

VASILY ZADOROZHNYI

Curriculum Vitae

Personal Information

OFFICE: 902 Patterson Office Tower, Lexington, Kentucky 40506 USA

@ EMAIL:	vasily.zadorozhnyy@uky.edu	in LINKEDIN:	vasilyzadorozhnyy
☎ PHONE:	+1 (859) 257-7216	g GOOGLE SCHOLAR:	qrIzKxgAAAAJ
☎ CELL PHONE:	Upon Request	✓ SEMANTIC SCHOLAR:	2032263714
🌐 WEB-SITE:	http://www.ms.uky.edu/viza222/	✎ DBLP:	280/3041
		👤 GITHUB:	vasily789

Education

Doctor of Philosophy in Mathematics MAY 2023
UNIVERSITY OF KENTUCKY | Lexington, KY
DISSERTATION ADVISOR: Qiang Ye, Ph.D.
RESEARCH AREA: Deep Learning

Master of Science in Mathematics OCTOBER 2019
UNIVERSITY OF KENTUCKY | Lexington, KY
COMMITTEE CHAIR: Qiang Ye, Ph.D.

Bachelor of Science APRIL 2017
GRAND VALLEY STATE UNIVERSITY | Allendale, MI
MAJOR: Mathematics | MINOR: Mathematical Statistics
INSTITUTIONAL HONORS: *Cum Laude*

Associate Degree in Science MAY 2015
LAKE MICHIGAN COLLEGE | Benton Harbor, MI
MAJOR: Mathematics
INSTITUTIONAL HONORS: *High Honors*

Employment

MICROSOFT RESEARCH LAB | Redmond, WA MAY 2022 - AUGUST 2022
PhD Research Intern - Machine Learning and Signal Processing in Speech and Computer Vision

UNIVERSITY OF KENTUCKY (UKY) | Lexington, KY MAY 2019 - PRESENT
Research Assistant in Department of Mathematics

- Design algorithm for Generative Adversarial Networks (GANs) for avoiding harmful training directions, resulting in new state-of-the-art STL-10 and CIFAR-100 dataset results for the unsupervised image generative task
- Develop methods that speed up training of symmetric structured data by utilizing the symmetry in the Convolution Neural Networks (CNNs), achieving significant improvement on Recommendation Problem while using less trainable parameters
- Create a generalization of widely-used normalization techniques for Recurrent Neural Networks (RNNs) and Transformers, obtaining a significant improvement (including new state-of-the-art) on Copying and Adding problems, multiple natural language processing (NLP) and language translation tasks

UNIVERSITY OF KENTUCKY | Lexington, KY

AUGUST 2017 - PRESENT

Teaching Assistant/Primary Instructor

- Lead interactive discussions about course materials for 60 undergraduate students to encourage collaboration, creating a more inclusive learning environment
- Assisted lecturers by taking over some responsibilities such as grading coursework and proctoring exams for up to 350 undergraduate students to assess student knowledge on a numerical scale and provide feedback creating a relationship based on mutual respect between teacher and student
- Provided one-on-one assistance to 60 undergraduate students in person and/or online based on student need to answer questions or provide time to make up assignments resulting in students showing better understanding of the course material as demonstrated by improved quiz scores each week
- Supervised two Mathematics undergraduate students by observing their teaching methods and providing feedback cultivating more effective pedagogy practices
- COURSES INCLUDE: Calculus I, II and III; Elementary Calculus and its Applications; Calculus I and II with Life Science Applications

UNIVERSITY OF KENTUCKY | Lexington, KY

MAY 2020, JANUARY 2021, DECEMBER 2021

Peer Advisor for Ph.D. students in Numerical Analysis Preliminary Exam Coaching

- Prepared a collection of practice problems for 12 graduate students to work through during group meetings allowing the students to become more familiar with the topic content
- Designed a detailed list of relevant content in a 500 page volume students would need to be familiar with to do well on the exam providing a valuable resource to the department to use for future lectures and exams
- Assisted 12 graduate students study content by providing group study sessions and being available to answer questions by appointment and email allowing the students to gain deeper understanding of the material necessary for the exam

GRAND VALLEY STATE UNIVERSITY | Allendale, MI

SEPTEMBER 2017 -MAY 2017

Teaching Assistant/Grader

- Assisted Paul Fishback, Ph.D. and Feryal Alayont, Ph.D. grading various course materials for 70 undergraduate students to gain experience in an authoritative role to prepare for graduate school
- COURSES INCLUDE: Calculus III, Differential Equations, Vector Analysis, Linear Algebra, and Introduction to Mathematical Reasoning

