

Uday Kumar Reddy Bondhugula

Associate Professor
Department of Computer Science and Automation
Indian Institute of Science
Bangalore, Karnataka 560012 INDIA

Tel: +91-80-2293-3249
Fax: +91-80-2360-2911
udayb@iisc.ac.in
<http://www.csa.iisc.ac.in/~uday>

Name as it appears on all publications: Uday Bondhugula

Research Interests

Compilation and parallelization for multicores, accelerators, and domain-specific hardware; high-performance domain-specific languages and compilers; automatic parallelization; polyhedral framework; MLIR. Domains of interest: high-performance AI, deep learning, stencils, and dense linear algebra.

Education

- Ph.D. in Computer Science and Engineering
The Ohio State University (OSU)
Thesis: *Effective Automatic Parallelization and Locality Optimization using the Polyhedral Framework*
Advisor: Prof. P. Sadayappan
Sep 2004 – Aug 2008
Columbus, OH, USA
- Bachelor of Technology in Computer Science and Engineering
Indian Institute of Technology (IIT), Madras.
Jul 2000 – Jul 2004
Chennai, India

Professional Experience

- Founder, CTO, and CEO
PolyMage Labs
May 2019 – present
Bangalore, India
- Associate Professor
Department of Computer Science and Automation
Indian Institute of Science
Bangalore, India
Dec 2016 – present
- Visiting Researcher
Google Brain team
Google, Mountain View
California, USA
Mar 2018 – Mar 2019
- Assistant Professor
Department of Computer Science and Automation
Indian Institute of Science
Bangalore, India
Jan 2011 – Dec 2016
- Postdoctoral Research Scientist
Advanced Compiler Technologies
IBM T.J. Watson Research Center, Yorktown Heights, New York
Yorktown Heights, NY, USA
Oct 2008 – Dec 2010
- Visiting Researcher
ALCHEMY team
INRIA Saclay (INRIA Futurs), Île-de-France
Orsay, France
Mar 2008 – May 2008
- Research Intern
Advanced Compilation Technologies
IBM T.J. Watson Research Center, Yorktown Heights, NY
Yorktown Heights, NY
Jun 2007 – Sep 2007

- Graduate Research Associate
Dept of Computer Science and Engineering
The Ohio State University
Columbus, OH, USA
Apr'05 – Jun'07, Oct'07 – Aug'08
- Graduate Teaching Associate
Dept of Computer Science and Engineering, OSU.
Columbus, OH, USA
Sep 2004 – Mar 2005
- Summer Intern
Trilogy Software Inc.
Bangalore, India
Jun 2003 – Aug 2003

Publications

[Google Scholar profile](#), [DBLP](#)

1. MLIR: Scaling Compiler Infrastructure for Domain-Specific Computation
Chris Lattner, Mehdi Amini, Uday Bondhugula, Albert Cohen, Andy Davis, Jacques Pienaar, River Riddle, Tatiana Shpeisman, Nicolas Vasilache, and Oleksandr Zinenko.
ACM CGO 2021 (accepted in Nov 2020).
2. An Effective Fusion and Tile Size Model for PolyMage
Abhinav Jangda and Uday Bondhugula
ACM Transactions on Programming Languages and Systems (TOPLAS), 42, 3, Article 12, 27 pages, Nov 2020.
3. Effective Loop Fusion in Polyhedral Compilation using Fusion Conflict Graphs
Aravind Acharya, Uday Bondhugula, Albert Cohen.
ACM Transactions on Architecture and Code Optimization (TACO), accepted in Jul 2020.
4. Optimizing the Linear Fascicle Evaluation Algorithm for Multi-Core and Many-Core Systems
Karan Aggarwal and Uday Bondhugula
ACM Transactions on Parallel Computing, Jun 2020 (accepted).
5. Bitwidth Customization in Image Processing Pipelines using Interval Analysis and SMT Solvers
Suresh Purini, Vinamra Benara, Ziaul Chowdhury, Uday Bondhugula
ACM SIGPLAN International Conference on Compiler Construction (CC), Feb 2020.
6. Optimizing the Linear Fascicle Evaluation Algorithm for Many-Core Systems
Karan Aggarwal, Uday Bondhugula
International Conference on Supercomputing (ICS), Jun 2019.
7. Polyhedral Auto-Transformation with No Integer Linear Programming
Aravind Acharya, Uday Bondhugula, Albert Cohen
ACM SIGPLAN PLDI 2018.
8. An Effective Fusion and Tile Size Model for Optimizing Image Processing Pipelines
Abhinav Jangda, Uday Bondhugula
ACM SIGPLAN symposium on Principles and Practice of Parallel Programming (PPoPP), Feb 2018.
Artifact evaluated (reusable and available).
9. Optimizing Geometric Multigrid Method Computation using a DSL Approach
Vinay Vasista, Kumudha KN, Siddharth Bhat, Uday Bondhugula
Supercomputing (SC), Nov 2017.
10. Diamond Tiling: Tiling Techniques to Maximize Parallelism for Stencil Computations
Uday Bondhugula, Vinayaka Bandishti, Irshad Pananilath
IEEE Transactions on Parallel and Distributed Systems (TPDS), pgs 1285–1298, vol 27, issue 3, May 2017.

