Rajeev Kumar, PhD (Sheffield Univ.)
Professor, Computer Science & Engineering (CSE)
Formerly: Professor @ IIT Kharagpur, IIT Kanpur, BITS Pilani, JNU Delhi;
Formerly: Scientist @ DRDO (DEAL) Dehradun, DST (Survey) Hyd/Delhi
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GitHub | LinkedIn | Google Scholar | Research Gate | ORCID | Facebook

Rajeev Kumar is an academician with **four decades** of teaching, research & development. He served Indian Institutes of Technology (**IITs) @ Kharagpur & Kanpur (17y)**, Birla Institute of Technology & Science (**BITS) Pilani (4y),** and **JNU New Delhi (8y)**. Prior to his academic tenure, he was a Scientist in Defence R & D Organization**: DEAL Dehradun (8y)** and Department of Science & Technology: **Survey of India,** Hyderabad/New Delhi (**3y**). He was a Visiting **Design Engineer** at National Semiconductors (**NSC) Germany.** He visited several universities in USA, UK, Germany, Switzerland, Japan, S. Korea, and Singapore.

He holds a **Ph.D.** degree in Computer Engineering from **Univ. Sheffield,** an **M.Tech.** in Computer Sc. & Tech. from **Univ. Roorkee** (now IIT Roorkee)**,** and an **M.Sc.** in Physics (Electronics) from **Univ. Allahabad.** His primary education was in a river-side *Gurukul*, Shri Dugdheshwar Sanskrit Mahavidyalaya at Pilibhit.

R & D: His initial learning at DRDO culminated in *technology transformation for end-users*. His research interests include machine/deep learning, medical image analysis, multimedia, programming languages, software systems, evolutionary optimization, and scientometrics. He has published over **250 research articles** in international journals and conferences, several in lead venues. He has supervised **nineteen doctoral, over eighty master theses,** and a hundred undergraduate projects. He worked on **industry-funded projects from Microsoft USA and NSC USA**; the NSC project was in close collaboration with their USA, Germany, and Israel units. He founded the ***Data to Knowledge (D2K)*** Lab at JNU, which has produced a few dozen Doctoral/Masters theses. He is a reviewer for journal/conference papers. He delivered several keynote & invited lectures and tutorials at conferences. His h-index on Google Scholar is 25.

Teaching: Rajeev has designed and taught several Computer Science & Engineering courses ranging from freshman to senior graduate level. He has taught programming (C/C++/C#/Java/R/Python), core and advanced (Data Struct., Algorithms, Compiler, Software Engg, Pattern Classification, Machine Learning), application (Image/Video Processing, Computer Vision, Multimedia Sys.), and specialized courses (Statistics, Evolutionary Comp, Research Method, etc.). At JNU, he introduced the *Academic Ethics* course. His teaching focuses **on active learning, thinking, creativity, and innovation** with flexible workloads/assessments.

Academic Leadership: He served as a Senator in IITs Kharagpur/Kanpur and BITS, a member of the Court and Academic Council in JNU, and several other academic bodies, e.g., Board of Studies, Statutory Comm. of Institutes/Universities. He worked for reforms in curriculum, academic structure, regulations, and ordinances. He mostly worked as a **crisis handler with out-of-box solutions for complex problems**.

Public Policy: His contribution to framing public policies for higher education is enormous. He reformed IITs admission examinations, bringing transparency and accuracy through well-defined processes. He pioneered ***common* examination** and ***common counseling (JoSAA/CSAB) for admissions in IITs/NITs/ IIITs/CFTIs***. Almost all admissions & competitive examinations of the country in most disciplines have been reformed following this model. His proposal for an independent body led to the setting of the National Testing Agency (**NTA**). Including common examinations in **NEP 2020** is a testimony of his work, leading to **CUETs** in Central Universities. His prototype for **common counseling in CUs** developed with the Ministry will be used fin 2024. He advocated for the Research Advisory Comm. (RAC) and Ethics course for PhD Students in JNU; UGC adopted both. Recently, IITs adopted several measures from his proposal for preventing suicides. India's Hon'ble Supreme Court hailed him as *one of the many* ***unsung heroes*** *who helped in improving the system*.

He defined quantitative Academic Performance Indices (**APIs**) in 2009. He co-authored/authored *output-based quantifiable* ABET-guided accreditation guidelines for undergraduate engineering programs from 2009 to 2011. These have been in public use since 2011, making the National Board of Accreditation (NBA) an autonomous body. This work led India to join the Washington Accord in June 2014 permanently.

His four decades of academic/administrative expertise acquired across universities and institutions in India and abroad have enriched his passion for ***teaching, research, curriculum development, faculty mentoring, and institution building***. His *reform-centric & student-oriented leadership, combined with* ***24/7 work ethics,*** **open comm.,** ***legal acumen,*** **and** ***wider*** **perception** across inst./univ., is an asset. *

1-Page Brief.

- **Education:**
  - **Ph.D. (Computer Engg.), Univ. Sheffield**, England. The thesis was nominated for the Distinguished Computer Science thesis award in UK.
  - **M.Tech. (Computer Sc. & Tech.), Univ. Roorkee** (now, IIT Roorkee). Awarded the Univ. Medal for being the first ranker.
  - **M.Sc. (Physics - Electronics)**, **Univ. of Allahabad**. 3rd ranker.
  - **LL.M. (Professional), National Law University**, Delhi: ***Pursuing***

- **Experience:** Teaching, Research & Development: Four Decades.
  - **Professor**: **IIT Kharagpur** (15y), **IIT Kanpur** (2y), **BITS** Pilani (4y), and **JNU** (8y) New Delhi.
  - **Scientist**: Survey of India (DST), Hyd'bad/New Delhi (3y); **DRDO** (DEAL), Dehradun (8y).
  - **Design Engineer**: National Semiconductors (**NSC**), Germany (Visiting); Projects with **Microsoft.**

- **Teaching**
  - Cover fundamentals with emerging technologies to keep the subject material relevant and employable.
  - Focus on student engagement for *active* learning, thinking, creativity, and innovation with enjoyment.
  - Introduced a variety of assignments, e.g., tiny (few sentences), 2-pages, and large – covering different aspects, incl. hands-on experiences of course contents at different paces spread throughout semester.
  - Introduced parallel evaluation in which students also self-evaluate, followed by closeness match.
  - Taught, developed and restructured core and advanced courses for U.G. and P.G. students.
  - Introduced new courses, incl. a pan-university course on Academic Ethics at JNU.
  - Comfortable in teaching smaller to large classes of a few hundred students.

