Kamila Zdybał, Ph.D.

kamilazdybal@gmail.com

 LinkedIn | Google Scholar | Personal website | GitHub | YouTube

In my research, I develop tools and algorithms that help **understand high-dimensional datasets** and **model high-dimensional systems** with computational efficiency.

I am passionate about science outreach, creating educational content, academic writing, and developing open-source scientific software.

Academic appointments

- Feb 2024 – Jan 2026, Postdoctoral researcher, Computational Engineering laboratory, Empa – Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland
  PI: Dr. Ivan Lunati

- May 2023 – Jan 2024, Postdoctoral researcher, Université Libre de Bruxelles, Brussels, Belgium
  PI: Prof. Alessandro Parente

Education

- Sep 2018 – Apr 2023, Ph.D. student, Université Libre de Bruxelles, Brussels, Belgium

  ◦ Jan 2020 – Apr 2020, research stay at the University of Utah, Salt Lake City, UT, USA

  Advisors: Prof. Alessandro Parente and Prof. James C. Sutherland
  Dissertation: *Reduced-order modeling of turbulent reacting flows using data-driven approaches.*
   https://doi.org/10.13140/RG.2.2.18843.95521

- Jul 2016 – Sep 2016, Research student, the von Karman Institute for Fluid Dynamics, Rhode-Saint-Genèse, Belgium
  Advisor: Prof. Miguel A. Mendez
  Report: *POD and DMD decomposition of numerical and experimental data.*
   https://doi.org/10.13140/RG.2.2.34150.91201

- Mar 2015 – Sep 2016, Master degree in Civil Engineering, Cracow University of Technology, Cracow, Poland
  Thesis: *Quasi-static model of wind action in flutter of bridge structures.*

- Oct 2010 – Feb 2014, Bachelor degree in Civil Engineering, Cracow University of Technology, Cracow, Poland
  Thesis: *Analysis of wind action on a support structure of a dual-rotor wind turbine.* Graduated with honors.

Work experience

- Feb 2017 – Aug 2018, Software test engineer, Nokia, Cracow, Poland

  ◦ Automating regression tests in Elixir language and manual black-box tests of base station software in the Long Term Evolution (LTE) standard, Python scripting, tutoring team members, writing *know-how* documentation, setup works of telecom laboratory equipment.

- May 2014 – Dec 2014, Civil structures intern, BMT Fluid Mechanics, Teddington, United Kingdom

  ◦ Taking part in all stages of wind tunnel tests of high-rise buildings and offshore structures: determining cladding pressures, forces and moments on structures, assessing pedestrian wind comfort, assisting in wind environment workshops with the clients, drawing 3D CAD models, communicating with the modeling team.

Academic awards & grants

- 2023, Winner of the **18th ERCOFTAC da Vinci Competition** – Awarded for the best European Ph.D. thesis in flow, turbulence and combustion, and outstanding scientific contributions with engineering relevance (€1,000)
- 2023, 39th ISOC Distinguished Paper Award for Numerical Combustion
- 2023, Student Travel Award for the SIAM Conference on Computational Science and Engineering ($700)
- 2022, Student Travel Award for the SIAM Conference on Mathematics of Data Science ($800)
- 2020, Funding for an abroad research stay, CCCI, Université Libre de Bruxelles (€4,500)
- 2019, F.R.S.-FNRS Aspirant Research Fellow grant & grant renewal in 2021 (€125,000 + €10,000 ancillary costs)
- 2018, Scholarship for the first year of my Ph.D., Université Libre de Bruxelles (€25,000 + €3,000 ancillary costs) Granted to Ph.D. students who scored just below the threshold for obtaining a F.R.S.-FNRS grant in 2018 to encourage another application to F.R.S.-FNRS next year.
- 2016, Funding for an abroad research stay, Erasmus+ (€500)
- 2016, Dean's scholarship for the best students, Cracow University of Technology (approx. €800)
- 2012, GE Foundation Scholar Leaders scholarship (€3,000)

Peer-reviewed journal articles (7)

2023 **K. Zdybał**, A. Parente, and J. C. Sutherland. Improving reduced-order models through nonlinear decoding of projection-dependent outputs. *Patterns*, 4:100859, 2023.
  </> https://github.com/kamilazdybal/nonlinear-decoding
  https://doi.org/10.1016/j.patter.2023.100859

2023 **K. Zdybał**, E. Armstrong, A. Parente, and J. C. Sutherland. PCAfold 2.0—Novel tools and algorithms for low-dimensional manifold assessment and optimization. *SoftwareX*, 23:101447, 2023.
  </> https://gitlab.multiscale.utah.edu/common/PCAfold
  https://doi.org/10.1016/j.softx.2023.101447
  https://www.youtube.com/watch?v=oVF4QaLpc6k

