Friend recommendation with Graph Neural Networks

Barát ajánlás Gráf Neurális Hálókkal

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1. Introduction

Nowadays, networks are present in every aspect of life, from the very noticeable transport and social networks to the invisible web of the Internet, down to the microscopic networks of molecules making up the fabric of the world. Network analysis is a vast research field seeking to investigate these structures using statistical analysis and graph theory. Thanks to the information boom of the last decade, the size of the networks available for analysis has greatly increased, parallel to the rise of computational power, which enables researchers to process these networks on a scale never seen before.

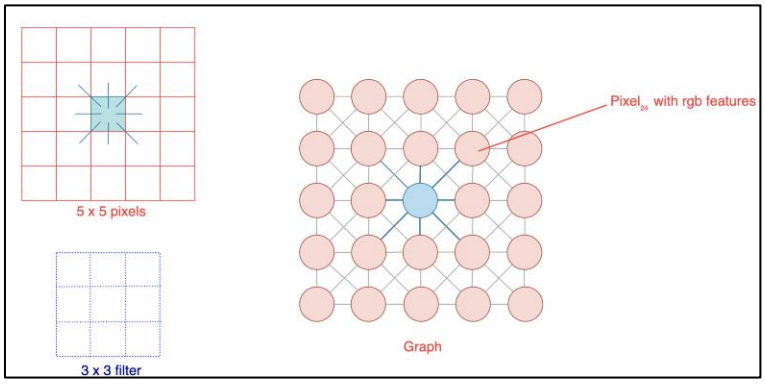
One of the vital applications of network analysis is friend recommendation, which seeks to enhance social networking platforms by intelligently connecting users with potential friends based on shared interests, activities, or mutual connections. These systems leverage complex algorithms and machine learning techniques to analyse user behaviour, interactions, and profile information, aiming to suggest connections that are not only relevant but also likely to foster meaningful relationships. With the advent of modern machine learning, several deep learning models have been proposed for operating on graph data for many different applications including friend recommendation.

Our goal was to develop a friend recommendation system by using Graph Neural Networks (GNNs), that utilises data about the users, as well as, their connections. For this purpose, we used the Stanford Social Circles Dataset, specifically the Facebook dataset.

2. Background

2.1. Graph Convolutional Neural Networks

In today's world, many important datasets take the form of graphs or networks: knowledge graphs, social networks or recommender systems. Graph Convolutional Networks (GCN) seek to harness the data present in the connections in these datasets. The structure of Graph Convolutional Networks most closely resembles Convolutional Neural Networks (CNN) used mainly for analysing visual data. Convolutional neural networks can be understood as unique graph convolutional networks, since a picture is a special kind of graph where the vertices are the pixels, edges connect the neighbouring pixels, and the graph data stored in the pixels/vertices is the RGB values. This



1. Figure Image data represented as a graph

similarity can be seen in figure 1. Graph convolution works similarly to traditional convolution as information is gathered into the vertex from a given radius, much like filter size in image convolution.

2.2. Friend Recommendation

Graph convolutional networks have many different, the largest categories are the following:

- **Node/Vertex prediction**: This is used for assigning class labels or regression values to the nodes of the graph based on the labels or values of the neighbouring nodes. For example, finding fraudulent entities in a network in an e-commerce community falls into this category.
- **Edge prediction**: In this case, the network either predicts a value, for example, the weight, of the edges or classifies them. A special and common subsection of this is link prediction, when the network has to predict whether nodes have an edge between them. This use case is instrumental in the user recommendation systems used in the industry, we also use this technique for this project.
- **Graph prediction:** In this vast category, networks are used for classifying or assigning a regression value to whole graphs, for instance, calculating a chemical property of a molecule.

3. Implementation

3.1. Dataset
3.2. Tools and Libraries
3.3. Data Preparation
3.4. Model
3.5. Hyperparameter Optimisation
3.6. Training
3.7. Evaluation methods and results

4. Results

5. Conclusions

6. Future Plans