Antonio **Caliò**

Ph. D. Student in Information and Communication Technologies

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I am a PhD candidate in ICT with the DIMES Department, University of Calabria, Italy.
My research interests range from problems in network/data science, to reinforcement learning algorithms.
I developed deep knowledge in a number of relevant computational problems in the field of social networks analysis, such as diffusion models, influence propagation/maximization, and graph-decomposition algorithms

Education

University of Calabria — Cosenza, IT
PhD Candidate in Information and Communication Technologies — Expected November 2020

University of Calabria — Cosenza, IT
MSc in Computer Science & Engineering — March 2017

Università degli Studi "Magna Græcia" — Catanzaro, IT
BSc in Biomedical Engineering — June 2013

Research Experiences

University of Calabria — Cosenza, IT
PhD Student — November 2017 - Present

- Investigated problems and evaluated algorithms in the context of influence propagation and maximization
- Designed, implemented and tested novel solutions for the problem of targeted influence maximization
- Explored the capability of several graph-decomposition algorithms for detecting influential users
- Developed expertise in analyzing complex systems and in data visualization
- Studied and followed courses in the Reinforcement Learning landscape

University of Calabria — Cosenza, IT
Research Fellow — April 2017 - November 2017

- Investigated users behavior in the context of viral marketing and (mis)information consumption
- Analyzed and interpreted the dynamics of information diffusion in polarized trust networks
- Formulated, implemented and tested a class of complex diffusion models

Publications

- *Attribute based Diversification of Seeds for Targeted Influence Maximization*
  A. Caliò, A. Tagarelli. **Information Sciences** - 2020
  Abstract - Embedding diversity into knowledge discovery is important: the patterns mined will be more novel, more meaningful, and broader. Surprisingly, in the classic problem of influence maximization in social networks, relatively little study has been devoted to diversity and its integration into the objective function of an influence maximization method. In this work, we propose the integration of a categorical-based notion of seed diversity into the objective function of a targeted influence maximization problem.

  In this respect, we assume that the users of a social network are associated with a categorical dataset where each tuple expresses the profile of a user according to a predefined schema of categorical attributes.

  Upon this assumption, we design a class of monotone submodular functions specifically conceived for determining the diversity of the subset of categorical tuples associated with the seed users to be discovered. This allows us to develop an efficient approximate method, with a constant-factor guarantee of optimality. More precisely, we formulate the *attribute-based diversity-sensitive targeted influence maximization* problem under the state-of-the-art reverse influence sampling framework, and we develop a method, dubbed ADITUM, that ensures a $(1 - 1/e - \epsilon)$-approximate solution under the general triggering diffusion model.

  Extensive experimental evaluation based on real-world networks as well as synthetically generated data has shown the meaningfulness and uniqueness of our proposed class of set diversity functions and of the ADITUM algorithm, also in comparison with methods that exploit numerical-attribute-based diversity and topology-driven diversity in influence maximization.

- *Cores matter? An analysis of graph decomposition effects on influence maximization problems*
  A. Caliò, A. Tagarelli, F. Bonchi. **ACM WebSci** - 2020
  Abstract - Estimating the spreading potential of nodes in a social network is an important problem which finds application in a variety of different contexts, ranging from viral marketing to spread of viruses and rumor blocking. Several studies have

exploited both mesoscale structures and local centrality measures in order to estimate the spreading potential of nodes. To this end, one known result in the literature establishes a correlation between the spreading potential of a node and its *coreness*: i.e., in a core-decompostion of a network, nodes in higher cores have a stronger influence potential on the rest of the network. In this paper we show that the above result does not hold in general under common settings of propagation models with submodular activation function on directed networks, as those ones used in the influence maximization (IM) problem.

Motivated by this finding, we extensively explore where the set of influential nodes extracted by state-of-the-art IM methods are located in a network w.r.t. different notions of graph decomposition. Our analysis on real-world networks provides evidence that, regardless of the particular IM method, the best spreaders are not always located within the inner-most subgraphs defined according to commonly used graph-decomposition methods. We identify the main reasons that explain this behavior, which can be ascribed to the inability of classic decomposition methods in incorporating higher-order degree of nodes. By contrast, we find that a distance-based generalization of the core-decomposition for directed networks can profitably be exploited to actually restrict the location of candidate solutions for IM to a single, well-defined portion of a network graph.

› *A framework for complex influence propagation based on the F2DLT class of diffusion models*

A. Caliò, A. Tagarelli. **SEBD** - 2020

Abstract - In order to match the complexity of influence propagation phenomena in real-world contexts, e.g., viral marketing and misinformation spread, an information diffusion model should fulfill many requirements. These include accounting for dynamic aspects in the propagation (e.g., latency, time horizon), dealing with multiple - possibly competitive - cascades of information, accounting for the contingencies that lead a user to change her/his leaning toward alternative information items, and leveraging trust/distrust in the users' relationships and its effect of influence on the users" decisions. In this work, we accept the challenge of unifying all the above requirements by proposing a novel class of diffusion models, inspired by the classic linear threshold model. Our proposed models are able to deal with many complex scenarios, enabling trust-aware, non-competitive and competitive, time-varying propagation phenomena. We carried out a theoretical inspection on our proposed models, analyzing important features such as the monotonicity and submodularity of the activation function. Our extensive experimental evaluation, whose goal is to mimic contexts of misinformation spread, was conducted on a number of publicly available networks. Results provide evidence on the meaningfulness and uniqueness of our models.

