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Navigating the Landscape of Large Language Models: A Comprehensive Review and Analysis of Paradigms and Fine-Tuning Strategies

Benjue Weng

With the surge of ChatGPT,the use of large models has significantly increased,rapidly rising to prominence across the industry and sweeping across the internet. This article is a comprehensive review of fine-tuning methods for large models. This paper investigates the latest technological advancements and the application of advanced methods in aspects such as task-adaptive fine-tuning,domain-adaptive fine-tuning,few-shot learning,knowledge distillation,multi-task learning,parameter-efficient fine-tuning,and dynamic fine-tuning.

link: http://arxiv.org/abs/2404.09022v1

An Agent-Based Model of Elephant Crop Raid Dynamics in the Periyar-Agasthyamalai Complex, India

Purathekandy Anjali, Meera Anna Oommen, Martin Wikelski, Deepak N Subramani

Human-wildlife conflict poses significant challenges to conservation efforts around the world and requires innovative solutions for effective management. We developed an agent-based model to simulate complex interactions between humans and Asian elephants (particularly solitary bull elephants) in the Periyar-Agasthyamalai complex of the Western Ghats in Kerala, India. Incorporating factors such as crop habituation, thermoregulation needs, and aggression models, this framework enables the evaluation of various experimental scenarios to quantify elephant behaviors and the resulting conflict situations. The ODD protocol, the various cognition models and environmental factors are provided in detail. We simulate different scenarios of food availability to analyze the behavior of elephant agents and assess the influence of environmental factors on space use and emergent conflict patterns. Validation is performed using field data from the region, and elephant movement parameters are tuned using relocation data. Through extensive experimentation, we show that wet months consistently exhibit increased conflict. Furthermore, the experiments reveal that thermoregulation requirements act as a crucial driver of elephant space use, which subsequently influences crop raid patterns. Our findings show how starvation drives wildlife toward crop damage, while crop habituation further exacerbates raid patterns, particularly in regions with limited forest food resources. This agent-based model offers valuable information to develop an intelligent decision support system for wildlife management and decision-making. This is the first step towards development of such a tool, specifically, a primary model that can, over time, be enhanced with layers of complexity and subtlety across various dimensions.

link: http://arxiv.org/abs/2404.09024v1

MING-MOE: Enhancing Medical Multi-Task Learning in Large Language Models with Sparse Mixture of Low-Rank Adapter Experts

Yusheng Liao, Shuyang Jiang, Yu Wang, Yanfeng Wang

Large language models like ChatGPT have shown substantial progress in natural language understanding and generation, proving valuable across various disciplines, including the medical field. Despite advancements, challenges persist due to the complexity and diversity inherent in medical tasks which often require multi-task learning capabilities. Previous approaches, although beneficial, fall short in real-world applications because they necessitate task-specific annotations at inference time, limiting broader generalization. This paper introduces MING-MOE, a novel Mixture-of-Expert~(MOE)-based medical large language model designed to manage diverse and complex medical tasks without requiring task-specific annotations, thus enhancing its usability across extensive datasets. MING-MOE employs a Mixture of Low-Rank Adaptation (MoLoRA) technique, allowing for efficient parameter usage by maintaining base model parameters static while adapting through a minimal set of trainable parameters. We demonstrate that MING-MOE achieves state-of-the-art (SOTA) performance on over 20 medical tasks, illustrating a significant

improvement over existing models. This approach not only extends the capabilities of medical language models but also improves inference efficiency.

link: http://arxiv.org/abs/2404.09027v1

A Parametric Rate-Distortion Model for Video Transcoding

Maedeh Jamali, Nader Karimi, Shadrokh Samavi, Shahram Shirani

Over the past two decades, the surge in video streaming applications has been fueled by the increasing accessibility of the internet and the growing demand for network video. As users with varying internet speeds and devices seek high-quality video, transcoding becomes essential for service providers. In this paper, we introduce a parametric rate-distortion (R-D) transcoding model. Our model excels at predicting transcoding distortion at various rates without the need for encoding the video. This model serves as a versatile tool that can be used to achieve visual quality improvement (in terms of PSNR) via trans-sizing. Moreover, we use our model to identify visually lossless and near-zero-slope bitrate ranges for an ingest video. Having this information allows us to adjust the transcoding target bitrate while introducing visually negligible quality degradations. By utilizing our model in this manner, quality improvements up to 2 dB and bitrate savings of up to 46% of the original target bitrate are possible. Experimental results demonstrate the efficacy of our model in video transcoding rate distortion prediction.

