

Dr. Ajay Kattapur | Curriculum Vitae

Embedded Systems & Robotics, TCS Research & Innovation, Bangalore, India

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Research Interests: Distributed Systems | Performance Modeling | Operations Research | Cognitive Systems.

Employment

- **TCS Research & Innovation** **Bangalore–Mumbai, India**
Research Scientist | Assistant Consultant *May 2014 – present*

Research Scientist at the Embedded Systems & Robotics Lab (since 2016) and Performance Engineering Research Center (2014–2016), Tata Consultancy Services (TCS) Research.
Explore Projects on Automated Planning for Cognitive Robotics; Knowledge Databases for Intelligent Agents; Industry 4.0 Automated Workflows; Optimization in Swarm Robotics; Computation and Communication Analysis of Fog Computing Networks; Performance Modeling and Evaluation of Multi-tier Distributed Applications.

- **INRIA, Paris-Rocquencourt** **Le Chesnay, France**
Post-doctoral Research Fellow *November 2012 – March 2014*

Post-doctoral Fellow at the French National Institute for Research in Computer Science and Control (INRIA) in the ARLES (Software Architecture and Distributed Systems) team.
Research on the EU Project *CHOReOS*: Large Scale Choreographies for the Future Internet, with specific focus on Quality of Service (QoS) aspects.

- **Institute for Infocomm Research (I2R), A*Star** **Singapore**
Research Intern *January 2006 – June 2006*

Internship at the embedded systems group with research focused on physical layer spectrum sensing protocols for Cognitive Radio systems.

Education

Academic Qualifications.....

- **INRIA, Université de Rennes 1** **Rennes, France**
Ph.D. in Computer Science *August 2009 – November 2012*

Doctorate (Ph.D.) in Computer Science at the French National Institute for Research in Computer Science and Control (INRIA) in the DistribCom (Distributed Algorithms for Telecommunications) team.
Fulfilled requirements of the Ecole Doctorale *MATISSE* at the Université de Rennes 1.
 - *Thesis*: “Flexible Quality of Service Management of Web Services Orchestrations”.
 - Advisers: Albert Benveniste (INRIA) and Claude Jard (Université de Nantes).
 - Defended Thesis on November 8, 2012 with mention *Trés Honorable*.
 - *Jury Members*: Jean-Marc Jezequel (Université de Rennes 1), William Cook (Univ. Texas-Austin), Danilo Ardagna (Politecnico di Milano), Valérie Issarny (INRIA), Fayçal Boujemaa (Orange).

- **Nanyang Technological University (NTU)** **Singapore**
Master of Engineering by Research *August 2007 – May 2009*

Master of Engineering (M. Eng. Research) in the School of Electrical and Electronics Engineering (EEE).
Specialization in Signal Processing Techniques for Communication Systems (Division of Information Engineering).
 - Thesis Topic: “Blind Source Separation Algorithms for mitigating Co-channel Interference and Noise in Wireless Communication Systems”.

- Advisers: Farook Sattar (NTU) and Chong Meng Samson See (Tamasek Labs).

○ **Nanyang Technological University (NTU)** **Singapore**
Bachelor of Engineering, First Class Honours *June 2003 – May 2007*
Bachelor of Engineering (B. Eng.) in the School of Electrical and Electronics Engineering (EEE) with First Class Honours (CGPA 4.6/5.0).

- *Major* in Info-communication Engineering with a *Minor* in Business.
- Final Year Project on Cognitive Radio Spectrum Sensing: received A+ grade; 2nd place in IEEE Singapore section student paper writing contest.

○ **Bishop Cottons Boys School** **Bangalore, India**
ISC Standard 12 *June 2001 – April 2003*
 Indian School Certificate (ISC) Standard 12 with aggregate of 94.4% (3rd in school).

