



## Rajeev Kumar

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### Bio

Rajeev Kumar's teaching and research activities span over 35 years in the areas of programming language systems, software engineering, multimedia, evolutionary computing, and machine learning. Currently, he is Professor of Computer Science at Jawaharlal Nehru University (JNU) New Delhi, and has earlier served at Indian Institute of Technology (IIT) Kharagpur / Kanpur, and Birla Institute of Technology & Science (BITS) Pilani. Prior to his academic tenure, he worked as a Scientist in Dept. Science & Technology (DST) and Defense R & D Organization (DRDO) in India. He holds a doctoral degree in Computer Engineering from University of Sheffield, and a masters degree in Computer Science & Technology from University of Roorkee (now, IIT Roorkee).

**Teaching:** Rajeev has designed and taught numerous courses in Computer Science ranging from freshman to senior graduate levels during his 22 year career in Academics. He has taught programming courses (C/C++/C#/Java/R/Python), core and advanced courses (Data Structures, Algorithms, Compiler, Software Engineering, Machine Learning), application courses (Image & Video Processing, Multimedia System), and specialized courses (Bio-Statistics, Evolutionary Computing, Research Methodology etc.). Recently, he introduced a course on *Academic Ethics* for research students. His teaching style focusses on enhanced student engagement and active learning.

**Research:** Rajeev's research interests include machine learning, programming language, software engineering, multimedia and evolutionary optimization. He has published over 150 research articles in international journal and conferences. He has supervised over 50 master and 10 doctoral theses. He is currently supervising over ten doctoral and master students. He has worked on industrial funded projects from Microsoft and National Semiconductors. His h-index is 22.

**Public Policy:** Rajeev has reformed policies for IITs admission examination bringing transparency through well-defined processes. He was instrumental in introducing a *single* examination and *common counselling* for admissions in all CFTIs in India. Almost all admission & competitive examinations, in all disciplines, have been reformed following this model. His proposal for an independent body led to formulation of the National Testing Agency (NTA). India's Apex Court hailed him as *one of the many unsung heroes who helped in improving the system*. He also authored accreditation guidelines, from 2009 to 2011, for UG engineering institutions, which helped India acquire permanent membership of Washington Accord in June 2014. He defined quantitative Academic Performance Indices (APIs) in 2009 for faculty.

**Services:** Rajeev has been active member of most statutory bodies of the institutions, he served, for reforms/revisions in curriculum, academic structure, regulations and ordinances. He has been a regular reviewer of research articles in several journals and conferences. He served as member of several Technical Program Committees. He has delivered invited lectures and tutorials in several conferences. He has served as a member of Board of Studies in several Institutions, currently serving LNMIIT Jaipur as an Adjunct Professor.

## Personal Information

- Nationality : Indian
- Date of birth : March 12, 1959
- Marital Status : Widower with two children

## Education

- Ph.D. in Computer Engineering (1997)  
University of Sheffield, UK  
*Commonwealth Scholar; Thesis was nominated for the best Thesis award in UK*
- M.Tech. in Computer Science & Technology  
University of Roorkee (now, IIT Roorkee), India  
*University Gold Medalist being the first ranker*
- M.Sc. in Physics (Electronics specialization)  
University of Allahabad, India  
*Third Rank in the University*
- B.Sc. in Maths, Physics & Chemistry  
Rohilkhand University, India

## Employment

- June 2015 onwards: Professor, School of Computer & Systems Sciences, Jawaharlal Nehru University (JNU), New Delhi, India
- April 2007 – June 2015: Professor, Department of Computer Science & Engineering, Indian Institute of Technology (IIT), Kharagpur, India
- Dec 2000 – April 2007: Assoc. Professor, Department of Computer Science & Engineering, Indian Institute of Technology (IIT), Kharagpur, India
- Feb 2000 – Dec 2000: Professor, Department of Computer Science & Information Systems, Birla Institute of Technology & Science (BITS), Pilani, India
- April 1997 – Feb 2000: Assoc. Professor, Department of Computer Science & Information Systems, Birla Institute of Technology & Science (BITS), Pilani, India
- June 1986 – March 1995: Scientist, Defense R & D Organization (DRDO), Defense Electronics Applications Lab (DEAL), Dehradun, India
- Dec 1983 – June 1986: Scientist, Department of Science & Technology (DST), Survey of India, Hyderabad / New Delhi, India

## Visiting Positions

- July 2019 onwards: Adjunct Professor, Department of Computer Science & Engineering, LNM Institute of Information Technology (LNMIIT), Jaipur, India
- July 2013 – May 2014: Visiting Faculty, Department of Computer Science & Engineering, Indian Institute of Technology (IIT), Kanpur, India
- June 2005 – May 2006: Visiting Faculty, Department of Computer Science & Engineering, Indian Institute of Technology (IIT), Kanpur, India
- May 2002 – July 2002: Visiting Design Engineer, National Semiconductors GmbH, Germany