2023 **K. Zdybał**, G. D'Alessio, A. Attili, A. Coussement, J. C. Sutherland, and A. Parente. Local manifold learning and its link to domain-based physics knowledge. *Applications in Energy and Combustion Science*, 14:100131, 2023.
  </> https://github.com/kamilazdybal/local-manifold-learning
  https://doi.org/10.1016/j.jaecs.2023.100131

2023 A. C. Ispir, **K. Zdybał**, B. H. Saracoglu, T. Magin, A. Parente, and A. Coussement. Reduced-order modeling of supersonic fuel-air mixing in a multi-strut injection scramjet engine using machine learning techniques. *Acta Astronautica*, 202:564–584, 2023.
  https://doi.org/10.1016/j.actaastro.2022.11.013

2022 **K. Zdybał**, E. Armstrong, J. C. Sutherland, and A. Parente. Cost function for low-dimensional manifold topology assessment. *Scientific Reports*, 12:14496, 2022.
  </> https://github.com/kamilazdybal/cost-function-manifold-assessment
  https://doi.org/10.1038/s41598-022-18655-1

2022 **K. Zdybał**, J. C. Sutherland, and A. Parente. Manifold-informed state vector subset for reduced-order modeling. *Proceedings of the Combustion Institute*, 39(4):5145–5154, 2023.
  This paper has received the Distinguished Paper Award from The Combustion Institute.
  </> https://github.com/kamilazdybal/manifold-informed-state-vector-subset
  https://doi.org/10.1016/j.proci.2022.06.019

2020 **K. Zdybał**, E. Armstrong, A. Parente, and J. C. Sutherland. PCAfold: Python software to generate, analyze and improve PCA-derived low-dimensional manifolds. *SoftwareX*, 12:100630, 2020.
  </> https://gitlab.multiscale.utah.edu/common/PCAfold
  https://doi.org/10.1016/j.softx.2020.100630

Book chapters (2)

2023 **K. Zdybał**, G. D'Alessio, G. Aversano, M. R. Malik, A. Coussement, J. C. Sutherland, and A. Parente. Advancing reactive flow simulations with data-driven models. In M. A. Mendez, A. Ianiro, B. R. Noack, and S. L. Brunton, editors, *Data-Driven Fluid Mechanics: Combining First Principles and Machine Learning*, chapter 15, pages 304–329. Cambridge University Press, 2023.
  https://doi.org/10.1017/9781108896214.022
  https://doi.org/10.48550/arXiv.2209.02051

2023 **K. Zdybał**, M. R. Malik, A. Coussement, J. C. Sutherland, and A. Parente. Reduced-order modeling of reactive flows using data-driven approaches. In N. Swaminathan and A. Parente, editors, *Machine Learning and Its Application to Reacting Flows: ML and Combustion*, chapter 9, pages 245–278. Springer, 2023.
  </> https://github.com/kamilazdybal/ROM-of-reacting-flows-Springer
  https://doi.org/10.1007/978-3-031-16248-0_9

Software development

- **pykitPIV** – a Python library for kinematic training for particle image velocimetry (PIV)
- **PCAfold** – a Python software package for generating, analyzing and improving low-dimensional manifolds
  </> https://pcafold.readthedocs.io
- **multipy** – an educational Python library for multicomponent mass transfer
  </> https://multipy-lib.readthedocs.io
- **reduced-order-modelling** – a collection of MATLAB® tools for data pre-processing, reduced-order modeling and results visualization
  </> https://github.com/burn-research/reduced-order-modelling
- **plotting** – a collection of MATLAB® functions for automating plotting scientific results in our research group
  </> https://github.com/burn-research/plotting
- **POD-DMD-GUI** – a MATLAB® GUI for POD and DMD decomposition of experimental or numerical data
  </> https://github.com/kamilazdybal/POD-DMD-decompositions

Contributions to teaching & science outreach

- 2024, September 9–13, Training school instructor for *Machine Learning for Reacting Flows*, Thessaloniki, Greece (**upcoming**).
- 2023–present, Creating YouTube tutorials for our open-source Python software, **PCAfold**
  ▶ YouTube playlist: PCAfold tutorials
- 2023–present, Creating YouTube tutorials *Python for Academics*
  ▶ YouTube playlist: Python for Academics
  </> https://github.com/kamilazdybal/python-for-academics
- 2022, Contributing to the course *Data-driven engineering*, Université Libre de Bruxelles
  </> https://github.com/burn-research/data-driven-engineering-course
  - Preparing and delivering exercise sessions for students using Jupyter notebooks
  - Delivering seminar talks on my research
- 2021, Developing Python software for a graduate course on multicomponent mass transfer
- 2019, Teaching *Fluid mechanics and transport phenomena* class, Université Libre de Bruxelles
- 2018–present, Developing open-source educational materials
  https://kamilazdybal.github.io
- 2018–present, Co-organizing annual *Pinguino Lecture Series* for fellow PhD students and academics
- 2016–2017, Leading *Arduino Study Group*, Jagiellonian University
  - 2017, A tutorial for one of our projects that uses Arduino and C++ can be found below:
    📄 https://github.com/kamilazdybal/objectif-morse/
- 2013–2015, Developing online materials in STEM for high school students as part of the GE Foundation Scholar Leaders voluntary experience
  https://wszechswiatnauki.wordpress.com
  - 2016, One of my educational articles is published in *Neutrino*, a popular science magazine issued by the Physics Department at the Jagiellonian University
    📄 http://www.neutrino.if.uj.edu.pl/archiwum/2016/33