11. A DSL Compiler for Accelerating Image Processing Pipelines on FPGAs
Nitin Chugh, Vinay Vasista, Suresh Purini, Uday Bondhugula
IEEE International conference on Parallel Architectures and Compilation Techniques (PACT 2016), Sep 2016.
12. Compiling Affine Loop Nests for a Dynamic Scheduling Runtime on Shared and Distributed Memory
Roshan Dathathri, Ravi Teja Mullapudi, Uday Bondhugula
ACM Transactions on Parallel Computing, volume 3, issue 2, Jul 2016.
13. SMO: An Integrated Approach to Intra-Array and Inter-Array Storage Optimization
Somashakaracharya Bhaskaracharya, Uday Bondhugula, Albert Cohen
ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages (POPL), Jan 2016.
14. The Pluto+ Algorithm: A Practical Approach for Parallelization and Locality Optimization of Affine Loop Nests
Uday Bondhugula, Aravind Acharya, Albert Cohen
ACM Transactions on Programming Languages and Systems, volume 38, issue 3, Apr 2016.
15. Automatic Storage Optimization for Arrays
Somashakaracharya Bhaskaracharya, Uday Bondhugula, Albert Cohen
ACM Transactions on Programming Languages and Systems (TOPLAS), volume 38, issue 3, Apr 2016.
16. An Optimizing Code Generator for a Class of Lattice-Boltzmann Computations
Irshad Pananilath, Aravind Acharya, Vinay Vasista, Uday Bondhugula
ACM Transactions on Architecture and Code Optimization (TACO), Volume 12 Issue 2, Article No. 14, Jul 2015.
17. PolyMage: Automatic Optimization for Image Processing Pipelines
Ravi Teja Mullapudi, Vinay Vasista, Uday Bondhugula
International Conference on Architecture Support for Programming Languages and Operating Systems (ASPLOS 2015), Mar 2015.
18. PLUTO+: Near-Complete Modeling of Affine Transformations for Parallelism and Locality
Aravind Acharya, Uday Bondhugula
ACM SIGPLAN PPOPP 2015, Feb 2015.
19. Tiling and Optimizing Time-Iterated Computations over Periodic Domains
Uday Bondhugula, Vinayaka Bandishti, Albert Cohen, Guillain Potron, Nicolas Vasilache
IEEE International conference on Parallel Architectures and Compilation Techniques (PACT 2014), Aug 2014.
Nominated for the best paper award.
20. Effective Automatic Computation Placement and Data allocation for Parallelization of Regular Programs
Chandan Reddy, Uday Bondhugula
ACM International Conference on Supercomputing (ICS), Jun 2014, Munich, Germany.
21. Automatic Data Allocation and Buffer Management for Multi-GPU Machines
Thejas Ramashekar, Uday Bondhugula
ACM Transactions on Architecture and Code Optimization (accepted Nov 2013), selected for presentation at HiPEAC '14, Jan 2014, Vienna, Austria.
22. Compiling Affine Loop Nests for Distributed-Memory Parallel Architectures
Uday Bondhugula
ACM/IEEE Supercomputing (SC '13), Nov 2013.
23. Generating Efficient Data Movement Code for Heterogeneous Architectures with Distributed-Memory
Roshan Dathathri, Chandan Reddy, Thejas Ramashekar, Uday Bondhugula
International conference on Parallel Architectures and Compilation Techniques (PACT 2013), Sep 2013.