○ **Frank Anthony Public School** **Bangalore, India**
ICSE Standard 10 *June 1991 – April 2001*
 Indian Certificate of Secondary Education (ICSE) Standard 10 with aggregate of 92.8% (1st in school).

Awards & Achievements.....

- TCS at 75 Time Capsule Innovation Award (*1st* among over 250 entrants), 2018.
- IEEE/ACM International Conference Best Paper Awards, 2015 - 2016.
- TCS Felicitations Awards for Outstanding Papers, Multiple Patent Filings, 2015 - 2019.
- Recipient of the competitive INRIA Post-doctoral fellowship (4 openings) at Paris-Rocquencourt, France, 2012 - 2014.
- Recipient of the INRIA grant and CORDIS fellowship for doctoral studies affiliated to University of Rennes 1 and Université Européenne de Bretagne, France, 2009 - 2012.
- Awarded the Nanyang Technological University Ministry of Defense Joint Project Programme (NTU-MINDEF JPP) full scholarship for Master of Engineering studies, 2007 - 2009.
- Bachelor of Engineering with First Class Honours - given to the top 5% of the graduating class in the School of Electrical and Electronics Engineering, 2007.
- Awarded the Second Prize in the Student Paper Writing Contest conducted by the IEEE Singapore Section for the paper entitled “Distributed Spectrum Sensing in Cognitive Radio Networks”, 2007.
- Selected to be a University President’s Research Scholar under the Undergraduate Research Experience on Campus (URECA) Scheme - awarded to the top 3% of students to pursue an independent research project, 2006.
- Received the Dean’s Commendation letter awarded to the top 30 students in the course for excellence in academics, 2003-2005.
- Secured the SIA-NOL scholarship for undergraduate studies in NTU - awarded to 30 students from India, 2003 - 2007.
- Placed 28th at the National Science Talent Search Examination and 99th at the National Science Olympiad in India, 2001.

Research Projects

- **TCS Research:** *Cognitive Robotic Architectures*

Intelligent robotic agents must sense, actuate, adapt and learn in uncertain situations. Modeled knowledge bases for action planning for intelligent robotics. Automated planning and adaptation techniques to enable service robotic deployments.

- **TCS Research:** *Industry 4.0 Warehouse Automation*

Industry 4.0 warehouses require automation involving business processes, robotic engines, cyber-physical systems and humans. Integrated workflow solutions that can model concurrency among distributed agents. Distributed optimization formulations among agents.

- **TCS Research:** *Fog Computing for Networked Robotics*

Studying the effect of offloading computation to edge devices rather than the remotely located cloud. Further analysis of tradeoffs between energy consumption, communication protocols, mobility patterns and computational requirements.

- **TCS Research:** *Service Demand Modeling for Performance Prediction*

Research on performance modeling of distributed, multi-tiered enterprise applications. The focus was to analyze service demands along with queuing network models to aid in accurate estimation of throughput/response time performance at higher workloads.

- **Post-doctoral Research:** *QoS in Choreography Middleware*

Quality of Service in Heterogeneous Choreographies for the *CHOReOS* EU project. Contributions involved the integration of QoS models in reconfigurable web services choreographies and heterogeneous middleware implementations.

- **Ph.D. Thesis:** *QoS in Web Services Orchestrations*

Research on multi-dimensional and probabilistic QoS models to enhance Web Services Orchestrations. This has been used to improve service level agreements from the angle of soft contract composition, optimal selection, negotiation and service product lines. *Toolkit: Q-Orc* for QoS weaving of SOA orchestrations written in Orc.

- **Master's Thesis:** *Blind Source Separation Algorithms for Wireless Communication Systems*

Research used source separation algorithms to mitigate co-channel interference in antenna-array communication systems. Compared and proposed superior techniques for SINR and BER improvement in GMSK modulated systems.

