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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**, *Dnipro National University*, Ukraine.
Advisors: Prof. Oleksandr Kochubey and Dr. Dmytro Yevdokymov

2007 – 2011 **B.S. in Thermal engineering**, *Dnipro National University*, Ukraine.

Professional experience

2020 – curr **Staff Mathematician**, *Data Analytics and Machine Learning Group*, ORNL.

2017 – 2020 **Postdoctoral Research Associate**, *Computational and Applied Mathematics Group*, ORNL.
Advisor: Clayton Webster

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

2011 – 2012 **Thermal 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

Data compression algorithms

Image and data processing algorithms

Uncertainty quantification

Numerical methods for stochastic differential equations

Research projects

August 2022 – **MGARD (MultiGrid Adaptive Reduction of Data)**, *PI: Scott Klasky*, ORNL.
MGARD is a technique for multilevel lossy compression of scientific data based on the theory of multigrid methods. I contribute to theoretical developments of error control and CPU implementation.

July 2022 – 2023 **Bayesian Neural Networks for Scientific Discovery in Nuclear Data**, *PI: Goran Arbanas*, Oak Ridge National Laboratory.
The overarching goal of this project is to explore new features of Bayesian Neural Networks (BNNs) for accelerated scientific discovery with uncertainty quantification (UQ) in physical sciences

2021 – 2023 **xSDK: Extreme-scale Scientific Software Development Kit**, *PI: Ulrike Meier Yang (LLNL)*, DOE Laboratories.
The vision of the xSDK is to provide infrastructure for and interoperability of a collection of related and complementary software elements developed by diverse, independent teams throughout the high-performance computing (HPC) community. I contribute to Continuous Integration and Development.

September 2019 – **Sparse learning algorithms for neural networks**, ORNL.
This project is devoted to the design of learning algorithms that 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 – 2020 **Non-local methods for image and data processing**, Oak Ridge National Laboratory.
This project was devoted to the development of new algorithms for the recovery of corrupted images and datasets using nonlocal methods.

December 2017 – **Toolkit for Adaptive Stochastic Modeling and Non-Intrusive ApproximatioN**, *Lead developer: Miroslav Stoyanov*, Oak Ridge National Laboratory.
I worked on enhancing and testing the FORTRAN interface module. I also contribute to Continuous Integration and Development (CI/CD)

March – May 2018 **Ugly Data Days Competition**, Oak Ridge National Laboratory.
The project analyzed the large volume of strain data collected from the Spallation Neutron Source target modules at ORNL for monitoring the damage to the mercury vessel and improving 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.

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

August 2023 **Dissipative residual layers for unsupervised implicit parameterization of data manifolds**, *"10th International Congress on Industrial and Applied Mathematics (ICIAM-2023)"*, Waseda University, Tokyo, Japan.

October 2022 **Stabilization of Latent Dynamics with Dissipative Bottleneck Layers**, *"AMS Sectional Meeting"*, The University of Tennessee at Chattanooga.

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

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.

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

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 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.

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

Poster presentations

March 2023 **Hierarchical approach for adaptive integration of Bragg peaks in time of flight neutron diffraction data**, *Conference on Data Analysis CODA2023*, `https://web.cvent.com/event/9d7caad6-df65-4288-8300-09f0fb6d2767/summary`.

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

January 2023 **2023 Exascale Computing Project Annual Meeting**, Houston, TX.

January 2022 **2022 Exascale Computing Project Annual Meeting**, online.

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] Qian Gong, Jieyang Chen, Ben Whitney, Xin Liang, Viktor Reshniak, Tania Banerjee, Jaemoon Lee, Anand Rangarajan, Lipeng Wan, Nicolas Vidal, Qing Liu, Ana Gainaru, Norbert Podhorszki, Richard Archibald, Sanjay Ranka, and Scott Klasky. MGARD: A multigrid framework for high-performance, error-controlled data compression and refactoring. *SoftwareX*, 24:101590, 2023.

[2] Qian Gong, Chengzhu Zhang, Xin Liang, Viktor Reshniak, Jieyang Chen, Anand Rangarajan, Sanjay Ranka, Nicolas Vidal, Lipeng Wan, Paul Ullrich, Norbert Podhorszki, Robert Jacob, and Scott Klasky. Spatiotemporally adaptive compression for scientific dataset with feature preservation – a case study on simulation data with extreme climate events analysis. In *2023 IEEE 19th International Conference on e-Science (e-Science)*, pages 1–10, 2023.

[3] Viktor Reshniak, Praveen Cheekatamarla, Vishaldeep Sharma, and Samuel Yana Motta. A review of sensing technologies for new, low global warming potential (GWP), flammable refrigerants. *Energies*, 16(18), 2023.

[4] Junqi Yin, Siyan Liu, Viktor Reshniak, Xiaoping Wang, and Guannan Zhang. A scalable transformer model for real-time decision making in neutron scattering experiments. *Journal of Machine Learning for Modeling and Computing*, 4(1), 2023.

[5] 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.

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

[7] 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.

[8] 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.

[9] 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.

[10] 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.

[11] 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.

[12] 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.

[13] 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. Dissipative residual layers for unsupervised implicit parameterization of data manifolds.

[2] 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, MDPI Applied Sciences, MDPI Processes, MDPI Axioms, Journal of Mathematical Imaging and Vision, Foundations of Data Science, Frontiers in Artificial Intelligence, Lithuanian Mathematical Journal, Mathematics and Computers in Simulation, Hindawi Journal of Probability and Statistics, Hindawi Mathematical Problems in Engineering, Numerical Methods for Partial Differential Equations

Synergetic activities

Novermber 2023 **GEM Fellowship reviewer**, *Washington DC*.

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).