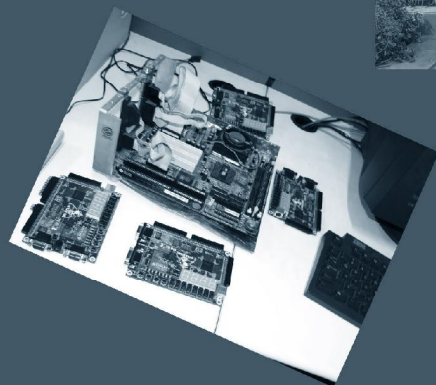




Research I Foundation

Annual Report 2006-07



Department of Computer Science & Engg.
IIT Kanpur

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RIF : Aims and Objectives

One of our alumni, Mr. N. R. Narayana Murthy, Chairman, Infosys, has created the Research I Foundation for the department with an endowment of Rupees 10 crores. The Research I Foundation board has the following members.

- Mr. N R Narayana Murthy, Chairman and Chief Mentor, Infosys
- Professor Sanjay G. Dhande, Director, IIT Kanpur
- Professor V Rajaraman, Honorary Professor, SERC, IISc
- Professor Keshav Pingali, Cornell University
- Professor Rajeev Motwani, Stanford University
- Professor Jitendra Malik, Berkeley University
- Head, Computer Science and Engineering, IIT Kanpur

The aim of Research I Foundation is to foster research in the department. To increase the research profile of the department, the foundation funds several types of research activities:

1. Visits of the department faculty members to the best research groups in the world for a period of 1-6 months.
2. Visits of internationally renowned researchers to the department for a period of up to six months.
3. Full travel support to present papers in any of the top conferences in the broad computer science and engineering area.
4. Research grants for a period of 2-3 years against proposals submitted by the faculty members of the department. This also includes an additional salary of Rs 1 Lakh per year.
5. Support for the young faculty in the form of “Research I Fellowships” for a duration of three years that includes a research grant of Rs 3 lakhs and a salary component of Rs 1.2 lakhs per annum.
6. Full support for up to 2 workshops every year in cutting edge areas.
7. *Hari Sahasrabhddhe lecture series* that has leaders in the area giving talks at IITK and a city in southern part of India.
8. Fellowship to PhD students up to Rs 20,000 per month.
9. Visits by PhD students for a semester to leading research groups around the world.
10. Employment of IIT students as research associates for up to 2 years.
11. Support to students from other colleges for summer internship in the department with a focused research agenda.
12. Support for the students in the department to present their papers in good conferences.

Research Activities during 2006-07 supported by RIF

Research I Foundation was used as a platform for supporting various research activities in the CSE department during the year 2006-07. A summary of these activities is given below. The details of these research activities are provided in the remaining part of the report.

Visits of faculty members to international research groups: Support for two faculty members was provided during 2006-07. Dr. Mainak Chaudhuri along with his M.Tech student visited the School of Electrical and Computer Engineering, Cornell university. Dr. Piyush Kurur visited the research group headed by Professor Joachim von zur Gathen at the Bonn-Aachen International Center for Information Technology, University of Bonn. Research I Foundation fully covered their travel and living expenses for these visits.

Visits of leading researcher in the world: During the year 2006-07, many internationally well known researchers visited the department. They gave seminars on their research area and also collaborated with faculty members of the department. These researchers are Dr. Matt Welsh from Harvard university, Prof. Sajal Kumar Das from university of Texas at Arlington, Prof. P. S. Thiagarajan from National university of Singapore, and Prof. Madhu Sudan from MIT.

Workshop on Algorithms for Data Streams: Prof. Sumit Ganguly organized a workshop on algorithms for data streams in the department during the period 18-20 December, 2006. World class researchers in the area of algorithms for data streams gave lectures in this workshop. A large number of faculty members and students from various engineering colleges in India attend the workshop and gave positive feedback.

Support for Research/project associates: RIF provided financial support for two research/project associates – Sayandeep Sen and Nilesch Mishra in the department.

Support for PhD students: The department provided additional fellowships to six PhD students in the department – Atul Gupta, Barna Saha, Sagarmoy Dutta, Chandan Saha, Badrinath G.S., and Vijaya Saradhi.

Workshop on Streaming Algorithms

A workshop on *Algorithms for Data Streams* was organized in the Department of Computer Sciences, IIT Kanpur from Dec 18-20, 2006. The workshop was sponsored by funds from the Research I foundation. The workshop on Algorithms for Data Streams was conceived along the broad charter of Research I foundation of providing impetus to cutting-edge research in active areas in Computer Science in order to boost the current research interests and productivity within the department. In view of current research activity in the area of Data Stream processing, and its wide-spread applicability in multiple disciplines, including, Database Systems, Networking, Data Mining and World-wide-web applications, it was decided to hold a workshop in this area. Professors Manindra Agrawal and Sumit Ganguly coordinated the efforts for the workshop at IIT Kanpur. The workshop was organized along the lines of established Dagstuhl seminar series in Germany. Professors Sudipto Guha (University of Pennsylvania) and Professor S. Muthukrishnan (Rutgers University) were invited to function as co-organizers of the workshop. The goal was to bring to the IIT Kanpur campus as many of the world's top researchers in this area as we could. Simultaneously, we also wished to invite participation from many notable academic institutions of India, including, IISc, all the IITs, NITs, CMI, Math Sciences, and a few other institutes. In view of this, it was decided that the workshop would bear the cost of economy air-travel of all the international speakers, and bear 2AC train fare for faculty and 3AC train fare for students. Room and board of all guests were covered by the workshop. In view of the limited capacity of lecture halls and guest rooms, attendance of the



workshop was restricted by invitation only. Students and faculty of IIT Kanpur were welcome to attend. A post-workshop one day bus-trip to Agra was also held for the international speakers.