- **B.Eng. Final Year Project:** *Spectrum Sensing for Cognitive Radios*

Data and Decision Fusion for Distributed Spectrum Sensing in Cognitive Radio Systems (in Collaboration with Institute for Infocomm Research, Singapore). Simulated the effects of various spectrum sensing in ad-hoc and distributed environments.

- **Undergraduate Research Experience on Campus:** *Broadband Communication in Complex Environments*

Examined the use of time reversal techniques in order to reduce noise production during broadband communication in indoor environments.

Research Achievements

Patents: Filed/Accepted.....

9. A. Kattapur and Balamuralidhar P., "Autonomous Robotic Planning and Adaptation", India Patent Application, TCS, 2019.

8. A. Kattepur, “Workflow Resource Patterns for Industry 4.0 Automation”, India/ US Patent Application, TCS, 2018.
7. A. Kattepur, S. Dey and Balamuralidhar P., “Hierarchical Robotic Action Planning through Knowledge Bases”, India/ US/ EU Patent Application, TCS, 2018.
6. A. Kattepur, H. K. Rath and A. Mukherjee, “Optimizing Workflows in Industry 4.0 Warehouse Automation”, India/ US Patent Application, TCS, 2018.
5. A. Kattepur, H. K. Rath, A. Simha and A. Mukherjee, “Systems and Methods for Distributed Task Allocation among Multiple Agents”, India / US Patent Application, TCS, 2017 (**US Patent Grant 2019**).
4. A. Kattepur, H. K. Rath and A. Simha, “Systems and Methods for A-Priori Performance Estimation of Offloaded Computations”, India / US Patent Application, TCS, 2017.
3. A. Kattepur, H. K. Rath and A. Simha, “Systems and Methods for Fog Based Offloading in Robotic Devices”, India / US Patent Application, TCS, 2017.
2. A. Kattepur and M. Nambiar, “Systems and Methods for Predicting Performance with Single-user Workloads”, India / US Patent Applications, TCS, 2016 (**US Patent Grant 2018**).
1. A. Kattepur and M. Nambiar, “Systems and Methods for Service Demand based Performance Prediction with Varying Workloads”, India / US Patent Applications, TCS, 2015 (**US Patent Grant 2018**).

Publications: Journals, Book Chapters.....

8. W. Wang, G., A. Kattepur and M. Nambiar, “QMLE: A Methodology for Statistical Inference of Service Demands from Queueing Data”, *ACM Transactions on Modeling and Performance Evaluation of Computing Systems (TOMPECS)*, 2018.
7. A. Kattepur, H. Rath and A. Mukherjee, “Distributed Optimization Techniques for Industry 4.0 Warehouse Automation”, *EAI Trans. on Intelligent Systems*, 2018.
6. A. Kattepur and M. Nambiar, “Service Demand Modeling and Performance Prediction with Single User Tests”, *Elsevier Performance Evaluation*, 2017.
5. M. Nambiar, A. Kattepur, G. Bhaskaran, R. Singhal and S. Duttagupta, “Model Driven Software Performance Engineering: Current Challenges and Way Forward”, *Performance Engineering Review (PER)*, ACM, 2016.
4. A. Kattepur and M. Nambiar, “Performance Modeling of Multi-tier Applications with Variations in Service Demands”, *International Journal of Networking and Computing (IJNC)*, 2016.
3. A. Benveniste, C. Jard, A. Kattepur, S. Rosario and J. Thywissen, “QoS Aware Management of Monotonic Service Orchestrations”, *Formal Methods in System Design*, Springer, vol. 1, pp. 1–43, 2014.
2. A. Kattepur and F. Sattar, “FebICA: Feedback Independent Component Analysis for Complex Domain Source Separation of Communication Signals”, Book Chapter, *Blind Source Separation*, Springer, pp. 499–519, 2014.
1. Y. Duan, K. Huang, D. Chen, Y. Wang, A. Kattepur, W. Du, “Service Value Broker Patterns: An Empirical Collection and Analysis”, *International Journal of Networked and Distributed Computing*, vol. 2, pp. 54–69, 2014.

