

Preface

Overview

Link prediction problem has been widely studied in the past. It is primarily applied in recommender systems. The problem deals with predicting new links that are likely to emerge in a network in the future, given the network at the current time. Two nodes tend to get connected if they are similar to each other. Hence, it is important to compute similarity between two nodes to assess the possibility of link formation between them. Some of the link prediction similarity measures such as *Common Neighbors (CN)*, *Adamic Adar Index (AA)*, *Resource Allocation Index (RA)*, *Preferential Attachment Index (PA)*, *Katz*, and *PropFlow* use the structure of the network like the neighborhood information and path information between a pair of nodes to compute similarity between two nodes. Higher similarity between two nodes implies higher possibility of link formation between the two nodes. Although power law degree distribution is an important notion in social networks, its role has not been explored adequately in the context of link prediction.

In this book, we propose link prediction similarity measures for social networks which exploit the degree distribution of the networks. In the context of link prediction in dense networks, we propose *Markov Inequality Degree Thresholding-based similarity measure (MIDT)*, which only considers nodes whose degree is below a threshold for a possible link. The threshold value is determined using the Markov Inequality. Next, we present similarity measures based on cliques (CNC, AAC, RAC), which assigns extra weight between nodes sharing more number of cliques. Further, we propose a *locally adaptive (LA)* similarity measure, which assigns different weights to common nodes based on the degree distribution of the local neighborhood and the degree distribution of the network. The weight of the common node varies with the neighborhood under consideration. In the context of link prediction in sparse networks, we propose a novel *two-phase framework* that adds edges to the sparse graph to form a boost graph. We use the boost graph instead of the original network for link prediction.

Audience

This book is intended for graduate students and researchers working on the link prediction problem. Specifically, we present similarity measures in link prediction by exploiting the *power law degree distribution* of the network that social networks typically follow. The techniques could be applied in different areas such as computer science, engineering, etc. It is assumed that the reader has a basic knowledge of mathematics at the high-school level, as well as a certain background in computing and programming. Although the algorithms can be implemented in programming languages, such as C++, Java and Python, etc, C++ implementation renders superior performance in terms of computational speed.

Organization

This book is organized as follows:

1. *Literature and Background*: Chapter 1 presents the literature and state-of-the-art techniques in link prediction. Further, we also discuss the relevant background required for link prediction.
2. *Link Prediction in Dense Networks*: Chapters 2 and 3 present link prediction similarity measures based on power law degree distribution of the network in dense networks.
 - (a) *Degree Thresholding*: Chapter 2 presents a node thresholding approach (MIDT) based on its degree. It assigns a smaller weight to the low-degree common nodes and ignores the contribution of the high-degree common nodes. Further, in Chap. 2, we also present a clique-based approach (CNC, AAC, RAC) to link prediction, which assigns heavier weights to node pairs that share common neighbors having more number of cliques.
 - (b) *Locally Adaptive Approach*: Chapter 3 presents a Locally Adaptive (LA) Approach wherein the weights to the common nodes for similarity computation is based on the degree distribution of the local neighborhood and the degree distribution of the network. Further, the weights assigned to the common nodes vary with the local neighborhood under consideration.
3. *Link Prediction in Sparse Networks*: We present a framework for link prediction, a novel two-phase approach, to deal with sparse networks in Chap. 4.
4. *Applications of Link Prediction*: We present and discuss various applications of link prediction in Chap. 5.
5. *Conclusion*: We conclude in Chap. 6 and also present potential future directions for link prediction based on power law degree distribution of the networks.

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Link Prediction in Social Networks

Role of Power Law Distribution

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