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Kempner Institute

Harvard University

Boston, MA 02134

## Academic Experience

- 2023–cur **Kempner Research Fellow**, Kempner Institute, Harvard University, USA.
- 2018–2023 **Ph.D. Machine Learning**, Advisor: Max Welling; University of Amsterdam, The Netherlands.
- 2015–2017 **M.S. Computer Science**, Advisor: Garrison Cottrell; University of California San Diego, USA.
- 2011–2015 **B.S. Computer Science (Honors)**, Advisor: Yaser Abu-Mostafa; California Institute of Technology, USA.

## Industry Experience

- 2022 **Research Intern**, Apple Machine Learning Research. Barcelona, Spain.
- 2016–2018 **Deep Learning Data Scientist**. Nervana → (acquired) → Intel AI Lab. San Diego, USA.

## Teaching Experience

- 2025 **Instructor of Record**: "The Neuroscience of Artificial Intelligence". Harvard College, Bachelor's.
- 2020 **Teaching Assistant**: "Machine Learning 1". University of Amsterdam, Bachelor's.
- 2019 **Teaching Assistant**: "Machine Learning 2". University of Amsterdam, Master's.
- 2016 **Head Teaching Assistant**: "Data Visualization". University of California San Diego, Master's.

## Selected Advising Experience

- 2023–cur **Emma Finn**. Undergraduate, Harvard College. (Daily supervisor)  
*Outcome*: [Rhodes Scholarship '26](#), [Two Undergraduate Research Fellowships](#) & [AISTATS '26 Paper](#).
- 2024–cur **Mozes Jacobs**. Ph.D. Candidate, Harvard. (Daily supervisor during primary advisor's sabbatical; last author)  
*Outcome*: [CCN '25 Proceedings \(Oral\)](#), & [ICLR '26 \(top 7% scores\)](#).
- 2025–cur **Hansen Lillemark**. Ph.D. Candidate, UCSD. (Daily supervisor for summer research visit; last author)  
*Outcome*: [ICML '26 \(under review\)](#), [Accepted submission at two NeurIPS '25, Workshops](#).
- 2020–2021 **Qinghe Gao**. Master's Candidate, University of Amsterdam. (Daily supervisor for master's thesis)  
*Outcome*: [Best Paper Award @ NeurIPS '21 SVRHM workshop](#).

## Selected Publications

- ICML '26 Under Review H. Lillemark, B. Huang, F. Zhan, Y. Du, and **T. A. Keller** (2026). "Flow Equivariant World Modeling: Structured Memory for Dynamic Environments". In: *International Conference on Machine Learning (ICML)*. Under review. url: <https://arxiv.org/abs/2601.01075>
- ICML '26 Under Review J. Bertram, L. Dybala, **T. A. Keller**, S. Kinger, and S. W. Zucker (2026). "How Neural is a Neural Foundation Model?" In: *International Conference on Machine Learning*. Under review. Accepted at Data on Brain & Mind Workshop @ NeurIPS 2025. url: <https://arxiv.org/abs/2601.21508>
- ICML '26 Under Review L. Fesser, T. Fel, M. Jacobs, **T. A. Keller**, and S. M. Kakade (2026). "A Unifying View of Attention Sinks: Two Algorithms, Two Solutions". In: *International Conference on Machine Learning*. Under review.
- ICLR '26 M. Jacobs, T. Fel, R. Hakim, A. Brondetta, D. E. Ba, and **T. A. Keller** (2026). "Block Recurrent Dynamics in Vision Transformers". In: *International Conference on Learning Representations (ICLR)*. url: <https://openreview.net/forum?id=gH3HhnfWLC>
- NeurIPS '25 Spotlight **T. A. Keller** (2025). "Flow Equivariant Recurrent Neural Networks". In: *Advances in Neural Information Processing Systems (NeurIPS)*. **Spotlight, Top 13% accepted**. arXiv: [2507.14793](https://arxiv.org/abs/2507.14793). url: <https://openreview.net/forum?id=N1KP0lcN6P>

