IBM Research - India

2014 Internship Program

Introduction

Curiosity has a way of finding answers.

Nowhere does this ring truer than at IBM Research-India, the premier software and service research facility of its kind in the Eastern hemisphere.

Since our inception in 1998 in Delhi, our single-minded mission has been to advance the state-of-the-art in information technology, through research in systems, software and services, in order to deliver innovations that not only bring tangible value to IBM's clients, but also positively impact individuals and communities, businesses and industries and society at large.

Co-located in New Delhi and in Bangalore (since August 2005), the IBM Research-India Lab are involved in a wide array of research areas, and boasts of a long list of achievements, in areas like high-performance computing, mobile-enabled emerging technologies, building enterprise resiliency, modelling natural disasters, bridging the digital divide, analytics and human language technologies…to mention just a few.

Key service innovations include Voice of Customer Analytics for contact centers, Recruiting, Staffing under Uncertainty and Business Contingency Planning technologies for workforce management, Application Assembly Optimization for streamlining global delivery, and Defect Prevention.

We owe much of our success to our culture of innovation, that thrives on global collaboration and our unmatched talent pool of world class researchers most of who are PhDs from premier global institutes like Cambridge, Carnegie Mellon, Cornell, Georgia Tech., IIT, IISc, INRIA, Stanford, University of California Berkeley, University of Maryland and Yale.

It is the curiosity displayed by these minds – the curiosity to explore uncharted frontiers and to push the innovation envelope-that is the driving force behind our achievements.


CURIOSITY
WANTED

Internship Opportunities

IBM Research – India (Bangalore & New Delhi)

We invite applications for our 2014 Internship Program in Computer Science, Mathematical Sciences and Services Science, Management & Engineering at its locations in New Delhi and Bangalore. We are seeking highly motivated graduate students, who are interested in experiencing an exciting summer of research. The selected students will have the opportunity to work closely with an outstanding research team on challenging problems that range from leading-edge exploratory work to prototyping real-world systems and applications. During the internship, the students will also have the opportunity to participate in the dynamic technical environment of the largest industrial research organization in the world and network with other students in different fields from other universities.

At a high level, our internships serve a dual purpose:

- Interns bring in fresh ideas and perspectives to the lab and help us conduct world-class research, thus creating impact.
- IBM Research provides interns an environment where they experience a world-class industrial research setting.

We measure the success of our internships in one of the following ways:

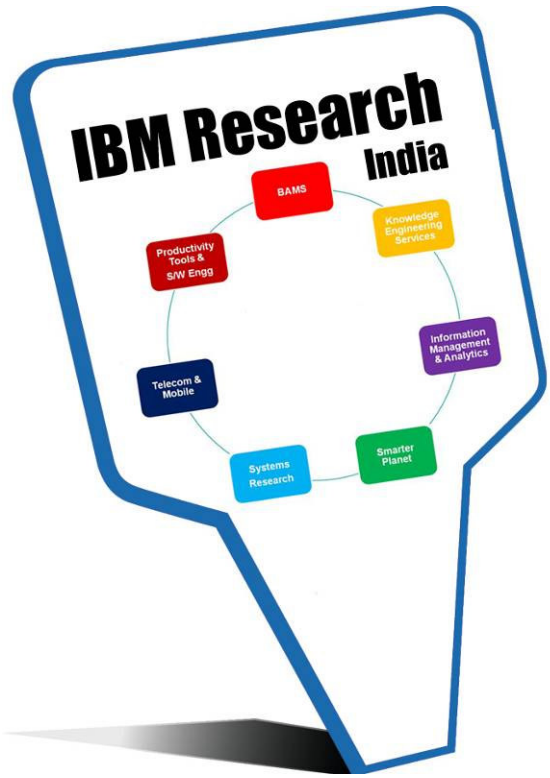
- Projects done at internships are targeted towards top conferences and journals. Most of our interns have been successful in the past in publishing their papers in top conferences.
- Projects completed during the internships become part of larger research projects at IBM.
- The projects that the students participate in are also of interest to the universities that they come from and help increase collaborations with the universities.


