Pengyu Cheng

pengyucheng95@gmail.com • linear95.github.io

Introduction

I am a senior researcher at Tencent AI Lab, primarily working on LLM training, AI agents, and dialogue systems. I have been experienced in research and projects about controllable generation, interpretability, and fairness of NLP. Besides, I have broad interests in probabilistic and information-theoretic machine learning methods.

Education

Duke University 08/2017 – 05/2021
Ph.D., Electrical and Computer Engineering *Adviser: Lawrence Carin*

Tsinghua University 08/2013 – 07/2017
B.S., Mathematics and Statistics *Adviser: Jiwen Lu*

Experiences

Tencent AI Lab 08/2022 – Present
Senior Researcher *Supervisor: Nan Du, Zhengyou Zhang*
Research and projects on LLM training, AI agents, dialogue systems, and controllable text generation.

Tencent Interactive Entertainment Group (IEG) 06/2021 – 08/2022
Senior Researcher *Supervisor: Dong Li*
Applications of dialogue systems, controllable text generation, style transfer in gaming scenarios and Metaverse.

Information Initiative at Duke (iiD) 08/2017 – 03/2021
Research Assistant *Adviser: Lawrence Carin*
Probabilistic and information-theoretic learning methods, and applications in natural language processing.

Microsoft Cloud & AI 06/2020 – 08/2020
Research Internship *Mentor: Zhe Gan, Yu Chen, Supervisor: Jingjing Liu*
Improving self-supervised multi-view contrastive learning with learnable data augmentations.

NEC Laboratories America 05/2019 – 08/2019
Research Internship *Mentor: Martin Renqiang Min*
Improving disentangled text representation learning with information-theoretic guidance.

Tsinghua Intelligent Vision Group (IVG) 03/2016 – 07/2016
Student Researcher *Adviser: Jiwen Lu*
Deep metric learning for person re-identification based on sequential frames information.

Student Research Program at Tsinghua 11/2015 – 05/2017
Student Researcher *Adviser: Xuegong Zhang*
Non-parametric k-sample tests with statistics based on local maximum energy distance.

Sogou Map Rendering Group 08/2014 – 09/2014
Research Internship *Mentor: Mao Wang*
Automatic smoothing and compression for polygonal line-like city road data.

Selected Publications

- D. Zeng*, Y. Dai*, **P. Cheng***, et al., *"On Diversified Preferences of Large Language Model Alignment"*, Preprint 2023
- **P. Cheng***, Y. Yang*, J. Li*, Y. Dai, and N. Du, *"Adversarial Preference Optimization"*, Preprint 2023
- **P. Cheng**, J. Xie, K. Bai, et al., *"Everyone Deserves A Reward: Learning Customized Human Preferences"*, Preprint 2023

- J. Xie, **P. Cheng**, et al., *"Chunk, Align, Select: A Simple Long-sequence Processing Method for Transformers"*, Preprint 2023
- **P. Cheng**, R. Li, *"Replacing Language Model for Style Transfer"*, Preprint 2022
- K. Bai*, **P. Cheng***, W. Hao, et al., *"Estimating Total Correlation with Mutual Information Estimators"*, AISTATS 2023
- R. Wang*, **P. Cheng***, R. Henao, *"Mitigating Gender Bias for Text Generation via MI Minimization"*, AISTATS 2023
- **P. Cheng***, W. Hao*, S. Yuan, et al., *"FairFil: Contrastive Neural Debiasing Method for Pretrained Text Encoders"*, ICLR 2021
- S. Yuan*, **P. Cheng***, R. Zhang, W. Hao, Z. Gan, and L. Carin, *"Improving Zero-Shot Voice Style Transfer via Disentangled Representation Learning"*, ICLR 2021
- **P. Cheng**, W. Hao, S. Dai, et al., *"CLUB: A Contrastive Log-ratio Upper Bound of Mutual Information"*, ICML 2020
- **P. Cheng**, M. Min, D. Shen, C. Malon, Y. Zhang, Y. Li and L. Carin, *"Improving Disentangled Text Representation Learning with Information-Theoretic Guidance"*, ACL 2020
- **P. Cheng**, Y. Li, X. Zhang, et al., *"Dynamic Embedding on Textual Networks via a Gaussian Process"*, AAAI 2020 Oral
- **P. Cheng***, D. Shen*, D. Sundararaman, X. Zhang, Q. Yang, M. Tang, A. Celikyilmaz, and L. Carin, *Learning Compressed Sentence Representations for On-Device Text Processing*, ACL 2019 Oral.

