



Kamila Zdybał, Ph.D.

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I am a graduate researcher at Université Libre de Bruxelles. Previously, I was a Ph.D. student supervised by Professor Alessandro Parente and co-supervised by Professor James C. Sutherland.

I develop tools and algorithms to help understand high-dimensional datasets and model high-dimensional systems. I am passionate about science outreach, creating educational content, academic writing and developing scientific software.

Education

- Apr 2023 – present, Graduate researcher, Université Libre de Bruxelles, Brussels, Belgium
- 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
- **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
• **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 commercial wind tunnel tests of high-rise buildings and offshore structures. This included determining cladding pressures, forces and moments on structures, assessing pedestrian wind comfort, assisting in wind environment workshops with the clients, drawing 3D CAD models and communicating with the modeling team.

Academic awards & grants

- 2023, 39th ISOC Distinguished Paper Award for Numerical Combustion
- 2023, Student Travel Award for the SIAM Conference on Computational Science and Engineering
- 2022, Student Travel Award for the SIAM Conference on Mathematics of Data Science
- 2020, Funding for an abroad research stay, CCCI, Université Libre de Bruxelles
- 2019, F.R.S.-FNRS Aspirant Research Fellow grant & grant renewal in 2021
- 2018, Scholarship for the first year of my PhD, Université Libre de Bruxelles
- 2016, Funding for an abroad research stay, Erasmus+
- 2016, Dean's scholarship for the best students, Cracow University of Technology
- 2012, GE Foundation Scholar Leaders scholarship

Contributions to teaching & science outreach

- 2022, Contributing to the course *Data-driven engineering*, Université Libre de Bruxelles
 - Preparing and delivering exercise sessions for students using Jupyter notebooks
 - Delivering a seminar talk on my research at the end of the semester

`</>` <https://github.com/burn-research/data-driven-engineering-course>
- 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
- 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>

Software development

- **multiply** – an educational Python library for multicomponent mass transfer
`</>` <https://multiply-lib.readthedocs.io>
- **PCAfold** – a Python software package for generating, analyzing and improving low-dimensional manifolds
`</>` <https://pcafold.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>





Peer-reviewed journal articles (5)

- 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>



Articles currently under review (2)

- 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. *Under review in SoftwareX*, 2023.
- 2023 K. Zdybał, A. Parente, and J. C. Sutherland. Improving reduced-order models through nonlinear decoding of projection-dependent model outputs. *Under review in Patterns*, 2023.

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

Invited talks (8)



- 2023 K. Zdybał. Reduced-order modeling and topological characteristics of low-dimensional manifolds. In *The von Karman Institute for Fluid Dynamics*, Rhode-Saint-Genese, Belgium, 2023. VKI Lecture Series (**upcoming, Sep 2023**).
- 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. Invited 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 Journées 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

Professional references

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Last updated: June 13, 2023.