Alessandro Fanfarillo

Current Position

I am a senior software engineer at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, in the Research Application Laboratory (RAL), National Security Applications Program (NSAP). My work is mostly devoted to performance enhancement of parallel weather models, GPGPU computing, software design/refactoring of scientific applications and design of machine learning-based solutions. I am also the Focus Area lead for High Performance Computing in the NSAP.

Education

University of Rome Tor Vergata, Italy - *PhD in Computer Science, Control and Geoinformation* from November 2012; graduated on March 2016, score: excellent. Full Ph.D. Scholarship granted by the Italian Ministry of Education, University and Research. PhD Advisors: Valeria Cardellini and Salvatore Filippone.

University of Rome Tor Vergata, Italy - *Italian professional engineering qualification*, Information Engineering, September 2012

University of Rome Tor Vergata, Italy - *Master in Computer Engineering, Summa cum laude*, April 2012 THESIS: Clusters of GPGPUs: hybrid MPI-CUDA programming for sparse matrix computations

University of Rome Tor Vergata, Italy - *Bachelor in Computer Engineering*, November 2008

Summer Schools and Training Programs

Deep Learning, a 5-course specialization by deeplearning.ai on Coursera. Specialization Certificate earned on May 30, 2018

Argonne Training Program on Extreme-Scale Computing (ATPESC 2017). July 30 - August 11, 2017, St. Charles, IL, USA.

Evident-Based Introduction to Teaching (EBIT 2017). July 24-28, 2017, Boulder, CO, USA.

10th Advanced School on Parallel Computing. February 10-14, 2014, Bologna, Italy.

22nd Summer School on Parallel Computing. July 15-26, 2013, Rome, Italy.

Work Experience

National Center for Atmospheric Research - Research Application Laboratory (NSAP), Boulder, CO, USA. February 2017 to present. Collaboration in the development and maintenance of turbulent plume dispersion and probabilistic weather prediction models. Performance improvement of hydrological and weather models. Refactoring and development of scientific software.

National Center for Atmospheric Research - Computational & Information System Laboratory (USS), Boulder, CO, USA. April 2016 to February 2018. Postdoctoral researcher. Implementation of fault tolerant coarray Fortran support in the GNU Fortran Compiler.

Sandia National Laboratories, Albuquerque, NM, USA. Freelance from May 2012 to July 2012. Design and development of a patch for the open-source GNU Compiler Collection (GCC) in order to add support for `Final` subroutines (Fortran 2003 standard) to the GNU Fortran compiler.

Independent work. Freelance from December 2010. IT consulting and software development.

Research Interests

Partitioned Global Address Space (PGAS) languages for High Performance Computing, in particular Coarray Fortran.

Communication optimization in parallel scientific applications.

Code optimization for multi- and many- core processors.

Compiler-based optimizations for PGAS languages.

Research Projects

OpenCoarrays (http://opencoarrays.org)

Google Summer of Code 2014 - Coarrays in GNU Fortran.

PSBLAS GPU Plugin (http://www.ce.uniroma2.it/psblas/index.html)

Hybrid MPI-CUDA Programming (http://www.ce.uniroma2.it/hybrid)

Hybrid Parallel Sparse Basic Linear Algebra Subroutines (http://www.ce.uniroma2.it/psblas)

International Research Experience

Sourcery Institute, Oakland, CA, USA. *Visiting PhD Student* from February 2015 to April 2015. Research topic: Optimization of coarray Fortran codes.

National Center for Atmospheric Research, Boulder, CO, USA. *Visiting PhD Student* from March 2014 to August 2014. Research topic: Coarray Fortran support in the GNU Fortran compiler.

Publications

Journal Articles

A. Fanfarillo, D. Del Vento. *AITuning: Machine Learning-Based Tuning Tool for Run-Time Communication Libraries*. The Journal of Concurrency and Computation: Practice and Experience, in press. Presented at the ExaMPI 2018 workshop.

A. Fanfarillo, S. Garain, D. Balsara, D. Nagle. *Resilient Computational Applications using Coarray Fortran*. Parallel Computing, Elsevier, December 2018.

A. Fanfarillo, D. Del Vento. *Notified Access in Coarray-based Hydrodynamics Applications on Many-Core Architectures: Design and Performance*. Parallel Computing, Elsevier, April 2018.

A. Fanfarillo, V. Cardellini, S. Filippone. *Coarray-based Load Balancing on Heterogeneous and Many-Core Architectures*. Parallel Computing, Elsevier, June 2017.

A. Fanfarillo and D. Rouson. *Leveraging OpenCoarrays to Support Coarray Fortran on IBM Power8E*, ACM SIGPLAN Fortran Forum. Vol. 34. No. 2, May 2015.