24. PolyGLoT: A Polyhedral Loop Transformation Framework for a Graphical Dataflow Language
Somashekaracharya Bhaskaracharya, Uday Bondhugula
International conference on Compiler Construction (CC 2013), Mar 2013, Rome, Italy.
25. Tiling Stencil Computations to Maximize Parallelism
Vinayak Bandishti, Irshad Pananilath, and Uday Bondhugula
ACM/IEEE Supercomputing, Nov 2012, Utah, USA.
26. Loop Transformations: Convexity, Pruning, and Optimization
Louis-Noel Pouchet, Uday Bondhugula, Cedric Bastoul, Albert Cohen, J Ramanujam, P Sadayappan,
and Nicolas Vasilache
ACM SIGACT-SIGPLAN Symposium on Principles of Programming Languages (PoPL), 2011.
27. Combined Iterative and Model-driven Optimization in an Automatic Parallelization Framework
Louis-Noel Pouchet, Uday Bondhugula, Cedric Bastoul, Albert Cohen, J Ramanujam, P Sadayappan
Supercomputing (SC) 2010.
28. A Model for Fusion and Code Motion in an Integrated Auto-Parallelizing Compiler
Uday Bondhugula, Oktay Gunluk, Sanjeeb Dash, and L. Renganarayana
International Conference on Parallel Architectures and Compilation Techniques (PACT), Sep 2010, Vi-
enna, Austria.
29. Compact multi-dimensional kernel extraction for register tiling
L. Renganarayana, Uday Bondhugula, Salem Derisavi, Alexandre E. Eichenberger, and Kevin O'Brien
Supercomputing 2009
30. Compiler-Assisted Dynamic Scheduling for Effective Parallelization of Loop Nests on Multicore Proces-
sors
M. Baskaran, N. Vydyanathan, Uday Bondhugula, J. Ramanujam, A. Rountev, and P. Sadayappan.
ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming (PPoPP'09), Feb 2009,
Raleigh, North Carolina.
31. Data Layout Transformation for Enhancing Locality on NUCA Chip Multiprocessors
Qingda Lu, Christophe Alias, Uday Bondhugula, Thomas Henretty, Sriram Krishnamoorthy, J. Ramanu-
jam, Atanas Rountev, P. Sadayappan, Yongjian Chen, Haibo Lin, and Tin-fook Ngai.
International Conference on Parallel Architectures and Compilation Techniques (PACT), 2009
32. A Practical Automatic Polyhedral Parallelizer and Locality Optimizer
Uday Bondhugula, A. Hartono, J. Ramanujam, and P. Sadayappan.
ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI '08), Jun
2008, Tucson, Arizona.
ACM SIGPLAN Most Influential Paper Award in 2018.
33. Automatic Transformations for Communication-Minimized Parallelization and Locality Optimization in
the Polyhedral Model
Uday Bondhugula, M. Baskaran, S. Krishnamoorthy, J. Ramanujam, A. Rountev, and P. Sadayappan.
International Conference on Compiler Construction (ETAPS CC'08), Apr 2008, Budapest, Hungary.
34. A compiler framework for optimization of affine loop nests for GPGPUs
M. Baskaran, Uday Bondhugula, S. Krishnamoorthy, J. Ramanujam, A. Rountev, and P. Sadayappan.
ACM International Conference on Supercomputing (ICS'08), Jun 2008, Kos, Greece.
35. Automatic data movement and computation mapping for multi-level parallel architectures with explicitly
managed memories
M. Baskaran, Uday Bondhugula, S. Krishnamoorthy, J. Ramanujam, A. Rountev, and P. Sadayappan.
ACM SIGPLAN PPoPP'08, Feb 2008, Salt Lake City, Utah.

