Dominik Dold, Dr. rer. nat.

Neuro-inspired AI, graph machine learning, neuromorphic computing, physics, space.
https://dodo47.github.io/
https://scholar.google.de/citations?user=RNlSvncAAAAJ

Positions

2024 – .... **MSCA Research Fellow**. Faculty of Mathematics, University of Vienna.
- Research on mathematical foundation of spiking neural networks, memristors, and self-organization in multi-agent robot systems using geometric deep learning.
- Associate editor for Springer's Astrodynamics.

2021 – 2024 **Internal Research Fellow in AI**. ESA, Advanced Concepts Team, Noordwijk.
- Research on neuroAI for space and graph algorithms for reconfigurable structures.
- Supervised 2 interns, 1 postgraduate, and 1 PhD candidate, resulting in 4 papers.
- Co-founded and organized international conference with $>$ 200 attendants.

2020 – 2021 **AI Residency Researcher**. Siemens AI Lab & Siemens Technology, Munich.
- Research on spike-based graph neural networks and graph learning for cybersecurity.
- Supervised 1 Master's thesis, resulting in 2 papers.
- 1 granted and 13 pending international patents.

Education

2016 – 2020 **Dr. rer. nat.**. Heidelberg University, Germany.
- Thesis: *Harnessing function from form: towards bio-inspired AI in neuronal substrates*.
- Advisors: Mihai A. Petrovici, Walter Senn, Karlheinz Meier, Andreas Mielke.
- 6 month visit, Senn Group for Computational Neuroscience, University of Bern.

2014 – 2016 **M.Sc. in Physics**. Heidelberg University, Germany.
- Thesis: *Stochastic Computation in Spiking Neural Networks Without Noise*.

2010 – 2014 **B.Sc. in Physics**. Heidelberg University, Germany.
- Thesis: *Energy Conservation in Fano Spectral Line Shape Control*.

Funding

2023	Marie Skłodowska-Curie Actions Fellowship (101103062):	200.000€
	ESA Internal Founder Program *Gravity Assist*:	30.000€
2022	ESA OSIP Co-Funded Project (4000140774):	90.000€
2021	ESA Internal Research Fellowship:	300.000€

Awards & honors

2024 **Dagstuhl Seminar invitation**.
- Seminar 25291: *(Actual) Neurosymbolic AI: Combining Deep Learning and Knowledge Graphs*.

2023 **Marie Skłodowska-Curie Actions Fellowship**.
- Title: *Biologically-inspired Autonomous Systems for Space Exploration*.

2021 **European Space Agency Research Fellowship**.
- Title: *Energy efficient and explainable learning systems for space missions*.

2019 **First prize: International Collegiate Competition for Brain-Inspired Computing**.
- Organized and hosted by Tsinghua University, Beijing.

Neuro-inspired Computation Course invitation.
- Organized by the International Research Center for Neurointelligence, Tokyo.

Mentoring

Supervision of postgraduate researchers

2023 – .... Zacharia A. Rudge
- PhD Candidate, co-funded via ESA's OSIP. 1 paper published, 1 under review.

2022 – 2023 Amy Thomas
- Project mentor during her Young Graduate Trainee position at ESA. 2 papers published.

Supervision of graduate students

2024 Nadezhda Dobreva
- Title: *Design of Decentralized Control of Self-Configuring Ensembles*.
- Internship, ESA ESTEC. 1 paper in preparation.

2023 India Walford
- Title: *Novel Neural Network Architectures for Spacecraft Autonomy*.
- Internship & Master's thesis, ESA ESTEC & University College London.

2021 Victor Caceres Chian
- Title: *Towards the integration of graph neural networks into neuromorphic architectures*.
- Master's thesis, Technical University Munich. 2 papers published.

2018 Maximilian Zenk
- Title: *Spatio-temporal predictions with spiking neural networks*.
- Master's thesis, Heidelberg University.

Commissions of trust

Community service

2024 – .... **Expert Panel**, Engineering and Physical Sciences Research Council (UK).

Associate Editor, Springer Astrodynamics.
- Special issue *spAIce 2024: One small step for AI in and for space*.

Reviewer, Nature npj Microgravity.

2024 **Co-organizer**, GECCO 2024 Space Optimisation Competition (SpOC).