## Teaching Courses

- Foundations of Computing (C, Java)
- Data Structures & Algorithms (Core & Adv.)
- Compiler Construction (Core & Adv.)
- Object Oriented Programming (C++, Java, C#)
- Object Oriented Analysis & Design (UML)
- Programming Methodology
- Multimedia Systems
- Machine Learning
- Research Methodology
- Academic Ethics
- Programming & Data Structures (C, C++, Java)
- Design & Analysis of Algorithms
- Software Engineering (Core & Adv.)
- Object Oriented Language Implementation
- Object Oriented Software Engineering
- Software Architecture
- Image & Video Processing
- Evolutionary Computing
- Bio-Statistics (with R)
- Technical Writing

## Research Interests

- Machine Learning: Generalization, Data Analytics & Educational Data Mining
- Dependable Software Systems: Prog. Lang. Systems & Software Engineering
- Evolutionary Algorithm & Multiobjective Combinatorial Optimization
- Multimedia & Embedded Systems: Design, Implementation & Performance

## Selected Sponsored & Industrial Projects

Educational Data Mining	2018 - 19	INR 500K	University Grants Commission
Virtual Lab – Programming & Data Structure Lab	2010 – 12	INR 1500 K	Min. Human Resource Development, Government of India
NPTEL Video Course Development – Compiler, Multimedia	2010 – 13	---	Min. Human Resource Development, Government of India
Object Oriented (C#/.NET centric) Courseware Development	2004 – 07	USD 22 K	Microsoft Corp., USA
Multiobjective Evolutionary Algorithms for Combinatorial Optim.	2002 – 07	INR 1000 K	Min. Human Resource Development, Government of India
Software Tools for Embedded Systems (co-PI)	2003 – 06	USD 100 K	National Semiconductors Corp., Germany/USA
Software Tools for CR Processors (co-PI)	2001 – 03	USD 225 K	National Semiconductors Corp., Germany/USA
Convergence of Multiobjective Evolutionary Algorithms	2001 – 03	INR 100 K	IIT Kharagpur

## Theses/Projects Supervision

	Completed	Ongoing
Doctoral	3 + 6*	8
Graduate (by research)	4*	2
Graduate	~ 50 + 10*	1
Undergraduate projects	~ 100 + 20*	--

\*: Joint supervision

## Publications

Book	1
Edited Books (Conf. Proceedings)	3
Chapters in Edited Books	2
Published Tutorials	3
Journal Research Articles	53
Conference/Workshop Research Articles	101

## Public Policy: In the Service of the Nation

- Credited with transparency and reforms in IIT-JEE (2006 onwards) in MCQ based Admission / Competitive Examination (Based on IIT-JEE Reform Proposals, Sep. 06, Oct. 08, Feb. 10, Sep. 10, July 11, Aug. 14, Nov. 15)
- Authored: Washington Accord *guided* NBA Accreditation Guidelines for UG Engg. Programs, May 11. India acquired permanent membership of Washington Accord in June 2014. In Public use: July 2011 to Jan. 2013. <http://www.nbaind.org/Files/engineering-programs.pdf>
- Co-Authored : NBA Revised guidelines for Accreditation UG Engg. Programs, July 09. In Public Use: July 2009 to June 2011. <http://www.nbaind.org/Files/Report%202009.pdf>

## External Services (a few recent ones)

- Adjunct Professor, LNM Institute of Information Technology (LNMIIT), Jaipur (2019+)
- Ext. Member, Board of Studies, Banasthali Univ. (2019+), Poorvanchal Univ. (2018+)
- Member, Apex Committee for DRDO Awards 2016, Dept. Def. R & D, Govt. of India
- CS & IT Expert, National Board of Accreditation (NBA), New Delhi
- CSE Expert, UPSC, New Delhi

## Academic Administration @ JNU New Delhi (2015 onwards)

- Member, Univ. Anti-Plagiarism Policy Draft Comm. (2016 - 17)
- Member, Univ. Anti-Plagiarism Policy Draft Comm. (2016 - 17)
- Chairman, AICTE Programme Approval Comm., School Comp. & Sys. Sci. (2015-16)
- Member, Faculty – Student Comm., School Comp. & Sys. Sci. (2015 Onwards)
- Member, MCA Re-structuring Comm., School Comp. & Sys. Sci., 2016.

## Academic Administration @ IIT Kharagpur (2001- 2015)

- Undergraduate Program Evaluation Committee (UGPEC): CSE coordinator (2001-05); (2007 – 11)
- Professor-in-Charge Library, CSE and Liaison with Central Library, IIT Kgp (2006 – 08)
- Member, CSE Dept. Administrative Committee, IIT Kgp (2004 - 05, 2006 - 10)
- Member, CSE Academic Committee, IIT Kgp (2001 – 05; 2007 – 11)
- Member, Doctoral Scrutiny Committee(s); Graduate Admissions Examiner, Senate
- Faculty Advisor/Counselor/Mentor, Faculty, PGDIT and PGDST Programs

## Academic Responsibility/Work @ BITS Pilani (1997 – 2000)

- Updated CS and IS Curriculum and Introduced/Restructured Courses
- Introduced Lab Components in CS Courses
- Faculty, Distance Education @ Wipro and others
- Resource Faculty, Teaching Workshops
- Member – Academics, Doctoral, Research & Consultancy, Recruitment, Library, Senate.