Participation: We were very fortunate to have in attendance, almost all the top researchers in the area of data streaming. A complete list of the speakers and a brief summary of their talks are

given later. There were 22 international speakers from US and Europe and two speakers from IIT Kanpur. [A speaker from IIT Delhi unfortunately could not make it.] There were about 80 delegates, both faculty and students, from colleges all over India, including, NIT Calicut, IIIT Hyderabad, IIIT Allahabad, Engineering College Bareilly, NIT Allahabad, NIT Jaipur, BITS Pilani, IIT Bombay, TIFR Bombay, College of Engineering Pune, College of Engineering Madurai, GSITS Indore. The international delegates were accommodated in the IIT Kanpur Visitors' Hostel and the Visiting Faculty Apartments. Delegates from India were accommodated in the rooms in Halls of Residence 5 and Girls' Hostel. We had a dedicated team of student volunteers, led by Vijaya Saradhi, PhD candidate, who coordinated the task of local arrangements, hospitality and travel reimbursements during the entire period of the workshop.

Technical summary: Data Streams processing pertains to very efficient monitoring of fast arriving data, such as network TCP/IP data, sensor data, etc., for anomalies (e.g., fingerprints of denial of service attack), patterns or user-programmed predicates for detecting high-level events. Approximation algorithms and randomized techniques have been invented in the last decade or so to address these problems. The field has gained impetus from a convergence of concerns in multiple application areas, including, approximate query processing and query estimation in Database Systems, telecom network monitoring, financial data monitoring, sensor networks, etc.

The technical topics were divided into several areas. In each area, there was one overview lecture of about an hour, followed by more in-depth talks by each speaker. The principal areas were (a) Data Streams: origins and algorithmic techniques, (b) Lower bounds: results and techniques, (c) Streaming Computational Geometry, (d) Data Stream processing for Networks, databases and the web, (e) Machine learning and streaming, (f) Databases and the Web, (g) Compressed Sensing, and (h) Graphs as Streams. In addition, a very interesting session on open problems and directions was organized at the close of the second day of the 3-day workshop.

The workshop was inaugurated by Director of IIT Kanpur, Professor S.G. Dhande. An inspiring technical overview of the area was given by Professor Yossi Matias, TelAviv University and Google, Inc., one of the seminal contributors to the area and the recipient of the Gödel Prize for this work. In the area of algorithmic techniques for data streams, Prof. Amit Chakrabarti, Dartmouth University, USA spoke on estimating entropy, Prof. Sudipto Guha, University of Pennsylvania USA, on Order and Information; Prof. Rajeev Raman, University of Leicester UK on algorithms for the reset model; Prof. Srikanta Tirthapura, University of Iowa, USA on estimating the number of distinct elements in a range; Prof. Ravi Kumar, Yahoo! Research, USA, on estimating the number of distinct elements in a stream; and Prof. Sivakumar, Google Inc., USA on multi-pass sketching. In the area of Computational Geometry and Streams, Prof. Piotr Indyk, MIT presented an overview. Prof. Subhash Suri, University of California Santa Barbara, USA spoke on algorithmic techniques for low dimensional geometric streams; Prof. Pankaj Agarwal, Duke University, USA spoke on space-optimal algorithms for computing coresets over stream of two-dimensional points and Prof. Christian Sohler, University of Paderborn, Germany, presented his work on clustering geometric streams.

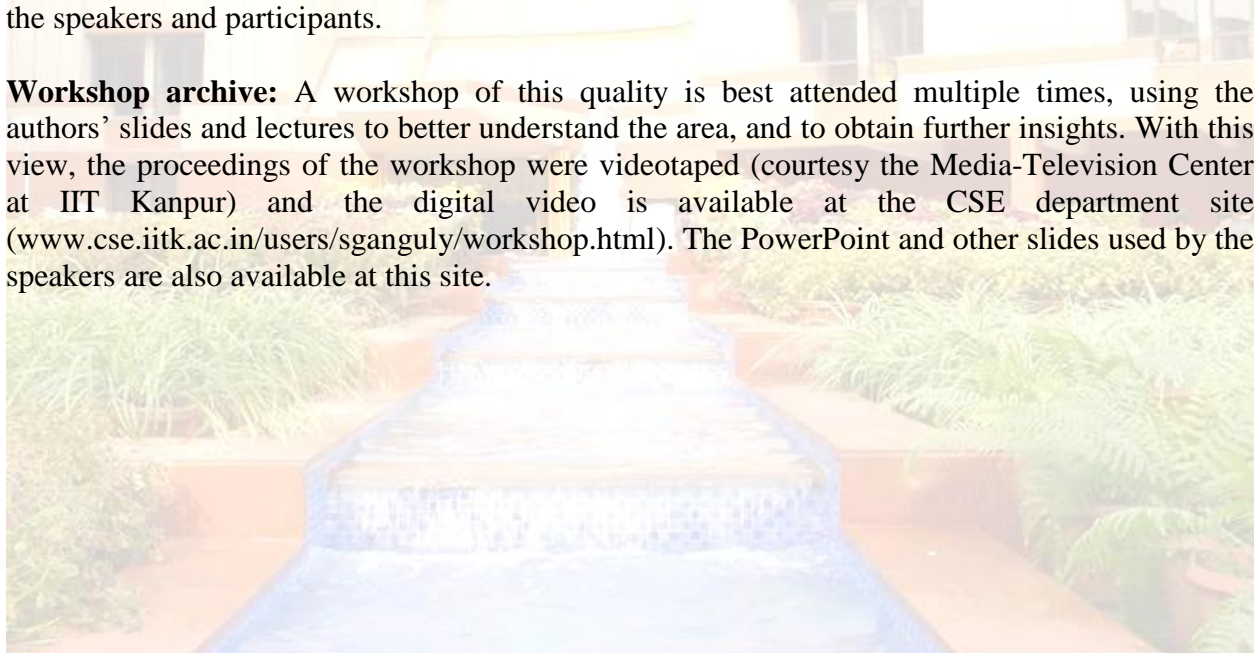
In the area of applications of data streams to Networking, Database Systems and the World-Wide-Web, Dr. Divesh Srivastava from AT&T Research, USA spoke about challenges in practical processing of streaming data at network line speeds. Prof. S. Muthukrishnan from Rutgers University and Google discussed the applications of stream processing in WWW searching, indexing and clustering. The area of lower bounds for problems in the streaming model is a fascinating subject as it helps prove the minimum computing resources required

