

Natural Language Explanation for Recommendations and Beyond

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A thesis submitted in partial fulfilment of the requirements
for the degree of
Doctor of Philosophy

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Prof. SURNAME Name (Hong Kong Baptist University)

May 2022

DECLARATION

I hereby declare that this thesis represents my own work which has been done after registration for the degree of PhD at Hong Kong Baptist University, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications.

I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures in accordance with the University's Research Ethics Committee (REC). I have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and/or safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

Signature: _____

May 2022

Abstract

Your abstract

Keywords: Explainable Recommendation, Explainable Artificial Intelligence, Recommender Systems

Acknowledgments

I would like to thank Dr. Guozhong Li for the nice suggestion of making this template as well as the procedure open-source.

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Chapter 1

Introduction

A brief introduction to this chapter.

1.1 Motivation

Sample citations: pre-trained GPT-2¹ [3], Transformer [2], RNN [1]

1.2 Outline

1.3 Contributions

Use the following command to shorten the captions shown in List of Tables/Figures:

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\caption[shorter caption in List of  
Tables/Figures]{Real caption above or below the table/figure}
```

See Fig. 1.1 for example.

¹Codes available at <https://github.com/lileipisces/PEPLER>

Chapter 2

Literature Survey

2.1 Explainable Recommendation

2.2 Context-aware Recommendation

2.3 Natural Language Generation

2.4 Learning to Rank

Chapter 3

Natural Language Explanation Generation

3.1 Background

3.2 Problem Formulation

3.3 Model Description

3.3.1 Input Representation

3.3.2 Transformer and Attention Masking

3.3.3 Explanation and Recommendation

Explanation Generation:

Context Prediction:

Rating Prediction:

Multi-task Learning:

Algorithm 1 Sentence Grouping via Locality-Sensitive Hashing (LSH)

Input: shingle size n , similarity threshold t , minimum group size g

Output: explanation set \mathcal{E} , groups of sentences \mathcal{M}

```
1: Pre-process textual data to obtain the sentence collection  $\mathcal{S}$ 
2:  $lsh \leftarrow MinHashLSH(t)$ ,  $\mathcal{C} \leftarrow \emptyset$ 
3: for sentence  $s$  in  $\mathcal{S}$  do
4:    $m \leftarrow MinHash()$  // create MinHash for  $s$ 
5:   for  $n$ -shingle  $h$  in  $s$  do
6:      $m.update(h)$  // convert  $s$  into  $m$  by encoding its  $n$ -shingles
7:   end for
8:    $lsh.insert(m)$ ,  $\mathcal{C}.add(m)$  //  $\mathcal{C}$ : set of all sentences' MinHash
9: end for
10:  $\mathcal{M} \leftarrow \emptyset$ ,  $\mathcal{Q} \leftarrow \emptyset$  //  $\mathcal{Q}$ : set of queried sentences
11: for  $m$  in  $\mathcal{C}$  do
12:   if  $m$  not in  $\mathcal{Q}$  then
13:      $\mathcal{G} \leftarrow lsh.query(m)$  //  $\mathcal{G}$ : ID set of duplicate sentences
14:     if  $\mathcal{G}.size > g$  then
15:        $\mathcal{M}.add(\mathcal{G})$  // only keep groups with enough sentences
16:        $\mathcal{E}.add(\mathcal{G}.get())$  // keep one explanation in each group
17:     end if
18:     for  $m'$  in  $\mathcal{G}$  do
19:        $lsh.remove(m')$ ,  $\mathcal{Q}.add(m')$  // for efficiency
20:     end for
21:   end if
22: end for
```

Table 3.1: Statistics of the three datasets.

| | Yelp | Amazon | TripAdvisor |
|----------------------|-----------|---------|-------------|
| #users | 27,147 | 7,506 | 9,765 |
| #items | 20,266 | 7,360 | 6,280 |
| #records | 1,293,247 | 441,783 | 320,023 |
| #features | 7,340 | 5,399 | 5,069 |
| #records / user | 47.64 | 58.86 | 32.77 |
| #records / item | 63.81 | 60.02 | 50.96 |
| #words / explanation | 12.32 | 14.14 | 13.01 |

3.4 Experimental Setup

3.4.1 Datasets

3.4.2 Evaluation Metrics

3.4.3 Compared Methods

3.4.4 Implementation Details

3.5 Results and Analysis

3.5.1 Quantitative Analysis on Explanations

3.5.2 Qualitative Case Study on Explanations

3.5.3 Recommendation Performance

3.5.4 Ablation Study

3.6 Summary

Table 3.2: Ablation study on the smallest dataset TripAdvisor. Arrows \uparrow and \downarrow respectively denote the performance increase and decrease compared with PETER.

| | Explainability | | | Text Quality | | | Recommendation | |
|-------------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-------------------|-------------------|-------------------|
| | FMR | FCR | DIV | USR | BLEU-1 | BLEU-4 | RMSE | MAE |
| Disable \mathcal{L}_c | 0.06 \downarrow | 0.03 \downarrow | 5.75 \downarrow | 0.01 \downarrow | 15.37 \downarrow | 0.86 \downarrow | 0.80 \uparrow | 0.61 \uparrow |
| Disable \mathcal{L}_r | 0.07 | 0.14 \uparrow | 2.90 \uparrow | 0.10 \uparrow | 16.16 \uparrow | 1.15 \uparrow | 3.23 \downarrow | 3.10 \downarrow |
| Left-to-Right Masking | 0.07 | 0.15 \uparrow | 2.68 \uparrow | 0.12 \uparrow | 15.73 \downarrow | 1.11 | 0.87 \downarrow | 0.68 \downarrow |
| PETER | 0.07 | 0.13 | 2.95 | 0.08 | 15.96 | 1.11 | 0.81 | 0.63 |

Chapter 4

Conclusion and Future Work

4.1 Conclusion

4.2 Future Work

Bibliography

- [1] Lei Li, Yongfeng Zhang, and Li Chen. Generate neural template explanations for recommendation. In *Proceedings of the 29th ACM International Conference on Information and Knowledge Management*, pages 755–764. ACM, 2020.
- [2] Lei Li, Yongfeng Zhang, and Li Chen. Personalized transformer for explainable recommendation. In *Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)*, pages 4947–4957, Online, August 2021. Association for Computational Linguistics.
- [3] Lei Li, Yongfeng Zhang, and Li Chen. Personalized prompt learning for explainable recommendation. *arXiv preprint arXiv:2202.07371*, 2022.

List of Publications

1. LEI LI, YONGFENG ZHANG, LI CHEN, *Personalized Prompt Learning for Explainable Recommendation*, **ACM Transactions on Information Systems**, 2022. [*submitted*]
2. LEI LI, YONGFENG ZHANG, LI CHEN, *Personalized Transformer for Explainable Recommendation*, **Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing**, pages 4947-4957, Online, Thailand, August 1–6, 2021. (**oral paper**)
3. LEI LI, LI CHEN, RUIHAI DONG, *CAESAR: Context-Aware Explanation based on Supervised Attention for Service Recommendations*, **Journal of Intelligent Information Systems**, volume 57 (1), pages 147-170, August 2021.

CURRICULUM VITAE

Academic qualifications of the thesis author, Mr. LI Lei:

- Received the degree of Bachelor of Engineering from Shenzhen University, June 2017.
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May 2022