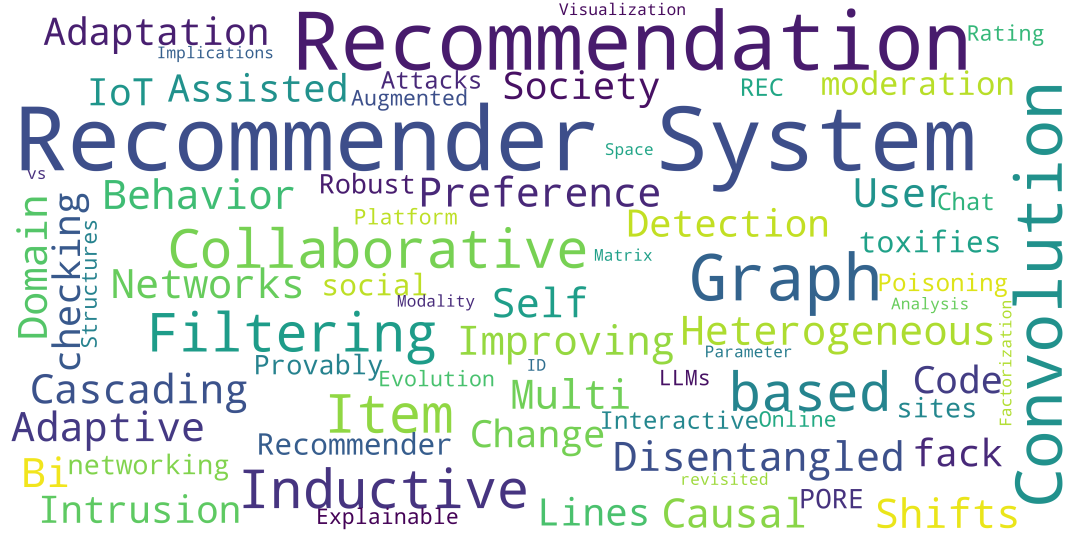
# 论文周报 | 推荐系统领域最新研究进展

原创 ML\_RSer [机器学习与推荐算法](javascript:void(0);) 2023-04-03 08:20 发表于北京

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**嘿，记得给“机器学习与推荐算法”添加星标**

本文精选了上周（0327-0402）最新发布的10篇推荐系统相关论文。



以下整理了论文标题以及摘要，如感兴趣可移步原文精读。

1. Causal Disentangled Recommendation Against User Preference Shifts2. Item Graph Convolution Collaborative Filtering for Inductive  Recommendations3. Multi-Behavior Recommendation with Cascading Graph Convolution Networks, WWW20234. Adaptive Bi-Recommendation and Self-Improving Network for Heterogeneous  Domain Adaptation-Assisted IoT Intrusion Detection5. Item Graph Convolution Collaborative Filtering for Inductive  Recommendations6. Can Few Lines of Code Change Society ? Beyond fack-checking and  moderation : how recommender systems toxifies social networking sites7. PORE: Provably Robust Recommender Systems against Data Poisoning Attacks, USENIX Security Symposium 20238. Chat-REC: Towards Interactive and Explainable LLMs-Augmented Recommender  System9. Where to Go Next for Recommender Systems? ID- vs. Modality-based  recommender models revisited10. Cascading Residual Graph Convolutional Network for Multi-Behavior Recommendation

### **1. Causal Disentangled Recommendation Against User Preference Shifts**

Wenjie Wang, Xinyu Lin, Liuhui Wang, Fuli Feng, Yunshan Ma, Tat-Seng Chua

https://arxiv.org/abs/2303.16068

Recommender systems easily face the issue of user preference shifts. User representations will become out-of-date and lead to inappropriate recommendations if user preference has shifted over time. To solve the issue, existing work focuses on learning robust representations or predicting the shifting pattern. There lacks a comprehensive view to discover the underlying reasons for user preference shifts. To understand the preference shift, we abstract a causal graph to describe the generation procedure of user interaction sequences. Assuming user preference is stable within a short period, we abstract the interaction sequence as a set of chronological environments. From the causal graph, we find that the changes of some unobserved factors (e.g., becoming pregnant) cause preference shifts between environments. Besides, the fine-grained user preference over categories sparsely affects the interactions with different items. Inspired by the causal graph, our key considerations to handle preference shifts lie in modeling the interaction generation procedure by: 1) capturing the preference shifts across environments for accurate preference prediction, and 2) disentangling the sparse influence from user preference to interactions for accurate effect estimation of preference. To this end, we propose a Causal Disentangled Recommendation (CDR) framework, which captures preference shifts via a temporal variational autoencoder and learns the sparse influence from multiple environments. Specifically, an encoder is adopted to infer the unobserved factors from user interactions while a decoder is to model the interaction generation process. Besides, we introduce two learnable matrices to disentangle the sparse influence from user preference to interactions. Lastly, we devise a multi-objective loss to optimize CDR. Extensive experiments on three datasets show the superiority of CDR.