Invited talks (13)

2024 **K. Zdybał**. The beauty and pitfalls of t-SNE. In *Université Libre de Bruxelles*, Online, 2024. Guest lecture in the master-level course MECA-H419 – Data-Driven Engineering.
▶ Part 1: https://youtu.be/tfk6Jo0pUQ8
▶ Part 2: https://youtu.be/8fqk-3Z7J4Y

2024 **K. Zdybał**. Introduction to artificial neural networks. In *Université Libre de Bruxelles*, Online, 2024. Guest lecture in the master-level course MECA-H419 – Data-Driven Engineering.

2024 **K. Zdybał**. Introduction to machine learning and artificial neural networks. In *The University of Utah*, Online, 2024. Guest lecture in the undergraduate course CHEN-2450 – Numerical Methods.
▶ https://www.youtube.com/watch?v=IGEWE81FWMA

2023 **K. Zdybał**. Efficient dimensionality reduction of combustion data. In *Machine Learning in Combustion*, Online, 2023. Technische Universität Darmstadt & RWTH Aachen University workshop.
▶ https://www.nhr4ces.de/machine-learning-in-combustion/

2023 **K. Zdybał**. Modeling high-dimensional systems with data science and machine learning. In *Empa, Swiss Federal Laboratories for Materials Science and Technology*, Dübendorf, Switzerland, 2023. Talk.

2023 **K. Zdybał**. Learning from high-dimensional data. In *Stanford University, School of Medicine*, Online, 2023. Seminar at Bendall Lab.

2023 **K. Zdybał**. How to project data? In *Université Libre de Bruxelles*, Brussels, Belgium, 2023. Seminar.

2023 **K. Zdybał**. Introduction to machine learning and artificial neural networks. In *The University of Utah*, Online, 2023. Guest lecture in the undergraduate course CHEN-2450 – Numerical Methods.
  ◖ https://www.youtube.com/watch?v=wPL2l1K6KPM

2023 **K. Zdybał**. Improving reduced-order models, one manifold at a time. In *The von Karman Institute for Fluid Dynamics*, Rhode-Saint-Genese, Belgium, 2023. Research Master seminar.

2023 **K. Zdybał**. Modeling turbulent reacting flows: Data science to the rescue. In *University of Utah*, Online, 2023. Graduate seminar at the Department of Chemical Engineering.

2022 **K. Zdybał**. Adventures in low-dimensional manifolds and reduced-order modeling. In *Université Libre de Bruxelles*, Brussels, Belgium, 2022. Seminar.

2022 **K. Zdybał**. Cost function for low-dimensional manifold topology optimization. In *The von Karman Institute for Fluid Dynamics*, Rhode-Saint-Genese, Belgium, 2022. Seminar.
  ◖ https://www.vki.ac.be/index.php/vki-seminars

2018 **K. Zdybał**. Principal Component Analysis for chemistry reduction. In *Pinguino Lecture Series*, Brussels, Belgium, 2018. Talk.

Conference presentations (15)

2023 **K. Zdybał**, J. C. Sutherland, and A. Parente. On the effect of manifold topology in reduced-order modeling of turbulent combustion. In *Joint Meeting of the Belgian and Italian Sections of the Combustion Institute*, Florence, Italy, 2023.

2023 H. Dave, M. R. Malik, **K. Zdybał**, H. G. Im, and A. Parente. On the use of projection to latent structures (PLS) and gaussian process regression (GPR) to reduce combustion chemistry. In *Joint Meeting of the Belgian and Italian Sections of the Combustion Institute*, Florence, Italy, 2023.

2023 **K. Zdybał**, A. Parente, and J. C. Sutherland. Reduced-order modeling of reacting flows with a regression-aware autoencoder. In *13th U.S. National Combustion Meeting*, Texas A&M University in College Station, TX, USA, 2023.

2023 J. C. Sutherland and **K. Zdybał**. Topological characteristics of low-dimensional manifolds in reduced-order modeling of turbulent combustion. In *SIAM Conference on Computational Science and Engineering*, Amsterdam, The Netherlands, 2023.

