Fake news detection with Graph Neural Network

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1 Thesis Summary

The rapid advancement of technology and the accelerating dissemination of information have contributed to a significant increase in the prevalence of fake news, defined as misleading or deliberately deceptive news articles. This proliferation poses a significant challenge, as it can erode trust in institutions and the media, incite violence and hatred, influence elections and public policy, discourage civic engagement, and fracture social cohesion. Therefore, developing effective and efficient strategies for detecting and intercepting online fake news is crucial. This thesis makes three research contributions focused on fake news detection, each employing graph neural networks (GNNs) and leveraging diverse graph data features to model social network.

This research addresses fake news detection through the application of GNNs, following a two-stage methodology. The initial stage involves constructing a graph model of the social network environment. Users and news entities are represented as nodes, while interactions and information sharing constitute edges, thereby encapsulating relevant social dynamics and propagation patterns. Subsequently, a GNN architecture is designed to process this graph-structured data, leveraging topological information and node attributes to discern the characteristics of fake news. The study also explores strategies for handling scenarios with multiple graphs, such as modular processing with subsequent information fusion, and addresses the requirements for modeling complex relational structures like hypergraphs. Three primary technical contributions stem from this research.

In first contribution, we investigate Graph Neural Networks that can handle graphs based on a Dynamic Heterogeneous Information Network, where the relationships between various types of elements in a real-world social network evolve over time, with new relationships forming or existing ones changing, represented as the evolution of the graph. A Heterogeneous Information Network (HIN) is a graph representing complex systems with multiple types of nodes (entities) and edges (relationships), providing a richer representation than simpler, homogeneous networks with only one type of node and edge. It can represent complex systems more accurately by capturing the diverse types of entities and relationships present in real-world scenarios. On the other hand, a dynamic graph can represent changes in the network structure over time. This includes the addition and removal of nodes and edges, as well as changes in their attributes. Static graphs simply cannot capture these dynamics. However, existing GNNs that handle dynamic heterogeneous information networks cause enormous computation costs during the training process and there are limitations on application in real-time detection due to this problem. To solve high training computation costs, we investigate the inefficiency of usual message-passing propagation in traditional GNN during the Dynamic Heterogeneous Information Network training process and replace it with a dynamic propagation scheme, which is inspired by [1], to reduce the inefficient costs. This approach significantly reduces the training time required for DHINs by 35% to 45% compared to existing techniques.

In second contribution, To emphasize the influence of early-stage news propagation dynamics on the detection of false news on platforms like Twitter [2], known for prevalent information sharing, we conduct research that simultaneously considers both a homogeneous information network (to highlight propagation patterns) and a heterogeneous information network (to capture the social context with its diverse node and edge types). To accomplish this, we employ separate training processes for the homogeneous and heterogeneous information networks. Subsequently, at designated timestamps, the features extracted from both networks are integrated and processed within a fused-temporal module. Consequently, we found that early-stage news propagation significantly influences the perceived veracity of news. Within the initial two-hour period, our model achieves approximately 80% accuracy on realworld datasets.

Lastly, we conducted research on fake news detection using hypergraphs, leveraging their ability to represent high-order connections to model both user interactions and author-topic relationships. It is inspired by whether the relationship between the author and topic affects fake news detection by examining the trustworthiness of news according to the author and various topics, along with user interaction. We established a connection between authors and topics using a topic model called author-topic modeling. However, representing each topic as a single edge leads to a loss of information regarding the specific authors associated with that topic to represent the relationship between topic and author, using a general pairwise graph requires a very large number of edges, and accordingly, inefficient computation costs cannot be avoided, but through hypergraphs can naturally represent relationships involving more than two entities, unlike standard graphs which are limited to pairwise connections. This is crucial and efficient for modeling group interactions. Furthermore, establishing connections between hyperedges allows for more effective information network construction, reflecting the relationships between authors and topics.

Research for contributions 1,2, and 3 is currently complete. Our plan is to finalize the draft for chapter 3 by the end of April, after which the focus will shift to writing the thesis.

References

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