IN PARTNERSHIP WITH:
Ecole normale supérieure de Lyon

Université Claude Bernard (Lyon 1)

Activity Report 2018

Project-Team DANTE

Dynamic Networks : Temporal and Structural Capture Approach

IN COLLABORATION WITH: Laboratoire de l'Informatique du Parallélisme (LIP)

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
Networks and Telecommunications

Table of contents

1. Team, Visitors, External Collaborators **1**
2. Overall Objectives **2**
3. Research Program **3**
3.1. Graph-based signal processing 3
3.2. Theory and Structure of dynamic Networks 4
3.3. Distributed Algorithms for dynamic networks: regulation, adaptation and interaction 4
4. Application Domains **5**
4.1. Life Science & Health 5
4.2. Network Science / Complex networks 5
4.3. Social Sciences / Epistemology 6
5. Highlights of the Year **6**
5.1.1. Machine Learning & Data Science for Complex and Dynamical Models 6
5.1.2. Books on Dynamic Networks by Márton Karsai 7
5.1.3. Awards 7
6. New Software and Platforms **7**
6.1. GraSP 7
6.2. IoT-LAB aggregation-tools 8
6.3. IoT-LAB cli-tools 8
6.4. IoT-LAB gateway 8
6.5. IoT-LAB robots 8
6.6. Queueing Systems 8
6.7. WSNet 8
7. New Results **9**
7.1. Graph Signal Processing and Machine Learning 9
7.1.1. Analytic signal in many dimensions 9
7.1.2. BGP Zombies: an Analysis of Beacons Stuck Routes 9
7.1.3. Design of graph filters and filterbanks 9
7.2. Optimization 10
7.2.1. A new proximal method for joint image restoration and edge detection with the Mumford-Shah model 10
7.2.2. Semi-Linearized Proximal Alternating Minimization for a Discrete Mumford–Shah Model 10
7.2.3. Discrete Mumford-Shah on graph for mixing matrix estimation 10
7.3. Wireless & Wired Networks 11
7.3.1. Conflict graph-based model for IEEE 802.11 networks: A Divide-and-Conquer approach 11
7.3.2. Video on Demand in IEEE 802.11p-based Vehicular Networks: Analysis and Dimensioning 11
7.3.3. An accurate and efficient modeling framework for the performance evaluation of DPDK-based virtual switches 11
7.3.4. Association optimization in Wi-Fi networks 12
7.3.5. Transient analysis of idle time in VANETs using Markov-reward models 12
7.4. Performance Evaluation of Communication Networks 13
7.4.1. First-Come-First-Served Queues with Multiple Servers and Customer Classes 13
7.4.2. A study of systems with multiple operating levels, probabilistic thresholds and hysteresis 13
7.4.3. Covert cycle stealing in an M/G/1 queue 13
7.4.4. LRU caches 13
7.4.5. Stochastic Multilayer Networks 14
7.5. Computational Human Dynamics and Temporal Networks 14

7.5.1. Correlations and dynamics of consumption patterns in social-economic networks 14
7.5.2. Mapping temporal-network percolation to weighted, static event graphs 14
7.5.3. Randomized reference models for temporal networks 14
7.5.4. Socioeconomic dependencies of linguistic patterns in Twitter: a multivariate analysis 15
7.5.5. Threshold driven contagion on weighted networks 15
7.5.6. Link transmission centrality in large-scale social networks 15
7.5.7. Prepaid or Postpaid? That Is the Question: Novel Methods of Subscription Type Prediction in Mobile Phone Services 15
7.5.8. Service Adoption Spreading in Online Social Networks 16
7.5.9. Attention on Weak Ties in Social and Communication Networks 16
8. Bilateral Contracts and Grants with Industry **16**
9. Partnerships and Cooperations **17**
9.1. Regional Initiatives 17
9.1.1. Idex Lyon ACADEMICS 17
9.1.2. ISI Torino / Dante 17
9.2. National Initiatives 18
9.2.1. Equipex FIT (Futur Internet of Things) 18
9.2.2. ANR GRAPHSIP (Graph Signal Processing) 18
9.2.3. ANR SoSweet 18
9.2.4. ANR DylNet 19
9.2.5. Inria PRE LIAISON 19
9.2.6. Inria & HCERES 19
9.2.7. Inria IPL BetterNet 19
9.3. European Initiatives 20
9.3.1.1. EMBERS 20
9.3.1.2. ARMOUR 20
9.4. International Initiatives 21
9.4.1. Participation in International Programs 21
9.4.2. International Initiatives 21
9.5. International Research Visitors 22
9.5.1. Visits of International Scientists 22
9.5.2. Visits to International Teams 22
10. Dissemination **22**
10.1. Promoting Scientific Activities 22
10.1.1. Scientific Events Organisation 22
10.1.1.1. General Chair, Scientific Chair 22
10.1.1.2. Member of the Organizing Committees 22
10.1.2. Scientific Events Selection 23
10.1.3. Journal 23
10.1.3.1. Member of the Editorial Boards 23
10.1.3.2. Reviewer - Reviewing Activities 23
10.1.4. Invited Talks 23
10.1.5. Leadership within the Scientific Community 24
10.1.6. Scientific Expertise 24
10.1.7. Research Administration 25
10.2. Teaching - Supervision - Juries 26
10.2.1. Teaching 26
10.2.2. Supervision 26
10.2.3. Juries 27
10.3. Popularization 27
10.3.1. Internal or external Inria responsibilities 27

10.3.2. Articles and contents 28
10.3.3. Interventions 28
11. Bibliography **28**

Project-Team DANTE

Creation of the Team: 2012 November 01, updated into Project-Team: 2015 January 01

Keywords:

Computer Science and Digital Science:

A1.2. - Networks
A1.2.4. - QoS, performance evaluation
A1.2.5. - Internet of things
A1.2.6. - Sensor networks
A1.2.9. - Social Networks
A3.4.1. - Supervised learning
A3.5. - Social networks
A3.5.1. - Analysis of large graphs
A5.9. - Signal processing
A5.9.4. - Signal processing over graphs
A8.1. - Discrete mathematics, combinatorics
A8.7. - Graph theory
A8.8. - Network science
A8.9. - Performance evaluation

Other Research Topics and Application Domains:

B2.3. - Epidemiology
B6. - IT and telecom
B6.3.4. - Social Networks
B6.4. - Internet of things
B9.5.1. - Computer science
B9.5.6. - Data science
B9.6.5. - Sociology
B9.6.8. - Linguistics
B9.6.10. - Digital humanities

1. Team, Visitors, External Collaborators

Research Scientists

Paulo Gonçalves [Team leader, Inria, Senior Researcher, HDR]
Philippe Nain [Inria, Senior Researcher, HDR]
Tommaso Venturini [Inria, Advanced Research Position, until Aug 2018, HDR]

Faculty Members

Thomas Begin [Univ de Claude Bernard, Associate Professor, HDR]
Anthony Busson [Univ de Claude Bernard, Professor, HDR]
Christophe Crespelle [Univ de Claude Bernard, Associate Professor, HDR]
Éric Fleury [Team leader, Ecole Normale Supérieure Lyon, Chair, until Mar 2018, HDR]
Marion Foare [Associate Professor, Ecole supérieure de chimie physique électronique de Lyon, since Sept. 2018]

Isabelle Guérin Lassous [Univ de Claude Bernard, Professor, HDR]
Márton Karsai [Ecole Normale Supérieure Lyon, Associate Professor]
Jean-Pierre Chevrot [Professor Univ Grenoble Alpes, ext. collaborator until Aug 2018]
Éric Philippe Guichard [Associate Professor Enssib, Lyon, ext. collaborator until march 2020]
Jean-Philippe Magué [Associate Professor Ecole Normale Supérieure Lyon, ext. collaborator until Aug 2018]

Post-Doctoral Fellows

Sarah de Nigris [CNRS, until Jun 2018]
Sebastien Lerique [Inria]
Mikhail Tsitsvero [Univ de Lyon, Labex MILyon]

PhD Students

Lafdal Abdelwedoud [Bourse du gouvernement Français pour étudiants étrangers]
Mohammed Amer [Ministère de défense Algérien, until Sep 2018]
Dominique Barbe [Univ de Lyon, from Sep 2018]
Esteban Bautista Ruiz [Bourse CONACyT, Méxique]
Nour El Houda Bouzouita [Ecole Normale Supérieure Lyon, from Nov 2018]
Sicheng Dai [Univ de Lyon]
Gaetan Frusque [Ecole Normale Supérieure Lyon]
Remy Grunblatt [Inria]
Jacob Levy Abitbol [Inria]
Marija Stojanova [Ecole Normale Supérieure Lyon]
Samuel Unicomb [Inria]

Interns

Nour El Houda Bouzouita [Univ de Claude Bernard, from Mar 2018 until Jul 2018]
Anca Maria Faur [Inria, from Jul 2018 until Sep 2018]

