Nikhil Jain

Contact Information

Web: http://nikhil-jain.github.io/
E-mail: nikhil.jain@acm.org
Phone: 217-979-0918

Research Interests

High performance computing networks, Application of parallel computing, Runtime systems, Parallel programming paradigms, Topology-aware mapping, Collective operations on parallel systems

Work Experience

Fernbach Postdoctoral Fellow, Lawrence Livermore National Lab (April 2016 – ongoing)

Summer Intern, Lawrence Livermore National Lab
Mentor - Dr. Abhinav Bhatele and Dr. Peter Barnes (May 2014 - August 2014)
Mentor - Dr. Todd Gamblin (May 2012 - August 2012)

Researcher, High Performance Computing Group, IBM Research - India
Manager - Dr. Yogish Sabharwal (June 2009 - Jan 2011)

Education

Ph.D., Department of Computer Science, 2016
University of Illinois at Urbana-Champaign
- Advisor: *Prof. Laxmikant (Sanjay) Kale* GPA: *4.0*
- Thesis Topic: *Optimization of Communication Intensive Applications on HPC Networks*

B.Tech - M.Tech Dual Degree, Computer Science and Engineering, 2009
Indian Institute of Technology Kanpur, India
- Advisor: *Prof. Phalguni Gupta* CGPA: *B.Tech - 9.0/10, M.Tech - 9.6/10*
- Thesis Topic: *SMP Based Solvers for Large Binary Linear Systems*

Awards and Honors

- **Fernbach Postdoctoral Fellow**, 2016-2018.
- **IBM PhD Fellow**, 2014-2015.
- Silver Award, ACM Student Research Poster Competition, SC 2013.
- **Andrew and Shana Laursen Fellow**, Department of Computer Science, UIUC, 2011-2012.
- Best Poster, LLNL Annual Student Poster Session, 2012.
- Co-winner of HPC Challenge Class 2 (performance), Charm++ Team, Supercomputing 2011.

Key Projects

Simulation based analysis of HPC networks
- Proposed and designed TraceR, a fast packet-level parallel network simulator for understanding and accurately predicting behavior of applications on extreme scale networks.
- Created Damselfly, a functional model that estimates the flow of traffic on Dragonfly networks, to find the best routing scheme and job placement policy for scenarios with multi-job executions.

Supervised learning for predicting performance of communication-bound applications
- Deployed ensemble methods, Extremely Randomized Trees and Gradient Boosted Regression Trees, to correctly predict performance of HPC applications.
- Identified a subset of network features, viz. average bytes and above average stalls on links, as the most important factors that impact the communication.

OpenAtom: Enabling AIMD at scale
- Developed generalized topology-aware mapping schemes for Cray XE6/XK7 and IBM Blue Gene/Q, which resulted in up to 50% reduction in execution time of OpenAtom.

- Designed and implemented a 2D-decomposition based message-driven FFT library that improved the strong scaling of a 436-molecule system to 65,536 cores.

Interoperation of Charm++ and MPI
- Created a framework to enable coexistence of Charm++ and MPI in production applications.
- Demonstrated the productivity and performance benefits of interoperation via several example use cases, such as parallel FFTW in NAMD, Charm++'s sorting library in Chombo, MPI-IO in EpiSimdemics, etc.

Charm++ features development
- Augmented the Charm++ runtime system with Partition framework, which enables execution of several loosely-connected Charm++ instances within a single application execution. This capability is currently used by NAMD for replica-exchange algorithm and Charm++ for soft-error fault tolerance.
- Active contributor to various levels of Charm++ stack, including the communication layer (PAMI, VERBS, and MPI), load balancing framework, and Adaptive MPI.

Peer Reviewed Publications

[20] **Nikhil Jain**, Eric Bohm, Eric Mikida, Subhasish Mandal, Minjung Kim, Prateek Jindal, Qi Li, Sohrab Ismail-Beigi, Glenn J. Martyna, and Laxmikant V. Kale. OpenAtom: Scalable Ab-Initio Molecular Dynamics with Diverse Capability. *ISC HPC 2016* (To appear).

[19] Abhinav Bhatele, **Nikhil Jain**, Yarden Livnat, Valerio Pascucci, and Peer-Timo Bremer. Analyzing network health and congestion in dragonfly-based systems. *IPDPS 2016* (To appear).

[18] Eric Mikida, **Nikhil Jain**, Elsa Gonsiorowski, Peter D. Barnes, Jr., David Jefferson, Christopher Carothers, and Laxmikant Kale. Towards PDES in a Message-Driven Paradigm: A Preliminary Case Study Using Charm++. *SIGSIM PADS 2016* (To appear).

[17] **Nikhil Jain**, Abhinav Bhatele, Jae-Seung Yeom, Mark F. Adams, Francesco Miniati, Chao Mei, Laxmikant Kale. Charm++ & MPI: Combining the Best of Both Worlds. *IPDPS 2015*. (acceptance rate: 21.8%, 108/496)

[16] Abhinav Bhatele, Andrew Titus, Jayaraman Thiagarajan, **Nikhil Jain**, Todd Gamblin, Peer-Timo Bremer, Martin Schulz, Laxmikant Kale. Identifying the Culprits behind Network Congestion. *IPDPS 2015*. (acceptance rate: 21.8%, 108/496)

[15] Ehsan Totoni, **Nikhil Jain**, Laxmikant Kale. Power Management of Extreme-scale Networks with On/Off Links in Runtime Systems. *TOPC 2014, Journal*.

