

William Merrill

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Last updated January 8, 2022

RESEARCH INTERESTS

Broad: NLP, deep learning, formal languages, semantics, historical linguistics, computational complexity

Specific:

- Formal capabilities and inductive biases of neural networks for language
- Theory of distributional learning
- Robustness and interpretability of NLP models

PROFESSIONAL EXPERIENCE

AI2	2019–2021	Predoc. Young Investigator with AllenNLP
Google	2018	Software Engineering Intern <i>"Exceeds expectations" rating; return offer</i>
Boston College	2017	Research Intern in Language Learning Lab
New York University	2013–2015	Research Intern in Morphology Lab

EDUCATION

New York University	2021–	Ph.D. at Center for Data Science
Yale University	2015–2019	B.S. with distinction in Computer Science B.A. with distinction in Linguistics Thesis: Sequential neural networks as automata <i>Cum laude; note of excellence on thesis</i>

MENTORS AND GROUP AFFILIATIONS

Noah A. Smith, Yoav Goldberg, Roy Schwartz	AllenNLP, AI2	2019–
Robert Frank, Dana Angluin	CLAY, Yale	2016–2019
Joshua Hartshorne, Sven Dietz	L3, Boston College	2017
Alec Marantz, Phoebe Gaston	MorphLab, NYU	2013–2015

PUBLICATIONS

- William Merrill, Yoav Goldberg, and Noah A. Smith. On the power of saturated transformers: A view from circuit complexity, 2021a.
- Matt Gardner, William Merrill, Jesse Dodge, Matthew E. Peters, Alexis Ross, Sameer Singh, and Noah Smith. Competency problems: On finding and removing artifacts in language data, 2021.
- William Merrill, Yoav Goldberg, Roy Schwartz, and Noah A. Smith. Provable Limitations of Acquiring Meaning from Ungrounded Form: What Will Future Language Models Understand? *Transactions of the Association for Computational Linguistics*, 9:1047–1060, 09 2021b. ISSN 2307-387X. doi: 10.1162/tacl_a_00412. URL https://doi.org/10.1162/tacl_a_00412.
- William Merrill, Vivek Ramanujan, Yoav Goldberg, Roy Schwartz, and Noah Smith. Effects of parameter norm growth during transformer training: Inductive bias from gradient descent, 2021c.
- William Merrill, Gail Weiss, Yoav Goldberg, Roy Schwartz, Noah A. Smith, and Eran Yahav. A formal hierarchy of RNN architectures. In *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics*, pages 443–459, Online, July 2020. Association for Computational Linguistics. doi: 10.18653/v1/2020.acl-main.43. URL <https://www.aclweb.org/anthology/2020.acl-main.43>.
- Lucy Lu Wang, Kyle Lo, Yoganand Chandrasekhar, Russell Reas, Jiangjiang Yang, Doug Burdick, Darrin Eide, Kathryn Funk, Yannis Katsis, Rodney Kinney, Yunyao Li, Ziyang Liu, William Merrill, Paul Mooney, Dewey Murdick, Devvret Rishi, Jerry Sheehan, Zhihong Shen, Brandon Stilson, Alex Wade, Kuansan Wang, Nancy Xin Ru Wang, Chris Wilhelm, Boya Xie, Douglas Raymond, Daniel S. Weld, Oren Etzioni, and Sebastian Kohlmeier. CORD-19: The COVID-19 open research dataset, 2020.
- William Merrill. On the linguistic capacity of real-time counter automata, 2020. URL <https://arxiv.org/abs/2004.06866>.
- William Merrill. Sequential neural networks as automata. In *Proceedings of the Workshop on Deep Learning and Formal Languages: Building Bridges*, pages 1–13, Florence, August 2019. Association for Computational Linguistics. URL <https://www.aclweb.org/anthology/W19-3901>.