to solve problems. In this area, we were given an overview talk by Dr. T.S. Jayram, from IBM Research, California, USA. Prof. Nicole Schweikardt, Humboldt-University, Berlin presented her work on lower bounds for query processing on streaming data and external memory data. Dr. Andrew McGregor, University of California, San Diego, USA presented a talk on the intersection of machine learning and data streams.

Graph algorithms over streaming edges have been an active area of research. The overview talk in this area was given by Prof. Sampath Kannan, University of Pennsylvania, Philadelphia, USA. Dr. Surender Baswana gave a lecture on algorithms for computing approximate spanners over streaming graphs. The area of processing matrix data for numerical and non-numerical analysis via data reduction techniques (e.g., sampling) has gathered momentum in recent times. A wonderful lecture on this topic was given by Prof. Ravi Kannan, Yale University, USA. Dr. Michael Mahoney, Yahoo! Research, USA, presented a lecture on Sampling Algorithms and Coresets for L_p regression and applications. Finally, the less structured session on discussions and open problems presented a very fascinating series of presentations, by Piotr Indyk from MIT, Sudipto Guha from University of Pennsylvania, and Sumit Ganguly from IIT Kanpur, Pankaj Mehra from HP Labs, D. Sivakumar from Google Inc., Yossi Matias from Google Inc., Sampath Kannan from University of Pennsylvania along with comments by others.

The workshop ended with a vote of thanks by the organizers to the sponsor, Mr. Narayan Murthy, to the IIT Kanpur student volunteers who helped facilitate the event, and to all the speakers and participants.

Workshop archive: A workshop of this quality is best attended multiple times, using the authors' slides and lectures to better understand the area, and to obtain further insights. With this view, the proceedings of the workshop were videotaped (courtesy the Media-Television Center at IIT Kanpur) and the digital video is available at the CSE department site (www.cse.iitk.ac.in/users/sganguly/workshop.html). The PowerPoint and other slides used by the speakers are also available at this site.



Scientific Visits of Researchers

Dr. Matt Welsh



Dr. Matt Welsh is an assistant professor in the Division of Engineering and Applied Sciences at Harvard University. His current research is in the area of operating systems, networks, and language support for large-scale distributed systems. He visited IIT Kanpur from August 1-31, 2006.

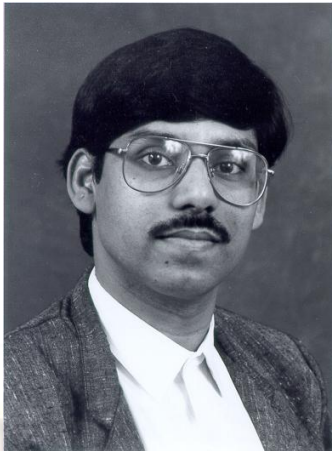
Research collaboration and related activities:

One of the chief purposes of his visit was to make contacts at the IITs, as well as to get direct exposure to the Indian educational system and burgeoning IT industry. On research front, he interacted with Dr. Bhaskaran Raman (and Dr. Chebrolu from the EE department) and their students, who have a number of projects that intersect directly with his interests: wireless communications and sensor networks. He delivered several lectures during his visit. He gave two talks to the CS department as a whole on various research topics: his work on volcano monitoring sensor networks, and a general research talk on virtual machines. He also delivered two guest lectures in the Operating Systems course (the equivalent of which he teaches at Harvard), on the mechanics of processes and threading in the Linux operating system.

Future Interactions:

Dr. Welsh hopes that his stay has laid the groundwork for a continued relationship with IIT Kanpur. The project on developing sensor network platforms for monitoring volcanic eruptions that his group has been working on at Harvard has much in common with one of Dr. Raman's projects, involving wireless sensors for railway bridge monitoring. The two groups have remained in contact and continue to assist each other on these development efforts after his return. He also told that as a result of his visit, there have been discussions within the EECS faculty at Harvard about starting up a summer internship program for foreign students, specifically targeted at students from IIT. He has expressed warm willingness to host a visit to Harvard by faculty from IIT Kanpur.