### **2. Item Graph Convolution Collaborative Filtering for Inductive  Recommendations**

Edoardo D'Amico, Khalil Muhammad, Elias Tragos, Barry Smyth, Neil Hurley, Aonghus Lawlor

https://arxiv.org/abs/2303.15946

Graph Convolutional Networks (GCN) have been recently employed as core component in the construction of recommender system algorithms, interpreting user-item interactions as the edges of a bipartite graph. However, in the absence of side information, the majority of existing models adopt an approach of randomly initialising the user embeddings and optimising them throughout the training process. This strategy makes these algorithms inherently transductive, curtailing their ability to generate predictions for users that were unseen at training time. To address this issue, we propose a convolution-based algorithm, which is inductive from the user perspective, while at the same time, depending only on implicit user-item interaction data. We propose the construction of an item-item graph through a weighted projection of the bipartite interaction network and to employ convolution to inject higher order associations into item embeddings, while constructing user representations as weighted sums of the items with which they have interacted. Despite not training individual embeddings for each user our approach achieves state of-the-art recommendation performance with respect to transductive baselines on four real-world datasets, showing at the same time robust inductive performance.

### **3. Multi-Behavior Recommendation with Cascading Graph Convolution Networks, WWW2023**

Zhiyong Cheng, Sai Han, Fan Liu, Lei Zhu, Zan Gao, Yuxin Peng

https://arxiv.org/abs/2303.15720

Multi-behavior recommendation, which exploits auxiliary behaviors (e.g., click and cart) to help predict users' potential interactions on the target behavior (e.g., buy), is regarded as an effective way to alleviate the data sparsity or cold-start issues in recommendation. Multi-behaviors are often taken in certain orders in real-world applications (e.g., click>cart>buy). In a behavior chain, a latter behavior usually exhibits a stronger signal of user preference than the former one does. Most existing multi-behavior models fail to capture such dependencies in a behavior chain for embedding learning. In this work, we propose a novel multi-behavior recommendation model with cascading graph convolution networks (named MB-CGCN). In MB-CGCN, the embeddings learned from one behavior are used as the input features for the next behavior's embedding learning after a feature transformation operation. In this way, our model explicitly utilizes the behavior dependencies in embedding learning. Experiments on two benchmark datasets demonstrate the effectiveness of our model on exploiting multi-behavior data. It outperforms the best baseline by 33.7% and 35.9% on average over the two datasets in terms of Recall@10 and NDCG@10, respectively.

### **4. Adaptive Bi-Recommendation and Self-Improving Network for Heterogeneous  Domain Adaptation-Assisted IoT Intrusion Detection**

Jiashu Wu, Yang Wang, Hao Dai, Chengzhong Xu, Kenneth B. Kent

https://arxiv.org/abs/2303.14317

As Internet of Things devices become prevalent, using intrusion detection to protect IoT from malicious intrusions is of vital importance. However, the data scarcity of IoT hinders the effectiveness of traditional intrusion detection methods. To tackle this issue, in this paper, we propose the Adaptive Bi-Recommendation and Self-Improving Network (ABRSI) based on unsupervised heterogeneous domain adaptation (HDA). The ABRSI transfers enrich intrusion knowledge from a data-rich network intrusion source domain to facilitate effective intrusion detection for data-scarce IoT target domains. The ABRSI achieves fine-grained intrusion knowledge transfer via adaptive bi-recommendation matching. Matching the bi-recommendation interests of two recommender systems and the alignment of intrusion categories in the shared feature space form a mutual-benefit loop. Besides, the ABRSI uses a self-improving mechanism, autonomously improving the intrusion knowledge transfer from four ways. A hard pseudo label voting mechanism jointly considers recommender system decision and label relationship information to promote more accurate hard pseudo label assignment. To promote diversity and target data participation during intrusion knowledge transfer, target instances failing to be assigned with a hard pseudo label will be assigned with a probabilistic soft pseudo label, forming a hybrid pseudo-labelling strategy. Meanwhile, the ABRSI also makes soft pseudo-labels globally diverse and individually certain. Finally, an error knowledge learning mechanism is utilised to adversarially exploit factors that causes detection ambiguity and learns through both current and previous error knowledge, preventing error knowledge forgetfulness. Holistically, these mechanisms form the ABRSI model that boosts IoT intrusion detection accuracy via HDA-assisted intrusion knowledge transfer.

