

Thilina Ratnayaka

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Education

PhD in Scientific Computing (In Progress), UofI. Aug 2016 - Present.
GPA - 3.62/4.00

B.Sc. Eng.(Hons), University of Moratuwa. Sri Lanka. May 2015.
Major: Computer Science and Engineering
GPA-3.84/4.20 (First Class Honours)

Maliyadeva College, Kurunegala. Sri Lanka. Aug 2009.
Advanced Level : Distinction in Combined Mathematics, Physics and Chemistry
Z-Score: 2.6865

Current Research

Research Interests - High Performance Computing, Numerical Linear Algebra.

I am currently working with Prof. Paul Fischer at UofI improving the performance of Nek5000 (fast and scalable high-order solver for computational fluid dynamics) and nekRS (Nek5000 on accelerators) in state of the art high performance computing architectures. This involves implementing efficient high-order spectral element kernels. I am also working in preparing Nek5000/nekRS workflows for upcoming exa-scale super computers, especially parallelization of mesh connectivity calculations and partitioning.

Publications

- [6] Ken Raffenetti, Abdelhalim Amer, Lena Oden, Charles Archer, Wesley Bland, Hajime Fujita, Yanfei Guo, Tomislav Janjusic, Dmitry Durnov, Michael Blocksome, Min Si, Sangmin Seo, Akhil Langer, Gengbin Zheng, Masamichi Takagi, Paul Coffman, Jithin Jose, Sayantan Sur, Alexander Sannikov, Sergey Oblomov, Michael Chuvelev, Masayuki Hatanaka, Xin Zhao, Paul Fischer, **Thilina Rathnayake**, Matt Otten, Misun Min, Pavan Balaji, "Why is MPI so slow?: analyzing the fundamental limits in implementing MPI-3.1", Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis (2017). [Link](#).
- [5] **Thilina Rathnayake**, Sanath Jayasena, Mahinsasa Narayana, "OpenFOAM on GPUs using AmgX", 25th High Performance Computing Symposium (HPC 2017). [Link](#).
- [4] Meurer A, Smith CP, Paprocki M, Čertík O, Kirpichev SB, Rocklin M, Kumar A, Ivanov S, Moore JK, Singh S, **Rathnayake T**, Vig S, Granger BE, Muller RP, Bonazzi F, Gupta H, Vats S, Johansson F, Pedregosa F, Curry MJ, Terrel AR, Roučka Š, Saboo A, Fernando I, Kulal S, Cimrman R, Scopatz A. (2017) SymPy: Symbolic computing in Python. PeerJ Computer Science 3:e103. [Link](#).

- [3] **T. Rathnayake**, M. Wijewardena, T. Kempitiya, K. Rathnasekara, T. Ganegedara, A. S. Perera, and D. Alahakoon, "Investigation of node deletion techniques for clustering applications of growing self organizing maps," in Advances in Intelligent Data Analysis XIV - 14th International Symposium, IDA 2015, Saint Etienne, France, October 22-24, 2015, Proceedings, ser. Lecture Notes in Computer Science, E. Fromont, T. D. Bie, and M. van Leeuwen, Eds., vol. 9385. Springer, 2015, pp. 229-240. [Link](#).
- [2] M. Wijewardena, T. Kempitiya, **T. Rathnayake**, K. Rathnasekara, T. Ganegedara, A. S. Perera, and D. Alahakoon, "Heterogeneous data fusion with multiple kernel growing self organizing maps," in Thirteenth Scandinavian Conference on Artificial Intelligence - SCAI 2015, Halmstad, Sweden, November 5-6, 2015, ser. Frontiers in Artificial Intelligence and Applications, S. Nowaczyk, Ed., vol. 278. 167-176. [Link](#).
- [1] Ondřej Čertík, Mateusz Paprocki, Aaron Meurer, Brian Granger and **Thilina Rathnayake**. Symbolic Computing. Encyclopedia of Applied and Computational Mathematics. [Link](#).