Publications: International Conferences, Workshops.....

29. A. Kattepur and Balamuralidhar P., “Towards and Automated Planning and Adaptation Framework for Intelligent Robotics”, *IJCAI under submission*, 2019.
28. A. Kattepur, “Structured Performance Analysis of Industry 4.0 Warehouse Resource Patterns”, *ACM International Conf. on Performance Engineering*, 2019.

27. A. Kattapur and Balamuralidhar P., “Robotic Action Planning via Knowledge Graph Queries”, *ACM Symposium on Applied Computing*, 2019.
26. A. Kattapur, S. Dey and Balamuralidhar P., “Hierarchical Robotic Action Planning via Knowledge Bases”, *IEEE Annual Conference on Industrial Electronics*, 2018.
25. G. Bouloukakis, A. Kattapur, N. Georgantas and V. Issarny, “Queueing network modeling patterns for reliable and unreliable publish/subscribe protocols”, *15th EAI International Conference on Mobile and Ubiquitous Systems*, 2018.
24. A. Kattapur, A. Mukherjee and Balamuralidhar P., “Verification and Timing Analysis of Industry 4.0 Warehouse Workflows”, *IEEE Emerging Technologies and Factory Automation*, 2018.
23. A. Kattapur, H. K. Rath, A. Simha and A. Mukherjee, “Distributed Optimization in Industry 4.0 Warehouse Automation”, *ACM Symposium on Applied Computing*, 2018.
22. A. Kattapur, A. Mukherjee, P. Balamurali and H. K. Rath, “Workflow Specification in Industry 4.0 Warehouses”, *IEEE RTSS Workshop*, 2017.
21. A. Kattapur, H. K. Rath and A. Simha, “A-Priori Estimation of Computation Times in Fog Networked Robotics”, *IEEE Edge Conference*, USA, 2017.
20. V. Mushunuri, A. Kattapur, H. K. Rath and A. Simha, “Resource Constrained Deployment of IoT Devices”, *IEEE Fog and Mobile Edge Computing*, Spain, 2017.
19. G. Bouloukakis, N. Georgantas, A. Kattapur and V. Issarny, “Timeliness Evaluation of Intermittent Mobile Connectivity over Pub/Sub Systems”, *ACM International Conference on Performance Engineering*, Italy, 2017.
18. A. Kattapur, H. Dohare, V. Mushunuri, H. K. Rath and A. Simha, “Resource Constrained Offloading in Fog Computing”, *ACM Middleware Workshops*, Italy, 2016.
17. A. Kattapur and M. Nambiar, “Service Demand Modeling and Performance Prediction with Single User Tests”, *ACM Compute*, India, 2016. (**Best Paper Award**)
16. M. Nambiar, A. Kattapur, G. Bhaskaran, R. Singhal and S. Duttagupta, “Model Driven Software Performance Engineering: Current Challenges and Way Forward”, *Computer Measurement Group (CMG) Impact*, California, 2016.
15. W. Wang, G. Casale, A. Kattapur and M. Nambiar, “Maximum Likelihood Estimation of Closed Queueing Network Demands from Queue Length Data”, *ACM International Conference on Performance Engineering*, Netherlands, 2016. (**Best Paper Award**)
14. A. Kattapur, N. Georgantas, G. Bouloukakis and V. Issarny, “Analysis of Timing Constraints in Heterogeneous Middleware Interactions”, *International Conference on Service Oriented Computing (ICSOC)*, Goa, 2015.
13. A. Kattapur and M. Nambiar, “Performance Modeling of Multi-tier Web Applications with Variations in Service Demands”, *Advances in Parallel and Distributed Computational Models (APDCM)*, IPDPS Workshops, Hyderabad, India, 2015. (**TCS Outstanding Paper Award**)
12. A. Kattapur, N. Georgantas and V. Issarny, “QoS Analysis in Heterogeneous Choreography Interactions”, *International Conference on Service-Oriented Computing (ICSOC)*, Germany, 2013.
11. A. Kattapur, N. Georgantas and V. Issarny, “QoS Composition and Analysis in Reconfigurable Web Services Choreographies”, *Intl. Conf. on Web Services (ICWS)*, USA, 2013.
10. Y. Duan, A. Kattapur and W. Du, “Service Value Broker Patterns: Integrating Business Modeling and Economic Analysis with Knowledge Management”, *Intl. Conf. on Web Services (ICWS)*, USA, 2013.

