Evaluating Adapter-based Knowledge-enhanced Language Models in the Biomedical Domain

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Outline

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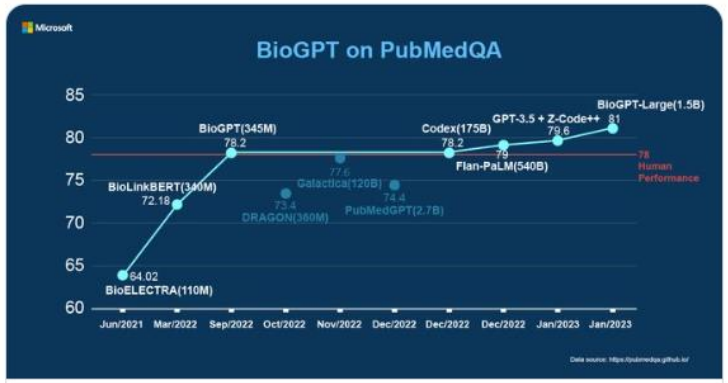
Motivation

Microsoft Research
@MSFTResearch

BioGPT, a domain-specific generative model pre-trained on large-scale biomedical literature, has achieved human parity, outperformed other general and scientific LLMs, and could empower biologists in various scenarios of scientific discovery. Learn more: msft.it/6014eAnLq



oup.com
BioGPT: pre-trained transformer for biomed text generation & mining

Original Investigation

April 28, 2023

Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum

John W. Ayers, PhD, MA[1,2]; Adam Poliak, PhD[3]; Mark Dredze, PhD[4]; et al

Key Points

Question Can an artificial intelligence chatbot assistant, provide responses to patient questions that are of comparable quality and empathy to those written by physicians?

Findings In this cross-sectional study of 195 randomly drawn patient questions from a social media forum, a team of licensed health care professionals compared physician's and chatbot's responses to patient's questions asked publicly on a public social media forum. The chatbot responses were preferred over physician responses and rated significantly higher for both quality and empathy.

Meaning These results suggest that artificial intelligence assistants may be able to aid in drafting responses to patient questions.

MIT News
ON CAMPUS AND AROUND THE WORLD

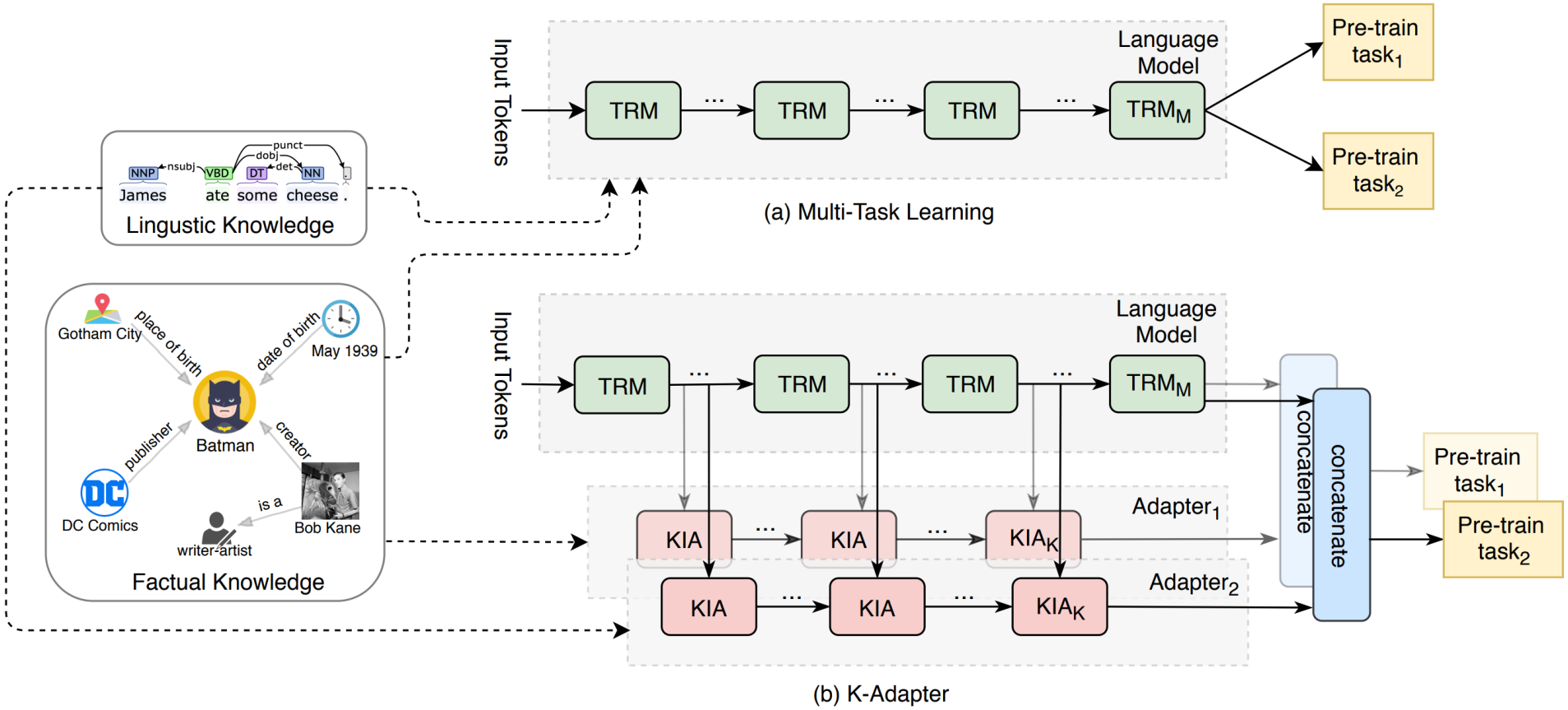
Large language models help decipher clinical notes

