P. N. Karthik

website linkedin scholar

Personal Data

Place and Date of Birth:	Bangalore, India | 20 Apr 1992
Address:	06-12, Block E4, Engineering Drive 3,
	National University of Singapore, 117583
Phone:	+65 85912944
Email:	karthik@nus.edu.sg

Research Interests

Multi-armed bandits, anomaly identification, statistical inference, federated learning, transfer learning

Work Experience

01/2022 - present
Research Fellow
Institute of Data Science, National University of Singapore, Singapore
Supervisor: Prof. Vincent Y. F. Tan
Responsibilities:
- Working on fundamental theoretical problems in machine learning (federated learning, transfer learning, best arm identification, etc.)
- Publishing papers in AAAI, ITW, IEEE Transactions on Information Theory
- Actively collaborating with professors, postdocs, and Ph.D. students (within and outside Singapore)
- Presenting research work at workshops and international conferences (to date, received S$ 8,500 funding to take part in international conferences)

11/2019 - 03/2020
Intern
Netradyne Technology India Pvt. Ltd., Bangalore
Collaborators: Pratik Verma, Ajeesh Sahadevan, and Prof. Rajesh Sundaresan
- Studied the effectiveness of the bus priority lane (BPL) in Bangalore using travel times of public transport buses
- Worked with big datasets ($\sim$ 150 Gigabytes per month collected from 6500 buses)
- Deployed Microsoft PowerBI and Kepler GL for geospatial data visualisation
- Proposed a novel technique for extracting travel times from GPS data
- Designed a novel metric for measuring driver stress levels
- Reported that the BPL reduced the worst 10% of the travel times by 4-28%
- Reported that the drivers were most stressed during the morning peak hours
- Suggested corrective measures for reducing travel times and driver stress levels

08/2019 - 12/2019
08/2018 - 12/2018
08/2017 - 12/2017
Graduate Teaching Assistant
Department of ECE, Indian Institute of Science, Bangalore
Courses: Information Theory (E2 201), Random Processes (E2 202)
Course Instructors: Prof. Himanshu Tyagi, Prof. Utpal Mukherji, Prof. Parimal Parag
- Taught a class of 83 students (weekly, 1.5 hours per week)
- Evaluated students' answer scripts (weekly assignments)
- Formulated questions for tests, exams, and weekly assignments

08/2014 - 06/2015
Project Assistant
Department of ECE, Indian Institute of Science, Bangalore
Supervisor: Prof. Chandra R. Murthy
- Characterised the area coverage uncertainty in a network of access points
- Validated the results with the data collected from access points in a hospital
- Presented the results to the Aerospace Network Research Consortium

Education

07/2015 - 03/2022	Doctor of Philosophy and Master of Science (Engineering), Indian Institute of Science, Bangalore Department: Electrical Communication Engineering Thesis: Sequential Controlled Sensing to Detect an Anomalous Process Supervisor: Prof. Rajesh Sundaresan GPA: 7.0/8.0 [list of courses studied]
08/2010 - 07/2014	Bachelor of Engineering, R V College of Engineering, Bangalore Major: Electronics and Communications GPA: 9.72/10.00 (rank 2 among 140 students)

Awards and Honors

- First place in the 100 seconds competition organised by INAE Kanpur Chapter
- Best paper award at the 2020 EECS Research Students' Symposium, Indian Institute of Science
- Best 3-minute presentation award at the ECE Students' Seminar Series, Department of Electrical Communication Engineering, Indian Institute of Science
- Rank 136 (among the top 0.01%) in the 2015 Graduate Aptitude Test in Engineering
- Infineon India scholarship for securing rank 2 in the 2011 Visvesvaraya Technological University examinations.
- Rank 23 (among the top 0.02%) in the 2010 Karnataka Common Entrance Test

