WSDM 2023 Tutorial

Knowledge-Augmented Methods for Natural Language Processing

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Disclaimer: This tutorial is our own opinions

- Not Microsoft's, USC'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/

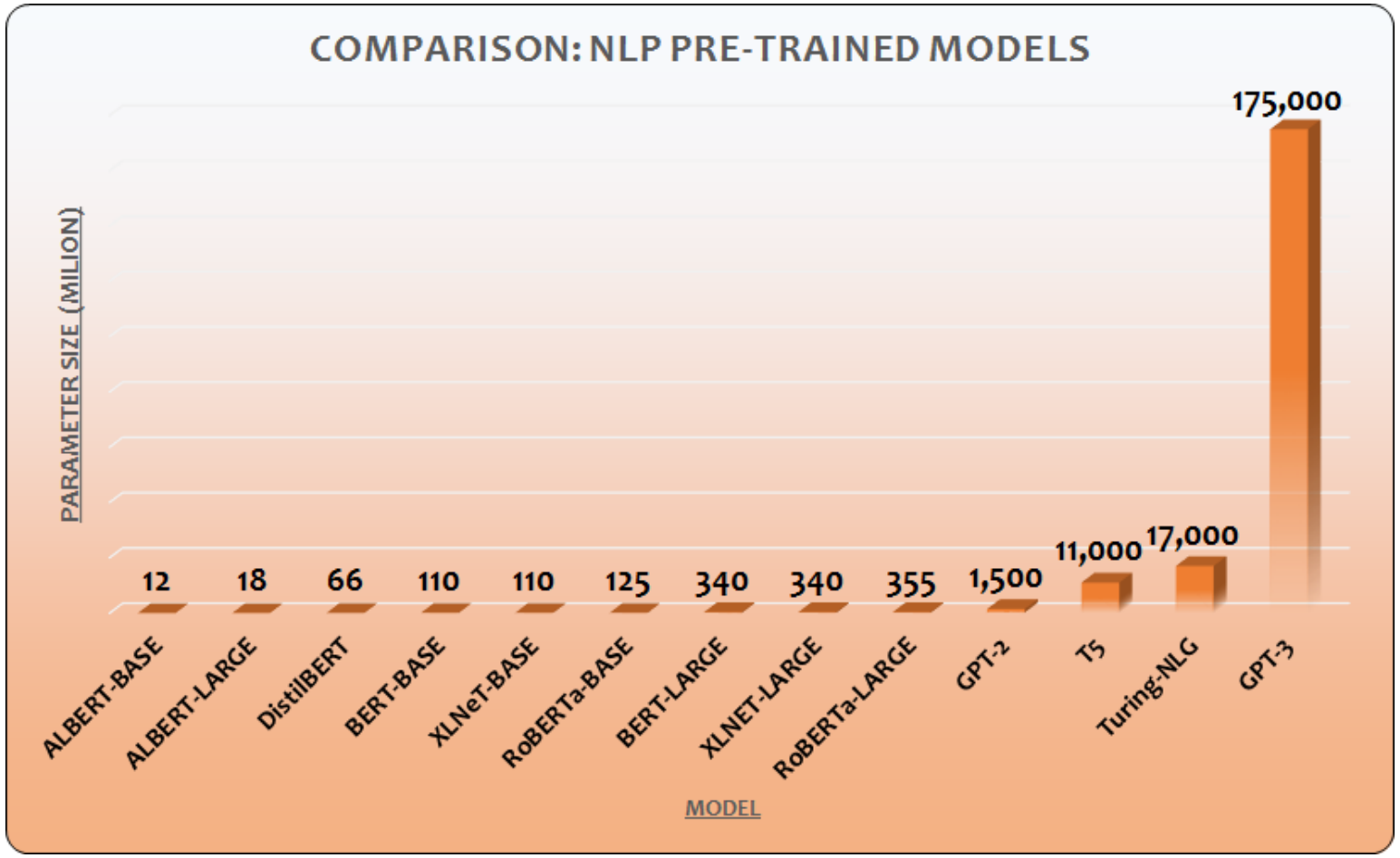
What is this tutorial about?