2023 – .... **Co-founder** and **chair of the scientific committee**, ESA's SPAICE conference.
- Oversaw website, social media, call for papers, submissions, reviews, keynote invites, program assembly, and proceedings. The first edition was a success with over 150 submitted papers, 200 participants, and renowned speakers like Jürgen Schmidhuber.

Scientific Committee, Italian Association of Aeronautics and Astronautics.

2023 **Chair**, AI Application Session, AIDAA XXVII International Congress.

Co-organizer, GECCO 2023 Space Optimisation Competition (SpOC).

Program Committee, International Joint Conference on Neural Networks.

2022 – .... **Reviewer**, Physical Review Research.

2021 **Chair**, Graph Based Methods Session, International Conference for Machine Learning and Applications.

Reviewer, International Conference on Artificial Neural Networks.

Institutional responsibilities

2024 – .... **Organizer**, Math of Machine Learning & Data Science Seminar, Univ. of Vienna.

2021 – 2023 **Organizer**, Advanced Concepts Team's Science Coffee, ESA.
- Managed inviting and hosting internationally renowned researchers.

2018 – 2020 **Organizer**, Electronic Vision(s) Journal Club, University of Heidelberg.

Patents

Granted

2024 Method and system for anomaly detection in a network, EP4270227.

Published application

2023 Method and system for anomaly detection in a network.
- USA: US20230353584A1, China: CN116980321A.

2022 Method and Device for Providing a Recommender System.
- Europe: EP4231199A1, WIPO: WO2023160947A1.

2021 Industrial device and method for building and/or processing a knowledge graph.
- Europe: EP4030351A1, USA: US20220229400A1, China: CN114819049A.

Neuromorphic hardware for processing a knowledge graph represented by observed triple statements and method for training a learning component.
- Europe: EP4030349A1, USA: US20220230056A1, China: CN114819048A.

Neuromorphic hardware and method for storing and/or processing a knowledge graph.
- Europe: EP4030350A1, USA: US20220237441A1, China: CN114819047A.

Selected talks

Invited talks

2024 Alan Turing Institute AI UK Fringe Events, Loughborough University, UK.
- Title: *Neuromorphic artificial intelligence in space and beyond*.

2022 MAFEX Gründungscamp AI-Day, University of Marburg, Germany.
- Title: *Getting from there to here – Wie durch KI die Raumschiffe von morgen aussehen könnten*.

2019 Huawei Research Center, Hangzhou, China.
- Title: *Deep learning and probabilistic computing in biological neural networks*.

Conference talks

2023 German Aerospace Congress, Stuttgart, Germany.
- Title: *Modelling the European Space Sector with Knowledge Graphs*.

2022 International Conference on Neuromorphic Systems (ICONS), USA.
- Title: *Neuro-symbolic computing with spiking neural networks*.

IEEE World Congress on Computational Intelligence (WCCI, IJCNN), Padua, Italy.
- Title: *Relational representation learning with spike trains*.

2021 International Joint Conference on Neural Networks (IJCNN), virtual.
- Title: *SpikE: spike-based embeddings for multi-relational graph data*.

2019 Computational and Systems Neuroscience (COSYNE) Conference, Lisbon, Portugal.
- Title: *Lagrangian dynamics of dendritic microcircuits enables real-time backpropagation of errors*.

Workshop talks

2025 The Spiking Neural Networks (SNN) Worshop, LMU Munich.
- Title: *Causal pieces: analysing and improving spiking neural networks piece by piece*.

2021 Spiking neural networks as universal function approximators (SNUFA), virtual.
- Title: *Spike-based embeddings for multi-relational graph data*.

Teaching

Seminars and guest lectures

2025 PhD Training Series at RICAM, Linz, Austria.
- Title: *How I (and soon maybe you?) got a Marie Curie Fellowship*.

2023 Guest lecture at the UCL AI Society, University College London, UK.
- Title: *Gazing into the future – From graphs, gradients and spiking neurons to space*.