9. A. Kattapur, A. Benveniste and C. Jard, "Negotiation Strategies for Probabilistic Contracts in Web Services Orchestrations", *Intl. Conf. on Web Services (ICWS)*, USA, 2012.
8. A. Kattapur, "Importance Sampling of Probabilistic Contracts in Web Services", *9th International Conference on Service-Oriented Computing (ICSOC)*, Cyprus, 2011.
7. A. Kattapur, A. Benveniste and C. Jard, "Optimizing Decisions in Web Services Orchestrations", *9th International Conference on Service-Oriented Computing (ICSOC)*, Cyprus, 2011.
6. A. Kattapur, S. Sen, B. Baudry, A. Benveniste and C. Jard, "Pairwise testing of dynamic composite services", *ICSE Symposium on Software Engineering for Adaptive and Self-Managing Systems (SEAMS)*, USA, 2011.
5. A. Kattapur, S. Sen, B. Baudry, A. Benveniste and C. Jard, "Variability Modeling and QoS Analysis of Web Services Orchestrations", *Intl. Conf. on Web Services (ICWS)*, USA, 2010.
4. A. Kattapur, F. Sattar and C. M. S. See, "Doppler Aided Blind Source Separation Algorithms for Communication Systems", *10th IEEE Intl Conf on Information Science, Signal Processing and their Applications (ISSPA)*, Malaysia, 2010.
3. A. Kattapur, J. Feng and F. Sattar, "Single Channel Source Separation for Convulsive Mixtures with Application to Respiratory Sounds", *BIOSIGNALS*, Spain, 2010.
2. A. Kattapur, J. P. Lie, F. Sattar and C. M. S. See, "High Fidelity Blind Source Separation of Speech Signals", *European Signal Processing Conference (EUSIPCO)*, Switzerland, 2009.
1. A. Kattapur, A. T. Hoang, Y. C. Liang and M. J. Er, "Data and decision fusion for distributed spectrum sensing in cognitive radio networks", *6th IEEE Intl. Conf. on Information, Communications and Signal Processing (ICICS)*, Singapore, December. 2007. (**IEEE Singapore Section Student Paper Award**)

Publications: Thesis, Reports.....

4. A. Kattapur, "Flexible Quality of Service Management of Web Services Orchestrations", *Ph.D. Thesis: Université de Rennes 1, INRIA*, France, pp. 245, 2012.
3. A. Kattapur, "Blind Source Separation Algorithms for mitigating Co-channel Interference and Noise in Wireless Communication Systems", *M. Eng. Thesis: Nanyang Technological University*, Singapore, pp. 130, 2010.
2. A. Kattapur, "Data and Decision Fusion for Distributed Spectrum Sensing in Cognitive Radio Networks", *B. Eng. Thesis: Nanyang Technological University*, Singapore, 2009.
1. A. Kattapur and J. Yang, "Broadband Wireless Communication in Complex Environments", *Proceedings of the URECA@NTU*, Singapore, pp. 63-68, 2006.

Research Talks.....

