A Contrastive Framework with User, Item and Review Alignment for Recommendation

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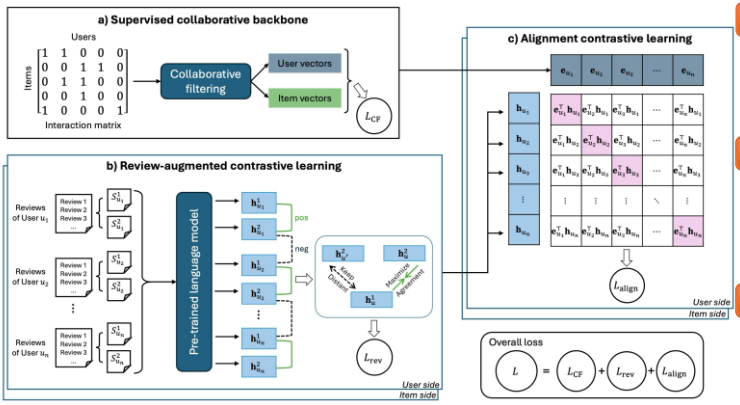
Contributions

In this works, our contributions can be summarized as follows:

- We identify the limitations inherent in treating review data merely as features and observe that reviews provide distinctive contrastive signals for both user and item sides.
- We propose a **Re**view-centric **C**ontrastive **A**lignment **F**ramework for **R**ecommendation (**ReCAFR**) framework that employs review data for augmentation to mitigate the sparsity problem and aligns the tripartite representations to improve robustness.

Framework: ReCAFR



CF backbone

$$y_{u,i} = \begin{cases} 1, & u \text{ has an observed interaction with } i \\ 0, & \text{otherwise.} \end{cases} \Rightarrow L_{\text{CF}} = \sum_{(u,i,j)\in O} - \ln \sigma(\hat{y}_{u,i} - \hat{y}_{u,j}),$$

Review-augmented contrastive learning

$$\mathbf{h}_u^k = \text{MEAN}(\{f(s) \mid s \in S_u^k\}), \quad \mathbf{h}_i^k = \text{MEAN}(\{f(s) \mid s \in S_i^k\}).$$

$$L_{\text{rev}}^{\text{user}} = \sum_{u\in U} - \log \frac{\exp(\text{sim}(\mathbf{h}_u^1, \mathbf{h}_u^2)/\tau)}{\sum_{u'\in U} \exp(\text{sim}(\mathbf{h}_u^1, \mathbf{h}_{u'}^2)/\tau))},$$

$$L_{\text{rev}}^{\text{item}} = \sum_{i\in I} - \log \frac{\exp(\text{sim}(\mathbf{h}_i^1, \mathbf{h}_i^2)/\tau)}{\sum_{i'\in I} \exp(\text{sim}(\mathbf{h}_i^1, \mathbf{h}_{i'}^2)/\tau))},$$

Alignment contrastive learning

$$L_{\text{align}}^{\text{user}} = \sum_{u\in U} - \log \frac{\exp(\text{sim}(\mathbf{e}_u, \mathbf{h}_u)/\tau)}{\sum_{u'\in U} \exp(\text{sim}(\mathbf{e}_u, \mathbf{h}_{u'}))/\tau))},$$

$$L_{\text{align}}^{\text{item}} = \sum_{i\in I} - \log \frac{\exp(\text{sim}(\mathbf{e}_i, \mathbf{h}_i)/\tau)}{\sum_{i'\in I} \exp(\text{sim}(\mathbf{e}_i, \mathbf{h}_{i'}))/\tau))},$$