D. Barbieri, V. Cardellini, A. Fanfarillo, S. Filippone. *Sparse Matrix-Vector Multiplication on GPGPUs*. ACM Transactions on Mathematical Software (TOMS), Volume 43, Issue 4, Article 30 (January 2017), 49 pages. DOI: https://doi.org/10.1145/3017994.

Books

A. Fanfarillo. *Parallel Programming Techniques for Heterogeneous Exascale Computing Platforms*. PhD Thesis, Aracne 2016.

Proceedings

D. Rouson, E. Gutmann, B. Friesen, A. Fanfarillo *Performance portability of an intermediate-complexity atmospheric research model in coarray Fortran*. In *Proceeding of the 2nd Annual PGAS Applications Workshop*, SC17, Denver, Colorado, USA, November 2017.

D. Rouson, J. McCreight, A. Fanfarillo *Incremental caffeination of a terrestrial hydrological modeling framework using Fortran 2015 teams*. In *Proceeding of the 2nd Annual PGAS Applications Workshop*, SC17, Denver, Colorado, USA, November 2017.

A. Fanfarillo, D. Del Vento. *Notified Access in Coarray Fortran*. In *Proceeding of the EuroMPI/USA 17: the 24th European Message Passing Interface (MPI) Users and Developers Conference*, Chicago, Illinois, USA, September 2017.

A. Fanfarillo, D. Del Vento, P. Nichols. *Optimizing Communication and Synchronization in CAF Applications*. In *Proceeding of the International Conference on Parallel Computing (ParCo 2017)*, Bologna, Italy, September 2017.

A. Fanfarillo, J. Hammond. *CAF Events Implementation Using MPI-3 Capabilities*. In *Proceeding of the EuroMPI 16: the 23rd European Message Passing Interface (MPI) Users and Developers Conference*, Edinburgh, Scotland, UK, September 2016.

V. Cardellini, A. Fanfarillo, S. Filippone. *Heterogeneous CAF-based load balancing on Intel Xeon Phi*, 6th International Workshop on Accelerators and Hybrid Exascale Systems (AsHES 2016) (in conjunction with the 30th IEEE International Parallel & Distributed Processing Symposium), Chicago, Illinois, May 2016. Published in *Proceedings of the 30th IEEE International Parallel & Distributed Processing Symposium Workshops*, 2016.

V. Cardellini, A. Fanfarillo, S. Filippone and D. Rouson. *Hybrid coarrays: A PGAS feature for many-core architectures*. In *Proceedings of the International Conference on Parallel Computing (ParCo2015)*, Edinburgh, UK, September 2015.

A. Fanfarillo, T. Burnus, V. Cardellini, S. Filippone, D. Nagle, D. Rouson. *OpenCoarrays: Open-source Transport Layers Supporting Coarray Fortran Compilers*. In *Proceedings of the 8th International Conference on Partitioned Global Address Space Programming Models (PGAS 14)*, Eugene, Oregon, USA. ACM, October 2014.

A. Fanfarillo, T. Burnus, V. Cardellini, S. Filippone, D. Nagle, D. Rouson. *Coarrays in GNU Fortran*. In *Proceedings of the 23rd International Conference on Parallel Architectures and Compilation Techniques (PACT 2014)*, 2 pages, Edmonton, Alberta, Canada, August 2014.

V. Cardellini, A. Fanfarillo, and S. Filippone. *Sparse matrix computations on clusters with GPGPUs*. In *Proceedings of 2014 International Conference on High Performance Computing & Simulation (HPCS 14)*, pp. 23-30. IEEE, July 2014.

V. Cardellini, A. Fanfarillo, and S. Filippone. *Heterogeneous sparse matrix computations on hybrid GPU/CPU platforms*. In *Proceedings of International Conference on Parallel Computing (ParCo 2013)*, pp. 203-212. IOS Press. 2014.

Technical Reports

A. Fanfarillo, V. Cardellini, S. Filippone. *Overlapping communication with computation in MPI applications*. Technical Report DICII RR-16.09, Universita di Roma Tor Vergata, Feb. 2016.

Invited Talks

A. Fanfarillo. *Vectorization explained: how to get the most out of modern processors.*, RAL Technology Affinity Group, NCAR, Boulder, CO, USA. December 17th 2018.

A. Fanfarillo. *Getting ready for exascale computing: New features of the Message Passing Interface (MPI), challenges and opportunities*, PennState University, State College, PA, USA. October 15th 2018.

A. Fanfarillo. *Performance Evaluation of MPI on Weather and Hydrological Models*, 6th Annual MVAPICH User Group (MUG) Meeting, Columbus, OH, USA. August 6-8 2018.