2023 **K. Zdybał**, A. Parente, and J. C. Sutherland. Reduced-order modeling with a regression-aware autoencoder. In *SIAM Conference on Computational Science and Engineering*, Amsterdam, The Netherlands, 2023.

2023 **K. Zdybał**. Reduced-order modeling using regression-aware autoencoder. In *Université Libre de Bruxelles and Vrije Universiteit Brussel BRITE workshop*, Brussels, Belgium, 2023. Talk.

2022 **K. Zdybał**, E. Armstrong, J. C. Sutherland, and A. Parente. Cost function for assessing the quality of low-dimensional manifolds. In *SIAM Conference on Mathematics of Data Science*, San Diego, CA, USA, 2022.

2022 **K. Zdybał**, J. C. Sutherland, and A. Parente. Manifold-informed state vector subset for reduced-order modeling. In *39th International Symposium on Combustion*, Vancouver, Canada, 2022.
  ◖ https://www.youtube.com/watch?v=MMldWMduCp0

2022 **K. Zdybał**, M. R. Malik, E. Armstrong, J. C. Sutherland, and A. Parente. Characterizing manifold topologies for reduced-order modeling. In *18th International Conference on Numerical Combustion*, La Jolla, CA, USA, 2022.

2022 A. Parente, L. Donato, **K. Zdybał**, A. Procacci, and M. Savarese. Data-enhanced analysis, parameterisation and reduced-order modelling of turbulent reacting flows. In *18th International Conference on Numerical Combustion*, La Jolla, CA, USA, 2022.

2022 **K. Zdybał**. Manifold-informed state vector subset for reduced-order modeling. In *26th Journees D'Etudes of the Belgian Section of the Combustion Institute*, Ghent, Belgium, 2022.

2022 **K. Zdybał**. Cost function for low-dimensional manifold topology optimization. In *Université Libre de Bruxelles and Vrije Universiteit Brussel BRITE workshop*, Brussels, Belgium, 2022. Talk.

2022 E. Armstrong, **K. Zdybał**, A. Parente, and J. C. Sutherland. A cost function for optimizing manifold topology in reduced-order modeling. In *2022 WSSCI Spring Technical Meeting*, Stanford, CA, USA, 2022.

2021 **K. Zdybał**, J. C. Sutherland, and A. Parente. Manifold-informed state vector subset for reduced-order modeling. In *Combura Symposium*, pages 39–40, Soesterberg, The Netherlands, 2021.

2019 G. D'Alessio, G. Aversano, **K. Zdybał**, A. Cuoci, and A. Parente. Feature extraction in combustion applications. In *17th International Conference on Numerical Combustion*, Aachen, Germany, 2019.

Posters (2)

2021 **K. Zdybał**, E. Armstrong, A. Parente, and J. C. Sutherland. PCAfold: Python software to generate, analyze and improve PCA-derived low-dimensional manifolds. In *Combura Symposium*, pages 88–89, Soesterberg, The Netherlands, 2021.
🗎 Poster file

2019 **K. Zdybał**, M. R. Malik, and A. Parente. Nonlinear regression of chemical source terms using Deep Neural Networks. In *Tsinghua-Princeton-CI 2019 Summer School on Combustion*, Beijing, China, 2019.
🗎 Poster file

Journal reviewer

Journal of Computational Physics | Proceedings of the Combustion Institute |

Society member

Society for Industrial and Applied Mathematics (SIAM) | American Physical Society (APS) |

Technologies used

Programming languages

Python (6 years of experience) | Elixir (1 year of experience) | Julia (beginner) | C/C++ (beginner) |

Other

Jupyter notebook | Jupyter lab | TensorFlow | Keras | PyTorch | Sphinx | git | GitHub | GitLab | MATLAB® | Notion | LaTeX | texmaker | draw.io | ReadTheDocs | SLURM | Atom | PyCharm | Rhinoceros 3D | AutoCAD | SketchBook | Confluence | Jira | wandb |

Selected course certifications

- **The Basics of Transport Phenomena**, Delft University of Technology
- **Advanced Transport Phenomena**, Delft University of Technology
- **Learning Data Visualization**, LinkedIn Learning
- **Deep Learning Fundamentals with Keras**, IBM
- **Deep Learning with Tensorflow**, IBM
- **Being a Good Mentor**, LinkedIn Learning
- **Communicating through Disagreement**, LinkedIn Learning

Professional references

🎓 **Prof. Alessandro Parente**, Université Libre de Bruxelles
Alessandro.Parente@ulb.be

🎓 **Prof. James C. Sutherland**, The University of Utah
James.Sutherland@utah.edu

🎓 **Prof. Miguel A. Mendez**, The von Karman Institute for Fluid Dynamics
Miguel.Alfonso.Mendez@vki.ac.be

Last updated: June 7, 2024.