- William Merrill, Lenny Khazan, Noah Amsel, Yiding Hao, Simon Mendelsohn, and Robert Frank. Finding hierarchical structure in neural stacks using unsupervised parsing. In *Proceedings of the 2019 ACL Workshop BlackboxNLP: Analyzing and Interpreting Neural Networks for NLP*, pages 224–232, Florence, Italy, August 2019a. Association for Computational Linguistics. URL <https://www.aclweb.org/anthology/W19-4823>.
- William Merrill, Gigi Stark, and Robert Frank. Detecting syntactic change using a neural part-of-speech tagger. In *Proceedings of the 1st International Workshop on Computational Approaches to Historical Language Change*, pages 167–174, Florence, Italy, August 2019b. Association for Computational Linguistics. URL <https://www.aclweb.org/anthology/W19-4721>.
- Yiding Hao, William Merrill, Dana Angluin, Robert Frank, Noah Amsel, Andrew Benz, and Simon Mendelsohn. Context-free transductions with neural stacks. In *Proceedings of the 2018 EMNLP Workshop BlackboxNLP: Analyzing and Interpreting Neural Networks for NLP*, pages 306–315, Brussels, Belgium, November 2018. Association for Computational Linguistics. URL <https://www.aclweb.org/anthology/W18-5433>.
- Jungo Kasai, Robert Frank, Pauli Xu, William Merrill, and Owen Rambow. End-to-end graph-based TAG parsing with neural networks. In *Proceedings of the 2018 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies, NAACL-HLT 2018, New Orleans, Louisiana, USA, June 1-6, 2018, Volume 1 (Long Papers)*, pages 1181–1194, 2018. URL <https://aclanthology.info/papers/N18-1107/n18-1107>.
- William Merrill. A semantics of subordinate clauses using delayed evaluation. *Toronto Undergraduate Linguistics Conference*, 2018. URL <https://ling.auf.net/lingbuzz/003487>.

INVITED TALKS

ArthurAI	2021	Competency problems
EMNLP	2021	Parameter norm growth for transformers
EMNLP	2021	Competency problems
AI2	2021	What will future language models understand?
Noah's ARK	2020	Formalizing form and meaning
BlackboxNLP	2018	Context-free transductions with neural stacks
Packer Symposium	2018	Neural networks, L2 acquisition, and the Voynich
CodeHaven	2018	Programming, language, and <i>The Book of Thoth</i>
TULCon	2018	A semantics of subordinate clauses using delayed evaluation

TEACHING ASSISTANT EXPERIENCE

CPSC 477	Natural Language Processing	Spring 2019
CPSC 477	Natural Language Processing	Spring 2018
CPSC 470	Artificial Intelligence	Fall 2017

All courses were taught by Dragomir Radev at Yale

SERVICE

Reviewing

ARR	2021	1 review
CL	2021	1 review
ACL	2021	6 reviews
EACL	2021	4 reviews
EMNLP	2020	2 reviews
Neural Networks	2020	1 review

Organization and Teaching

Yale Tangut Language Workshop	2018	Workshop facilitator
Yale NACLO	2017	Student volunteer
Yale Kitan Language Workshop	2016	Workshop facilitator
CodeHaven	2016–2018	Student volunteer
Splash at Yale	2016–2017	Student instructor

SELECTED PUBLIC SOFTWARE

- **StackNN**: Differentiable stacks, queues, and dequeues in PyTorch
- **Voynich2Vec**: Word embedding analysis of the Voynich manuscript
- **The Book of Thoth**: A puzzle game with dynamic spell casting in Ancient Egyptian
- Contributor to open-source NLP framework **AllenNLP**

BLOG POSTS

NLP

- Capsule networks for NLP
- Review: Learning to transduce with unbounded memory
- Word2vec analysis of the Voynich manuscript

Translations

- The Wanderer (Old English)
- After Ragnarok (Old Norse)
- The Saga of Mary (Old Norse)

AWARDS AND GRANTS

- **DELFOL student travel grant** presented by Naver Labs (2019)
- **Mellon grant** for senior thesis work, presented by Benjamin Franklin College at Yale University (2019)
- **Grace Hopper prize** for computer science finalist (2017)
- Yale College **freshman rap battle champion** (2016)
- **Rising scientist award** presented by the Child Mind Institute (2015)

- **National Merit Scholarship** letter of commendation (2013)
- **Study of American history award** presented by the Society of Mayflower Descendants (2013)
- National Latin Exam *cum honore maximo egregio* (2010)

SELECTED COURSEWORK

<i>AI/NLP</i>	Selected Topics in Neural Networks Advanced Natural Language Processing Computational Vision and Biological Perception Neural Networks and Language Natural Language Processing Deep Learning Theory and Applications Computing Meanings
<i>CS Theory</i>	Computational Complexity Theory Computability and Logic Systems Programming and Computer Organization Design and Analysis of Algorithms Data Structures and Programming Techniques
<i>Linguistics</i>	Formal Foundations of Linguistic Theory Syntax I Semantics I Phonology I Hybrid Grammars Indo-European Linguistics Old English Advanced Old English Seminar: Beowulf
<i>Math</i>	Introduction to Analysis Vector Calculus and Linear Algebra I Vector Calculus and Linear Algebra II

LANGUAGES

- *Coding* Python, Java, C, Haskell, PyTorch, AllenNLP, *inter alias*
- *Modern* English (Native), Icelandic (Intermediate)

- *Ancient* Latin, Old Norse, Old English