Experiments

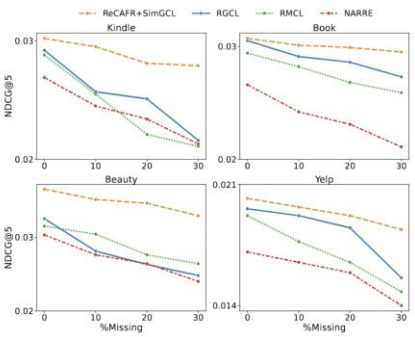
Comparison to baselines w/o review data

Methods	Kindle			Book			Beauty			Yelp		
	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5
BPR	.0203±.0003	.0223±.0008	.0242±.0005	.0142±.0009	.0227±.0006	.0236±.0001	.0264±.0007	.0272±.0009	.0310±.0003	.0109±.0006	.0157±.0007	.0166±.0002
ReCAFR+BPR	**.0226**±.0001	**.0241**±.0009	**.0245**±.0001	**.0143**±.0002	**.0228**±.0001	**.0237**±.0008	**.0277**±.0003	**.0287**±.0002	**.0313**±.0008	**.0115**±.0008	**.0162**±.0004	**.0169**±.0004
LightGCN	.0232±.0001	.0253±.0007	.0281±.0001	.0152±.0005	.0244±.0001	.0254±.0006	.0254±.0008	.0261±.0005	.0298±.0000	.0112±.0006	.0159±.0004	.0168±.0002
ReCAFR+LightGCN	**.0243**±.0005	**.0265**±.0009	**.0293**±.0001	**.0187**±.0005	**.0299**±.0002	**.0311**±.0001	**.0266**±.0006	**.0276**±.0004	**.0300**±.0006	**.0125**±.0006	**.0168**±.0002	**.0175±.0005**
SGL	.0237±.0006	**.0259**±.0007	.0286±.0007	.0169±.0001	.0270±.0008	.0281±.0005	.0269±.0002	**.0276**±.0009	.0316±.0008	.0101±.0004	.0143±.0001	.0151±.0004
ReCAFR+SGL	**.0242**±.0009	.0257±.0005	**.0291**±.0005	**.0171**±.0006	**.0274**±.0007	**.0285**±.0007	**.0276**±.0007	.0273±.0004	**.0319**±.0009	**.0106**±.0001	**.0148**±.0008	**.0158**±.0001
DirectAU	.0255±.0009	.0271±.0003	.0309±.0007	.0167±.0009	.0269±.0007	.0281±.0009	.0298±.0007	.0284±.0007	.0338±.0006	**.0124**±.0009	.0161±.0008	.0169±.0005
ReCAFR+DirectAU	**.0262**±.0000	**.0273**±.0006	**.0317**±.0009	**.0172**±.0006	**.0271**±.0006	**.0285**±.0007	**.0301**±.0008	**.0286**±.0008	**.0341**±.0007	.0121±.0006	**.0179**±.0001	**.0172**±.0008
SimGCL	.0253±.0002	.0277±.0004	**.0306**±.0003	.0180±.0007	.0289±.0006	.0301±.0007	.0288±.0000	.0295±.0002	.0339±.0007	.0145±.0001	.0181±.0002	.0188±.0002
ReCAFR+SimGCL	**.0269**±.0002	**.0285**±.0001	.0302±.0003	**.0184**±.0003	**.0295**±.0006	**.0307**±.0001	**.0296**±.0007	**.0304**±.0005	**.0365**±.0001	**.0155**±.0007	**.0191**±.0009	**.0202**±.0004

Comparison to review-based baselines

Method	Kindle			Book			Beauty			Yelp		
Using all available reviews												
	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5
NARRE	.0238±.0009	.0235±.0005	.0269±.0007	.0160±.0008	.0257±.0003	.0266±.0001	.0266±.0006	.0276±.0002	.0303±.0009	.0129±.0002	.0182±.0009	.0171±.0006
RGCL	.0242±.0006	.0264±.0009	.0292±.0001	.0183±.0003	.0293±.0003	.0305±.0003	.0269±.0006	.0279±.0002	.0325±.0004	.0142±.0002	.0189±.0006	.0196±.0005
RMCL	.0236±.0008	.0259±.0006	.0288±.0001	.0172±.0003	.0286±.0001	.0294±.0009	.0273±.0006	.0265±.0006	.0315±.0004	.0144±.0007	.0186±.0003	.0192±.0006
ReCAFR+SimGCL	**.0269**±.0004	**.0285**±.0008	**.0302±.0003**	**.0184**±.0005	**.0295**±.0005	**.0307±.0003**	**.0296**±.0003	**.0304**±.0001	**.0365**±.0008	**.0155**±.0009	**.0191**±.0008	**.0202**±.0007
Removing 30% of the reviews												
	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5	Recall@5	Prec@5	NDCG@5
NARRE	.0206±.0007	.0229±.0009	.0213±.0008	.0141±.0005	.0214±.0008	.0211±.0006	.0239±.0007	.0261±.0007	.0240±.0006	.0102±.0006	.0145±.0005	.0140±.0007
RGCL	.0215±.0009	.0238±.0004	.0216±.0009	.0152±.0002	.0258±.0009	.0273±.0006	.0247±.0005	.0274±.0008	.0248±.0008	.0109±.0001	.0152±.0005	.0156±.0001
RMCL	.0226±.0007	.0248±.0002	.0211±.0005	.0163±.0005	.0247±.0003	.0259±.0001	.0251±.0001	.0279±.0006	.0264±.0008	.0116±.0005	.0163±.0004	.0148±.0005
ReCAFR+SimGCL	**.0241**±.0007	**.0254**±.0005	**.0279**±.0007	**.0171**±.0001	**.0261**±.0005	**.0295**±.0004	**.0274**±.0008	**.0289**±.0009	**.0329**±.0006	**.0121**±.0005	**.0175**±.0005	**.0184**±.0001

