

Introduction

Natural Language Processing and Large Language Models

Jan 13, 2026

Outline

1 Introduction

2 Grading

3 Comments

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Course logistics

- Instructor: Dr. Hakyung Sung

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Learning goals

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Natural Language Processing (NLP) &
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What is NLP?

- “When scientists consider artificial intelligence, they mostly think of modeling or recreating the capabilities of an individual human brain... The power of language is fundamental to human societal intelligence, and language will retain an important role in a future world in which human abilities are augmented by artificial intelligence (AI) tools ... For these reasons, the field of natural language processing (NLP) emerged in tandem with the earliest development in AI.” (Manning, 2022, pp. 127-128)

Sourced from: Manning, C. D. (2022). Human language understanding & reasoning. Daedalus, 151(2), 127-138.

Learning goals

What is NLP?

Natural language processing (NLP) is a subfield of computer science and **artificial intelligence (AI)** that uses **machine learning** to enable computers to understand and communicate with human language.

Sourced from: <https://www.ibm.com/think/topics/natural-language-processing>

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 - leverage NLP to automatically analyze large-scale text data
 - can extract patterns, meanings, and structures that are difficult to capture manually
 - want to understand human minds; leverage nlp-techniques to generate and explore cogsi hypotheses

Learning goals

What is LLM?

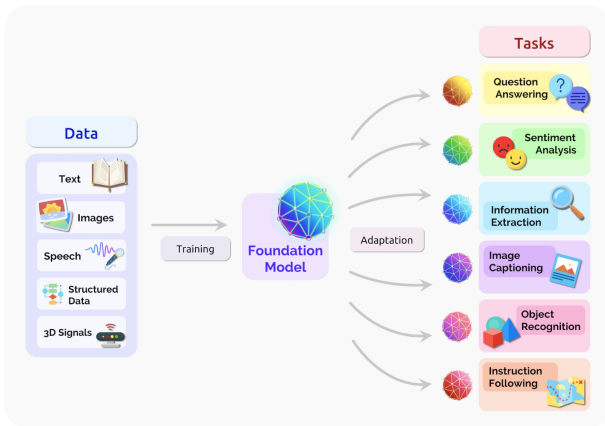
Learning goals

What is LLM?

- “A *foundation model* is any model that is trained on broad data (generally using self-supervision at scale) that can be adapted (e.g., fine-tuned) to a wide range of downstream tasks; current examples include BERT, GPT-3... We choose the term *foundation models* to capture the unfinished yet important status of these models... Existing terms (e.g., pretrained , self-supervised) partially capture the technical dimension of these models, but fail to capture the **significance of the paradigm shift in an accessible manner for those beyond machine learning**” (Bommasani et al., 2021, p. 3)

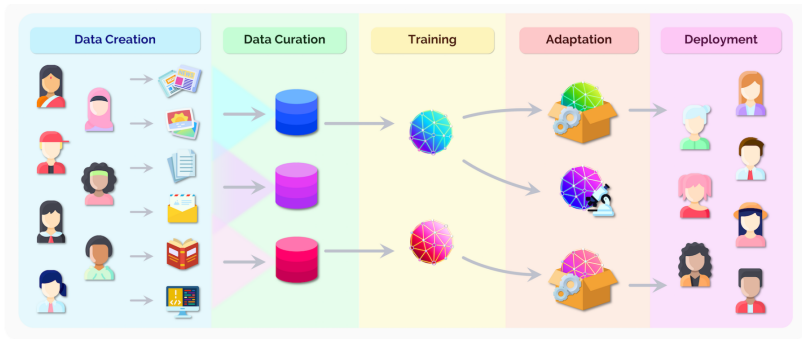
Sourced from: Bommasani, R. et al. (2021). On the opportunities and risks of foundation models. [arXiv:2108.07258](https://arxiv.org/abs/2108.07258).  Rochester Institute of Technology

Learning goals



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Learning goals

3. Applications



Healthcare
3.1



Law
3.2



Education
3.3

4. Technology



Modeling
4.1



Training
4.2



Adaptation
4.3



Evaluation
4.4



Systems
4.5



Data
4.6



Security
4.7



Robustness
4.8



AI Safety
& Alignment
4.9



Theory
4.10



Interpretability
4.11

Sourced from: Bommasani, R. et al. (2021).