## **New Courses Developed / Restructured**

- Academic Ethics [2016]
- Software Engineering [2006] – *brings synergy between SE and Trusted Computing*
- Object Oriented System Implementation [2005]–*synergy in PLI, SE, VEE for trusted computing*
- Foundations of Computing [2005] – *with Java*
- Multimedia Systems [2001] – *developing MMS on a general purpose computing system*
- Evolutionary Algorithm [1999]
- Programming Language & Compiler Construction [1998]
- Data Structures & Algorithms [1998]
- Computational Intelligence [1998]

## **Awards & Professional Recognition**

- Affiliation with Professional Bodies
  - Fellow, IETE, India
  - Fellow, IASS, India
  - Senior Member, ACM, USA
  - Senior Member, IEEE, USA
  - Entrusted with Drafting Washington Accord based UG Engg. Accreditation Guidelines
    - Drafted the 3<sup>rd</sup> fully Revised Edition (May 11); In National Use since May 2011.  
India acquired permanent membership of Washington Accord in June 2014.
    - Conducted National Awareness Workshops for Institutes and Assessors (June – Aug. 09)
- Tech. Paper Reviewer, Conference Organization, Conf. Program Committee Member : In many
- RTI Citizen's Runner-up Award for Public Services (2009)
- Karmaveer Chakra (2013)

## **Tutorials**

- EMCO @ GECCO-07, London; GECCO-08, Atlanta; GECCO-09, Montréal.
- Architecture exploration for embedded system design @ HiPC-04, Bangalore.
- Multimedia system design for QoS @ HiPC-03, Hyderabad.
- Multimedia system @ ITPC-03, Kathamandu.

## **Invited Talks / Seminars**

### **Education, Sc. & Tech.**

- Crisis in HEIs in India: A Technological Perspective @ Press Club of India, JNUTA, Nov. 2018.
- Evolution of Sc. & Tech. for better Academic Life: A journey from stone-age to paperless age, in Seminar series on Decoding Sc. & Tech. for everyone @ JNU, Oct. 2018.
- Academy Autonomy: Gurukuls and Today's HEI @ ISSCA Workshop, Delhi Univ., Feb. 2018.
- Academic Autonomy vs. Quality in Education: from Gurukul to Today's Institutions. A plenary talk in Workshop for Growth of Science & Technology, Purvanchal Univ., Sep. 2017.

### **Computer Science Overview: Trends in Computing**

- Personal Computers to Personalized Computing for Socializing and Banking : A Paradigm Shift in Computing & Comm. Research, Indian Social Science Congress, Andhra Univ., Mar. 2015.

### **Machine Learning & Data Analytics**

- ML: Research Directions and Applications @ FDP, KEIT Ghaziabad, June 2019.
- AI: Issues and Current Trends @ World TelComm. & Info. Society Day, C-DoT Delhi, June 2018.
- ML: Issues & Research Directions @ ML Workshop, IMS Ghaziabad, Jan. 2018.
- Trends in Outlier Detection: Issues & Challenges @ Data Mining STC, NSIT Delhi, Nov. 2017.

- Data-mining by meta-learning @ IARCS Course, 2004.
- Meta-learning of high-dim. spaces for scaling and generalization in data mining @ IIIT-H, 2000.
- Scaling and generalization in data mining by meta learning of data patterns @ IETE Pilani, 1999.
- Hybrid computational intelligent systems @ KanGAL, IIT Kanpur, 1997.
- Hierarchical organization of intelligent models @ TIET Patiala, 1997.
- Hybrid Intelligent models @ BITS Pilani, 1997.

### **Programming Languages & Software Engineering**

- Software Engineering and Runtime Systems @ NIT Rourkela, May 2009.
- Object oriented software engg. :: concepts and practices @ NIT Durgapur, Thapar Univ., 2008.
- Virtual execution environment for trusted computing @ NIT Rourkela, October 2008.
- Object oriented software engineering:: A Lecture series @ IIITU Noida, September 2008.
- Programming pearls and pitfalls @ IIITU Noida, January 2008.
- Multiple polymorphic arguments in object-oriented lang. @ IIT Delhi, TU-Darmstadt, 2006.
- Object oriented language implementation course – a working proposal @ Microsoft, 2006.
- Reusable plug-in software components for dependable systems @ EuroIndia, 2004.
- Message dispatch in object-oriented systems @ IIIT Hyderabad, 2000.

