Alena Kopaničáková

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Personal information

Date of birth	May 1992
Nationality	Slovak
Family status	Single
Address	Providence, Rhode Island, USA

Employment history

06/2022 – Providence, USA	**Visiting Scholar in Applied Mathematics (2 years, realized via SNSF grant)** Brown University, Host: Prof. G. Karniadakis
06/2022 – Providence, USA	**Scientific collaborator (Mandate contract, 20%)** Università della Svizzera italiana
02/2021 – 05/2022 Lugano, Switzerland	**Post-doctoral Researcher** Università della Svizzera italiana
10/2015 – 1/2021 Lugano, Switzerland	**Research Assistant** Università della Svizzera italiana, Advisor: Prof. R. Krause
07/2017 – 12/2017 Los Angeles, USA	**Research Intern** Walt Disney Animation Studios, Advisor: Dr. R. Tamstorf
06/2015 – 09/2015 Lugano, Switzerland	**Student Assistant** Università della Svizzera italiana, Advisor: Prof. R. Krause

Education

10/2015 – 11/2020 Lugano, Switzerland	**PhD in Computational Science (Awarded by Università della Svizzera italiana)** Thesis: *Multilevel minimization in trust-region framework - Algorithmic and software developments.* Advisor: Prof. R. Krause, Scientific committee: Prof. S. Gratton, Dr. M. Weiser, Dr. R. Tamstorf, Prof. M. Multerer, Prof. O. Schenk
09/2013 – 07/2015	**Master of Science in Informatics (Awarded by Università della Svizzera italiana)** Thesis: *Investigating Optimization Strategies for Quadratic Programming Components of a Data Analysis Framework.* Advisor: Prof. I. Horenko

08/2014 – 07/2015	Master of Science in Informatics, Università della Svizzera italiana
02/2014 – 07/2014	Erasmus exchange program, Università della Svizzera italiana
09/2013 – 08/2014	Master of Artificial Intelligence, Technical University of Košice

09/2010 – 07/2013 Košice, Slovakia	**Bachelor of Business for Informatics (Awarded by Technical University of Košice)** Thesis: *Data analysis of an emotion recognition system.* Advisors: Prof. P. Sinčák

Third-party funding

Research projects, collaborators and research visits

Research projects:

06/2022 –	Multilevel training of DeepONets-multiscale and multiphysics applications, Role: **PI**
04/2021 –	ML^2 - Multilevel and Domain Decomposition Methods for Machine Learning, Role: **Post-doctoral researcher** (until 05/2022), **Scientific collaborator** (from 06/2022)
09/2016 – 09/2019	Large-scale simulation of pneumatic and hydraulic fracture with a phase-field, Role: **PhD student**

Collaborations:

11/2022 –	Prof. A. Ang from University of Southampton, UK
10/2022 –	Prof. S. Gratton from University of Toulouse, France and Prof. Ph. L. Toint from Universitē de Namur, Belgium
06/2022 –	Prof. G. Karniadakis, and Dr. S. Goswami from Brown University, USA
10/2018 –	Dr. A. Fadel, and A. Fink from Swiss National Supercomputing Centre, Switzerland
04/2018 –	F. Chegini and Dr. M. Weiser from the Zuse Institute Berlin, Germany
10/2017 –	Dr. P. Zulian, Dr. M. Nestola, Dr. H. Kothari, USI, Switzerland, Large-scale simulations of coupled multi-physics problems; scalable nonlinear multilevel and domain decomposition methods
06/2018 – 09/2019	Prof. P. Deuflhard from Zuse Institute Berlin, Germany
09/2016 – 12/2019	C. Bilgen, Prof. K. Weinberg from University of Siegen, Germany

Research visits:

10/2021 – 11/2021	Research visit at Zuse Institute Berlin, Germany, Host: Dr. M. Weiser

Supervision of junior researchers

During my stay at Università della Svizzera italiana (USI), I have co-supervised (senior advisor Prof. R. Krause) several junior researchers.

