

Dr. Benjamin M. Ruppik

Topological Deep Learning Researcher — Short biography

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I am a postdoctoral researcher in the *Dialog Systems and Machine Learning* Lab at Heinrich Heine University Düsseldorf. My work focuses on *Topological Deep Learning* and the use of *Topological Data Analysis (TDA)* to study the latent spaces of language models, with applications to representation learning and task-oriented dialogue systems.

Employment

January 2022 –
current

Postdoctoral Researcher,

Topological Data Analysis and Topological Deep Learning for Natural Language Processing, Heinrich-Heine-Universität Düsseldorf, Faculty of Mathematics and Natural Sciences, Dialog Systems and Machine Learning Lab at the Computer Science Institute, Building 25.12.01, Universitätsstraße 1, 40225 Düsseldorf; Chair: Prof. Dr. Milica Gašić.

Employed in the European Research Council project [Dynamic dialogue modelling \(DYMO\)](#).

Key Publications

Less is More: Local Intrinsic Dimensions of Contextual Language Models

Benjamin Ruppik *et al.*

[Advances in Neural Information Processing Systems \(NeurIPS 2025\)](#).

Project page: [🔗 aidos-lab/Topo_LLM_public](#)

We introduce a framework using local intrinsic dimension estimates to analyze an LLM's representations, linking dimension shifts to generalization, grokking, and training dynamics.

Local Topology Measures of Contextual Language Model Latent Spaces With Applications to Dialogue Term Extraction

Benjamin Ruppik *et al.*

[Proceedings of the 25th Annual Meeting of the Special Interest Group on Discourse and Dialogue \(SIGDIAL 2024\)](#).

Project page: [🔗 tda4contextualembeddings-public](#)

[Nominated for the SIGDIAL 2024 Best Paper Award](#)

Our proposed method uses local topology measures in contextual embedding spaces to identify dialogue-relevant terms and improve term extraction performance.

Publications and Preprints

Topological Deep Learning

Benjamin Ruppik, Julius von Rohrscheidt, Carel van Niekerk, Michael Heck, Renato Vukovic, Shutong Feng, Hsien-chin Lin, Nurul Lubis, Bastian Rieck, Marcus Zibrowius, Milica Gašić:

'Less is More: Local Intrinsic Dimensions of Contextual Language Models'

Advances in Neural Information Processing Systems 38; Proceedings of the 39th Conference on Neural Information Processing Systems (NeurIPS 2025; San Diego, in press);

[arXiv:2506.01034](#); Project page: [🔗 aidos-lab/Topo_LLM_public](#).

Benjamin Ruppik, Michael Heck, Carel van Niekerk, Renato Vukovic, Hsien-chin Lin, Shutong Feng, Marcus Zibrowius, Milica Gašić:

'Local Topology Measures of Contextual Language Model Latent Spaces With Applications to Dialogue Term Extraction'

Nominated for [Best Paper Award at SIGDIAL 2024](#).

Proceedings of the 25th Annual Meeting of the Special Interest Group on Discourse and Dialogue (SIGDIAL 2024), Kyoto University, Japan;

[doi:10.18653/v1/2024.sigdial-1.31](#); [arXiv:2408.03706](#); Project page: [🔗 tda4contextualembeddings-public](#).

Benjamin Ruppik:

Position Paper: ‘Topological Deep Learning for Term Extraction’

Proceedings of the 20th Workshop of Young Researchers’ Roundtable on Spoken Dialogue Systems, pages 43–45, Kyoto, Japan;

[doi:10.18653/v1/2024.yrrsds-1.16](https://doi.org/10.18653/v1/2024.yrrsds-1.16); [ACLAnthology:2024.yrrsds-1.16](https://aclanthology.org/2024.yrrsds-1.16).

Renato Vukovic, Michael Heck, **Benjamin Ruppik**, Carel van Niekerk, Marcus Zibrowius and Milica Gašić:

‘Dialogue Term Extraction using Transfer Learning and Topological Data Analysis’

Proceedings of the 23rd Annual Meeting of the Special Interest Group on Discourse and Dialogue (SIGDIAL 2022), pages 564–581, Edinburgh, UK;

[doi:10.18653/v1/2022.sigdial-1.53](https://doi.org/10.18653/v1/2022.sigdial-1.53); [arXiv:2208.10448](https://arxiv.org/abs/2208.10448).