Impact of missing reviews



Ablation Study

Table 4: Ablation study on ReCAFR, reporting NDCG@5.

Variants	Kindle	Book	Beauty	Yelp
ReCAFR+SimGCL	**.0302**	**.0307**	**.0365**	**.0202**
w/o text emb. init.	.0294	.0286	.0351	.0199
w/o user CL	.0281	.0281	.0346	.0186
w/o item CL	.0276	.0284	.0331	.0182

LLM enhancement

You will serve as an assistant to help me determine which types of books a specific user is likely to enjoy.
I will provide you with information about books that the user has purchased, as well as his or her review of that book.
Here are the instructions:
1. Each purchased book will be described in JSON format, with the following attributes:
{ "title": "the title of the book", (if there is no title, I will set this value to "None")
"description": "a description of what types of users will like this book",
"review": "the user's review on the book" (if there is no review, I will set this value to "None")}
2. The information I will give you:
PURCHASED ITEMS: a JSON string describing the item that the user has purchased.

Requirements:
1. Please provide your decision in JSON format, following this structure:
{ "summarization": "A summarization of what types of books this user is likely to enjoy" (if you are unable to summarize it, please set this value to "None")
"reasoning": "briefly explain your reasoning for the summarization}
2. Please ensure that the "summarization" is no longer than 100 words.
3. The "reasoning" has no word limits.
4. Do not provided any other text outside the JSON string.

Instruction

{"title": "The Mythic Guide to Characters: Writing Characters Who Enchant and Inspire",
"description": "The Mythic Guide to Characters is, in short, a remarkable book. It's intelligent and insightful but at the same time easily approachable and user friendly..."
"review": "The Mythic Guide to Characters is a well-organized effort to assist writers, especially those early in their careers, in creating strong and varied characters..."}

Input Prompt

{ "summarization": "This user is likely to enjoy books focused on writing and character development, particularly those aimed at helping aspiring writers improve their craft.",
"reasoning": "The user praised The Mythic Guide to Characters' for its organizational structure and practical advice for early-career writers, indicating a strong interest in writing as a form of expression. The appreciation for examples from popular works suggests a desire for relatable references and a focus on character creation. This aligns with an enjoyment for instructional and insightful literature that aids in the writing process."}

Generated from LLM

Table 5: Demonstration of ReCAFR with LLM-enhanced reviews on the Beauty dataset.

Methods	Recall@5	Prec@5	NDCG@5
BPR	.0264	.0272	.0310
ReCAFR+BPR	**.0277**	.0287	.0313
ReCAFR+BPR (LLM)	.0269	**.0289**	**.0315**
LightGCN	.0254	.0261	.0298
ReCAFR+LightGCN	.0266	.0276	.0300
ReCAFR+LightGCN (LLM)	**.0269**	**.0277**	**.0311**
DirectAU	.0298	.0284	.0338
ReCAFR+DirectAU	.0301	.0286	.0341
ReCAFR+DirectAU (LLM)	**.0306**	**.0295**	**.0349**
SimGCL	.0288	.0295	.0338
ReCAFR+SimGCL	.0296	.0304	.0365
ReCAFR+SimGCL (LLM)	**.0298**	**.0313**	**.0376**

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For complete references please refer to:

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