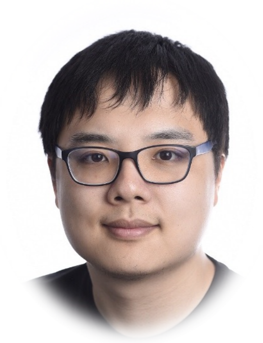
WSDM 2023 Tutorial

Knowledge-Augmented Methods for Natural Language Processing

Chenguang Zhu[1], Yichong Xu[1], Xiang Ren[2], Bill Yuchen Lin[3], Meng Jiang[4], Wenhao Yu[4]

[1]Microsoft Cognitive Services Research [2]University of Southern California [3]Allen Institute for AI [4] University of Notre Dame

Presenters



Chenguang Zhu

Principal Research Manager

Microsoft Cognitive Services Research

Yichong Xu

Senior Researcher

Microsoft Cognitive Services Research

Xiang Ren

Assistant Professor

Dept. of Computer Science

University of Southern California

Bill Yuchen Lin

Young Investigator

Allen Institute for AI

Meng Jiang

Assistant Professor

Dept. of Computer Science and Engineering

University of Notre Dame

Wenhao Yu

Ph.D. candidate

Dept. of Computer Science and Engineering

University of Notre Dame

Disclaimer: This tutorial is our own opinions

- Not Microsoft’s, USC’s, Allen Institute of AI’s or Univ. of Notre Dame’s
- To access mentioned models + datasets, please refer to corresponding licensing information
- We’re not promoting the use of any particular model and/or datasets
- There are slides / figures borrowed from respective papers
- This tutorial is by no means exhaustive: we’ve tried our best to include relevant materials

How to access tutorial materials

- Detailed information about our tutorial can be found at: https://www.wsdm-conference.org/2023/program/tutorials
- Talk slides are at: https://github.com/zcgzcgzcg1/WSDM2023_Knowledge_NLP_Tutorial/

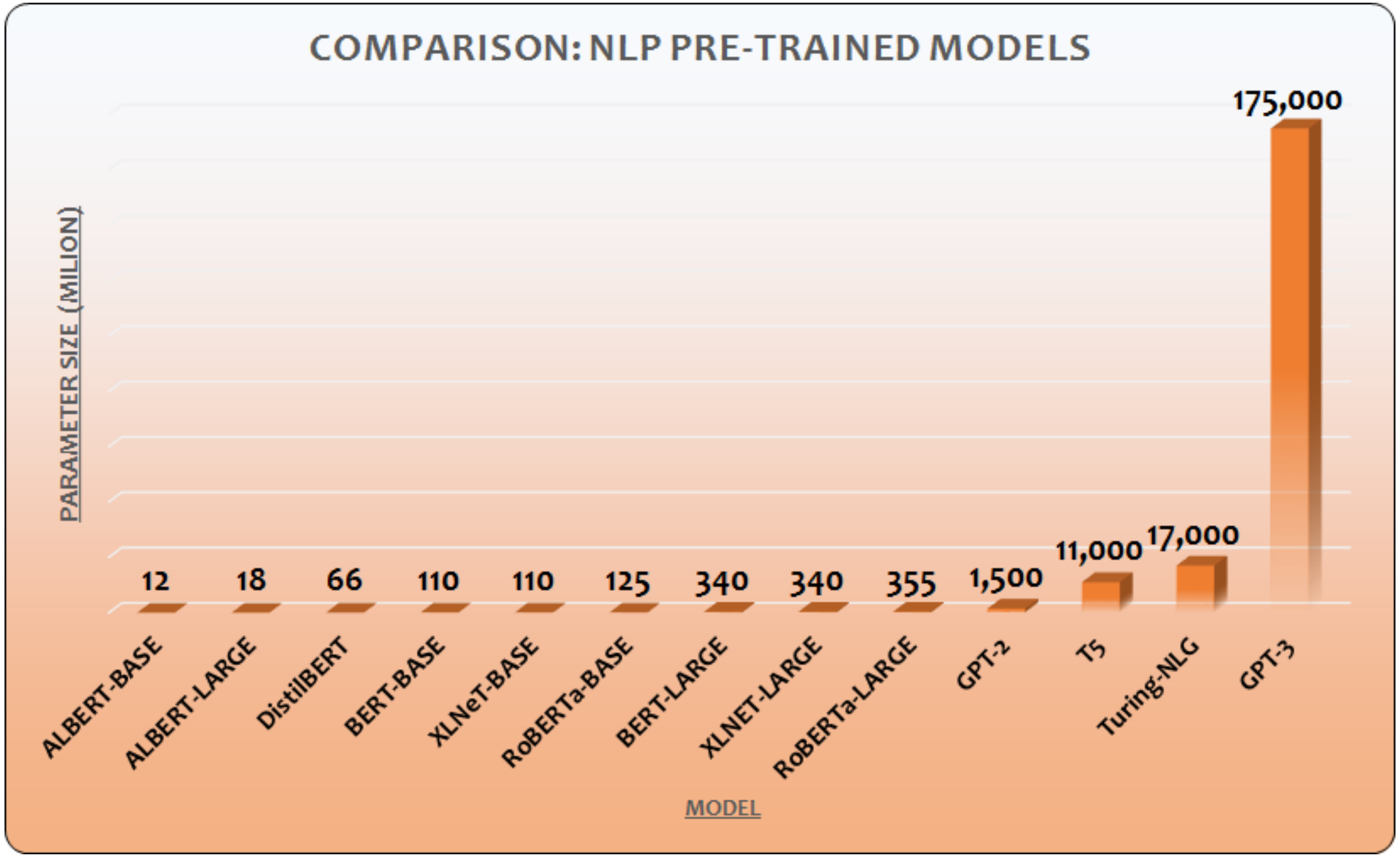
What is this tutorial about?