Researchers used a powerful deep-learning model to extract important data from electronic health records that could assist with personalized medicine.

Rachel Gordon | MIT CSAIL
December 1, 2022

[Mi23] Microsoft: *BioGPT: generative pre-trained transformer for biomedical text generation and mining*
[Go22] Gordon, R.: *Large language models help decipher clinical notes*
[Ay23] Ayers, J., Poliak, A., Dredze, M., et al.: *Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum*

Background: What are KELMs?

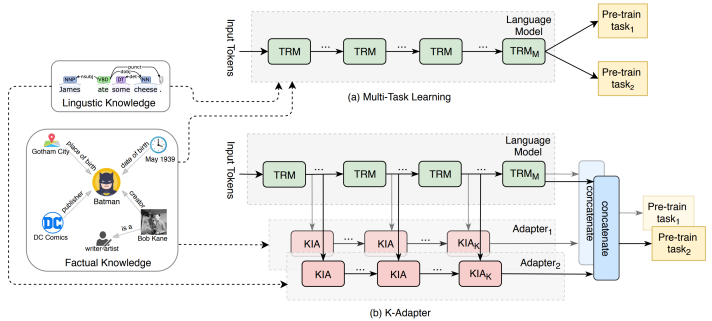


[Wa21a] Wang, R., Tang, D., Duan, N., Wei, Z., Huang, X., Ji, J., Cao, G., Jiang, D., Zhou, M.: K-ADAPTER: Infusing Knowledge into Pre-Trained Models with Adapters

Background: What are KELMs?

Medical natural language inference task (NLI):

- **Patient Premise**: No history of blood clots or DVTs, has never had chest pain prior to one week ago
- **Hypothesis**: Patient has angina
- **Correct Classification:** Entailment



[Lu21] Lu, Q., Dou, D., Nguyen, T.H.: Parameter-Efficient Domain Knowledge Integration from Multiple Sources for Biomedical Pre-trained Language Models

Background: What are KELMs?

Relevance

- Active research area
- LMs lack knowledge awareness
- Superior performance over vanilla LMs

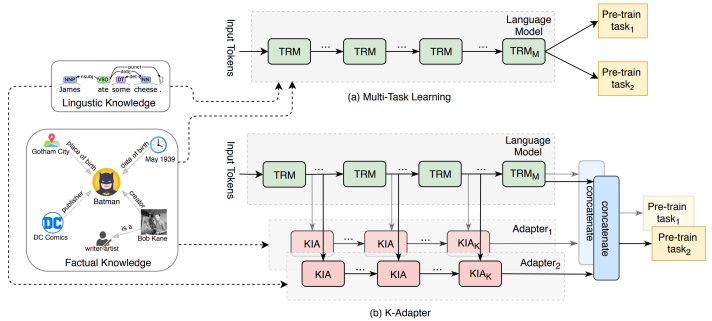
Approach Variety

- Input Focused
- Architecture Focused
- Output Focused

Shortcomings

- Long Training Periods
- Catastrophic forgetting when several knowledge sources are injected

→ Lightweight “Adapters” retain original parameters and enable quick resource efficient knowledge injection