link: http://arxiv.org/abs/2404.09029v1

Active Learning for Control-Oriented Identification of Nonlinear Systems

Bruce D. Lee, Ingvar Ziemann, George J. Pappas, Nikolai Matni

Model-based reinforcement learning is an effective approach for controlling an unknown system. It is based on a longstanding pipeline familiar to the control community in which one performs experiments on the environment to collect a dataset, uses the resulting dataset to identify a model of the system, and finally performs control synthesis using the identified model. As interacting with the system may be costly and time consuming, targeted exploration is crucial for developing an effective control-oriented model with minimal experimentation. Motivated by this challenge, recent work has begun to study finite sample data requirements and sample efficient algorithms for the problem of optimal exploration in model-based reinforcement learning. However, existing theory and algorithms are limited to model classes which are linear in the parameters. Our work instead focuses on models with nonlinear parameter dependencies, and presents the first finite sample analysis of an active learning algorithm suitable for a general class of nonlinear dynamics. In certain settings, the excess control cost of our algorithm achieves the optimal rate, up to logarithmic factors. We validate our approach in simulation, showcasing the advantage of active, control-oriented exploration for controlling nonlinear systems.

link: http://arxiv.org/abs/2404.09030v1

Improving Personalisation in Valence and Arousal Prediction using Data Augmentation

Munachiso Nwadike, Jialin Li, Hanan Salam

In the field of emotion recognition and Human-Machine Interaction (HMI), personalised approaches have exhibited their efficacy in capturing individual-specific characteristics and enhancing affective prediction accuracy. However, personalisation techniques often face the challenge of limited data for target individuals. This paper presents our work on an enhanced personalisation strategy, that leverages data augmentation to develop tailored models for continuous valence and arousal prediction. Our proposed approach, Distance Weighting Augmentation (DWA), employs a weighting-based augmentation method that expands a target individual's dataset, leveraging distance metrics to identify similar samples at the segment-level. Experimental results on the MuSe-Personalisation 2023 Challenge dataset demonstrate that our method significantly improves the performance of features sets which have low baseline performance, on the test set. This improvement in poor-performing features comes without sacrificing performance on high-performing features. In particular, our method achieves a maximum combined testing CCC of

0.78, compared to the reported baseline score of 0.76 (reproduced at 0.72). It also achieved a peak arousal and valence scores of 0.81 and 0.76, compared to reproduced baseline scores of 0.76 and 0.67 respectively. Through this work, we make significant contributions to the advancement of personalised affective computing models, enhancing the practicality and adaptability of data-level personalisation in real world contexts.

link: http://arxiv.org/abs/2404.09042v1

Do LLMs Play Dice? Exploring Probability Distribution Sampling in Large Language Models for Behavioral Simulation

Jia Gu, Liang Pang, Huawei Shen, Xueqi Cheng

With the rapid advancement of large language models (LLMs) and their remarkable capabilities in handling complex language tasks, an increasing number of studies are employing LLMs as agents to emulate the sequential decision-making processes of humans often represented as Markov decision-making processes (MDPs). The actions within this decision-making framework adhere to specific probability distributions and require iterative sampling. This arouses our curiosity regarding the capacity of LLM agents to comprehend probability distributions, thereby guiding the agent's behavioral decision-making through probabilistic sampling and generating behavioral sequences. To answer the above question, we divide the problem into two main aspects: simulation where the exact probability distribution is known, and generation of sequences where the probability distribution is ambiguous. In the first case, the agent is required to give the type and parameters of the probability distribution through the problem description, and then give the sampling sequence. However, our analysis shows that LLM agents perform poorly in this case, but the sampling success rate can be improved through programming tools. Real-world scenarios often entail unknown probability distributions. Thus, in the second case, we ask the agents to change the activity level in online social networks and analyze the frequency of actions. Ultimately, our analysis shows that LLM agents cannot sample probability distributions even using programming tools. Therefore, careful consideration is still required before directly applying LLM agents as agents to simulate human behavior.

link: http://arxiv.org/abs/2404.09043v1

Adapting Mental Health Prediction Tasks for Cross-lingual Learning via Meta-Training and In-context Learning with Large Language Model