CURIOSITY
WANTED

Areas of Research

We offer internship positions in various research areas such as:

- **Business Analytics and Mathematical Sciences**
  - Mathematical Programming and Combinatorial Optimization
  - Stochastic Modeling and Optimization
  - Scalable Machine Learning and Online Computation
  - High Performance Computing & Analytics
  - Scientific Computing & Modeling Using Coupled PDEs
  - Game Theory and Mechanism Design
- **Information Management and Analytics**
  - Big Data Processing
  - Social Media Analytics
  - Cleansing Noisy Data
  - Spatio-Temporal Data
  - Information Fusion @ Scale
  - Information Integration and Entity Resolution
  - IT Operational Analytics
  - Information Trust and Security
  - Network Analytics
- **Knowledge Engineering Services**
  - Natural Language Processing
  - Information Retrieval & Extraction
  - Text Analytics
  - Machine Learning & Machine Translation
- **Mobile & Telecom Research**
  - Telecom and Mobile Analytics
  - Telecom Infrastructure and Middleware
  - Mobile Application Development Environments and Run-time
  - Mobile Device and Application Management
  - Context-aware Services
  - Machine to Machine
  - Mobile Enabled Solutions for industries
- **Programming Technologies and Software Engineering**
  - Software Testing
  - Debugging and Program Repair
  - Mining Software Repositories
  - Programming the Web
  - Software Security
- **Smarter Planet Solutions**
  - High-performance computing
  - Weather & climate modeling
  - Renewable energy
  - Power systems
  - Machine learning
  - Optimization
  - User Interface/Experience Design
  - Embedded systems
- **Systems Research**
  - Cloud Computing
  - Distributed Systems
  - Systems (Network, Storage, Servers)
  - Software Defined Networking
  - Data Center Networking
  - Wireless Architecture



Business Analytics & Mathematical Sciences

The Business Analytics and Mathematical Sciences (BAMS) department conducts research in Optimization, Machine Learning, Game Theory, and High Performance Computing & Analytics. We focus on solving real world problems from natural resources and industrial management, smarter commerce and customer insight, workforce management using and furthering state of the art techniques in the mentioned research areas. Our research work is published in leading conferences and journals like IPCO, FOCS, SIJCOM, ICDM, SDM, AAAI, IJCAI, AAMAS, VLDB, IPDPS, EuroPar, HiPC, EDBT etc. Apart from collaborating with different business units within IBM, we actively collaborate with academia leading to joint publications.

We engage in collaborative projects with our partners in different business units within IBM, government organizations/universities, and IBM customers addressing real world problems from diverse industrial sectors. In workforce management, we work on strategic talent planning (e.g., hiring, engagement/deployment, retention/compensation), career development, demand forecasting, capacity planning and utilization, etc. with a focus on the next-gen "smarter workforce" comprising of autonomous workers collaborating on social technology platforms. In smarter commerce and customer insight, we work on problems such as social influence analysis, active information acquisition, channel attribution, and estimating life-time value of customers. In natural resource and industrial management we work on predictive modeling for asset management, energy management and optimization for industrial production/distribution, and analytics for large scale operations and project management. Doing these projects, we apply ideas from graphical models, online inference, non-parametric techniques, time-series analysis, spatio-temporal analysis, discrete-event simulation analysis, anomaly detection, linear and stochastic programming, convex optimization, and mechanism design. For Oil/Gas and Mining, we also design and develop scientific computing models based on coupled PDEs for areas such as Seismic Modeling/Full Waveform Inversion, Fracture Modeling and other problems crucial in exploration and production. Alongside, we design and optimize high performance scalable implementations of compute-intensive and/or data-intensive scientific and machine learning kernels on multi-core and many-core distributed architectures such as GPU / Linux clusters and supercomputers such as Blue Gene/P and Blue Gene/Q.

For further details, visit: http://researcher.ibm.com/researcher/view_project.php?id=4959

Skill Set / Level: Ph.D. or Master Students, familiar with at least a few of the following subjects either through course work or self-study: linear & nonlinear optimization, combinatorial optimization, machine learning, game theory, high performance computing, and agent-based modeling & simulation. The candidates should be able to work with the following programming tools/languages/platforms: Java/C++, ILOG, SPSS/R, MATLAB, AnyLogic, MPI/OpenMP, OpenCL/CUDA, Pthreads.