GRAND VALLEY STATE UNIVERSITY | Allendale, MI

SEPTEMBER 2016 -MAY 2017

Mathematics and Statistics Tutor

- Tutored 5 students individually and in groups to provide support and help them develop effective study habits to promote their success
- COURSES INCLUDE: Calculus (I, II, III), Differential Equations, Vector Analysis, Linear Algebra, Abstract Algebra, Discrete Mathematics, Complex Analysis, Real Analysis, Optimization Theory, and Mathematical Statistics

LAKELAND HEALTH HOSPITAL | St. Joseph, MI

MAY 2015 - AUGUST 2015

Information Technology/Performance Support Intern

- Implemented data analytics within annual national healthcare database statistically summarizing it according to the hospital's needs
- Developed a computer program for new patient registration through call-center database system
- Implemented a computer program for transferring patients between physicians' offices involving the Epic system in collaboration with Information Technology team
- Assisted the president of the hospital with developing a model of disease-death relationships for understanding and predicting future population health outcomes

- Assisted students with setting up accounts and guided their registration process in Wavelink software
- Helped setting up payments with the e-cashier system, printed personal schedules, and provided instructions and support to students
- Entered confidential data, filed and shredded documents, delivered mail, and faxed documents
- Provided support during New Student Orientation, including planning the session
- Assisted Records Office with mailing projects, receiving official transcripts, telephone calls, and entering confidential student information

Doctoral Degree Progress

Qualifying Exam

MARCH 2020

TITLE: Adaptive Weighted Discriminator for Training Generative Adversarial Networks

ABSTRACT: The original Generative Adversarial Network was introduced by Ian Goodfellow et al. in 2014, together with a discriminator loss function, called binary cross-entropy. Later, other discriminator loss functions were developed: WGAN loss, hinge loss, Dragan loss, etc. We introduce a new family of discriminator loss functions. Experiments validated the effectiveness of our loss functions on unconditional image generation task.

Master's Exam

October 2019

TITLE: Generative Adversarial Networks

ABSTRACT: In 2014, Ian Goodfellow et al. proposed a new framework for estimating generative models via an adversarial process, in which we simultaneously train two models: a generative model G that captures the data distribution, and a discriminative model D that estimates the probability that a sample came from the training data rather than G . The training procedure for G is to maximize the probability of D making a mistake. In this talk, I will talk about the structure of such a framework, how we train it as well as some theoretical results and applications.

Passed Preliminary Exam in Partial Differential Equations

June 2019

Passed Preliminary Exam in Numerical Analysis

JANUARY 2019

Passed Preliminary Exam in Analysis

JUNE 2018

Summer School Experience

2021 CIFAR Deep Learning + Reinforcement Learning Summer School | Virtual

JULY 2021

- Accepted to and attended one of the most prestigious summer schools in Deep Learning, only 300 participants were selected out of 1,200
- Received the Certificate of Attendance

Leadership Activities

Treasurer of the UKY chapter of Society for Industrial and Applied Mathematics (SIAM)

MAY 2020

President of the University of Kentucky (UKY) chapter of SIAM

MAY 2019

Coordinator of the UKY Mathematics Department Graduate Student Colloquium

FALL 2018

Co-Coordinator of the UKY Mathematics Department Graduate Student Colloquium

SPRING 2018

Awards and Recognitions

SIAM Certification for outstanding efforts and accomplishments of the UKY SIAM Chapter

APRIL 2020

Max Steckler Fellowship Recipient, University of Kentucky (UKY)

AUGUST 2017

Outstanding Graduate in Mathematics Award, Grand Valley State University (GVSU)

APRIL 2017

Math Department Senior Award, GVSU	APRIL 2017
Winter 2017 Dean's List, GVSU	APRIL 2017
Fall 2016 Dean's List, GVSU	DECEMBER 2016
3 rd place at 22 nd Annual Michigan Autumn Take Home Challenge, University of Michigan	NOVEMBER 2016
Pi Mu Epsilon Distinguished Speaker Award, MATHFEST 2016	AUGUST 2016
Winter 2016 Dean's List, GVSU	MAY 2016
Alayont Undergraduate Research Fellowship in Mathematics, GVSU	MAY 2016
Inducted to Pi Mu Epsilon Honor Society, GVSU	APRIL 2016
Inducted to Phi Kappa Phi Honor Society, GVSU	MARCH 2016
Fall 2015 Dean's List, GVSU	DECEMBER 2015
Summer 2015 President's List, Lake Michigan College (LMC)	JULY 2015
Spring 2015 President's List, LMC	MAY 2015
All-Michigan Academic Team, National Level, Lansing, MI	APRIL 2015
2 nd place at Mathelete Competition, LMC	APRIL 2015
Fall 2014 President's List, LMC	DECEMBER 2014
Inducted to Phi Theta Kappa Honor Society, LMC	NOVEMBER 2014
Summer 2014 President's List, LMC	AUGUST 2014
Spring 2014 President's List, LMC	MAY 2014
Fall 2013 Dean's List, LMC	DECEMBER 2013
Benton Harbor Promise Zone, Benton Harbor, MI	SEPTEMBER 2013
Inducted to National Honor Society, Countryside Academy	MAY 2013

