., identifying if any arm satisfies the constraint on CVaR or not.

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.

Select Course Projects

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

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.

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

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, IIT Bombay

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.

Mentoring and Tutoring

Coordinator, Department Academic Mentorship Program (Apr.'18 to Apr.'19)
Mentor, Department Academic Mentorship Program (Apr.'17 to June'20)

- Co-headed a team of 22 hand-picked mentors who guided over 35 academically under-performing students.
- Assisted 8 students over 3 years to overcome academic & personal issues that they encountered.

Teaching Assistant, Data Analysis & Interpretation (July'19 to Dec.'19)
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**: Reinforcement Learning, 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++

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