A. Fanfarillo. *GPU Computing: A Gentle Introduction*, National Oceanic and Atmospheric Administration (NOAA), Boulder, CO, USA. July 17th 2018.

A. Fanfarillo. *The Message Passing Interface at the end of Petascale era.*, RAL Technology Affinity Group, NCAR, Boulder, CO, USA. June 26th 2018.

A. Fanfarillo. *Everything you wanted to know about GPUs (but had no one to ask)*, RAL Technology Affinity Group, NCAR, Boulder, CO, USA. May 22th 2018.

A. Fanfarillo. *Fault Tolerance in Fortran 2018*, Birds-of-a-Feather - Resilient Programming Environments, SC17, Denver, CO, USA. November 14th 2017.

D. Rouson, A. Fanfarillo. *Towards exascale computing with Fortran 2018 on Intel many-core processors*, Intel HPC Developer Conference 2017, Denver, CO, USA. November 11-12 2017.

A. Fanfarillo. *Myths and reality of communication/computation overlap in MPI applications*, Software Engineering Assembly, NCAR Mesa Lab, Boulder, CO, USA. October 12th 2017.

A. Fanfarillo. *Exascale computing - Architectures and Parallel Programming Techniques*, Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), Bologna, Italy. September 13th 2017.

A. Fanfarillo. *Exascale computing - Architectures and Parallel Programming Techniques*, CNR-INSEAN, Rome, Italy. May 8th 2017.

D. Rouson, A. Fanfarillo. *Towards Exascale Computing with Fortran 2015*, HPC Advisory Council, Stanford University, Stanford, CA, USA. February 7th 2017.

A. Fanfarillo. *Fault Tolerance in Fortran 2015*, Software Engineering Assembly, NCAR Mesa Lab, Boulder, CO, USA. January 26th 2017.

A. Fanfarillo. *Parallel Programming Techniques for Heterogeneous Exascale Computing Platforms*. Seconda Universita' degli Studi di Napoli, April 2016.

A. Fanfarillo. *Introduction to coarray Fortran using GNU Fortran*, ENEA Frascati, Italy. December 2014.

A. Fanfarillo. *Coarrays in GNU Fortran*, Fortran Standardization Committee J3/WG5 Meeting (n. 204), Las Vegas, NV, USA. June 2014.

A. Fanfarillo. *Coarrays in GNU Fortran*, Software Engineering Assembly, NCAR Mesa Lab, Boulder, CO, USA. June 2014.

Posters

I. Beekman, A. Fanfarillo, B. Friesen, E. Gutmann, D. Rouson. *Many-core performance of coarray Fortran 2015 with GNU Fortran*. PGAS booth at SuperComputing 2017, Denver, November 2017.

A. Fanfarillo, V. Cardellini, S. Filippone, D. Rouson. *Many-core performance of coarray Fortran 2015 with GNU Fortran*. PGAS booth at SuperComputing 2016, Salt Lake City, November 2016.

A. Fanfarillo, S. Filippone, D. Nagle, D. Rouson. *OpenCoarrays: A coarray Fortran API and ABI*. PGAS booth at SuperComputing 2015, Salt Lake City, November 2015.

A. Fanfarillo, T. Burnus, V. Cardellini, S. Filippone, D. Nagle, D. Rouson. *OpenCoarrays: Open-source transport layers supporting coarray Fortran compilers*. PGAS booth at SuperComputing 2014, New Orleans, November 2014.

A. Fanfarillo. Coarrays in GNU Fortran. Poster presented at the *ACM Student Research Competition (SRC) of the 23rd International Conference on Parallel Architectures and Compilation Techniques (PACT 2014)*, Edmonton, Alberta, Canada, August 2014.

Teaching Experience

Symposium Organizer, "Overlapping Communication with Computation". April 2018. Software Engineering Assembly, Boulder, CO.

University of Rome Tor Vergata. Teaching assistant of Fundamentals of Computing for mechanical, energy and civil engineering (taught 28 % of teaching hours), 2014/2015. Prof: Salvatore Filippone.

University of Rome Tor Vergata. Teaching assistant of Fundamentals of Computing for mechanical engineering (taught 14 % of teaching hours), 2012/2013. Prof: Salvatore Filippone.

Board Memberships

Chairman of Best-Practices Committee at Software Engineering Assembly (sea.ucar.edu).

Programming Language Skills

C: Proficient.

Fortran: Proficient.

CUDA: Proficient.

C++: Familiar.

Python: Familiar.

Matlab: Proficient.

Language Skills

Italian: native speaker.

English: professional working proficiency - TOEFL score: 99 (Sept.2014).

Spanish: professional working proficiency.