### **Evolutionary Multiobjective Combinatorial Optimization (EMCO)**

- EMCO: Issues and Research Directions @ UGC HRDC, JNU, Sep. 2015.
- EMCO :: A keynote talk @ ICCO, Noida, Sep. 2008.
- EMCO - solving hard problems @ KUIET, 2007.
- Solving hard problems in EMO - a practitioner's approach @ KanGAL, IIT Kanpur, 2006.
- Convergence in multiobjective genetic optim. & combinatorial prob. @ IlliGAL UIUC, 2003.
- Convergence in multiobjective genetic optim. using rank-histograms @ ETH Zurich, 2002.
- Population driven computational paradigm for search and optimization @ BITS Pilani, 2000.
- A practical approach to EMO @ IIT Roorkee, 1997.

### **Multimedia & Embedded Systems**

- Video coding – history & practices: Keynote talk @ Int. Conf. SP, SATI Vidisha (2016).
- Video transcoding :: algorithms and architectures @ TU-Darmstadt, 2006.
- Networked multimedia @ DPN Conf., Kharagpur, 2004.
- Globalization through miniaturized multimedia devices @ Allahabad Univ. (2004).
- Embedded System Design @ Galgotias Noida, 2004.
- Design space exploration tools for embedded systems @ CEERI (2004), EuroIndia (2004).
- Transcoding and QoS for multimedia traffic @ MONET, UIUC (2003).
- Teaching with tech.: multimedia in computer aided learning @ Kendriya Vidyalaya (2003).
- On QoS: reality check @ HiPC Trusted Internet Workshop, 2002.
- Triplet geometric representation: novel local invariants for robust recognition @ CMU, 1996.

## **Research Publications** (in reverse chronology)

### **Book**

- [1] Soham S. Chakraborty, Rajeev Kumar and PP Chakrabarti. *Static Analysis and Optimization of Object Oriented Systems – Concepts and Approaches*. 2012. Lap Lambert Academic Publishing GmbH, Germany. ISBN 978-3-8484-1353-9.

### **Edited Volumes (Conf. Proceedings)**

- [2] Sanjay Kumar Jena, Rajeev Kumar, Ashok Kumar Turuk, and Manoranjan Dash. *Proc. Int. Conf. Communication, Computing and Security (ICCCS 2011)*, Rourkela, India, February 12-14, 2011. ACM Press.
- [3] Sanjay Ranka, Srinivas Aluru, Rajkumar Buyya, Yeh-Ching Chung, Sumeet Dua, Ananth Grama, Sandeep K. S. Gupta, Rajeev Kumar, Vir V. Phoha: *Contemporary Computing – 2<sup>nd</sup> Int. Conf., IC3 2009*, Noida, India, August 17-19, 2009. *Proceedings 2009*. Springer.
- [4] Ajit Pal, Ajay Kshemkalyani, Rajeev Kumar, and Arobinda Gupta (Eds.). *Distributed Computing - Proc. Int. Workshop Distributed Computing (IWDC)*. *Lecture Notes in Computer Science*, Volume 3741, December 2005. ISBN 3-540-309-59-4. Springer.

### **Edited Book Articles**

- [5] Rajeev Kumar and PK Singh. "Pareto Evolutionary Algorithm Hybridized with Local Search for Biobjective TSP". In *Hybrid Evolutionary Systems: Chap 6*, 2007. *Studies in Computational Intelligence Series*, Springer.
- [6] Rajeev Kumar. "On Machine Learning with Multiobjective Genetic Optimization". In Carlos A. Coello Coello, and Gary B. Lamont (Eds.), *Applications of Multiobjective Evolutionary Algorithms*, Chap. 17: 393 - 425, December 2004. ISBN 981-256-106-4. World Scientific.

### **Published Tutorials**

- [7] Rajeev Kumar. A Tutorial on "Evolutionary Multiobjective Combinatorial Optimization (EMCO)" -- A Specialized Tutorial. In *Proc. Genetic and Evolutionary Computation Conference (GECCO-2009)*, Montréal, pp. 3413-3436, 09 July 2009. ACM Press.
- [8] Rajeev Kumar. A Tutorial on "Evolutionary Multiobjective Combinatorial Optimization". A Specialized Tutorial in *Genetic and Evolutionary Computing Conference (GECCO)*, Atlanta, pp. 2805 - 2828, 13 July 2008. ACM Press.
- [9] Rajeev Kumar. A Tutorial on "Evolutionary Multiobjective Combinatorial Optimization". A Specialized Tutorial in *Genetic and Evolutionary Computing Conference (GECCO)*, London, pp. 3366 - 3390, 08 July 2007. ACM Press.

### **Research Articles in Refereed Journals & Newsletters**

- [10] Neha Kumari and Rajeev Kumar. Evolution of generic programming in OOPs. *ACM SIGSOFT Software Engineering Notes* 44(1): Jan. 2019. ACM Press
- [11] Mahesh Shirole and Rajeev Kumar. UML behavioral model based test case generation: A survey. *ACM SIGSOFT Software Engineering Notes* 38(4): July 2013. ACM Press.
- [12] Soma Saha, Rajeev Kumar and Gyan Baboo. Characterization of graph properties for improved Pareto fronts using heuristics and EA for bi-objective graph coloring problem. *Applied Soft Computing* 13(5): 2812 – 2822, May 2013. Elsevier.
- [13] Mahesh Shirole and Rajeev Kumar. Testing for concurrency in UML diagrams. *ACM SIGSOFT Software Engineering Notes* 37(5), Sep. 2012. ACM Press
- [14] Surender Kumar and Rajeev Kumar. Precise Static Analysis for Generic Programs in Object Oriented Languages. *ACM SIGSOFT Software Engineering Notes* 37(3): May 2012. ACM Press.
- [15] S. Harikrishnan and Rajeev Kumar. Space efficient non-constant time multi-method dispatch in object oriented systems. *ACM SIGSOFT Software Engineering Notes* 37(2): Mar. 2012. ACM Press.