Zita Lifelo, Huansheng Ning, Sahraoui Dhelim

Timely identification is essential for the efficient handling of mental health illnesses such as depression. However, the current research fails to adequately address the prediction of mental health conditions from social media data in low-resource African languages like Swahili. This study introduces two distinct approaches utilising model-agnostic meta-learning and leveraging large language models (LLMs) to address this gap. Experiments are conducted on three datasets translated to low-resource language and applied to four mental health tasks, which include stress, depression, depression severity and suicidal ideation prediction. we first apply a meta-learning model with self-supervision, which results in improved model initialisation for rapid adaptation and cross-lingual transfer. The results show that our meta-trained model performs significantly better than standard fine-tuning methods, outperforming the baseline fine-tuning in macro F1 score with 18\% and 0.8\% over XLM-R and mBERT. In parallel, we use LLMs' in-context learning capabilities to assess their performance accuracy across the Swahili mental health prediction tasks by analysing different cross-lingual prompting approaches. Our analysis showed that Swahili prompts performed better than cross-lingual prompts but less than English prompts. Our findings show that in-context learning can be achieved through cross-lingual transfer through carefully crafted prompt templates with examples and instructions.

link: http://arxiv.org/abs/2404.09045v1

Multilingual Evaluation of Semantic Textual Relatedness

Sharvi Endait, Srushti Sonavane, Ridhima Sinare, Pritika Rohera, Advait Naik, Dipali Kadam

The explosive growth of online content demands robust Natural Language Processing (NLP) techniques that can capture nuanced meanings and cultural context across diverse languages. Semantic Textual Relatedness (STR) goes beyond superficial word overlap, considering linguistic elements and non-linguistic factors like topic, sentiment, and perspective. Despite its pivotal role, prior NLP research has predominantly focused on English, limiting its applicability across languages. Addressing this gap, our paper dives into capturing deeper connections between sentences beyond simple word overlap. Going beyond English-centric NLP research, we explore STR in Marathi, Hindi, Spanish, and English, unlocking the potential for information retrieval, machine translation, and more. Leveraging the SemEval-2024 shared task, we explore various language models across three learning paradigms: supervised, unsupervised, and cross-lingual. Our comprehensive methodology gains promising results, demonstrating the effectiveness of our approach. This work aims to not only showcase our achievements but also inspire further research in multilingual STR, particularly for low-resourced languages.

link: http://arxiv.org/abs/2404.09047v1

Rethinking Iterative Stereo Matching from Diffusion Bridge Model Perspective

Yuguang Shi

Recently, iteration-based stereo matching has shown great potential. However, these models optimize the disparity map using RNN variants. The discrete optimization process poses a challenge of information loss, which restricts the level of detail that can be expressed in the generated disparity map. In order to address these issues, we propose a novel training approach that incorporates diffusion models into the iterative optimization process. We designed a Time-based Gated Recurrent Unit (T-GRU) to correlate temporal and disparity outputs. Unlike standard recurrent units, we employ Agent Attention to generate more expressive features. We also designed an attention-based context network to capture a large amount of contextual information. Experiments on several public benchmarks show that we have achieved competitive stereo matching performance. Our model ranks first in the Scene Flow dataset, achieving over a 7% improvement compared to competing methods, and requires only 8 iterations to achieve state-of-the-art results.

link: http://arxiv.org/abs/2404.09051v1

ALICE: Combining Feature Selection and Inter-Rater Agreeability for Machine Learning Insights

Bachana Anasashvili, Vahidin Jeleskovic

This paper presents a new Python library called Automated Learning for Insightful Comparison and Evaluation (ALICE), which merges conventional feature selection and the concept of inter-rater agreeability in a simple, user-friendly manner to seek insights into black box Machine Learning models. The framework is proposed following an overview of the key concepts of interpretability in ML. The entire architecture and intuition of the main methods of the framework are also thoroughly discussed and results from initial experiments on a customer churn predictive modeling task are presented, alongside ideas for possible avenues to explore for the future. The full source code for the framework and the experiment notebooks can be found at: https://github.com/anasashb/aliceHU

link: http://arxiv.org/abs/2404.09053v1

CodeCloak: A Method for Evaluating and Mitigating Code Leakage by LLM Code Assistants

Amit Finkman, Eden Bar-Kochva, Avishag Shapira, Dudu Mimran, Yuval Elovici, Asaf Shabtai