Services & Awards

- Reviewer/Program Committee for ICML, NeurIPS, ICLR, AAAI, IJCAI, ACL, EMNLP, NAACL, ARR.
- Fellowship of Electrical and Computer Engineering at Duke 08/2018
- First in Duke-Tsinghua Machine Learning Summer School (1/112) 08/2017
- Academic Excellence Award of Tsinghua University (top 30%) 10/2014
- Top 5 in the 18-th "Sogou Cup" Artificial Intelligence Programming Contest (5/200) 04/2014
- Silver medal in the 28-th Chinese Mathematical Olympiad (CMO) 01/2013
- First Prize in Chinese National Olympiad in Informatics in Provinces (NOIP) 11/2012

Selected Projects

AI Agents for Virtual Characters 03/2023 – Present
Project Lead *Supervisor: Nan Du*

- **Framework Design & Implementation**: Designed an LLM-powered AI agent system for virtual characters, including functions such as vector-database retrieval, API tools usage, active topic/task guidance, natural language configuration, *etc*. Implemented the high-level overall framework and the details of the intent detector, planning, and response generator.
- **LLM-based Planning Module**: Inspired by *Toolformer*, designed multi-step planning and APIs calling scheme. Utilized *P-Tuning* strategies to accelerate reaction inference and to support efficient multi-character configuration.
- **RAG & API Tools**: Optimized the retrieval-augmented generation (RAG) and APIs calling pipeline. Finetuned LLM to simultaneously output retrieval embeddings which reduced Agent reaction pending time.
- **RLHF for Agents**: With human feedback of agent behavior, conducted reinforcement learning from human feedback (RLHF) algorithm to further improve agent-human interaction quality.

Large Language Model (LLM) Training 03/2023 – Present
Core Member *Supervisor: Haitao Mi, Nan Du*

- **Data Collection**: Collected and cleaned text data from gaming scenarios for LLM pre-training and supervised fine-tuning. Implemented task classification models to categorize SFT and PPO queries for data collection and LLM evaluation.
- **Framework Implementation**: Implemented RM and PPO training based on *Megatron-Deepspeed* codebase, supporting 3D-parallel. Implemented rejection sampling based on *HF-transformers* and *DeepSpeed*.
- **Reward Modeling (RM)**: Explored multiple training strategies to improve RM performance, including marginal loss, calibration error, RM pre-training, multi-task learning, and imitation leanring. Published papers: *DSP*, *MORE*.
- **LLM Alignment**: Implemented and experiented alignment algorithms: *RLHF*, *DPO*, *RJS*. Proposed a novel adversarial LLM alignment algorithm and published paper *Adversarial Preference Optimization (APO)*.

Task-oriented Dialogue System for Virtual Characters 08/2021 – 03/2023

Project Lead *Supervisor: Nan Du*

Built from scratch a task-oriented dialogue system for virtual characters, which can easily adapt to different virtual characters by simple configuration. The system primarily consisted of four parts:

- **Perception**: Implemented intent-slot joint detector based on the *JointBERT* model. Designed a general intent-slot label system based on the concept of Ontology. Built a data augmentation pipeline to collect character-related intent training data efficiently.
- **Planning**: Implemented a condition-oriented rule-based planning module that can quickly combine different logic rules to guide characters' actions. Built a dialog state tracker that enhanced coreference resolution in multi-turn dialogues.
- **Knowledge**: Designed an ontology-based knowledge base that can easily switch knowledge data among different characters.
- **Expression**: Constructed a hybrid response generator compatible with both template-based and decoder-based response generation. Applied controllable text generation techniques for sentiment/characteristic-related responses with *DialogGPT*.

Controllable Text Generation in Gaming Scenarios 06/2021 – 11/2022

Project Lead

Utilized Pretrained Language Models (PLMs, including *BERT*, *GPT-2*, *BART*, *T5*) to improve text generation tasks including conditional text generation, sentiment transfer, and style transfer in Game and Metaverse applications.

- **Stylized Nickname Generation**: Implemented style-controllable nickname generation via a two-step fine-tuning scheme: first trained PLMs on text corpus with the target style; then continuously fine-tuned generators with nickname data.
- **Keyword-oriented Nickname Generation**: Trained PLMs via masked language modeling with nickname tokens masked except keywords. Generated nicknames by adding mask tokens around the keyword then forwarded through PLMs.
- **Synonym-based Text Rewriting & Style Transfer**: Utilized synonyms to solve text rewriting and style transfer with low-resource supervision. Randomly replaced each word in sentences by synonyms with the style-related word usage frequencies. Filtered the rewritten text samples by perplexity calculated from target-style PLMs.
- **Replacing Language Model**: Bridged the gap between autoregressive and non-autoregressive generation. Autoregressively masked each token in source sentences with a target-style span generated non-autoregressively by masked language models.