2022 PhD seminar at the Observatory of the University of Vienna, Vienna, Austria.
Title: *Two Ways to ESA Fellowships*.

University lectures (University of Vienna)

2025 Lecturer of the core lecture *Mathematics of Data Science* (Master's in Data Science).

Classes (Heidelberg University)

2018 Teaching assistant for the lecture *Brain-Inspired Computing*.

2015 Teacher for the *Medicine Beginner's Introduction Courses in Physics and Mathematics*.

Publications

ORCID: `https://orcid.org/0000-0001-7626-9960`

Google scholar: `https://scholar.google.ch/citations?user=RNlSvncAAAAJ&hl`

Personal webpage: `https://dodo47.github.io/publications.html`

* marks equal contributions.

Book chapters

2023 Artificial Intelligence for Space: AI4SPACE – Trends, Applications, and Perspectives
- Chapter: *Neuromorphic Computing and Sensing in Space*
- D. Izzo*, A. Hadjiivanov*, **D. Dold***, G. Meoni*, and E. Blazquez*. CRC Press, ISBN 9781032432441.

Artificial Intelligence for Space: AI4SPACE – Trends, Applications, and Perspectives
- Chapter: *Selected Trends in Artificial Intelligence for Space Applications*
- D. Izzo, G. Meoni, P. Gomez, **D. Dold** and A. Zoechbauer. CRC Press, ISBN 9781032432441.

Magazine articles

2025 Stabiles Lernen durch Pulse
- **D. Dold**. Brennpunkt, Physik Journal, Deutsche Physikalische Gesellschaft.

Spike Mechanism of Biological Neurons May Boost Artificial Neural Networks
- **D. Dold**. Viewpoint, Physics 18, 5, American Physical Society.

Edited

2024 Proceedings of SPAICE2024: The First Joint European Space Agency / IAA Conference on AI in and for Space.
- Edited by **D. Dold**, A. Hadjiivanov, D. Izzo. DOI: 10.5281/zenodo.13889941

Peer-reviewed (co-)first author publications

2023 Differentiable graph-structured models for inverse design of lattice materials
- **D. Dold*** and D. Aranguren van Egmond*. Cell Reports Physical Science.

Publications (continued)

A Neuronal Least-Action Principle for Real-Time Learning in Cortical Circuits
- W. Senn*, **D. Dold***, A. F. Kungl, B. Ellenberger, Y. Bengio, J. Sacramento, J. Jordan, and M. A. Petrovici*. eLife.

Modelling the European Space Sector with Knowledge Graphs
- A. Berquand* & **D. Dold***. German Aerospace Congress (DLRK).

2022 Neuro-symbolic computing with spiking neural networks
- **D. Dold**, J. Soler Garrido, V. Caceres Chian, M. Hildebrandt, and T. Runkler. International Conference on Neuromorphic Systems (ICONS).

Relational representation learning with spike trains
- **D. Dold**. IEEE World Congress on Computational Intelligence (WCCI) & International Joint Conference on Neural Networks (IJCNN).

Evaluating the feasibility of interpretable machine learning for globular cluster detection
- **D. Dold*** and K. Fahrion*. Astronomy & Astrophysics (A&A), 663, 81.

2021 An energy-based model for neuro-symbolic reasoning on knowledge graphs
- **D. Dold** and J. Soler Garrido. 20th IEEE International Conference on Machine Learning and Applications (IEEE ICMLA).

Machine learning on knowledge graphs for context-aware security monitoring
- J. Soler Garrido*, **D. Dold*** and J. Frank. IEEE International Conference on Cyber Security and Resilience (IEEE CSR).

SpikE: spike-based embeddings for multi-relational graph data
- **D. Dold** and J. Soler Garrido. International Joint Conference on Neural Networks (IJCNN).

2019 Stochasticity from function - why the Bayesian brain may need no noise
- **D. Dold***, I. Bytschok*, A. F. Kungl, A. Baumbach, O. Breitwieser, J. Schemmel, K. Meier, and M. A. Petrovici*. Neural Networks, 119, 200-213.

Peer-reviewed senior author publications

2024 Guidance and Control Neural Network Acceleration using Memristors
- Z. Rudge, D. Izzo, M. Fieback, A. Gebregiorgis, S. Hamdioui, **D. Dold**. Proceedings of The First Joint European Space Agency / IAA Conference on AI in and for Space.