Administrative Assistant

Laetitia Gauthe [Inria, until Nov 2018]

Visiting Scientists

Dorsaf Ghozlani [Innov'Com, Tunise, from Apr 2018 until Jul 2018]
Donald Towsley [U. of Massachusetts Amherst, US, from Mar 2018 until Jun 2018]
Alexandre Brandwajn [U. of California, Santa Cruz, US, from Feb 2018 until Mar 2018]

2. Overall Objectives

2.1. Overall Objectives

The goal of DANTE is to develop **novel models, algorithms and methods to analyse the dynamics of large-scale networks**, (*e.g. social networks, technological networks such as the Web and hyperlinks, Articles and co-citation, email exchanges, economic relations, bacteria/virus propagation in human networks...*). Large datasets describing such networks are nowadays more "accessible" due to the emergence of online activities and new techniques of data collection. These advantages provide us an unprecedented avalanche of large data sets, recording the digital footprints of millions of entities (*e.g.* individuals, computers, documents, stocks, etc.) and their temporal interactions [1]. Such large amount of information allows for easier and more precise traceability of social activities, better observation of the structural and temporal evolution of social/technological/economical networks, the emergence of their localized and cascading failures, and provides information about the general roles of self-organization in an interdisciplinary sense. All these questions represent a major scientific, economic, and social challenge, which has the potential to revolutionize our understanding of the arising socio-technical world of our age.

[1] YouTube claims to receive 48 hours of video every minute, Google and Facebook represent major world companies that generate millions of traces on our activities every second. Every day, hundreds of millions of posts are added to the blogosphere, from which information on citizen opinions and their evolutions can be collected.

Our main challenge is to propose **generic methodologies and concepts to develop relevant formal tools to model, analyse the dynamics and evolution of such networks, that is, to formalise the dynamic properties of both structural and temporal interactions of network entities/relations**:

- **Ask** application domains relevant questions, to learn something new about such domains instead of merely playing with powerful computers on huge data sets.
- **Access** and collect data with adapted and efficient tools. This includes a reflexive step on the biases of the data collected and their relations to real activities/application domain.
- **Model** the dynamics of networks by analyzing their structural and temporal properties jointly, inventing original approaches combining graph theory with signal processing. A key point is to capture temporal features in the data, which may reveal meaningful insights on the evolution of the networks.
- **Interpret** the results, make the knowledge robust and useful in order to be able to control, optimise and (re)-act on the network structure itself and on the protocols exchange/interactions in order to obtain a better performance of the global system.

The challenge is to solve a major scientific puzzle, common to several application domains (*e.g.*, sociology, information technology, epidemiology) and central in network science: how to understand the causality between the evolution of macro-structures and individuals, at local and global scales?

3. Research Program

3.1. Graph-based signal processing

Participants: Paulo Gonçalves, Éric Fleury, Márton Karsai, Marion Foare, Thomas Begin.

Evolving networks can be regarded as "*out of equilibrium*" systems. Indeed, their dynamics are typically characterized by non standard and intricate statistical properties, such as non-stationarity, long range memory effects, intricate space and time correlations.

Analyzing, modeling, and even defining adapted concepts for dynamic graphs is at the heart of DANTE. This is a largely open question that has to be answered by keeping a balance between specificity (solutions triggered by specific data sets) and generality (universal approaches disconnected from social realities). We will tackle this challenge from a graph-based signal processing perspective involving signal analysts and computer scientists, together with experts of the data domain application. One can distinguish two different issues in this challenge, one related to the graph-based organization of the data and the other to the time dependency that naturally exits in the dynamic graph object. In both cases, a number of contributions can be found in the literature, albeit in different contexts. In our application domain, high-dimensional data "naturally reside" on the vertices of weighted graphs. The emerging field of signal processing on graphs merges algebraic and spectral graph theoretic concepts with computational harmonic analysis to process such signals on graphs [76].

As for the first point, adapting well-founded signal processing techniques to data represented as graphs is an emerging, yet quickly developing field which has already received key contributions. Some of them are very general and delineate ambitious programs aimed at defining universal, generally unsupervised methods for exploring high-dimensional data sets and processing them. This is the case for instance of the “diffusion wavelets” and “diffusion maps” pushed forward at Yale and Duke [58]. Others are more traditionally connected with standard signal processing concepts, in the spirit of elaborating new methodologies via some bridging between networks and time series, see for instance [71] and references therein. Other viewpoints can be found as well, including multi-resolution Markov models [79], Bayesian networks or distributed processing over sensor networks [70]. Such approaches can be particularly successful for handling static graphs and unveiling aspects of their organization in terms of dependencies between nodes, grouping, etc. Incorporating possible time dependencies within the whole picture calls however for the addition of an extra dimension to the problem "as it would be the case when switching from one image to a video sequence", a situation for which one can imagine to take advantage of the whole body of knowledge attached to non-stationary signal processing [59].

3.2. Theory and Structure of dynamic Networks

Participants: Christophe Crespelle, Éric Fleury, Anthony Busson, Márton Karsai, Jean-Philippe Magué, Éric Guichard, Jean-Pierre Chevrot, Tommaso Venturini.

Characterization of the dynamics of complex networks. We need to focus on intrinsic properties of evolving/dynamic complex networks. New notions (as opposed to classical static graph properties) have to be introduced: rate of vertices or links appearances or disappearances, the duration of link presences or absences. Moreover, more specific properties related to the dynamics have to be defined and are somehow related to the way to model a dynamic graph.

Through the systematic analysis and characterization of static network representations of many different systems, researchers of several disciplines have unveiled complex topologies and heterogeneous structures, with connectivity patterns statistically characterized by heavy-tails and large fluctuations, scale-free properties and non trivial correlations such as high clustering and hierarchical ordering [73]. A large amount of work has been devoted to the development of new tools for statistical characterisation and modelling of networks, in order to identify their most relevant properties, and to understand which growth mechanisms could lead to these properties. Most of those contributions have focused on static graphs or on dynamic process (*e.g.* diffusion) occurring on static graphs. This has called forth a major effort in developing the methodology to characterize the topology and temporal behaviour of complex networks [73], [63], [80], [69], to describe the observed structural and temporal heterogeneities [56], [63], [57], to detect and measure emerging community structures [60], [77], [78], to see how the functionality of networks determines their evolving structure [68], and to determine what kinds of correlations play a role in their dynamics [64], [67], [72].

The challenge is now to extend this kind of statistical characterization to dynamical graphs. In other words, links in dynamic networks are temporal events, called contacts, which can be either punctual or last for some period of time. Because of the complexity of this analysis, the temporal dimension of the network is often ignored or only roughly considered. Therefore, fully taking into account the dynamics of the links into a network is a crucial and highly challenging issue.

Another powerful approach to model time-varying graphs is via activity driven network models. In this case, the only assumption relates to the distribution of activity rates of interacting entities. The activity rate is realistically broadly distributed and refers to the probability that an entity becomes active and creates a connection with another entity within a unit time step [75]. Even the generic model is already capable to recover some realistic features of the emerging graph, its main advantage is to provide a general framework to study various types of correlations present in real temporal networks. By synthesising such correlations (*e.g.* memory effects, preferential attachment, triangular closing mechanisms, ...) from the real data, we are able to extend the general mechanism and build a temporal network model, which shows certain realistic feature in a controlled way. This can be used to study the effect of selected correlations on the evolution of the emerging structure [66] and its co-evolution with ongoing processes like spreading phenomena, synchronisation, evolution of consensus, random walk etc. [66], [74]. This approach allows also to develop control and immunisation strategies by fully considering the temporal nature of the backgrounding network.

3.3. Distributed Algorithms for dynamic networks: regulation, adaptation and interaction

Participants: Thomas Begin, Anthony Busson, Isabelle Guérin Lassous, Philippe Nain.

Dedicated algorithms for dynamic networks. First, the dynamic network object itself trigger original algorithmic questions. It mainly concerns distributed algorithms that should be designed and deployed to efficiently measure the object itself and get an accurate view of its dynamic behavior. Such distributed measure should be “transparent”, that is, it should introduce no bias or at least a bias that is controllable and corrigible. Such problem is encountered in all distributed metrology measures / distributed probes: P2P, sensor network, wireless network, QoS routing... This question raises naturally the intrinsic notion of adaptation and control of the dynamic network itself since it appears that autonomous networks and traffic aware routing are becoming crucial.

Communication networks are dynamic networks that potentially undergo high dynamicity. The dynamicity exhibited by these networks results from several factors including, for instance, changes in the topology and varying workload conditions. Although most implemented protocols and existing solutions in the literature can cope with a dynamic behavior, the evolution of their behavior operates identically whatever the actual properties of the dynamicity. For instance, parameters of the routing protocols (*e.g.* hello packets transmission frequency) or routing methods (*e.g.* reactive / proactive) are commonly hold constant regardless of the nodes mobility. Similarly, the algorithms ruling CSMA/CA (*e.g.* size of the contention window) are tuned identically and they do not change according to the actual workload and observed topology.