Prof. Sajal Kumar Das



Prof. Sajal Kumar Das is the director of the Center for Research in Wireless Mobility and Networking ([CReWMaN](#)). He is also a Professor in the department of Computer Science and Engineering, University of Texas at Arlington. He is also an adjunct faculty member of the CSE department at IIT Kanpur. His current research is in the area of cellular mobile communication and computing, wireless multimedia, sensor networks/computer security, broadband networking, parallel and distributed processing. He visited the CSE department during July 15 - August 9, 2006.

Research collaboration and related activities:

Prof. Das continued research collaboration with Prof. R. K. Ghosh and his students on wireless sensor networks. This effort led to following joint work.

1. G. Das, R. K. Ghosh and S. K. Das, "On Designing Zero Overhead Protocols: Cooperation and Holistic Scheduling in Wireless Sensor Networks," submitted to IEEE Journal on Selected Areas in Communications, Aug 2006.
2. P. Agrawal, R. K. Ghosh and S. K. Das, "An Efficient Localization Scheme for Wireless Sensor Nodes using Proximity and Multilateration," to be submitted to IEEE International Conference on Distributed Systems (ICDCS 2007) by Oct 2006.
3. G. Das, R.K. Ghosh and S. K. Das, "Routing in Wireless Sensor Nodes With or Without Short-Cuts," to be submitted to ACM International Conference on Information Processing with Sensor Networks (IPSN 2007) by Nov 2006.
4. P. Agrawal, R. K. Ghosh and S. K. Das, "Security in Wireless Sensor Networks," under preparation.

Additionally, Prof. Das initiated preliminary collaboration with Prof. Phalguni Gupta on integrating sensor networks with Biometrics research for developing novel techniques and systems for national security. He visited Prof. Gupta's Biometrics Lab and had intense discussions with his group. Prof. Das had also exciting discussions with Prof. S. Biswas and Prof. H. Karnick on Systems Biology and Bioinformatics research. They exchanged papers to understand each other's work, with the goal of initiating future collaboration. Finally, Prof. Das discussed with Prof. D. Sanghi on network security as well as wireless mesh networks. Prof. Das also delivered a seminar talk on August 4, 2006 on his current research. The title of the talk was "Information Intensive Wireless Sensor Networks: Challenges and Solutions." As an Adjunct Professor of the CSE department, Prof. Das remotely co-supervises Piyush Agrawal working under Prof. Ghosh. During this visit, he met with Piyush on a regular basis to complete a couple of joint work ([2, 4] above). He also advised another student of Prof. Ghosh on building trust models in a grid computing environment, and a couple of students of Prof. Gupta on how to extend biometrics research to sensor networks.

Prof. Madhu Sudan



Prof. Madhu Sudan is a Fujitsu Professor of EECS at Massachusetts Institute of Technology (MIT). Madhu Sudan's research interests include computational complexity theory, algorithms and coding theory. He is best known for his works on probabilistic checking of proofs, and on the design of list-decoding algorithms for error correcting. Madhu Sudan is a recipient of numerous awards including the ACM Doctoral Dissertation Award (1992), the IEEE Information Theory Society Paper Award (2000), the Gödel (2001) and the Nevanlinna Prize (2002). He visited IIT Kanpur from Jan 1-13, 2007.

Research activities:

Professor Sudan principally explored directions in algebraic computation with Professor Manindra Agrawal. These discussions spanned many diverse topics and were meant to be exploratory to find topics for future research. Some of the topics explored included:

- *New approaches for factoring integers:* The topic of factoring integers is a long-standing open problem in mathematics. Professors Agrawal and Madhu Sudan considered the possibility of using information from the AKS algorithm for testing primality to factor non-prime numbers. They also explored the possibility of using lattice reduction algorithms and list-decoding algorithms for factorization.
- *Algebraic approaches to the graph isomorphism problem:* This work was inspired by recent algorithms of Prof. Agrawal's group reducing graph isomorphism to several ring homomorphism problems. The graph isomorphism problem is a classical open problem in computational complexity, whose resolution would be considered a major breakthrough.
- *Probabilistically checkable proofs (PCPs) and locally decodable codes (LDCs):* Professors Madhu Sudan and Agrawal also discussed some of the recent results in PCPs and LDCs that are based on algebraic methods and discussed the possibility of improving some constructions.

On the non-algebraic side, Professors Madhu Sudan and Sumeet Ganguly discussed the possibility of using the concept of universal semantic communication to resolve some fundamental problems in heterogeneous databases. On the whole, while the discussions did not lead to any new results, they were very illuminating in suggesting many directions for joint work in future. During his visit to the Institute, Prof. Madhu Sudan gave three public lectures: The first was a guest lecture in a freshman seminar course. The second was a departmental colloquium addressed to computer scientists broadly (and attended by several members outside the department as well). The last was a technical talk on some new results in theoretical computer science. The specific details are as follows:

- *Error-correcting codes.* 09-01-2007 (9am). Guest lecture in freshman seminar (D-0) run by Prof. Dheeraj Sanghi.
- *Universal Semantic Communication* (based on joint work with Brendan Juba). 09-01-2007 (5pm), hosted by Prof. Manindra Agrawal.
- *Algebraic Property Testing* (based on joint work with Tali Kaufman). 10-01-2007 (4pm), hosted by Prof. Manindra Agrawal.