2023 Totimorphic structures for space application
- A. Thomas, J. Grover, D. Izzo, & **D. Dold**, XXVII Italian Association of Aeronautics and Astronautics Congress (AIDAA).

2021 Learning through structure: towards deep neuromorphic knowledge graph embeddings
- V. Caceres Chian*, M. Hildebrandt*, T. Runkler, and **D. Dold***. International Conference on Neuromorphic Computing (ICNC).

Peer-reviewed co-author publications

2025 The Connectome of a Drosophila as a Computational Reservoir
- L. Costi, A. Hadjiivanov, **D. Dold**, Z. Hale, D. Izzo. Biomimetics 2025, 10(5), 341.

Scalable network emulation on analog neuromorphic hardware
- E. Arnold, P. Spilger, J.V. Straub, E. Müller, **D. Dold**, G. Meoni, J. Schemmel. Frontiers in Neuroscience 18, 1523331.

2024 Energy efficiency analysis of Spiking Neural Networks based on temporal coding for space applications
- P. Lunghi, S. Silvestrini, **D. Dold**, G. Meoni, A. Hadjiivanov, D. Izzo. Springer Astrodynamics (accepted, in print).

Lost in space but not in data: Tracking Technology Trends in the Space Field
- A. Berquand, A. V. Ladeira, **D. Dold**. Proceedings of SPAICE2024: The First Joint European Space Agency / IAA Conference on AI in and for Space.

Publications (continued)

The Space Optimization Competition: Third Edition
- M. Bannach, E. Blazquez, D. Izzo, G. Acciarini, A. Hadjiivanov, G. Heißel, R. Mastroianni, S. Origer, J. Grover, **D. Dold**, Z. Rudge. The Genetic and Evolutionary Computation Conference.

Towards Large-scale Network Emulation on Analog Neuromorphic Hardware
- E. Arnold, P. Spilger, J. Straub, E. Müller, **D. Dold**, G. Meoni, J. Schemmel. Neuro Inspired Computational Elements Conference (NICE).

2022 Detection, Explanation and Filtering of Cyber Attacks Combining Symbolic and Sub-Symbolic methods
- A. Himmelhuber, **D. Dold**, S. Grimm, S. Zillner, and T. Runkler. Computational Intelligence In Cyber Security (IEEE CICS), IEEE Symposium Series on Computational Intelligence.

2021 Fast and energy-efficient neuromorphic deep learning with first-spike times
- J. Göltz, L. Kriener, A. Baumbach, S. Billaudelle, O. Breitwieser, B. Cramer, **D. Dold**, ... M. A. Petrovici. Nature Machine Intelligence, Volume 3.

2020 Versatile emulation of spiking neural networks on an accelerated neuromorphic substrate
- S. Billaudelle*, Y. Stradmann*, K. Schreiber*, B. Cramer*, A. Baumbach*, **D. Dold***, J. Göltz*, A. F. Kungl*, T. Wunderlich*, et al. IEEE International Symposium on Circuits and Systems (ISCAS), Sevilla, 2020, pp. 1-5.

2019 Accelerated physical emulation of Bayesian inference in spiking neural networks
- A. F. Kungl, S. Schmitt, J. Klähn, P. Müller, A. Baumbach, **D. Dold**, ... M. Kleider, et al. Frontiers in Neuroscience, 13, 1201.

Preprints

2025 Causal pieces: analysing and improving spiking neural networks piece by piece
- **D. Dold**, P. Petersen. arXiv:2504.14015.

2024 Stable Learning Using Spiking Neural Networks Equipped With Affine Encoders and Decoders
- A.M. Neuman, **D. Dold**, P. Petersen. arXiv:2404.04549.

Continuous Design and Reprogramming of Totimorphic Structures for Space Applications
- **D. Dold**, A. Thomas, N. Rosi, J. Grover, D. Izzo. arXiv:2411.15266.

In preparation

2025 Decentralised self-organisation of pivoting cube ensembles using geometric deep learning
- N. Dobreva, **D. Dold**. In prep.

Memristor-Based Neural Network Accelerators for Space Applications: Enhancing Performance with Temporal Averaging and SIRENs
- Z. Rudge, **D. Dold**, M. Fieback, D. Izzo, S. Hamdioui. Under review.