Co-supervised Bachelor theses (BSc in Informatics):

09/2021 – 02/2022	Stefano Gonçalves, *Implementation of a hybrid data-parallel algorithm for neural network training with reduced communication targeted to GPU-based supercomputers*
09/2020 – 07/2021	Filippo Cesana, *Python Front-End for Utopia with Algorithmic Implementations Related to Financial Machine Learning*, together with Dr. P. Zulian (USI)

Co-supervised Master theses (MSc in Computational Science/Mathematics):

01/2023 –	Marc Salvadó, *Multilevel approaches for enhancing the training of transformers*
09/2021 – 03/2022	Andrea Angino, *Knight descent - a parallel stochastic method for non-linear optimization problems*, together with Prof. M. Donatelli (Insubria, Como, Italy)
09/2019 – 09/2020	Samuel Cruz, *Learning multilevel hierarchies*
09/2019 – 07/2020	Vanessa Braglia, *Multilevel training for neural networks*

Co-mentored PhD students:

01/2021 –	Samuel Cruz, *Domain decomposition methods and deep-learning*

Co-supervised student assistants:

02/2022 –	Marc Salvadó, *Layer parallel training of transformers*
07/2021 – 10/2021	Francesco Lacommare, *Multilevel variant of Adam optimizer*
06/2020 – 10/2021	Filippo Cesana, *Python interface for UTOPIA*, together with Dr. P. Zulian (USI)
06/2020 – 05/2021	Dylan Ramelli, *xSDK integration for UTOPIA*, together with Dr. P. Zulian (USI)
08/2020 – 01/2021	Nicholas Robertson, *Domain decomposition and machine learning*
06/2019 – 12/2020	Lisa Gaedke-Merzhäuser, *Multilevel training of deep residual networks*
01/2019 – 09/2020	Samuel Cruz, *Learning multigrid transfer operators using reinforcement learning*
06/2019 – 07/2020	Vanessa Braglia, *Multilevel variance reduction methods*
06/2016 – 12/2016	Eric Botter, *Continous integration using CDash*

Teaching activities

I have served as a teaching assistant and substitute lecturer at Università della Svizzera italiana, Lugano.

Lecture list (substitute lecturer):

02/2022 – 06/2022	Solution and Optimization Methods for Large Scale Problems (MSc/PhD)

Lecture list (teaching assistant):

02/2019 – 07/2019	Solution and Optimization Methods for Large Scale Problems (MSc/PhD)
09/2018 – 01/2019	Calculus (BSc)
08/2018	Functional and Numerical Analysis (MSc/PhD)
02/2018 – 07/2018	Multiscale methods (MSc/PhD)
02/2017 – 07/2017	Optimization methods (BSc)
09/2016 – 01/2017	Enterprise Resource Planning (MSc)

Mentoring:

03/2022	Teens in AI Hackathon (Lugano event for International Women's Day)

Active memberships in scientific societies, fellowships in renowned academies and reviewing activities

09/2022 –	Member of Association for Women in Mathematics (AWM)
01/2022	Participant of Swiss Science Council: Postdoc Workshop
10/2021 –	Member of Association of Applied Mathematics and Mechanics (GAMM)
09/2021 –	Member of Swiss Mathematical Society (SWISSCOMAS)
01/2019 –	Member of Society for Industrial and Applied Mathematics (SIAM)
Reviewing activities	Computer Methods in Applied Mechanics and Engineering, Optimization Methods and Software, Numerical Linear Algebra with Applications, SIAM Journal on Scientific Computing

Organisation of conferences

06/2023	Co-organizer, Thematic Einstein semester workshop, "Optimization for machine learning", at Humboldt Universität zu Berlin
08/2022	Co-organizer, minisymposia "Combining the domain decomposition and the multilevel methods with machine learning approaches" at International Multigrid Conference
05/2021 – 07/2021	Co-organizer, FoMICS-DADSi seminars on Physics Informed Neural Networks
07/2015, 2016, 2017	Student Volunteer, Platform for Advanced Scientific Computing Conference

Prizes, awards and fellowships

02/2023	Selected for Rising Stars in Computational and Data Sciences event, Oden Institute for Computational Engineering and Sciences at The University of Texas
09/2022	Early Career Travel Award for the SIAM Conference on Mathematics of Data Science, National Science Foundation (NSF grant DMS – 1757085)
08/2022	Plenary Speaker at International Multigrid Conference 2022
08/2022	Travel Support Award for the International Conference on Domain Decomposition Methods 2022
07/2022	Women in STEM Travel Support Award for the European Solid Mechanics Conference
06/2022 –	SNSF Postdoc Mobility Fellowship at Brown University
10/2019, 10/2018	Selected for Eurohack19/18: GPU programming hackathon week
02/2014 – 07/2014	Semester Study Abroad Award (Erasmus Exchange Program)
02/2009, 02/2010	Academic merit scholarship, Technical University of Košice

