# Satwik **Bhattamishra**

**Research Fellow, Microsoft Research**

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## Education

**May 2019** | **Birla Institute of Technology and Science Pilani** — **Pilani, India**
**Aug 2014** | B.E. (Hons.), Computer Science and Int. M.Sc. (Hons), Biological Science

## Experience

**Present** | **Microsoft Research** — **Bangalore, India**
**July 2019** | *Research Fellow | Advisors: Dr. Navin Goyal, Dr. Monojit Choudhury*
Working on analyzing the abilities of Transformers and LSTMs in modeling different behaviour and properties relevant for modeling language. Also working on building robust and interpretable methods for semantic parsing problems.

**Jan 2019** | *Research Intern | Advisors: Dr. Navin Goyal, Dr. Monojit Choudhury*
Worked on Semantic Parsing problems, particularly on NL-to-SQL problem. Explored the possibility of using graph networks to encode sentence as well as the table schema (context) to improve the model.

**Dec 2018** | **Machine and Language Learning Lab, IISc** — **Bangalore, India**
**June 2018** | *Research Intern (Senior Thesis) | Advisor: Prof. Partha P. Talukdar*
Worked on increasing diversity in paraphrase generation while retaining fidelity (quality). To incorporate diversity in the paraphrase generation framework, we introduced a submodular optimization-based approach for generating diverse meaning-preserving paraphrases.

**Aug 2017** | **Agency of Science Technology & Research** — **Singapore**
**May 2017** | *Summer Research Intern | Advisor: Dr. Anders Skanderup*
Worked on improving methods for learning lower-level representations of gene expression data. Work involved analysis of gene expression data and exploring various optimization and regularization methods of non-negative matrix factorization for better deconvolution and clustering of gene expression data.

**Aug 2016** | **Google Summer of Code 2016 [🌐]** — **Remote**
**May 2016** | *Student Developer | Mentors: Dr. Chris Mungall, Dr. Dan Keith*
Worked on the Phenopacket scraper project which extracts information from texts scraped from life sciences websites, analyzes them and generates a phenopacket based on the correct ontology references.

## Publications

**On the Ability and Limitations of Transformers to Recognize Formal Languages** [pdf] [code]
Satwik Bhattamishra, Kabir Ahuja, Navin Goyal
*2020 Conference on Empirical Methods in Natural Language Processing* [EMNLP'20]

**On the Practical Ability of Recurrent Neural Networks to Recognize Hierarchical Languages** [pdf] [code]
Satwik Bhattamishra, Kabir Ahuja, Navin Goyal
*2020 International Conference on Computational Linguistics* **[Best Short Paper Award]** [COLING'20]

**On the Computational Power of Transformers and Its Implication in Sequence Modeling** [pdf] [code]
Satwik Bhattamishra, Arkil Patel, Navin Goyal
*2020 Conference on Computational Natural Language Learning* [CoNLL'20]

**On the Ability of Self-Attention Networks to Recognize Counter Languages**
Satwik Bhattamishra, Kabir Ahuja, Navin Goyal
*5th Workshop on Representation Learning for NLP [Extended Abstract]* [Repl4NLP@ACL'20]

**Submodular Optimization-based Diverse Paraphrasing and its Effectiveness in Data Augmentation** [pdf] [code]
Ashutosh Kumar*, Satwik Bhattamishra*, Manik Bhandari, Partha Talukdar (* = Equal Contribution)
*2019 Conference of North American Chapter of the Association for Computational Linguistics* **[Oral]** [NAACL'19]

**Unsung Challenges of Building and Deploying Language Technologies for Low Resource Language Communities**
P. Joshi, C. Barnes, S. Santy, S. Khanuja, S. Shah, A. Srinivasan, Satwik Bhattamishra, S. Sitaram, M. Choudhury, K. Bali
*16th International Conference on Natural Language Processing* [ICON'19]

## Selected Research Projects

**Semantic Parsing Problems**

Advisors: Dr. Navin Goyal, Dr. Monojit Choudhury — Jan'19 - Present

- Currently working on building methods to solve Math Word Problems. Conducted various experiments to show that existing models rely on shallow heuristics to solve the problem. Work is in submission at **NAACL'21**.
- Exploring approaches to build more robust and interpretable model to solve math word problems.
- Previously explored graph neural networks based approaches for NL-to-SQL problem.

**Analysis of RNNs on Context-free languages**

Advisor: Dr. Navin Goyal — Jan'20 - Aug'20

- Worked on investigating the disparity between the results of previous works examining the ability of RNNs to model nested dependencies based on context-free languages and natural languages.
- Provided theoretical and empirical evidence to show that RNNs can recognize context-free languages with bounded depth which have closer connections to natural language. This led to a publication at **COLING'20**.

**Analysis of Transformers on Formal Languages**

Advisor: Dr. Navin Goyal — July'19 - Aug'20

- Initially worked on analyzing the computational power of complete Transformer architecture. Showed the components necessary for Turing-completeness of the network. This work led to a publication at **CoNLL'20**.
- Subsequently worked on analyzing the encoder-only version of Transformers. Showed that they can recognize certain counter languages but are limited in their ability to recognize regular languages. This work got accepted at **EMNLP'20**.

**Diverse Paraphrase Generation**

Advisor: Prof. Partha P. Talukdar — June'18 - Dec'18

- Explored the domain of diverse subset selection methods to build a method for diverse generation of paraphrases. Devised a method based on submodular optimization to generate diverse paraphrases while having constraints over the quality of the generated outputs.
- Also demonstrated that the paraphrases generated by our proposed method is more effective for data augmentation as compared to several other baselines. This work was accepted at **NAACL'19**.

## Selected Dev Projects

**LibNMF [Github]**

An easy to use python library with implementations of a set of tested optimization and regularization methods of NMF. Implemented Algorithms include graph regularized NMF, probabilistic NMF, a first-order primal-dual algorithm ...etc.

**pyDPP [Github]**

Developed a python package available in pip (Python packaging index) with modules for sampling from Determinantal Point Processes (DPP). Contains implementations of algorithms to sample from DPPs that encourage diversity in the selection of a subset of points from a grounded superset.

**Machine Learning Contests [Kaggle Profile]**

Kaggle Level : **Competitions Expert**. Global Rank: **5640**$^{th}$ / 150,000 active users. **Silver** medal in Kaggle Satander Value Prediction Challenge, Rank: Pvt. 185$^{th}$ | Pub. 189$^{th}$/4484. **Bronze** medal in Kaggle Instacart Competiton, Rank: Pvt. 195$^{th}$ | Pub. 74$^{th}$/2623. Qualified for **Zonal** Round in India Hacks Machine Learning Competition by Hackerearth, Rank: 29$^{th}$/860.

**Review Miner | Microsoft Code.Fun.Do Hackathon [Github]**

Developed a cross-platform application which analyses reviews from commercial websites and provides insights about products based on keyword extraction and sentiment analysis. **Winner** of Hackathon at BITS Pilani, Rank 1$^{st}$/90+.

## Services, Teaching and Leadership Roles

**Teaching Assistant** **Neural Networks and Fuzzy Logic** — Jan'18 - May'18

Responsible for designing and evaluating 3 programming tests and a course project. Conducted tutorials on python and numpy for over 70 students.

**Joint-Coordinator, DVM** **Oasis, BITS Pilani** — June'16 - Nov'16

Head of the department of over 40 skilled enthusiasts. Responsible for building websites, mobile apps, videos and registration systems. Our systems managed over 1000 participants over the course of four days.

**Reviewer** **EMNLP 2020, NAACL 2021**