- NeurIPS '25 Y. Song, **T. A. Keller**, S. Brodjan, T. Miyato, Y. Yue, P. Perona, and M. Welling (2025). “Kuramoto Orientation Diffusion Models”. In: *Advances in Neural Information Processing Systems (NeurIPS)*. url: <https://arxiv.org/abs/2509.15328>
- NeurIPS '25 A. Karuvally, F. Nowak, **T. A. Keller**, C. A. Alonso, T. Sejnowski, and H. T. Siegelmann (2025). “Bridging Expressivity and Scalability with Adaptive Unitary SSMs”. In: *The Thirty-ninth Annual Conference on Neural Information Processing Systems*. url: <https://openreview.net/forum?id=s4zitEu2R8>
- NeurIPS '25 Workshop S. Bharthulwar, **T. A. Keller**, M. Theodosis, and D. E. Ba (2025). “From Extrapolation to Generalization: How Conditioning Transforms Symmetry Learning in Diffusion Models”. In: *NeurIPS 2025 Workshop on Symmetry and Geometry in Neural Representations*. url: <https://openreview.net/forum?id=UI82R3lwar>
- CCN '25 Oral, Proceedings M. Jacobs, R. C. Budzinski, L. Muller, D. E. Ba, and **T. A. Keller** (2025). “Traveling Waves Integrate Spatial Information Through Time”. In: *Conference on Cognitive Computational Neuroscience (CCN)*. **Oral presentation, Top 7%**. url: <https://openreview.net/forum?id=QEzqo546V5>
- Springer '25 Book Y. Song, **T. A. Keller**, N. Sebe, and M. Welling (May 2025). *Structured Representation Learning*. en. Synthesis Lectures on Computer Vision. Cham, Switzerland: Springer International Publishing. url: <https://link.springer.com/book/10.1007/978-3-031-88111-4>
- COSYNE '25 Abstract **T. A. Keller** (2025). “Nu-Wave State Space Models: Traveling Waves as a Biologically Plausible Context”. In: *COSYNE Abstracts*. doi: [10.57736/b30b-8eed](https://doi.org/10.57736/b30b-8eed)
- AISTATS '26 E. L. Byrnes Finn, B. Wang, **T. A. Keller**, and D. E. Ba (2026). “Where the Score Lives: A Wavelet View of Diffusion”. In: *Proceedings of the 29th International Conference on Artificial Intelligence and Statistics (AISTATS)*. Also accepted at SPIGM Workshop @ NeurIPS 2025.
- PNAS '25 L. H. B. Liboni, R. C. Budzinski, A. N. Busch, S. Löwe, **T. A. Keller**, M. Welling, and L. E. Muller (2025). “Image segmentation with traveling waves in an exactly solvable recurrent neural network”. In: *Proceedings of the National Academy of Sciences (PNAS)* 122.1, e2321319121. doi: [10.1073/pnas.2321319121](https://doi.org/10.1073/pnas.2321319121). url: <https://www.pnas.org/doi/abs/10.1073/pnas.2321319121>
- ICML '25 Workshop E. L. B. Finn, **T. A. Keller**, M. Theodosis, and D. E. Ba (2025). “Origins of Creativity in Attention Based Diffusion Models”. In: *High-dimensional Learning Dynamics 2025 @ ICML '25*. url: <https://openreview.net/forum?id=xMqRYKvrD1>
- CCN '25 Abstract Y. Song, **T. A. Keller**, Y. Yue, P. Perona, and M. Welling (2024). “Langevin Flows for Modeling Neural Latent Dynamics”. In: *Conference on Cognitive Computational Neuroscience (CCN)*. url: <https://arxiv.org/abs/2507.11531>
- ICLR '24 **T. A. Keller**, L. Muller, T. Sejnowski, and M. Welling (2024). “Traveling Waves Encode the Recent Past and Enhance Sequence Learning”. In: *International Conference on Learning Representations (ICLR)*. url: <https://openreview.net/forum?id=p4S5Z6Sah4>
- arXiv '24 **T. A. Keller**, L. Muller, T. J. Sejnowski, and M. Welling (2024). *A Spacetime Perspective on Dynamical Computation in Neural Information Processing Systems*. arXiv: [2409.13669](https://arxiv.org/abs/2409.13669) [q-bio.NC]. url: <https://arxiv.org/abs/2409.13669>
- TPAMI '24 Y. Song, **T. A. Keller**, Y. Yue, P. Perona, and M. Welling (2024). “Unsupervised Representation Learning from Sparse Transformation Analysis”. In: *IEEE Transactions on Pattern Analysis and Machine Intelligence*. arXiv: [2410.05564](https://arxiv.org/abs/2410.05564) [cs.LG]. url: <https://arxiv.org/abs/2410.05564>
- arXiv '24 E. Finn, **T. A. Keller**, E. Theodosis, and D. E. Ba (2024). *Learning Artistic Signatures: Symmetry Discovery and Style Transfer*. arXiv: [2412.04441](https://arxiv.org/abs/2412.04441) [cs.CV]
- CCN '24 Abstract **T. A. Keller**, T. Konkle, and C. Conwell (2024). “Towards the Use of Relative Representations for Lower-Dimensional, Interpretable Model-to-Brain Mappings”. In: *Conference on Cognitive Computational Neuroscience (CCN)*. url: <https://2024.ccneuro.org/poster/?id=317>
- ICML '23 **T. A. Keller** and M. Welling (2023). “Neural Wave Machines: Learning Spatiotemporally Structured Representations with Locally Coupled Oscillatory Recurrent Neural Networks”. In: *Proceedings of the 40th International Conference on Machine Learning (ICML)*. vol. 202. Proceedings of Machine Learning Research, pp. 16168–16189. url: <https://proceedings.mlr.press/v202/keller23a.html>
- NeurIPS '23 Y. Song, **T. A. Keller**, N. Sebe, and M. Welling (2023). “Flow Factorized Representation Learning”. In: *Advances in Neural Information Processing Systems (NeurIPS)*. vol. 36. Curran Associates, Inc., pp. 49761–49782. url: [https://proceedings.neurips.cc/paper\\_files/paper/2023/file/9bfc2c20fa2f56a18397eafe1be8a50a-Paper-Conference.pdf](https://proceedings.neurips.cc/paper_files/paper/2023/file/9bfc2c20fa2f56a18397eafe1be8a50a-Paper-Conference.pdf)