- [16] Pravanjan Choudhury, PP Chakrabarti and Rajeev Kumar. Online Scheduling of Dynamic Task Graphs with Communication and Contention for Multiprocessors. *IEEE Trans. Parallel and Distributed Systems* 23(1): 126 – 133, January 2012.
- [17] Rajeev Kumar and Nilanjan Banerjee. Multiobjective network topology design. *Applied Soft Computing* 11 (8): 5120 - 5128, December 2011. Elsevier.
- [18] Soma Saha and Rajeev Kumar. Bounded-diameter MST instances with hybridization of multi-objective EA, *Int. J. Computer Applications* 18(4): 17 – 25, 2011.
- [19] Rajeev Kumar and PK Singh. Assessing solution quality of biobjective 0-1 Knapsack problem using evolutionary and heuristic algorithms. *Applied Soft Computing* 10(3): 711 - 718, June 2010. Elsevier.
- [20] Dipankar Das, PP Chakrabarti, and Rajeev Kumar. Thermal analysis of multiprocessor SoC applications by simulation and verification. *ACM Trans. Design Automation of Electronic Systems (TODAES)* 15(2), Article 15, Pages 52, February 2010. ACM Press.
- [21] Dipankar Das, PP Chakrabarti, and Rajeev Kumar. Scenario based timing verification of multiprocessor embedded applications. *ACM Trans. Design Automation of Electronic Systems (TODAES)* 14(3), Article 37, Pages 58, May 2009. ACM Press.
- [22] Sandip Aine, Rajeev Kumar, and PP Chakrabarti. Adaptive parameter control of evolutionary algorithms to improve quality-time trade-off. *Applied Soft Computing* 9 (2): 527-540, March 2009. Elsevier.
- [23] DP Mohapatra, M. Sahu, Rajeev Kumar, and R. Mall. Dynamic slicing of aspect-oriented programs. *Informatica* 32 (3): 261 - 274, October 2008. Slovene Informatika.
- [24] SK Panda, Arnab Roy, PP Chakrabarti and Rajeev Kumar. Simulation Based Verification using Temporally Attributed Boolean Logic. *ACM Trans. Design Automation of Electronic Systems (TODAES)* 13(4), Article 63, Pages 52, September 2008. ACM Press.
- [25] Rajeev Kumar and Dipankar Das. Code compression for performance enhancement of variable length embedded processors. *ACM Trans. Embedded Computing Systems* 7(3), Article 35, Pages 36, April 2008. ACM Press.
- [26] Vasant Patil and Rajeev Kumar. "A fast inverse motion compensation algorithm for DCT-domain video transcoder". *IEEE Trans. Circuits and Systems for Video Technology* 18(3): 394 – 399, March 2008. IEEE Press.
- [27] Pravanjan Choudhury, Rajeev Kumar and PP Chakrabarti. Conditional and unpredicted task scheduling with selective duplication for embedded multiprocessors under memory and time constraints. *IEEE Trans. Parallel and Distributed Systems* 19 (7): 967 - 980, July 2008. IEEE CS Press.
- [28] Sandip Aine, Rajeev Kumar, and PP Chakrabarti. Adaptive meta-level strategies for optimizing quality-time trade-off. *Artificial Intelligence Review*. Kluwer/Springer. (in press)
- [29] Sandip Aine, PP Chakrabarti, and Rajeev Kumar. An automated meta-level control framework for optimizing the quality-time trade-off of VLSI algorithms. *IEEE Trans. Computer-Aided Design of Integrated Circuits and Systems* 26(11): 1992 – 2008, November 2007. IEEE Press.
- [30] Rajeev Kumar. "A statistical approach to robust video temporal indexing and segmentation". *Int. Journal Wavelets, Multiresolution and Information Processing* 5 (5): 769 – 783, September 2007. World Scientific.
- [31] Dipankar Das, PP Chakrabarti, and Rajeev Kumar. Functional verification of task partitioning for multiprocessor embedded systems. *ACM Trans. Design Automation of Electronic Systems* 12(4), Article 44, Pages 53, September 2007. ACM Press.
- [32] Rajeev Kumar and Vikram Agrawal. "Multiple dispatch in reflective runtime environment". *Computer Languages, Systems & Structures* 33 (2) : 60 – 78, 2007. Elsevier.
- [33] Rajeev Kumar and Soham S. Chakraborty. "Precise static type analysis for object oriented programs". *ACM SIGPLAN Notices* 42 (2) : 17 – 27, February 2007. ACM Press.