[We21a] Wei, X., Wang, S., Zhang, D., Bhatia, P., Arnold A.: Knowledge Enhanced Pretrained Language Models: A Compreshensive Survey

[Wa21a] Wang, R., Tang, D., Duan, N., Wei, Z., Huang, X., Ji, J., Cao, G., Jiang, D., Zhou, M.: K-ADAPTER: Infusing Knowledge into Pre-Trained Models with Adapters

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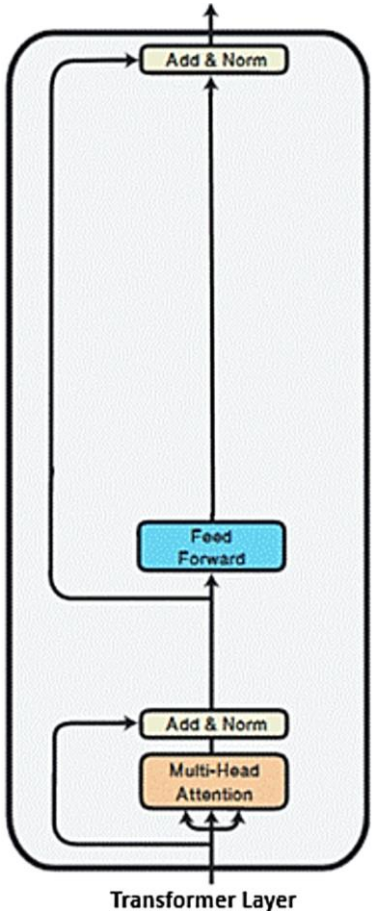

[Pf20a] Pfeiffer, J., Rücklé, A., Poth, C., Kamath, A., Vulić, I., Ruder, S., Cho, K., Gurevych, I.: AdapterHub: A Framework for Adapting Transformers

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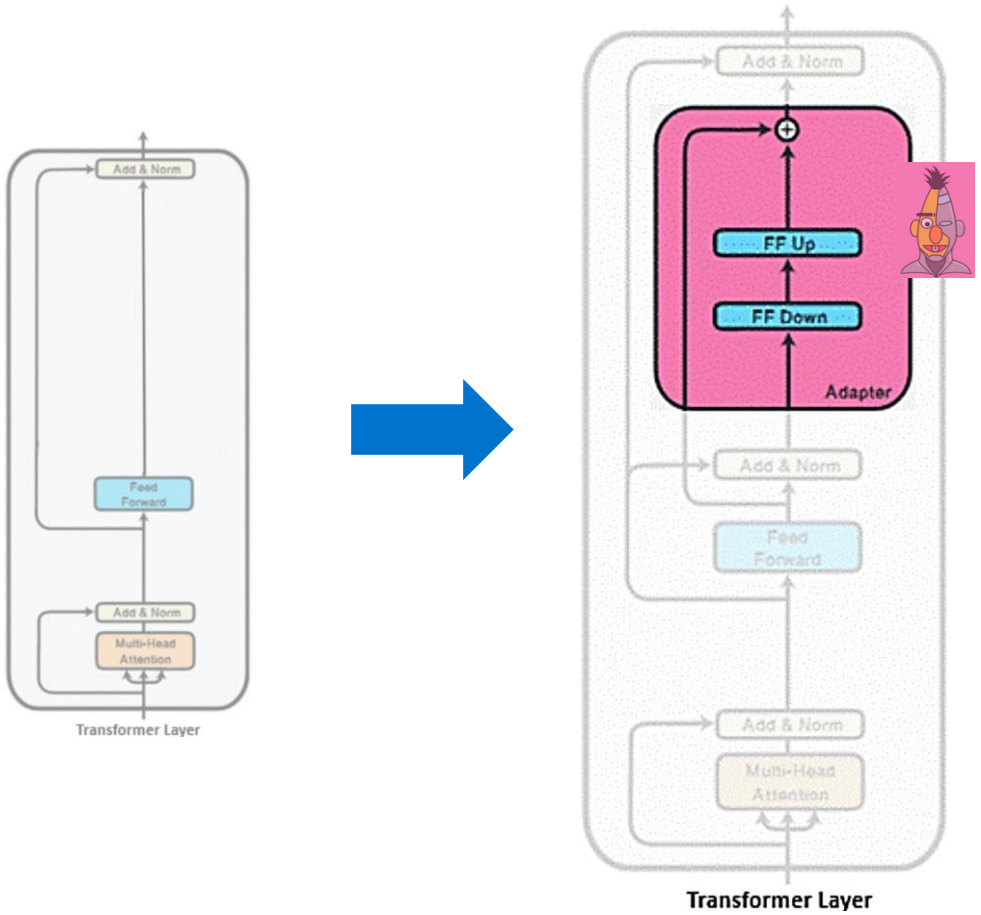