- **How to fuse knowledge and common sense into natural language processing**
- Knowledge in natural language understanding (NLU)
  - Natural language inference, sentence classification, sequence labeling, etc.
- Knowledge in natural language generation (NLG)
  - Text summarization, dialogue response generation, story generation, etc.
- Commonsense reasoning
  - Commonsense Q&A, commonsense generation

Schedule

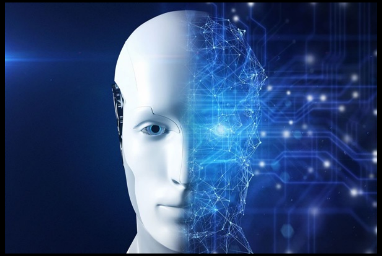
Local time (GMT+8)	Content	Presenter
08:30-08:45	Motivation and Introduction of Knowledge in NLP	Chenguang Zhu
08:45-09:35	Knowledge in Natural Language Understanding	Yichong Xu
09:35-10:00	Knowledge in Natural Language Generation	Wenhao Yu / Meng Jiang
10:00-10:30	Coffee Break	
10:30-10:55	Knowledge in Natural Language Generation	Wenhao Yu / Meng Jiang
10:55-11:45	Commonsense Knowledge and Reasoning for NLP	Yuchen Lin / Xiang Ren
11:45-12:00	Summary and Future Direction	Meng Jiang / Xiang Ren

Where is NLP heading?



- Large, Huge, Gigantic Language models
- Training cost affordable only by few large companies
- Even fine-tuning is impossible for a majority of researchers and practitioners
- Does model size solve everything?
  - *Unfortunately, no*
- Then why are we doing it?

Diagram from https://medium.com/analytics-vidhya/openai-gpt-3-language-models-are-few-shot-learners-82531b3d3122



Integration of External Knowledge

Knowledge in NLP

- A language model (LM) learns **how to express**

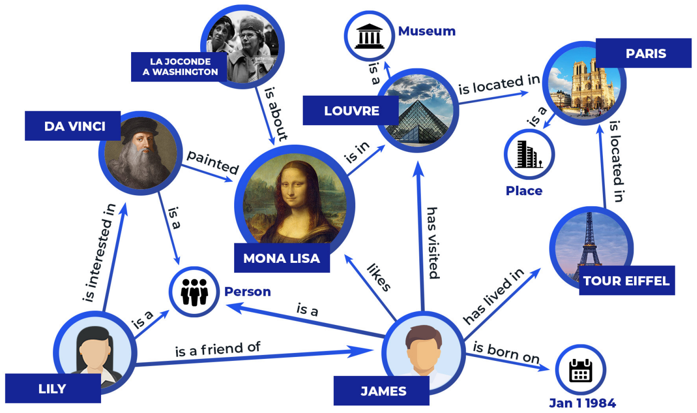
  I go school to to want. ✗

  I want to go to school. ✓

- Knowledge indicates **what to express**

  Q: Where is the painting **Mona Lisa**?

