Dominik Dold, Dr. rer. nat.

🎓 AI, neuromorphic computing, machine learning, neuroscience, physics, space
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Work experience

2021 – ····	🚩 **Internal Research Fellow in AI.** ESA ESTEC, Advanced Concepts Team, Noordwijk.
2020 – 2021	🚩 **AI Residency Researcher.** Siemens AI Lab Residency, Siemens AG, Munich.
2017 – 2018	🚩 **Visiting Researcher.** Senn group for computational neuroscience, University of Bern.
2016 – 2020	🚩 **Doctoral Researcher.** Petrovici group for neuro-inspired AI, Heidelberg University.
2014 – 2015	🚩 **Research Assistant.** Evers group for theoretical quantum dynamics, MPIK Heidelberg.

Education

2016 – 2020	🚩 **Dr. rer. nat.**, Heidelberg University, Germany. Thesis title: *Harnessing function from form: towards bio-inspired AI in neuronal substrates.*
2014 – 2016	🚩 **M.Sc. in Physics**, Heidelberg University, Germany. Thesis title: *Stochastic Computation in Spiking Neural Networks Without Noise.*
2010 – 2014	🚩 **B.Sc. in Physics**, Heidelberg University, Germany. Thesis title: *Energy Conservation in Fano Spectral Line Shape Control.*

Awards and fellowships

2021	🚩 **Research Fellowship** by the European Space Agency (ESA).
2019	🚩 **First prize** in the finals of the 2019 **International Collegiate Competition for Brain-Inspired Computing** (ICCBC) at Tsinghua University in Beijing, China.

Mentoring

Supervision of graduate students

2021	🚩 V. Caceres Chian. *Towards the integration of graph neural networks into neuromorphic architectures.* **Master's thesis**, Technical University Munich.
2018	🚩 M. Zenk. *Spatio-temporal predictions with spiking neural networks.* **Master's thesis**, Heidelberg University.

Teaching activities

2019	🚩 Teaching position, *Physics Laboratory Course for Beginners*, Heidelberg University, Germany.
2018	🚩 Teaching assistant for the lecture *Brain-Inspired Computing*, Heidelberg University, Germany.
2017	🚩 Teaching position, *Laboratory Courses for Medical Students*, Heidelberg University, Germany.
2016	🚩 Teaching position, *Physics Laboratory Course for Beginners*, Heidelberg University, Germany.
2015	🚩 Teaching position, *Medicine Beginner's Introduction Courses in Physics and Mathematics*, Heidelberg University, Germany.
2014	🚩 Teaching position, *Physics Laboratory Course for Beginners*, Heidelberg University, Germany.
2013	🚩 Teaching position, *Physics Laboratory Course for Beginners*, Heidelberg University, Germany.

Engagement beyond research activities

Institutional responsibilities

2021 – ····   🔖 Organiser of ESA's Advanced Concepts Team Science Coffee.

2018 – 2020   🔖 Organiser of the Journal Club in my PhD research group.

Community service

2022   🔖 Reviewer for the Journal *Physical Review Research* (PRR, APS physics).

2021   🔖 Chair of the session *Graph Based Methods* at the International Conference for Machine Learning and Applications (ICMLA).

🔖 Reviewer for the International Conference on Artificial Neural Networks (ICANN).

Memberships of scientific societies

2022 – ····   🔖 Member of the *International Neural Network Society (INNS)*.

2017 – ····   🔖 Member of the *Bernstein Network Computational Neuroscience*.

Participation in scientific collaborations

2016 – 2020   🔖 My PhD research was part of subproject (SP) 4, SP9 and co-design project (CDP) 5 of the European Commission Future and Emerging Technologies Flagship *Human Brain Project*.

Additional training and experience

June 2020   🔖 **AI@Sustainability 72h Hackathon** organized by the Siemens AI Lab.

August 2019   🔖 **Team communication - key roles and intercultural contexts workshop.**[†]

June 2019   🔖 **DS³ data science summer school.**
Five-day school co-organized by the École polytechnique & the DATAIA Institute.