Dynamicity in computer networks tends to affect a large number of performance parameters (if not all) coming from various layers (viz. physical, link, routing and transport). To find out which ones matter the most for our intended purpose, we expect to rely on the tools developed by the two former axes. These quantities should capture and characterize the actual network dynamicity. Our goal is to take advantage of this latter information in order to refine existing protocols, or even to propose new solutions. More precisely, we will attempt to associate "fundamental" changes occurring in the underlying graph of a network (reported through graph-based signal tools) to quantitative performance that are matter of interests for networking applications and the end-users. We expect to rely on available testbeds such as SensLab and FIT to experiment our solutions and ultimately validate our approach.

4. Application Domains

4.1. Life Science & Health

In parallel to the advances in modern medicine, health sciences and public health policy, epidemic models aided by computer simulations and information technologies offer an increasingly important tool for the understanding of transmission dynamics and of epidemic patterns. The increased computational power and use of Information and Communication Technologies make feasible sophisticated modelling approaches augmented by detailed in vivo data sets, and allow to study a variety of possible scenarios and control strategies, helping and supporting the decision process at the scientific, medical and public health level. The research conducted in the DANTE project finds direct applications in the domain of LSH since modelling approaches crucially depend on our ability to describe the interactions of individuals in the population. In the TUBEXPO and ARIBO projects, we are collaborating with Pr. Jean-Christopge Lucet (Professeur des université Paris VII, Praticien hospitalier APHP). Within PhD work of G. Frusque, we collaborate with Dr. Julien Jung from Hôpital de Neurologie de Bron (HCL) and with Nadine Ravel, DR CNRS (CRNL, INSERM).

4.2. Network Science / Complex networks

In the last ten years the science of complex networks has been assigned an increasingly relevant role in defining a conceptual framework for the analysis of complex systems. Network science is concerned with graphs that map entities and their interactions to nodes and links. For a long time, this mathematical abstraction has contributed to the understanding of real-world systems in physics, computer science, biology, chemistry, social sciences, and economics. Recently, however, enormous amounts of detailed data, electronically collected and meticulously catalogued, have finally become available for scientific analysis and study. This has led to the discovery that most networks describing real world systems show the presence of complex properties and heterogeneities, which cannot be neglected in their topological and dynamical description. This has called forth a major effort in developing the methodology to characterise the topology and temporal behaviour of complex networks, to describe the observed structural and temporal heterogeneities, to detect and measure emerging community structure, to see how the functionality of networks determines their evolving structure, and to determine what kinds of correlations play a role in their dynamics. All these efforts have brought us to a point where the science of complex networks has become advanced enough to help us to disclose the deeper roles of complexity and gain understanding about the behaviour of very complicated systems.

In this endeavour the DANTE project targets the study of dynamically evolving networks, concentrating on questions about the evolving structure and dynamical processes taking place on them. During the last year we developed developed several projects along these lines concerning three major datasets:

- Mobile telephony data: In projects with academic partners and Grandata we performed projects based on two large independent datasets collecting the telephone call and SMS event records for million of anonymised individuals. The datasets record the time and duration of mobile phone interactions and some coarse grained location and demographic data for some users. In addition one of the dataset is coupled with anonymised bank credit information allowing us to study directly the socioeconomic structure of a society and how it determines the communication dynamics and structure of individuals.
- Skype data: Together with Skype Labs/STACC and other academic groups we were leading projects in the subject of social spreading phenomena. These projects were based on observations taken from a temporally detailed description of the evolving social network of (anonymised) Skype users registered between 2003 and 2011. This data contains dates of registration and link creation together with gradual information about their location and service usage dynamics.
- Twitter data: In collaboration with ICAR-ENS Lyon we collected a large dataset about the microblogs and communications of millions of Twitter users in the French Twitter space. This data allows us to follow the spreading of fads/opinions/hashtags/ideas and more importantly linguistic features in online communities. The aim of this collaboration is to set the ground for a quantitative framework studying the evolution of linguistic features and dialects in an social-communication space mediated by online social interactions.

4.3. Social Sciences / Epistemology

Political impacts of the internet and of networks begin to be well known (Cambridge Analytica, Russian trolls, etc.). Hence the public at large begins to be aware of the abuses of the leaders of the internet (privacy by firms and advertising, surveillance by states, fake news by activists, etc.). In the same time, on-line exchanges now give scientific estimations of the political life [61] and policital sciences begin to consider the internet as a relevant subject of study. As the internet is a *technology*, philosophy is the best approach to understand what socially happens (or can be made) with the internet. We develop it by two ways:

- political philosophy. Some Dante members are working with Triangle laboratory (social sciences, philosophy and politics; Ens de Lyon and CNRS).
- epistemology, because computer sciences discoveries are related with the evolution of science(s): we discovered that, in the case of the internet, political philosophy can do few if not strongly related to epistemology [62]. Epistemological approach is developped in collaboration with Jean Dhombres (who holds a seminar at Enssib: http://barthes.enssib.fr/cours/Dhombres2018-2019.html and with Hcéres (new relations between social and exact sciences, cf. point 9.2.6).

This approach should help computer scientists to understand how their research may depend on foreign initiatives and to create new links between social sciences and Inria.

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Machine Learning & Data Science for Complex and Dynamical Models

The Dante team is part of a consortium (including the LIP, the Physics Lab from ENS de Lyon, the LabHC from U. Jean Monnet and LIRIS from U. Lyon 1) that got funded a 4 years project within the call “Scientific Breakthrough” of **IDEX de Lyon**.

With a total envelope of 1.2M euros, the project "mAChine LeArning & Data sciEnce for coMplex and dynamICal modelS" (ACADEMICS) combines **Machine Learning (ML) and Data Science (DS)** for the purpose of scientific research into two challenging directions:

1. **Computing and information processing** – develop new theoretical frameworks and learning algorithms adapted to difficult scientific contexts involving heterogeneous, irregular, error-prone, dynamic and complex data, while taking into account prior knowledge whenever it is relevant.
2. **Complex and dynamic models learning** – leverage the synergy between ML and DS to devise data-driven models in two scientific domains: **climate modeling**, and **quantitative understanding of social systems**. Focusing on these two case studies, the project will tackle the key issue of how to learn intricate models from numerous, heterogeneous and dynamic data.

The **research program** is elaborated along specific scientific issues that can reasonably lead to significant results within the 3-year lifetime of the project. The two case studies are instrumental to frame the way ML and DS can combine to yield relevant models. The methodological axes are:

- **Representation and model learning for complex data:** How to find sparse latent spaces for complex data or graphs, and how to learn compressed models? How to identify exceptional phenomena?
- **Estimation and learning from multi-source and/or dynamic data:** How to transfer a model learned from *source* data to related but different *target* data? How to learn from multi-source complex data?
- **Distributed and adaptive machine learning for graphs and complex models:** How to design distributed optimization-based learning? How to develop adaptive and distributed model inference in high dimension?

In close connexion with these methodological questions, the climate modeling use-case raises the central interrogation of **how to learn effective dynamic models**, firstly in a nonparametric way by means of ML tools and secondly, by mixing several data sources (from observations and simulations). As for computational social science, the challenge is **to embed together in ML approaches, individual features, global structures and dynamics of social networks**. The goal here, is to benefit from their complementarity to infer latent correlations, to identify behavioral mechanisms and to better model emergent social phenomena.

5.1.2. Books on Dynamic Networks by Márton Karsai

After a book chapter on *Control Strategies of Contagion Processes in Time-varying Networks* in Temporal Network Epidemiology in collaboration with Nicola Perra [65], a full book on *Bursty Human Dynamics* was just released at the end of the year in collaboration with Hang-Hyun Jo and Kimmo Kaski [40].

5.1.3. Awards

- Márton Karsai received the Junior Scientific Award of the Complex System Society, Sept. 2018.
- Márton Karsai, awarded Fellow of the ISI Foundation (Torino, Italy), 2018.
- Samuel Unicomb (PhD of Márton Karsai) obtained the best poster award at the NetSci'18 conference in Paris in June 2018.

6. New Software and Platforms

6.1. GraSP

Graph Signal Processing
KEYWORDS: Matlab - LaTeX - Graph - Graph visualization - Signal processing - GNU Octave
FUNCTIONAL DESCRIPTION: Matlab / GNU Octave toolbox to manipulate and visualize signals on graphs. LaTeX package to draw signals.

- Contact: Benjamin Girault

6.2. IoT-LAB aggregation-tools

KEYWORD: Internet of things
FUNCTIONAL DESCRIPTION: IoT-LAB aggregation-tools allow aggregating data results from many nodes at a time. It connects to several tcp connections and handle the received data.