  A: It is in **Louvre, Paris**.



Knowledge sources

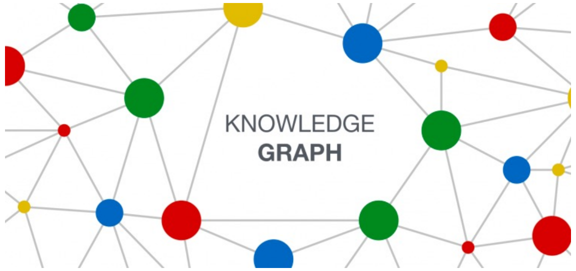
Structured

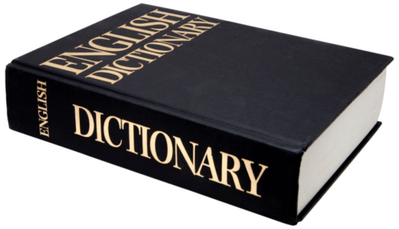
- **Knowledge graph**: A meta-representation of knowledge, common sense, entities, relations
- **Dictionary**: explanation of words and phrases

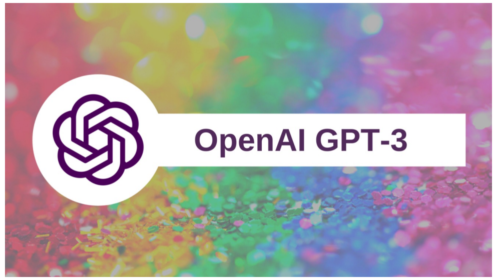
Unstructured

- **Text data**: Knowledge from data without a predefined format, e.g., documents, emails
- **Large language models**, e.g., ChatGPT

Knowledge is any external information absent from the input but helpful for generating the output







Integrate Knowledge into LM

- Step 1: **Ground** language into related knowledge
- Step 2: **Represent** knowledge
- Step 3: **Fuse** knowledge representation into language model

Integrate Knowledge into LM

- **Ground** language into related knowledge
  - String matching, NER, Entity linking, information retrieval
  - Identify concepts and relations in the knowledge source

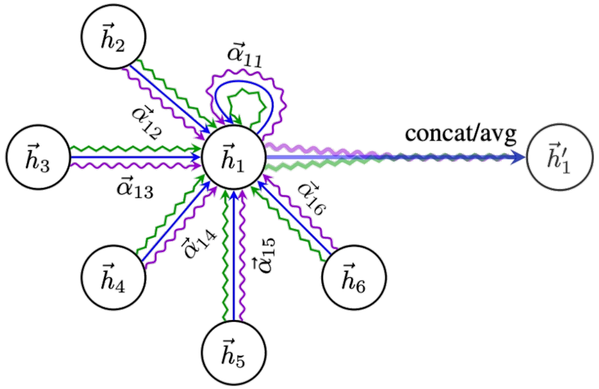
The **pen** is on the **desk**.

Integrate Knowledge into LM

- **Represent** knowledge
  - Concept names
  - Description of concepts
  - Graph embeddings

Desk

Desk: A table, frame, or case, now usually with a flat top, for writers and readers. It often has a drawer or repository underneath.



Integrate Knowledge into LM

- **Fuse** knowledge representation into language model
  - Concatenate concept names/descriptions into input

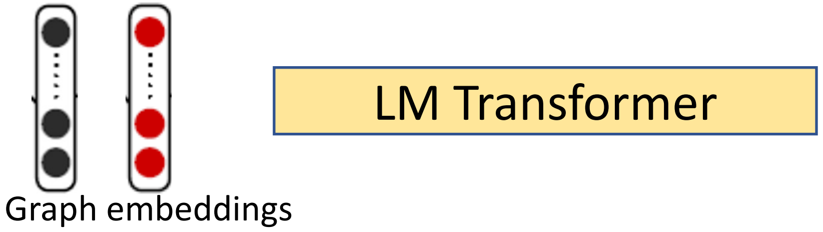
The pen is on the desk. [SEP] desk: a table, …

  - Append/add concept embeddings into input embeddings

The pen is on the desk.

  - Attention

Graph embedding of pen
Graph embedding of desk


LM Transformer
Graph embeddings