March 2019   🔖 **IRCN course in neuro-inspired computation.**
Four-day course offered by the University of Tokyo.

🔖 **University leadership and management (Epigeum).**[†]

February 2019   🔖 **Business management course "Grundlagenwissen BWL".**[†]

October 2018   🔖 **Computational physics with GPUs.**[†]

April 2017   🔖 **Machine learning in science and industry.**[†]
[†] Courses offered by the Heidelberg graduate academy and graduate school for physics.

Science communication

Invited talks (7)

2023   🔖 **Guest speaker at the UCL AI Society**, University College London, UK.
Invited by Miriam Jansen (events officer of the UCL AI Society).

2022   🔖 **Talk at the MAFEX Gründungscamp AI–Day**, Philipps-Universität Marburg, Germany.
Title: *Getting from there to here – Wie durch KI die Raumschiffe von morgen aussehen könnten.*
Invited by Dipl.-Geogr. Astrid Bendix.

🔖 **PhD seminar at the Observatory of the University of Vienna**, Vienna, Austria.
Title: *Two Ways to ESA Fellowships.* Invited by Prof. G. van de Ven.

🔖 **Galaxy Coffee seminar at the MPIA**, Heidelberg, Germany.
Title: *New ways of finding old globular clusters.* Invited by Dr. N. Neumayer.

Science communication (continued)

2019   ◄ **Invited talk at Huawei research center**, Hangzhou, China.
Title: *Deep learning and probabilistic computing in biological neural networks.* Invited by Dr. Y. Chua.

◄ **ICCBC 2019 at Tsinghua University**, Beijing, China.
Title: *Why spikes? Exploring spike-based Bayesian inference for accelerated neuronal substrates.*

2018   ◄ **ETH Institute of Neuroinformatics**, Zurich, Switzerland.
Title: *From Euler-Lagrange to error backpropagation in cortical circuits.* Invited by Prof. B. Grewe.

Conference talks (6)

2022   ◄ **International Conference on Neuromorphic Systems (ICONS)**, hybrid.
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   ◄ **IEEE International Conference on Machine Learning and Applications (ICMLA)**, virtual.
Title: *An energy-based model for neuro-symbolic reasoning on knowledge graphs.*

◄ **International Conference on Neuromorphic Computing (ICNC)**, virtual.
Title: *Learning through structure: towards deep neuromorphic knowledge graph embeddings.*

◄ **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 (9)

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

2019   ◄ **Perception and attention mechanisms in the primate brain: An integrated, multi component perspective**, European Institute for Theoretical Neuroscience, Paris, France.
Title: *Physics of perception: models of inference and learning in neuronal substrates.*

◄ **Human Brain Project Co-Design Project 5 Meeting**, Heidelberg, Germany.
Title: *Predictive or prospective? Real-time backprop in cortical circuits.*

2018   ◄ **Human Brain Project Subproject 9 Meeting**, Bern, Switzerland.
Title: *Dendritic error backpropagation and reinforcement learning in deep cortical microcircuits.*

◄ **Intel Neuromorphic Research Community (INRC) Workshop**, Reykjavik, Iceland.
Title: *Real-time error backpropagation for deep cortical networks.*

◄ **From Bench to Machine Learning Workshop**, Institute of Advanced Studies, University of Surrey, England.
Title: *From Euler-Lagrange to time-continuous error backpropagation in cortical microcircuits.*

◄ **Human Brain Project Subproject 9 Fürberg Workshop**, Fürberg, Austria.
Title: *Continuous error backpropagation in cortical microcircuits from Euler- Lagrange equations.*

◄ **From Neuroscience to Machine Learning Workshop**, European Institute for Theoretical Neuroscience, Paris, France.
Title: *Real-time error backpropagation for deep cortical networks.*

2016   ◄ **Human Brain Project Subproject 9 Fürberg Workshop**, Fürberg, Austria.
Title: *Self-sustained sampling – using networks of LIF Boltzmann machines as intrinsic noise sources.*

Poster presentations (9)

