Title: Post-doc position, Université Côte d'Azur@Inria Sophia Antipolis, Evolution over time of the structure of social graphs

Evolution over time of the structure of social graphs

L'Université Côte d'Azur invites applications for a post-doctoral researcher to work on the evolution over time of the structure of social networks. The research grant is awarded for 12 months and its monthly gross salary is about 2600€. The researcher will join the COATI project (https://team.inria.fr/coati/) located at Inria Sophia Antipolis.
Laboratory: COATI project - INRIA (2004, route des Lucioles – Sophia Antipolis)

Application.
Interested candidates should contact Frédéric Giroire (frederic.giroire@cnrs.fr) and David Coudert (david.coudert@inria.fr) by sending a detailed CV, graduate transcript(s), representative publications, statement of research experience and interests, and two references. We may contact interesting candidates once we receive the application. Therefore, please submit your application as early as possible.

Pre-requisites: The candidates should have a Ph.D. in one or more of the following fields
Graph algorithms, big data and clustering, network analysis, social networks.

Description: The goal of the project is to develop methods to analyse the evolution across time of a social network. We will have to propose models of dynamic weighted networks with disruptive changes (e.g. a funding) on the weight and investigate the evolution of such networks. This is a novelty over literature which mainly consider the evolution of networks without weight changes [1]. We will investigate metrics to measure the impact of the disruptive change on the network global structure, such as changes of clustering and of speed of information diffusion, using methods from graph theory [2], complex networks [3], or statistical physics [4].

Background. The postdoc work will be part of a larger project (SNIF) on the evaluation of the impact of funding on scientific research. The project involves researchers in economics, sociology, and computer science. Scientific collaboration networks play a crucial role in modern science. This simple idea underlies a variety of initiatives aiming to promote scientific collaborations between different research teams, universities, countries and disciplines. The recent French IDEX experience is one of them. By fostering competition between universities and granting few of them with a relatively small amount of additional resources (as compared to their global budget), public authorities aim to encourage them to deeply reshape the way academic activities are organized in order to significantly increase the quality of their research, educational programs and innovative activities. The project aims to question the validity of this line of thought. To do this, we will develop both quantitative and qualitative comprehensive analyses.

Datasets. The postdoc will have the opportunity to work on two datasets to test the proposed models and algorithms. The first one is a snapshot of the entire Twitter social graph with more than 500 million accounts and 24 billion links, representing the following/follower relationship [1]. The second one is a graph of co-authorship which is collected as part of the SNIF project.

Expected contributions. Depending on its background and taste, the researcher will work on one or more of the following points:

- **Data collection and data consolidation.** Both existing datasets have to be completed. The snapshot from Twitter is several years old and should be annotated with the date of creation of each account to be able to analyze its evolution. The graph of co-authorship still has to be completed and consolidated (e.g. handling multiple profiles for the same author). It would also be of primary interest to create a graph of citations.

- **Data analysis.** We are interested in the evolution of the two social networks across time. clustering in the two datasets. First, we will focus on simple metrics (e.g. degree distribution and compare the evolutions across time. Then, will start studying the evolution of the structure (connected components, clustering coefficient, clusters) of the network and will look at whether they are observing an evolution of their clustering due to the emergence of new social links or collaborations.

- **Algorithms to compute properties of large social networks.** A number of algorithms have been proposed for studying structural and metric properties of complex networks. However, many of them do not scale to graphs with millions of nodes and are not incremental (require full recomputation after small changes in the graph). Hence, we will investigate the design of scalable and incremental algorithms for analysing large social networks. We will also consider the use of decomposition methods enabling to split the graph into smaller pieces on which to apply algorithms and then combine the results to deduce solutions for the entire network.

- **Models of complex networks.** As stated, we will have to propose models of dynamic weighted networks with disruptive changes on the weight and investigate the evolution of such networks. We are particularly interested in models of directed networks, as, so far, only a few preferential attachment models in the literature are for directed graphs [6]. Still, some social networks are inherently directed, and among them Twitter which is based on followers and followed.

References

[1] Albert and Barabási. Topology of evolving networks: local events and universality. Physical review letters, 85(24):5234, 2000

[2] Crescenzi, P., Grossi, R., Habib, M., Lanzi, L., & Marino, A. (2013). On computing the diameter of real-world undirected graphs. Theoretical Computer Science, 514, 84-95.

[3] Luxburg U. V. A tutorial on spectral clustering Statistics and computing, 2007.
Nag, Corley, Gioia, 2007

[4] Reichardt J., Bornholdt S. Statistical Mechanics of Community Detection Physical Review E, 2006.

[5] Maksym Gabielkov, Ashwin Rao, and Arnaud Legout. Studying Social Networks at Scale: Macroscopic Anatomy of the Twitter Social Graph. In Proc. of ACM SIGMETRICS 2014, June 16--20, 2014, Austin, Texas, USA.

[6] Béla Bollobás, Christian Borgs, Jennifer Chayes, and Oliver Riordan. Directed scale-free graphs. In Proceedings of the fourteenth annual ACM-SIAM symposium on Discrete algorithms, pages 132–139. Society for Industrial and Applied Mathematics, 2003.