- **Research:** Research interests include machine/deep learning, medical image analysis, multimedia, medical image analysis, programming language, evolutionary optimization, and scientometrics.
  - Published over 250 research articles in international journals and conf. proc. Reviewer.
  - Presented papers in lead international conf. in USA, UK, Germany, Canada, Japan, S. Korea, etc.
  - Invited/research talks in universities abroad, international conferences, FDPs, STCs, etc.
  - Program Chair, Publication Chair, Publicity Chair, etc. in several international conferences.
  - Supervised 19 doctoral, 80 master theses.
  - Worked on industrial-funded projects from Microsoft and National Semiconductors (NSC).
  - Awarded *Test of Time* award in ISCE 2022 for the paper presented in ISEC 2011.
  - Founded *Data to Knowledge* (**D2K**) Lab in School of Computer & Systems Sciences, JNU. The D2K Lab produced quality research papers in decent Journals and conf. proceedings.
  - *h-index*, on Google Scholar (from incomplete data), is 25, which is good in sub-fields of C.S.

- **Industry Collaboration: R & D**
  - Member, Board's IT Strategy Group and I.T. Advisory Comm., Canara Bank (2022 - Present)
  - Core Design Engineer, National Semiconductors Team with members from Germany, Israel & U.S. for developing System S.W. tools, simulators, compilers, etc. for their CR16X series of processors. In this work, Prof. Richard Brown, Univ. Michigan USA was another collaborator. We made per week deliveries for their design engineers, which were regularly used by many categories of stakeholders, from system designers to application users. (2001 – 2006)
  - NET/C# Project, Microsoft Inc. USA (2004 – 07).

- **Industry Collaboration: Teaching**
  - Developed courseware for .NET/C# as an emerging technology (**Microsoft** Inc. USA). (2004-07)
  - Faculty, Multimedia & Object-Oriented System Courses for Wipro/S.W. Industry employees @ Bangalore/Hyderabad under BITS Industry Off-Campus Collaboration Program. (1997- 2000)

Pursuing Adjunct Professor-ship @ Premier Tech. Inst. & Univ.

With his extensive and varied experience in academics — student, faculty, and institution builder — he aims to contribute and advise on value additions for institutions and leaders, going beyond the typical faculty role:

- **Teaching Specialized CS/AI/ML Courses & Delivering Lectures in Executive Program**
  - In Emerging Technologies to undergraduate/postgraduate/research students
  - In Core Technologies for an in-depth understanding of concepts
  - Lectures in Specialized / Executive Programs to CSE/ECE/EE/General Engg. Students & Faculty
- **Research Advisor for UG Projects / Masters / PhD Thesis / Research Centers**
  - Inculcating the spirit of the research & publications: identify and catch them early,
  - Define Master/PhD thesis dissertation: applicable theory, concept, technology, and applications
  - Strengthen technical writing skills and research plans in phases.
- **Faculty Mentor, In-house Peer Review, & Thesis Evaluation**
  - Most Institutions have a heavily skewed distribution of young/new faculty,
  - Mentoring young faculty for effective teaching, learning, evaluation, and grading (TLEG),
  - Teaching workshops and FDPs for TLEG and Institute's services,
  - In-house peer review of faculty for self-assessment and feedback. Thesis Evaluation.
- **Curriculum Revision / Restructuring**
  - Involved with UG/PG/Research curriculum updates since the 1990s at IITs, BITS, JNU, and others.
  - This exercise should be done regularly to prepare graduating students with the latest technologies.
- **Seminar and Hands-on Workshop Series**
  - Weekly seminar series on standard technologies with guests/experts and in-house faculty/students.
  - Hands-on workshop on the latest tools/technologies with external experts and in-house developers.
- **Strengthening Placement Skills & Employability**
  - Developing code-labs for hands-on coding experience through the process of building applications.
  - Working on industry-supported toolkits and developing applications and newer features.
- **Improving Academic SoPs for Self-Regulatory Administration**
  - Continuous monitoring of Academic/Administrative SoPs for improvement aimed at zero government
  - Shifting towards self-regulatory governance and no-delay grievance redressal system.
- **Institutional Committee Chair/Member for Out-of-Box Solutions**
  - Worked in several committees at all levels – department, Institute, national, and international
  - In Institutional academic/administrative committees in academic interest as a crisis handler.
- **Ranking, Accreditation, and Interfacing with External Agencies**
  - Drafted accreditation guidelines for public use with academicians, government, international agencies
  - Practical understanding of ranking/accreditation parameters and their interplay
- **Academic Leadership with Legal Acumenship**
  - Handled several types of academic leadership tasks with active participation as a crisis handler,
  - Handled several academic legal cases via Special Leave Petitions (SLPs) and Writ Petitions (WPs),
  - Excellent in Service/CCS (CCA) Rules, Disciplinary Proc., and Administrative Laws.
- **Public Policies for Institutional Buildup**
  - Defining policies for institutional built-up and defining rational & minimal SoPs
  - Quality upgradation, Ranking improvement, etc.

