Tianheng Wang

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Research interests: Nature Language Processing, Information Extraction, Large Language Models, Federated Learning

Education

Tsinghua University, Master in Department of Automation Sep.2020-Jun.2023

University of Electronic Science and Technology of China; Bachelor of Engineering in Automation, Bachelor of Management and Economics Sep.2016-Jun.2020

Professional Experiences

Hangzhou Institution of Medicine Chinese Academy of Science *Algorithmic Engineer* Jul.2023-Now

- Take charge of algorithmic innovation in deep learning, including improvements in Parameter-Efficient Fine-Tuning(PEFT) methods, KG-based large language model(LLM) generation, multi-agent and so on.

Fuzhou Institute for Data Technology *Algorithm Intern* Jun.2021-Sep.2022

- Mainly responsible for LLMs training and structure improvement, including pre-training LLMs in geoscience domain and integrating federated learning with pre-trained models.

Researches

AIM Lab, Hangzhou Institution of Medicine, Chinese Academy of Science

Research on Structural Improvement in Large Language Model(LLM), Pre-training Hybrid Model of LLM and GNN, Multi Generative Agents.

Advisor: ***Xiaolin Andy Li****, Chief AI Scientist* *Algorithmic Engineer* Jul.2023-Now

- Proposed similarity grouping query attention approach(SQA), which fuses the key and value based on the similarity of attention heads in LLMs, thus alleviating the semantic conflict problem of attention fusion in the grouping query attention(GQA) method. Generated a paper that will be submitted to CIKM 2024.
- Constructed a graph neural network-enhanced generative large language model(GNN-enhanced LLM) based on the Flamingo framework, using graph structure information to enhance the performance of LLMs on question-answering(QA) tasks.
- Proposed a novel parameter fusion method, which integrated the parameters of LLMs and task-specific LoRA module by using cross-attention. This approach mitigated the phenomenon of catastrophic forgetting that can occur during the fine-tuning based on LoRA, enabling the model to retain the knowledge from pre-trained parameters while simultaneously adapting to downstream tasks.
- Investigated the influence of conflict and competition in multi-agent groups, and analyzed the similarities and differences between multi-agent group behavior and human society. Drawing inspiration from this, designed more efficient, collaborative, and socially-aware multi-agent systems.

Information Processing Institute, Tsinghua University

Research on Geoscience Knowledge Construction based on Federated Learning, and Large Language Model in Geoscience Domain

Advisor: ***Hairong Lv****, Associate Professor* *Research Assistant* Sep.2020-Jun.2023

➢ **Crowd Cooperative Construction of Geoscience Knowledge Graph Representation Model** Sep.2020-Dec.2022

- Constructed an entity-relation joint extraction model based on federated learning which simultaneously addressed data privacy issues and training data scarcity in geomatics organizations.
- Constructed a document-level relation extraction method based on an adjacency matrix, which effectively solved the long sequence modeling in document relation extraction by generating the adjacency matrix and reachability matrix of the target entity pairs, and then fusing the multi-hop entity pair information by using the distance function.

➢ **Deep-time Digital Earth(DDE) International Large-Scale Science Program** Sep.2020-Oct.2022

- Pre-trained a mineralogical LLM, enhanced with spatio-temporal information through whole entity masking, significantly outperformed the original BERT on evaluation tasks, proving the efficacy of domain-specific pre-training and incorporating spatio-temporal data.
- Constructed DenseBERT by concatenating all previous layer outputs and integrating GNNs to encode text dependency

trees, significantly outperformed BERT on GLUE and SQUAD by leveraging word-level information for enhanced semantic understanding.

- Assisted in the development of the DDE Editor system. Designed the DDE KG Editor to help geoscientists co-create high-quality large-scale Geoscience Professional Knowledge Graphs (GPKGs). It provided distinctive features such as collaborative editing, peer review, contribution records, intelligent assistance, and discussion forums. All contributors and contributions will be recorded and displayed, and the constructed GPKGs in DDE KG Editor are free for non-commercial use.