Dr. Mainak Chaudhuri



Dr. Mainak Chaudhuri is an assistant professor in the department of CSE, IIT Kanpur. Mainak's research interests include parallel computer architecture, scalable cache coherence protocols, intelligent memory controller architecture, microarchitecture, and performance modeling and evaluation. He visited Cornell University with his Master of Technology student Mr. Arkaprava Basu during the period 20th June, 2006 to 20th July, 2006. Both of their travel and stay were funded from the Research I Foundation grant.

Research Collaboration and Activities:

The central focus of the visit was to strengthen the existing research collaboration in the general area of computer architecture with Professor Jos'e Mart'inez of the School of Electrical and Computer Engineering. The visit was useful. They started working on an extension to the paper that they published together in 2005. The focus of this research was to address the bottlenecks that Dr. Mainak had discovered during their past collaboration. They used to meet regularly for group meetings involving one more PhD student from the Computer Systems Laboratory. The major part of the month-long visit was spent formulating the problem, coming up with a preliminary design, and setting up the simulation infra-structure. When Dr. Mainak left Cornell they had a somewhat clear idea about what the final architecture would look like and what the performance-critical components would be. After returning to Kanpur, Dr. Mainak continued working on the problem. At the time of this writing, He had completed designing one of the two critical components of the architecture. This component proposes a novel victim cache architecture sitting between the last level of cache and the memory controller. He has devised a novel skewed Bloom filter architecture coupled with a min-heap based cache block reuse frequency ranker to decide which of the evicted cache blocks should be put in the victim cache. The second component of the design involves improving the state-of-the-art load value predictors used in the final architecture. He will work on this over the next couple of months. On the non-academic front, Dr. Mainak's visit was a reunion with some of his old mentors, friends, and colleagues at Cornell. He also met some of his teachers at Cornell and had academic as well as non-academic (these were eye-openers) discussions with them.

Prof. P. S. Thiagarajan



Prof. P.S. Thaigarajan is a professor in the school of computing of National University of Singapore. He served two terms (1997 - 2003) as a member of the Governing Council of the *European Association for Theoretical Computer Science (EATCS)*. He is a Fellow of the *Indian Academy of Sciences* and the *Indian National Academy of Sciences*. His current research interests are: System-level design methods for embedded systems, real time and hybrid systems and computational systems biology. He visited IIT Kanpur from May 1-6, 2006.

Research Activities:

During this visit he engaged principally in research discussions with Professor Manindra Agrawal and Dr. Anil Seth on topics in Hybrid Automata and Logic. He also gave a seminar on his work. Hybrid Automata are used to model digital control of continuously evolving systems, e.g., chemical plants. One of the most important questions here is that given such an automata, how one certifies that it correctly controls the plant. In an earlier work, Professors Thaigarajan and Manindra Agrawal had shown how to do this certification for certain types of automata. The discussion this time centered on trying to enlarge the class of automata for which certification is possible. With Dr Anil Seth, Professor Thaigarajan worked on designing a logic to reason about (temporal) behavior of objects in such interacting process classes. After making the semantics of this logic precise, they quickly found that such logics have undecidable satisfiability and model-checking problem. Then they started work on some variants of these logics which may have decidable model-checking problem. Professor Thiagarajan also gave a talk on Interacting Process Classes. These are classes of interacting objects in reactive control systems where the objects belonging to a class exhibit similar behavior. He proposed a modeling and simulation technique for interacting process classes. Control flow in a process class is captured by a labeled transition system and unit interactions by MSCs. The execution semantics in the proposed approach leads to a symbolic simulation technique which is both time and memory efficient.



Dr. Piyush Kurur



Dr. Piyush Kurur is an assistant professor in the department of CSE at I.I.T. Kanpur. His research interests are in the area of Complexity Theory, Algorithms, and Quantum Computing. He visited the research group headed by Professor Joachim von zur Gathen at the Bonn-Aachen International Center for Information Technology, University of Bonn. The visit was from June 10, 2006 to September 12, 2006, and was funded by Research I Foundation.

Research Activities:

One of the central problems in algebraic complexity is the asymptotic complexity of multiplying $n \times n$ matrices. Starting with the work of Strassen [5], there has been considerable progress in trying to bound the exponent of matrix multiplication with the current bound being $\omega \leq 2.38$ proved by Coppersmith and Winograd [4]. During the visit Dr. Kurur had a detailed study of the complexity of matrix multiplication. Recently Cohn *et al.* [2,3] have developed a new approach towards designing fast matrix multiplication algorithms. The key ingredient in their approach is to construct groups G and subsets S_1, S_2 and S_3 of G such that for any triple $q_i \in S_i^{-1}S_i, i = 1,2,3$ we have $q_1 q_2 q_3 = 1$ if and only if $q_i = 1$ for all i . He attempted to construct examples of such subsets via computer search. He also worked on problem of counting polynomials over integers. Given a bound H , one is interested in the number of polynomials in $\mathbb{Z}[X]$ with coefficients of absolute value bounded by H that satisfy certain property (for example being irreducible or having full Galois group). Let $G_n(H)$ denote the number of degree n polynomials with Galois group S_n . It was proved by van der Warden that as n increases for $H > e^{n^2}$, $G_n(H) \approx H^n$. However for smaller H 's the bounds are not tight. Currently they are working to tighten these bounds. Dr. Kurur also participated in the workshop on Cryptography ("crypt@bit" 2006) held in B-IT during 17-21 July 2006 and attended *Mathematical Foundations on Computer Science, 2006* (MFCS06), Stara Lesna, Slovakia to presented a contributed paper [1].