LLM-based code assistants are becoming increasingly popular among developers. These tools help developers improve their coding efficiency and reduce errors by providing real-time suggestions based on the developer's codebase. While beneficial, these tools might inadvertently expose the developer's proprietary code to the code assistant service provider during the development process. In this work, we propose two complementary methods to mitigate the risk of code leakage

when using LLM-based code assistants. The first is a technique for reconstructing a developer's original codebase from code segments sent to the code assistant service (i.e., prompts) during the development process, enabling assessment and evaluation of the extent of code leakage to third parties (or adversaries). The second is CodeCloak, a novel deep reinforcement learning agent that manipulates the prompts before sending them to the code assistant service. CodeCloak aims to achieve the following two contradictory goals: (i) minimizing code leakage, while (ii) preserving relevant and useful suggestions for the developer. Our evaluation, employing GitHub Copilot, StarCoder, and CodeLlama LLM-based code assistants models, demonstrates the effectiveness of our CodeCloak approach on a diverse set of code repositories of varying sizes, as well as its transferability across different models. In addition, we generate a realistic simulated coding environment to thoroughly analyze code leakage risks and evaluate the effectiveness of our proposed mitigation techniques under practical development scenarios.

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Exploring Explainability in Video Action Recognition

Avinab Saha, Shashank Gupta, Sravan Kumar Ankireddy, Karl Chahine, Joydeep Ghosh

Image Classification and Video Action Recognition are perhaps the two most foundational tasks in computer vision. Consequently, explaining the inner workings of trained deep neural networks is of prime importance. While numerous efforts focus on explaining the decisions of trained deep neural networks in image classification, exploration in the domain of its temporal version, video action recognition, has been scant. In this work, we take a deeper look at this problem. We begin by revisiting Grad-CAM, one of the popular feature attribution methods for Image Classification, and its extension to Video Action Recognition tasks and examine the method's limitations. To address these, we introduce Video-TCAV, by building on TCAV for Image Classification tasks, which aims to quantify the importance of specific concepts in the decision-making process of Video Action Recognition models. As the scalable generation of concepts is still an open problem, we propose a machine-assisted approach to generate spatial and spatiotemporal concepts relevant to Video Action Recognition for testing Video-TCAV. We then establish the importance of temporally-varying concepts by demonstrating the superiority of dynamic spatiotemporal concepts over trivial spatial concepts. In conclusion, we introduce a framework for investigating hypotheses in action recognition and quantitatively testing them, thus advancing research in the explainability of deep neural networks used in video action recognition.

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CuriousLLM: Elevating Multi-Document QA with Reasoning-Infused Knowledge Graph Prompting

Zukang Yang, Zixuan Zhu

In the field of Question Answering (QA), unifying large language models (LLMs) with external databases has shown great success. However, these methods often fall short in providing the advanced reasoning needed for complex QA tasks. To address these issues, we improve over a novel approach called Knowledge Graph Prompting (KGP), which combines knowledge graphs with a LLM-based agent to improve reasoning and search accuracy. Nevertheless, the original KGP framework necessitates costly fine-tuning with large datasets yet still suffers from LLM hallucination. Therefore, we propose a reasoning-infused LLM agent to enhance this framework. This agent mimics human curiosity to ask follow-up questions to more efficiently navigate the search. This simple modification significantly boosts the LLM performance in QA tasks without the high costs and latency associated with the initial KGP framework. Our ultimate goal is to further develop this approach, leading to more accurate, faster, and cost-effective solutions in the QA domain.

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Safe Reinforcement Learning on the Constraint Manifold: Theory and Applications

Puze Liu, Haitham Bou-Ammar, Jan Peters, Davide Tateo

Integrating learning-based techniques, especially reinforcement learning, into robotics is promising for solving complex problems in unstructured environments. However, most existing approaches are trained in well-tuned simulators and subsequently deployed on real robots without online fine-tuning. In this setting, the simulation's realism seriously impacts the deployment's success rate. Instead, learning with real-world interaction data offers a promising alternative: not only eliminates the need for a fine-tuned simulator but also applies to a broader range of tasks where accurate modeling is unfeasible. One major problem for on-robot reinforcement learning is ensuring safety, as uncontrolled exploration can cause catastrophic damage to the robot or the environment. Indeed, safety specifications, often represented as constraints, can be complex and non-linear, making safety challenging to guarantee in learning systems. In this paper, we show how we can impose complex safety constraints on learning-based robotics systems in a principled manner, both from theoretical and practical points of view. Our approach is based on the concept of the Constraint Manifold, representing the set of safe robot configurations. Exploiting differential geometry techniques, i.e., the tangent space, we can construct a safe action space, allowing learning agents to sample arbitrary actions while ensuring safety. We demonstrate the method's effectiveness in a real-world Robot Air Hockey task, showing that our method can handle high-dimensional tasks with complex constraints. Videos of the real robot experiments are available on the project website (https://puzeliu.github.io/TRO-ATACOM).

link: http://arxiv.org/abs/2404.09080v1