Power Electronics and Advanced Control Center, University of Electronic Science and Technology of China

Design FPGA-Centric High-Performance Computer Architecture

Advisor: Shuyan Jiang, Professor *Research Assistant* Sep.2018-Mar.2020

- Designed a novel, efficient, variable-length router with optimized microarchitecture, timing, and arbitration to relieve congestion and enhance data transmission in hierarchical networks.

Publications

- **Wang T**, Zheng L, Lv H, et al. A Distributed Joint Extraction Framework for Sedimentological Entities and Relations with Federated Learning[J]. Expert Systems with Applications, 2023, 213: 119216. (SCI Q1, IF:8.665)
- Zhang J, **Wang T**, Wang C, Bai Y, Zhang Y, Li Y. Emotional Polarity Attention Mechanism for Text Sentiment Analysis. DASFAA 2024. (CCF B)
- Liu K, Hou C, **Wang T**, et al. DDE KG Editor: A Data Service System for Knowledge Graph Construction in Geoscience, JDG. (JCR Q1, IF:2.5)
- Contributed to the authoring of the chapter on Federated Learning in the book "Blockchain and Data Sharing", ISBN:9787121455148
- Zhen L, **Wang T**, Lv H, et al. MineBERT: A Pretrained Language Model for Mineralogical Text with Enhanced Temporal-Spatial Entities, ACM TOIS (submitted)
- Zhang J, **Wang T**, Huang T, Zhang Y, Li X. An Evaluation Framework for Long-tail Word Senses in Word Sense Disambiguation and Large Language Models, CIKM 2024(submitted)
- **Wang T,** Wang J, Zhang J, Li X. SQA: Grouping Query Attention based on Similarity, CIKM(submitted)
- **Wang T**. Model Evolution: A small-batch parameter fusion approach for mitigating catastrophic forgetting in continuous learning, NeurlPS(submitted)

Patents

- A Method and Device for Constructing A Joint Extraction Model Based on Federated Learning (Patent No. CN202111246766)
- A Document-level Relation Extraction Method and Storage Device based on Adjacency Matrix (Patent No. CN202210602851)
- An Entity-relation Joint Extraction Method and Storage Device (Patent No. CN202111521891)
- A Design Method of Blocking and Breaking Bypass Router Oriented to Data Acquisition System (Patent No. CN110460530B)
- A Design Method of Indeterminate Packet Length Router with Congestion Grooming for Upper Networks (Patent No. CN110460545B)
- A Data Acquisition Method Based on Network-on-Chip (Patent No. CN110460546A)
- A community grid-based monitoring and management platform based on blockchain technology (Patent No. CN117612738A)

Awards & Honors

- Top 10 of CIKM 2022 AnalytiCup Competition Federated Hetero-Task Learning (International) Oct.2022
- Third Prize of Excellent Projects of Surveying and Mapping Geographic Information Industry in Guizhou Province (Provincial) Aug.2021
- Outstanding Student Scholarship of the School of Automation Engineering, UESTC Dec.2018&Dec.2017
- Outstanding Student Leader of UESTC May.2018
- Outstanding Individual of Social Practice of UESTC Oct.2017

Activities

Co-founder, Beijing Yunshi Intelligent Technology Co. Jan.2024-Now

***Active member,* Science and Technology Innovation Center, UESTC** Sep.2018-Jun.2019

- Took charge of software development of the smart car and debugged the trajectory of the car.

***Volunteer*, Voluntary Team of UESTC** Jul.2017-Jul.2018

***President,* Student Union of School of Automation Engineering, UESTC** Sep.2016-Sep.2018

- Planned and organized 25 school activities, redesigned its management structure, etc.

Skills

- **I.T.:** Python, C, MatLab, Letax, Linux, PyTorch, Transformers, Tensorflow.
- Proficiency in diverse large language model architectures and the capability to modify and adapt the codebase of these models.
- Proficient in knowledge graph construction and have experience in distributed knowledge graph construction.
- Have a research foundation in natural language processing and pre-trained language models.