Education & Professional Experience

Personal Information

- Nationality : Indian
- Date of birth : March 12, 1959
- Marital Status : Widower with two children:
  Son (S.W. Engg: Agoda | ex- Google, Microsoft, Grab | MBA: NUS, NYU | ISB);
  Daughter (Faculty, GaTech Atlanta | PDF: Univ Penn | PhD: Rice Univ)

Education

- **Ph.D. in Computer Engineering (1997)**
  University of Sheffield, UK
  Thesis: Feature Selection, Representation & Classification.
  Thesis nominated for best Thesis award in UK.

- **M.Tech. in Computer Science & Technology (1992)**
  University of Roorkee (now, IIT Roorkee), India
  Dissertation: *Performance Study of Simulated Multiprocessor for Functional Programs.*
  University Medalist being the first ranker

- **M.Sc. in Physics (Electronics) (1979)**
  University of Allahabad, India
  Third Rank in the University

- **LL.M. (Professional): Pursuing**
  National Law University, Delhi India

Research Scholar

- **University of Sheffield, UK**: Commonwealth Research Scholar: March 1994 – March 1997.
- **University of Allahabad, India:** UGC Research Scholar: July 1980 – Dec 1983.

Employment

- **Jawaharlal Nehru University (JNU), New Delhi, India**
  School of Computer & Systems Sciences (SC&SS)
  Professor: June 2015 – March 2024.

- **Indian Institute of Technology (IIT), Kharagpur, India**
  Department of Computer Science & Engineering (CSE)
  Professor: April 2007 – June 2017; Assoc. Professor: Dec 2000 – April 2007.

- **Birla Institute of Technology & Science (BITS), Pilani, India**
  Department of Computer Science & Information Systems (CSIS)
  Professor: Feb 2000 – Dec 2000; Assoc. Professor: April 1997 – Jan 2000.

- **Defense R & D Organization (DRDO), India**
  Defense Electronics Applications Lab (DEAL), Dehradun, India
  Scientist C: July 1989 – April 1995; Scientist B: June 1986 – June 1989.
  R&D: Image Processing, Computer Vision, Machine Learning, Military Intelligence.

- **Department of Science & Technology (DST), India**
  Survey of India, Hyderabad / New Delhi, India
  Deputy Superintending Surveyor: Dec 1983 – June 1986.

Visiting Positions

- **Indian Institute of Technology (IIT), Kanpur, India**
  Department of Computer Science & Engineering,
  Visiting Professor: July 2013 – May 2014; Visiting Assoc. Professor: June 2005 – May 2006.

- **National Semiconductors GmbH, Germany.**
  Oct. 2001, May – July 2002: Visiting Design Engineer.

Academic Tasks & Leadership

- **External Academic Institutions**
  - Advisor, Cyber Security Upskilling Edu. Inst., VMSB Uttarakhand Tech. Univ, Dehradun (2024)
  - Ext. Member, CSE Curriculum Revision, IIT Patna (2022, 2024)
  - Ext. Member, Faculty of Maths & Computing, Banasthali Univ. (2019 - 22)
  - Ext. Member, Board of Studies, Dept. CSE & Dept. CS Applications, Poorvanchal Univ. (2018 - 20)
  - Visiting Professor, JIIT Noida (2007-10)
  - …. (several others)

- **National level**:
  - CS Expert: NTA Tech. Eval. Comm. (2023 – 24),
  - CS Expert: Faculty Selections: ASRB (2022), DRDO (2016-18), UPSC (2014), etc.
  - Chair/Member, NBA UG/PG Accreditation Teams (2006 – 2018).
  - Chair, NBA UG Engineering Accreditation Guidelines Draft Comm. (2010 – 11).
  - Chief Examiner, GATE Computer Science, IITs (2005).
  - Professor-In-Charge, JEE Examination Centre(s), IIT Kharagpur (2001 – 04).

- **Institute/University level**: IIT Kharagpur, BITS Pilani, and JNU New Delhi
  - JNU: Member, University Court, and Academic Council (2022 - 2024).
  - JNU: Member, Intellectual Property Management Comm. (2017)
  - JNU: Co-opted Member, Anti-Plagiarism Policy Draft Comm. (2016 - 17).
  - JNU: Conceptualized Dual-degree program combining Comp Sc with Social Sc (2016-17).
  - IIT Kharagpur: Senator (2007 – 2015)
  - IIT Kharagpur: Member, UG Prog. Eval. Senate Sub-Comm. (UGPEC) (2001-05, 2007-11)
  - BITS Pilani: Senator (1997 – 2000).
  - BITS Pilani: Resource Faculty, Intensive Teaching Workshop (1997 – 2000)
  - BITS Pilani: Member, Research & Consultancy Board (1997 - 1999).
  - BITS Pilani: Member, Library Comm. (1997 – 1999).

- **Department/School level**: BITS Pilani, IIT Kharagpur, and JNU New Delhi.
  - JNU: Founder Director, *Data to Knowledge* (D2K) Lab, SC&SS (2016 – 2024)
  - JNU: Member, Special Comm. (a.k.a. Board of Studies), School Comp. Sys. Sc. (2015 – 2024)
  - JNU: Member, Student - Faculty Comm., School Comp. & Sys. Sci. (2015 – 2019)
  - JNU: Chair, AICTE's MTech. Prog. Approval Comm., School Comp. & Sys. Sci. (2015 – 2016)
  - IIT Kharagpur: CSE Academic Comm, (2001-05, 2007 - 11)
  - IIT Kharagpur: CSE Administrative Comm., (2004-05, 2006-10)
  - IIT Kharagpur: Doctoral Scrutiny Committees: Assorted (2001 – 2011)
  - IIT Kharagpur: Faculty Advisor/Counselor/Mentor and Faculty PGDIT and PGDST (2001-08)
  - IIT Kharagpur: Professor-in-Charge, CSE Library & Liaison with Central Library (2006 – 08)
  - BITS Pilani: Member, C.S. & I.S. Group (1997 – 2000).