Personal skills

Languages	Slovak (Native), English (Fluent), German (Basic), Italian (Basic)
Operating Systems	Linux, macOS, Microsoft Windows
Programming languages	C/C++, Python, MATLAB
Scientific libraries	PETSc, LibMesh, MOOSE, FEniCS/DOLFINx, Firedrake, JAX, Keras/TensorFlow, PyTorch, NumPy
Technical tools	bash, Vim, Git, Docker, Slurm
Vizualization tools	Paraview, VisIt
Documentation	LaTeX/TikZ/Pgfplot/Beamer, Microsoft office, Keynote

OUTPUT LIST
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In the publications listed below, the author's order is always based according to the contributions, except [J2], [J7], [J10], [B3], [C4], where the alphabetical order was followed.

Publications in peer-reviewed scientific journals

[J1] **A. Kopaničáková**, H. Kothari, G. Karniadakis, and R. Krause. Enhancing training of physics-informed neural networks using domain-decomposition based preconditioning strategies. *Under review in SIAM Journal on Scientific Computing*, 2023. Preprint

[J2] S. Gratton, **A. Kopaničáková**, and P. Toint. Multilevel Objective-Function-Free Optimization with an Application to Neural Networks Training. *Under review in SIAM Journal on Optimization*, 2023. Preprint

[J3] A. **Kopaničáková**, H. Kothari, and R. Krause. Nonlinear field-split preconditioners for solving monolithic phase-field models of brittle fracture. *Computer Methods in Applied Mechanics and Engineering*, 403:115733, 2023. Published article

[J4] **A. Kopaničáková** and R. Krause. Globally Convergent Multilevel Training of Deep Residual Networks. *SIAM Journal on Scientific Computing*, 0(0):S254–S280, 2022. Published article

[J5] P. Zulian*, **A. Kopaničáková***, M. G. C. Nestola, N. Fadel, A. Fink, J. VandeVondele, and R. Krause. Large scale simulation of pressure induced phase-field fracture propagation using Utopia. *CCF Transactions on High Performance Computing*, 2021. **(*Equal contribution)**, Published article

[J6] F. Chegini, **A. Kopaničáková**, R. Krause, and M. Weiser. Efficient identification of scars using heterogeneous model hierarchies. *EP Europace*, 23(Supplement_1):i113–i122, 2021. Published article

[J7] C. Bilgen, **A. Kopaničáková**, R. Krause, and K. Weinberg. A detailed investigation of the model influencing parameters of the phase-field fracture approach. *GAMM-Mitteilungen*, 43(2):e202000005, 2020. Published article

[J8] **A. Kopaničáková** and R. Krause. Recursive multilevel trust region method with application to fully monolithic phase-field models of brittle fracture. *Computer Methods in Applied Mechanics and Engineering*, 360:112720, 2020. Published article, Preprint

[J9] **A. Kopaničáková**, R. Krause, and R. Tamstorf. Subdivision-based nonlinear multiscale cloth simulation. *SIAM Journal on Scientific Computing*, 41(5):S433–S461, 2019. Published article, Postprint

[J10] C. Bilgen, **A. Kopaničáková**, R. Krause, and K. Weinberg. A phase-field approach to conchoidal fracture. *Meccanica*, pages 1–17, 2017. Published article

Peer-reviewed book chapters

[B1] **A. Kopaničáková**. On the use of hybrid coarse-level models in multilevel minimization methods. *Accepted for publication in Domain Decomposition Methods in Science and Engineering XXVII*, 2022. Preprint

[B2] H. Kothari, **A. Kopaničáková**, and R. Krause. Nonlinear Schwarz preconditioning for nonlinear optimization problems with bound constraints. *Accepted for publication in Domain Decomposition Methods in Science and Engineering XXVII*, 2022. Preprint

[B3] C. Bilgen, **A. Kopaničáková**, R. Krause, and K. Weinberg. A phase-field approach to pneumatic fracture. In J. Schröder and P. Wriggers, editors, *Non-standard Discretisation Methods in Solid Mechanics*, pages 217–241, 2022. Published article

