# Rahulkumar Gayatri

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**Summary**


- Currently an Application Performance Specialist in the application performance group at NERSC, Lawrence Berkeley National Laboratory (LBL). My job duties require to help science teams optimize their codes for future high performance architectures. As a part of the staff member at NERSC I am involved with two main projects
  1. EXAALT - an Exascale Computing Project (ECP) molecular dynamics application
  2. ECP Application Assesment - assess and reproduce the results presented by ECP applications. Analyze the bottlenecks and provide guidance to the respective teams to overcome the challenges.
- Previously a Postdoc at NERSC, LBL. During that time, I worked in the "Application Readiness for Exascale Architectures" project in the NERSC department. I was involved with two projects:
  1. Writing performance portable application kernels using programming models such as OpenMP{3.0, 4.5}, Cuda, Kokkos, OpenACC and RAJA.
  2. SW4 - I worked on the SW4 project, which is a Seismic code that simulates the effects of an earthquake. My role in the project is to improve the performance of the code on the Intel-knl processor.
- Mentored GPU hackathons. I helped science teams during hackathons that focussed on porting their codes on to the NVIDIA GPUs. We succesfully ported and optimized codes on newer generation GPU hardware used on top supercomputers such as Summit and Cori.
- Succesfully organized and led the workshop and tutorial at the 2018 Computational Science Graduate Fellowship (CSGF) held in Washington,DC.
- Worked on the Moose project, a simulation model of neural connections in human brain.

  - My role was to parallelize the ODE solvers used to simulate the electrical and chemical interactions between neurons.
- Experience in the areas of compiler and runtime development for parallel programming models.

  - Introduced new compiler directives and the necessary runtime support in the OMPSs framework to handle synchronization of multiple threads.
- Knowledge and experience in the area of Transactional Memory framework.
- Experience in sequential and parallel algorithm development.

  - Designed and implemented a Breadth First Search (BFS) algorithm that takes advantage of low memory on IBM's Cell B/E. processor.

  - Parallelized Graph500 benchmarks on an SMP machine using the OMPSs programming model.
- Experience in exploiting the underlying processor arhitecture to enchance the application performance.
- Experience in working with profiling and analysis tools such as Intel-advisor, Intel-vtune, LIKWID, Intel-SDE, Nvprof, valgrind.

**Technical Skills**

## Programming Languages

- C, C++, Fortran, Python

## Programming Models

- MPI, OpenMP, CUDA, Kokkos, OpenACC, OMPSs, Pthreads, STM

## Scripting

- Shell, Latex, Sed, Awk, gnuplot

## Profiling Tools

- Intel Vtune, Intel Vector Advisor, Intel SDE, LIKWID, Nvidia Visual Profiler (NVVP), Nsight, Valgrind

## Operating Systems

- Unix, Linux, Windows

**Education**

| | Degree | Year | University | Specialization |
|---|---|---|---|---|
| 1 | Doctor of Philosophy (PhD) | 2015 | Barcelona Supercomputing Center | *Thesis title :* Increasing Parallelism through Speculation in a Task-Based Programming Model |
| 2 | Master of Technology (Mtech) | 2009 | Sri Sathya Sai University | Computer Science |
| 3 | Master of Science | 2007 | Sri Sathya Sai University | Mathematics |
| 4 | Bachelor of Science | 2005 | Sri Sathya Sai University | Mathematics |

