

# Caleb Belth

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## Positions

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**Assistant Professor** Department of Linguistics, University of Utah, Salt Lake City, UT 2023-Present  
**Director** *Belth Labs*

## Education

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**PhD**, Computer Science, University of Michigan, Ann Arbor, MI 2018-2023

Advisors: Andries Coetzee, Danai Koutra

Thesis: *Towards an Algorithmic Account of Phonological Rules and Representations*

Committee: Andries Coetzee (LING), Danai Koutra (CS), Charles Yang (LING, UPenn), Richard Lewis (Psychology), Lu Wang (CS)

**M.S.**, Computer Science, University of Michigan, Ann Arbor, MI 2018-2019

**B.S.**, Computer Science, Purdue University, West Lafayette, IN 2014-2018

Minors: Philosophy, Mathematics

Research Advisors: Jennifer Neville, Dan Goldwasser, Daisuke Kihara

## Research Interests

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*Phonology, Computational Linguistics, Language Acquisition, Linguistic Representations, Variation and Change, Psycholinguistics, Artificial Intelligence*

## Awards and Honors

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Tanner Humanities Center Faculty Fellowship 2024

Rackham Graduate School Travel Award 2022

Weinberg Institute of Cognitive Science Travel Award 2022

Rackham Graduate School Travel Award 2022

Weinberg Institute of Cognitive Science Travel Award 2021

Richard F. and Eleanor A. Towner Prize for Distinguished Academic Achievement 2021

Awarded to the outstanding graduate student in each degree program

Best paper candidate, IEEE ICDM 2020

NSF Graduate Research Fellowship 2020

NDSEG Fellowship (declined for NSF GRF) 2020

Rackham Graduate School Travel Award 2019

ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD) Travel Award 2019

Dean's List, Purdue 2015-2018

Semester Honors, Purdue 2015-2018

## Journal Articles

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3. **Caleb Belth.** 2024. A Learning-Based Account of Phonological Tiers. *Linguistic Inquiry*, 1-63.  
DOI: [https://doi.org/10.1162/ling\\_a\\_00530](https://doi.org/10.1162/ling_a_00530)
2. **Caleb Belth.** 2023. A Learning-Based Account of Local Phonological Processes. *Phonology* 40(1-2), 1-33.  
DOI: <https://doi.org/10.1017/S0952675724000083>
1. **Caleb Belth, Alican Büyükçakır, and Danai Koutra.** 2022. A Hidden Challenge of Link Prediction: Which Pairs to Check? *Knowledge and Information Systems*. 64(3), 743-771.  
DOI: <https://doi.org/10.1007/s10115-021-01632-x>

## Peer-Reviewed Proceedings Articles

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11. **Caleb Belth.** 2025. A Theory of When and How Learners Construct Tiers: Implications for Opaque and Transparent Vowels. *Society for Computation in Linguistics*.
10. **Caleb Belth.** 2024. Meaning-Informed Low-Resource Segmentation of Agglutinative Morphology. *Society for Computation in Linguistics*.
9. **Caleb Belth.** 2023. Towards a Learning-Based Account of Underlying Forms: A Case Study in Turkish. *Society for Computation in Linguistics*.
8. **Caleb Belth, Sarah Payne, Deniz Beser, Jordan Kodner, and Charles Yang.** 2021. The Greedy and Recursive Search for Morphological Productivity. *CogSci*.
7. **Caleb Belth, Alican Büyükçakır, and Danai Koutra.** 2020. A Hidden Challenge of Link Prediction: Which Pairs to Check? *IEEE International Conference on Data Mining (ICDM)*.  
Selected as one of the best papers at ICDM'20. Invited for publication at the KAIS Journal, Springer.
6. **Caleb Belth, Xinyi Zheng, Danai Koutra.** 2020. Mining Persistent Activity in Continually Evolving Networks. *ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD)*.
5. **Caleb Belth, Xinyi Zheng, Jilles Vreeken, and Danai Koutra.** 2020. What is Normal, What is Strange, and What is Missing in a Knowledge Graph: Unified Characterization via Inductive Summarization. *ACM The Web Conference (WWW)*.
4. **Caleb Belth, Xinyi Zheng, Danai Koutra.** 2020. Mining Persistent Activity in Continually Evolving Networks. *ACM SIGKDD Workshop on Mining and Learning with Graphs (MLG)*.
3. **Tara Safavi, Caleb Belth, Lukas Faber, Davide Mottin, Emmanuel Muller, and Danai Koutra.** 2019. Personalized Knowledge Graph Summarization: From the Cloud to Your Pocket. *IEEE International Conference on Data Mining (ICDM)*.
2. **Caleb Belth, Fahad Kamran, Donna Tjandra, and Danai Koutra.** 2019. When to remember where you came from: Node representation learning in higher-order networks. *IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM)*.
1. **Caleb Belth, Fahad Kamran, Donna Tjandra, and Danai Koutra.** 2019. When to remember where you came from: Node representation learning in higher-order networks. *ACM SIGKDD Workshop on Mining and Learning with Graphs (MLG)*.

