Dr. Austen Duffy

Chief Technical Officer
Citilabs
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Education

Ph.D. Applied and Computational Mathematics, Florida State University, 2011
Dissertation: *Massively Parallel Algorithms for CFD Simulation and Optimization on Heterogeneous Many-Core Architectures.*
Advisor: Mark Sussman, Co-Advisor : M.Y. Hussaini.

M.S. Applied and Computational Mathematics, Florida State University, 2009.

M.S. Applied Mathematics, Indiana University of Pennsylvania, 2005.
Thesis: *Numerical Reaction-Diffusion Models for Intracellular Communication in Biology.*

B.S. Mathematics, York College of Pennsylvania, 2003.

Current and Previous Research Interests

- High Performance and GPU Computing
    - Distributed Scene Generation
    - Real-Time Simulation
    - Use of HPC in HWIL Testing
    - Parallel Algorithm Development
    - GPGPU Computing
- Data Assimilation
- Simulation Based Design
    - Computational Design of Microfluidic devices
    - Ship hull optimization
- Traffic Assignment and OD Estimation
- Biomathematics
    - Computational Cell Biology
    - Computational Epidemiology
    - Mathematics of Cancer
- Computational Mathematics
    - Numerical Optimization
    - Partial Differential Equations
    - Level Set methods
    - Adjoint methods
- Computational Fluid Dynamics
    - Multiphase Fluids
    - Microfluidics

Work Experience

Citilabs

- **Chief Technical Officer.** January 2018 – Present. Lead the product development team at Citilabs including the software engineering and data analytics divisions. Oversee all company IT including the creation and implementation of corporate Cybersecurity policies. Take guidance of corporate strategy from the CEO and incorporate it into the overall technical vision for the company. Work with the CFO to define fiscally responsible strategies for expanding the computing infrastructure to handle the growing data analytics business. Work with the solutions and sales teams to provide transparency and dialogue on various aspects of company products. Guide corporate policy relating to technical efforts including software development and releases, data analysis strategies, quality improvement, and computing infrastructure management.   Perform hands on technical work as necessary including maintenance and development of the Analyst Drive software. Provide technical analysis, written technical reports and white papers as necessary to support the solutions and sales teams. Provide high level technical and informational support to current and potential clients.

- **Computational Mathematician.** May 2011-December 2014.   Created the *Analyst Drive* program module, part of the Cube software platform (the product webpage can be found at http://www.citilabs.com/products/cube/cube-analyst). *Analyst Drive* uses data assimilation techniques to optimize static and dynamic origin-destination trip demand matrices (known as 'Matrix Estimation' in the traffic engineering community).   Primary activities involved working with traffic engineers to design and build the software, running a beta testing program to refine the software for customer needs, and the creation and maintenance of technical user documentation.   *Analyst Drive* is built for Windows platforms and is designed to run in HPC environments. The code set consists of primarily Fortran (with some C) and is parallel at various levels using both OpenMP and MPI. Also developed numerous traffic assignment software prototypes based on more modern methods than were available in the Cube platform.

Air Force Research Laboratory (AFRL/RW)
- **Operations Research Analyst, HPC Group Lead.** July 2017 – Jan 2018. Performed and directed technical efforts in the areas of scene generation, high performance computing (HPC), real-time software, and distributed simulations. Served as the AFRL Munitions Directorate resident HPC expert and advocate for the development of advanced HPC capabilities for hardware-in-the-loop (HWIL) testing. Engaged in technical research supporting HWIL activities at the Kinetic Kill Vehicle Hardware-in-the-Loop Simulation (KHILS) facility. Represented Air Force and AFRL interests on the Sensor/Seeker Infrared Projector Technology Working Group and on the Joint Army-Navy-NASA-Air Force (JANNAF) Propulsion Group's Exhaust Plumes and Signatures Subcommittee. Managed scientific and technical contracts for the government and evaluated proposals for future contract awards. Wrote proposals to acquire external funding for HPC related projects, including the award of the multi-million-dollar Cernan HPC to AFRL/RW. Provided professional and technical mentorship to numerous young defense contractors and military personnel within the directorate.