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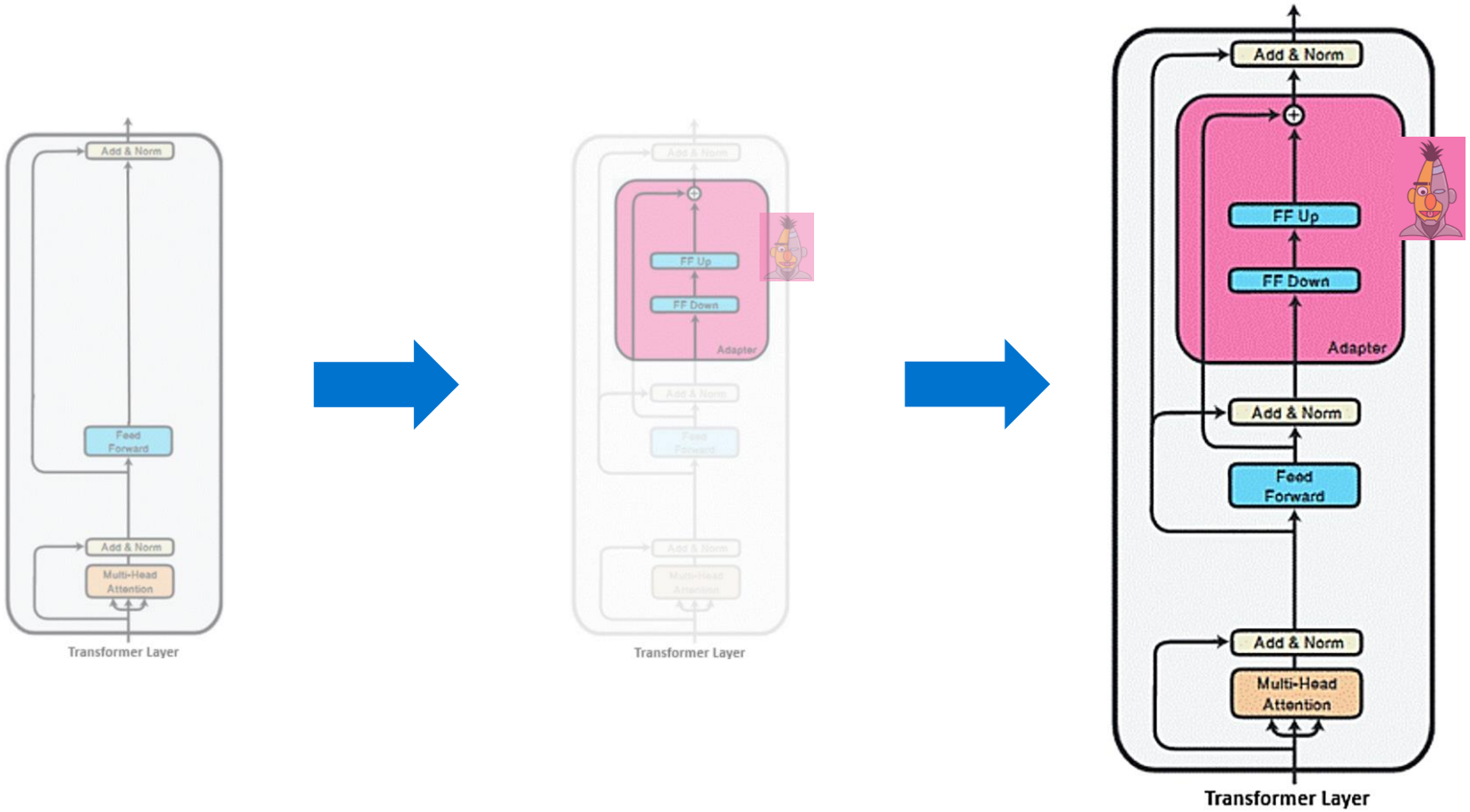

