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Viktor Reshniak

Curriculum Vitae

Education

2012 – 2017 **Ph.D. in Computational Science**, *Middle Tennessee State University*.
Advisors: Prof. Yuri A. Melnikov and Prof. Abdul Khaliq

2012 – 2016 **M.S. in Computer Science**, *Middle Tennessee State University*.

2011 – 2012 **M.S. in Thermal Physics**, *Dnipropetrovsk National University*, Ukraine.
Advisors: Prof. Oleksandr Kochubey and Dr. Dmytro Yevdokymov

2007 – 2011 **B.S. in Heat engineering**, *Dnipropetrovsk National University*, Ukraine.

Professional experience

2020 – curr **Staff Mathematician**, *Data Analytics and Machine Learning*, Oak Ridge National Laboratory.

2017 – 2020 **Postdoctoral Research Associate**, *Computational and Applied Mathematics Group, Math for Deep Learning Team*, Oak Ridge National Laboratory.

2012 – 2017 **Graduate Teaching Assistant**, *Department of Mathematics*, Middle Tennessee State University.

2011 – 2012 **Heating engineer**, *Energotechprom LTD*, Dnipro, Ukraine.

Programming skills

Languages FORTRAN, C/C++, Python, MATLAB

HPC MPI, OpenMP, Pthreads, Cuda

Miscellaneous Linux, Bash scripting, LaTeX, LAPACK, Trilinos, TensorFlow, PyTorch

Research interests

Machine learning algorithms

Image and data processing algorithms

Uncertainty quantification

Numerical methods for stochastic differential equations

Research projects

September 2019 – **Sparse learning algorithms for neural networks**, ORNL.
This project is devoted to the design of learning algorithms which promote sparsity during training.

March 2019 – **Robust machine learning algorithms**, ORNL.
This project is devoted to the design of new stable and robust ML algorithms for scientific applications.

May 2018 – **Non-local methods for image and data processing**, Oak Ridge National Laboratory.
This project is devoted to the development of new algorihtms for the recovery of corrupted images and data-sets using nonlocal methods.

December 2017 – **Toolkit for Adaptive Stochastic Modeling and Non-Intrusive ApproximatioN**, *Lead developer: Miroslav Stoyanov*, Oak Ridge National Laboratory.
I am working on enhancing and testing the FORTRAN interface module. I also contribute to the CUDA acceleration of the base C++ code.

March – May 2018 **Ugly Data Days Competition**, Oak Ridge National Laboratory.
This short interdisciplinary project involved researchers from the Spallation Neutron Source (SNS) and Computational and Applied Math (CAM) group at ORNL. The goal was to analyze the large volume of strain data collected from the SNS target modules with the idea of using it to monitor damage to the mercury vessel and to improve the design of future targets. This project won the competition (`https://datadays.pages.ornl.gov`), I contributed to the selection and numerical implementation of the data analysis tools.

September 2015 – May 2016 **Efficient numerical methods for systems of multidimensional nonlinear time dependent PDEs**, *PI: Abdul Khaliq*, Middle Tennessee State University.
The objective of this NSF grant proposal was to design a highly efficient and accurate numerical scheme by incorporating Krylov subspace approximation and WENO scheme into locally extrapolated exponential time differencing scheme for the numerical solution of the large system of ordinary differential equations that result from the discretization of multidimensional nonlinear advection-diffusion-reaction systems. I contributed to the stability analysis of the scheme and to the numerical implementation.

June – August 2014 **Acceleration of the multilevel Monte Carlo method in application to PDEs with random input data**, *PI: Clayton Webster*, Oak Ridge National Laboratory.
I developed the acceleration technique based on the learning of initial guesses to iterative linear solvers from the previously calculated data and performed the asymptotic cost analysis of the accelerated method.

2011 – 2012 **Mathematical models of potential theory for continuum medium processes with multi-scale and localized effects**, *PI: Dmytro Yevdokymov*, Dnipropetrovsk National University.
The project was devoted to the construction of mathematical models of multiphase flows using Lagrangian description of the solid phase and integral representations of the potential theory describing the main fluid phase. My contribution was in the numerical implementation of the proposed models.

Presentations

Invited talks

March 2021 **Method of Green's potentials for elliptic PDEs in domains with random boundaries**, *GAMM 91st Annual Meeting*, Kassel, Germany.

March 2021 **Robust learning with implicit residual networks**, *2021 SIAM CSE*, Fort Worth, TX.