Aegis Technologies

- **HPC Software Architect.** January 2015-July 2017. Led the Distributed Scene Generation (DSG) effort at the Air Force Research Laboratory's Kinetic Kill Vehicle Hardware-in-the-Loop Simulation (KHILS) facility. Directed a team of engineers including defense contractors and civilian personnel in the development of the ParFLITES software framework. ParFLITES was designed to utilize the Fast Line-of-Sight Target and Exhaust Signature (FLITES) API on high performance computing systems containing graphics co-processors. Provided the design concept for the Parallel FLITES Integration (ParFLINT) hardware to allow ParFLITES imagery to be fed to an IR-LED projector (later built as an AFRL civilian employee).

National Institute of Aerospace

- **Visiting Researcher.** Summer 2010.   Worked in the Computational AeroSciences branch at NASA Langley Research Center investigating the suitability of computing architectures containing general purpose graphics processors for use with the FUN3D code. Ported the point implicit solver of the FUN3D code to run on heterogeneous architectures containing graphics processors.

Florida State University, Department of Mathematics

- *Research Assistant, Fall 2008–Spring 2011.* Investigated strategies for simulation based design involving incompressible multiphase flow, as well as strategies to increase the speed of the flow solvers including multigrid strategies with adaptive meshes.   Work primarily based off of the coupled level set volume of fluid (CLSVOF, C based) code of Sussman.
  See my advisors page at http://www.math.fsu.edu/~sussman/ for some projects I have worked on.
- *Teaching Assistant, Fall 2006, Fall 2007–Spring 2008. Instructor, Pre-Calculus Algebra*
- *Research Assistant, Spring 2007.* Numerical Ship Wave Simulations. Primarily investigated the development of 'numerical wavemakers' for the Numerical Flow Analysis (NFA, Fortran based) code of SAIC.
- *Teaching Assistant, Fall 2005–Summer 2006, Summer 2007. Recitation Instructor/Lecture Assistant.*

Florida State University, Department of Oceanography

- *Research Assistant, Summer 2008.* Numerical Studies of a North Atlantic Right Whale. Worked with researchers in the oceanography department to create a realistic animation of a North Atlantic Right Whale for use in a flow code (CLSVOF) to study its flow dynamics.

Indiana University of Pennsylvania, Department of Mathematics

- *Graduate Assistant, Fall 2003–Spring 2005.*

Software

- ***ParFLITES*** – Creator and lead architect. ParFLITES is a software framework which provides the tools necessary to utilize the FLITES API in an HPC environment. The code is a mixture of C++, CUDA C and OpenGL.
- ***Analyst Drive*** – Sole developer, written primarily in Fortran with some C. *Analyst Drive* is a commercial matrix estimation program which is part of the *Cube* software suit of Citilabs.
- ***OpenME*** – Sole developer, wrote both Fortran and C versions. *OpenME* is an open source matrix estimation program intended for academic research uses, the source code was sold to a research group at Florida International University by Citilabs.
- [*FUN3D*](#) – Contributor, written in Fortran with my primary contributions being written in CUDA C. FUN3D is a production level aerodynamics code developed and maintained at the Computational AeroSciences Branch at NASA Langley Research Center. My contribution came from porting the point implicit solver to allow for GPU computation.
- ***CLSVOF*** – Coupled Level-Set and Volume of Fluid code set maintained by Professor Mark Sussman and originally developed at Lawrence Livermore national lab. My contributions came in several areas, primarily with adaptive mesh multigrid solvers and GPU code porting.

