

Sequence-based Recommendation with *Bidirectional LSTM Network*

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Abstract

In modern recommendation systems, most methods often neglect the sequential relationship between items. So we propose a novel Sequence-based Recommendation model with Bidirectional Long Short-Term Memory neural network (BiLSTM4Rec) which can capture the sequential feature of items to predict what a user will choose next. By collecting consumed items of a user in a sequence with time ascending order, fitting the model with the last item as the label, the rest items as the features, we regard this recommendation assignment as a super multiple classification task. Once trained well, the output layer of our model will export the probabilities of the next items with given sequence. In the experiments, we compare our approach with several commonly used recommendation methods on a real-world dataset. Experimental results indicate that our sequence-based recommender can perform well for short-term interest prediction on a sparse, large dataset.

Introduction

The primary assignments of recommendation systems faced with consist of two parts: ratings predicting and products recommendation. So to predict what a user will choose next given his consumed history is one of the crucial mission [2] in recommendation area. In many websites and applications, such as online electronic business, news/videos website, music/radio station, they need an excellent service for users to recommend what they will like in future. Existing recommenders mainly concentrate on finding the neighbor sets for users or items, or leveraging other explicit/implicit information (such as tags, reviews, item contents and user profiles) for neighborhood-aware. However, to the best of our knowledge, few works use the sequential feature of data to build recommender. We find that the sequence of data implicates much exciting and relevant information, for example in a video website, the user who watched "Winter is coming" (S01, E02 of Game of Thrones) will be more likely to watch "The Kingsroad" (S01, E02 of Game of Thrones). Even at the 2011 Recsys conference, Pandora's researchers gave a speech about music recommendation and said they found many users consumed music in sequences.

Our work was inspired by the previous study of Siwei Lai et al. [1], where a neural network is proposed to capture the sequence of words in a sentence. We took a similar approach by considering one item as a word, the catalog of items as a vocabulary, and the historical consumed items of one user as a sentence, to capture the sequence of the user consumed items.

Main Objectives

- We propose a novel Sequence-based Recommendation model with Bidirectional Long Short-Term Memory neural network, or BiLSTM4Rec for short, which can capture the sequential features of data, as well scales linearly with the number of objectives (both of users and items).
- We regard item sequence as a sentence and use an $M \times d$ embedding matrix E to represent M items which reduces memory cost evidently when faced big data.

Materials and Methods

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Mathematical Section

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$$E = mc^2 \quad (1)$$

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$$\begin{aligned} \cos \bar{\phi}_k Q_{j,k+1,t} + Q_{j,k+1,x} + \frac{\sin^2 \bar{\phi}_k}{T \cos \bar{\phi}_k} Q_{j,k+1} = \\ - \cos \phi_k Q_{j,k,t} + Q_{j,k,x} - \frac{\sin^2 \phi_k}{T \cos \phi_k} Q_{j,k} \end{aligned} \quad (2)$$

and

$$\begin{aligned} \cos \bar{\phi}_j Q_{j+1,k,t} + Q_{j+1,k,y} + \frac{\sin^2 \bar{\phi}_j}{T \cos \bar{\phi}_j} Q_{j+1,k} = \\ - \cos \phi_j Q_{j,k,t} + Q_{j,k,y} - \frac{\sin^2 \phi_j}{T \cos \phi_j} Q_{j,k}. \end{aligned} \quad (3)$$