Research Projects

1. **Best Arm Identification in Multi-Armed Bandits**
   National University of Singapore 01/2022 – present
   - Applying ideas from Markov decision processes to analyse the problem of best arm identification in restless Markovian multi-armed bandits (target application: communication networks)
   - Designing algorithms for best arm identification in a federated learning setting with a server and multiple clients, with almost-nil communication costs (target application: recommendation ads)
   - Characterising the fundamental performance limits of best arm identification in additive transfer learning bandits (target application: vaccine trials)
   - Published the results in AAAI, ITW, and IEEE Transactions on Information Theory
2. **Bus Priority Lane in Bengaluru: Effect on Travel Times and Driver Stress**
   Netradyne Technology India Pvt. Ltd., Bangalore 11/2019 – 03/2020
   - Studied the effectiveness of the bus priority lane (for the exclusive use of public transport buses) in Bangalore in terms of reducing travel times and driver stress levels
   - Formatted big datasets ($\sim$ 150 Gigabytes of accelerometer and GPS data per month collected from 6500 buses) using Python libraries (pandas, numpy, scikit)
   - Deployed Microsoft PowerBI and Kepler GL for geospatial analytic data visualisation
   - Extracted the bus travel times from GPS data using a novel "geofencing" technique
   - Proposed a novel metric for measuring driver stress levels
   - Submitted the results to *Transport Policy* journal
3. **Anomaly Identification in Multi-Armed Bandits**
   Indian Institute of Science, Bangalore 07/2015 – 03/2022
   - Analysed the problem of finding an anomalous process (arm) in a multi-armed bandit as quickly as possible, subject to an upper bound on the error probability (target applications: neuroscience, power systems, communication networks)
   - Modeled each arm as a Markov chain on a finite state space
   - Provided the first-known lower and upper bounds on the limiting growth rate of the expected time to find the anomalous arm as the error probability vanishes for two distinct settings: rested bandits and restless bandits

- Published the results in ISIT (2019, 2020, 2021) and Transactions on Information Theory
- Best paper award at the 2020 EECS Research Students' Symposium, Indian Institute of Science

Publications

Preprints

1. *Federated Best Arm Identification with Heterogeneous Clients* [arxiv]
   Chen Zhirui, P. N. Karthik, Vincent Y. F. Tan, and Yeow Meng Chee
   Submitted, Oct 2022
2. *Bus Priority lane in Bangalore: A Study of its Effectiveness and Driver Stress*
   P. N. Karthik, Nihesh Rathod, Sarath Yasodharan, Wilson Lobo, Ajeesh Sahadevan, Rajesh Sundaresan and Pratik Verma
   Submitted to the Special Issue of Transport Policy Journal on Sustainable City Transportation in the Indian Subcontinent, Jan 2022
3. *Learning to Detect an Odd Restless Markov Arm with a Trembling Hand* [arxiv]
   P. N. Karthik and Rajesh Sundaresan
4. *Axiomatic Characterisation of Projection Rules: An Open Question* [draft]
   P. N. Karthik and Rajesh Sundaresan

Journal Publications

1. *Best Arm Identification in Restless Markov Multi-Armed Bandits* [arxiv]
   P. N. Karthik, Kota Srinivas Reddy, and Vincent Y. F. Tan
   IEEE Transactions on Information Theory, 2022+
2. *Detecting an Odd Restless Markov Arm with a Trembling Hand* [xplore]
   P. N. Karthik and Rajesh Sundaresan
   IEEE Transactions on Information Theory, Aug 2021
3. *Learning to Detect an Odd Markov Arm* [xplore]
   P. N. Karthik and Rajesh Sundaresan
   IEEE Transactions on Information Theory, Jul 2020

Doctoral Dissertation

- *Sequential Controlled Sensing to Detect an Anomalous Process* [pdf]
  Karthik Periyapattana Narayanaprasad
  Department of Electrical Communication Engineering, Indian Institute of Science, Nov 2021

Conference Publications

1. *Almost Cost-Free Communication in Federated Best Arm Identification* [arxiv]
   Kota Srinivas Reddy, P. N. Karthik, and Vincent Y. F. Tan
   37th AAAI Conference on Artificial Intelligence (AAAI), Feb 2023
2. *Best Restless Markov Arm Identification* [xplore]
   Karthik Periyapattana Narayana Prasad, Kota Srinivas Reddy, and Vincent Y. F. Tan
   IEEE Information Theory Workshop (ITW), Nov 2022
3. *Learning to Detect an Odd Restless Markov Arm* [xplore]
   P. N. Karthik and Rajesh Sundaresan
   IEEE International Symposium on Information Theory (ISIT), Jul 2021
4. *Detecting an Odd Restless Markov Arm with a Trembling Hand* [xplore]
   P. N. Karthik and Rajesh Sundaresan
   IEEE International Symposium on Information Theory (ISIT), Jun 2020
5. *Learning to Detect an Odd Markov Arm* [xplore]
   P. N. Karthik and Rajesh Sundaresan
   IEEE International Symposium on Information Theory (ISIT), Jul 2019