Publications and Presentations

Conference Proceedings

- Larry Herald, John Grimes and Austen Duffy, *A Parallel FLINT Interface for HD-ILEDS Projectors*, Sensor-Seeker Test Technology Working Group. Ft. Walton Beach, FL, October 2017.
- Austen Duffy and Charles Coker, *ParFLITES: A Parallel Software Framework for Distributed Scene Generation*, AIAA Defense Forum 2017. Laurel MD, April 2017.
- Larry Herald, Austen Duffy and Ron Rapp, *PACE Common Drive Electronics / HD-ILEDS Drive Electronics Development*, Sensor-Seeker Test Technology Working Group. Ft. Walton Beach, FL, July 2016.
- Austen Duffy and Charles Coker, *FLITES Scene Generation on Remote Visualization Clusters*, AIAA Defense Forum 2016. Laurel, MD, March 2016.
- Austen Duffy, [*Conceptual Differences Between Cube Analyst and Cube Analyst Drive*](#), Futura 2013. Ponte Vedra Beach, FL, October 2013.
- Austen Duffy and Matthew Martimo, *Cube Analyst 2.0: An Introduction to the Next Generation of Matrix Estimation Software,* Futura 2011. Palm Springs, CA, October 2011.
- Austen Duffy, [*Gradient Free Design of Microfluidic Structures on a GPU Cluster*](#), SIAM Conference on Computational Science and Engineering. Reno, NV, March 2011.
- Austen Duffy, [*A GPU/Multi-Core Accelerated Multigrid Preconditioned Conjugate Gradient Method for Adaptive Mesh Refinement*](#), SIAM Conference on Computational Science and Engineering. Reno, NV, March 2011.

- Austen Duffy and Mark Sussman, *A GPU Accelerated PCG Pressure Projection Solver on Dynamic Adaptive Grids*, SIAM Conference on Parallel Processing for Scientific Computing.   Seattle, WA, February 2010.

Refereed Journal Articles
- Austen Duffy, *Where do computational mathematics and computational statistics converge?*, Wiley Interdisciplinary Reviews: Computational Statistics, Vol. 6 No. 5, September 2014.

Peer Reviewed Technical Papers
- Austen Duffy, Dana Hammond and Eric Nielsen, Production Level CFD Code Acceleration on Hybrid Many-Core Architectures – NASA TM-2012-21770.

Invited Talks
- Austen Duffy, *Air Force Needs*, JANNAF 36th Exhaust Plume and Signatures Subcommittee Meeting. Hampton, VA, December 2017.
- Austen Duffy, *Scene Generation*, U.S. Air Force Scientific Advisory Board AFRL/RW S&T Review. Eglin AFB, FL, October 2017.
- Austen Duffy, *A "Crash" Course in Traffic Engineering*, Florida State University Math Fun Day. Tallahassee, FL, October 2014.
- Austen Duffy, *CFD Code Acceleration for Hybrid Many-Core Architectures*, Computational AeroSciences Branch, NASA Langley Research Center. Hampton, VA, August 2010.
- Austen Duffy, *Accelerating FUN3D on Hybrid Many-Core* Architectures, Computational Fluid Dynamics Seminar, National Institute of Aerospace. Hampton, VA, August 2010.

Other Technical Research Papers
- Austen Duffy, Allen Kuhnle and Mark Sussman, An Improved Variable Density Pressure Projection Solver for Adaptive Meshes, 2010.
- Austen Duffy, An Introduction to Gradient Computation by the Discrete Adjoint Method, Technical Report, Florida State University, Summer 2009.
- Austen Duffy, et al., Numerical Animation of a North Atlantic Right Whale, 2009.

Professional Certifications
- Currently completing the Microsoft Professional Program in Cybersecurity
- Level 1 Science and Technology Manager, Defense Acquisition University (U.S. Department of Defense)
- Professional Certificate in Nutrition and Disease, Wageningen University (Netherlands)

Awards/Other
- Member of the American Institute for Aeronautics and Astronautics (AIAA)

- Member of the Association for Computing Machinery (ACM) and the Special Interest Group on High Performance Computing (SIGHPC)
- SIAM student travel award recipient.
- Member of the *Pi Mu Epsilon* National Mathematics Honor Society.
- Book Reviewer: Cuda Fortran for Scientists and Engineers.
- Google Scholar Page: http://scholar.google.com/citations?user=tMXuzVsAAAAJ&hl=en
- Academic Descendant of Markov, Chebyshev and Copernicus - https://www.genealogy.math.ndsu.nodak.edu/id.php?id=156449
- Security Clearance: DoD Secret (inactive, expires January 2020)