

Research On Mining Users' Daily Requirements Considering Variable-Order Dependencies: Behavior Analysis Based On Higher-Order Dependency Networks

Chang Gong, Jiaping Cao, Liwei Qian, Jichao Li

College of Systems Engineering, National University of Defense Technology, Changsha, China

Keywords: requirements mining, higher-order dependency networks, requirements traceability, community detection

In the life, have you ever been distressed because you forgot to bring something when you went out? Are you depressed because you get up in the morning and open the refrigerator and suddenly find it empty? At this point, you will think how nice it would be if someone could anticipate this situation in advance, dig out your needs in advance and give hints. Imagine getting up in the morning, walking to the window, and the curtains open, giving you a beautiful view. Or sitting in front of the computer in the study, getting ready to work, and the air conditioning turns on and the room plays relaxing music. At this time, you will feel that life is quite easy, because these smart homes accurately mine your possible needs. The important premise to mine these needs is behavior prediction. In a home equipped with various sensors and IoT furniture, it would be a feasible solution to collect and record users' daily behaviors for analysis through sensors and human-furniture interaction, based on which the potential requirements of users can be explored and services provided.

Collect daily behavioral time series data to construct behavioral sequences. Given a large amount of daily behavior sequence data, it is a common practice to rewire the network for prediction. By counting the number of interactions between node pairs in the sequence, nodes and edges are constructed to form a network. Afterwards, a random walk is performed in the network to complete the prediction of subsequent actions. But there is a serious problem in behavior prediction using the network constructed by the above method. Since the above network construction process relies on the Markov assumption, where the probability of transitioning to the next state only depends on the current state.

Requirement mining is a task requiring high accuracy. Considering the important role of daily behavior in mining potential requirement, accurate analysis of user behavior is an important prerequisite for requirement mining. The original prediction on sequential data usually suffers from low dependency, poor interpretability and time dependency, so this paper introduces the method of HON into requirement mining based on daily behavior prediction to increase the interpretability and traceability of behavior prediction and requirement mining.

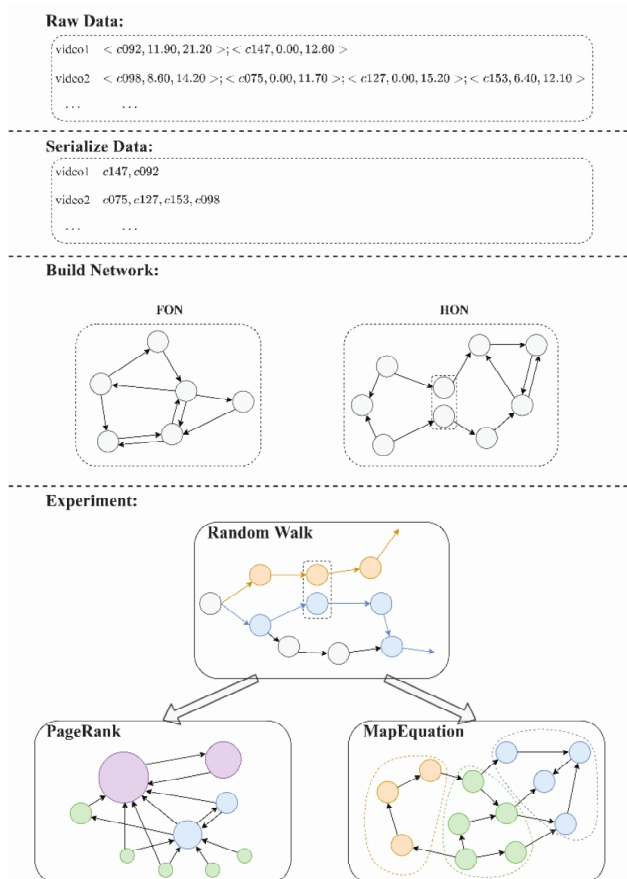


Fig. 1. The main work of this paper. Firstly, we input the label data of the video, including the behavior name, start time and end time. After that, we process the data into behavior sequences. We use the sequence data to construct FON and HON. Finally, we conduct experiments such as random wandering, key node recognition and association detection on the two networks respectively, and compare the results of the two networks.

Acknowledgements

This research was funded by the National Natural Science Foundation of China (NNSFC) under Grant 72001209, 72231011, 72371244 and 72071206, and the Science Foundation for Outstanding Youth Scholars of Hunan Province under Grant 2022JJ20047.

References

- Martin, R., Alcides, V.E., Andrea, L., Jevin, D.W., Renaud, L. 2014. Memory in network flows and its effects on spreading dynamics and community detection. *Nature Communications* 5(1), 4630.
- Mandana, S., Jian, X., Lance, M.K., Bruno, R., Nitesh, V.C. 2020. Efficient modeling of higher-order dependencies in networks: from algorithm to application for anomaly detection. *EPJ Data Science* 9(1), 15.
- Jian, X., Nitesh, L.W., Nitesh, V.C. 2016. Representing higher-order dependencies in networks. *Science Advances* 2(5), e1600028.
- Martin, R., Bergstrom, C.T. 2008. Maps of random walks on complex networks reveal community structure. *Proceedings of the National Academy of Sciences of the United States of America* 105(4), 1118-1123.
- Lambiotte, R., Rosvall, M., Scholtes, I. 2019. From networks to optimal higher-order models of complex systems. *Nature Physics* 15(4), 313–320.