6. *On The Equivalence of Projections in Relative α-Entropy and Rényi Divergence* [xplore]
   P. N. Karthik and Rajesh Sundaresan
   National Conference on Communications (NCC), Feb 2018
7. *Model-Based Interference Cartography and Visualization* [xplore]
   P. N. Karthik, Raksha Ramakrishna, Geethu Joseph, Chandra R. Murthy,
   Joyson Sebastian, and Neelesh B. Mehta
   National Conference on Communications (NCC), Mar 2016

Research Presentations and Seminars

2022

1. *Best Restless Markov Arm Identification* [slides]
   IEEE Information Theory Workshop, Mumbai, India, Nov 2022
2. *Behind the Scenes of $Ax = b$: Axioms and an Open Question* [video] [slides]
   A talk given to Prof. Vincent Tan's research group, Mar 2022

2021

1. *Sequential Controlled Sensing to Detect an Anomalous Process* [video] [slides]
   Ph.D. defence, Department of Electrical Communication Engineering,
   Indian Institute of Science, Nov 2021
2. *Finding a Markov Anomaly Quickly and Accurately* [video]
   100 seconds competition organised by INAE Kanpur Chapter, Oct 2021
   First place under "Electronics and Communication Engineering" category
3. *GATE 2022: A Pathway to Research* [video]
   An online interactive session on the Graduate Aptitude Test in Engineering as a
   pathway to research organised by the Division of EECS, Indian Institute of Science, Oct 2021
4. *Information Geometry and Its Applications to Statistics* [video] [notes]
   An online lecture for the students of Indian Institute of Science, Sep 2021
5. *Learning to Detect an Odd Restless Markov Arm* [video] [slides]
   IEEE International Symposium on Information Theory, Jul 2021
6. *Sequential Controlled Sensing to Detect an Anomalous Process* [video] [slides]
   Ph.D. colloquium talk, Department of Electrical Communication Engineering,
   Indian Institute of Science, Jun 2021
7. *Crack Open the GATE* [video]
   A session conducted for the students of R V College of Engineering
   to educate them about the Graduate Aptitude Test in Engineering, May 2021
8. *Probability in Real-Life: Example Applications from Visual Neuroscience,
   Colour Blindness Detection, and Covid-19 Outbreak Modelling* [video] [slides]
   A talk presented virtually to the 5th semester students and the faculty of the Department of Electronics
   and Communication Engineering, R V College of Engineering, Sep 2020

2020

1. *Odd Arm Identification in Multi-armed Bandits with Markov Observations* [video] [slides]
   EECS Research Students' Symposium, Indian Institute of Science, Jul 2020
   Best paper award under "Signal Processing, Communication Networks,
   and Information Theory" track
2. *Detecting an Odd Restless Markov Arm with a Trembling Hand* [video] [slides]
   IEEE International Symposium on Information Theory, Jun 2020
3. *Visual Search with a Trembling Hand: An Analysis of Odd Arm Identification
   in Restless Multi-armed Bandits* [video] [slides]
   Centre for Networked Intelligence, Indian Institute of Science, May 2020
4. *On Detecting an Anomalous Arm in a Multi-armed Bandit with Markov Observations* [slides]
   STCS Symposium, Tata Institute of Fundamental Research, Mumbai, Jan 2020