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Results

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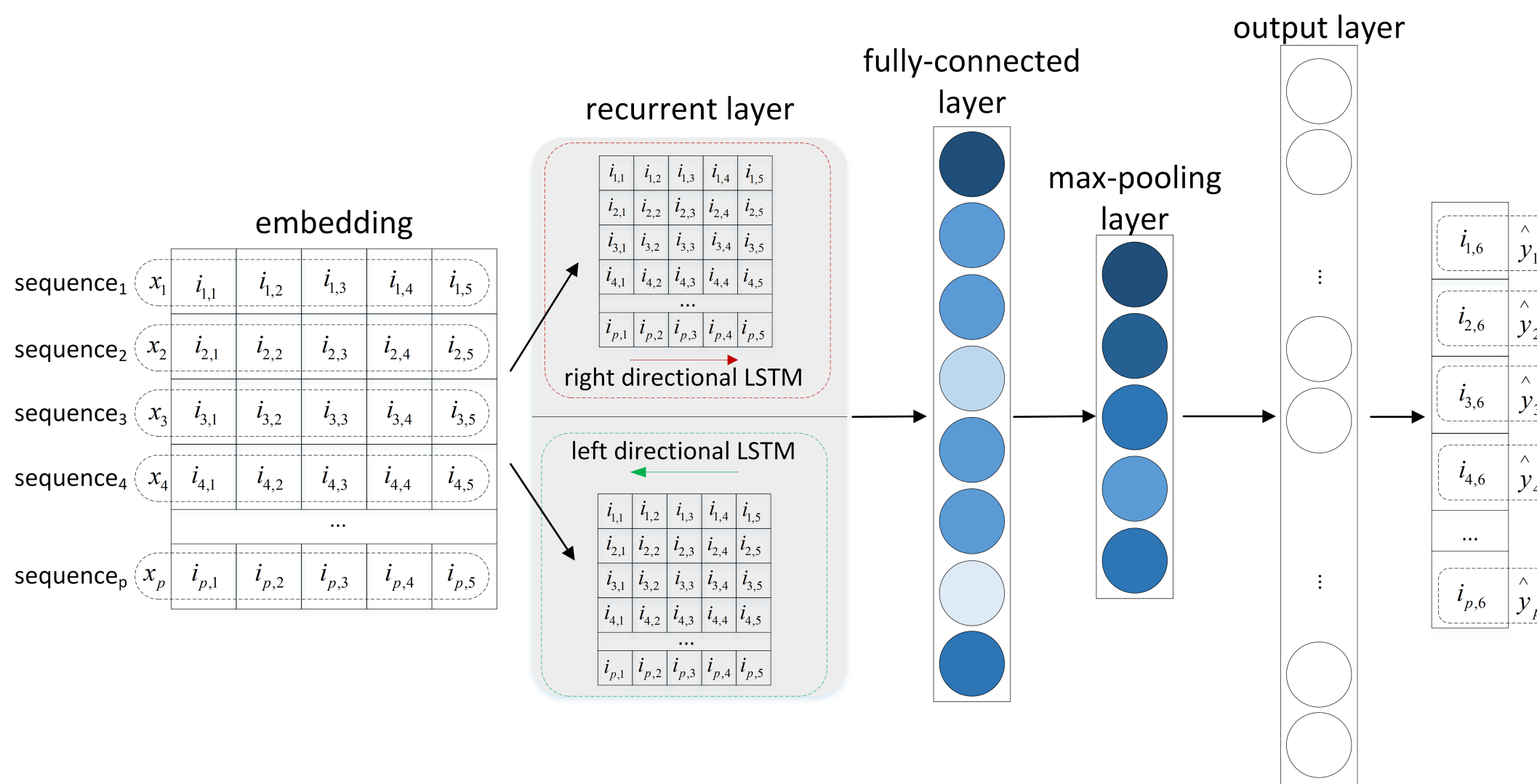


Figure 1: Framework of sequence-based recommendation

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Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 2: Table caption

