Online Social Networks and Media 3–4 (2017) 75–97

Contents lists available at ScienceDirect

Online Social Networks and Media

journal homepage: www.elsevier.com/locate/osnem

Recommender Systems for Online and Mobile Social Networks: A survey

Mattia G. Campana*, Franca Delmastro

IIT-CNR, Via G. Moruzzi 1, 56124 Pisa, Italy

ARTICLE INFO

Article history:
Received 24 September 2017
Revised 28 October 2017
Accepted 30 October 2017

Keywords:
Recommender Systems
Online Social Networks
Mobile Social Networks

ABSTRACT

Recommender Systems (RS) currently represent a fundamental tool in online services, especially with the advent of Online Social Networks (OSN). In this case, users generate huge amounts of contents and they can be quickly overloaded by useless information. At the same time, social media represent an important source of information to characterize contents and users' interests. RS can exploit this information to further personalize suggestions and improve the recommendation process. In this paper we present a survey of Recommender Systems designed and implemented for Online and Mobile Social Networks, highlighting how the use of social context information improves the recommendation task, and how standard algorithms must be enhanced and optimized to run in a fully distributed environment, as opportunistic networks. We describe advantages and drawbacks of these systems in terms of algorithms, target domains, evaluation metrics and performance evaluations. Eventually, we present some open research challenges in this area.

Contents

* Corresponding author.
E-mail addresses: m.campana@iit.cnr.it (M.G. Campana), f.delmastro@iit.cnr.it (F. Delmastro).

https://doi.org/10.1016/j.osnem.2017.10.005
2468-6964/

1. Introduction

Recommender Systems (RS) and Online Social Networks (OSN) have established a strong cooperation in the last few years. They both aim at coping with the huge amount of data produced and shared by users through online platforms, trying to maintain a high user engagement. This cooperation is built upon the advantages that both systems can achieve: the optimization of the recommendation techniques, by exploiting additional content and user characterization derived from OSN, and the increasing request of OSN services' personalization. RS targeting the social media domain have been already defined in the literature as Social Recommender Systems (SRS) [1,2]. However, this notion should be further expanded, embracing also the recent evolution of social media towards the pervasive and mobile computing environment. Here, the network can be also implemented by the physical co-location of users and devices, and their ability to exploit direct wireless communications for content sharing and dissemination, without requiring a constant Internet access. In this direction, the concept of Mobile Social Networks (MSN) has been introduced in [3], not as a simple extension of OSN services running on mobile devices, but as the opportunity to create real *networks of people*, in which users actively participate in the generation and sharing of contents, anywhere and anytime, based on opportunistic networking and device-to-device (D2D) communications. In this scenario, RS can be optimized by exploiting additional information derived from users' mobile devices (i.e., sensors), which help contextualize the user's preferences, and to rely on a partial and dynamic knowledge of the network and the available data. This concept contributes to the migration towards a new Internet paradigm, the Internet of People (IoP) [4], in which users are at the center, by actively contributing to the network evolution both from the communication and data point of views.

In this paper we present a survey of RS defined both for OSN and MSN, highlighting advantages and drawbacks of standard recommendation techniques applied in these environments, and how those systems evolved over time, in terms of technical solutions, target domains, evaluation metrics and performance evaluations. In Section 2, we summarize the problem of recommendations and the evaluation metrics generally used in the literature. Then, in Section 3, we present an overview of standard techniques like Collaborative Filtering (CF), Content-based RS, Network-based RS and Context-aware RS, with particular attention to the various information used to characterize the relationship between users and items to further optimize and personalize the recommendations. This section would also introduce the reader with standard notations and methods applied in RS, which will be analyzed in the subsequent sections. In Sections 4 and 5, we describe the main solutions presented in the literature for OSN and MSN, respectively. The first area has been widely studied in the last years, proposing solutions that can address different target domains (e.g., to recommend people, locations, point of interests, tags or contents) by exploiting heterogeneous context information. Therefore, we decided to group the proposed solutions by the type of context information used (e.g., social relationships, tags, location) and the recommendation target (e.g., to recommend contents, tags, friends, people).

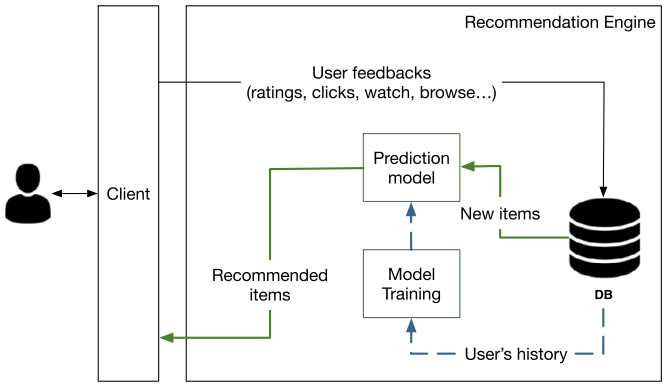

Fig. 1. Recommender System architecture.

The research area of RS for MSN is still in its infancy, and few solutions have been presented in the literature, mainly aimed at optimizing content dissemination in opportunistic networks through personalized recommendations. The main difference between RS for OSN and MSN relies on the knowledge they use to select the recommendations for their final users. In OSN, RS assume to have access to a complete knowledge of all the available objects in the network (i.e., contents, tags, etc.), residing on a centralized infrastructure. Instead, in MSN, RS can rely on the local knowledge of each user, represented by the local available objects and those declared by other users in proximity through D2D communications. In this scenario, each mobile device has a different knowledge of the network, which grows up through its personal mobility and its opportunities to communicate with the others. In addition, mobile devices have limited computational capabilities and RS must be characterized by efficient response time. This is due to the limited and unpredictable duration of the opportunistic contact, during which mobile devices can exchange their local knowledge and the recommended objects. In order to evaluate and compare the performance of RS for MSN, it is necessary to reproduce the realistic behavior of mobile users in a synthetic environment, since a common evaluation framework and appropriate real datasets are not currently available. In Section 5 we present the proposed RS in this area, highlighting the advantages of using context information to improve the recommendation process and demonstrating their efficiency with respect to centralized solutions. Eventually, in Section 6 we present some concluding remarks and open research challenges in this area.

2. The recommendation task

As a general concept, RS try to identify and foresee users' interests in specific contents, based on their previous experiences. Fig. 1 depicts the high-level architecture of a typical RS. When a user interacts with the system, she provides a set of explicit or implicit feedbacks (e.g., likes, clicks, ratings) about her tastes. For example, if a user positively rates an article about a new smartphone, she may also be interested in reading news about mobile apps. Therefore, the basic idea of RS is to exploit this information to infer user