- [34] DP Mohapatra, R. Mall, and Rajeev Kumar. "A parallel algorithm for dynamic slicing of distributed Java programs in non-DSM systems". *Int. J. Information & Communication Technology*, 1(1): 38 – 49, 2007. InderScience Pub.
- [35] DP Mohapatra, Rajeev Kumar, R. Mall, DS Kumar, and M. Bhasin. "Distributed dynamic slicing of Java programs". *Journal Systems & Software* 79 (12) : 1661 – 1678, December 2006. Elsevier.
- [36] Rajeev Kumar and Vasant Patil. "An efficient motion vector composition scheme for arbitrary frame down-sampling video transcoder." *IEEE Trans. Circuits and Systems for Video Technology* 16 (9): 1164 – 1171, September 2006. IEEE Press.
- [37] Vasant Patil, Rajeev Kumar and Jayanta Mukherjee. "A fast arbitrary factor video re-sizing algorithm". *IEEE Trans. Circuits and Systems for Video Technology* 16 (9): 1148 - 1152, September 2006. IEEE Press.
- [38] Arnab Sarkar, PP Chakrabarti, and Rajeev Kumar. "Frame based proportional round-robin". *IEEE Trans. Computers* 55 (9) : 1121 – 1129, September 2006. IEEE CS Press.
- [39] Ashok Turuk and Rajeev Kumar. "A flexible contention resolution scheme for QoS provisioning in optical burst switching networks". *Computer Communications* 29 (12) : 2361 – 2376, August 2006. Elsevier.
- [40] Rajeev Kumar and Nilanjan Banerjee. "Analysis of a multiobjective evolutionary algorithm on the 0-1 knapsack problem". *Theoretical Computer Science* 358 (1), 104 - 120, July 2006. Elsevier.
- [41] DP Mohapatra, R. Mall, and Rajeev Kumar. "An overview of slicing techniques for object-oriented programs". *Informatika* 30 (2) : 253 – 277, 2006. Slovene Informatika.
- [42] Rajeev Kumar, Amit Gupta, BS Pankaj, Mrinmoy Ghosh, and PP Chakrabarti. "Post-compilation optimization for multiple gains with pattern matching". *ACM SIGPLAN Notices* 40 (12): 14 – 23, December 2005. ACM Press.
- [43] Ashok Turuk and Rajeev Kumar. "QoS provisioning in WDM ring networks with tunable transceivers". *Journal of High Speed Networks* 14 (4): 317 – 339, November 2005. IOS Press.
- [44] DP Mohapatra, R. Mall, and Rajeev Kumar. "Computing dynamic slices of concurrent object-oriented programs". *Information & Software Technology* 47 (12): 805 – 817, September 2005. Elsevier.
- [45] Ashok Turuk and Rajeev Kumar. "Delay-on-Demand: A signaling protocol to reduce blocking probability in optical burst switching networks". *Photonic Network Communications*, 10 (2): 253 – 266, September 2005. Kluwer/Springer.
- [46] Sujoy Ghosh, Rajeev Kumar, Nilanjan Banerjee, and Raja Datta. "Multihop virtual topology design in WDM optical networks for self-similar traffic". *Photonic Network Communications*, 10 (2): 199 – 214, September 2005. Kluwer/Springer.
- [47] Rajeev Kumar and Vishnu Makkapati. "Encoding of multispectral and hyperspectral image data using wavelet transform and gain shape vector quantization". *Image & Vision Computing* 23 (8): 721 – 729, August 2005. Elsevier.
- [48] Arnab Roy, SK Panda, Rajeev Kumar, and PP Chakrabarti. "A framework for systematic validation and debugging of pipelined simulators". *ACM Trans. Design Automation of Electronic Systems*, 10 (3): 462 – 491, July 2005. ACM Press.
- [49] Rajeev Kumar, Vikram Agrawal, and Anil Mangolia. "Realization of multimethods in single dispatch object-oriented languages". *ACM SIGPLAN Notices* 40 (5): 18 – 27, May 2005. ACM Press.
- [50] Raja Datta, Ashok Turuk, Sujoy Ghose, Rajeev Kumar, and IS Gupta. "New schemes for connection establishment in GMPLS environment for WDM networks". *Int. Journal Wireless & Optical Communications*, 2005. World Scientific.
- [51] Ashok Turuk and Rajeev Kumar. "A token based distributed algorithm to support QoS in a WDM ring network". *Optics Communications* 240 (1-3): 99 - 121, October 2004. Elsevier.
- [52] Ashok Turuk and Rajeev Kumar. "A scalable and collision-free MAC protocol for all optical ring networks", *Computer Communications* 27 (15): 1453 – 63, September 2004. Elsevier.

