PREFACE

In the last two decades, rapid proliferation of information technology and ubiquitous computing has spurred tremendous growth of knowledge being captured in digital form and archived all over the world. Such huge repository has created a multifaceted information overload problem. While in one hand, it offers a great convenience for users to access and share information, organizing and searching content in such a collection is a challenge. In this era of big data, recommender systems that aim to suggest items of potential interest to users are gaining growing amount of attention from the research community. Recent years have witnessed rapidly growing scholarly information due to the expanding academic activities: publishing papers, collaborating with other authors, citing papers/authors etc. both in academia and industry. These involve an overwhelming number of articles, journals, conferences, reviewers, affiliations, and researchers. Getting articles, venues, collaborators, and/or reviewers that satisfy a user's need in this complex research ecosystem is not trivial. Academic recommender systems is fast becoming an emerging field to provide recommendations for papers, citations, collaborators, reviewers, and academic venues. These systems are particularly useful to academicians as they provide personalized information services.

Researchers always look for the most appropriate academic venues that are in-line with their scholarly interests and of high relevance. Even a high-quality paper is sometimes rejected due to a mismatch between the area of the paper, and the scope of the journal attempted to. Recommending appropriate academic venues, therefore, enables researchers to identify and take part in relevant conferences and to publish in journals of high impact. Researchers often collaborate with their peers to improve the quality of research and thereby enhance academic profiles. However, growing number of research areas, and dynamic changes in researchers' interests, throws a difficulty in identifying the potential researchers for effective collaboration. In this thesis, we develop a multi-objective

academic recommender system focusing on two main tasks: journal and collaborator recommendation. We propose three novel journal recommender systems: DISCOVER, CNAVER, and DeepRec and one collaborator recommender system: DRACoR.

DISCOVER: A Diversified yet Integrated Social network analysis and COntextual similarity-based scholarly VEnue Recommender system contains a multi-stage layered approach: social network analysis, citation analysis and main path analysis. Each layer performs a specific task in DISCOVER. Across the layers, topic modeling based contextual similarity is used multiple times to filter out irrelevant papers. As a part of content analysis, newly proposed keyword-based search strategy also largely reduces the number of candidate papers that are potentially related to a given seed paper. Several other techniques, at each stage, identify the important papers and remove irrelevant papers. This work mainly addresses cold start issues for a new researcher and a new venue along with considerable reduction in data sparsity, and overall computational costs. Special emphasis is given to enhance the overall quality of recommendation. Experiments based on Microsoft Academic Graph (MAG) dataset show that the proposed DISCOVER outperforms state-of-the-art recommendation techniques in terms of standard metrics like precision@k, nDCG@k, MRR, $F - measure_{macro}$, and average venue quality.

DISCOVER incorporate both social network analysis and contextual similarity in a cascading manner and addresses the problem of cold start for new researchers reasonably well. However, cold start issues for new venues, sparsity, diversity, and stability issues are not adequately addressed. Specifically DISCOVER did not capture venue scope variation with time (when scope of journal is modified). These issues are specially taken into consideration in CNAVER: a Content and Network-based Academic VEnue Recommender system. It provides an integrated framework employing a rank-based fusion of paper-paper peer network (PPPN) model and venue-venue peer network (VVPN) model. While PPPN explores the interaction among papers for venue recommendation, VVPN actually studies it among publication venues. The cold-start issue for new venues is given more careful attention in VVPN. In VVPN, in addition to abstract similarity (for papers with no citations), meta-path features (common papers, authors, citations, co-citations, terms, or topics) are considered to assign importance to venues. Venues having less number of papers and citations thus also get due consideration in the venue-venue graph (VVG). CNAVER only requires the title and abstract of a paper to provide venue recommen-

dations, thus assisting researchers even at the earliest stage of paper writing. Another salient point is that, in CNAVER recommendations are independent of keywords. Within PPPN, we adopt two-stage filtering techniques such as centrality measures based citation analysis and contextual similarity like LDA on abstract and Doc2Vec on the title. This filtering strategy considers both importance and relevance parameters to reduce the bibliographic network size and also to increase the relatedness among papers. To capture the shift in a venue's scope with time, an age-discounted weighting scheme is proposed in CNAVER. The topics from recently published papers are prioritized, while topics from older publications are penalized in this scheme. CNAVER addresses cold start issues such as the involvement of an inexperienced researcher and a novel venue along with the problems of data sparsity, and diversity, in a better way than DISCOVER.

We employed two kinds of analysis: citation analysis and contextual similarity analysis in both DISCOVER, and CNAVER. These processes require good amount both space and time to store and organize shortlisted papers properly (by storing title, abstract, and citations relationship among papers). CNAVER is also sensitive to the structure of bibliographic citation network and may result in some irrelevant recommendations. In order to make better space-time utilization, and to enhance relevance, and stability of recommendation, we, introduce DeepRec: a Deep learning-based scholarly venue Recommender system. Deep learning has the ability to discover the intricate structure and deep semantics in high dimensional data, that we leverage in the model to recommend journals. The proposed system is based on a stacked generalized ensemble learning. Our ensemble learning-based model is elaborately designed based on convolution neural network (CNN), and Long short-term memory (LSTM). CNN is mainly adopted to extract local structure of the data, while LSTM can capture the temporal correlation and dependencies in the text snippet. Extensive experiments have been conducted on the DBLP dataset to demonstrate that CNAVER and DeepRec outperform state-of-the-art recommendation techniques using standard metrics of precision@k, nDCG@k, accuracy, MRR, and stability.

As the final contribution, we present DRACoR: A Deep learning and Random walk based Academic Collaborator Recommender system. It is a multi-level fusion-based model to provide recommendation for potential peer-level collaborators that share similar research interests. DRACoR is mainly designed to recommend most influential collabora-

tors (MICs) incorporating Meta-path aggregated Random walk based Collaborator Recommendation (MRCR) that finds out most potential collaborators (MPCs) with Deep learning-Boosted Collaborator Recommendation (DBCR) models that find most valuable collaborators (MVCs). To capture the shift in an author's research interest with time, a time-aware inverse logarithmic weighting scheme is adopted. Deep learning incorporating Word2Vec and Long Short Term Memory (LSTM) techniques are employed in DBCR. The fusion of both MRCR and DBCR can provide relevant collaborators for a given researcher. Extensive experiments on DBLP and hep-th datasets demonstrate the effectiveness of our proposed DRACoR model against various state-of-the-art methods in terms of precision, recall, F1-score, MRR, and nDCG.

Academic recommendation is an emerging field that is gaining increasing attention worldwide nowadays. Although few works have focused on different objectives one at a time, there has not been any reported work with multiple objectives attempted simultaneously. We have proposed here a general framework of an academic recommender system that can provide a recommendation of multiple entities based on a user's requirements. In this thesis, we focused on journal and collaborator recommendations and came up with three different proposals for journal recommendation (DISCOVER, CNAVER, and DeepRec) and one for collaborator recommendation (DRACoR). DISCOVER was our first journal recommender that addressed the cold start issue of new researchers reasonably well and suggested better quality venues compared to state-of-the-art competitors. Cold start issue for new venues is given more careful attention in our second journal recommender CNAVER that also provided more diversity among its recommendations. Our third journal recommender DeepRec outperformed state-of-the-art systems and addressed some other issues like data sparsity, and stability present in other systems. Our collaborator recommender DRACoR also showed better relevance over its competitors and reasonably addressed the cold start issue for new researchers. The proposed framework has the potential to be extended to other entity recommendations like reviewer recommendation, citation recommendations, and providing decision support to paper reviewing-some of which we would like to continue as future work.