Location: Internship positions are available at New Delhi and Bangalore.

Information Management & Analytics

The Information Management and Analytics Group at IBM Research - India is focused on developing next-generation technologies for big data processing, spatio-temporal analytics, data quality and uncertainty reduction, information integration, multimodal information fusion, enterprise search, etc. These technologies are driven by IBM Research's goal of building intelligent solutions and services to address business problems in various industrial sectors including finance, telecommunication, retail, healthcare, and natural resources, among others.

The major contributors to the data explosion in the recent years are Web, sensors, and human generated. Data from these sources are inherently noisy or uncertain. By 2015, 80% of all available data will be uncertain. Most of the real-world data collected in enterprises, such as customer demographic data, SMS, instant messenger logs, e-mail and automatically transcribed conversational data, is uncertain. The uncertainty can range from spelling errors, syntactic variations, and semantic ambiguities to deliberate misrepresentations and rumors. Managing uncertainty at scale is a significant scientific challenge. We need robust analytics techniques providing useful insights even if the input is uncertain. One of the focus areas of the Information Management and Analytics group is efficient algorithms that can reduce the uncertainty in massive amounts of data to derive actionable and high confidence intelligence. The team works on advanced statistical and logic based techniques to process, analyze, and fuse data for reducing the uncertainty in noisy data streams such as social media feeds, streams from sensors, Web data, and enterprise data.

Data collected from various sources such as sensors, social media, and mobile devices have spatio-temporal characteristics. Spatio-temporal analysis of such data has become very important in different scenarios such as road traffic analysis, trend analysis in social media, disease patterns, weather/ air quality analysis, and public safety. Due to the large volumes of such data, traditional data management platforms are not sufficient. To address this gap, the group is working on extending existing platforms to support various kinds of spatio-temporal analysis. Further the data from these sources is multimodal and includes text, images, audio, GPS, etc. The group is working on developing methods to fuse these different data types to derive the full context around an entity or event.

The group brings together the capabilities of information integration and text analytics to build next-generation integrated enterprise information management systems. Due to the explosion in the number of data sources, the variety in the data, and the number of people needing analytics, there is a need for tools that can enable self service analytics. Data curation and provisioning are important steps in the process of building analytics for various domains. The group is working on various technologies to automate these phases. One such technique is to discover relationships between data sources, thus enabling the analyst to easily identify the data relevant for any business need. Operationalizing the data by automatically generating analytics artifacts is another area we are exploring.

Information Management & Analytics Contd..

In the area of information extraction from text, the group is involved in advancing the state of the art in rule-based information extraction systems. In particular, a major focus is on novel techniques and tools that contribute to an integrated development environment for building, customizing, and deploying rule-based extraction modules. Techniques for automatic induction of extraction rules, large-scale pattern detection, intelligent generation and maintenance of test document sets to aid development of extractors, etc., are some of the important topics of interest.

The group is also involved in the area of scalable data management systems, platforms, and techniques to power IT Operational Analytics, i.e., analytics at scale on data coming from IT infrastructure (logs, metrics, and events from routers, servers, VM's, middleware, applications, etc.) for better availability and performance management. We are building indexing, linking, and predictive analytic techniques to enable IT infrastructure administrators to better manage, troubleshoot problems, and today's large, complex, and highly dynamic IT environments.

Related to information extraction and enterprise search is the group's interest in building large-scale document processing, and indexing workflows using IBM's Hadoop based BigInsights analytics platform. Of particular interest to the group is work on extending open source systems such as HBase to support the complex storage, bulk load, and retrieval requirements of text-heavy analytic workloads.

We are also exploring some newer areas of information trust and security. Data security is a major concern in the new model of cloud based data services. This can be addressed by storing data in an encrypted form. However, encryption precludes query processing and analytics at the cloud and the data needs to be downloaded to the client for any processing. To address this, we are designing a system that can directly run queries and analytics on encrypted data, with only the results being decrypted at the client.

For further details, visit: http://researcher.ibm.com/researcher/view_project.php?id=4966

Skill Set/Level: Highly motivated PhD or Master Students with relevant background and strong research interest in related areas are encouraged to apply.

