Chapter 18
Using Graph Neural Network to Enhance Quality of Service Prediction

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ABSTRACT

Quality of service (QoS) prediction has great importance in today's web services computing. Several researchers proposed methods to enhance the quality of service prediction. The most used one is collaborative filtering (CF), which can be categorized into three main categories: memory-based algorithms, model-based algorithms, and context-based CF algorithms. This paper proposes a model-based algorithm using the graph neural network (GNN) to predict the QoS values. To evaluate the performance of the proposed method, an experiment was conducted. The WS-dream dataset used in the experiment and the proposed method performance were compared with three baseline methods (User item-based Pearson correlation coefficient for QoS prediction-UIPCC, reputation-aware network embedding-based QoS Prediction-RANEP, and trust-aware approach TAP for personalized QoS prediction). The experiment results show that the proposed method, the GNN-based QoS prediction algorithm, performs better than memory-based and other model-based methods in terms of RMSE and MAE in most cases.

INTRODUCTION

With the development of technology, the use of web services increased. In addition, the volume of data transmitted over networks is rising, making studying technologies that facilitate the transmission of this data a necessity. In the next few decades, it is expected that many web services will offer the same

services. Clients will demand more value-added and informative services than those provided by single, isolated web services. As a result, the problem of synthesizing high-quality web services has been raised as a significant problem, and clients face the problem of choosing or creating a configuration plan from among the many possible projects that meet their quality of service (QoS) requirements. That is why QoS prediction for web services has been a hot research topic in services computing in recent years.

QoS is the description or measurement of the overall performance of a service. In other definition, QoS can be defined as a set of non-functional attributes that may impact the QoS offered by a web service (Kritikos & Plexousakis, 2009). QoS has many different features, such as accuracy, capacity, availability, reputation, and cost. Also, the response time and throughput are QoS attributes that can be considered essential. Several researchers proposed methods for QoS prediction. However, the most used one is collaborative filtering (CF). CF is technique recommender systems use that learns the user's previous behaviors, provides personalized service support and predicts their current preferences for particular products. Moreover, this is used to improve the accuracy of recommendations. In the general sense of CF, CF is the process of filtering information or patterns using methods involving collaboration between multiple agents, viewpoints, data sources, etc. In a narrower one, CF is a method of automatically predicting (filtering) a user's interests by collecting information about the preferences or tastes of many users (collaboration).

The advancement of neural networks encouraged researchers to investigate their ability to enhance QoS predictions. Neural Network is a subset of machine learning which, in turn, is a subset of artificial intelligence. Neural Network name and structure are inspired by the human brain, mimicking how biological neurons signal each other. One of these neural networks is the graph neural network (GNN). Best of our knowledge, two recently published works proposed using GNN for QoS prediction. The first is using a Two-Level Heterogeneous Graph Attention Network for QoS Prediction (Lv et al., 2022). The second combines multi-component graph convolutional CF and a DeepFM for QoS prediction (MGCCF-DFM) (Ding et al., 2021). Although these two methods achieved good performance, there is still some space for improvement. Hence, our main contribution is to propose another method that fills in the gap and improves the performance of QoS prediction.

This paper proposes a GNN-based QoS prediction method. The paper starts with a background description of some QoS methods and a background of the GNNs. Then the proposed method and the experiment description will be discussed. After that, the experiment results are presented. Finally, some conclusions are drawn, and future research direction is described.

BACKGROUND

Quality of Service

As mentioned before, the response time and throughput are QoS attributes that can be considered essential. Response time is the time to complete a web service request from a client's perspective. In contrast, throughput is the number of web service requests served at a given period. Many researchers have used QoS prediction methods to get accurate and feasible QoS values. One of the most important approaches for predicting the QoS is CF. CF-based methods can be classified into three main categories: memory-based algorithms, model-based algorithms, and context-based CF algorithms (Ghafouri et al., 2021).

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