› *Complex influence propagation based on trust-aware dynamic linear threshold models*

Antonio Caliò, Andrea Tagarelli. **Applied Network Science** - 2019

Abstract - In order to match the complexity of influence propagation phenomena in real-world contexts, e.g., viral marketing and misinformation spread, an information diffusion model should fulfill many requirements. These include accounting for dynamic aspects in the propagation (e.g., latency, time horizon), dealing with multiple - possibly competitive - cascades of information, accounting for the contingencies that lead a user to change her/his leaning toward alternative information items, and leveraging trust/distrust in the users' relationships and its effect of influence on the users' decisions. In this work, we accept the challenge of unifying all the above requirements by proposing a novel class of diffusion models, inspired by the classic linear threshold model. Our proposed models are able to deal with many complex scenarios, enabling trust-aware, non-competitive and competitive, time-varying propagation phenomena. We carried out a theoretical inspection on our proposed models, analyzing important features such as the monotonicity and submodularity of the activation function. Our extensive experimental evaluation, whose goal is to mimic contexts of misinformation spread, was conducted on a number of publicly available networks. Results provide evidence on the meaningfulness and uniqueness of our models.

› *Topology-Driven Diversity for Targeted Influence Maximization with Application to User Engagement in Social Networks*

A. Caliò, R. Interdonato, C. Pulice, A. Tagarelli. **IEEE Transactions on Knowledge and Data Engineering (TKDE)** - 2018

Abstract - Research on influence maximization has often to cope with marketing needs relating to the propagation of information towards specific users. In this setting, little attention has been paid to the fact that from the diversity of the initial influencers may depend the success of the viral marketing campaign. We conjecture that if seeds, in addition to be able to influence target nodes, are linked to more diverse (group of) users, then the influence triggers will be diversified as well, and hence the target users will get higher chance of being engaged. Base on this intuition we propose the Diversity-sensitive Targeted Influence Maximization (DTIM) problem, which assumes to model user diversity by exploiting only topological information within a social graph. To the best of our knowledge, this is the first attempt to embed the concepts of topology-driven diversity into targeted IM problems. Also, we propose approximate solutions of DTIM, which detect a size-k set of users that maximizes the diversity-sensitive capital objective function, for a given selection of target users. We evaluate our methods on a special case of user engagement in online social networks, which concerns users who are not actively involved in the community life. Experimental evaluation revealed the meaningfulness of our approach, also highlighting the usefulness of further development of solutions for DTIM applications.

› *Trust-Based Dynamic Linear Threshold Models for Non-competitive and Competitive Influence Propagation*

A. Caliò, A. Tagarelli. **TrustCom/BigDataSE** - 2018

Abstract - What are the key-features that enable an information diffusion model to explain the inherent dynamic, and often competitive, nature of real-world propagation phenomena? In this paper we aim to answer this question by proposing a novel class of diffusion models, inspired by the classic Linear Threshold model, and built around the following aspects:

trust/distrust in the user relationships, which is leveraged to model different effects of social influence on the decisions taken by an individual; changes in adopting one or alternative information items; hesitation towards adopting an information item over time; latency in the propagation; time horizon for the unfolding of the diffusion process; and multiple cascades of information that might occur competitively. To the best of our knowledge, the above aspects have never been unified into the same LT-based diffusion model. We also define different strategies for the selection of the initial influencers to simulate non-competitive and competitive diffusion scenarios, particularly related to the problem of limitation of misinformation spread. Results on publicly available networks have shown the meaningfulness and uniqueness of our models.

Talks

The 12th ACM Web Science Conference 2020 (WebSci'20) — Southampton, UK
Conference Presenter — July 2020
"Cores matter? An analysis of graph decomposition effects on influence maximization problems"

The 28th Symposium on Advanced Database Systems (SEBD 2020) — Villasimius, IT
Conference Presenter — June 2020
"A framework for complex influence propagation based on the F2DLT class of diffusion models"

The 17th IEEE Int. Conf. On Trust, Security And Privacy In Computing And Communications (TrustCom-18) — New York, USA
Conference Presenter — August 2018
"Trust-based dynamic linear threshold models for non-competitive and competitive influence propagation"

The First Machine Learning Study Jam at Google Developer Group Cosenza — Cosenza, IT
Guest Lecturer — June 2018
"Machine Learning Crash Course with TensorFlow APIs"

Teaching

University of Calabria — Cosenza, IT
Teaching Assistant

- "Data Mining". MSc in Computer Science & Engineering. — 2018-2020
- "Foundations of Computer Science". BSc in Civil Engineering. — 2017-2019

Skills

Programming/Scripting Languages: (Proficient) Python, C++, Java, (Familiar) Javascript, Bash
Framework and tools: scikit-learn, pandas, seaborn, Flask, D3.js, React, Git, CMake, Docker
Language Skills: (Native) Italian, (Fluent) English