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3. Applications



Healthcare

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Education

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Second language
learning/education



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- Explain core NLP techniques and recent advancements (mostly the changes of technology)

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- Gain hands-on experience applying basic NLP tools (including LLMs) and explore their use within domains of individual interest (tools for applications)
- Report on how they collaborated in *teams* to design and develop customized NLP solutions leveraged LLMs for real-world contexts (applications)

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Grading components: Lab

[a × b] a = number; b = points

- Lab [6 × 6]: 36%

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- 8 labs in total (on Thursday)

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- 8 labs in total (on Thursday)
- *Lab 1 and the lowest-scoring lab assignment will be dropped.

■ on the Syllabus

Week	Date	Topic	Paper assigned	Due (Friday, 11:59 pm)
1	1/13	Introduction, Word vectors		
	1/15	Lab1 Python basics		Lab 1
2	1/20	Word vectors	[1] Mikolov et al. (2013) [2] Pennington et al. (2014)	
	1/22	Lab2 Word vectors	[3] Levy et al. (2015)	Lab 2
3	1/27	Neural network	[4] Collobert et al. (2011) §3	
	1/29	Lab 3 PyTorch, Project guide		Lab 3
4	2/3	Dependency parsing	[5] Chen & Manning (2014)	
	2/5	Lab 4 Dependency parsing	[6] de Marneffe et al. (2021)	Identify team members
5	2/10	RNNs, LSTMs	[7] Sak et al. (2014)	
	2/12	Lab 5 Sentiment analysis	[8] Du et al. (2024)	Lab 4
6	2/17	Self-attention & Transformer	[9] Vaswani et al. (2017)	
	2/19	Lab 6 Hugging face	[10] Huang et al. (2018)	Lab 5
7	2/24	Pre-training	[11] Devlin (2019)	
	2/26	Lab 7 Ollama	[12] Smith (2020)	Lab 6
8	3/3	Project group meeting		
	3/5	Project proposal presentation		Lab 7
9	3/10	Spring break (No class)		
	3/12			Project proposal
10	3/17	Post-training	[13] Chung et al. (2022) [14] Wang et al. (2022)	
	3/19	Lab 8 Constructed language	[15] Taguchi & Sproat (2025)	
11	3/24	LLMs in 2025 (async)		
	3/26	Efficient Adaptation	[16] Brown et al. (2020) [17] Hu et al. (2021)	Lab 8

Grading components: Paper presentation

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- Paper presentations [1 × 6] 6%

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12	3/31	Background research presentation 1	
	4/2	Background research presentation 2	
13	4/7	Benchmarking and evaluation	[18] Hendrycks et al. (2021) [19] Liang et al. (2023) §2-3
	4/9	Agent, Tool use, RAG	[20] Yao et al. (2023) [21] Shick et al. (2023)
14	4/14	Reasoning 1	[22] Wei et al. (2023) [23] Wang et al. (2023)
	4/16	Reasoning 2	[24] Lightman et al. (2023) [25] Snell et al. (2024)

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- Guidelines for preparing the presentation:
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- At the end of today's class, you will have time to choose the paper you want to present.
- Presentations will begin next Tuesday.
Tip: The first two papers are the easiest; the papers become more complex as they get more recent.

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Project 48%

- Identify team members [1×2] 2%

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- Final presentation [1×12] 12%

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- Final paper [1×15] 15%

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- Ideal goals: Submit to conference/workshop (e.g., EMNLP mid May)

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- Completing ad-hoc events that the instructor announces in class 1%

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- Active participation in final presentation 3%

Any questions?

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- **Will be strict about this policy**

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- Please acknowledge and document how AI tools were used in your work (including individual exercises).

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- Early morning classes can be challenging (especially in this weather) but being present and engaged will help.
- If weather conditions are severe, I will notify you by 7:00 am on the day of class regarding cancellation or a switch to Zoom.

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- Check the syllabus while answering to the mini survey (which is attached to the homepage or MyCourses).

Preview: On Thursday

- We will have our first lab session on Thursday to brush up Python skills. Please bring your laptop. (You will need your laptop for every lab session.)

Thank you and see you on Thursday!