Brian Christian DuSell

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	Home Page	bdusell.com
	Google Scholar	https://scholar.google.com/citations?user=1AkLaFIAAAAJ
	GitHub	https://github.com/bdusell

Research Interests

Natural Language Processing, Neural Networks, Formal Language Theory

Education

University of Notre Dame, Notre Dame, IN — Aug 2016 to May 2023
M.S. and Ph.D., Computer Science
Dissertation: *Nondeterministic Stacks in Neural Networks*
Advisor: David Chiang

University of Notre Dame, Notre Dame, IN — Aug 2009 to May 2013
B.S., Computer Science, *magna cum laude*

Research Projects

Nondeterministic Stacks in Neural Networks
My Ph.D. dissertation addressed limitations in the abilities of state-of-the-art neural network architectures (namely, RNNs and transformers) to learn syntax. I did this by incorporating differentiable stacks into neural networks, drawing inspiration from theoretical connections between syntax and stacks. Whereas prior work employed deterministic stacks, mine was the first to use nondeterministic stacks, which are crucial for handling syntactic ambiguity and recognizing the full class of context-free languages. In work published at highly selective conferences (ICLR, CoNLL), I have shown that RNNs and transformers with nondeterministic stacks learn context-free languages and natural languages more effectively than prior stack-augmented models.

Publications

Stephen Bothwell, **Brian DuSell**, David Chiang, and Brian Krostenko. PILA: A Historical-Linguistic Dataset of Proto-Italic and Latin. In *Proc. LREC-COLING*. 2024. To appear.

Brian DuSell and David Chiang. Stack Attention: Improving the Ability of Transformers to Model Hierarchical Patterns. In *Proc. ICLR*. 2024. To appear.
Spotlight paper (awarded to 5% of submitted papers).

Brian DuSell. *Nondeterministic Stacks in Neural Networks*. Ph.D. dissertation, University of Notre Dame. 2023.

Brian DuSell and David Chiang. The Surprising Computational Power of Nondeterministic Stack RNNs. In *Proc. ICLR*. 2023.

Alexandra Butoi, **Brian DuSell**, Tim Vieira, Ryan Cotterell, and David Chiang. Algorithms for Weighted Pushdown Automata. In *Proc. EMNLP*. 2022.

Brian DuSell and David Chiang. Learning Hierarchical Structures with Differentiable Nondeterministic Stacks. In *Proc. ICLR*. 2022.
Spotlight paper (awarded to 5% of submitted papers).

Brian DuSell and David Chiang. Learning Context-Free Languages with Nondeterministic Stack RNNs. In *Proc. CoNLL*. 2020.
Acceptance rate: 23%.

Kenton Murray, **Brian DuSell**, and David Chiang. Efficiency through Auto-Sizing: Notre Dame NLP's Submission to the WNGT 2019 Efficiency Task. In *Proc. Workshop on Neural Generation and Translation*. 2019.

Invited Talks

- "Stack Attention: Improving the Ability of Transformers to Model Hierarchical Patterns" — Apr 2024
  Seminars on Formal Languages and Neural Networks
  Recording: https://www.youtube.com/watch?v=NrKLnGfEeeg
- "Stack Attention: Improving the Ability of Transformers to Model Hierarchical Patterns" — Feb 2024
  ZurichNLP Meetup
  URL: https://zurich-nlp.ch/event/zurichnlp-meetup-8/
- "Nondeterministic Stacks in Neural Networks" — Oct 2022
  Seminars on Formal Languages and Neural Networks
  Recording: https://www.youtube.com/watch?v=tkj6E9_n82U
- "Stack Nondeterminism in Neural Networks" — Nov 2021
  Notre Dame NL+
  URL: https://nlp.nd.edu/nlplus/2021/11/10/dusell.html
- "How to Install Literally Anything: A Practical Guide to Singularity." — May 2019
  XSEDE Campus Champions Tech Talk
  Recording: https://www.youtube.com/watch?v=D5pe4ewtDe8

Research Experience

Postdoc — Nov 2023 to present
ETH Zürich
Department of Computer Science
Rycolab
Supervisor: Ryan Cotterell

Postdoctoral Research Associate — Jun 2023
University of Notre Dame
Department of Computer Science and Engineering
Natural Language Processing Group
Supervisor: David Chiang

Research Assistant — Aug 2016 to May 2023
University of Notre Dame
Department of Computer Science and Engineering
Natural Language Processing Group
Supervisor: David Chiang

Applied Scientist Intern — Jun to Sep 2021
Amazon Web Services
Team: Amazon Translate
Manager: Georgiana Dinu
Mentors: Xing Niu and Anna Currey

Applied Scientist Intern — Jun to Sep 2020
Amazon Web Services
Team: Amazon Translate
Manager: Georgiana Dinu
Mentors: Xing Niu and Greg Hanneman

Research Assistant — Sep 2011 to May 2013
University of Notre Dame
Department of Computer Science and Engineering
Cooperative Computing Lab
Supervisor: Douglas Thain
Summary: Contributed to BioCompute, a distributed computing environment for bioinformatics accessible via a web interface.

Teaching Experience

Instructor of Record Spring 2022
CSE 30151: Theory of Computing
University of Notre Dame
Department of Computer Science and Engineering
Designed and led an in-person course in formal language and complexity theory for a class of over 80 undergraduate students. I received a median course instructor feedback score of 4, on a scale from 0 to 5, which is the unofficial threshold for excellent teaching used in making tenure decisions at Notre Dame.