- TMLR '23 **T. A. Keller**, X. Suau, and L. Zappella (2023). “Homomorphic Self-Supervised Learning”. In: *Transactions on Machine Learning Research*. issn: 2835-8856. url: <https://openreview.net/forum?id=tEKqQgbwbf>
- ICML '23 Y. Song, **T. A. Keller**, N. Sebe, and M. Welling (2023). “Latent traversals in generative models as potential flows”. In: *Proceedings of the 40th International Conference on Machine Learning*. ICML'23. Honolulu, Hawaii, USA: JMLR.org. url: <https://dl.acm.org/doi/10.5555/3618408.3619746>
- ICML '23 X. Suau, F. Danieli, **T. A. Keller**, A. Blaas, C. Huang, J. Ramapuram, D. Busbridge, and L. Zappella (2023). “DUET: 2D Structured and Approximately Equivariant Representations”. In: *Proceedings of the 40th International Conference on Machine Learning*. Vol. 202. Proceedings of Machine Learning Research. PMLR, pp. 32749–32769. url: <https://proceedings.mlr.press/v202/suau23a.html>
- NeurIPS '23 Workshop N. L. Masclef and **T. A. Keller** (2023). “Deep Generative Models of Music Expectation”. In: *NeurIPS 2023 Workshop on Machine Learning for Audio*. arXiv: [2310.03500](https://arxiv.org/abs/2310.03500) [cs.SD]
- COSYNE '22 Abstract **T. A. Keller** and M. Welling (2022). “Locally Coupled Oscillator Networks Learn Traveling Waves and Topographic Organization”. In: url: <https://akandykeller.github.io/papers/LocoRNN.pdf>
- ICML '21 **T. A. Keller**, J. W. T. Peters, P. Jaini, E. Hoogeboom, P. Forré, and M. Welling (July 2021). “Self Normalizing Flows”. In: *Proceedings of the 38th International Conference on Machine Learning (ICML)*. vol. 139. Proceedings of Machine Learning Research. PMLR, pp. 5378–5387. url: <https://proceedings.mlr.press/v139/keller21a.html>
- ICCVW '21 Oral **T. A. Keller** and M. Welling (2021). “Predictive Coding with Topographic Variational Autoencoders”. In: *IEEE/CVF International Conference on Computer Vision Workshops (ICCVW)*. **Oral presentation**, pp. 1086–1091. doi: [10.1109/ICCVW54120.2021.00127](https://doi.org/10.1109/ICCVW54120.2021.00127)
- SVRHM '21 Best Paper Award T. A. Keller\*, Q. Gao, and M. Welling (2021). “Modeling Category-Selective Cortical Regions with Topographic Variational Autoencoders”. In: *Shared Visual Representations in Humans and Machines (SVRHM) Workshop @ NeurIPS*. **Best Paper Award**. url: [https://openreview.net/forum?id=yGRq\\_lW54bI](https://openreview.net/forum?id=yGRq_lW54bI)
- NeurIPS '21 **T. A. Keller** and M. Welling (2021). “Topographic VAEs Learn Equivariant Capsules”. In: *Advances in Neural Information Processing Systems (NeurIPS)*. vol. 34. Curran Associates, Inc., pp. 28585–28597. url: <https://proceedings.neurips.cc/paper/2021/file/f03704cb51f02f80b09bffa15751691-Paper.pdf>
- arXiv '18 **T. A. Keller**, S. N. Sridhar, and X. Wang (2018). “Fast Weight Long Short-Term Memory”. In: *arXiv preprint*. doi: [10.48550/ARXIV.1804.06511](https://doi.org/10.48550/ARXIV.1804.06511). url: <https://arxiv.org/abs/1804.06511>
- APL '14 C. M. Donahue, P. W. J. Anzel, L. Bonanomi, **T. A. Keller**, and C. Daraio (Jan. 2014). “Experimental realization of a nonlinear acoustic lens with a tunable focus”. In: *Applied Physics Letters* 104.1, p. 014103. issn: 0003-6951. doi: [10.1063/1.4857635](https://doi.org/10.1063/1.4857635)