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Background: BLURB

Dataset	Task	Train	Dev	Test	EvaluationMetrics
BC5-chem	NER	5203	5347	5385	F1entity-level
BC5-disease	NER	4182	4244	4424	F1entity-level
NCBI-disease	NER	5134	787	960	F1entity-level
BC2GM	NER	15197	3061	6325	F1entity-level
JNLPBA	NER	46750	4551	8662	F1entity-level
EBMPICO	PICO	339167	85321	16364	MacroF1word-level
ChemProt	RelationExtraction	18035	11268	15745	MicroF1
DDI	RelationExtraction	25296	2496	5716	MicroF1
GAD	RelationExtraction	4261	535	534	MicroF1
BIOSSES	SentenceSimilarity	64	16	20	Pearson
HoC	DocumentClassification	1295	186	371	MicroF1
PubMedQA	QuestionAnswering	450	50	500	Accuracy
BioASQ	QuestionAnswering	670	75	140	Accuracy

BLURB

Biomedical **L**anguage **U**nderstanding and **R**easoning **B**enchmark

[Gu20] Gu, Y., Tinn, R., Cheng, H., Lucas, M., Usuyama, N., et al.: AdapterHub: Domain-Specific Language Model Pretraining for Biomedical Natural Language Processing

Research Concept: Research Questions

Can adapter-based approaches outperform other knowledge injection methods in downstream tasks (Blurb, claim verification)?

- Literature review
- Thesis experiments

How does the performance of KELMs in closed domains compare to open domain performance?

- Literature review
- Thesis experiments

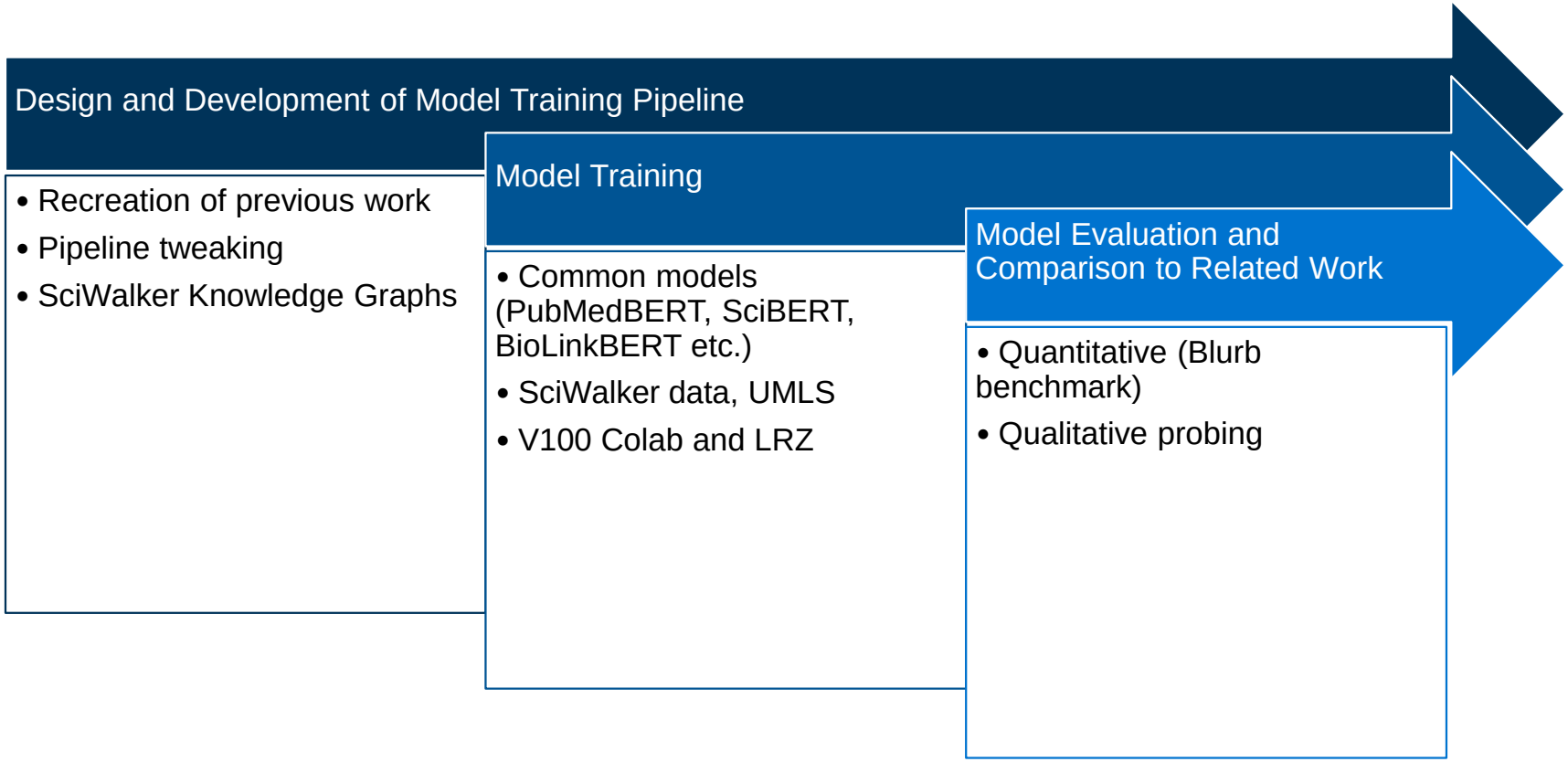
How do models trained on a private ontology (e.g., OntoChem) compare to models trained on public ontologies (e.g., UMLS)?