Location: Internship positions are available at New Delhi and Bangalore.

Knowledge Engineering Services

The Knowledge Engineering Services department is focused on developing technologies for efficiently acquiring, representing, retrieving, and delivering knowledge to individuals and organizations. Working closely with IBM business divisions and external clients, we help create new products and offerings based on advanced text analytics, machine learning, the Watson/Jeopardy! Technology and data mining techniques. Our efforts help create innovative solutions for delivering personalized education, for creating automated self-help systems for technical problem resolution and to improve the efficiency of IT services delivery.

The following areas of work provide more details on our ongoing research initiatives:

- **Effective knowledge management:** Technologies to enable practitioners to re-use the knowledge for faster analysis of the problem and provide a general framework for analyzing problem information from IT and application data to automatically identify critical areas for improvement. This requires addressing core research problems in the areas of machine learning, text analytics, information retrieval, and data management.
- **The Watson Technology:** The technology is aimed at building interactive systems for problem solving or question answering with minimal knowledge engineering effort required for adapting it to a new domain. Unlike a search system that provides only search results and the decision maker has to analyze them to make decision, this technology comes up with a precise decision. This requires addressing core research problems in the areas of machine learning, natural language processing, information retrieval.
- **Smarter and Personalized Education:** Develop analytics and instrumentation driven techniques to enable personalized education at-scale, improving learning outcomes and ultimately guiding students towards successful career pathways. This requires addressing problems related to content analytics, risk stratification, and personalization.

For further details, visit: http://researcher.ibm.com/researcher/view_project.php?id=4968

Skill Set / Level: Highly motivated Ph.D. or Master Students with relevant background and strong research interest in related areas are encouraged to apply.

Location: Internship positions are available at New Delhi and Bangalore.

Mobile and Telecom Research

There has been a tremendous growth in the penetration of the Mobile phones in the recent years. Moreover, there has been significant progress in the computing power, memory, display and other features of mobile phones. The Telecom & Mobile Department at IBM India Research Lab focuses on this exciting area of mobile computing and challenges of Telecommunication industry with the goal of creating innovative solutions and platforms. Researchers in the department collaborate extensively with other IBM business units, Telecom Service Providers, various customers looking for Mobile solutions as well as Academia.

Focused on promoting advanced telecommunications and mobile solutions and infrastructure development, the department currently conducts research in following key areas:
1. Telecom and Mobile Analytics
2. Telecom Infrastructure and Middleware
3 Mobile Application Development Environments and Run-time
4. Mobile Device and Application Management
5. Context-aware Services
6. Machine to Machine
7. Mobile Enabled Solutions for industries (such as Retail, Finance, etc.)

For further details, visit: http://researcher.ibm.com/researcher/view_project.php?id=4979

Skill Set / Level: We are seeking applications from Ph.D. or Master Students in Computer Science (or related field). Knowledge of one or more of Mobile Device Platforms, Distributed Systems, Networking, Data Mining, Programming knowledge in Java/C++ and/or platforms like iPhone, Android, etc.

Location: Internship positions are available at New Delhi and Bangalore.

Productivity Tools & Software Engineering

The research agenda of the Programming Technologies and Software Engineering department at IBM Research – India focuses on improving productivity in software development, testing, and maintenance, and on improving software quality and security. Our agenda is driven specifically by the needs of the software services industry. Our research uses many core techniques, such as static and dynamic program analysis, text analysis, and data mining. In addition to developing new technologies that have a significant business impact, we strive for broader scientific impact by publishing our research in top conferences. Below we describe our current research themes.

Testing

Our research agenda in software testing focuses on developing innovative techniques and tools that bring automation and rigor to the tasks that are performed manually in testing services, often in an ad-hoc manner, and are prone to human lapses. Our research covers many topics, including test automation, test data generation, test suite reduction, test repair, and regression testing.

Debugging

Our group is developing scalable automated techniques for fault localization, fault repair, and creating debugging tools to use such techniques effectively in diverse application domains, such as database-driven applications, Java, JavaScript, and model transformations. Our methods employ sophisticated constraint-solving and theorem-proving techniques coupled with efficient program analysis, such as slicing and differencing, along with visualization in debuggers.