21. Structured Performance Analysis of Workflow Patterns, ACM ICPE, Mumbai, 2019.
20. **Keynote Speaker:** Intelligent Robotic Automation for Industry 4.0, Intelligent Computing Conference, Bangalore, 2018.
19. Knowledge Based Hierarchical Planning for Intelligent Robots, IEEE IECON, USA, 2018.
18. Verification and Timing Analysis in Industry 4.0 Automation, IEEE ETFA, Italy, 2018.
17. Distributed Automation in Industry 4.0 Workflow Automation, ACM SAC, France, 2018.
16. Workflow Orchestration in Industry 4.0 Automation, RTSS, Paris, 2017.

15. Fog Computing in IoT, TCS Smart Living Workshop, Faculty Development Programme, India, 2017.
14. Resource Constrained Offloading in Fog Computing, Middleware, Italy, 2016.
13. Service Demand Modeling and Performance Prediction with Single User Tests, ACM Compute, India, 2016.
12. Analysis of Timing Constraints in Heterogeneous Middleware Interactions, ICSOC, India, 2015.
11. Performance Modeling of Multi-tier Web Applications with Variations in Service Demands, IPDPS, India, 2015.
10. Mean Value Analysis Algorithms, TCS Research Meeting Group, India, 2015.
9. QoS Analysis in Heterogeneous Choreography Interactions, ICSOC, Germany, 2013.
8. QoS Composition and Analysis in Reconfigurable Web Services Choreographies, ICWS, USA, 2013.
7. Flexible QoS Management of Web Services Orchestrations, ARLES Research Seminar, Paris-Rocquencourt, France, 2012; Living Analytics Research Centre, SMU, Singapore, 2013.
6. Negotiation Strategies for Probabilistic Contracts in Web Services Orchestrations, ICWS, USA, 2012; INRIA 68NQRT Seminar Series, France, 2012.
5. Importance Sampling of Probabilistic Contracts in Web Services, ICSOC, Cyprus, 2011.
4. Optimizing Decisions in Web Services Orchestrations, ICSOC, Cyprus, 2011.
3. Variability Modeling and QoS Analysis of Web Services Orchestrations, ICWS, USA, 2010.
2. Blind Source Separation Algorithms – overview, TL@NTU, Singapore, 2008.
1. Distributed Spectrum Sensing in Cognitive Radio Networks, ICICS, Singapore, 2007.

Technical Reviewer, Program Committee.....

- o *Journals*: Robotics and Autonomous Systems, IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Services Computing, ACM Transactions on Internet Technology, IEEE Transactions on Cognitive Communications and Networking, International Journal of Distributed Sensor Networks.
- o *Conferences/Workshops*: IEEE CASE, ACM Mobihoc, Valuetools, ICIOT, TCS TACTiCS Conference Series.
- o *Program Committee*: Area Editor EAI Trans. on Scalable Systems, Industry Track Chair IEEE FMEC, IEEE ICIOT, IEEE Comnet-IoT.

Technical Skills

- o **Advanced Courses**: AI Planning and Adaptation, Distributed Systems, Performance Modeling of Computer and Communication Systems, Queuing Networks, Multi-agent Systems, Optimization, Statistical Analysis, Business Process/Web Services Standards, Wireless/Digital Communication Systems.
- o **Programming Languages**: Matlab/Scilab (Numerical/Simulation/Scientific), Orc (Concurrent), Python/C (Imperative), Linux BASH (Scripting), WeBots (Robotics), PDDL (Planning).
- o **Tools**: AI Automated Planners, Graph Databases, The Grinder/IBM Rational Performance Tester, Linux Performance Monitors, CPU Profilers (perf, likwid, Intel VTune), Uppaal, OpenCV, SQL, L^AT_EX, Beamer, Open Office Suite.
- o **Operating Systems**: Linux (Servers, Debian/Fedora based Distros).

Personal Background

Nationality: Indian

Date of Birth: 30 March, 1985

Languages: English (Fluent), Kannada (Fluent), Hindi (Intermediate), French (Elementary).

Reading interests: popular science, philosophy, political history, macroeconomics, espionage.

References

Available on request.