- Participant: Gaetan Harter
- Contact: Eric Fleury
- URL: https://github.com/iot-lab/aggregation-tools

6.3. IoT-LAB cli-tools

KEYWORD: Internet of things
FUNCTIONAL DESCRIPTION: IoT-LAB cli-tools provide a basic set of operations for managing IoT-LAB experiments from the command-line.

- Participants: Frédéric Saint-Marcel and Gaetan Harter
- Contact: Eric Fleury
- URL: https://github.com/iot-lab/cli-tools

6.4. IoT-LAB gateway

KEYWORD: Internet of things
FUNCTIONAL DESCRIPTION: IoT-LAB software embedded on a IoT-LAB gateway node new generation provides the local management of the experiment on that node. It is a software bridge between the IoT-LAB server, the user open node and the control node.

- Contact: Frédéric Saint-Marcel
- URL: https://github.com/iot-lab/iot-lab-gateway

6.5. IoT-LAB robots

KEYWORDS: Internet of things - Robotics
FUNCTIONAL DESCRIPTION: IoT-LAB robots is an embedded robot controler on a Turtlebot2 providing the IoT-LAB node mobility functionnality

- Partner: Université de Strasbourg
- Contact: Julien Vandaële
- URL: https://github.com/iot-lab/

6.6. Queueing Systems

FUNCTIONAL DESCRIPTION: This tool aims at providing a simple web interface to promote the use of our proposed solutions to numerically solve classical queueing systems.

- Participants: Alexandre Brandwajn and Thomas Begin
- Contact: Thomas Begin
- URL: http://queueing-systems.ens-lyon.fr/

6.7. WSNet

KEYWORD: Network simulator

FUNCTIONAL DESCRIPTION: WSNet is a modular event-driven simulator targeted to Wireless Sensor Networks. Its main goals are to offer scalabiliy, extensibility and modularity for the integration of new protocols/hardware models and a precise radio medium simulation. We still hope to find the proper resource to make WSNet evolve into a wireless capillary network simulator suitable for conducting simulations at the urban scale.

- Participants: Rodrigue Domga Komguem and Fabrice Valois
- Partner: CEA-LETI
- Contact: Guillaume Chelius
- URL: https://gforge.inria.fr/projects/wsnet-3/

7. New Results

7.1. Graph Signal Processing and Machine Learning

Participants: Paulo Gonçalves, Esteban Bautista Ruiz, Mikhail Tsitsvero, Sarah de Nigris.

7.1.1. Analytic signal in many dimensions

In a series of two articles [30] and [54] (in collaboration with P. Borgnat), we extended analytic signal to the multidimensional case. First we showed how to obtain separate phase-shifted components and how to combine them into instantaneous amplitude and phase. Secondly we defined the proper hypercomplex analytic signal as a holomorphic hypercomplex function on the boundary of polydisk in the hypercomplex space. Next it was shown that the correct phase-shifted components can be obtained by positive frequency restriction of the Scheffers-Fourier transform based on the commutative and associative algebra generated by the set of elliptic hypercomplex numbers. Moreover we demonstrated that for $d > 2$ there is no corresponding Clifford-Fourier transform that allows to recover phase-shifted components correctly. Finally the euclidean-domain construction of instantaneous amplitude was extended to manifold and manifold-like graphs and point clouds.

7.1.2. BGP Zombies: an Analysis of Beacons Stuck Routes

Joint work with Romain Fontugne (IIJ Research Lab, Japan) and Patrice Abry (CNRS, Physics Lab of ENS de Lyon) [25].

Network operators use the Border Gateway Protocol (BGP) to control the global visibility of their networks. When withdrawing an IP prefix from the Internet, an origin network sends BGP withdraw messages, which are expected to propagate to all BGP routers that hold an entry for that address space in their routing table. Yet network operators occasionally report issues where routers maintain routes to IP prefixes withdrawn by their origin network. We refer to this problem as BGP zombies and characterize their appearance using RIS BGP beacons, a set of prefixes withdrawn every four hours at predetermined times. Across the 27 monitored beacon prefixes, we observe usually more than one zombie outbreak per day. But their presence is highly volatile, on average a monitored peer misses 1.8% withdraws for an IPv4 beacon (2.7% for IPv6). We also discovered that BGP zombies can propagate to other ASes, for example, zombies in a transit network are inevitably affect- ing its customer networks. **We employ a graph-based semi-supervised machine learning technique to estimate the scope of zombies propagation**, and found that most of the observed zombie outbreaks are small (i.e. on average 10% of monitored ASes for IPv4 and 17% for IPv6). We also report some large zombie outbreaks with almost all monitored ASes affected.

7.1.3. Design of graph filters and filterbanks

Book chapter [43], co-authored with Nicolas Tremblay (CNRS, UGA Gipsa-Lab) and Pierre Borgnat (CNRS, Physics Lab, ENS de Lyon).

Basic operations in graph signal processing consist in processing signals indexed on graphs either by filtering them or by changing their domain of representation, in order to better extract or analyze the important information they contain. The aim of this chapter is to review general concepts underlying such filters and representations of graph signals. We first recall the different Graph Fourier Transforms that have been developed in the literature, and show how to introduce a notion of frequency analysis for graph signals by looking at their variations. Then, we move to the introduction of graph filters, that are defined like the classical equivalent for 1D signals or 2D images, as linear systems which operate on each frequency band of a signal. Some examples of filters and of their implementations are given. Finally, as alternate representations of graph signals, we focus on multiscale transforms that are defined from filters. Continuous multiscale transforms such as spectral wavelets on graphs are reviewed, as well as the versatile approaches of filterbanks on graphs. Several variants of graph filterbanks are discussed, for structured as well as arbitrary graphs, with a focus on the central point of the choice of the decimation or aggregation operators.

7.2. Optimization

Participant: Marion Foare.

7.2.1. A new proximal method for joint image restoration and edge detection with the Mumford-Shah model

Joint work with Nelly Pustelnik (CNRS, Physics Lab of ENS de Lyon) and Laurent Condat (CNRS, GIPSA Lab) [24].

In this paper, we propose an adaptation of the PAM algorithm to the minimization of a nonconvex functional designed for joint image denoising and contour detection. This new functional is based on the Ambrosio–Tortorelli approximation of the well-known Mumford–Shah functional. We motivate the proposed approximation, offering flexibility in the choice of the possibly non-smooth penalization, and we derive closed form expression for the proximal steps involved in the algorithm. We focus our attention on two types of penalization: 1-norm and a proposed quadratic-1 function. Numerical experiments show that the proposed method is able to detect sharp contours and to reconstruct piecewise smooth approximations with low computational cost and convergence guarantees. We also compare the results with state-of-the-art re-laxations of the Mumford–Shah functional and a recent discrete formulation of the Ambrosio–Tortorelli functional.

7.2.2. Semi-Linearized Proximal Alternating Minimization for a Discrete Mumford–Shah Model

Joint work with Nelly Pustelnik (CNRS, Physics Lab of ENS de Lyon) and Laurent Condat (CNRS, GIPSA Lab) [51].

The Mumford–Shah model is a standard model in image segmentation and many approximations have been proposed in order to approximate it. The major interest of this functional is to be able to perform jointly image restoration and contour detection. In this work, we propose a general formulation of the discrete counterpart of the Mumford–Shah functional, adapted to nonsmooth penalizations, fitting the assumptions required by the Proximal Alternating Linearized Minimization (PALM), with convergence guarantees. A second contribution aims to relax some assumptions on the involved functionals and derive a novel Semi-Linearized Proximal Alternated Minimization (SL-PAM) algorithm, with proved convergence. We compare the performances of the algorithm with several nonsmooth penalizations, for Gaussian and Poisson denoising, image restoration and RGB-color denoising. We compare the results with state-of-the-art convex relaxations of the Mumford–Shah functional, and a discrete version of the Ambrosio–Tortorelli functional. We show that the SL-PAM algorithm is faster than the original PALM algorithm, and leads to competitive denoising, restoration and segmentation results.

7.2.3. Discrete Mumford-Shah on graph for mixing matrix estimation

Joint work with Yacouba Kaloga (Physics Lab of ENS de Lyon), Nelly Pustelnik (CNRS, Physics Lab of ENS de Lyon) and Pablo Jensen (CNRS, Physics Lab of ENS de Lyon) [53].

The discrete Mumford-Shah formalism has been introduced for the image denoising problem, allowing to capture both smooth behavior inside an object and sharp transitions on the boundary. In the present work, we propose first to extend this formalism to graphs and to the problem of mixing matrix estimation. New algorithmic schemes with convergence guarantees relying on proximal alternating minimization strategies are derived and their efficiency (good estimation and robustness to initialization) are evaluated on simulated data, in the context of vote transfer matrix estimation.

7.3. Wireless & Wired Networks

Participants: Thomas Begin, Anthony Busson, Isabelle Guérin Lassous.