Mining Software Repositories

Repositories, such as version management systems and bug management systems, contain a wealth of information on how an application evolves over time. This information, if mined appropriately, can help project teams gain insights for supporting maintenance of the software, improving design/reuse, and enabling effective transitioning of new people into a project. Our research agenda in this area focuses on using a text analytics, mining, code analysis, and visualization to enable decision making, based on knowledge derived from software repositories.

Productivity Tools & Software Engineering

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Programming the Web

Programming modern, interactive web applications is hard owing to multiple challenges: gluing together multiple mismatched web technologies, ubiquity of dynamically typed languages and heterogeneous mobile platforms. Our research on structured web programming intends to systematize the prevalent chaotic practices for application development across their complete lifecycle, i.e., their design, implementation, deployment and maintenance, to enable low-effort, rapid application development. Our investigations span over multiple interesting problems including language design for technology-independent application creation, responsive web design for mobile platforms and modular, type-safe web development.

Software Security

We are interested in a broad range of topics related to software security in the context of mobile and cloud applications. Typical focus areas include JavaScript and Java analysis, configuration analysis, secure middleware, taint analysis, software protection, and some recent work on user-managed access control and mobile payments. Projects will include a combination of analysis and tool development.

For further details, visit: http://researcher.ibm.com/researcher/view_project.php?id=4955

Skill Set / Level: We are seeking applications from Ph.D. or Master Students in Computer Science (or related field). Candidates with knowledge of one or more in empirical software engineering, compilers, program analysis, software verification, web technologies, mining and analysis of software engineering artifacts are welcome to apply.

Location: Internship positions are available at New Delhi and Bangalore.

Smarter Planet Solutions

A significant initiative has been taken at IBM to make the world better instrumented, highly interconnected and more intelligent. We believe the recently announced, new era of "Cognitive Computing" will accelerate realization of this goal. Several key research directions aligned with this initiative are being pursued at the Smarter Planet Solutions department of IBM Research in India. For example, leveraging the power of High Performance Computing, we are creating ultra high-resolution weather models to provide highly customized weather prediction and integrating them with hydrology models to provide early warning on potential floods. High-resolution weather models combined with long-term climate models are being utilized to help farmers better plan their farm activities (sowing, irrigation, pesticide application, etc.) and also identify the right crop for their geographical region. We are working on combining weather modeling with renewable energy generation to come-up with optimal wind-farm and solar-farm design and scheduling algorithms at power generation plants. We are working on various machine learning and optimization algorithms using the data collected from power generation plants, transmission and distribution networks to help companies predict and manage demand peaks, identify leaks, predict black-outs and estimate connectivity models to utilize their resources most efficiently. We are also innovating on "smarter plugs" which can sense grid status, appliance characteristics and user preferences and analyze to flatten the demand curve and help stabilize both grid and appliance operations. See the website given below for more details.

http://researcher.ibm.com/researcher/view_project.php?id=4990

Skill Set/Level: We are inviting applications for summer internship from highly motivated MS and Ph. D students with a strong academic record, working in the following areas.

- High-performance computing
- Weather & climate modeling
- Renewable energy
- Power systems
- Machine learning
- Optimization
- User Interface/Experience Design
- Embedded systems

Location: Internship positions are available at New Delhi and Bangalore.

Systems Research

The goal of system research department is to design and build next generation systems with higher levels of elasticity, flexibility, performance, and cost efficiency based on a holistic view of compute, network, storage, & software. Our current focus areas include enterprise cloud and data center networking. High-level pre-requisites and current projects are listed below.

Distributed Systems

The Distributed Systems group works in the area of cloud computing to make it more consumable in an enterprise setting. To that end we are developing new techniques for efficiently migrating traditional enterprise client systems to managed cloud environment, and for automating system management in enterprise clouds.

Pre-requisites:

- Server Virtualization Basics, Strong knowledge of operating systems and computer architectures
- Algorithms and machine learning knowledge (preferred)
- Strong system building skills in C/C++/Python/Java, shell scripting

Data Center Networking

The Data Center Networking group is exploring ways to prevent network from becoming a performance and manageability bottleneck in large-scale cloud data centers. Some of the topics that we are currently investigating include: software defined networking (SDN) - unique value it can bring to an enterprise network and challenges to its adoption; and opportunities for co-optimization of computation, storage & networking using network-aware virtual machine management.