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Teaching (Undergraduate and Graduate)

- Foundations of Computing (C, C++, Java, Python)
- Data Structures & Algorithms (Core & Adv.)
- Compiler Construction (Core & Adv.)
- Object-Oriented Programming (C++, Java, C#)
- Object-Oriented Analysis & Design
- Programming Methodology
- Multimedia Systems
- Machine/Deep Learning (Core & Adv.)
- Artificial Intelligence
- Academic Ethics
- Research Methodology
- 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
- Pattern Classification
- Evolutionary Computing
- (Bio-)Statistics (with R) @ Life Sciences
- Technical Writing

New Courses Developed / Restructured

- Bio-Statistics [2018] @ JNU – *bringing computation with R*
- Academic Ethics [2016] @ JNU
- Software Engineering [2006] – *bringing synergy with Trusted Computing* @ IIT Kharagpur
- O.O. Sys. Implementation [2005] –*synergy in PLI, S.E., VEE for trusted computing* @ IIT Kanpur
- Foundations of Computing [2005] – *with Java* @ IIT Kanpur
- Multimedia Systems [1998, 2001] @ BITS Pilani, IIT Kharagpur
- Evolutionary Algorithm [1999] @ BITS Pilani
- Programming Language & Compiler Construction [1998] @ BITS Pilani
- Data Structures & Algorithms [1998] @ BITS Pilani
- Computational Intelligence [1998] @ BITS Pilani

Industry Teaching Collaboration: National & International

Microsoft Research USA	Object Oriented (C#/.NET centric) Courseware	2004 – 07
Wipro & S.W. Industries	Object Oriented System Development, Systems @ BITS Multimedia Pilani	1998 – 2000

Awards & Professional Recognition

- ISEC's *Test of Time* Award for the ISEC 2011 Paper (2022)
- Karmaveer Chakra (2013)
- Hon'ble Supreme Court's *Unsung Hero* (2011)
- RTI Citizen's Runner-up Award for Public Services (2009)
- Commonwealth Scholarship (1994 – 97)
- Affiliation with Professional Bodies
  - Fellow, IETE, India
  - Fellow, ISSA (Indian Social Science Academy), India
  - Senior Member, ACM, USA
  - Senior Member, IEEE, USA

Recognition as Student

- Class Representative, MTech., Dept. Electronic & Computer Engg., Univ Roorkee (1991- 92)
- Prefect, Sir GN Jha Hostel, Univ of Allahabad, (1981-83)

... (others)

Research

Research Interests

- Machine Learning: Generalization, Outlier Detection, and AI & Ethics.
- Multimedia: Medical Image Analysis, Multi-Modaling, and Social Networks.
- Scientometrics and Edu. Data Mining.
- Programming Language System and Software Engineering.
- Evolutionary Multiobjective Combinatorial Optimization (EMCO) and Nature Inspired Algorithms (NIA).

Publications

Book	1
Edited Books (Conf. Proceedings)	3
Chapters in Edited Books	4
Published Tutorials (USA)	3
Journal Research Articles	~80
International Conference/Workshop Research Articles	~150
National Conference/Workshop Research Articles	~20

Theses & Student Projects Supervision

	Completed	Ongoing
Doctoral	19 (6*)	1
Graduate (by research)	4	--
Graduate (M.Tech., MPhil, MSc)	~ 80 (10*)	---
Undergraduate projects	~ 120 (20*)	--

*: In joint-supervision.

Visitor @ Universities Abroad

Visitor	GaTech Atlanta, US	ML, PL	Feb.2023, April 2024
Visitor	NUS, Singapore	ML, PL	June, Dec. 2022
Visitor	UPenn, Rice Univ, USA	Prog. Lang., ML	May 2022
Visitor	NUS, Singapore	Multimedia, ML	July 2019
Visitor	Rice Univ., USA	Machine Learning	Mar. 2018
Visitor	Univ. Sheffield, UK	Evo. Algo. Comb. Optim.	July 2007
Visitor	GIST, S. Korea	Evo. Algo. Comb. Optim.	Mar. 2007
Visitor	TU Darmstadt, Germany	Prog. Lang., Multimedia	Sep. 2006
Visitor	Aizu Univ., Japan	Evo. Algo. Comb. Optim.	Jan.2005
Visitor	UIUC, USA	Multimedia, Evo. Algo	July 2003
Visitor	ETH Zurich Switzerland	Multi-obj. Evo. Algo.	June 2002
Visitor	MIT, CMU: USA	Machine Vision	July 1996
PhD, TA	Sheffield Univ., U.K.	Comp. Engg.	Mar 1994 to Apr 1997

R & D, Industrial Consultancy, & Services

Academia Industry Research Projects

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

Industry R & D Consultancy

Advisor	IT Advisory Comm. Canara Bank India	Banking SW, Online, Data Analytics Tools, etc.	2022 - Present
Design Engineer	NSC Germany	SW System Tools: Compiler, Simulator etc.	May – July 2002 Oct. 2001

R & D Institutions & Others: Services -- a few

- CS Expert, NTA Tech. Eval. Comm. (2023 – 24)
- Expert, Tech. Comm., Agriculture Scientists Recruitment Board (ASRB), Dept. Agri. Res. Edu. (2022)
- Chairman/Expert, National Accreditation Board (NBA) Visiting Committees to Engg. Instt. (2007 - 2018)
- Member, Apex Committee for DRDO Awards (2016)
- CSE Expert, UPSC, New Delhi (2014)
- Secretary cum Treasurer, IEEE Kharagpur Centre (2002 – 04)
- Secretary, IETE Local Centre, Dehradun (1988 – 90, 1992 – 94)

. . . (several more)

Tutorials, Seminars, FDPs & Talks

Tutorials

- Evo. Multi-criteria Optim. @ 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 / FDPs /STCs

Machine Learning & Data Analytics

- D2K: Machine Learning & Data Intelligence @ FDP, JIIT Noida, Jan. 2023.
- Evolution of a perceptron to massively connectionist deep learning architecture with applications @ UPES Dehradun, Dec. 2021.
- Evolving a perceptron to massively connectionist deep learning architecture with applications @ Rajiv Gandhi University, Itanagar, Sep. 2021
- Intro. to Prob. Theory in ML @ NIT Jalandhar, Sep. 2020
- The Pedagogy of AI for Multidisciplinary Students @ Huawei A.I. Educator Symp, Mumbai, Dec. 2019
- 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.