7.3.1. Conflict graph-based model for IEEE 802.11 networks: A Divide-and-Conquer approach

WLANs (Wireless Local Area Networks) based on the IEEE 802.11 standard have become ubiquitous in our daily lives. We typically augment the number of APs (Access Points) within a WLAN to extend its coverage and transmission capacity. This leads to network densification, which in turn demands some form of coordination between APs so as to avoid potential misconfigurations. In our article [20], we describe a performance modeling method that can provide guidance for configuring WLANs and be used as a decision-support tool by a network architect or as an algorithm embedded within a WLAN controller. The proposed approach estimates the attained throughput of each AP, as a function of the WLAN's conflict graph, the AP loads, the frame sizes, and the link transmission rates. Our modeling approach employs a Divide-and-Conquer strategy which breaks down the original problem into multiple sub-problems, whose solutions are then combined to provide the solution to the original problem. We conducted extensive simulation experiments using the ns-3 simulator that show the model's accuracy is generally good with relative errors typically less than 10%. We then explore two issues of WLAN configuration: choosing a channel allocation for the APs and enabling frame aggregation on APs.

7.3.2. Video on Demand in IEEE 802.11p-based Vehicular Networks: Analysis and Dimensioning

This is a joint work with A. Boukerche. In [31], we consider a VoD (Video on-Demand) platform designed for vehicles traveling on a highway or other major roadway. Typically, cars or buses would subscribe to this delivery service so that their passengers get access to a catalog of movies and series stored on a back-end server. Videos are delivered through IEEE 802.11p Road Side Units deployed along the highway. In this paper, we propose a simple analytical and yet accurate solution to estimate (at the speed of a click) two key performance parameters for a VoD platform: (i) the total amount of data down-loaded by a vehicle over its journey and (ii) the total "interruption time" , which corresponds to the time a vehicle spends with the playback of its video interrupted because of an empty buffer. After validating its accuracy against a set of simulations run with ns-3, we show an example of application of our analytical solution for the sizing of an IEEE 802.11p-based VoD platform.

7.3.3. An accurate and efficient modeling framework for the performance evaluation of DPDK-based virtual switches

This is a joint work with B. Baynat, G. Artero Gallardo and V. Jardin [4]. Data plane development kit (DPDK) works as a specialized library that enables virtual switches to accelerate the processing of incoming packets by, among other things, balancing the incoming flow of packets over all the CPU cores and processing packets by batches to make a better use of the CPU cache. Although DPDK has become a de facto standard, the performance modeling of a DPDK-based vSwitch remains a challenging problem. In this paper, we present an analytical queueing model to evaluate the performance of a DPDK-based vSwitch. Such a virtual equipment is represented by a complex polling system in which packets are processed by batches, i.e., a given CPU core processes several packets of one of its attached input queues before switching to the next one. To reduce the complexity of the associated model, we develop a general framework that consists in decoupling the polling system into several queueing subsystems, each one corresponding to a given CPU core. We resort to servers with vacation to capture the interactions between subsystems. Our proposed solution is conceptually simple,

easy to implement and computationally efficient. Tens of comparisons against a discrete-event simulator show that our models typically deliver accurate estimates of the performance parameters of interest (e.g., attained throughput, packet latency or loss rate). We illustrate how our models can help in determining an adequate setting of the vSwitch parameters using several real-life case studies.

7.3.4. Association optimization in Wi-Fi networks

Densification of Wi-Fi networks has led to the possibility for a wireless station to choose between several access points (APs), improving coverage, wireless link quality and mobility. But densification of APs may generate interference, contention and decrease the global throughput as these APs have to share a limited number of channels. The recent trend in which Wi-Fi networks are managed in a centralized way offers the opportunity to alleviate this problem through a global optimization of the resource usage. In particular, optimizing the association step between APs and stations can increase the overall throughput and fairness between stations. In this work, we propose an original solution to this optimization problem. First, we propose a mathematical model to evaluate and forecast the throughput achieved for each station for a given association. The best association is then defined as the one that maximizes a logarithmic utility function using the stations' throughputs predicted by the model. The use of a logarithmic utility function allows to achieve a good trade-off between overall throughput and fairness. A heuristic based on a local search algorithm is used to propose approximate solutions to this optimization problem. This approach has the benefit to be tuned according to the CPU and time constraints of the WLAN controller. A comparison between different heuristic versions and the optimum solution shows that the proposed heuristic offers solutions very close to the optimum with a significant gain of time.

In the first place, we consider a saturated network. Even if such traffic conditions are rare, the optimization of the association step under this assumption has the benefit to fairly share the bandwidth between stations. Nevertheless, traffic demands may be very different from one station to another and it may be more useful to optimize associations according to the stations' demands. In a second step, we propose an optimization of the association step based on the stations' throughputs and the channel busy time fraction (BTF). The latter is defined as the proportion of time the channel is sensed busy by an AP. We propose an analytical model that predicts BTF for any configuration. Associations are optimized in order to minimize the greatest BTF in the network. This original approach allows the Wi-Fi manager to unload the most congested AP, increase the throughput for most of the stations, and offer more bandwidth to stations that need it. We present a local search technique that finds local optima to this optimization problem. This heuristic relies on an analytical model that predicts BTF for any configuration. The model is based on a Markov network and a Wi-Fi conflict graph. NS-3 simulations including a large set of scenarios highlight the benefits of our approach and its ability to improve the performance in congested and non-congested Wi-Fi networks.

Lastly, we consider the latest amendments of the IEEE 802.11 standard. The main challenges are to propose models that take into account recent enhancements such as spatial multiplexing (MIMO) at the physical layer and frame aggregation mechanism at the MAC layer. To assess these new features, we derive an association optimization approach based on a new metric, named Hypothetical Busy Time Fraction (H-BTF), that combines the classical Busy Time Fraction (BTF) and the frame aggregation mechanism [3].

7.3.5. Transient analysis of idle time in VANETs using Markov-reward models

The development of analytical models to analyze the behavior of vehicular ad hoc networks (VANETs) is a challenging aim. Adaptive methods are suitable for many algorithms (*e.g.* choice of forwarding paths, dynamic resource allocation, channel control congestion) and services (*e.g.* provision of multimedia services, message dissemination). These adaptive algorithms help the network to maintain a desired performance level. However, this is a difficult goal to achieve, especially in VANETs due to fast position changes of the VANET nodes. Adaptive decisions should be taken according to the current conditions of the VANET. Therefore, evaluation of transient measures is required for the characterization of VANETs. In the literature, different works address the characterization and measurement of the idle (or busy) time to be used in different proposals to attain a more efficient usage of wireless network. We focus on the idle time of the link between two VANET nodes. Specifically, we have developed an analytical model based on a straightforward Markov reward chain (MRC)

to obtain transient measurements of this idle time. Numerical results from the analytical model fit well with simulation results [12].

7.4. Performance Evaluation of Communication Networks

Participants: Thomas Begin, Philippe Nain, Isabelle Guérin Lassous.

7.4.1. First-Come-First-Served Queues with Multiple Servers and Customer Classes

This a joint work with A. Brandwajn [5]. We present a simple approach to the solution of a multi-server FCFS queueing system with several classes of customers and phase-type service time distributions. The proposed solution relies on solving a single two-class model in which we distinguish one of the classes and we aggregate the remaining customer classes. We use a reduced state approximation to solve this two-class model. We propose two types of aggregation: exact, in which we merge the phase-type service time distributions exactly, and approximate, in which we simplify the phase-type distribution for the aggregated class by matching only its first two moments. The proposed approach uses simple mathematics and is highly scalable in terms of the number of servers, the number of classes, as well as the number of phases per class. Our approach applies both to queues with finite and infinite buffer space.

7.4.2. A study of systems with multiple operating levels, probabilistic thresholds and hysteresis

This a joint work with A. Brandwajn [6]. Current architecture of many computer systems relies on dynamic allocation of a pool of resources according to workload conditions to meet specific performance objectives while minimizing cost (e.g., energy or billing). In such systems, different levels of operation may be defined, and switching between operating levels occurs at certain thresholds of system congestion. To avoid rapid oscillations between levels of service, "hysteresis" is introduced by using different thresholds for increasing and decreasing workload levels, respectively. We propose a model of such systems with general arrivals, arbitrary number of servers and operating levels where each higher operating level may correspond to an arbitrary number of additional servers and soft (i.e. non-deterministic) thresholds to account for "inertia" in switching between operating levels. In our model, request service times are assumed to be memoryless and server processing rates may be a function of the current operating level and of the number of requests (users) in the system. Additionally, we allow for delays in the activation of additional operating levels. We use simple mathematics to obtain a semi-numerical solution of our model. We illustrate the versatility of our model using several case study examples inspired by features of real systems. In particular, we explore optimal thresholds as a tradeoff between performance and energy consumption.