Research

<p>Orthogonality Preserving Recurrent Nets University of Kentucky</p> <p>ADVISORS: Duc Nguyen, Ph.D. and Qiang Ye, Ph.D.</p> <p>COLLABORATION: Joint work with Edison Muclari, M.S.</p> <p>TITLE: Orthogonality Preserving Gated Recurrent Unit</p> <p>SUPPORT: Supported in part by NSF under grants DMS-1821144 and DMS-1620082</p>	AUGUST 2021 - PRESENT
<p>Preconditioning of Recurrent Based Nets Project University of Kentucky</p> <p>ADVISOR: Qiang Ye, Ph.D.</p> <p>COLLABORATION: Joint work with Cole Pospisil, M.S.</p> <p>TITLE: Batch Normalization Preconditioning for Recurrent Based Nets</p> <p>SUPPORT: Supported in part by NSF under grants DMS-1821144 and DMS-1620082</p>	JUNE 2021 - PRESENT
<p>Deep Learning in the Drug Discovery Project University of Kentucky</p> <p>ADVISORS: Duc Nguyen, Ph.D. and Qiang Ye, Ph.D.</p> <p>COLLABORATION: Joint work with Edison Muclari, M.S.</p> <p>TITLE: A Novel Molecular Descriptor for Bio-Molecular Data</p> <p>SUPPORT: Supported in part by NSF under grants DMS-1821144 and DMS-1620082</p>	OCTOBER 2020 - PRESENT
<p>Temporal Normalization in Transformers and RNNs University of Kentucky</p> <p>ADVISOR: Qiang Ye, Ph.D.</p> <p>COLLABORATION: Joint work with Cole Pospisil, M.S.</p> <p>TITLE: TempNorm: Breaking Time Invariance for a Language Modelling Transformer</p> <p>ABSTRACT: (not provided due to the conference reviewing policy)</p> <p>SUPPORT: Supported in part by NSF under grants DMS-1821144 and DMS-1620082</p>	APRIL 2021 - JAN. 2022

Symmetric Convolutional Neural Networks Project | University of Kentucky JUNE 2020 - APRIL 2021

ADVISOR: Qiang Ye, Ph.D.

COLLABORATION: Joint work with Kehelwala Dewage Gayan Maduranga, Ph.D.

TITLE: Symmetry Structured Convolutional Neural Networks

ABSTRACT: (not provided due to the journal reviewing policy)

SUPPORT: Supported in part by NSF under grants DMS-1821144 and DMS-1620082

Generative Adversarial Networks Project | University of Kentucky MAY 2019 - OCTOBER 2020

ADVISOR: Qiang Ye, Ph.D.

COLLABORATION: Joint work with Qiang Cheng, Ph.D.

TITLE: Adaptive Weighted Discriminator for Training Generative Adversarial Networks

ABSTRACT: Generative adversarial network (GAN) has become one of the most important neural network models for classical unsupervised machine learning. A variety of discriminator loss functions have been developed to train GAN's discriminators and they all have a common structure: a sum of real and fake losses that only depends on the actual and generated data respectively. One challenge associated with an equally weighted sum of two losses is that the training may benefit one loss but harm the other, which we show causes instability and mode collapse. In this paper, we introduce a new family of discriminator loss functions that adopts a weighted sum of real and fake parts, which we call adaptive weighted loss functions or aw-loss functions. Using the gradients of the real and fake parts of the loss, we can adaptively choose weights to train a discriminator in the direction that benefits the GAN's stability. Our method can be potentially applied to any discriminator model with a loss that is a sum of the real and fake parts. Experiments validated the effectiveness of our loss functions on unconditional and conditional image generation tasks, improving the baseline results by a significant margin on CIFAR-10, STL-10, and CIFAR-100 datasets in Inception Scores (IS) and Frechet Inception Distance (FID) metrics.

SUPPORT: Supported in part by NSF DMS-1821144, DMS-1620082, OIA 2040665, and NIH NS100606-05 grants

Senior Thesis | Grand Valley State University AUGUST 2016 - DECEMBER 2016

ADVISOR: Feryal Alayont, Ph.D.