Task-oriented Dialogue Systems

- Michael Heck, Christian Geischauser, Nurul Lubis, Carel van Niekerk, Shutong Feng, Hsien-Chin Lin, **Benjamin Ruppik**, Renato Vukovic, Milica Gašić:
‘Learning from Noisy Labels via Self-Taught On-the-Fly Meta Loss Rescaling’
Proceedings of the AAAI Conference on Artificial Intelligence (AAAI 2025);
[doi:10.1609/aaai.v39i22.34580](https://doi.org/10.1609/aaai.v39i22.34580); [arXiv:2412.12955](https://arxiv.org/abs/2412.12955)
- Renato Vukovic, David Arps, Carel van Niekerk, **Benjamin Ruppik**, Hsien-Chin Lin, Michael Heck, Milica Gašić:
‘Dialogue Ontology Relation Extraction via Constrained Chain-of-Thought Decoding’
Published in the *Proceedings of the 25th Annual Meeting of the Special Interest Group on Discourse and Dialogue (SIGDIAL 2024)*, Kyoto University, Japan;
[doi:10.18653/v1/2024.sigdial-1.33](https://doi.org/10.18653/v1/2024.sigdial-1.33); [arXiv:2408.02361](https://arxiv.org/abs/2408.02361)
- Shutong Feng, Hsien-chin Lin, Christian Geischauser, Nurul Lubis, Carel van Niekerk, Michael Heck, **Benjamin Ruppik**, Renato Vukovic, Milica Gašić:
‘Infusing Emotions into Task-oriented Dialogue Systems: Understanding, Management, and Generation’
Published in the *Proceedings of the 25th Annual Meeting of the Special Interest Group on Discourse and Dialogue (SIGDIAL 2024)*, Kyoto University, Japan;
[doi:10.18653/v1/2024.sigdial-1.60](https://doi.org/10.18653/v1/2024.sigdial-1.60); [arXiv:2408.02417](https://arxiv.org/abs/2408.02417)
- Christian Geischauser, Carel van Niekerk, Nurul Lubis, Hsien-chin Lin, Michael Heck, Shutong Feng, **Benjamin Ruppik**, Renato Vukovic, Milica Gašić:
‘Learning With an Open Horizon in Ever-Changing Dialogue Circumstances’
Published in *IEEE/ACM Transactions on Audio, Speech, and Language Processing*, vol. 32, pp. 2352–2366 (2024);
[doi:10.1109/TASLP.2024.3385289](https://doi.org/10.1109/TASLP.2024.3385289).
- Carel van Niekerk, Christian Geischauser, Michael Heck, Shutong Feng, Hsien-chin Lin, Nurul Lubis, **Benjamin Ruppik**, Renato Vukovic, Milica Gašić:
‘CAMELL: Confidence-based Acquisition Model for Efficient Self-supervised Active Learning with Label Validation’
Transactions of the Association for Computational Linguistics (TACL) 2025, volume 13:167–187;
[doi:10.1162/tacl_a_00734](https://doi.org/10.1162/tacl_a_00734); [arXiv:2310.08944](https://arxiv.org/abs/2310.08944).
- Shutong Feng, Nurul Lubis, **Benjamin Ruppik**, Christian Geischauser, Michael Heck, Hsien-chin Lin, Carel van Niekerk, Renato Vukovic, Milica Gašić:
‘From Chatter to Matter: Addressing Critical Steps of Emotion Recognition Learning in Task-oriented Dialogue’
Published in the *Proceedings of the 24th Annual Meeting of the Special Interest Group on Discourse and Dialogue (SIGDIAL 2023)*;
[doi:10.18653/v1/2023.sigdial-1.8](https://doi.org/10.18653/v1/2023.sigdial-1.8); [arXiv:2308.12648](https://arxiv.org/abs/2308.12648).
- Hsien-Chin Lin, Shutong Feng, Christian Geischauser, Nurul Lubis, Carel van Niekerk, Michael Heck, **Benjamin Ruppik**, Renato Vukovic, Milica Gašić:
‘EmoUS: Simulating User Emotions in Task-Oriented Dialogues’
Published in *Proceedings of the 46th International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR 2023)*, Association for Computing Machinery, New York, NY, USA;
[doi:10.1145/3539618.3592092](https://doi.org/10.1145/3539618.3592092); [arXiv:2306.01579](https://arxiv.org/abs/2306.01579).
- Michael Heck, Nurul Lubis, **Benjamin Ruppik**, Renato Vukovic, Shutong Feng, Christian Geischauser, Hsien-Chin Lin, Carel van Niekerk, Milica Gašić:
‘ChatGPT for Zero-shot Dialogue State Tracking: A Solution or an Opportunity?’
Published in *Proceedings of the 61st Annual Meeting of the Association for Computational Linguistics (ACL)*, Toronto, Canada, July 2023;
[doi:10.18653/v1/2023.acl-short.81](https://doi.org/10.18653/v1/2023.acl-short.81); [arXiv:2306.01386](https://arxiv.org/abs/2306.01386).