Pre-requisites:

- IP communication network fundamentals
- Solid programming skills in any one high level language (Java preferred)
- Familiarity with network simulation and modeling tools (desired)
- Familiarity/expertise in python (a plus)
- Familiarity/expertise in Openstack Networking – Neutron (a plus)

Systems Research

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Smarter Wireless, Network Analytics

With the increasing compute and networking capabilities of general purpose processors in the cloud, the wireless/IT research group explores applying traditional IT optimizations and analytics to wireless infrastructures. Our research mainly focuses on (i) developing next generation wireless architectures on cloud platforms and (ii) building smarter wireless networks, specifically cellular networks by applying spatio-temporal analytics and optimizations. Interest in systems research towards building solutions in cellular networks in a large team with emphasis on applied research in real network deployments.

Pre-requisites:

- Wireless and IP communication network fundamentals
- Basic machine learning, data mining and their application to wireless and networking.
- Familiarity with network simulation and modeling tools
- Solid programming skills in Java or C++

For further details, visit: http://researcher.ibm.com/researcher/view_project.php?id=4948

Skill Set/Level: We are inviting applications for summer internship from highly motivated MS and Ph. D students with strong academic record and pre-requisites given above.

Location: Internship positions are available at New Delhi and Bangalore.

How to apply

Eligibility Criteria: Graduate students (preferably PhD) in Computer Science, Mathematical Science and Services Science, Management & Engineering and related.

Stipend and Relocation: The interns will be paid a stipend that is competitive with what other leading companies pay in India. IBM Research - India will also cover expenses related to travel to the work location and provide logistical support for accommodation. In the case of PhD interns, additional monetary support will also be provided for accommodation.

Location: New Delhi and Bangalore.

Application along with your latest CV can be submitted at
https://university-relations.in/wps/portal/internship

You must submit your internship application on or before **January 31, 2014** for consideration in the 2014 program. Short-listed candidates will be contacted for interviews in February 2014.

Work & Fun

At IBM Research, we not only stress on quality work but we'd also like you to enjoy your time with us. We not only offer challenging research problems, but we also offer "extracurricular" activities throughout the program. We count on our interns to keep these activities lively!

What our interns say..

"It has been a great experience in all respects. I made a lot of new friends. It was my first experience working in an office- something outside of my campus. I got to attend a lot of technical talks by eminent researchers. Weekly open house events provided a lot of insight about current research areas and projects across a wide range of research groups here. Apart from this, working with the most helpful mentors is something that I am going to miss. I am extremely happy to have worked at a place where people work hard and people have fun- there is a music club, there are movie screenings, there are birthday bashes, there are ice-cream parties, there are farewells, and there is an awesome work environment".
Amol Mittal, Dual Degree, Maths & Stats, IIT Delhi (2013 Batch)

"This was my first experience at research or, for that matter, at an industry-level project. I was amazed at the variety of problems covered and the approach being taken for solving these problems. Interacting with researchers from different fields and knowing about their research projects helped me widen my perspective regarding the applications of computer science in various fields. From the courses and projects, I undertook in college, I was curious as to how new problems are thought about and the way in which these problem is approached. IBM is a distinguished name in the field of research and I thought it would provide me an opportunity to help me decide better regarding the field and job I would be striving for in the future".
Manav Garg, Dual Degree, CSE, IIT Kanpur (2013 Batch)

"I had a wonderful experience here both in terms of work as well as fun. I got to meet a lot of people here who helped me in various ways knowingly or unknowingly. One of the best thing was meeting other PhD candidates from outside my core domain who will constitute my peers in the future. There were a lot of technical discussions with them. I have also received inputs from fellow students regarding orthogonal thinking directions for my thesis and how inter discipline collaborations can happen in my research problem. Be it office or the guest house, the atmosphere was always lively. people discussed work as enthusiastically as the cricket matches. It was a perfect blend of work and fun. One fun experience was celebrating my b'day in office which was a pleasant surprise for me".
Sougata Sen, Ph.D., Singapore Management University (2013 Batch)