**Publications**

1. *Rahulkumar Gayatri, Charlene Yang, Thorsten Kurth, Jack Deslippe* "A Case Study for Performance Portability using OpenMP 4.5."
   WACCPD, 2018.
2. *Charlene Yang, Rahulkumar Gayatri, Thorsten Kurth,..., Jack Deslippe* "An Empirical Roofline Methodology for Quantitatively Assessing Performance Portability"
   P3HPC, 2018.
3. *Tuomas Koskela, Zakhar Matveev, Rahulkumar Gayatri, et all* "A Novel Multi-Level Integrated Roofline Model Approach for Performance Characterization."
   ISC2018, Frankfurt, Germany.
4. *Rahulkumar Gayatri, Rosa M. Badia, Eduard Ayguade* "Loop level speculation in a task based programming model."
   20th Anual International Conference on High Performance Computing, Bangalore, 2013, pp.39-48.
5. *Rahulkumar Gayatri, Rosa M. Badia, Eduard Ayguade* "Transactional access to shared memory in StarSs, a task based programming model."
   Euro-Par 2012 Parallel Processing, pp 514-525.
6. *Rahulkumar Gayatri, Rosa M. Badia, Eduard Ayguade* "Analysis of the overheads incurred due to speculation in a task based programming model."
   Multiprog 2015: proceedings of 8th Workshop on Programmability Issues for Heterogeneous Multicores. Amsterdam:2015, p.1-12
7. *Roberto Giorgi et al.* "TERAFLUX: Harnessing dataflow in next generation teradevices."
   Microprocessors and Microsystems, Volume 38, Issue 8, pp.976-990

8. *Rahulkumar Gayatri, Rosa M. Badia, Eduard Ayguade* "Presented a Poster on the benefits of using CellSs ( a programming model for Cell Processor) in the ACACES 2010 summer school of HiPEAC."
9. *Rahulkumar Gayatri,Pallav Baruah* "Parallelizing Breadth First Search Using Cell BE, HiPC, Student Symposium, 2008"

**Projects**

1. **Berkeley GW** - Material science kernels, that predicts the excited state properties of a wide range of materials.. The aim is to port the kernel using different programming models such as OpenMP3.0, OpenMP4.5 (for GPU's using the target directives), Kokkos, RAJA and OpenACC. We compare the performance of the kernel ported using the above mentioned programming models to the best known implementations of the kernel for the specific architecture. The goal is to test the programmability, performance and portability of these frameworks.
2. **SW4** - Seismic wave code of 4th order. It simulates the effects of an earthquake.My role in the project is to optimize the code for the Knights Landing architecture from Intel. For this I use techniques such as vectorization, cache-blocking, reducing the OpenMP overhead.
3. **MOOSE** - The simulation environment uses various ODE system solvers to understand the chemical and electrical interactions inside a cell. I worked on parallelizing the ODE solvers that simulate the behavior of the cell over multiple timesteps. I have parallelized the kinetic and stochastic solvers that solve a system of linear equations using the Runge-Kutta method of order 5. Kinetic solver achieved a 2.3X speedup with 4 threads whereas the stochastic solver gained a 3.6X speedup.
4. **Doctoral Thesis** - Focussed in the area of parallel programming models, specifically on providing compiler and runtime support for synchronization of multiple threads in StarSs. The synchronization was achieved using TinySTM, a Software Transactional Memory Library (STM). This approach along with improving the performance and the efficiency also offers an opportunity to exploit higher degree of parallelism from an application. Papers published in this project: [1],[2] and [3].
5. **StarSs** - A task-based programming model to make parallel programming easier. It consists of compiler directives and the required runtime support. My contribution to the project was to maintain the runtime framework and resolve conflicts when new directives and their required implementation were introduced. I also worked on design and implementation of parallel applications using the framework for the application repository.
6. **Teraflux** - It was a project supported and funded by European Union which focused on exploiting dataflow parallelism in a Teracomputing device. My contribution to the project was to introduce STM-based concurrency to handle simultaneous access to shared memory. Papers published in this project: paper [4].
7. **MTech Thesis** - An efficient Breadth First Search (BFS) implementation that exploits memory locality in the IBM's Cell.B.E architecture. Poster[5] presented the results achieved in this project.

**Professional Career**

- * Postdoc at Lawrence Berkeley National Lab.

- Technical Specialist, High Performance Computing (HPC), Wipro Infotech August, 2015 - September 2016

- Doctoral student at Barcelona Supercomputing Center -

**Honors && Highlights**

- Led the Workshop and Tutorial at the 2018 Computational Science Graduate Fellowship (CSGF).
- Received a Pre-Doctoral scholarship, FI AGAUR grant, by Generalitat de Catalunya