Low-dimensional Topology

- Patricia Cahn, Gordana Matic, **Benjamin Ruppik**:
'Algorithms for Computing Invariants of Trisected Branched Covers'
 Submitted;
[arXiv:2308.11689](#).
- Sarah Blackwell, Robion Kirby, Michael R. Klug, Vincent Longo, **Benjamin Ruppik**:
'A group-theoretic framework for low-dimensional topology or, how not to study low-dimensional topology?'
 Published in *Algebr. Geom. Topol.* 25 (2025) 4667–4718;
[doi:10.2140/agt.2025.25.4667](#); [arXiv:2301.05685](#).
- Samantha Allen, Kenan Ince, Seungwon Kim, **Benjamin Ruppik**, Hannah Turner:
'Unknotting via null-homologous twists and multi-twists'
 Published in *Pacific J. Math.* 330(2024), no.1, 25–41;
[doi:10.2140/pjm.2024.330.25](#); [arXiv:2211.04621](#).
- Daniel Kasprowski, Johnny Nicholson, **Benjamin Ruppik**:
'Homotopy classification of 4-manifolds whose fundamental group is dihedral'
 Published in *Algebr. Geom. Topol.* 22(6): 2915–2949 (2022);
[doi:10.2140/agt.2022.22.2915](#); [arXiv:2011.03520](#).
- Michael Klug, **Benjamin Ruppik**:
'Deep and shallow slice knots in 4-manifolds'
 Published in *Proc. Amer. Math. Soc. Ser. B* 8 (2021), 204–218;
[doi:10.1090/bproc/89](#); [arXiv:2009.03053](#).
- Jason Joseph, Michael Klug, **Benjamin Ruppik**, Hannah Schwartz:
'Unknotting numbers of 2-spheres in the 4-sphere'
 Published in *J. Topology* 14.4 (2021), 1321–1350;
[doi:10.1112/topo.12209](#); [arXiv:2007.13244](#).
- Daniel Kasprowski, Mark Powell, **Benjamin Ruppik**:
'Homotopy classification of 4-manifolds with finite abelian 2-generator fundamental groups'
 Published in *Mathematical Proceedings of the Cambridge Philosophical Society.* 2024;177(2):263–283;
[doi:10.1017/S0305004124000227](#); [arXiv:2005.00274](#).

Recent Research Talks

- 2025-11 **'Measuring the Topology of Word Embeddings'**,
 Invited talk in the [Applied CATS Seminar](#) on 2025-11-25; Department of Mathematics, KTH, Stockholm, Sweden.
- 2023-02 **'Exploring the Shape of Word Spaces with Topological Data Analysis'**,
 Invited talks in the Pitt NLP Seminar, University of Pittsburgh Computer Science department, Pittsburgh, PA, USA, on 2023-03-28; MIT CSAIL Spoken Language Systems Group, Cambridge, MA, USA, on 2023-03-01; and Columbia University NLP Seminar, New York, NY, USA, on 2023-02-17.
- 2022-12-01 **'Topological Data Analysis in Word Embedding Spaces'**,
 Invited talk at the [Geometry Graduate Colloquium](#), ETH Zurich, Switzerland.

Recent Conferences & Travel

- 2025-12 [The Thirty-Ninth Annual Conference on Neural Information Processing Systems \(NeurIPS 2025\)](#);
 San Diego, CA, USA; December 2 – 7, 2025;
San Diego Poster & Video: 'Less is More: Local Intrinsic Dimensions of Contextual Language Models'.
- 2025-03 [Graduate Research Opportunities for Women \(GROW 2025\)](#); Goethe University Frankfurt am Main, Germany; March 27, 2025;
Invited panelist in the discussion 'What is mathematics research like? What to do with a PhD in mathematics? How to apply for a PhD in mathematics?'
- 2024-09 [25th Annual Meeting of the Special Interest Group on Discourse and Dialogue \(SIGDIAL 2024\)](#);
 Kyoto University, Kyoto, Japan; September 18 – 20, 2024;
Talk: 'Local Topology Measures of Contextual Language Model Latent Spaces With Applications to Dialogue Term Extraction'.
 Nominated for Best Paper Award.
- 2024-09 [20th Workshop on Spoken Dialogue Systems for PhDs, PostDocs & New Researchers \(YRRSDS 2024\)](#);
 Kyoto University, Kyoto, Japan; September 16 – 17, 2024;
Position paper and talk: 'Topological Deep Learning for Term Extraction'.