## Invited Talks

- 2025 **NSF IAIFAI Colloquium** (MIT/Harvard, USA): “Flow Equivariance: Enforcing Time-Parameterized Symmetries in Sequence Models”. 📺 Recording: [youtube.com/watch?v=fO-wsJgGeL8](https://www.youtube.com/watch?v=fO-wsJgGeL8)
- 2025 **Fields Symposium on Spatiotemporal Neural Dynamics** (U of T, CA): “The Computational Inductive Biases of Spatiotemporal Artificial Neural Networks”. 📺 Recording: [youtube.com/watch?v=Rd-4lubEYc4](https://www.youtube.com/watch?v=Rd-4lubEYc4)
- 2025 **Neuro AI Emerging Leaders Webinar**: “The Computational Inductive Biases of Spatiotemporal Dynamics”. 📺 Recording: [youtube.com/watch?v=nmiGZo5uPH4](https://www.youtube.com/watch?v=nmiGZo5uPH4)
- 2024 **NeurReps International Speaker Series**: “A Spacetime Perspective on Neural Information Processing Systems”. 📺 Recording: [youtube.com/watch?v=FeVHfmRSicQ](https://www.youtube.com/watch?v=FeVHfmRSicQ)
- 2024 **Woods Hole Computational Neuroscience Workshop** (Telluride, USA): “Wave Information Processing Systems”. 📺 Recording: [youtube.com/watch?v=2kre5gyfLzI](https://www.youtube.com/watch?v=2kre5gyfLzI)
- 2024 **Active Inference Institute Seminar** (Virtual): “Natural Structure in Artificial Neural Networks”. 📺 Recording: [youtube.com/watch?v=1uIRljnLtc4](https://www.youtube.com/watch?v=1uIRljnLtc4)
- 2025 **AI, Brain, & Cognition Seminar, Center for NeuroImaging Research, Korea** (Virtual): “Computational Inductive Biases of Spatiotemporal Dynamics”.
- 2025 **Guest Lecture: Applied Math 220, Geometric Deep Learning @ Harvard** (Harvard, USA): “Flow Equivariance”.
- 2024 **CSML Reading Group** (Imperial College London, UK): “Traveling Waves in Brains and Machines”.