7.4.3. Covert cycle stealing in an M/G/1 queue

Consider an M/G/1 queue where arriving jobs are under control of a party (Willie). There exists a second party, Alice who may or may not want to introduce a sequence of jobs to be serviced. Her goal is to prevent Willie from being able to distinguish between these two cases. The question that we address is: can Alice introduce her stream of jobs covertly, i.e., prevent Willie from distinguishing between the two possibilities, either her introducing the stream or not, and if so, at what rate can she introduce her jobs? We present a square-root law on the amount of service Alice can receive covertly. The covertness criterion is that the probabilities of false alarm and missed detection is arbitrarily close to one. One result we have established is the following: consider exponential service times for Alice's jobs and Willies' jobs with rate μ_1 and μ_2, respectively. During n Willie's job busy periods, Alice can submit covertly $O(\sqrt{n})$ jobs if $\mu_1 < 2\mu_2$, $O(\sqrt{n/\log n})$ jobs if $\mu_1 = 2\mu_2$, and $O(n^{\mu_1/\mu_2})$ jobs if $\mu_1 > 2\mu_2$. This is the first time that such a phase transition has been observed in this context. This ongoing research, carried out by P. Nain in collaboration with D. Towsley (Univ. Massachusetts) and B. Jiang (Shanghai Jiao Tong Univ.), has various applications in the context of service level agreement.

7.4.4. LRU caches

The work on network caches operating under the standard Least-Recently-Used (LRU) management policy, initiated in 2017 (see 2017 Dante Activity Report), has been completed and published [13]. Under weak statistical assumptions on the content request process, this work establishes the validity of the so-called "Che's approximation" as the cache size and the number of content go to infinity.

7.4.5. Stochastic Multilayer Networks

A stochastic multilayer network is the aggregation of M networks (one per layer) where each is a subgraph of a foundational network G. Each layer network is the result of probabilistically removing links and nodes from G. The resulting network includes any link that appears in at least K layers. This model is an instance of a non-standard site-bond percolation model. Two sets of results are obtained in [28]: first, we derive the probability distribution that the M-layer network is in a given configuration for some particular graph structures (explicit results are provided for a line and an algorithm is provided for a tree), where a configuration is the collective state of all links (each either active or inactive). Next, we show that for appropriate scalings of the node and link selection processes in a layer, links are asymptotically independent as the number of layers goes to infinity, and follow Poisson distributions. Numerical results are provided to highlight the impact of having several layers on some metrics of interest (including expected size of the cluster a node belongs to in the case of the line). This model finds applications in wireless communication networks with multichannel radios, multiple social networks with overlapping memberships, transportation networks, and, more generally, in any scenario where a common set of nodes can be linked via co-existing means of connectivity.

7.5. Computational Human Dynamics and Temporal Networks

Participants: Márton Karsai, Éric Fleury, Jean-Philippe Magué, Philippe Nain, Jean-Pierre Chevrot.

7.5.1. Correlations and dynamics of consumption patterns in social-economic networks

In [16], we analyse a coupled dataset collecting the mobile phone communications and bank transactions history of a large number of individuals living in a Latin American country [16]. After mapping the social structure and introducing indicators of socioeconomic status, demographic features, and purchasing habits of individuals, we show that typical consumption patterns are strongly correlated with identified socioeconomic classes leading to patterns of stratification in the social structure. In addition, we measure correlations between merchant categories and introduce a correlation network, which emerges with a meaningful community structure. We detect multivariate relations between merchant categories and show correlations in purchasing habits of individuals. Finally, by analysing individual consumption histories, we detect dynamical patterns in purchase behaviour and their correlations with the socioeconomic status, demographic characters and the egocentric social network of individuals. Our work provides novel and detailed insight into the relations between social and consuming behaviour with potential applications in resource allocation, marketing, and recommendation system design.

7.5.2. Mapping temporal-network percolation to weighted, static event graphs

The dynamics of diffusion-like processes on temporal networks are influenced by correlations in the times of contacts. This influence is particularly strong for processes where the spreading agent has a limited lifetime at nodes: disease spreading (recovery time), diffusion of rumors (lifetime of information), and passenger routing (maximum acceptable time between transfers). In [14], we introduce weighted event graphs as a powerful and fast framework for studying connectivity determined by time-respecting paths where the allowed waiting times between contacts have an upper limit. We study percolation on the weighted event graphs and in the underlying temporal networks, with simulated and real-world networks. We show that this type of temporal-network percolation is analogous to directed percolation, and that it can be characterized by multiple order parameters.

7.5.3. Randomized reference models for temporal networks

Many real-world dynamical systems can successfully be analyzed using the temporal network formalism. Empirical temporal networks and dynamic processes that take place in these situations show heterogeneous, non-Markovian, and intrinsically correlated dynamics, making their analysis particularly challenging. Randomized reference models (RRMs) for temporal networks constitute a versatile toolbox for studying such systems. Defined as ensembles of random networks with given features constrained to match those of an input (empirical) network, they may be used to identify statistically significant motifs in empirical temporal networks (i.e. over-represented w.r.t. the null random networks) and to infer the effects of such motifs on dynamical processes

unfolding in the network. However, the effects of most randomization procedures on temporal network characteristics remain poorly understood, rendering their use non-trivial and susceptible to misinterpretation. In the work presented in [52], we propose a unified framework for classifying and understanding microcanonical RRMs (MRRMs). We use this framework to propose a canonical naming convention for existing randomization procedures, classify them, and deduce their effects on a range of important temporal network features. We furthermore show that certain classes of compatible MRRMs may be applied in sequential composition to generate more than a hundred new MRRMs from existing ones surveyed in this article. We provide a tutorial for the use of MRRMs to analyze an empirical temporal network and we review applications of MRRMs found in literature. The taxonomy of MRRMs we have developed provides a reference to ease the use of MRRMs, and the theoretical foundations laid here may further serve as a base for the development of a principled and systematic way to generate and apply randomized reference null models for the study of temporal networks.

7.5.4. Socioeconomic dependencies of linguistic patterns in Twitter: a multivariate analysis

Our usage of language is not solely reliant on cognition but is arguably determined by myriad external factors leading to a global variability of linguistic patterns. This issue, which lies at the core of sociolinguistics and is backed by many small-scale studies on face-to-face communication, is addressed in [29], by constructing a dataset combining the largest French Twitter corpus to date with detailed socioeconomic maps obtained from national census in France. We show how key linguistic variables measured in individual Twitter streams depend on factors like socioeconomic status, location, time, and the social network of individuals. We found that (i) people of higher socioeconomic status, active to a greater degree during the daytime, use a more standard language; (ii) the southern part of the country is more prone to use more standard language than the northern one, while locally the used variety or dialect is determined by the spatial distribution of socioeconomic status; and (iii) individuals connected in the social network are closer linguistically than disconnected ones, even after the effects of status homophily have been removed. Our results inform sociolinguistic theory and may inspire novel learning methods for the inference of socioeconomic status of people from the way they tweet.

7.5.5. Threshold driven contagion on weighted networks

Weighted networks capture the structure of complex systems where interaction strength is meaningful. This information is essential to a large number of processes, such as threshold dynamics, where link weights reflect the amount of influence that neighbours have in determining a node's behaviour. Despite describing numerous cascading phenomena, such as neural firing or social contagion, the modelling of threshold dynamics on weighted networks has been largely overlooked. We fill this gap in [21], by studying a dynamical threshold model over synthetic and real weighted networks with numerical and analytical tools. We show that the time of cascade emergence depends non-monotonously on weight heterogeneities, which accelerate or decelerate the dynamics, and lead to non-trivial parameter spaces for various networks and weight distributions. Our methodology applies to arbitrary binary state processes and link properties, and may prove instrumental in understanding the role of edge heterogeneities in various natural and social phenomena.

7.5.6. Link transmission centrality in large-scale social networks

Understanding the importance of links in transmitting information in a network can provide ways to hinder or postpone ongoing dynamical phenomena like the spreading of epidemic or the diffusion of information. In our work [22], we propose a new measure based on stochastic diffusion processes, the*transmission centrality*, that captures the importance of links by estimating the average number of nodes to whom they transfer information during a global spreading diffusion process. We propose a simple algorithmic solution to compute transmission centrality and to approximate it in very large networks at low computational cost. Finally we apply transmission centrality in the identification of weak ties in three large empirical social networks, showing that this metric outperforms other centrality measures in identifying links that drive spreading processes in a social network.

7.5.7. Prepaid or Postpaid? That Is the Question: Novel Methods of Subscription Type Prediction in Mobile Phone Services

In the paper [41], we investigate the behavioural differences between mobile phone customers with prepaid and postpaid subscriptions. Our study reveals that (a) postpaid customers are more active in terms of service usage and (b) there are strong structural correlations in the mobile phone call network as connections between customers of the same subscription type are much more frequent than those between customers of different subscription types. Based on these observations, we provide methods to detect the subscription type of customers by using information about their personal call statistics, and also their egocentric networks simultaneously. The key of our first approach is to cast this classification problem as a problem of graph labelling, which can be solved by max-flow min-cut algorithms. Our experiments show that, by using both user attributes and relationships, the proposed graph labelling approach is able to achieve a classification accuracy of $\sim 87\%$, which outperforms by $\sim 7\%$ supervised learning methods using only user attributes. In our second problem, we aim to infer the subscription type of customers of external operators. We propose via approximate methods to solve this problem by using node attributes, and a two-way indirect inference method based on observed homophilic structural correlations. Our results have straightforward applications in behavioural prediction and personal marketing.