Research Projects

Ongoing

exaAlgo (Aug 2019 - Present)

A collection of algorithms for exascale computing architectures. [\(Github\)](#).

nekRS (Aug 2018 - Present)

nekRS is an open-source based Navier Stokes solver using the spectral element method. It is build on top of the discretization library [libParanumal](#) targeting modern processors and accelerators including multi/many-core CPU and GPU platforms using [OCCA](#). [\(Github\)](#).

parRSB (Aug 2017 - Present)

parRSB is a parallel domain decomposition software based of recursive spectral bisection. This finds the Fiedler vector for the dual graph representing the mesh and then split the mesh based on the Fiedler values. parRSB has been tested on 262,144 MPI ranks on ALCF Mira. [\(Github\)](#).

libCEED (Aug. 2017 - Present)

libCEED is a library created by ECP CEED project for providing an uniform API for finite element operators and providing high performing implementations of the actions of these operators. I created and maintain the Fortran interface for libCEED (written in C). The Fortran interface is complete and provide all the functionality the C API provides. Currently working on an OpenCL backend for libCEED as well. [\(Github\)](#).

Past

OpenFOAM solvers in GPUs (Aug 2015 - Aug 2016)

Ported OpenFOAM (Open source CFD Software) solvers to GPUs using AmgX library from NVIDIA. This project was supervised by Prof. Sanath Jayasena PhD (UofI) and Dr. Mahinsasa Narayana PhD (UK) of University of Moratuwa, Sri Lanka.

Genjitsu - A framework for exploratory data mining Final Year Project (May 2014 - May 2015)

Genjitsu supports text, image and video feature extraction. Genjitsu has the ability to fuse these multi-modal information and create more accurate and detailed models incrementally. An improved version of the Growing Self Organizing Maps (GSOM) algorithm and Incremental Knowledge Acquisition and Self Learning (IKASL) algorithm were used in Genjitsu. The project was supervised by Dr. Amal Shehan Perera PhD (NDSU) at University of Moratuwa and Prof. Damminda Alahakoon PhD (Monash) at La Trobe University.

Internships

Givens Fellow at ANL (Summer 2019)

I worked under Misun Min at Argonne National Laboratory (ANL) on nekRS: a fast scalable CFD solver which runs on accelerators including GPUs ([Github](#)).

Givens Fellow at ANL (Summer 2018)

I worked under Misun Min at Argonne National Laboratory (ANL) in running CEED bakeoff problems in ALCF Cetus (BG/Q) for ECP CEED project. I also worked on interfacing Nek5000 (Fortran) with libParanumal (C/C++). Both are spectral element flow solvers. Nek5000 runs entirely in CPU while libParanumal runs on accelerators. This interface allowed Nek5000 to run on GPUs.

Computation student intern, LLNL (Summer 2017)

I worked as a summer intern at Lawrence Livermore National Laboratory (LLNL) on extracting and implementing higher order kernels from Nek5000 (a fast scalable spectral element CFD solver) to be used as reusable components for other higher order software libraries. The project was mentored by Tzanio Kolev.

Google Summer of Code intern at SymEngine (Summer 2014)

SymEngine ([Github](#)) is a fast C++ symbolic manipulation library. Implemented a Linear Algebra Module for SymEngine during the internship. The project was mentored by Ondřej Čertík at Los Alamos National Laboratory ([Website](#)). The deliverables included the following:

- Algorithms for matrix operations (addition, multiplication, transpose, determinant, inverse, etc.), matrix factorizations (LU, LDL, QR, Cholesky, etc.), solving linear systems, finding eigenvalues.
- Support for sparse matrices (COO to CSR conversion, basic operations, etc.).
- Fraction free versions of some of the algorithms for matrices with symbolic entries.

Trainee Software Engineer at Zone24x7 (Pvt.) Ltd. (Nov. 2013 - May 2014)

Developed a Key Performance Indicator (KPI) Engine for calculating KPIs of devices managed by Matrix24x7 (<http://www.matrix24x7.com/>) which is a device management framework developed by Zone24x7.

Google Summer of Code intern at SymPy (Summer 2013)

SymPy ([Website](#)) is a popular Computer Algebra System written in Python. Implemented a Diophantine Equation Module for SymPy during the internship. The project was mentored by Ondřej Čertík. Solutions for linear, quadratic and ternary quadratic Diophantine equations were implemented.

Development Projects

NekBench (Aug. 2017 - Present)

NekBench is a collection of bash scripts which let you benchmark Nek5000 in high performance computing facilities like ALCF Mira, ALCF Theta, NeRSC Cori/Edison. NekBench lets a user run a suite of benchmarks just by letting user specify parameter values ([Github](#)).

Tank Game (Jun. 2013 - Sep. 2013)

Developed a 2D Tank game using the XNA framework.