- 2024 **Yale Wu Tsai Neuro AI Seminar**: "A Spacetime Perspective on Neural Information Processing Systems".
- 2024 **CERN CMS Machine Learning Seminar** (Geneva, Switzerland): "Traveling Waves in Brains and Machines".
- 2024 **Computational Neuroscience Next Generation Symposium** (WashU, USA): "A Spacetime Perspective on Neural Information Processing Systems".
- 2023 **Frankfurt Institute for Advanced Studies, Giersch School and International Conference on Complex Systems** (Frankfurt, Germany): "Generalized Equivariance through Fluid Representations in Brains and Machines".
- 2023 **A.D. de Groot Cognitive AI Lecture** (Amsterdam, Netherlands): "Topographic Organization and Traveling Waves as Natural Representational Structure for Artificial Neural Networks".
- 2023 **Workshop on Structured Learning, Chalmers AI Research Center** (Gothenburg, Sweden): "Natural Neural Structure for Artificial Intelligence".
- 2022 **Seminar on Advances in Probabilistic Machine Learning** (Helsinki, Finland): "Topographic Variational Autoencoders Learn Equivariant Capsules".

## Awards

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- 2025 **Spotlight (Top 13% Accepted)**. "Flow Equivariant Recurrent Neural Networks", [Keller, T. A.](#), NeurIPS '25.
- 2025 **Contributed Talk (Top 7% Accepted)**. "Traveling Waves Integrate Information over Space", Jacobs, M., ..., [Keller, T. A.](#), CCN '25.
- 2025 **Top Reviewer Award**. NeurIPS '25. Award Value: \$800.
- 2025 **Contributed Talk (Top 17%)**. "Flow Equivariant Cybernetics", Lillemark, ..., [Keller, T. A.](#), Champalimaud Foundation Research Symposium '25.
- 2025 **Travel Award**. Champalimaud Foundation. Amount: \$800.
- 2025 **FENS Brain Conference Travel Grant**. FENS. Amount: \$800.
- 2024 **Contributed Talk (Top 10%)**. "Traveling Waves in State Space Models". [Keller, T. A.](#). From Neuroscience to AI Systems (NAISys) Conference.
- 2023 **Travel Award**. COSYNE. Amount: \$800.
- 2022 **Travel Award**. CIFAR Neuroscience of Consciousness Winter School. Award Value: \$1,500.
- 2021 **Contributed Talk (Top 10%)**. "Predictive Coding with Topographic VAEs". [Keller, T. A.](#) & Welling, M., Visual Inductive Priors Workshop, ICCV '21.
- 2021 **Best Paper Award**. "Modeling Category-Selective Cortical Regions with TVAEs". [Keller, T. A.\\*](#), Gao, Q.\*, & Welling, M., Shared Visual Representations in Humans and Machines (SVRHM) Workshop; NeurIPS '21. Award Value: \$300.

## Community Service

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- 2025-cur **Workshop Co-organizer**, Telluride Neuromorphic Engineering Workshop on Spatiotemporal Dynamics
- 2025-cur **Speaker Series Organizer**, Foundation Role Models Speaker Series, CRISP Lab, Harvard
- 2025-cur **Reviewer**, ICLR Workshop Proposals
- 2025-cur **Reviewer**, TMLR Proceedings
- 2025-cur **Reviewer**, UAI Proceedings
- 2025-cur **Reviewer**, AAAI Proceedings
- 2025-cur **Reviewer**, CCN Proceedings
- 2024-cur **Reviewer**, NeurIPS Proceedings
- 2024-cur **Reviewer**, Neural Computation
- 2024-cur **Reviewer**, ICLR Proceedings
- 2024-cur **Reviewer**, AISTATS Proceedings
- 2025-cur **Program Committee (Reviewer)**, Re-Align Workshop
- 2024-cur **Program Committee (Reviewer)**, NeuReps Workshop
- 2019-2022 **Board Member**, Inclusive AI, University of Amsterdam, [ivi.fnwi.uva.nl/ellis/inclusive-ai/](http://ivi.fnwi.uva.nl/ellis/inclusive-ai/)