- Thesis experiments
- SciWalker

Is there interest in the results of this thesis amongst medical professionals and can they make use of biomedical KELMs?

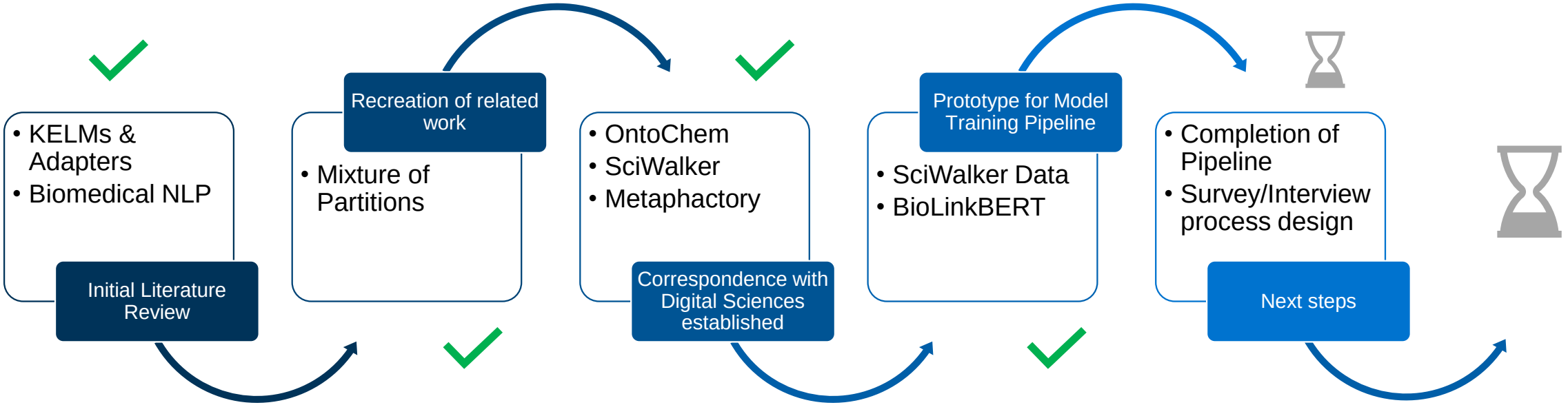
- Survey and Interviews
- Mini-workshops on knowledge enhancement with adapters