### **5. Item Graph Convolution Collaborative Filtering for Inductive  Recommendations**

Edoardo D'Amico, Khalil Muhammad, Elias Tragos, Barry Smyth, Neil Hurley, Aonghus Lawlor

https://arxiv.org/abs/2303.15946

Graph Convolutional Networks (GCN) have been recently employed as core component in the construction of recommender system algorithms, interpreting user-item interactions as the edges of a bipartite graph. However, in the absence of side information, the majority of existing models adopt an approach of randomly initialising the user embeddings and optimising them throughout the training process. This strategy makes these algorithms inherently transductive, curtailing their ability to generate predictions for users that were unseen at training time. To address this issue, we propose a convolution-based algorithm, which is inductive from the user perspective, while at the same time, depending only on implicit user-item interaction data. We propose the construction of an item-item graph through a weighted projection of the bipartite interaction network and to employ convolution to inject higher order associations into item embeddings, while constructing user representations as weighted sums of the items with which they have interacted. Despite not training individual embeddings for each user our approach achieves state of-the-art recommendation performance with respect to transductive baselines on four real-world datasets, showing at the same time robust inductive performance.

### **6. Can Few Lines of Code Change Society ? Beyond fack-checking and  moderation : how recommender systems toxifies social networking sites**

David Chavalarias (CAMS, ISC-PIF), Paul Bouchaud (CAMS, ISC-PIF), Maziyar Panahi (ISC-PIF)

https://arxiv.org/abs/2303.15035

As the last few years have seen an increase in online hostility and polarization both, we need to move beyond the fack-checking reflex or the praise for better moderation on social networking sites (SNS) and investigate their impact on social structures and social cohesion. In particular, the role of recommender systems deployed at large scale by digital platforms such as Facebook or Twitter has been overlooked. This paper draws on the literature on cognitive science, digital media, and opinion dynamics to propose a faithful replica of the entanglement between recommender systems, opinion dynamics and users' cognitive biais on SNSs like Twitter that is calibrated over a large scale longitudinal database of tweets from political activists. This model makes it possible to compare the consequences of various recommendation algorithms on the social fabric and to quantify their interaction with some major cognitive bias. In particular, we demonstrate that the recommender systems that seek to solely maximize users' engagement necessarily lead to an overexposure of users to negative content (up to 300% for some of them), a phenomenon called algorithmic negativity bias, to a polarization of the opinion landscape, and to a concentration of social power in the hands of the most toxic users. The latter are more than twice as numerous in the top 1% of the most influential users than in the overall population. Overall, our findings highlight the urgency to identify harmful implementations of recommender systems to individuals and society in order better regulate their deployment on systemic SNSs.

### **7. PORE: Provably Robust Recommender Systems against Data Poisoning Attacks, USENIX Security Symposium 2023**

Jinyuan Jia, Yupei Liu, Yuepeng Hu, Neil Zhenqiang Gong

https://arxiv.org/abs/2303.14601

Data poisoning attacks spoof a recommender system to make arbitrary, attacker-desired recommendations via injecting fake users with carefully crafted rating scores into the recommender system. We envision a cat-and-mouse game for such data poisoning attacks and their defenses, i.e., new defenses are designed to defend against existing attacks and new attacks are designed to break them. To prevent such a cat-and-mouse game, we propose PORE, the first framework to build provably robust recommender systems in this work. PORE can transform any existing recommender system to be provably robust against any untargeted data poisoning attacks, which aim to reduce the overall performance of a recommender system. Suppose PORE recommends top- items to a user when there is no attack. We prove that PORE still recommends at least  of the  items to the user under any data poisoning attack, where  is a function of the number of fake users in the attack. Moreover, we design an efficient algorithm to compute  for each user. We empirically evaluate PORE on popular benchmark datasets.