[1] V. Arvind and Piyush P Kurur. *A Polynomial Time Nilpotence Test for Galois Groups and Related Results*. In 31st International Symposium on Mathematical Foundations of Computer Science, 2006.

[2] Henry Cohn, Christopher Umans. *A Group-Theoretic Approach to Fast Matrix Multiplication*. FOCS 2003, pages 438-449.

[3] Henry Cohn, Robert D. Kleinberg, Balázs Szegedy, Christopher Umans. *Group-theoretic Algorithms for Matrix Multiplication*. FOCS 2005, pages 379-388

[4]{coppersmith1987matrix} D. Coppersmith and S. Winograd. Matrix multiplication via arithmetic progression. In *19th annual ACM Symposium on Theory of Computing, STOC*, pages 1--6. 1987.

[5] V. Strassen. *Gaussian Elimination is not Optimal*. Numer. Math. 13, p. 354-356, 1969.

Project/Research Associates supported by RIF

Sayandeep Sen



Sayandeep Sen is a research associate supported by RIF at the department of CSE, IIT Kanpur. He completed his M. Tech in 2006 from the same Department. He works under Dr. Bhaskaran Raman and Dr. Kameswari Chebrolu. He has been involved in RuralNet (a.k.a Digital Gangetic Plains) project. The goal of the project is to develop low-cost technologies for building a long distance wireless access network for rural India. The project is under the aegis of [Media Labs Asia Kanpur-Lucknow Branch](#).

Research Contribution:

Sayandeep Sen has been working on WiFi-based Rural Data ACcess and TELephony (FRACTEL) project since August 2006. This work builds on his Master's thesis and the lessons from the earlier measurement studies carried out in Digital Gangetic Plains project. It involves designing and deploying a planned WiFi-based rural mesh network. The project aims to provide voice/data services to each house in a village. The target deployment setting constrains the network to be cost, power and bandwidth efficient. As part of the project, along with another graduate student he has carried out extensive experiments to characterize the wireless media for medium distance (up to a kilometer) settings. These measurement studies have shown that a) under certain constraints link abstraction holds for community mesh links (contrary to current wisdom), and that b) current mesh deployments can be "planned" for predictable performance. This in turn makes current research issues in ad-hoc/ mesh networking like designing intelligent routing metrics redundant for our settings. A paper based on our observations and findings is under review at SIGCOMM'07. He has been currently working on the formulation of the network architecture and the design of MAC and routing protocols for the above networks. In addition, until the month of November 2006, he worked on extending his Master's thesis. This involved designing algorithms for planning long distance wireless networks. The work was accepted for publication in WWW'07 conference (acceptance rate 14.4 %). He has also presented the work in a panel discussion on "Cost Effective Wireless Innovations" at the Airjaldi Summit.

[1] Sayandeep Sen and Bhaskaran Raman. *Long Distance Wireless Mesh Network Planning: Problem Formulation and Solution*. To appear in the 16th Annual International World Wide Web Conference (WWW 2007), May 2007, Banff, Canada. [Acceptance rate: 14.4%]

Nilesh Mishra



Nilesh Mishra is a Senior Project Associate supported by RIF in the CSE department of IIT Kanpur since the fall of 2006. Prior to that, He completed his undergraduate (B.Tech) and postgraduate (M.Tech) studies in the same department as part of the Dual Degree curriculum. His research interests include Sensor & Wireless Networks, and System Design.

Research Contribution:

Nilesh's work has been primarily in the domains of "Power management of 802.11 mesh networks" and "Structural Health Monitoring of Railway Bridges using Wireless Sensor Networks". More specifically, they are developing a low cost automated structural health monitoring system which can be deployed on a country wide scale. Continuing the work on a previous paper titled Wake-on-WLAN [1] the short comings of the design were taken care of. This work was subsequently presented as a paper [2] and a poster[3]. A poster titled "Wake-on-WLAN" [4] was also presented at Microsoft Research India's TechVista'07 where it won the "Best Poster Award" of Rs. 1,00,000 amongst 24 entries from PhD and M. Tech students of IITs, IISc and other premier institutes in India. The BriMon project [5] at IIT Kanpur is designing a cost effective structural health monitoring application for autonomous and on-demand monitoring of remote railway bridges. Working as a part of a team the design has been taken to a prototype stage which can be deployed and tested on a bridge. This work was presented as a poster [6] in Wisard'07 at Bangalore and won the "Best Poster Award" and prize of Rs 10,000.

[1] Nilesh Mishra, Kameswari Chebrolu, Bhaskaran Raman, and Abhinav Pathak. *Wake-on-WLAN*. Appeared in the 15th Annual International World Wide Web Conference (WWW 2006), May 2006, Edinburgh, Scotland.

[2] Nilesh Mishra, Dheeraj Golchha, Akhilesh Bhadauria, Bhaskaran Raman, Kameswari Chebrolu. *S-WOW: Signature based Wake-on-WLAN*. To appear in the First Annual Workshop on Wireless Systems: Advanced Research and Development (WISARD 2007), A COMSWARE 2007 Workshop, Jan 2007, Bangalore, India.