December 2019 **Robust learning with implicit residual networks**, *"Advanced Statistics meets Machine Learning III" workshop*, Argonne National Laboratory, Lemont, IL.

September 2019 **A Nonlocal Feature Driven Exemplar-Based Image Inpainting**, *2019 SIAM Southeastern Atlantic Section*, Knoxville, TN.

February 2019 **Sparse approximation of nonlocal operator equations via compressed sensing**, *2019 SIAM CSE*, Spokane, WA.

February 2017 **Acceleration of the Multilevel Monte Carlo method for certain classes of differential systems**, *2017 SIAM CSE*, Atlanta, GA.

April 2016 **Split-step methods for stiff stochastic differential systems with multiple jumps**, *2016 SIAM UQ*, Lausanne, Switzerland.

March 2014 **Split-step Milstein methods for multi-channel stiff stochastic differential systems**, *2014 SIAM UQ*, Savannah, GA.

Contributed talks

July 2022 **Stabilization of Deep Latent Dynamics with Dissipative Bottleneck Layers**, *"2022 SIAM Annual Meeting"*, Pittsburgh, Pennsylvania.

September 2020 **Robust learning with implicit residual networks**, *"Second Symposium on Machine Learning and Dynamical Systems"*, Fields Institute, Toronto, Canada.

March 2015 **Fully implicit Runge-Kutta methods for multi-channel stiff stochastic differential systems with jumps**, *2015 SIAM CSE*, Salt Lake City, Utah.

July 2014 **Split-step balanced Milstein methods for multi-channel stiff stochastic differential systems**, *2014 SIAM Annual Meeting*, Chicago, IL.

Poster presentations

January 2021 **A nonlocal feature-driven exemplar-based approach for image inpainting**, *One Nonlocal World Workshop*, `https://sites.google.com/view/onenonlocalworld/events`.

December 2020 **Robust learning with implicit residual networks**, *PSU Machine Learning Workshop*, Penn State University.

August 2019 **A Nonlocal Feature Driven Exemplar-Based Image Inpainting**, *7th Annual Oak Ridge Postdoctoral Association Research Symposium*, ORNL.

July 2019 **A Nonlocal Feature Driven Exemplar-Based Image Inpainting**, *AI Expo*, ORNL.

July 2019 **Robust learning with implicit residual networks**, *AI Expo*, ORNL.

March 2019 **A Nonlocal Feature Driven Exemplar-Based Image Inpainting**, *ICERM "Computational Imaging" Workshop*, Brown University, Providence, RI.

2018 **Slow-scale split-step tau-leaping methods for stiff stochastic chemical systems**, *2018 SIAM UQ*, Orange County, CA.

2015 **Split-step methods for stochastic partial differential equations**, *Workshop "Numerical methods for large-scale nonlinear problems and their applications"*, ICERM, Brown University.

2015 **Fully implicit Runge-Kutta methods for multi-channel stiff stochastic differential systems with jumps**, *2015 SIAM CSE*, Salt Lake City, Utah.

2014 **Balanced split-step methods for stiff multiscale stochastic systems with uncertainties**, *2014 SIAM UQ*, Savannah, GA.

Colloquium talks

September 2020 **Robust learning with implicit residual networks**, *Second Symposium on Machine Learning and Dynamical Systems*, Fields Institute, Toronto, CA.

August 2019 **Robust learning with implicit residual networks**, *7th Annual Oak Ridge Postdoctoral Association Research Symposium*, Oak Ridge National Laboratory.

February 2018 **Sparse approximation of nonlocal operator equations via compressed sensing**, *CAM seminar*, Oak Ridge National Laboratory.

March 2017 **Reducing computational cost of the Multilevel Monte Carlo method by selection of suitable pathwise integrators**, *CAM seminar*, Oak Ridge National Laboratory.

June 2016 **Acceleration of the Multilevel Monte-Carlo method for certain classes of differential systems**, *CAM seminar*, Oak Ridge National Laboratory.

Additional training

March 2019 **Workshop "Computational Imaging"**, *Brown University* , Providence, RI.

February 2019 **Workshop "Theory and Practice in Machine Learning and Computer Vision"**, *Brown University* , Providence, RI.

January 2019 **Workshop "Scientific Machine Learning"**, *Brown University* , Providence, RI.