Research Concept: Experiment Methodology



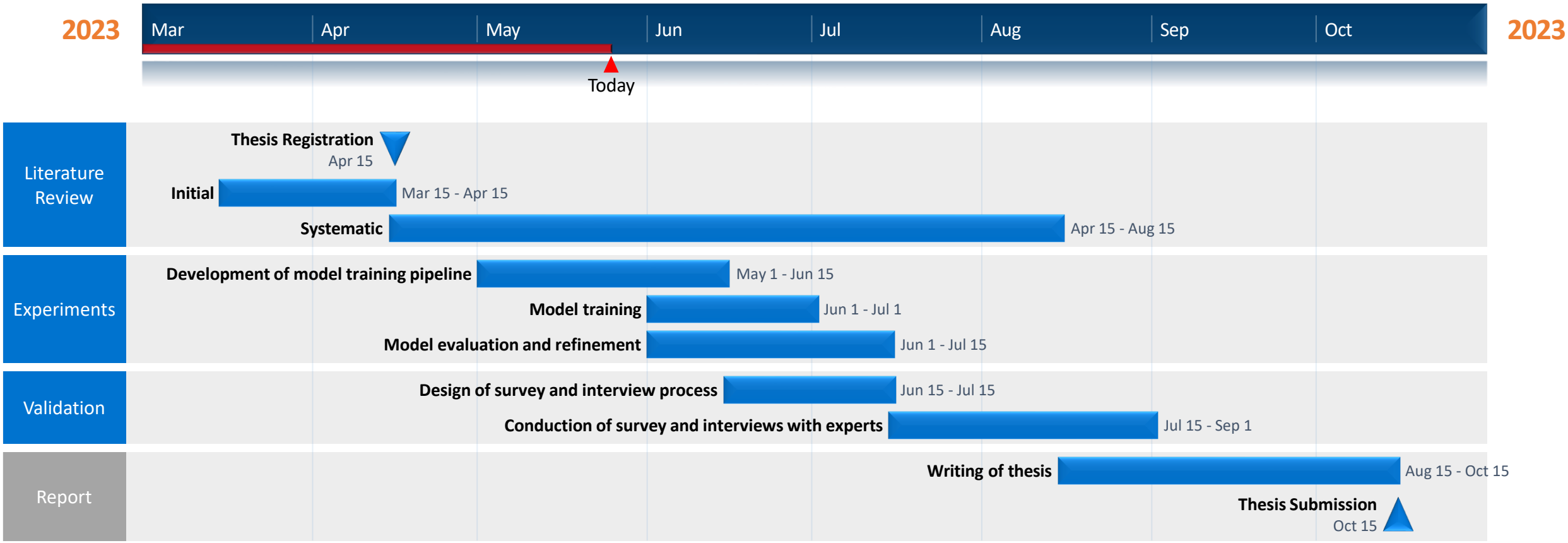
- Survey and interviews with experts about relevance of results
- Mini-workshop on knowledge enhancement with adapters

