

# P. N. Karthik



## Personal Data

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Scholar: <https://scholar.google.com/citations?user=D39u7bkAAAAJ&hl=en&authuser=1>

## Research Interests

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Information theory, statistical learning, sequential analysis, hypothesis testing, Markov decision processes, anomaly detection, ergodic control, data science, data analysis

## Work Experience

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- Jan'22 - present    Research Fellow  
*Institute of Data Science, National University of Singapore, Singapore*  
Supervisor: Prof. [Vincent Y. F. Tan](#)
- Characterising the fundamental performance limits of pure exploration algorithms for federated learning, transfer learning, and best arm identification
  - Collaborating with researchers from IIT Chennai, IIT Mumbai, RPI, and the Technion
  - Working in teams with Ph.D. students and professors
  - Publishing papers at top machine learning venues (such as AAAI, ICML, NeurIPS, JMLR)
- Nov'19 - Mar'20    Intern  
*Netradyne Technology India Pvt. Ltd., Bangalore (in collaboration with the Bangalore Metropolitan Transport Corporation (BMTC))*
- 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
  - 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 to BMTC for reducing travel times and driver stress
- Aug'19 - Dec'19    Graduate Teaching Assistant  
Aug'18 - Dec'18    *Department of ECE, Indian Institute of Science, Bangalore*  
Aug'17 - Dec'17    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
- Aug'14 - Jun'15    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

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- Jul'15 - Mar'22    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
- Aug'10 - Jul'14    Bachelor of Engineering, [RV College of Engineering](#), Bangalore  
Major: Electronics and Communications  
GPA: 9.72/10.00 (**rank 2** among 140 students)

## Awards and Honors

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- 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

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### 1. **Best Arm Identification in Multi-Armed Bandits**

*National University of Singapore, Singapore*

Jan'22 – 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 linear transfer bandits (target application: vaccine trials)

### 2. **Bus Priority Lane in Bengaluru: Effect on Travel Times and Driver Stress**

*Netradyne Technology India Pvt. Ltd., Bangalore*

Nov'19 – Mar'20

- 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*

Jul'15 – Mar'22

- 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

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### 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  $\alpha$ -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

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### 2023

1. *Best Arm Identification with Limited Precision Sampling* [slides]  
A talk given to Prof. Vincent Tan's research group at NUS, Feb 2023
2. *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
3. *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  $\alpha$ -Entropy and Rényi Divergence* [slides]  
National Conference on Communications,  
Indian Institute of Technology, Hyderabad, Feb 2018
2. *On the Equivalence of Projections in Relative  $\alpha$ -Entropy and Rényi Divergence* [slides]  
Lectures on Probability and Stochastic Processes XII,  
Indian Statistical Institute, Kolkata, Dec 2017

## Professional Service

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- 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

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Python | Microsoft [PowerBI](#) | [Notion](#) |  $\text{\LaTeX}$  | MATLAB

## Professional Referees

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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](mailto: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](mailto:utpal@iisc.ac.in)
3. Prof. [Navin Kashyap](#)  
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Department of Electrical Communication Engineering (ECE),  
Indian Institute of Science, Bangalore 560012  
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4. Prof. [Himanshu Tyagi](#)  
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Robert Bosch Center for Cyber Physical Systems  
Indian Institute of Science, Bangalore 560012  
E-mail: [htyagi@iisc.ac.in](mailto:htyagi@iisc.ac.in)
5. Prof. [Parimal Parag](#)  
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Department of Electrical Communication Engineering (ECE),  
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6. Prof. [Vincent Y. F. Tan](#)  
Associate Professor,  
Department of Mathematics,  
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National University of Singapore, Singapore 119077  
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