

P. N. Karthik

Personal Data

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Research Interests

Information theory, statistical learning, machine learning, hypothesis testing, stochastic adaptive control, Markov decision processes

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 international conferences and journals (to date: [AAAI](#), [ITW](#), IEEE Transactions on Information Theory)
 - Actively collaborating with professors, postdocs, and Ph.D. students (within and outside Singapore)
- 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](#) (~ 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 Graduate Teaching Assistant
08/2018 - 12/2018 *Department of ECE, Indian Institute of Science, Bangalore*
08/2017 - 12/2017 Courses: Information Theory (E2 201), Random Processes (E2 202)
Instructors: Prof. [Himanshu Tyagi](#), Prof. [Utpal Mukherji](#) and Prof. [Parimal Parag](#)
- Taught a class of 83 students (weekly, 1.5 hours per week)
 - Evaluated students' answer scripts (weekly assignments)
 - Formulated questions for 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 (ANRC)

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
- 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: ads recommendation)
- Characterising the fundamental performance limits of best arm identification in additive **transfer learning** bandits (target application: vaccine trials)
- Publishing the results in top machine learning and information theory conferences and journals (to date: 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** (~ 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. *Optimal Best Arm Identification in Linear Transfer Bandits*
Bharati K, [P. N. Karthik](#), Vincent Y. F. Tan, and Krishna Jagannathan
Submitted, Feb 2023
2. *Best Arm Identification in Bandits with Limited Precision Sampling*
Kota Srinivas Reddy, [P. N. Karthik](#), Nikhil Karamchandani, and Jayakrishnan Nair
Submitted, Feb 2023
3. *Federated Best Arm Identification with Heterogeneous Clients* [[arxiv](#)]
Chen Zhirui, [P. N. Karthik](#), Vincent Y. F. Tan, and Yeow Meng Chee
Submitted, Oct 2022
4. *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
5. *Learning to Detect an Odd Restless Markov Arm with a Trembling Hand* [[arxiv](#)]
[P. N. Karthik](#) and Rajesh Sundaresan
6. *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

2023

1. *Almost Cost-Free Communication in Federated Best Arm Identification* [poster]
Poster presentation, 37th AAAI Conference on Artificial Intelligence (AAAI 2023), Walter E. Washington Convention Center, Washington D.C., Feb 2023
2. *Almost Cost-Free Communication in Federated Best Arm Identification* [slides]
Invited talk, Workshop on Information Theory and Data Science, Institute for Mathematical Sciences, National University of Singapore, Jan 2023

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, RV 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]
RV 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]
RV 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
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3. Prof. [Navin Kashyap](#)
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4. Prof. [Himanshu Tyagi](#)
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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](#)
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Department of Electrical and Computer Engineering (ECE),
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