- **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
09:30-09:45	Motivation and Introduction of Knowledge in NLP	Chenguang Zhu
09:45-10:35	Knowledge in Natural Language Understanding	Yichong Xu
10:35-11:00	Knowledge in Natural Language Generation	Wenhao Yu / Meng Jiang
11:00-11:30	Coffee Break	
11:30-11:55	Knowledge in Natural Language Generation	Wenhao Yu / Meng Jiang
11:55-12:45	Commonsense Knowledge and Reasoning for NLP	Yuchen Lin / Xiang Ren
12:45-13:00	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**

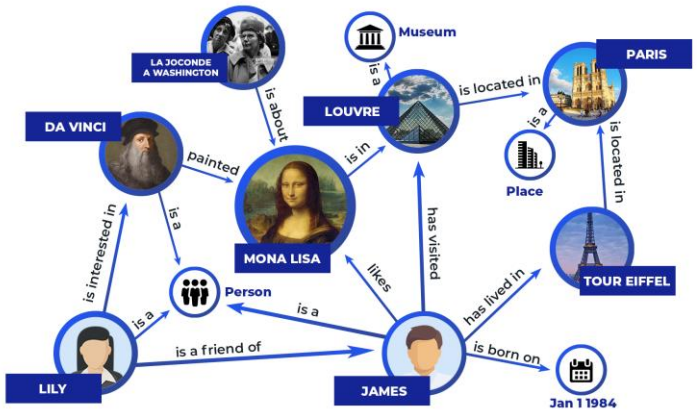
  I go school to to want. ✗

  I want to go to school. ✓

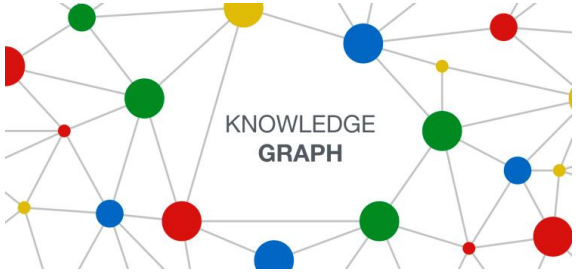
- Knowledge indicates **what to express**

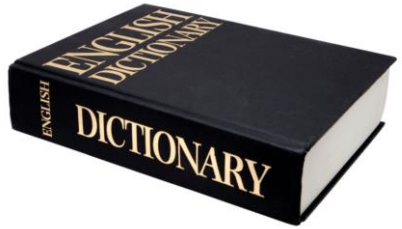
  Q: Where is the painting **Mona Lisa**?

  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., GPT-3

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

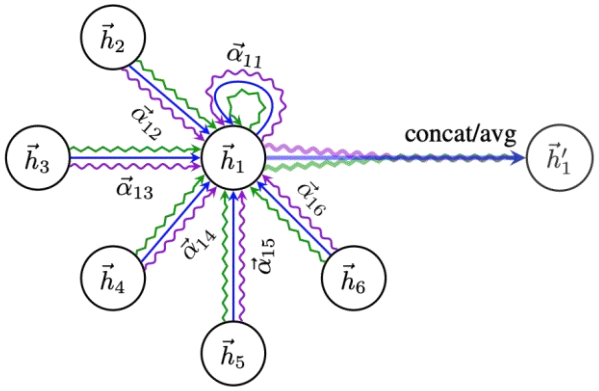
- **Represent** knowledge
  - Concept names

Desk

  - Description of concepts

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

  - Graph embeddings



Integrate Knowledge into LM

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

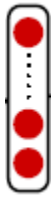
The pen is on the desk. [SEP] desk: a table, …

  - Append/add concept embeddings into input embeddings

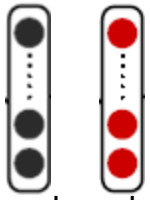
The pen is on the desk.

  - Attention

Graph embedding of pen



Graph embedding of desk



Graph embeddings

LM Transformer