- 2022-09 [3rd Workshop on Topological Methods in Data Analysis](#); Heidelberg University, Germany (online); September 28 – 30, 2022;
Lightning talk: ‘Detecting Relevant Terms in Word Embedding Spaces’.
- 2022-09 [23rd Annual Meeting of the Special Interest Group on Discourse and Dialogue \(SIGDIAL 2022\)](#); Heriot-Watt University, Edinburgh, UK; September 07 – 09, 2022;
Talk: ‘Dialogue Term Extraction using Transfer Learning and Topological Data Analysis’.
- 2022-09 [18th Workshop on Spoken Dialogue Systems for PhDs, PostDocs & New Researchers \(YRRSDS 2022\)](#); Heriot-Watt University, Edinburgh, UK; September 05 – 06, 2022;
Poster: ‘Topology in Word Embedding Spaces’.
- 2022-08 Algebraic Topology and Topological Data Analysis: A Conference in Honor of Gunnar Carlsson; Institute for Mathematics and its Applications, Minneapolis, MN USA; August 01 – 05, 2022.
- 2021-09 MATRIX-MFO Tandem Workshop ID 2136a: Invariants and Structures in Low-Dimensional Topology; Oberwolfach; September 05 – 11, 2021;
Talk: ‘Concordances in (non-orientable 3-manifold) $\times [0, 1]$ ’.

Education

- October 2018 – June 2022 **PhD in Mathematics, specializing in Low-Dimensional Topology**,
Thesis: ‘Casson-Whitney Unknotting, Deep Slice Knots and Group Trisections of Knotted Surface Type’, advised by Arunima Ray, PhD and Prof. Dr. Peter Teichner;
member of the Bonn International Graduate School of Mathematics;
funded by the International Max Planck Research School on Moduli Spaces,
Max-Planck-Institute for Mathematics, Vivatsgasse 7, 53111 Bonn,
Graduation: June 2022.
- 2016 – 2018 **Master of Science in Mathematics**, *University of Bonn, Graduation: August 2018.*
- 2013 – 2016 **Bachelor of Science in Mathematics**, *University of Bonn, Graduation: June 2016.*

Selected Teaching

- Summer Term 2026 **Lecture: Topological Data Analysis (planned)**,
Master CS; Master AI & Data Science, Faculty of Mathematics and Natural Sciences, Heinrich-Heine-University Düsseldorf,
My role: Designing the lecture content to highlight recent progress in Topological Deep Learning (combining topological tools with deep learning models); teaching weekly lectures and exercise classes throughout the semester; designing, administering, and grading the final exam.
- Winter Term 2022/2023 **Oberseminar: Dialog Systems and Machine Learning**,
Faculty of Mathematics and Natural Sciences, Heinrich-Heine-University Düsseldorf,
My role: Inviting speakers for this semester’s research seminar highlighting recent progress in Task-oriented Dialogue Systems; chairing the seminar sessions.
- Summer Term 2022 & 2023 **Master’s Seminar on Word Embedding Spaces**,
Master CS; Master AI & Data Science, Faculty of Mathematics and Natural Sciences, Heinrich-Heine-University Düsseldorf,
My role: Designing and coordinating a new seminar on applications of representation learning in NLP; organising preparatory meetings with students; grading student talks and written reports.
- October 2014 – September 2020 **Teaching assistant**, MATHEMATICAL INSTITUTE OF THE UNIVERSITY OF BONN, Bonn.
Employed as tutor for the lectures *Analysis I, II, Linear Algebra I, II, Introduction to Algebra (Galois theory), Introduction to Geometry and Topology, Topology I, II (Homology & Cohomology), Algebraic Topology I, II (Introduction to Stable Homotopy Theory; Orthogonal Spectra)*

Experience

- 2021 **External PhD representative**, *Max-Planck-Institute for Mathematics, Bonn.*
- April 2018 – September 2018 **Student associate**, INSTITUTE OF COMPUTER SCIENCE III, Bonn.
Semantic segmentation of RGB-images and point clouds captured by a Velodyne LiDAR;
[ben300694/semanticLabelingTool](#)