Education, Sc. & Tech., Ethics & Governance

- Enlightened Education: Nurturing Minds with Discipline, Ethics, and Joy. LNMIIT Jaipur, Mar. 2024.
- Ethical Writing: Learning form experiences of day-to-day live examples @ ICARS Delhi, June 2020.
- Scientometrics and Publication Ethics @ VJTI Mumbai, Dec. 2019.
- E-Governance with AI / ML @ Refresher Course, UGC-HRDC, JNU, July 2018, Aug. 2019.
- Crisis in HEIs in India: A Technological Perspective @ Press Club of India, JNUTA, Nov. 2018.
- Evolution of Paperless PhD: 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, VBS Purvanchal Univ., Sep. 2017.
- Personal Computers to Personalized Computing for Socializing and Banking: A Paradigm Shift in Computing & Comm. Research, Ind. Social Science Congress (ISSC), Andhra Univ., Mar. 2015.

Programming Languages & Software Systems

- 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 @ JIITU Noida, September 2008.

- Programming pearls and pitfalls @ JIITU 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.
- Software tools for extensible CompactRisc processors @ National, Munich, June 2002.
- 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 @ IC3, JIIT Noida, Sep. 2008.
- EMCO - solving hard problems @ Gwangju IST, S. Korea, Mar. 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, June 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. S.P., 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 @ H*i*PC Trusted Internet Workshop, 2002.
- Triplet geometric representation: novel local invariants for robust recognition @ CMU, 1996.

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Public Policies for IITs/CFTIs/CUs/HEIs

Actively involved in drafting policies for HEIs, maintaining a delicate balance between stakeholders: Government and academicians while developing impact-driven public policies. **Most are in Public Use**

IIT JEE Reforms (2006 – 2015)

Pioneered transparency, common examination (JEE), common counselling (JoSAA/CSAB), and systematic reforms in Engg. admissions for IITs/NITs/IIITs/CFTIs. The proposal led to institution of National Testing Agency (**NTA**). These concepts have been adopted for admissions in most disciplines in the country.

I. Prior to 2006, IITs admission examination/processes were marred with several types of irregularities, irrationalities, ad hoc-ism, etc., due to the complete opaqueness of the system. For example,

(a) **Student(s) with marks as high as 279 were not admitted, though students with fewer marks of 154 were admitted.** The then IIT-JEE subject cut-offs {37, 48, 55} in 2006 became single digits {1, 4, 3} & {5, 0, 3} in subsequent years, respectively in 2007 and 2008 out of 182 in Maths, Physics, Chemistry, making IIT-JEE a laughing stock in public.

(b) There were **errors in questions and answer keys**; ambiguous instructions in the question paper led to wide-ranging manipulations.

(c) A student was admitted to multiple institutions, leading to a national waste of time, resources, efforts, etc. **Hundreds of seats remained unfilled**, leading to backdoor admissions.

A student was unaware of why one was selected/rejected due to the opaqueness of the system.

II. As a Professor at IIT Kharagpur, I **discovered several such irregularities through research & analysis of admission-specific data**. The Hon'ble High Court termed the then situation of IITs admissions with "*a proverbial situation of it being darkest beneath the lamp … if becomes known to the world at large, may make them (IITs) a laughing stock in the eyes of their clients*.

III. My **tenacious decade-long efforts** of cleaning up IITs admissions led to wide-ranging reforms in admissions through transparency, well-defined *prior* decision-making, and standardized processes, as

(a) **Subject cut-offs were fixed** a priori at 10% of the Max. Marks for GEN category and others;

(b) Students were allowed to carry the question paper, **model answer keys were uploaded**, and feedback about correctness was given. The **corrected answer keys** were uploaded and used for final evaluation.

(c) A carbon copy of the ORS was made available to candidates, and the **evaluated ORS** was uploaded for verification of marks before the announcement of the final result;

(d) Pioneered ***Common Examination*** (**JEE (Main)**) for UG Engineering admissions;

(e) Conceptualized **Common Counselling** (**JoSAA/CSAB**) for UG engineering admissions in all CFTIs. Multiple rounds of counselling for filling most seats through centralized seat allocation.

(f) Institution of National Testing Agency (**NTA**) for most admission (MCQ-based) examinations.

The above methodologies have been adopted by most UG and PG admissions and MCQ-based examinations across almost **all professional disciplines**, benefitting millions of students every year.

IV. **The Hon'ble Supreme Court** hailed me as ***one of the many unsung heroes*** *who helped in improving the system*. The Apex court also asked, "*IITs and the candidates who now participate in the examinations must, to a certain extent, thank the appellants for their efforts in bringing such transparency and accuracy in the ranking procedure*." Furthermore, inclusion of common examinations in NEP 2020 and the adoption of CUET for UG/PG programs with common counseling are live examples in action.

Quantifiable Accreditation Guidelines: In Public Use (2008 – 2011)

Authored NBA Accreditation ABET Compliance, Guidelines for U.G. Engg. Programs. Conducted National Awareness Workshops (Public use: July 2009 to Jan. 2013).

V. Co-authored *output-based quantifiable* accreditation guidelines for UG Engg. Programs and defined quantitative Academic Performance Indices (**APIs**) for engineering faculty (2009).