Progress

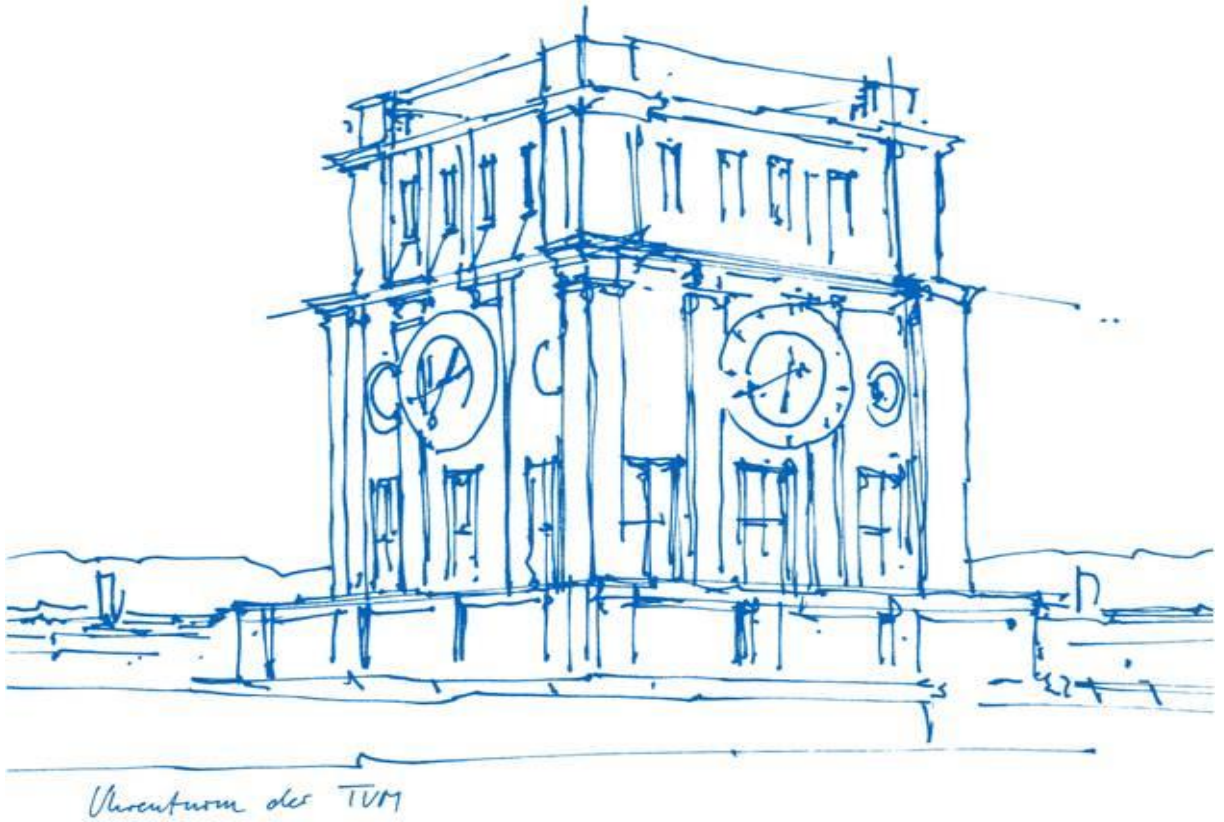


[Gu20] Meng, Z., Liu, F., Clark, T.H., Shareghi, E., Collier, N.: Mixture-of-Partitions: Infusing Large Biomedical Knowledge Graphs into BERT

Timeline



Thanks!



B.Sc.

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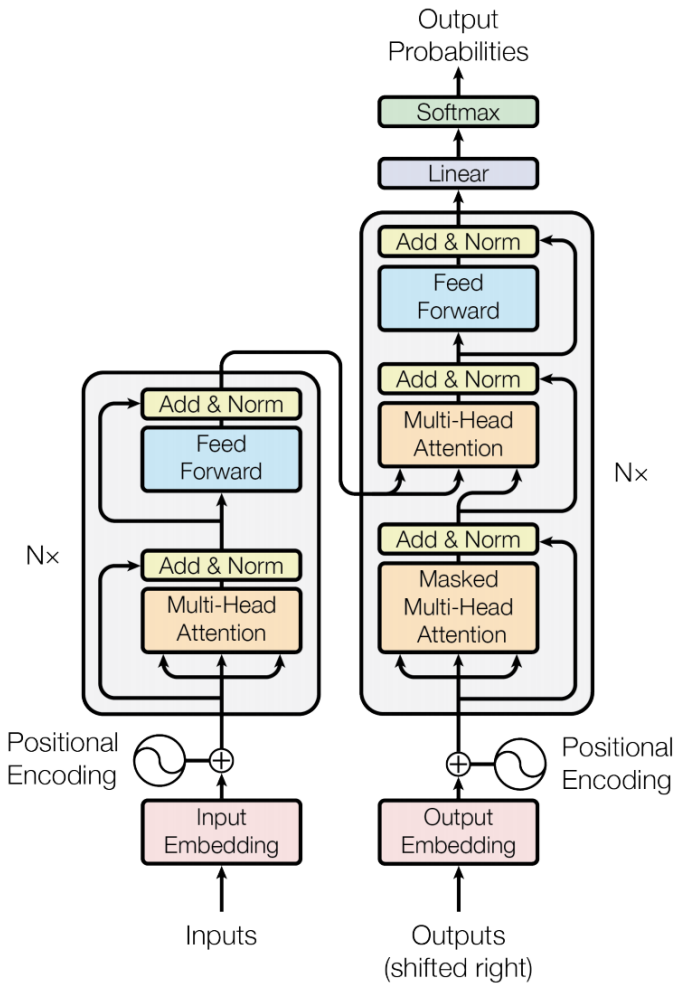
Appendix A: PubMedQA

Question:
Do preoperative statins reduce atrial fibrillation after coronary artery bypass grafting?
Context:
(Objective) Recent studies have demonstrated that statins have pleiotropic effects, including anti-inflammatory effects and atrial fibrillation (AF) preventive effects [...]
(Methods) 221 patients underwent CABG in our hospital from 2004 to 2007. 14 patients with preoperative AF and 4 patients with concomitant valve surgery [...]
(Results) The overall incidence of postoperative AF was 26%. ***Postoperative AF was significantly lower in the Statin group compared with the Non-statin group (16% versus 33%, p=0.005).*** Multivariate analysis demonstrated that independent predictors of AF [...]
Long Answer:
(Conclusion) Our study indicated that preoperative statin therapy seems to reduce AF development after CABG.
Answer: yes

Figure 1: An instance (Sakamoto et al., 2011) of PubMedQA dataset: Question is the original question title; Context includes the structured abstract except its conclusive part, which serves as the Long Answer; Human experts annotated the Answer yes. Supporting fact for the answer is ***highlighted***.

[Ji19] Jin,Q., Dhingra, B., Liu, Z., Cohen, W., et al.: PubMedQA: A Dataset for Biomedical Research Question Answering

Appendix B: Transformers



[Va17] Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., et al.: Attention Is All You Need