May 2018 **7th International Conference on Computational Harmonic Analysis**, *Vanderbilt University*, Nashville, TN.

September 2015 **Workshop "Numerical methods for large-scale nonlinear problems and their applications"**, *Brown University* , Providence, RI.

June 2014 **Short course on uncertainty quantification**, *Stanford University*, Stanford, CA.

Publications

Thesis

[1] Viktor Reshniak. *Reducing computational cost of the Multilevel Monte Carlo method by construction of suitable pathwise integrators*. PhD thesis, Middle Tennessee State University, 2017.

[2] Viktor Reshniak. Computational analysis of fluid dynamics and heat and mass transfer processes in multiphase medium by methods of potential theory. Master's thesis, Dnipropetrovsk National University, 2012.

Journal articles

[1] Massimiliano Lupo Pasini, Junqi Yin, Viktor Reshniak, and Miroslav K. Stoyanov. Anderson acceleration for distributed training of deep learning models. In *SoutheastCon 2022*, pages 289–295, 2022.

[2] Viktor Reshniak and Clayton G Webster. Robust learning with implicit residual networks. *Machine Learning and Knowledge Extraction*, 3(1):34–55, 2021.

[3] Viktor Reshniak, Jeremy Trageser, and Clayton G. Webster. A nonlocal feature-driven exemplar-based approach for image inpainting. *SIAM Journal on Imaging Sciences*, 13(4):2140–2168, 2020.

[4] V. Reshniak and Yu. A. Melnikov. Method of Green's potentials for elliptic PDEs in domains with random apertures. *Journal of Scientific Computing*, 84, 2020.

[5] V. Reshniak, A. Khaliq, and D. Voss. Slow-scale split-step tau-leap method for stiff stochastic chemical systems. *Journal of Computational and Applied Mathematics*, 361:79 – 96, 2019.

[6] H. Lay, Z. Colgin, V. Reshniak, and A. Khaliq. On the implementation of multilevel Monte Carlo simulation of the stochastic volatility and interest rate model using multi-GPU clusters. *Monte Carlo Methods and Applications*, 24:309–321, 2018.

[7] V. Reshniak, A.Q.M. Khaliq, D.A. Voss, and G. Zhang. Split-step Milstein methods for multi-channel stiff stochastic differential systems. *Applied Numerical Mathematics*, 89:1–23, 2015.

[8] Yu.A. Melnikov and V. Reshniak. A semi-analytical approach to Green's functions for heat equation in regions of irregular shape. *Engineering Analysis with Boundary Elements*, 46:108–115, 2014.

[9] V. Reshniak. Some Further Developments in the Infinite Product Representation of Elementary Functions. *Global Journal of Science Frontier Research*, 13, 2013.

Submitted manuscripts

[1] Viktor Reshniak and Clayton Webster. Stabilization of latent dynamics with dissipative bottleneck layers.

Teaching activities

Instructor

2014 – 2017 **Applied Calculus**, *Department of Mathematics*, Middle Tennessee State University.

Teaching assistant

2017 **Numerical methods in Computational Science**, *Computational Science Program*, Middle Tennessee State University.

2014 – 2017 **Calculus I, II, III**, *Department of Mathematics*, Middle Tennessee State University.

Professional activities

Editorial positions

2018 – Associate Editor, International Journal of Computer Mathematics

Memberships

2014 – Society for Industrial and Applied Mathematics (SIAM)

2017 – American Mathematical Society (AMS)

2018 – Society of Applied Mathematics and Mechanics (GAMM)

Journal Reviewer

International Journal of Computer Mathematics, Applied and Computational Harmonic Analysis, MDPI Stats, MDPI Mathematics, Journal of Mathematical Imaging and Vision, Foundations of Data Science, Frontiers in Artificial Intelligence

Symposia organizer

2021 **SIAM CSE 2021**, *Virtual event*, In Quest of Predictable and Robust Machine Learning: Theoretical and Applied Perspectives, co-organized with Sandeep Madireddy (Argonne National Laboratory) and Clayton Webster (UT Austin).

2020 **SIAM Southeastern Atlantic Section**, *Auburn University*, Theory and practice of machine learning, co-organized with Joseph Daws (UT Knoxville).

2019 **SIAM Southeastern Atlantic Section**, *Knoxville, TN*, Data-driven and machine learning approaches for applications, co-organized with Jae-Hun Jung (SUNY Buffalo) and Rick Archibald (ORNL).