36. Automatic mapping of nested loops to FPGAs
Uday Bondhugula, J. Ramanujam, and P. Sadayappan.
ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming (PPoPP '07), Mar 2007, San Jose, California.
37. Effective automatic parallelization of stencil computations
S. Krishnamoorthy, M. Baskaran, Uday Bondhugula, J. Ramanujam, A. Rountev, and P. Sadayappan.
ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI '07), Jun 2007, San Diego, California.
38. Hardware/software integration for FPGA-based all-pairs shortest-paths
Uday Bondhugula, A. Devulapalli, J. Dinan, J. Fernando, P. Wyckoff, E. Stahlberg, and P. Sadayappan.
IEEE Symposium on Field-Programmable Custom Computing Machines (FCCM '06), Apr 2006, Napa Valley, California.
39. Parallel FPGA-based all-pairs shortest-paths in a directed graph
Uday Bondhugula, Ananth Devulapalli, Joseph Fernando, Pete Wyckoff, and P. Sadayappan
20th IEEE International Parallel and Distributed Processing Symposium (IPDPS '06), Apr 2006, Rhodes, Greece.
40. High performance RDMA-based all-to-all broadcast for InfiniBand clusters
S. Sur, Uday Bondhugula, A. Mamidala, H.-W. Jin, and D. K. Panda
12th IEEE International Conference on High Performance Computing (HiPC '05), Dec 2005.

Software and Tools

1. MLIR

<https://mlir.llvm.org/>

Founding team member of the MLIR project, and co-developer of the early infrastructure, especially, the polyhedral/mid-level analysis and optimization infrastructure; open-sourced by Google in Apr 2019 and now an LLVM sub-project with high traction in the industry/community.

The MLIR project was initiated to deliver the next generation optimizing compiler infrastructure with a focus on serving the computational demands of AI and machine learning programming models. At Google itself, one of the project's goals is to address the compiler challenges associated with the TensorFlow ecosystem. MLIR is a new intermediate representation designed to provide a unified, modular, and extensible infrastructure to progressively lower dataflow compute graphs, through loop nests potentially, to high-performance target-specific code. MLIR shares similarities with traditional CFG-based three-address SSA representations (including LLVM IR or Swift intermediate language), but also introduces notions from the polyhedral compiler framework as first class concepts to allow powerful analysis and transformation in the presence of loop nests and multi-dimensional arrays. MLIR supports multiple front- and back-ends and uses LLVM IR as one of its primary code generation targets. It is thus a very useful infrastructure for developing new compilers, especially to solve the compilation challenges involved in targeting emerging AI and machine learning programming languages/models to the plethora of specialized accelerator chips.

2. Pluto

<http://pluto-compiler.sourceforge.net>

Original and lead author of Pluto.

Pluto is a source-to-source parallelization and optimization tool based on the polyhedral compiler framework. It can automatically optimize affine loop nests (sequences of imperfectly nested loops with regular data access patterns) for parallelism and locality using affine transformations. It can target both shared-memory multicore architectures (by generating code with OpenMP parallel pragmas) and distributed-memory architectures (by generating message passing MPI code). Pluto/Pluto+ is extensively used for advanced experimentation with loop optimization and parallelization, optimization of scientific stencil computations, and in university courses teaching loop transformations.