2019

1. *Search in Research: The Importance of the Theory of Probability in Real-Life* [slides]
   R V College of Engineering, Dec 2019
2. *Learning to Detect an Odd Markov Arm* [slides]
   Lectures on Probability and Stochastic Processes XIV,
   Indian Statistical Institute Delhi, Dec 2019
3. *On Detecting an Anomalous Arm in Multi-armed Bandits with Markov Observations* [slides]
   Networks Seminar, Robert Bosch Centre for Cyber Physical Systems,
   Indian Institute of Science, Nov 2019
4. *Learning to Detect an Odd Markov Arm* [poster]
   Joint Telematics Group Summer School, Indian Institute of Technology, Madras, Aug 2019
5. *Learning to Detect an Odd Markov Arm* [slides]
   Program on Advances in Applied Probability,
   International Centre for Theoretical Sciences, Aug 2019
6. *Learning to Detect an Odd Markov Arm* [slides]
   IEEE International Symposium on Information Theory, Jul 2019
7. *A Short Course on Probability and Random Processes* [course material]
   R V College of Engineering, Jun 2019
8. $Ax = b$*: A Familiar Setup, Axioms and An Open Question* [slides]
   ECE Students' Seminar Series, Department of Electrical Communication Engineering,
   Indian Institute of Science, Feb 2019

2018 and Earlier

1. *On the Equivalence of Projections in Relative* α*-Entropy and Rényi Divergence* [slides]
   National Conference on Communications,
   Indian Institute of Technology, Hyderabad, Feb 2018
2. *On the Equivalence of Projections in Relative* α*-Entropy and Rényi Divergence* [slides]
   Lectures on Probability and Stochastic Processes XII,
   Indian Statistical Institute, Kolkata, Dec 2017

Professional Service

- Reviewer, IEEE Transactions on Information Theory (T-IT)
- Reviewer, IEEE Transactions on Signal Processing (TSP)
- Reviewer, Entropy
- Reviewer, Sadhana
- Reviewer, Journal on Selected Areas in Communications (JSAC)
- Reviewer, IEEE International Symposium on Information Theory (ISIT)
- Reviewer, National Conference on Communications (NCC)

Software Knowledge

Python | Microsoft PowerBI | Notion | LaTeX | MATLAB

Professional Referees

1. Prof. Rajesh Sundaresan (Ph.D. supervisor)
   Professor, Department of Electrical Communication Engineering (ECE),
   Robert Bosch Centre for Cyber-Physical Systems,
   Centre for Networked Intelligence
   Indian Institute of Science, Bangalore 560012
   E-mail: rajeshs@iisc.ac.in

2. Prof. Utpal Mukherji
Professor, Department of Electrical Communication Engineering (ECE),
Indian Institute of Science, Bangalore 560012
E-mail: utpal@iisc.ac.in

3. Prof. Navin Kashyap
Professor,
Department of Electrical Communication Engineering (ECE),
Indian Institute of Science, Bangalore 560012
E-mail: nkashyap@iisc.ac.in

4. Prof. Himanshu Tyagi
Associate Professor,
Department of Electrical Communication Engineering (ECE),
Robert Bosch Center for Cyber Physical Systems
Indian Institute of Science, Bangalore 560012
E-mail: htyagi@iisc.ac.in

5. Prof. Parimal Parag
Associate Professor,
Department of Electrical Communication Engineering (ECE),
Indian Institute of Science, Bangalore 560012
E-mail: parimal@iisc.ac.in

6. Prof. Vincent Y. F. Tan
Associate Professor,
Department Department of Mathematics,
Department of Electrical and Computer Engineering (ECE),
National University of Singapore, Singapore 119077
E-mail: vtan@nus.edu.sg

Doctor of Philosophy and Master of Science (Engineering), Indian Institute of Science

List of Courses Taken for Credit and Grades Obtained

Course Code	Course	Grade*	Credit Hrs
E2 201	Information Theory	S	3
E2 202	Random Processes	S	3
E2 205	Error-Control Codes	A	3
MA 221	Analysis-I	D	3
E1 244	Detection and Estimation Theory	S	3
MA 222	Analysis-II: Measure and Integration	A	3
MA 229	Calculus on Manifolds	B	3
MA 241	Ordinary Differential Equations	A	3
MA 361	Probability Theory	S	3

Total Credit Hrs	27
GPA (out of 8.0)	**7.0**

*Grading Scheme: S=8, A=7, B=6, C=5, D=4

List of Courses Taken for Audit

Topics in Information Theory and Statistical Learning
Concentration Inequalities
Topics in Multi-user Communications
Large Deviations
Online Prediction and Learning
Data Analytics
Stochastic Approximation Algorithms