- [53] AK Turuk, Rajeev Kumar and R. Badrinath, "A token based distributed algorithm for medium access in an optical ring network", *Optics Communications* 231(1-6): 199 – 212, February 2004. Elsevier.
- [54] Rajeev Kumar and Peter Rockett, "Improved sampling of the Pareto front in multiobjective genetic optimisations by steady state evolution: a Pareto Converging Genetic Algorithm", *Evolutionary Computation* 10 (3): 283 – 314, July 2002. MIT Press.
- [55] Rajeev Kumar, "A neural network compiler system for hierarchical organization", *ACM SIGPLAN Notices* 36 (2): 26 – 36, February 2001. ACM Press.
- [56] N. Chakraborty, Rajeev Kumar, and Dilip Jain. "A study of continuous casting mold using a Pareto converging genetic algorithm". *Applied Mathematical Modelling* 25 (1): 287 – 297, January 2001. Elsevier.
- [57] Rajeev Kumar, "ANCHOR – a connectionist architecture for partitioning feature spaces and hierarchical nesting of neural nets", *Int. J. Artificial Intelligence Tools* 9 (3): 397 – 416, September 2000. World Scientific.
- [58] Mayur Naik and Rajeev Kumar, "Efficient message dispatch in object oriented systems", *ACM SIGPLAN Notices* 35(3): 49 – 58, March 2000. ACM Press.
- [59] Mayur Naik and Rajeev Kumar, "Object oriented symbol management in syntax directed compiler systems", *ACM SIGPLAN Notices* 34(6): 58 – 67, June 1999. ACM Press.
- [60] Rajeev Kumar and PI Rockett, "Multiobjective genetic algorithm partitioning for hierarchical learning of high dimensional pattern spaces: a Learning follows Decomposition strategy", *IEEE Trans. Neural Networks* (Special issue on Hybrid Intelligent Models) 9(5): 822 – 830, September 1998. IEEE Press.
- [61] Rajeev Kumar and PI Rockett, "Decomposition of high dimensional pattern spaces for hierarchical classification" *Kybernetika*, 34(4): 435 – 442, September 1998. Academy Sciences, Czech Republic.
- [62] Rajeev Kumar and PI Rockett, "Triplet geometric representation: a novel scale, translation and rotation invariant feature representation based on geometric constraints for recognition of 2D object features", *Image & Vision Computing* 15(3): 235 – 249, March 1997. Elsevier.

### **Research Papers in Refereed Conference/Workshop Proceedings (*incomplete list*)**

(Papers are grouped first in different areas and then, in reverse chronology)

#### **Programming Languages, Systems & Software Engineering ::**

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## Multiobjective Optimization & Evolutionary Algorithm ::

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## **Machine Learning & Data Analytics ::**

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### **Miscellaneous ::**

- [161] M. Prashant, R. Siddharth, and Rajeev Kumar. "Formulation of an encryption algorithm on the basis of molecular genetics and image patterns". 3rd Int. Conf. Computational Intelligence & Multimedia Applications (ICCIMA-99), New Delhi, pp. 76-80, September 1999. IEEE CS Press.
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## PhD Thesis Supervision: Completed

- [1] Mahesh Shirole, Concurrency Test Scenario Generation using UML Transition Sequences, July 2014.
- [2] Soma Saha, Unifying Heuristics and Evolutionary Computing for Characterizing and Solving Certain Combinatorial Optimization Problems, Sep. 2014.
- [3] Pravanjan Choudhury, Task Scheduling on Embedded Multiprocessors, Jan. 2013. (*jointly with Prof. P.P. Chakrabarti*)
- [4] Subrat Kumar Panda, Simulation Based Verification of Pipelined Processors, May 2010. (*jointly with Prof. P.P. Chakrabarti*)
- [5] Vasant Patil, Efficient Algorithms for Video Transcoding, October 2009.
- [6] Dipankar Das, Functional and Performance Verification for Multiprocessor Embedded Applications, July 2009. (*jointly with Prof. P.P. Chakrabarti*)
- [7] Sandip Aine, Design and Control of Anytime Algorithms, September 2008. (*jointly with Prof. P.P. Chakrabarti*)
- [8] Pramod Singh, Multiobjective Combinatorial Optimization with Hybridization of EA, March 2008. (*jointly with Prof. P.P. Chakrabarti*)
- [9] Durga Mohapatra, Dynamic Slicing of Object-Oriented Programs, September 2005. (*jointly with Prof. R. Mall*)
- [10] Ashok Turuk, QoS Provisioning in WDM Networks, February 2005.

## Selected Sponsored/Consultancy Projects :: Completed

- [1] *Sponsored Project* : Programming and Data Structures Virtual Lab  
*Funded by* : MHRD, Govt. of India  
*Period* : 2010 – 12 *Amount* : INR 1500 K  
*Principal Investigator* : Rajeev Kumar *Co-Investigator* : ---

The course is the basic core course which is usually done by every engineering student of all engineering branches in their first year of study. A student is introduced to the basic concepts of programming and an algorithmic approach to problem solving. Since this is the first course in programming, the lab plays a very important role in understanding the programming concepts and problem solving using computer. In the absence of a lab, this course remains an abstract course. Through the lab, a student understands the intricacies of programming and problem solving.