Point of Sales System (Jul. 2012 - Jan. 2013)

POS system is capable of users management, generating invoices, view/update inventory etc.

Sinhala Screen Reader (Jun. 2012 - Dec. 2012)

Developed a software to help the retired blind soldiers in SL Army to access documents and web sources to ease their day-to-day computer related work. NVDA screen reader and eSpeak synthesizer were used to develop this system.

Path Following Robot (Feb. 2011 - May 2011)

The robot used the IR sensors to detect the black path in the white background and was able to correct itself if it missed the track.

Talks

- [2] "CEED Performance Metrics & Objectives",SIAM CSE 19, Feb. 25- Mar. 1, Spokane, WA.
- [1] "Nek5000+libParanumal,libCEED and NekBench",CEED 2nd Annual Meeting, Aug. 8-10, Boulder, CO.

Posters

- [1] "parRSB - Parallel Recursive Spectral Bisection",IPDPS 2019, May 20-24, Rio de Janeiro, Brazil.

Workshops / Meetings

- [6] CEED - Thrid annual meeting, Aug. 6-8, 2019, Blacksburg, VA.
- [5] CEED - Second annual meeting, Aug. 8-10, 2018, Boulder, CO.
- [4] CEED - First annual meeting, Aug. 15-17, 2017, Livermore, CA.
- [3] CEED - Kick-off meeting, 2017, ANL, IL.
- [2] Argonne Training Program in Extreme Scale Computing, July 30 - Aug. 10, 2017, St. Charles, IL.
- [1] ALCF Computational Performance Workshop, May 2-5, 2017, ANL

Achievements, Awards & Grants

Bronze Medal in International Mathematics competition (IMC) (2014)

IMC - 2014 was co-organized by University College, London and American University in Bulgaria. 323 students from nearly 50 countries took part in the competition. Problem areas: Analysis (Real and Complex), Algebra, Geometry and Combinatorics.

Honorable Mention in International Mathematics Olympiad (IMO) (2007)

IMO is the oldest of the International Science Olympiads and most recognized mathematics competition for pre-collegiate students. 520 students from 93 countries participated in the event. Problem areas: Algebra, Number Theory, Geometry and Combinatorics.

Bronze Medal in Sri Lankan Mathematical Olympiad (SLMO) (2007)

Represented Sri Lanka in Prof. Braham Prakash Memorial Materials Quiz (BPMMQ) (2008)

BPMMQ is organized annually by Indian institute of Metals, Kalpakkam Chapter.

3rd Place in All Island Astronomy and Space Science Quiz (2003)

High Distinction in Australian National Chemistry Quiz (2006)

Included in Dean's List for 5 out of 7 academic semesters (University of Moratuwa)

Awarded Mahapola Merit Scholarship

Awarded Prof. V.K Samaranayake Research Grant (Aug 2015 - Aug 2016)

Teaching Experience

Teaching Assistant at Uoff - CS450 - Numerical Analysis (Fall 2017)

Visiting Lecturer at University of Moratuwa (Oct 2015 - Jan 2016)
Involved in designing and teaching of CS4552: Scientific computing.

Visiting Instructor at University of Moratuwa (Aug. 2015 - Dec 2015)
Involved in instructing the labs and grading the assignments of CS2022: Data Structures and Algorithms.

Visiting Lecturer at University of Moratuwa (May 2015 - Sep. 2015)
Conducted two lectures on Growing Self Organizing Maps and Support Vector Machines for CS4642: Data Mining and Information Retrieval.

Activities

Member of Data Mining research group, University of Moratuwa, led by Dr. Amal Shehan Perera - (2013 - 2016)

Mentored the project "Fast Series Expansion for SymEngine" in Google Summer of Code 2015.

Examiner - IT Mastermind programme organized by Computer Society, Sri Lanka (CSSL) (2013).

Collaborator - CSE OutReach program: an IT knowledge improvement program for school students in rural areas of Sri Lanka (2011).

Professional Experience

Student Member - Society for Industrial and Applied Mathematics (SIAM) and SIAG/LA (May 2015 - May 2016)

Student Member - Association of Computing Machinery (ACM) (May 2014 - May 2015)

Student member - The Institute of Electrical and Electronics Engineers (IEEE) (2010 - 2013)

Member - Computer Society, Sri Lanka (CSSL) (2012 - present)

I, Thilina Rathnayake, hereby declare that the above mentioned information is true and correct to the best of my knowledge.

Thilina Rathnayake