## Peer-Reviewed Abstracts with Proceedings

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6. **Caleb Belth.** 2025 (Accepted; I declined option to publish in proceedings). On Variation and Lexical Idiosyncrasy in Hungarian Vowel Harmony. *North East Linguistics Society*.
5. **Caleb Belth.** 2025 (Accepted; I declined option to publish in proceedings). Learning The Categories Underlying Turkish Voicing Alternations. *Boston University Conference on Language Development*.
4. **Caleb Belth.** 2025. A Learning Based Account of Turkish Laryngeal Alternations. *Annual Meeting on Phonology*.
3. **Caleb Belth.** 2024 (Accepted; I declined option to publish in proceedings). Revisiting (Im)possible Interactions in Learning Turkish Laryngeal Alternations. *Boston University Conference on Language Development*.
2. **Caleb Belth.** 2023. A Learning-Based Account of Non-Productivity in Dutch Voicing Alternations. *Boston University Conference on Language Development*.
1. **Caleb Belth.** 2022. Learning Non-Local Phonological Alternations via Automatic Creation of Tiers. 2022. *Cognitive Modeling and Computational Linguistics workshop at ACL*.

## Talks and Posters

(all presented by me or in tandem with coauthor(s) unless otherwise stated)

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27. **Caleb Belth**. 2025. *On Variation and Lexical Idiosyncrasy in Hungarian Vowel Harmony*. Talk at the 56<sup>th</sup> Annual Meeting of the North East Linguistics Society (NELS). Oct 17.
26. **Caleb Belth**. 2025. *A Theory of When and How Learners Construct Tiers: Implications for Opaque and Transparent Vowels*. Talk at 7<sup>th</sup> annual meeting of the Society for Computation in Linguistics (SCiL). Jul 19.
25. **Caleb Belth**. 2024. *Revisiting (Im)possible Interactions in Learning Turkish Laryngeal Alternations*. Poster (remote) at 49<sup>th</sup> Annual Boston University Conference on Language Development. Nov 9.
24. **Caleb Belth**. 2024. *A Learning Based Account of Turkish Laryngeal Alternations*. Poster at the Annual Meeting on Phonology. Nov 3.
23. **Caleb Belth**. 2024. *Meaning-Informed Low-Resource Segmentation of Agglutinative Morphology*. Poster at the 6<sup>th</sup> annual meeting of the Society for Computation in Linguistics (SCiL). Jun 28.
22. **Caleb Belth**. 2024. *Experimental Evidence that Learning of Morphophonological Alternations Starts Local*. Talk at the 54<sup>th</sup> Annual Meeting of the North East Linguistics Society (NELS). Jan 27.
21. **Caleb Belth**. 2023. *A Learning-Based Account of Non-Productivity in Dutch Voicing Alternations*. Poster at the 48<sup>th</sup> Annual Boston University Conference on Language Development. Nov 3.
20. **Caleb Belth**. 2023. *A Learning-Based Account of Non-Productivity in Dutch Voicing Alternations*. Poster accepted, but unable to present due to schedule conflict.
19. **Caleb Belth**. 2023. *Towards a Learning-Based Account of Underlying Forms: A Case Study in Turkish*. Poster at the 6<sup>th</sup> Annual Meeting of the Society for Computation in Linguistics. Held Jun 16-17.
18. **Caleb Belth**. 2023. *A Learning-Based Account of Phonological Tiers*. Talk at the 47<sup>th</sup> Annual Penn Linguistics Conference. Held Mar 18-19.
17. **Caleb Belth**. 2023. *Learning Non-Local Phonological Alternations via Automatic Creation of Tiers*. Talk at the 97<sup>th</sup> Annual Meeting of the Linguistic Society of America. Held Jan 5-8.
16. **Caleb Belth**. 2022. *How a Proclivity for Adjacency can Drive the Learning of Non-Local Alternations*. Talk at MidPhon 27. Oct 8.
15. **Caleb Belth**. 2022. *Learning Non-Local Phonological Alternations via Automatic Creation of Tiers*. Poster at the ACL workshop on Cognitive Modeling and Computational Linguistics. May 22.
14. Sarah Payne, **Caleb Belth**, Jordan Kodner, and Charles Yang. 2022. *Searching for Morphological Productivity*. Talk given at the 96<sup>th</sup> Annual Meeting of the Linguistic Society of America. Held Jan 6-9.
13. **Caleb Belth**, Sarah Payne, Deniz Beser, Jordan Kodner, and Charles Yang. 2021. *The Greedy and Recursive Search for Morphological Productivity*. Poster at the 43rd Annual Meeting of the Cognitive Science Society. Held Jul 26-29.
12. {**Caleb Belth**, Sarah Payne}, Jordan Kodner, and Charles Yang. 2021. *Searching for Morphological Productivity*. Talk by Sarah Payne at the 46<sup>th</sup> Annual Boston University Conference on Language Development. Held Nov 4-7.
11. Sarah Payne, **Caleb Belth**, Jordan Kodner, and Charles Yang. 2021. *The Recursive Search for Morphological Productivity*. Poster at the 5<sup>th</sup> Annual American International Morphological Meeting. Held Aug 26-29.
10. **Caleb Belth**, Alican Büyükçakır, and Danai Koutra. 2020. *A Hidden Challenge of Link Prediction: Which Pairs to Check?*. Talk at the IEEE International Conference on Data Mining (ICDM). Held Nov 17-20.
9. **Caleb Belth**, Xinyi Zheng, Danai Koutra. 2020. *Mining Persistent Activity in Continually Evolving Networks*. Talk at the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD). Held Aug 23-27.
8. **Caleb Belth**, Xinyi Zheng, Jilles Vreeken, and Danai Koutra. 2020. *What is Normal, What is Strange, and What is Missing in a Knowledge Graph: Unified Characterization via Inductive Summarization*. Talk at ACM The Web Conference (WWW). Held Apr 20-24.
7. **Caleb Belth**, Xinyi Zheng, Danai Koutra. 2020. *Mining Persistent Activity in Continually Evolving Networks*. Talk at the ACM SIGKDD Workshop on Mining and Learning with Graphs (MLG). Aug 24.
6. Tara Safavi, **Caleb Belth**, Lukas Faber, Davide Mottin, Emmanuel Muller, and Danai Koutra. 2019. *Personalized Knowledge Graph Summarization: From the Cloud to Your Pocket*. Talk by Tara Safavi at the IEEE International Conference on Data Mining (ICDM). Held Nov 8-11.