COLLABORATION: Joint work with Stephanie Loewen

TITLE: Recurrence relation for rook placement on Genocchi boards in four and five dimensions

ABSTRACT: The two-dimensional rook theory can be generalized to three and higher dimensions by assuming that rooks attack along hyperplanes. Using this generalization, Alayont and Krzywonos defined two families of boards in any dimension generalizing the triangular boards of two dimensions whose rook numbers correspond to Stirling numbers of the second kind. One of these families of boards is the family of Genocchi boards whose rook numbers are the Genocchi numbers. This combinatorial interpretation of the Genocchi numbers provides a new triangle generation of the Genocchi numbers. In our project, we investigate whether such a similar triangle generation exists for the generalized Genocchi numbers in four and five dimensions.

Undergraduate Research Project | Grand Valley State University MAY 2016 - AUGUST 2016

ADVISOR: Darren Parker, Ph.D.

TITLE: A Group Theory Version of the Lights Out Game

ABSTRACT: The original Lights Out game has a 5×5 grid of buttons/vertices that can be toggled and can either be turned on or off. When a player starts a game, some of the lights are on and some are off. When player toggles a vertex, that vertex changes the state of every adjacent vertex and itself. The goal of the game is to toggle vertices in a way such that all lights are off. We are studying a different version of the Lights Out game. All vertices are labeled with elements of \mathbb{Z}_n and when we toggle a vertex, we add the number that is currently on it to every adjacent vertex and itself. For example, when a particular vertex has a label of 4 in \mathbb{Z}_8 and we toggle it, it adds 4 to itself and every adjacent vertex, and the label becomes 0. The game gives the set of all possible labelings a digraph structure, where arc of a digraph corresponds to the toggling of a vertex that changes the graph from one labeling to another. In our research we are focusing on connected components of this digraph, and how they are related to some issues of whether or not the game can be won.

SUPPORT: Supported by Alayont Undergraduate Research Fellowship

Applied Math and Chemistry Research Project | Vladimir State University, Russia 2013 - 2016
 ADVISOR: Valentina Kuzurman, Ph.D.
 TITLE: Calculations of the Optimal Parameters for Technological Process of Penocarbides Manufacturing
 ABSTRACT: Research of mathematical planning for optimization of parameters for technological process of penocarbides manufacturing. (translated from Russian)

Chemistry Research Project | Vladimir State University, Russia SEPTEMBER 2011 - FEBRUARY 2012
 ADVISOR: Valentina Kuzurman, Ph.D. | Raisa Mamanova, M.S.
 TITLE: Evaluation of nitrate content in food and methods of its reduction
 ABSTRACT: This paper deals with comparative analysis of the nitrate content in foods. The methods were developed for reducing the nitrate content in vegetable foods, the level of which exceeds the norm.

Invited/Conference Talks

-
- AMS Spring Central Sectional Meeting (Online, scheduled) MARCH 2022
TITLE: TempNorm: A Better Way to Normalize an NLP Transformer
 - Microsoft Research Lab – Redmond, Deep Learning Group JANUARY 2022
TITLE: Introduction to awGAN, SCNN, and TempNorm
 - University of Kentucky Applied Math Seminar DECEMBER 2021
TITLE: Symmetry structured data and its application to symmetric CNNs
 - University of Kentucky Department of Mathematics Graduate Student Colloquium OCTOBER 2021
TITLE: Introduction into the World of Recurrent Neural Networks, Attentions, and Transformers
 - 2021 Conference on Computer Vision and Pattern Recognition (CVPR) (Online) JUNE 2021
TITLE: Adaptive Weighted Discriminator for Training Generative Adversarial Networks (Poster)
 - Southern Georgia Mathematics Conference (Online) APRIL 2021
TITLE: Adaptive Weighted Discriminator for Training Generative Adversarial Networks
 - University of Kentucky Applied Math Seminar MARCH 2020
TITLE: Improved Training of Generative Adversarial Network
 - University of Kentucky Applied Math Seminar OCTOBER 2019
TITLE: Generative Adversarial Networks
 - University of Kentucky Department of Mathematics Graduate Student Colloquium FEBRUARY 2018
TITLE: A New Version of the Lights Out Game
 - University of Kentucky Department of Mathematics Graduate Student Colloquium SEPTEMBER 2017
TITLE: Generalized Genocchi Numbers
 - MAA MathFest 2017 JULY 2017
TITLE: A New Triangle Generation of Generalized Genocchi Numbers
 Using Rook Placements on Genocchi Boards
 - Grand Valley State University Mathematics Department Seminar MAY 2017
TITLE: Generalization of Generalized Genocchi Numbers
 - Grand Valley State University 2017 Student Scholars Day APRIL 2017
TITLE: A Group Theory Version of the Lights Out Game
 - Grand Valley State University 2017 Student Scholars Day APRIL 2017
TITLE: A New Triangle Generation of Generalized Genocchi Numbers
 Using Rook Placements on Genocchi Boards
 - 2017 Annual Meeting of the Michigan Section of the MAA in Big Rapids, MI MARCH 2017
TITLE: A New Triangle Generation of Generalized Genocchi Numbers
 Using Rook Placements on Genocchi Boards
 - 2017 Joint Mathematics Meetings JANUARY 2017
TITLE: A New Triangle Generation of Generalized Genocchi Numbers (Poster)
 - MAA MathFest 2016 JULY 2016
TITLE: A group labeling version of the lights out game
AWARD 🏆: Pi Mu Epsilon Distinguished Speaker