3. PolyMage

<http://mcl.csa.iisc.ernet.in/polymage.html>

PolyMage is a domain-specific language and compiler for automatic parallelization and optimization of image processing pipelines. PolyMage takes an image processing pipeline expressed by the user in a high-level language (embedded in Python) and generates a C++ implementation of the pipeline optimized using the polyhedral framework as the intermediate representation. It uses OpenCV for image I/O handling, islpy/ISL for integer set operations, 'cgen' for AST code generation and 'OpenMP' to mark parallel loops. PolyMage uses an asymmetric overlapped tiling technique (overlapped tiling extended for heterogeneous accesses and non-constant dependence vectors) to exploit locality and parallelism simultaneously. It uses a model-driven approach to automatically fuse image processing pipeline stages for tiling, and employs an in-built autotuner to find the best performing code within a small well-defined search space.

Awards and Honors

- Honorable Mention - ACM India Early Career Research Award 2020
- Cray APJ Abdul Kalam HPC award 2019 — Young Researcher HPC Systems
- ACM SIGPLAN PLDI Most Influential Paper award in 2018 for PLDI 2008 paper
- ACM SIGPLAN PLDI 2017 Distinguished Reviewer Award as PC member
- Indian National Science Academy Medal for Young Scientists 2017
- Indian National Academy of Engineering Young Engineer Award 2016
- Awarded Indian Academy of Sciences Young Associate 2016–2019
- Google Faculty Research Award 2015
- Nominated for the best paper award at PACT 2014 for 'Tiling and Optimizing Time-Iterated Computations over Periodic Domains'
- INRIA Associate Team award (2013–2015) from INRIA, France (awarded on a competitive basis worldwide)
- Nominated for the ACM SIGPLAN doctoral dissertation award 2008
- ACM SIGPLAN student travel award for PLDI 2008
- All-India Rank 84 (top 0.06%) at the Indian Institutes of Technology Joint Entrance Examination 2000, out of a total of about 1,27,000 candidates
- Represented state of Andhra Pradesh, India at the Indian National Mathematical Olympiad in 1999
- Pratibha scholarship by the Govt of Andhra Pradesh (2000–2004) for performance at IIT-JEE 2000
- Recipient of the National Talent Search Exam (NTSE) scholarship (India) in 1998

Research Grants

- Department of Science and Technology / SERB extra-mural research grant 2017–2020
- Google Faculty Research award (2015)
- AMD research gift in support of research in the area of compilation for heterogeneous multicores (2011–)
- Gift from National Instruments in support of research on compiler optimizations for LabVIEW (2013–2015)

- INRIA Associate Team award (2012–2015) with Albert Cohen (INRIA / ENS)
- NVIDIA GPU research center award for 2012–2013, 2015–2016
- Research grants from Intel labs, Bangalore (2013–2014) and from C-DAC, Bangalore (2013–2014)

Students and Advising

- Ph.D.: 2 (1 best CS thesis medal), 4 (ongoing)
- M-Tech (Res.): 9 (4 best CS thesis medals), 1 (ongoing)
- M-Tech: 8 (graduated), 1 (ongoing)

Miscellaneous

- Program committee member: ASPLOS 2018, PLDI 2017, Supercomputing 2016, PPOPP 2016, CC 2016, PPOPP 2012, IMPACT 2011–2016; External review committee: PLDI 2014; Associate editor: ACM TACO
- Program chair: IMPACT 2012
- Reviewer: LCPC'06, PPOPP'07, ICS'07, LCPC'07, PACT'09, GPGPU workshop 2010, PPOPP 2011, HPCA 2011, IMPACT 2011–2016, ACM TOPLAS, ACM TACO, IEEE TPDS, JPDC
- Table Tennis: The Ohio State University team (2007 - short while), IISc TT tournament champions 2013 (CSA team)
- Football: IISc university team (2012 - present), IISc university tournament champions 2011–2012, 2012–2013, Bangalore C-division player
- Swimming: Karnataka state masters championships 2013 – 50m freestyle bronze, 4x50m medley relay bronze, 4x50m freestyle relay bronze – NCBS/IISc team
- Languages: English (fluent), Hindi (native), Telugu (native), French (intermediate), Kannada (intermediate)