Publications

Pengyu Cheng, Yifan Yang, Jian Li, Yong Dai, and Nan Du. Adversarial preference optimization. *arXiv preprint arXiv:2311.08045*, 2023.

Pengyu Cheng, Jiawen Xie, Ke Bai, Yong Dai, and Nan Du. Everyone deserves a reward: Learning customized human preferences. *arXiv preprint arXiv:2309.03126*, 2023.

Rui Wang, Pengyu Cheng, and Ricardo Henao. Toward fairness in text generation via mutual information minimization based on importance sampling. In *International Conference on Artificial Intelligence and Statistics*, pages 4473–4485, . PMLR, 2023.

Ke Bai, Pengyu Cheng, Weituo Hao, Ricardo Henao, and Larry Carin. Estimating total correlation with mutual information estimators. In *International Conference on Artificial Intelligence and Statistics*, pages 2147–2164, . PMLR, 2023.

Dun Zeng, Yong Dai, Pengyu Cheng, Tianhao Hu, Wanshun Chen, Nan Du, and Zenglin Xu. On diversified preferences of large language model alignment. *arXiv preprint arXiv:2312.07401*, 2023.

Jiawen Xie, Pengyu Cheng, Xiao Liang, Yong Dai, and Nan Du. Chunk, align, select: A simple long-sequence processing method for transformers. *arXiv preprint arXiv:2308.13191*, 2023.

Pengyu Cheng and Ruineng Li. Replacing language model for style transfer. *arXiv preprint arXiv:2211.07343*, 2022.

Shengxuan Luo, Pengyu Cheng, and Sheng Yu. Semi-constraint optimal transport for entity alignment with dangling cases. In *Findings of the Association for Computational Linguistics*, pages 2330–2339, 2022.

Weituo Hao, Nikhil Mehta, Kevin J Liang, Pengyu Cheng, Mostafa El-Khamy, and Lawrence Carin. Waffle: Weight anonymized factorization for federated learning. *IEEE Access*, 10:49207–49218, 2022.

Hao Zhang, Long Tian, Zhengjue Wang, Yishi Xu, Pengyu Cheng, Ke Bai, and Bo Chen. Multiscale visual-attribute co-attention for zero-shot image recognition. *IEEE Transactions on Neural Networks and Learning Systems*, 2021.

Pengyu Cheng, Weituo Hao, Siyang Yuan, Shijing Si, and Lawrence Carin. Fairfil: Contrastive neural debiasing method for pretrained text encoders. In *International Conference on Learning Representations*, 2020.

Pengyu Cheng, Yitong Li, Xinyuan Zhang, Liqun Chen, David Carlson, and Lawrence Carin. Dynamic embedding on textual networks via a gaussian process. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 34, pages 7562–7569, 2020.

Pengyu Cheng, Martin Renqiang Min, Dinghan Shen, Christopher Malon, Yizhe Zhang, Yitong Li, and Lawrence Carin. Improving disentangled text representation learning with information-theoretic guidance. In *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics*, pages 7530–7541, 2020.

Siyang Yuan, Pengyu Cheng, Ruiyi Zhang, Weituo Hao, Zhe Gan, and Lawrence Carin. Improving zero-shot voice style transfer via disentangled representation learning. In *International Conference on Learning Representations*, 2020.

Pengyu Cheng, Weituo Hao, Shuyang Dai, Jiachang Liu, Zhe Gan, and Lawrence Carin. Club: A contrastive log-ratio upper bound of mutual information. In *International conference on machine learning*, pages 1779–1788, . PMLR, 2020.

Chang Liu, Jingwei Zhuo, Pengyu Cheng, Ruiyi Zhang, and Jun Zhu. Understanding and accelerating particle-based variational inference. In *International Conference on Machine Learning*, pages 4082–4092, . PMLR, 2019.

Liqun Chen, Guoyin Wang, Chenyang Tao, Dinghan Shen, Pengyu Cheng, Xinyuan Zhang, Wenlin Wang, Yizhe Zhang, and Lawrence Carin. Improving textual network embedding with global attention via optimal transport. In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, pages 5193–5202, 2019.

Dinghan Shen, Pengyu Cheng, Dhanasekar Sundararaman, Xinyuan Zhang, Qian Yang, Meng Tang, Asli Celikyilmaz, and Lawrence Carin. Learning compressed sentence representations for on-device text processing. In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, pages 107–116, 2019.

Pengyu Cheng, Chang Liu, Chunyuan Li, Dinghan Shen, Ricardo Henao, and Lawrence Carin. Straight-through estimator as projected wasserstein gradient flow. In *NeurIPS 2018 Bayesian Deep Learning Workshop*, 2018.