- SUMMR Conference in Dearborn, MI JUNE 2016
TITLE: A new version of the lights out game
- Vladimir State University Department of Chemistry Seminar APRIL 2012
TITLE: Assessment of nitrate content in food products and methods for their reduction

Publications and Works-in-Progress

1. Edison Muclari*, **Vasily Zadorozhnyy***, Duc Nguyen, Qiang Ye. Orthogonality Preserving Gated Recurrent Unit. In process of submitting to a conference proceedings, 2022 (* - equal contribution)
2. **Vasily Zadorozhnyy**, Edison Muclari, Duc Nguyen, Qiang Ye. A Novel Molecular Descriptor for Bio-Molecular Data. In process of submitting a biomedical journal, 2022
3. Cole Pospisil*, **Vasily Zadorozhnyy***, Qiang Ye. Batch Normalization Preconditioning for Recurrent Based Nets. In process of submitting to a conference proceedings, 2022 (* - equal contribution)
4. **Vasily Zadorozhnyy***, Cole Pospisil*, Qiang Ye. TempNorm: Breaking Time Invariance for a Language Modelling Transformer. Submitted to the 39th International Conference on Machine Learning (ICML 2022), 2022 (* - equal contribution)
5. Kehelwala Dewage Gayan Maduranga*, **Vasily Zadorozhnyy***, Qiang Ye. Symmetry Structured Convolutional Neural Networks. Submitted to IEEE Transactions on Neural Networks and Learning Systems journal, 2021 (* - equal contribution)
6. Darren B. Parker and **Vasily Zadorozhnyy**. A group labeling version of the lights out game. Involve, a Journal of Mathematics 14-4 (2021), 541–554. DOI 10.2140/involve.2021.14.541
7. **Vasily Zadorozhnyy**, Qiang Cheng, Qiang Ye. Adaptive Weighted Discriminator for Training Generative Adversarial Networks. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2021, pp. 4781-4790
8. Feryal Alayont, Stephanie Loewen, and **Vasily Zadorozhnyy**. Triangle Generation of Some Generalized Genocchi Numbers. Submitted to the Minnesota Journal of Undergraduate Mathematics, 2020
9. **Zadorozhnyy, V. I.**, Zadorozhnyy, I. V., Kuzurman, V. A. Calculation of the optimal parameters for technological process of penocarbides manufacturing. XXVIII International Scientific Conference: Mathematical Methods in Engineering and Technology MMTT-28 (translated from Russian). 8(1), 204-206, 2015, ISBN: 9785743323869
10. **Zadorozhnyy, V. I.**, Kuzurman, V. A. Mathematical planning and optimization of technological process parameters for the manufacture of porous carbide materials (translated from Russian). Youth Forum: Technical and Mathematical Science, 3(7): 382-386, 2015, doi: 10.12737/14884
11. **Zadorozhnyy, V. I.**, Kuzurman, V. A., Mamanova, R. G. Assessment of nitrate content in food products of plant origin and methods for their reduction (translated from Russian). Materials of the Scientific and Practical Conference in the framework of the Days of Science of Students and Postgraduates of Vladimir State University named after Alexander Grigoryevich and Nikolai Grigoryevich Stoletov (translated from Russian). 1.(1): 397–399, 2012, ISBN: 9785998402548

Languages and Computer Skills

Languages: English(fluent), Russian(fluent), French(basic knowledge)
 Programming languages: PYTHON, BASH, C++, HTML/CSS, PHP, SWIFT, VB, PASCAL
 Mathematical and statistical softwares: Matlab, Mathematica, Maple, SAS, R, LaTeX
 Machine and Deep learning libraries: NumPy, SciPy, CuPy, TensorFlow, PyTorch, Theano, Chainer