

# Kamila Zdybał, Ph.D.

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 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.

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## Education

- May 2023 – present, Postdoctoral Research Fellow, 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
- 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, Finalist of the **18th ERCOFTAC da Vinci Competition**
- 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 (approx. €110,000 + €10,000 of auxiliary costs)
- 2018, Scholarship for the first year of my Ph.D., Université Libre de Bruxelles
- 2016, Funding for an abroad research stay, Erasmus+ (€500)
- 2016, Dean's scholarship for the best students, Cracow University of Technology
- 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. (**Accepted, to appear online on Oct 10th, 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](https://doi.org/10.1007/978-3-031-16248-0_9)

## Software development

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

- 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>


## Articles in preparation (2)

- 2023 **K. Zdybał**, A. Parente, and J. C. Sutherland. The effect of manifold topology in modeling turbulent combustion. *In preparation for Proceedings of the Combustion Institute*, 2023. **(To be submitted in Dec 2023.)**
- 2023 **K. Zdybał**, A. Procacci, M. A. Mendez, T. Grenga, A. Coussement, and A. Parente. Advances in dimensionality reduction and manifold learning for parametrization and modeling of large combustion systems: A review. *In preparation for Progress in Energy and Combustion Science*, 2023. **(To be submitted in Dec 2023.)**



## Invited talks (9)

- 2023 **K. Zdybał**. Efficient dimensionality reduction of combustion data. In *Machine Learning in Combustion*, Online, 2023. TU Darmstadt workshop (**upcoming, Nov 2023**).  
■ <https://www.nhr4ces.de/machine-learning-in-combustion/>
- 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 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


## Journal reviewer


Journal of Computational Physics


## Technologies used

Python | Jupyter notebook | Jupyter lab | TensorFlow | Keras | Sphinx | Elixir | git | GitHub | GitLab | MATLAB | Notion | LaTeX | texmaker | draw.io | ReadTheDocs | SLURM | Atom | Rhinoceros 3D | AutoCAD | Confluence | Jira |

## 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