[B4] F. Chegini, **A. Kopaničáková**, M. Weiser, and R. Krause. Quantitative analysis of nonlinear multifidelity optimization for inverse electrophysiology. In *Domain Decomposition Methods in Science and Engineering XXVI*. Springer, 2021. Published article

[B5] **A. Kopaničáková** and R. Krause. Multilevel Active-Set Trust-Region (MASTR) Method for Bound Constrained Minimization. In *Domain Decomposition Methods in Science and Engineering XXVI*. Springer, 2021. Published article

[B6] H. Kothari, **A. Kopaničáková**, and R. Krause. A Matrix-free Multigrid Preconditioner for Jacobian-free Newton-Krylov Methods. In *Domain Decomposition Methods in Science and Engineering XXVI*. Springer, 2021. Published article

Publications in peer-reviewed conference proceedings

[C1] L. Gaedke-Merzhäuser*****, **A**. **Kopaničáková***, and R. Krause. Multilevel minimization for deep residual networks. In *In ESAIM Proceedings and Surveys*, volume 71, pages 131–144, 2021. **(*Equal contribution)**, <u>Published article</u>

[C2] C. von Planta, **A**. **Kopaničáková**, and R. Krause. Training of residual networks with stochastic MG/Opt. In *ICML 2021 Workshop: Beyond First Order Methods in Machine Learning*, 2021. <u>Published article</u>

[C3] V. Braglia*****, **A**. **Kopaničáková***, and R. Krause. A multilevel approach to training. In *ICML 2020 Workshop: Beyond First Order Methods in Machine Learning*, 2020. **(*Equal contribution)**, <u>Published article</u>

[C4] C. Bilgen, **A**. **Kopaničáková**, R. Krause, and K. Weinberg. A phase-field approach to pneumatic fracture. In *PAMM*, volume 17, pages 71–74, 2017. <u>Published article</u>

[C5] **A**. **Kopaničáková**, M. Virčíková, and P. Sinčák. Gesture recognition using DTW and its application potential in human-centered robotics. In *Proceedings of the 13th Scientific Conference of Young Researchers of Faculty of Electrical Engineering and Informatics Technical University of Košice*, 2013. <u>Published article</u>

Manuscripts in preparation

[J10] **A**. **Kopaničáková**, A. Kahana, and G. Karniadakis. Composing deeponet-based preconditioners for solving large scale linear systems of equations. 2023

Presentations and poster contributions

Plenary and invited talks:

[T1] **A**. **Kopaničáková**. Enhancing Training of Deep Neural Networks Using Multi-level and Domain-decomposition Methods. **Plenary talk** at International Multigrid Conference (IMG), 2022

[T2] **A**. **Kopaničáková**. Multilevel training of deep neural networks. Invited talk in the group of Prof. S. Bordas (University of Luxemburg, Luxemburg), 2022

[T3] **A**. **Kopaničáková** and R. Krause. Multilevel minimization and Deep Residual Networks (ResNets). Invited talk in the group of Prof. M. Jaggi (Swiss Federal Institute of Technology Lausanne, Switzerland), 2020

[T4] **A**. **Kopaničáková** and R. Krause. Trust-region based minimization techniques for phase-field fracture simulations. Invited talk in the group of Prof. L. de Lorenzis (Technical University of Braunschweig, Germany), 2019

Selected oral presentations:

[T5] **A**. **Kopaničáková**, S. Gratton, and P. Toint. Multilevel Objective-Function-Free Trust-Region with an Application to Neural Networks Training. Copper Mountain Conference On Multigrid Methods, 2023

[T6] **A**. **Kopaničáková**. Nonlinear multilevel minimization methods with applicaitons in computational science and machine-learning. Rising Stars in Computational & Data Science event, 2023

[T7] **A**. **Kopaničáková**, H. Kothari, and R. Krause. Towards Large-Scale Training of Deep Neural Networks Using Domain-Decomposition Methods. SIAM Conference on Computational Science and Engineering (CSE23),, 2023

[T8] **A**. **Kopaničáková** and R. Krause. Multiscale Training Algorithms for Deep Neural Networks. SIAM Mathematics of Data Science Conference (SIAM-MDS), 2022

[T9] **A**. **Kopaničáková**, H. Kothari, P. Zulian, and R. Krause. Multilevel and domain decomposition methods for phase-field fracture simulations. 15th World Congress on Computational Mechanics & 8th Asian Pacific Congress on Computational Mechanics (WCCM-APCOM), 2022

