PROCORE - FRANCE/HONG KONG JOINT RESEARCH SCHEME COMPLETION REPORT

Project Reference Number

F-HK31/11T

Project Title

Private Recommendation System in Social Networks

Particulars

	Hong Kong team	French team
Name of Project Co-ordinator (with title)	English: Dr. T-H. Hubert Chan Chinese: 陳子康	Prof. Pierre Senellart
Name of Co-Investigator (if any)	English: Chinese:	
Institution or Institutional affiliation	[ ] CityU [✓] HKU [ ] CUHK [ ] HKUST [ ] HKBU [ ] LU [ ] HKIEd [ ] PolyU	[ ] CEA [ ] INRA [✓] CNRS No. 5141 [ ] INRIA [ ] INFREMER [ ] INSERM No. [ ] University of [✓] Others: Télécom ParisTech
Other project team members (if any)	Reynold Cheng Silviu Maniu Li Ning	Mauro Sozio Muhammad Faheem Georges Gouriten

Funding Period

	1st year	2nd year (if applicable)
Start Date	1 Jan 2012	1 Jan 2013
Completion Date	31 Dec 2012	31 Dec 2013

Objective(s) as per original application

[O1] To design private recommendation systems in social networks.
[O2] To formally evaluate the privacy of recommendation systems.
[O3] To formally evaluate the usefulness of recommendation systems.
[O4] To investigate how new products spread in a privacy-preserving social network.
[O5] To find application with real data.

[Please attach relevant document(s)]

i) Outline of proposed research and results obtained

The main objective [O1] of the work is on private recommendation system in social network, which involves the following topics organized in a logical flow, with indication of relevant objectives.

How to perform social recommendation while maintaining privacy [O1,O2]?
We have shown how collaborative filtering can be performed using features provided by communications among users. This allows biasing recommendations by past interactions among users. We have considered the problem of maintaining privacy of user information through such social recommendation.

How to provide recommendations using graph-structured data [O1,O3]?
We have shown how a user can get recommendations in graph-structured data by providing examples of pairs of items that he is interested in, the system inferring a meta-path from this pair of items and proposing new pairs of items connected by similar relationships.

How to search efficiently such a social network [O3]?
We have obtained from the previous work a probabilistic graph; the problem of answering graph queries (e.g., reachability) over a probabilistic graph is usually solved by sampling. We have shown that we can achieve more precise and faster results using tree decomposition techniques.

How new products spread in a privacy-preserving social network [O2,O4]?
New products usually spread in a social network by word-of-mouth. However, in the scenario where possession of the new product is private information, we have developed new models to analyze the cascading behavior of users to adopt the new product. We have run experiments on both empirical and real data.

How to efficiently acquire data from social networks [O1,O5]?
The first step to use social data for recommendation is to acquire it from existing social platforms such as Twitter. We have considered the problem of efficiently crawling a social network graph focusing on a given topic. We have proposed a general framework for focused crawling and show how basic predictions can be combined using either linear regression or multi-armed bandits, for increased performance over baselines.

ii) Significance of research results

Our methods have offered general tools for modeling interaction between social network users concerning different items, which can facilitate social recommendation. With users constantly interacting on social platforms and generating huge volumes of data such as item ratings and comments, our framework is able to capture how information about items propagates when there is a concern for privacy.

Our new models have provided powerful tools for tackling privacy issues in problems such as influence propagation and maximization problems, which have been studied previously only in social network models in which information is complete.

Apart from being theoretically sound, our methods have practical impact. We have considered several approaches to acquire and analyze real-world data. Our results can potentially convince companies and organizations to adopt privacy-preserving social recommendation system, and it will be beneficial to do so, because ultimately users will be dubious to use an application if their privacy is not protected.

iii) Research output

The following publications have already appeared or been accepted:

S. Maniu, R. Cheng, and P. Senellart, ProbTree: A Query-Efficient Representation of Probabilistic Graphs. In SIGMOD Workshop on Big and Uncertain Data, Snowbird, USA, June 2014. [O1,O3]

W. Tang, X. Wu, T-H. H. Chan, An Incentive Protocol for Distributed Dynamic P2P Video-on-Demand Streaming. In ICCCN Workshop on Wireless Mesh and Ad-hoc Networking, Shanghai, August 2014. [O2,O4]

G. Gouriten, S. Maniu, and P. Senellart, Exploration adaptative de graphes sous contrainte de budget. In Proc. BDA, Nantes, France, October 2013. [O1,O5]

G. Gouriten, S. Maniu, and P. Senellart, Scalable, Generic, and Adaptive Systems for Focused Crawling. In ACM Hypertext, Santiago, Chile, September 2014. [O1,O5]

The following works are in submission or preparation:

C. Meng, R. Cheng, S. Maniu, W. Zhang, and P. Senellart. Discovering Meta-Paths in Large Knowledge Bases. [O1,O3]

L. Ning, T.-H. H. Chan. Private social recommendation. [O1,O2]

Students involved:

The PhD thesis of L. Ning (Social network) at HKU, with collaboration with the French PI, has been defended during the project.

The PhD thesis of G. Gouriten (Knowledge-based content suggestions on the social Web) has involved collaboration with HKU researchers over the course of the project.

iv) Potential for or impact on further research collaboration

Our collaboration has inspired the following directions for future collaboration.

How to learn the probabilities of influence among users in a social network?
In a social network, not all links have the same weight. Some have higher probability of influence from one user to the next. In this work, we show how these probabilities of influence can be computed online, as influence maximization campaigns are run.

Work in progress:
S. Lei, R. Cheng, S. Maniu, and P. Senellart. Online social influence maximization.

How to efficiently find subgraphs of large density in social networks?
We study a natural generalization of the densest subgraph problem, where we seek to find k disjoint subgraphs whose aggregate total density is maximized. After showing the NP-hardness of our problem, we present several heuristics which come with some provable interesting properties. One rather surprising property is that all graphs with maximum density can be found efficiently by our heuristics.

Work in progress:
O. Balalau, F. Bonchi, T.-H. Hubert Chan, F. Gullo, M. Sozio. Finding disjoint subgraphs with maximum total density.