2022   ◄ **Neuromorphic Algorithms Workshop (NEAL)**, Volpriehausen, Germany.
Title: *Relational representation learning with spiking neural networks.*

Science communication (continued)

2019   🔖 **Bernstein Conference**, Berlin, Germany.
Title: *An energy-based model of folded autoencoders for unsupervised learning in cortical hierarchies.*

🔖 **Annual Computational Neuroscience Meeting**, Barcelona, Spain.
Title: *Lagrangian dynamics for real-time error backpropagation across cortical areas.*

🔖 **DS3 Data Science Summer School**, Paris, France.
Title: *Physical models of the brain – from theory to neural substrates.*

🔖 **IRCN Course in Neuro-Inspired Computation**, Tokyo, Japan.
Title: *Function from form – two models of coding and learning in cortical circuits.*

2018   🔖 **Bernstein Conference**, Berlin, Germany.
Title: *Continuous learning in dendritic cortical microcircuits using Lagrangian mechanics.*

🔖 **EMBO Dendrites Workshop**, Heraklion, Greece.
Title: *Continuous learning in dendritic cortical microcircuits using Lagrangian mechanics.*

2017   🔖 **Bernstein Conference**, Göttingen, Germany.
Title: *Stochastic computation on spiking neuromorphic hardware.*

🔖 **Annual Computational Neuroscience Meeting**, Antwerp, Belgium.
Title: *Spike-based inference with correlated noise.*

Publications

Patent applications (5 in Germany, 3 in the US)

2022   🔖 *Method and system for anomaly detection in a network.*
Dold, D., Liu, Y., Joblin, M. and Hildebrandt, M.
DE: first published in 07/2022.

🔖 *Method and Device for Providing a Recommender System.*
Dold, D., Hildebrandt, M. and Mogoreanu, S.
DE: first published in 03/2022.

2021   🔖 *Industrial device and method for building and/or processing a knowledge graph.*
Dold, D. and Soler Garrido, J.
DE: File No.: 21152148.9 (18/01/2021).
US: Document ID "US 20220229400 A1" (21/07/2022)

🔖 *Neuromorphic hardware for processing a knowledge graph represented by observed triple statements and method for training a learning component.*
Dold, D. and Soler Garrido, J.
DE: File No. 21152139.8 (18/01/2021).
US: Document ID "US 20220230056 A1" (21/07/2022).

🔖 *Neuromorphic hardware and method for storing and/or processing a knowledge graph.*
Dold, D. and Soler Garrido, J.
DE: File No. "21152142.2" (18/01/2021).
US: Document ID "US 20220237441 A1" (28/07/2022).

Peer-reviewed first author publications (9)

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

🔖 *Relational representation learning with spike trains.*
Dold, D. (2022). 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.*
Dold*, D. and Fahrion*, K. (2022). Astronomy & Astrophysics (A&A), 663, 81.

Publications (continued)

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

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

🔖 *Machine learning on knowledge graphs for context-aware security monitoring.*
Soler Garrido*, J., **Dold***, **D.** and Frank, J. (2021). 2021 IEEE International Conference on Cyber Security and Resilience (IEEE CSR).

🔖 *SpikE: spike-based embeddings for multi-relational graph data.*
Dold, D. and Soler Garrido, J. (2021). 2021 International Joint Conference on Neural Networks (IJCNN)

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

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

<div align="right">* marks equal contributions</div>

Peer-reviewed co-author publications (2)

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

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

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

Publications in preparation (3)

🔖 *Emerging Trends in Artificial Intelligence for Space Applications.*
Izzo*, D., Hadjiivanov*, A., **Dold***, **D.**, Gomez*, P., Blazquez*, E., Zoechbauer*, A. and Meoni*, G.

🔖 *Differentiable graph-structured models for inverse design of lattice materials.*
Dold*, **D.**, Aranguren van Egmond*, D., et al.

🔖 *A neural least action principle for real-time dendritic error backpropagation across cortical circuits.*
Senn*, W., **Dold***, **D.**, Kungl, A.F., Ellenberger, B., Bengio, Y., Sacramento, J., Jordan, J. and Petrovici*, M.A.