[3] Nilesh Mishra, Akhilesh Bhadauria, Dheeraj Golchha. *S-WOW: Signature based Wake-on-WLAN*. Presented as a poster at The First Annual Workshop on Wireless Systems: Advanced Research and Development (WISARD 2007), A COMSWARE 2007 Workshop, Jan 2007, Bangalore, India.

[4] Nilesh Mishra, Raj Kumar, Phani Kumar, Hemanth Haridas. *BRIMON: Railway BRIDGE MONitoring*. Presented as a poster at The First Annual Workshop on Wireless Systems: Advanced Research and Development (WISARD 2007), A COMSWARE 2007 Workshop, Jan 2007, Bangalore, India.

[5] <http://www.cse.iitk.ac.in/users/braman/brimon.html>

[6] Nilesh Mishra. Poster session. *Wake-on-WLAN*. Appeared in Tech Vista 2007 - Microsoft Research India's annual research symposium.

PhD Students supported by RIF

Atul Gupta



Unit Testing of Object-Oriented Programs:

Unit testing is normally the first formal test activity performed in the software life cycle and it occurs during the implementation phase after each program unit is finished. Unit testing is an efficient method of detecting and isolating defects in individual units of code. A program unit can be one class, a group of classes, or a subsystem in the object-oriented software-system being developed. As unit testing helps in detecting most of the defects injected during coding, it is critical to ensuring the final quality of the completed system. In this work, we aim to study some important issues relating to unit testing- like assessing efficiency of the unit testing process along with its effectiveness, where it is more effective when done in conjunction with inspection, whether it is helpful to write unit test cases before and after coding, and how to generate unit test cases automatically.

Badrinath G. S.



Computer Networks:

There are several research projects that I plan to focus on in the future that are novel, challenging and important to the networking field, in particular Wireless Sensor Networks. Although the broad area of sensor networks has received much attention in the recent past, I believe that design of such networks is highly application specific. I plan to explore specific applications by designing and building prototypes. Examples of possible applications include: environment monitoring (e.g. river pollution), habitat monitoring (for endangered species), and structure health monitoring (of buildings and other constructions). One more critical requirement for applications on top of next generation networks is end to end real-time services on wireless networks. Real-time services requirement is further evidenced by the fact that distributed real time systems and services have been identified as a critical component of NSF's Global Environment for Network Innovations (GENI) program. Unfortunately, meeting the real-time requirement also happens to be one of the most challenging issues facing the networking community because of the limited bandwidth and also energy constrained in wireless sensor networks. This clearly imposes physical and unavoidable restrictions of wireless sensor networks are far from capable to support real-time services. What is needed is the design of radically new architectures, methodologies and protocols to meet this demand. I am considering this exciting new area as an important focus of my research.

Barna Saha



Streaming Algorithms:

In Data streaming model voluminous data arrive rapidly and continuously in the form of a stream. In this model system has no control over the order in which data arrives and a data once discarded cannot be obtained again for processing. Consequently algorithms for processing such data-streams need to create on-the-fly concise summary of the stream and give answers (may be approximate) in time-efficient manner. There is a growing interest in designing algorithms in this model due to its many applications in the domain of networking, database, mining, scheduling etc. Many of the problems arising in these applications are NP-Hard in nature and one can only expect (even in offline) to have approximate answers for them in polynomial time. Naturally to come up with approximation algorithms for these problems in such a restricted model is far more difficult. Our aim is to design a common paradigm for streaming algorithms (for example: LP, randomized rounding are two very common techniques in the field of offline approximation algorithm) to tackle this kind of problems efficiently. We are currently looking into some famous NP-Hard problems like Set Cover, Weighted Vertex Cover and 0-1 Knapsack in streaming setting to find out any common trend in these algorithms, which can be explored further to discover a generic technique to solve a large class of NP-Hard problems in data streaming model.



Chandan Saha



Theoretical Computer Science:

I am working in theoretical computer science with primary emphasis on a couple of broad research areas: 1. Computational Number Theory with applications in Cryptography and Coding Theory; and 2. Randomized Algorithms. In computational number theory, I have been working on the problem of 'finding an efficient algorithm for polynomial factorization over finite fields' with some progress. I am also studying the subject Algebraic Number Theory that serves as a useful tool in handling problems in this area. Presently, I am also working towards improvement of a bound given by a randomized algorithm called 'Go With the Winners' algorithm. I am planning to continue research in these areas for partial fulfillment of my doctoral research activities.

Sagarmoy Dutta



Quantum Interactive Proof System:

It is a computational model where two parties, a prover and a verifier, solve a problem by exchanging quantum information and performing quantum mechanical operations on the data and finally measuring it. Problems can be categorized into complexity classes depending on how many rounds of information transfer is performed. In spite of two strong result that (i) the classical interactive proof system has been shown to be equivalent to polynomial space and (ii) polynomially many quantum interactions reduces to only three interactions (which is not true classically) , it is not known whether any bound better than exponential time exists for QIP. I am trying to see whether this bound can be made tighter. It is also not known whether one, two and three interaction proof classes are distinct. Considering more than one prover and shared entanglement them as resources one can talk of other classes also. It is known that polynomially many entanglements does not make any difference. But it is still open to figure out what happens if unlimited entanglement is allowed.