[14] Abhinav Bhatele, **Nikhil Jain**, Katherine E. Isaacs, Ronak Buch, Todd Gamblin, Steven H. Langer, Laxmikant V. Kale. Improving Application Performance via Task Mapping on IBM Blue Gene/Q. *HiPC 2014*. (acceptance rate: 22.6%, 49/216)

[13] **Nikhil Jain**, Abhinav Bhatele, Xiang Ni, Nicholas J. Wright, Laxmikant Kale. Maximizing Network Throughput on the Dragonfly Interconnect. *SC 2014*. (acceptance rate: 21%, 82/394)

[12] Bilge Acun, Abhishek Gupta, **Nikhil Jain**, Akhil Langer, Harshitha Menon, Eric Mikida, Xiang Ni, Michael Robson, Yanhua Sun, Ehsan Totoni, Lukasz Wesolowski, Laxmikant Kale. Parallel Programming with Migratable Objects: Charm++ in Practice. *SC 2014*. (acceptance rate: 21%, 82/394)

[11] James Phillips, Yanhua Sun, **Nikhil Jain**, Eric J. Bohm, Laxmikant Kale. Mapping to Irregular Torus Topologies and Other Techniques for Petascale Biomolecular Simulation. *SC 2014*. (acceptance rate: 21%, 82/394)

[10] **Nikhil Jain**, Abhinav Bhatele, Michael Robson, Todd Gamblin, Laxmikant Kale. Predicting application performance using supervised learning on communication features. *SC 2013*. (acceptance rate: 20%, 92/457)

[9] Xiang Ni, Esteban Meneses, **Nikhil Jain**, Laxmikant Kale. ACR: Automatic Checkpoint/Restart for Soft and Hard Error Protection. *SC 2013*. (acceptance rate: 20%, 92/457)

[8] **Nikhil Jain**, JohnMark Lau, Laxmikant Kale. Collectives on Two-tier Direct Networks. *EuroMPI 2012*.

[7] Harshitha Menon, **Nikhil Jain**, Gengbin Zheng, Laxmikant Kale. Automated Load Balancing Invocation based on Application Characteristics. *Cluster 2012*. (acceptance rate: 28.9%, 58/200)

[6] Anshul Mittal, **Nikhil Jain**, Thomas George, Yogish Sabharwal, Sameer Kumar. Collective Algorithms for Sub-communicators. *ICS 2012*. (acceptance rate: 22.3%, 36/161)

[5] Abhinav Bhatele, **Nikhil Jain**, William Gropp and Laxmikant Kale. Avoiding hot-spots on two-level direct networks. *SC 2011*. (acceptance rate: 21%, 74/352)

[4] Ehsan Totoni, Abhinav Bhatele, Eric Bohm, **Nikhil Jain**, Celso Mendes, Ryan Mokos, Gengbin Zheng and Laxmikant Kale. Simulation-based Performance Analysis and Tuning for a Two-level Directly Connected System. *ICPADS 2011*.

[3] Anshul Mittal, Jagobondhu Hazra, **Nikhil Jain**, Vivek Goyal, Deva Seetharam and Yogish Sabharwal. Real Time Contingency Analysis for Power Grids. *Euro-Par 2011*. (acceptance rate 29.9%, 81/271)

[2] **Nikhil Jain** and Yogish Sabharwal. Optimal Bucket Algorithms for large MPI Collectives on Torus Interconnect. *ICS 2010*. (acceptance rate: 17.8%, 32/180)

[1] Venkatesan Chakaravarthy, **Nikhil Jain** and Yogish Sabharwal. Optimizing Matrix Transpose on Torus Interconnects. *Euro-Par 2010*.

Peer Reviewed Workshop Publications

[5] Bilge Acun, **Nikhil Jain**, Abhinav Bhatele, Misbah Mubarak, Christopher Carothers, Laxmikant Kale. Preliminary Evaluation of a Parallel Trace Replay Tool for HPC Network Simulations. *Workshop on Parallel and Distributed Agent-Based Simulations at EURO-PAR 2015*.

[4] Ehsan Totoni, **Nikhil Jain**, Laxmikant Kale. Toward Runtime Power Management of Exascale Networks by On/Off Control of Links. *Workshop on Higher Peformance Power Aware Computing at IPDPS 2013*.

[3] Laxmikant Kale, **Nikhil Jain**, Akhil Langer, Esteban Meneses, Phil Miller, Osman Sarood, Ehsan Totoni. A Multi-resolution Emulation + Simulation Methodology. *Position paper at Workshop on Modeling & Simulation of Exascale Systems & Applications 2013*.

[2] Laxmikant Kale, Osman Sarood, Eric Bohm, **Nikhil Jain**, Akhil Langer, Esteban Meneses. Actionable Performance Modeling for Future Supercomputers. *Position paper at Workshop on Modeling & Simulation of Exascale Systems & Applications 2013*.

[1] **Nikhil Jain**, Brajesh Pande and Phalguni Gupta. SMP Based Solver for Large Binary Systems. *The Tenth International Workshop on Parallel and Distributed Algorithms and Applications 2009*.

Posters

[4] Interoperating MPI and Charm++ for Productivity and Performance. *Poster at SC 2014*.

[3] Fast Prediction of Network Performance: k-packet Simulation. *Poster at SC 2013*. **Silver Award**.

[2] Understanding Network Contention on Blue Gene Supercomputers. *LLNL Student Poster Session 2012*. **Best Poster Award**.

[1] Collective Algorithms for Sub-communicators. *PPoPP 2012*.

Patents

Content Delivery Using Multiple Sources Over Heterogeneous Interfaces. IBM. US Patent number 20130124689.

Trusted Content Access Management Using Multiple Social Graphs Across Heterogeneous Networks. IBM. US Patent number 20130055302.

Performing synchronized collective operations over multiple process groups. IBM. US Patent number 20130339499.

Professional Service

- Program Chair for Charm++ Workshop, 2014.
- Technical reviewer for JPDC, IPDPS-14, Cluster-12