[T10] **A**. **Kopaničáková**, H. Kothari, P. Zulian, and R. Krause. Nonlinear multilevel and domain decomposition methods for phase-field fracture simulations in monolithic framework. 27th International Conference on Domain Decomposition Methods (DD27), 2022

[T11] **A**. **Kopaničáková**, H. Kothari, and R. Krause. Nonlinear preconditioning strategies for monolithic phase-field fracture models. 11th European Solid Mechanics Conference (ESMC), 2022

[T12] **A**. **Kopaničáková**, H. Kothari, and R. Krause. Nonlinear additive and multiplicative preconditioning strategies for monolithic phase-field fracture models. 8th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS CONGRESS), 2022

[T13] **A**. **Kopaničáková** and R. Krause. Affine Similar Trust-Region Method with Application to Phase-Field Models of Brittle Fracture. The US National Congress on Computational Mechanics (USNCCM 16), 2021

[T14] **A**. **Kopaničáková** and R. Krause. A large scale phase-field fracture simulations. The Platform for Advanced Scientific Computing (PASC) Conference, 2021

[T15] **A**. **Kopaničáková** and R. Krause. Globally Convergent Multilevel Training of Deep Residual Networks. 20th Copper Mountain Conference On Multigrid Methods, 2021

[T16] **A**. **Kopaničáková** and R. Krause. Multilevel training of deep residual networks. 26th International Domain Decomposition Conference, (DDXXVI), 2020

[T17] **A**. **Kopaničáková** and R. Krause. A recursive multilevel trust region method with application to fully monolithic phase-field models of brittle fracture. The US National Congress on Computational Mechanics (USNCCM 15), 2019

[T18] **A**. **Kopaničáková**, R. Krause, and R. Tamstorf. Subdivision-based nonlinear multiscale cloth simulation. Eccomas Thematic Conference on eXtended Discretization MethodS (X-DMS), 2019

[T19] **A**. **Kopaničáková** and R. Krause. Recursive multilevel trust region strategy with application to phase-field fracture. The 13th World Congress in Computational Mechanics (WCCMXIII), 2018

[T20] **A**. **Kopaničáková**, R. Krause, and R. Tamstorf. Subdivision-based nonlinear multiscale cloth simulations. Copper Mountain Conference On Iterative Methods, 2018

[T21] **A**. **Kopaničáková**, C. Bilgen, K. Weinberg, and R. Krause. Recursive multilevel trust region method, application to phase-field fracture. SIAM Conference on Parallel Processing for Scientific Computing (SIAM-PP), 2018

[T22] **A**. **Kopaničáková** and R. Krause. A non-linear multilevel method for phase-field fracture models. The Platform for Advanced Scientific Computing (PASC) Conference, 2017

Posters:

[P1] **A**. **Kopaničáková**, S. Cruz, H. Kothari, and R. Krause. Distributed Training of Deep Neural Networks. The Platform for Advanced Scientific Computing (PASC) Conference, 2022

[P2] P. Zulian, **A**. **Kopaničáková**, M. Nestola, D. Ganellari, N. Fadel, J. VandeVondele, and R. Krause. Utopia: a Hardware Portable Library for Large Scale Simulations in Computational Geophysics. The Platform for Advanced Scientific Computing (PASC) Conference, 2022

[P3] P. Zulian, **A**. **Kopaničáková**, M. G. C. Nestola, and R. Krause. Open-source software library for non-conforming domain decomposition methods targeting computational energy. The Future Swiss Electrical Infrastructure (SCCER-FURIES) Annual Conference, 2019

[P4] P. Zulian, M. G. C. Nestola, **A**. **Kopaničáková**, and R. Krause. Fluid-structure interaction methods and software libraries for in-silico analysis of the aortic heart valve. Towards the Digital Twin (TRM) Forum, 2019

Other artefacts with documented use

Software:

UTOPIA	Open-source C++ embedded domain specific language designed for parallel non-linear solution strategies and finite element analysis. Code repository. (Core developer)
ROOK	Large-scale finite-element framework for (pressure-induced) phase-field fracture simulations. (Solo developer)
MultiscAI	Stochastic multilevel optimization framework for training ODE-based deep neural networks. (Solo developer)
DistTraiNN	Model parallel framework for distributed training of deep neural networks. (Core developer)
Heart	Parallel framework for inverse problems in electrophysiology. (Contributor)