Vijaya Vedula Saradhi



Kernel Methods:

Kernel methods have gained prominence in the field of machine learning due to their promising generalization performance. Classification is achieved by finding the best hypothesis in a mapped feature space. However, there are several problems with kernel methods. These include: (1) obtaining the best hypothesis (2) high classifier complexity and (3) choosing the 'best' mapping for the optimal generalization error. The primary focus of this work is to propose some improvements to kernel methods to address the above problems. Kernel methods that have been studied in this thesis are (1) support vector data description (SVDD) for one-class classification problems (2) support vector machines (SVMs) and (3) learning the kernel matrix (LKM) for multi-class classification problems.

Future Plans

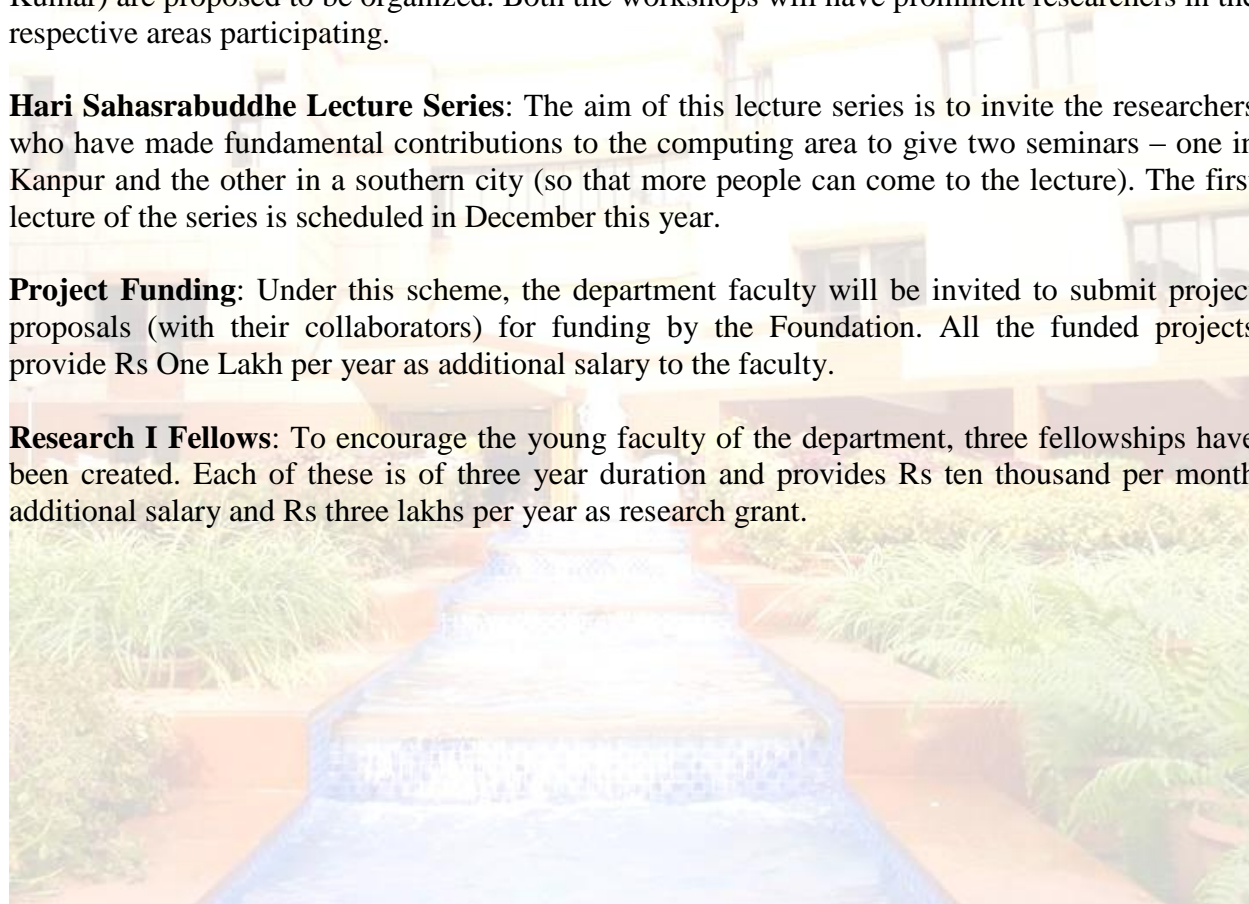
In the year 2007-08, several activities are planned to be funded by the Foundation. The prominent amongst these are:

Workshops: Two workshops, one in Computational Biology (organized by Somenath Biswas and Harish Karnick) and the other in High Performance Computing (organized by Sanjeev Kumar) are proposed to be organized. Both the workshops will have prominent researchers in the respective areas participating.

Hari Sahasrabuddhe Lecture Series: The aim of this lecture series is to invite the researchers who have made fundamental contributions to the computing area to give two seminars – one in Kanpur and the other in a southern city (so that more people can come to the lecture). The first lecture of the series is scheduled in December this year.

Project Funding: Under this scheme, the department faculty will be invited to submit project proposals (with their collaborators) for funding by the Foundation. All the funded projects provide Rs One Lakh per year as additional salary to the faculty.

Research I Fellows: To encourage the young faculty of the department, three fellowships have been created. Each of these is of three year duration and provides Rs ten thousand per month additional salary and Rs three lakhs per year as research grant.





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