5. **Caleb Belth**, Fahad Kamran, Donna Tjandra, and Danai Koutra. 2019. *When to remember where you came from: Node representation learning in higher-order networks*. Talk at the IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM). Held Aug 27-30.
4. **Caleb Belth**, Fahad Kamran, Donna Tjandra, and Danai Koutra. 2019. *When to remember where you came from: Node representation learning in higher-order networks*. Poster at the ACM SIGKDD Workshop on Mining and Learning with Graphs (MLG). Aug 5.
3. **Caleb Belth**, Jilles Vreeken, and Danai Koutra. 2019. *What is Normal, What is Strange, and What is Missing in a Knowledge Graph: Unified Characterization via Inductive Summarization*. Poster at the University of Michigan MIDAS Symposium. Nov 15.
2. **Caleb Belth**, Fahad Kamran, Donna Tjandra, and Danai Koutra. 2019. *When to remember where you came from: Node representation learning in higher-order networks*. Poster at University of Michigan AI Symposium. Oct 19.
1. **Caleb Belth** and Daisuke Kihara. 2017. *Deep Learning for Protein Binding Ligand Prediction*. Poster at the Purdue University Undergraduate Research & Poster Symposium. Apr 11.

## Teaching

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HUM 1500: Great Books in the Humanities	Fall 2025
LING 6024: Child Language Acquisition	Fall 2025
LING 3010: Introductory Phonetics and Phonology	Spring 2025
LING 5024: Child Language Acquisition	Spring 2025
LING 3010: Introductory Phonetics and Phonology	Fall 2024
LING 5981/6080: Insights into Language Through Computational Learning Models	Fall 2024
Independent Study: Computational Approaches to Phonological Learning Independent study on computational phonology, focusing on phonological learning	Spring 2024
LING 5981/6080: Python for Linguists	Fall 2023
LING 111: Lenses into Language (Teaching Assistant)	Winter/Spring 2023
LING 347 / PSYCH 349: Psycholinguistics (Teaching Assistant)	Fall 2022
International Summer School on Data Science (Tutorial Instructor)	2020
MIDAS Data Science Summer Camp for High School Students, University of Michigan	2019

## Outreach and Service

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Editorial Board, <i>Phonology</i>	Dec 2025-Present
Lead Developer and Maintainer of Python package <i>algophon</i> <a href="#">[link]</a>	2024-Present
College of Humanities Linguistics Executive Committee Representative	2025-Present
Department of Linguistics Executive Committee Member	2024-Present
Department of Linguistics Undergraduate Committee Member	Fall 2025 – Spring 2025
North American Computational Linguistics Open Contribute to organizing	2023-Present
Department of Linguistics Search Committee Member	2023-2024
Diversity Initiative in Graduate Applications, University of Michigan Founder, program to connect students from underrepresented communities to UM research groups	2022-2023
M-DICE, City of Detroit, World Economic Forum, The Knight Foundation Graduate student lead, project to make access to transportation more equitable	2019-2021