### **8. Chat-REC: Towards Interactive and Explainable LLMs-Augmented Recommender  System**

Yunfan Gao, Tao Sheng, Youlin Xiang, Yun Xiong, Haofen Wang, Jiawei Zhang

https://arxiv.org/abs/2303.14524

Large language models (LLMs) have demonstrated their significant potential to be applied for addressing various application tasks. However, traditional recommender systems continue to face great challenges such as poor interactivity and explainability, which actually also hinder their broad deployment in real-world systems. To address these limitations, this paper proposes a novel paradigm called Chat-Rec (ChatGPT Augmented Recommender System) that innovatively augments LLMs for building conversational recommender systems by converting user profiles and historical interactions into prompts. Chat-Rec is demonstrated to be effective in learning user preferences and establishing connections between users and products through in-context learning, which also makes the recommendation process more interactive and explainable. What's more, within the Chat-Rec framework, user's preferences can transfer to different products for cross-domain recommendations, and prompt-based injection of information into LLMs can also handle the cold-start scenarios with new items. In our experiments, Chat-Rec effectively improve the results of top-k recommendations and performs better in zero-shot rating prediction task. Chat-Rec offers a novel approach to improving recommender systems and presents new practical scenarios for the implementation of AIGC (AI generated content) in recommender system studies.

### **9. Where to Go Next for Recommender Systems? ID- vs. Modality-based  recommender models revisited**

Zheng Yuan, Fajie Yuan, Yu Song, Youhua Li, Junchen Fu, Fei Yang, Yunzhu Pan, Yongxin Ni

https://arxiv.org/abs/2303.13835

Recommendation models that utilize unique identities (IDs) to represent distinct users and items have been state-of-the-art (SOTA) and dominated the recommender systems (RS) literature for over a decade. Meanwhile, the pre-trained modality encoders, such as BERT and ViT, have become increasingly powerful in modeling the raw modality features of an item, such as text and images. Given this, a natural question arises: can a purely modality-based recommendation model (MoRec) outperforms or matches a pure ID-based model (IDRec) by replacing the itemID embedding with a SOTA modality encoder? In fact, this question was answered ten years ago when IDRec beats MoRec by a strong margin in both recommendation accuracy and efficiency. We aim to revisit this 'old' question and systematically study MoRec from several aspects. Specifically, we study several sub-questions: (i) which recommendation paradigm, MoRec or IDRec, performs better in practical scenarios, especially in the general setting and warm item scenarios where IDRec has a strong advantage? does this hold for items with different modality features? (ii) can the latest technical advances from other communities (i.e., natural language processing and computer vision) translate into accuracy improvement for MoRec? (iii) how to effectively utilize item modality representation, can we use it directly or do we have to adjust it with new data? (iv) are there some key challenges for MoRec to be solved in practical applications? To answer them, we conduct rigorous experiments for item recommendations with two popular modalities, i.e., text and vision. We provide the first empirical evidence that MoRec is already comparable to its IDRec counterpart with an expensive end-to-end training method, even for warm item recommendation. Our results potentially imply that the dominance of IDRec in the RS field may be greatly challenged in the future.

### **10. Cascading Residual Graph Convolutional Network for Multi-Behavior Recommendation**

Mingshi Yan , Zhiyong Cheng , Chen Gao , Jing Sun , Fan Liu , Fuming Sun , Haojie Li

https://dl.acm.org/doi/10.1145/3587693

Multi-behavior recommendation exploits multiple types of user-item interactions, such as view and cart, to learn user preferences and has demonstrated to be an effective solution to alleviate the data sparsity problem faced by the traditional models that often utilize only one type of interaction for recommendation. In real scenarios, users often take a sequence of actions to interact with an item, in order to get more information about the item and thus accurately evaluate whether an item fits their personal preferences. Those interaction behaviors often obey a certain order, and more importantly, different behaviors reveal different information or aspects of user preferences towards the target item. Most existing multi-behavior recommendation methods take the strategy to first extract information from different behaviors separately and then fuse them for final prediction. However, they have not exploited the connections between different behaviors to learn user preferences. Besides, they often introduce complex model structures and more parameters to model multiple behaviors, largely increasing the space and time complexity. In this work, we propose a lightweight multi-behavior recommendation model named Cascading Residual Graph Convolutional Network (CRGCN for short) for multi-behavior recommendation, which can explicitly exploit the connections between different behaviors into the embedding learning process without introducing any additional parameters (with comparison to the single-behavior based recommendation model). In particular, we design a cascading residual graph convolutional network (GCN) structure, which enables our model to learn user preferences by continuously refining the embeddings across different types of behaviors. The multi-task learning method is adopted to jointly optimize our model based on different behaviors. Extensive experimental results on three real-world benchmark datasets show that CRGCN can substantially outperform the state-of-the-art methods, achieving 24.76%, 27.28%, and 25.10% relative gains on average in terms of HR@K (K={10, 20, 50, 80}) over the best baseline across the three datasets. Further studies also analyze the effects of leveraging multi-behaviors in different numbers and orders on the final performance.

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