Teaching Assistant Fall 2018
CSE 40657/60657: Natural Language Processing
University of Notre Dame
Department of Computer Science and Engineering
Instructor: David Chiang

Teaching Assistant Spring 2017
CSE 30151: Theory of Computing
University of Notre Dame
Department of Computer Science and Engineering
Instructor: David Chiang
Received the department's Outstanding Graduate TA award.

Teaching Assistant Fall 2016
CSE 30151: Theory of Computing
University of Notre Dame
Department of Computer Science and Engineering
Instructor: Peter Kogge
Received an Honorable Mention for the department's Outstanding Graduate TA award.

Teaching Assistant Fall 2012
CSE 30331: Data Structures
University of Notre Dame
Department of Computer Science and Engineering
Instructors: Paul Brenner and Raul Santelices

Tutor Spring and Fall 2012
University of Notre Dame
Academic Services for Student-Athletes
Tutored a student-athlete for the courses CSE 30151: Theory of Computing and CSE 40113: Design and Analysis of Algorithms.

Industry Experience

Software Developer May 2014 to Aug 2016
Oak Financial Software Corp
Developed Chapulín, a hybrid mobile and web application for executing international money transfers to Latin America. Implemented frontend and contributed to backend functionality, tools for analytics, and test automation. Technologies used: JavaScript, Cordova, Python, Node.js.

Member of Technical Staff Jul 2013 to May 2014
NetApp, Inc.
Performed quality assurance for data replication software included in the Data ONTAP storage OS. Technologies used: Perl, Jenkins.

Software Engineer, Intern May to Aug 2012
Wolverine Trading, LLC
Developed a high-performance Syslog daemon with a configurable message handling system and real-time GUI client. Achieved 300-fold improvement in message processing rate over previous tool. My code was deployed to 80 production servers within the next two months. Technologies used: C++, C#, WPF, XAML.

Programming Skills

Proficient in Python, PyTorch, Bash scripting, Docker, JavaScript/Node.js, frontend/backend web development.
Very familiar with C, C++, Java, PHP, SQL, MXNet.

Software

Stack Attention (https://github.com/bdusell/stack-attention)
PyTorch implementation of transformers with stack attention, including a full machine translation pipeline.

Nondeterministic Stack RNN (https://github.com/bdusell/nondeterministic-stack-rnn)
PyTorch implementation of my Nondeterministic Stack RNN model, as well as other Stack RNN models.

Semiring Einsum (https://bdusell.github.io/semiring-einsum/)
Efficient PyTorch implementation of einsum (a generalization of matrix multiplication) in multiple semirings.

QFunnel (https://github.com/bdusell/qfunnel)
Command-line tool for efficiently queueing large numbers of experiments on Notre Dame's research computing cluster.

dockerdev (https://github.com/bdusell/dockerdev)
Shell scripts for easily managing development environments in Docker containers.

rougescore (https://github.com/bdusell/rougescore)
Python implementation of the ROUGE metric.

Jishosen (jishosen.com)
A Japanese-English dictionary website based on freely available data.

pycfg (https://github.com/bdusell/pycfg)
Implementation of several context-free grammar algorithms, including Tomita's GLR parsing algorithm.

romaji-cpp (https://github.com/bdusell/romaji-cpp)
C++ library for transliterating Japanese phonetic characters to Latin letters.

jgreek (https://github.com/bdusell/jgreek)
Java library for dealing with orthography in ancient Greek.

xlator (https://github.com/bdusell/xlator)
Programmable machine translation system based on syntactic transfer.

Professional Service

- ACL 2024, Reviewer — Feb to Mar 2024
- ICML 2024, Reviewer — Feb to Apr 2024
- EMNLP 2023, Reviewer — Jul to Sep 2023
- NeurIPS 2023, Reviewer — May to Aug 2023
- ACL 2023, Reviewer — Feb to Apr 2023
- EMNLP 2022, Reviewer — Jun to Aug 2022
- EMNLP 2021, Reviewer — Jun to Aug 2021
- Organizing Committee for Midwest Speech and Language Days — May 2018

Leadership and Mentoring

- Mentor, Graduate Resilience Alliance at Notre Dame — Jan to Apr 2023
  Mentored a group of first-year Notre Dame graduate students.
- Graduate Orientation Ambassador, University of Notre Dame — 2017 to 2019
  Organized the fall orientation program for incoming graduate students.
- Graduate Representative, University of Notre Dame — 2019
  Recruited fellowship awardees for the Graduate School.
- CSE Peer Mentor, University of Notre Dame — 2018 to 2019
  Mentored first-year graduate students in the Computer Science and Engineering Department.

Awards

- Notebaert Premier Fellowship — 2016
  University of Notre Dame Graduate School
  A competitive fellowship funded through the largest single gift bestowed upon the university for graduate education.
- First Place, Chinese Speech Contest (2nd Year Chinese) — Apr 2019
  University of Notre Dame Department of East Asian Languages
- Outstanding Graduate Teaching Assistant — May 2018
  Department of Computer Science and Engineering
  University of Notre Dame
- Honorable Mention, Outstanding Graduate Teaching Assistant — May 2017
  Department of Computer Science and Engineering
  University of Notre Dame
- B.S. *magna cum laude*, University of Notre Dame — 2013
- Member, Tau Beta Pi Engineering Honor Society — 2012
- Member, Upsilon Pi Epsilon Computing Honor Society — 2012
- College of Engineering Dean's List — Fall 2010 to Spring 2013
  University of Notre Dame