7.5.8. Service Adoption Spreading in Online Social Networks

The collective behaviour of people adopting an innovation, product or online service is commonly interpreted as a spreading phenomenon throughout the fabric of society. This process is arguably driven by social influence, social learning and by external effects like media. Observations of such processes date back to the seminal studies by Rogers and Bass, and their mathematical modelling has taken two directions: One paradigm, called simple contagion, identifies adoption spreading with an epidemic process. The other one, named complex contagion, is concerned with behavioural thresholds and successfully explains the emergence of large cascades of adoption resulting in a rapid spreading often seen in empirical data. The observation of real-world adoption processes has become easier lately due to the availability of large digital social network and behavioural datasets. This has allowed simultaneous study of network structures and dynamics of online service adoption, shedding light on the mechanisms and external effects that influence the temporal evolution of behavioural or innovation adoption. These advancements have induced the development of more realistic models of social spreading phenomena, which in turn have provided remarkably good predictions of various empirical adoption processes. In our chapter [39], we review recent data-driven studies addressing real-world service adoption processes. Our studies provide the first detailed empirical evidence of a heterogeneous threshold distribution in adoption. We also describe the modelling of such phenomena with formal methods and data-driven simulations. Our objective is to understand the effects of identified social mechanisms on service adoption spreading, and to provide potential new directions and open questions for future research.

7.5.9. Attention on Weak Ties in Social and Communication Networks

Granovetter's weak tie theory of social networks is built around two central hypotheses. The first states that strong social ties carry the large majority of interaction events; the second maintains that weak social ties, although less active, are often relevant for the exchange of especially important information (e.g., about potential new jobs in Granovetter's work). While several empirical studies have provided support for the first hypothesis, the second has been the object of far less scrutiny. A possible reason is that it involves notions relative to the nature and importance of the information that are hard to quantify and measure, especially in large scale studies. In our work [48], we search for empirical validation of both Granovetter's hypotheses. We find clear empirical support for the first. We also provide empirical evidence and a quantitative interpretation for the second. We show that attention, measured as the fraction of interactions devoted to a particular social connection, is high on weak ties—possibly reflecting the postulated informational purposes of such ties—but also on very strong ties. Data from online social media and mobile communication reveal network-dependent mixtures of these two effects on the basis of a platform's typical usage. Our results establish a clear relationships between attention, importance, and strength of social links, and could lead to improved algorithms to prioritize social media content.

8. Bilateral Contracts and Grants with Industry

8.1. GranData

Participants: Márton Karsai [correspondant], Éric Fleury.

Founded in 2012, Grandata is a Palo Alto-based company that leverages advanced research in Human Dynamics (the application of « big data » to social relationships and human behaviour) to identify market trends and predict customer actions. Leading telecom and financial services firms are using Grandata's Social Universe product to transform « big data » into impressive business results.

The DANTE team and Grandata started to collaborate in 2014 on the analysis of large datasets provided by the company. The aim of the collaboration is to gain better understanding about the dynamical patterns of human interactions, mobility, and the socio-economic structure of the society. This collaboration was very successful over the years, leading to several publications within the PhD thesis of Yannick Leo. Currently the collaboration is supported by the MOTIF Stic-AmSud project (2018-2020) (coordinated by Márton Karsai) which allows to meet frequently with the company. Recent projects within this collaboration are focusing on socioeconomic inference using remote sensing techniques.

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Idex Lyon ACADEMICS

Participants: Paulo Gonçalves, Dominique Barbe, Gaetan Frusque.

See Section 5.1.1 for an executive summary of this project. The project brings together a **consortium of 4 teams from Laboratories of Université de Lyon** (UdL) and will form a working group with complementary expertise in machine learning (deep learning, statistical learning, data mining), in data science (complex data analysis, adaptive and/or data-driven methods, network science) and in the studies of climate modeling and of computational social science. It comprises:

- Laboratoire Informatique du Parallélisme (LIP): P. Gonçalves (PI), M. Karsai (PI for Comp. Social Sc.)
- Laboratoire de Physique (LP): P. Borgnat (Coordinator), F. Bouchet (PI for Climate)
- Laboratoire Hubert Curien (LabHC), Université Jean Monnet: M. Sebban (PI)
- Laboratoire d'InfoRmatique en Images et Systèmes d'information (LIRIS): C. Robardet (PI)

The **impacts** of the project will stem from the efficiency of our proposed methods to learn from complex and dynamic data, and if so, **future applications** will naturally follow in many areas: social science and study of social interactions, climate and environmental science but also in technological networks, neuroscience with the study of brain networks and more generally in any domain where effective dynamical models of complex situations are to be learned from data. All these situations go beyond the current classical applicative frameworks of ML (time measurements, 2D images, or texts) and compel us to work out a major scientific breakthrough.

9.1.2. ISI Torino / Dante

Participant: Márton Karsai [correspondant].

Duration of the project: **October 2016 - October 2020**.

This project involves M. Karsai and L. Gauvin (ISI Torino) and funded by the IXXI Complex System Institute. The purpose of this project is to investigate the presence and the importance of higher-order correlations in dynamical networks. As the first attempt to address this problem we applied autoencoder, a recent representation using deep neural networks, on modelled and small-scale real temporal networks. However, since the results were trivial on the modelled network and not convincing on the real one we decided to take a different approach during the second phase of the project. We involved an ISI PhD student Maddalena Toricelli, to work out a method for temporal network embedding. Our idea is to extend the node2vec representation of static networks for time-varying structures, by using a local random walk to explore the structural-temporal neighbourhood of a node. Based on such local information we can effectively propose an embedding, which captures the temporal and structural properties of nodes in a temporal network.

9.2. National Initiatives

9.2.1. Equipex FIT (Futur Internet of Things)

Participant: Éric Fleury [correspondant].

FIT was one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8 million euro grant from the French government Running from 22.02.11 – 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.

9.2.2. ANR GRAPHSIP (Graph Signal Processing)

Participants: Paulo Gonçalves [correspondant], Éric Fleury, Thomas Begin, Mikhail Tsitsvero.

Duration of the project: **October 2014 - October 2018**.

An increasing number of application areas require the processing of massive datasets. These data can often be represented by graphs in order to encode complex interactions. When data vectors are associated with graph vertices, a so-called graph signal is obtained. The processing of such graph signals includes several open challenges because of the nature of the involved information. Indeed graph theory and signal and image processing methodologies do not combine readily. In particular, such a combination requires new developments, allowing classical signal processing methods to work on irregular grids and non Euclidean spaces. Considering the significant success of classical signal processing tools, it appears essential to generalise their use to graph signals. The GRAPHSIP project aims at developing a set of advanced methods and algorithms for the processing of graph signals: multi-scale transforms and solutions of variational problems on graphs. The major outcomes of this project are expected to lead to significant breakthroughs for graph data processing. The project will also focus on two novel applications on instances of graph signals: brain networks and 3D colour point clouds. They will exemplify and illustrate the proposed methodological advances on emerging applications.

9.2.3. ANR SoSweet

Participants: Jean Pierre Chevrot, Éric Fleury, Márton Karsai [correspondant], Jean-Philippe Magué [PI].

Duration of the project: **November 2015 - November 2019**.

The SoSweet project focuses on the synchronic variation and the diachronic evolution of the variety of French used on Twitter. The recent rise of novel digital services opens up new areas of expression which support new linguistic behaviours. In particular, social medias such as Twitter provide channels of communication through which speakers/writers use their language in ways that differ from standard written and oral forms. The result is the emergence of new varieties of languages. The main goal of SoSweet is to provide a detailed account of the links between linguistic variation and social structure in Twitter, both synchronically and diachronically. Through this specific example, and aware of its bias, we aim at providing a more detailed understanding of the dynamic links between individuals, social structure and language variation and change.

9.2.4. ANR DylNet

Participants: Márton Karsai [correspondant], Jean Pierre Chevrot, Jean-Philippe Magué, Éric Fleury.

Duration of the project: **September 2016 - September 2020**.

The DylNet project aims to observe and to characterise the relationships between childhood sociability and oral-language learning at kindergarten. With a view to this, it takes an multidisciplinary approach combining work on language acquisition, sociolinguistics, and network science. It will be implemented by following all the children (≈ 220) and teaching staff in one kindergarten over a 3-year period. The use of wireless proximity sensors will enable collection of social contacts throughout the study. The data on sociability will be linked to the results of language tests and recordings of verbal interactions used to follow the children's progress on both a psycholinguistic level (lexicon, syntax, pragmatics) and a sociolinguistic level (features showing belonging to a social group). The aim is to better understand the mechanisms of adaptation and integration at work when young children first come into contact with the school context.