VI. Authored solely *output-based quantifiable* ABET-guided accreditation guidelines for UG Engg. Programs. Conducted All-India workshops for awareness and training. The National Board of Accreditation (NBA) was made an autonomous body. (2009 – 2011)

VII. This work led India to join the **Washington Accord** in June 2014. Revised guidelines are in public use.

Misc. Proposals submitted to the Ministry (2018 – 2023)

VIII. Grievance Redressal by a neutral third party in HEIs (Nov. 2018).

IX. Common Entrance Examinations in Central Universities led to **CUET**: My proposal differed from the CUET 2022; however, the current CUET is inching towards my proposal after Delhi University adopted CLAT for its LLB Program 2023 (March 2021). Including Common Examinations in **NEP 2020** is a testimony of this work.

X. Prevent suicides in IITs, resulting in a draft OM in Feb. 2023: Proposed measures and processes for mental well-beings, early alert generations with the involvement of several stakeholders, and grievance redressals (GR) for preventing unfortunate incidences in IITs. Most of these measures have been adopted by IITs for the prevention of suicides (2022 - 23). This proposal was an extension of my Grievance Redressal Proposal for CFTIs (Nov. 2022 – Feb. 2023)

XI. Implementation of Common Counselling for CUET (Oct. 2022 – Apr 2023). The Prototype developed with the 'Samarth' (DU) was planned for Common Counselling 2024 and onward.

Academic Services at JNU (2015 – 2024)

(a) Proposed **dual-degree programs** in engineering with social sciences and admissions and counselling through **JEE** (Mains) and **JoSAA** (2016–17), led to the School of Engineering in JNU.

(b) Drafted JNU's **anti-plagiarism** policy (2016-17); replaced by UGC Regulations, 2018. Initiated IPR policy (2017).

(c) **AICTE recognition** of the M.Tech. Program (2016 – 17),

(d) Addition of **laboratory courses** in the academic programs of the School (2015 – 16),

(e) Institution of Research Advisory Committee (**RAC**) for every PhD student in the School (2015– 16). It was later adopted by JNU and subsequently adopted in **UGC Regulations, 2018**.

(f) Introduced ***Academic Ethics*** course for thesis students (2016–18),

(g) Initiated a **seminar series** combining sciences and social sciences (2018),

(h) Suggested to have a ***common protesting venue*** in JNU for minimizing disruptions in work (later, Hon'ble High Court directed for the same), etc. (2016),

(i) Suggested adopting the existing national level entrance examination be considered for admissions for all postgraduate and doctoral admissions, e.g., **GATE and NIMCET** for admissions in MTech and MCA of the School of Computer & Systems Sciences (2018 – 21),

(j) **Adopted a new work culture** in Feb. 2016, through which no teaching or research guidance has been interrupted due to any lockdown, strikes, protests, etc. (2016 onwards).

Most of the above are in public use. **Some of these are/were being counted as flagship initiatives** of the former Vice-Chancellor, Prof. M. Jagadesh Kumar (now, Chairman UGC).

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[235] Priti Kumari, Roopam Sadh, and Rajeev Kumar (2020) Research criteria for measuring quality: Do they promote genuine research or manipulation? Int. Summit in Quality Indices in Higher Edu., DTU Delhi, Nov 2020.

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* * *

Doctoral (PhD) Thesis Supervision

In progress @ JNU

[1] Farheen. Deep learning for sequential data: architecture, algorithms, & applications. (by June 2024).

Graduated @ JNU

[2] Bhupendra Kumar. Pattern discovery & clustering in ordinal survey data: algorithms and applications. Jan 2024.

[3] Gouranga Duari. Decomposition for outlier detection. Jan 2024.

[4] Akhilesh Rawat. Assessing generalization in deep learning architecture with medical image analysis. Jan 2024.

[5] Neha Kumari. A safe generic type system for Java. Nov. 2023.

[6] Priti Kumari. Scientometrics of computer science research publications. July 2023.

[7] Akanksha Mukhriya. Ensemble learning for unsupervised outlier detection: algorithms and applications. Oct. 2022.

[8] Neeraj Pathak. Hybrid evolutionary algorithms for solving hard combinatorial problems. Aug. 2022.

[9] Sonal Tuteja. Graph model for schema and data mapping. July 2022.

[10] Roopam Sadh. Knowledge discovery from quantitative survey data with pattern clustering and machine learning. March 2022.

Not Completed @ JNU

[11] Om Prakash. Machine intelligence with multi-modal media for social welfare. Under Investigation: Publication Misconduct: March 2024.

[12] Irfan Zaboo. FSA Extraction from Sequential Neural Networks. (Registration Cancelled: Feb. 2024)

[13] Sonam Chhikara. Information theoretic image steganalysis for LSB steganography. (deceased Dec. 2019).

Graduated @ IIT Kharagpur

[14] Mahesh Shirole. Concurrency Test Scenario Generation using UML Transition Sequences. Feb. 2021.

[15] Soma Saha. Unifying Heuristics and Evolutionary Computing for Characterizing and Solving Certain Combinatorial Optimization Problems, Sep. 2014.

[16] Pravanjan Choudhury. Task Scheduling on Embedded Multiprocessors, Jan. 2013. (with Prof. P.P. Chakrabarti)

[17] Subrat Kumar Panda. Simulation-Based Verification of Pipelined Processors, May 2010. (with Prof. P.P. Chakrabarti)

[18] Vasant Patil. Efficient Algorithms for Video Transcoding, October 2009.

[19] Dipankar Das. Functional and Performance Verification for Multiprocessor Embedded Applications, July 2009. (with Prof. P.P. Chakrabarti)

[20] Sandip Aine. Design and Control of Anytime Algorithms, September 2008. (with Prof. P.P. Chakrabarti)

[21] Pramod Singh. Multiobjective Combinatorial Optimization with Hybridization of E.A., March 2008. (with Prof. P.P. Chakrabarti)

[22] Durga Prasad Mohapatra. Dynamic Slicing of Object-Oriented Programs, September 2005. (with Prof. R. Mall)

[23] Ashok Turuk. QoS Provisioning in WDM Networks, February 2005.