CSEG Wellness, University of Michigan Co-founder, organization to improve graduate student wellness	2019-2021
Explore Graduate Studies, University of Michigan Volunteer, workshop to broaden participation in computer science graduate programs	2019

## Student Mentoring

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Michael Kamerath, M.A. (Prev. Undergraduate), University of Utah Co-Mentoring with Aniello De Santo.	2024-Present
Mohammed Al-Ariqy Dissertation Committee Member	2023-2025
Casey Miller, Undergraduate, University of Utah	2024-2025
Xueming Xu, Undergraduate, University of Michigan Now: Software Engineer, TikTok	2020-2021
Xinyi Zheng, Undergraduate, University of Michigan Now: PhD student, Carnegie Mellon University CS	2019-2020

## Invited Talks

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<i>An Algorithmic Approach to Phonological Tiers and its Implications for Vowel Harmony</i> Michigan State University (Linguistics Seminar)	2025 (upcoming)
<i>Phonological Grammar as Interplay Between Learner and Input:</i> <i>An Algorithmic Account of Developmental Differences among West Germanic Noun Voicing Alternations</i> University of Pennsylvania (ISLT Seminar)	2024
<i>Stories from An Algorithmic Approach to Phonology</i> , Brigham Young University	2024
<i>The Interaction Between Learning Algorithms and Formal Language Theory</i> LSA Conference Organized Session on Formal Language Theory in Morphology and Phonology	2024
<i>Historical Contingency in Language</i> , College of Humanities, University of Utah	2023
<i>ThinkBIG: Your Roadmap to Landing a Role at a Startup</i> , Purdue University	2017

## Guest Lectures

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<i>In Charles Yang's Graduate Seminar on Discovery Procedures</i> , UPenn	2023
<i>In Kyle Gorman's Graduate Seminar on Computational Linguistics</i> , CUNY	2022

## Reviewing

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<i>Linguistic Inquiry</i> Adjudicator	2025
<i>Phonology</i> Reviewer	2025
<i>Linguistic Inquiry</i> Squib Reviewer	2025
Society for Computation in Linguistics (SCiL) Reviewer	2025
<i>Lingua</i> Reviewer	2025

International Conference on Computational Linguistics Area Chair, <i>Linguistic Theories, Cognitive Modeling, and Psycholinguistics</i> track	2024
NSF Linguistics Program Ad hoc reviewer	2024
<i>Phonology</i> Reviewer	2024
Society for Computation in Linguistics (SCiL) Reviewer	2024
CogSci Conference Reviewer	2021
ACM The Web Conference (WWW) Subreviewer	2021
ACM International Conference on Information and Knowledge Management (CIKM) PC member, posters and demos session	2020
SIAM Workshop on Network Science (NS20) Subreviewer	2020
ACM The Web Conference (WWW) Subreviewer	2020
ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD) Subreviewer	2019
IEEE International Conference on Data Science and Advanced Analysis (DSAA) Subreviewer	2019

## Grants and Funding

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Virgil C. Aldrich Faculty Fellowship, Tanner Humanities Center \$15,000 (to department)	2025
Rackham Graduate Student Research Grant \$3,000	2023
Facebook Research Award \$50,000; Based on my research, and contributed to writing.	2020

## Industry Experience

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<i>Applied Science Intern</i> , Amazon, Seattle, WA (Remote; COVID-19) Created an approach for discovering product attributes	Summer 2020
<i>Software Engineer Intern</i> , Sift, San Francisco, CA Developed and deployed a gradient tree-boosting algorithm for automated fraud detection	Summer 2018
<i>Software Engineer Intern</i> , Handshake, San Francisco, CA Developed a web platform for university students to find their ideal employers	Summer 2017
<i>Software Engineer Intern</i> , Iris, Owosso, MI Developed Android code to run computer vision inference on mobile	Summer 2016
<i>Software Engineer Intern</i> , Iris, Owosso, MI Developed Android code	Summer 2015
<i>Software Development Intern</i> , Enspire Software, Fort Wayne, IN Developed Android code	Summer 2014

## **Programming Languages in order of Proficiency**

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Python (expert), Java (proficient), C (proficient), C++ (proficient), Bash (proficient), Scala (familiar)

## **Professional Membership**

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Linguistic Society of America (LSA) Member	Present
Association of Computing Machinery (ACM) Student Member 2018	Graduate School
Institute of Electrical and Electronics Engineers (IEEE) Student Member	Graduate School

## **Other Projects**

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Machine Learning Text and Network Joint Embeddings, Purdue University	2017-2018
Deep Learning for Protein Binding Ligand Prediction, Purdue University	2015-2018