For programming, the general and most versatile, C-language is being used currently. However, the next phase of Virtual Lab can have Java programming language as the medium of the problem solving.

- [2] *Consultancy Project* : Object Oriented (C#/.NET centric) Courseware Development  
*Funded by* : Microsoft Corp., USA (under Global CFP)  
*Period* : 2004 – 07 *Amount* : USD 22 K  
*Principal Consultant* : Rajeev Kumar *Co-Consultant* : ---

The course is designed primarily to bring synergy and interplay among the following components – Object Oriented Technology (OOT) for better programming methodologies and code reuse, Programming Language Design and Implementation (PLDI) for better understanding of language semantics, Virtual Execution Environment (VEE) for an insight of the runtime system providing extensible and safer computing towards code certification, and Software Engineering (SE) for trusted and reusable system.

The course was introduced as a graduate level course at IIT Kanpur and is offered since then at IIT Kharagpur. Many research articles are the outcome of this activity.

- [3] *Sponsored Project* : Multiobjective Evolutionary Algorithms for Combinatorial Optim.  
*Funded by* : MHRD, Govt. of India  
*Period* : 2002 – 07 *Amount* : INR 1000 K  
*Principal Investigator* : Rajeev Kumar *Co-Investigator* : ---

Most combinatorial problems are computationally *hard*. In a multiobjective setting, the major challenge is to obtain a set of many representative diverse solutions across the desired/optimal Pareto-front. In simple treatments, multiple objectives are combined in an *ad hoc* manner to yield a scalar objective. Other conventionally used optimization heuristics model the multiobjective problem in a single objective domain treating all but one of the objectives as constraints. In this project, the standard single objective problems (with or without constraints), e.g., spanning tree, 0/1 knapsack, traveling salesman, graph coloring etc., are recasted into their respective biobjective optimization problems. Empirically, it is shown that the solutions obtained with multiobjective evolutionary algorithms (MOEA) as black-box optimization tools, cover a larger range and are superior, in terms of diversity and convergence, to the deterministic heuristics.

Outcome of this sponsored research project is reflected in many research publications. Another, important spin-off of this research activity is that the tutorial on “Evolutionary Multiobjective Combinatorial Optimization (EMCO),” which became a regular feature at ACM’s GECCO till 2009, the lead conference in this area.

- [4] *Consultancy Project* : Software Tools for Embedded Systems  
*Funded by* : National Semiconductors Corp., Germany/USA  
*Period* : 2003 – 06 *Amount*: USD 100 K  
*Principal Consultant* : Prof. P.P. Chakrabarti *Co-Consultant* : Rajeev Kumar

- [5] *Consultancy Project* : Software Tools for CR Family of Processors  
*Funded by* : National Semiconductors Corp., Germany/USA  
*Period* : 2001 – 03 *Amount:* USD 225 K  
*Principal Consultant* : Prof. P.P. Chakrabarti *Co-Consultant* : Rajeev Kumar

These two consultancy projects were due to the collaborative research between IIT Kharagpur and the Compact RISC (CR) Processing groups of National Semiconductor Corporation (NSC) located at Germany and Israel. University of Michigan (UoM) was another partner in this activity looking into the hardware related aspects whereas IIT Kharagpur concentrated on software related issues.

Twin projects were focused on development of software tools for rapid reduction in the time to market a custom solution based on the CR family of processors. This included software development tools, architecture exploration and evaluation tools and Instruction Set Architecture (ISA) verification tools. The aim was to help NSC develop tools that would speed up the development of new architectures (like functional and performance simulators), produce systems software tools (like Debuggers, Assemblers, Linkers, Compilers) for customers and rapidly explore the design space by providing tools for extensible CR processors (ISA verification and software toolset for CR-X). This effort also aimed at developing the Software Quality Assurance (QA) framework for the tools produced by this activity.

The project activity had three primary parts, namely tools for CR16C, extension of the toolset to handle CR16C family of processors, and development of scalable toolset concept for the extensible CR (CR-X). The CR-X activity also aimed at developing a mechanism so that the toolset can be automatically generated for CR based processors. Generation of tests and testing the software in a proper QA framework was a very important goal. The platform for development was Linux. The effort aimed at maximum use of available GNU following the GNU rules/coding standards.

While working on these twin projects, the project team encountered many interesting issues and challenges, solutions to some of those culminated in several research publications.

- [6] *Sponsored Project* : Convergence of Multiobjective Evolutionary Algorithms  
*Funded by* : IIT Kharagpur  
*Period* : 2001 – 03 *Amount:* INR 100 K  
*Principal Investigator* : Rajeev Kumar *Co-Investigator* : ---

In multiobjective optimizations, solutions which are non-dominated at some stage in the computations, become dominated by a superior solution at some later stage. Moreover, for most of the real-world problems, the desired/optimal Pareto front is *unknown*. This project was aimed at extending the previous work (GALESIA, 1997) and to incorporate the notion of convergence in multiobjective evolutionary algorithms (MOEA).

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