* * *

Master Thesis Supervision: MTech, MS & MPhil

Graduated @ JNU

[1] Biraja Mishra. Anomaly Detection from Medical Time-Signals with Deep Learning. June 2023.
[2] Law Kumar. Hybridized Anomaly Detectors for Social Networks. June 2023.
[3] Sai Teja Tangudu. Cost-Sensitive Learning for Class Imbalance Data. June 2023.
[4] Khumaningthou Khumanthem. Interpreting outlier detection scores in ensembles. Jan. 2023.
[5] Saurabh Tewari. Social network for blended learning model. Jan. 2023.
[6] Junaciya K. Assessing generalization in medical image data. Oct. 2022.
[7] Anish Sharma. Automata modelling with recurrent neural networks. Sep. 2022.
[8] Trishita Mukherjee. Anomaly detection in complex graphs. Aug. 2022.
[9] Pooja Singh. Assessing generalization in imbalanced datasets. Aug. 2022.
[10] Gargi Mishra. Fairness in outlier detection ensembles. Aug. 2022.
[11] Surabhi Shrivastav. Abnormality detection in medical images with deep learning. Oct. 2021.
[12] Suresh Vyas. Meta-learning in ensembles. Oct. 2021.
[13] Anjali Gautam. Time series prediction with deep learning. Sep. 2021.
[14] Dipanjana De. Modelling automata by sequential neural networks. Aug. 2021.
[15] Om Prakash. Anomaly detection in social networks. July 2021.
[16] Akhilesh Rawat. Outlier detection in high dimensional datasets. June 2021.
[17] Aditya Kumar. Assessing generalization in deep learning networks. April 2021.
[18] Priti Kumar. Scientometrics of computer science publications in journals and conferences. July 2018.
[19] Neha Kumari. A framework for runtime type genericity in Java generics. July 2018.
[20] Akanksha Mukhriya. Unsupervised outlier detection ensembles. July 2016.
[21] Neeraj Pathak. Hybrid evolutionary bi-objective optimization. July 2016.

Graduated @ IIT Kharagpur

[22] Mounika Kommuri. Test-case generation for concurrent sequence transitions, May 2012.
[23] Surender Kumar. Static analysis of generic object oriented programs, May 2012.
[24] S. Harikrishnan. Space efficient multi-method dispatch in object oriented languages, May 2012.
[25] Gyan Baboo. Multiobjective combinatorial optimization with EA, May 2012.
[26] Swadhin Barisal. Safer Java Programming Language Environment, May 2011.
[27] Krunal Modi. Graph Topology Generation, May 2011. (with Nilanjan Banerjee, Univ. Ark., USA)
[28] Amit Suthar. Generation of test cases from UML diagrams using EAs, May 2010.
[29] Abhiram Kasina. Trusted Computing, May 2010.
[30] Mohammad Aslam. Multiobjective combinatorial optimization with GP, May 2010
[31] Sri Harsha Dandibhotle. Multiobjective combinatorial optimization with EAs, May 2010
[32] Siddharth Tiwary. Register Allocation May 2009. (with Prof. Jens Palsberg, UCLA, USA)
[33] Anchal Nema. Concurrent Programs, May 2009.
[34] Neeraj Kumar. OO Testing, May 2009.
[35] Kundan Singh. Synchronization and Race Condition, May 2009
[36] Paresh Tolay. Multiobjective combinatorial optimization for Graph Coloring with GP, May 2009.
[37] Bipul Kumar Bal. Multiobjective combinatorial optimization for BDMST with GP, May 2009
[38] Krishna Banka. Multiobjective combinatorial optimization with GP, May 2008
[39] Ashwin Joshi. Multiobjective combinatorial optimization with GP, May 2008
[40] Soham Chakraborty. Type analysis & optimization of O.O. Systems, Feb. 2008. [with Prof. P.P. Chakrabarti]
[41] Sanjay Chaterjee, Algorithms for post-compilation power optimization in embedded processors, Dec. 2006. [with Prof. P.P. Chakrabarti]
[42] Arnab Sarkar. Low-Overhead Real-Time Proportional Fair Scheduling, May 2006. [with Prof. P.P. Chakrabarti]

[43] T. Kalyani. Video transcoding: H.264 to MPEG-II bit-streams, May 2006. [with Prof. J. Mukherjee]
[44] Atul Bhartia. Video transcoding: Arbitrary resizing of H.264 bit-streams, May 2006. [with Prof. J. Mukherjee]
[45] Anshuman Mishra. Software watermarking scheme for Java class files, May 2006. [with Prof. P.P. Chakrabarti]
[46] Vikram Agarwal. Multiple polymorphic arguments in object-oriented languages, May 2005.
[47] M. Sreenivasulu. Code compression for performance enhancement of variable length embedded processors, May 2005.
[48] Amit Gupta. Optimizing binaries using pattern matching, May 2005.
[49] Mrinmoy Ghosh. Compiler backend generation and optimization for extensible architectures, June 2004. [with Prof. P.P. Chakrabarti]
[50] Sant Saran Gupta. Code compression in variable length RISC processors, May 2004.
[51] Arnab Roy. Simulation based verification of microprocessor pipeline simulators, May 2004. [with Prof. P.P. Chakrabarti]
[52] Vasant Patil. Video transcoding algorithms, May 2004.
[53] Anil Mangolia. Preprocessor for multimethods in object-oriented languages, Jan 2003.
[54] GK Rao. QoS support for multimedia traffic with transcoding, Jan 2003.
[55] K. Krishnakumar. RWA in WDM networks, May 2002.
[56] Arun Kumar. Modelling of multimedia traffic, May 2002.
[57] JS Rao. QoS support for multimedia traffic, Jan 2002.
[58] B. Srikanth Reddy. Modelling of multimedia traffic, May 2001.

