Name	Naoki Yoshinaga	Laboratory	Institute of Industrial Science (IIS)	Research	Natural Language Processing

Computing Language Accurately and Efficiently

Languages enable us to think, record experiences, and communicate. Our laboratory studies efficient yet accurate **natural language processing (NLP)** to support various language activities and elucidate the human mind and society through countless words. The pursuit of fast, compact, yet accurate models seeks to uncover **the "shape" of language, as a natural phenomenon, that behaves both probabilistically and regularly** (**computational linguistics**), ultimately leading to the understanding and refinement of human intelligence.

`https://www.tkl.iis.u-tokyo.ac.jp/~ynaga/index.en.html`

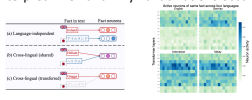
We believe research by students with diverse linguistic, cultural, and academic backgrounds elucidates the nature of language; **students are expected to set their research themes independently and voluntarily**. We welcome those who pursue novel research questions, unconstrained by standard or routine methodologies.

Natural Language Processing

Large language models (LLMs), trained on web-scale textual data with massive computational resources, can perform a wide range of tasks from natural language instructions and are increasingly taking over human intellectual tasks. However, they still suffer from hallucinations arising from modeling discrete processes such as knowledge recall and reasoning as continuous processes, as well as from the amplification of biases present in training data.

We study the internal mechanisms of LLMs from an engineering perspective to improve their performance and broaden their applications. Specifically, our work includes knowledge-based model analysis, compression, decomposition, and composition; test-time compute and retrieval-augmented generation; multimodal multilingual processing; and applications to social informatics.

Mechanistic Interpretability of LLMs
[EACL 2024, 2026, **EMNLP 2024**, **ACL 2025**]
- Study knowledge recall and symbolic reasoning
- Interpret when and why hallucinations occur

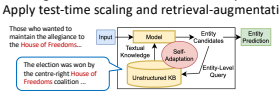


Elucidating LLM's intelligence

Multilingual Multimodal LLMs
[NAACL 2024 SRW, AACL 2025, **ACL 2025**]
- Multilingual benchmarks with vision and audio
- Generation using vision and speech LLMs

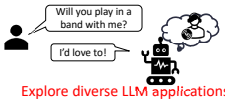
Understanding human perception

Making LMs More Efficient and Accurate
[EACL 2023, **ACL 2023**, CoNLL 2024, **SIGIR 2026**]
- Optimize vocabulary for *minimalist* LLMs
- Recast generation as search for efficiency
- Apply test-time scaling and retrieval-augmentation



Expand the applicability of LMs

More LLM Applications
[FEVER WS 2024, EACL 2026 SRW, **ACL 2026**]
- Simulate users faithfully (personalization)
- Detect unfaithful information propagation on SNS



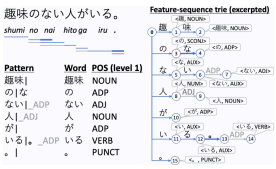
Explore diverse LLM applications

Computational Linguistics

Although large language models (LLMs) achieve accurate approximations of language behavior by optimizing massive continuous parameter spaces, they still face challenges in interpretability, and a mathematical understanding of language as a natural phenomenon remains underdeveloped. Moreover, for symbolic processing that requires systematic generalization, such as knowledge recall and arithmetic or other forms of strict symbolic reasoning, there are fundamental limits to performance improvements from simply scaling models due to data and computational constraints.

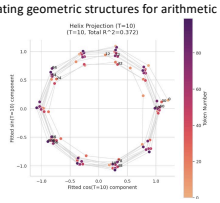
We study how LLMs realize symbolic processing from a scientific perspective and aim to improve their structural capabilities. We leverage algorithms and data structures in computer science to push the limits of symbolic processing and design learning strategies that induce such mechanisms. Currently, we aim to identify unknown structural knowledge within LLMs to extend human intelligence.

Empirical Symbol Processing
- Recasting ML models as symbolic processing



Breaking a 20-year-old speed limit in core analysis
(1 million sentences/s on M2 MacBook Air)

Understanding symbolic processing in LLMs
- Elucidating geometric structures for arithmetic



Rationalist mathematical modeling of language

Our laboratory works closely with the Toyoda and Goda laboratories, sharing resources (data, computing facilities, and student rooms). Lab members **can pursue interdisciplinary research beyond NLP**, including social informatics using full microblog data, and receive feedback from diverse perspectives.

Feel free to contact me (`ynaga@iis.u-tokyo.ac.jp`) for any questions or visit requests.