Individual Doctor Recommendation in Large Networks by Constrained Optimization

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ABSTRACT

In this paper, the authors try to systematically investigate the problem of individual doctor recommendation and propose a novel method to enable patients to access such intelligent medical service. In their method, the authors first mine doctor-patient ties/relationships via Time-constraint Probability Factor Graph model (TPFG) from a medical social network. Next, they design a constraint-based optimization framework to efficiently improve the accuracy for doctor-patient relationship mining. Last, they propose a novel Individual Doctor Recommendation Model, namely IDR-Model, to compute doctor recommendation success rate based on weighted average method. The authors conduct experiments to verify the method on a real medical data set. Experimental results show that they obtain better accuracy of mining doctor-patient relationship from the network, and doctor recommendation results of IDR-Model are reasonable and satisfactory.

INTRODUCTION

It is difficult for patients to find the most appropriate doctor to diagnose. In most cases, just considering Authority Degrees of Candidate Doctors (AD-CDs) cannot satisfy this need due to some objective preferences such as economic affordability of a patient, commuting distance for visiting doctors and so on. In this paper, we study individual doctor recommendation which is an

emerging research topic. Several main challenges/difficulties exist: 1) How to measure authority degree of a doctor. 2) How to make individual doctor recommendation according to patients' preferences information. 3) How to evaluate the recommendation accuracies of our method.

To address these above challenges, we try to systematically investigate the problem of individual doctor recommendation. First of all, we mine doctor-patient relationships via TPFG Model (Wang, 2010) from a medical social network. Next, we make constrained optimization analysis of Doctor-Patient Relationships and design a constrained optimization framework to efficiently improve the accuracy for doctor-patient relationship mining under various constraints. Last, we propose a novel weighted-average-based approach, namely IDR-Model, for solving the problem of individual doctor recommendation.

RELATED WORK

Traditional information retrieval models, such as Boolean Model (Ricardo, 1999), Multi-keyword method (Chen, 2012) and Vector Space Model (Salton, 1975), all compute similarity degree between query keywords and destination doctors. A closely related research topic is *expertise search*, such as expertise search based on candidate vote by Macdonald and Ounis (Macdonald, 2006), expertise mining from social network by Tang et al.(Tang, 2009), and transfer learning from expertise search to Bole search by Yang et al. (Heidelberger, 2011). The probabilistic topic models are often used in social ties/relationships analysis and mining (Zheng, 2012). Bloom Filter based distributed random replication scheme is proposed for content retrieval in unstructured P2P networks (Chen, 2012). Several recent studies focus on how to model the imbalanced and noisy data in order to improve relationships mining performance (Yuan, 2012; Zhou, 2009), how to search in P2P Networks (Chen, 2009; Chen, 2010) and how to obtain better classification results (Zhang, 2009).

The most basic method to solve experts matching problem is Bipartite Graph Matching. It considers tasks and experts as two point sets in a bipartite graph, respectively. Then it computes the relevance between tasks and experts by setting some kind of preference. Thus we can obtain a fully connected weighted bipartite graph and solve the problem using the classical Hungarian algorithm (Kuhn, 1995). More advanced methods include: 1) obtain keywords by searching on Internet and then make matching; 2) calculate the relevance in order to make matching using LSI (Latent Semantic Indexing) method(Karimzadehgan, 2008; Mimno, 2007); 3) obtain assignment scheme using Linear Programming (Karimzadehgan, 2009); and 4) make assignment using minimum cost network flow method (Hartvigsen, 1999).

In the literature, some recommendation methods only consider the similarity between the query keywords and individual doctors, but ignore the relationships between doctors and patients in a social network (Macdonald, 2006). Without considering doctor-patient relationship, this simple keyword match based approach to doctor recommendation does not differ much from existing research on expertise search. Other approaches consider the social network for modeling, but most of them focus on computing the Authority Degree of objects in the network, and a ranking of those objects based on the Authority Degree (Yang, 2009). The limitations of these methods are: 1) It is difficult to set the parameters by users in the traditional ranking models (e.g., Boolean model, probabilistic model, etc.). It is also hard to detect and avoid model over fitting and integrate multiple models. 2) As the evaluation of the Authority Degree of doctors can be subjective, the Authority Degree scores in the test data may be biased, thus it is hard to give a "fair" ranking result. In contrast, our proposed method computes the success rate of finding the

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