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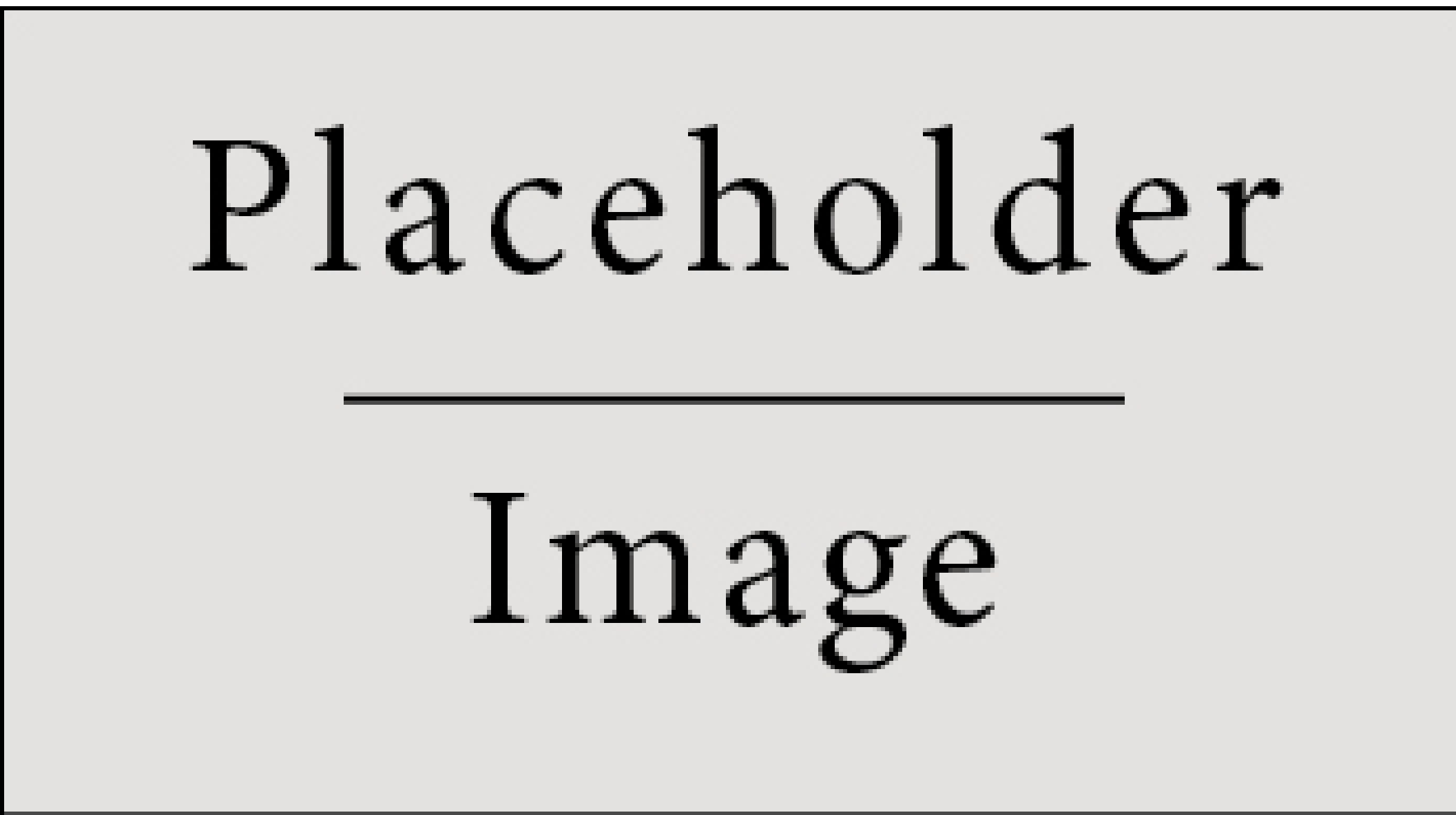


Figure 2: Figure caption

Conclusions

BiLSTM4Rec is a novel recommendation by modeling recent consumed items as a "sentence" to predict what users will choose next. We introduced the Bidirectional Long Short-Term Memory neural network to a new application domain: recommendation system. We dealt with consumed items sequences by embedding matrix to save memory cost, and the final model can learn short-term interest of the user. Experimental results show that our approach outperforms existing methods to a great extent, and shows it is suitable to do a short-term prediction. Moreover, it doesn't have an unacceptable time complexity.

Forthcoming Research

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References

- [1] Siwei Lai, Liheng Xu, Kang Liu, and Jun Zhao. Recurrent convolutional neural networks for text classification, 2015.
- [2] Shengxian Wan, Yanyan Lan, Pengfei Wang, Jiafeng Guo, Jun Xu, and Xueqi Cheng. Next basket recommendation with neural networks. In *RecSys Posters*, 2015.

Acknowledgements

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