Graduated @ BITS Pilani

[59] S. Prasanth. Network topology design using multiobjective EA, Dec 2000.
[60] MS Sudarshan. Network topology design using multiobjective EA, Dec 2000.
[61] Ishan Banerjee. Polymorphism in cipher design, Dec 2000.
[62] V. Devtha. Video temporal segmentation, Dec 2000.
[63] KL Arvind. Visual modelling, May 2000. [with Prof. I.J. Nagrath]
[64] Mayank Gupta. Hybrid learning algorithm for vector quantization, May 2000.
[65] Bhanu Prakash. Hybrid learning algorithm for vector quantization, May 2000.
[66] Vinay Seth. Finger print identification, May 2000.
[67] Vishnu Makkapati. Encoding of multi-/hyper-spectral image data, Dec 1999.
[68] Mahesh Agarwal. Face recognition, Dec 1999.
[69] SK Santhanakrishnan. Communication network topology design using multiobjective EA, Dec 1999.
[70] N. Vinay Kumar. Object oriented toolkit for multiobjective EA, May 1999.
[71] Dilip Jain. Multiobjective optimization with evolutionary algorithm, May 1998. [with Prof. N. Chakraborty]
[72] ... and several others.

* * *

Supervision of Research Associates: IIT Kharagpur

[1] Pritam Khanda. MHRD's Virtual Lab, 2010-11.
[2] Soham Chakraborty. Microsoft's Object-Oriented Technology, 2004-06.
[3] P. Sankar Muthu. MHRD's Multiobjective E.A.s for Combinatorial Optimization Problems, 2004-05.
[4] Panchali Sen. Microsoft's Object-Oriented Technology, 2003-04.
[5] Dipankar Das. NSC's Software Tools for Embedded Systems, 2003-04. (with Prof. P.P. Chakrabarti)
[6] Sandip Aine. NSC's Software Tools for Embedded Systems, 2003-04. (with Prof. P.P. Chakrabarti)
[7] Arnab Sarkar. NSC's Software Tools for Embedded Systems, 2003-04. (with Prof. P.P. Chakrabarti)
[8] Vibha Rathi. NSC's Software Tools for Embedded Systems, 2003-04. (with Prof. P.P. Chakrabarti)
[9] Sanjay Chaterjee. NSC's Software Tools for Embedded Systems, 2003-04. (with Prof. P.P. Chakrabarti)
[10] Samik Das. NSC's Software Tools for Embedded Systems, 2003-04. (with Prof. P. P. Chakrabarti)
[11] Subrat Panda. NSC's Software Tools for Extensible CompactRISC Processors, 2002-04. (with Prof. P.P. Chakrabarti)
[12] Rakesh Gupta. NSC's Software Tools for Extensible CompactRISC Processors, 2002-03. (with Prof. P.P. Chakrabarti)
[13] Mrinmoy Ghosh. NSC's Software Tools for Extensible CompactRISC Processors, 2001-04. (with Prof. P.P. Chakrabarti)
[14] Banit Agarwal. NSC's Software Tools for Extensible CompactRISC Processors, 2001-03. (with Prof. P.P. Chakrabarti)
[15] Debjit Sinha. NSC's Software Tools for Extensible CompactRISC Processors, 2001-02. (with Prof. P.P. Chakrabarti)
[16] Supratik Mazumdar. NSC's Software Tools for Extensible CompactRISC Processors, 2001-02. (with Prof. P.P. Chakrabarti)
[17] Rahul Chaudhary. NSC's Software Tools for Extensible CompactRISC Processors, 2001-02. (with Prof. P.P. Chakrabarti)

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Consultancy & Sponsored Projects

[1] *Sponsored Project* : Educational Data Mining
Funded by : UGC, Govt. of India
Period : 2018 – 19 *Amount* : INR 500 K
Principal Investigator : Rajeev Kumar *Co-Investigator* : ---

This sponsored project aimed to develop a framework for educational data mining for HEIs. In this work, Deep/Machine Learning (DL/ML) techniques were employed for knowledge extraction from voluminous data about HEIs. This project developed tools and techniques for Data-to-Knowledge (D2K) extraction.

[2] *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 introductory core course, usually done by every engineering student from all engineering branches in their first year of study. Students are introduced to the basic programming concepts and an algorithmic problem-solving approach. Since this is the first course in programming, the lab plays a critical role in understanding programming concepts and problem-solving using computers. In the absence of a lab, this course remains an abstract course. A student understands the intricacies of programming and problem-solving through the lab.

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

[3] *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 a 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 (S.E.) 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.

[4] *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 obtaining many representative, diverse solutions across the desired/optimal Pareto-front. In simple treatments, multiple objectives are combined ad hoc to yield a scalar objective. Other conventionally used optimization heuristics models 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 recast 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 to the deterministic heuristics in terms of diversity and convergence.

The outcome of this sponsored research project is reflected in many research publications. Another important spin-off of this research activity is 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.

[5] *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

[6] *Consultancy Project* : Software Tools for C.R. 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 (C.R.) National Semiconductor Corporation (NSC) processing groups located in 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 focused on software tool development for rapid reduction in the time to market a custom solution based on the C.R. family of processors. It 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, and Compilers) for customers, and rapidly explore the design space by providing tools for extensible C.R. processors (ISA verification and software toolset for CR-X). This effort also aimed to develop the Software Quality Assurance (Q.A.) framework for the tools produced by this activity.

The project activity had three primary parts: tools for CR16C, an extension of the toolset to handle the CR16C family of processors, and a scalable toolset concept for the extensible C.R. (CR-X). The CR-X activity also aimed at developing a mechanism to generate the toolset for C.R.-based processors automatically. The critical goals were to generate tests and test the software in a proper Q.A. framework. 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, and solutions to some of those culminated in several research publications.

[7] *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 that 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 aimed to extend the previous work (GALESIA, 1997) and incorporate the notion of convergence in multiobjective evolutionary algorithms (MOEA).

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