9.2.5. Inria PRE LIAISON

Participants: Márton Karsai [correspondant], Éric Fleury.

Duration of the project: **November 2017 - December 2019**.

This project implements unsupervised deep learning approaches to infer correlations/patterns that exist between dynamic linguistic variables, the mesoscopic and dynamic structure of the social network, and their socio-economic attributes. This interdisciplinary project is positioned at the crossroads of Natural Language Processing (NLP), Network Science, Data Science and Machine Learning.

More precisely, we develop a joint feature-network embedding, named AN2VEC (Attributed Network to Vector), which ultimately aims at disentangling the information shared by the structure of a network and the features of its nodes. Building on the recent developments of Graph Convolutional Networks (GCN), we use a multitask GCN Variational Autoencoder where different dimensions of the generated embeddings can be dedicated to encoding feature information, network structure, or shared feature-network information separately. This method thus defines a range of models whose performance in embedding a given data set varies depending with the allocation of dimensions. By exploring the behaviour of these models on synthetic data sets having different levels of feature-network correlation, we show (i) that embeddings relying on shared information perform better than the corresponding reference with unshared information, and (ii) that this performance gap increases with the correlation between network and feature structure, thus confirming that our embedding is able to capture joint information of structure and features.

9.2.6. Inria & HCERES

Participants: Éric Guichard [correspondant], Éric Fleury.

Bilateral project on the evolution of the Multi/inter-disciplinary of SHS.

An increasing number of researchers in SHS has the desire to develop new researches with computer scientists or mathematicians because they want to apply new methodologies (according to various or numerous data) or to develop older ones, which can now be easily implemented online. Some also develop a reflexion on their discipline, with the idea that epistemological questions are revitalized by the internet. This reality invite them to discuss with philosophers or with other SHS scientists who have the same intuition (eg: cartography, visualisation).

The project is hence to measure these new forms or inter-multi-disciplinarity. The main source will be the publications of all academics of French SHS laboratories, to find out who writes a paper with somebody of a different discipline and/or laboratories. All data are anonymized,

9.2.7. Inria IPL BetterNet

Participant: Éric Guichard.

An Observatory to Measure and Improve Internet Service Access from User Experience [2].

BetterNet aims at building and delivering a scientific and technical collaborative observatory to measure and improve the Internet service access as perceived by users. In this Inria Project Lab, we will propose new original user-centered measurement methods, which will associate social sciences to better understand Internet usage and the quality of services and networks with a particular focus on geography and cartography.

9.3. European Initiatives

9.3.1. FP7 & H2020 Projects

9.3.1.1. EMBERS

- Title: Enabling a Mobility Back-End as a Robust Service
- Programm: H2020
- Duration: December 2015 - November 2018
- Coordinator: UPMC
- Partners:
  - Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev (Germany)
  - Technische Universitat Berlin (Germany)
  - Universite Pierre et Marie Curie - Paris 6 (France)
  - Ubiwhere Lda (Portugal)
- Inria contact: Eric Fleury
- EMBERS will bring to market a back-end for smart city mobility that is developed by a European small enterprise based upon its smart parking and smart traffic management products that two municipalities in Portugal currently deploy. The Mobility Back-end as a Service (MBaaS) replaces such all-in-one systems, in which a municipality purchases the full set of components from a single vendor. Instead, the city manager can purchase best-of-breed devices and apps developed by third parties, with the only constraint being that they interoperate with the back-end via a free, open, smart city mobility API. This domain-specific API lowers barriers to entry for app and device developers, making it easier for innovative SMEs to enter the market. Furthermore, the API is offered via a variety of generic interfaces, including oneM2M, ETSI M2M, OMA LWM2M, and FIWARE NGSI. EMBERS thus clears the way for developers and to municipalities that have adopted any one of these potential emerging machine-to-machine (M2M) communication standards. Beyond its primary goal of bringing the MBaaS to market, EMBERS will stimulate development of an entire ecosystem around the MBaaS smart city mobility API. Separating out the back-end from the other components will, however, require rigorous testing. EMBERS will experiment with the system on two testbeds that are part of the FIRE OneLab facility: the FUSECO Playground, for M2M communications, and FIT IoT-LAB, for wireless sensor devices. EMBERS will host a hackathon and an app challenge to bring in third party developers. The project will also include three demonstrators by third parties via an open call. These activities will contribute back to FIRE by demonstrating successful experimentation by SMEs developing close-to-market products. The project will also conduct real world pilots in two or more cities as a final step in bringing the MBaaS to market.

9.3.1.2. ARMOUR

Title: Large-Scale Experiments of IoT Security & Trust (Project nÂ°688237)

Programm: H2020

Duration: 2015 Dec to 2018

Coordinator: UPMC

Partners:

[2] https://www.inria.fr/en/research/research-teams/inria-project-labs

Synelixis Lyseis Pliroforikis Automatismou & Tilepikoinonion Monoprosopi EPE (Greece)

Smartesting Solutions & Services (France)

Unparallel Innovation, Lda (Portugal)

Easy Global Market (France)

ODIN Solutions (Spain)

Universite Pierre et Marie Curie - Paris 6 (France)

Inria contact: Eric Fleury

ARMOUR will provide duly tested, benchmarked and certified Security & Trust solutions for large-scale IoT using upgraded FIRE large-scale IoT/Cloud testbeds properly-equipped for Security & Trust experimentations. ARMOUR takes the top large-scale FIT IoT-LAB testbed a FIRE OpenLAB / FIT IoT LAB facility â and enhances it as to enable experimentally-driven research on a key research dimension: large-scale IoT Security & Trust. Presently, no proper installations exist to experiment IoT Security & Trust on large-scale conditions; ARMOUR will develop and install such capability.

9.4. International Initiatives

9.4.1. Participation in International Programs

9.4.1.1. PHC Peridot

Participants: Mohammed Amer, Thomas Begin, Anthony Busson, Isabelle Guérin Lassous.

Framework for Control and Monitoring of Wireless Mesh Networks (WMN) using Software-Defined Networking (SDN). The main objective of this project is propose mechanisms and modifications in the SDN architecture, specifically in the OpenFlow, which allow SDN mechanisms to operate over WMN considering the dynamic network topology that WMN may experience and some other relevant characteristics. The project will involve devising mechanisms for controlling mesh switches through controllers in a wireless environment, which will require developing novel and WMN-specific rules, actions and commands. The project will involve proposing mechanism that consider dynamic environment of WMN along with providing redundancy in the network. Besides, there is a requirement to have an adaptive measurement API for WMN. This is the second objective of our research project. The proposed measurement API will enable the network operators to monitor network traffic over WMN which may be content-specific or host-specific. This is a joint project between DANTE and M. A. Jinnah University, Islamabad. It started in June 2015 and will end in June 2018.

9.4.2. International Initiatives

9.4.2.1. MOTif - Mobile phone sensing of human dynamics in techno-social environment

- Program: Stic AmSud
- Duration: January 2018 - December 2019
- Coordinator: Inria DANTE (Márton Karsai)
- Partners:
  - Universidad de Buenos Aires (Argentina)
  - Grandata (USA-Argentina)
  - Universidade Federal de Minas Gerais (Brazil)
  - LNCC (Brazil)

This project brings together two Inria teams - INFINE (Saclay) - DANTE (Lyon) and multiple Latin-American partners to work together with the IT company Grandata.

Scope of the project: Information and Communication Technology (ICT) is becoming increasingly social, as demonstrated by the multitude of emerging technologies and technology platforms that facilitate social interactions, taking place as communication via telephone, text message, email, online social networks etc. At the same time, our social activities are increasingly embedded in the ICT environments that enable and enhance our ability to transact, share experiences, and maintain social relationships. One of the best ways to explore these developments is through the mining and analysis of data, which are collected through mobile phones and allow us to investigate how individuals act when embedded in a technology-enabled environment. Unlimited access to a wide range of mobile applications and services may change our way to gain information, to communicate, or even to behave in different contextual places like home, work, or anywhere else. Thus understanding individual activity patterns and the source of decisions behind them is moreover important for the design of future services and to estimate the demand on the infrastructure. The MOTIf project builds on the analysis and modeling of geo-localized temporally detailed but fully anonymised mobile phone call networks. These datasets allow us to address the two scientific objectives about spatiotemporal patterns of service usage of anonymised individuals to learn when, where, and what people are doing; and about the fine-grained sociodemographic structure of society and its effect on the the individual social behaviour. In other words our goal in general is to understand how individuals behave in a dynamic techno-social environment.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

- Don Towsley, University of Massachusetts, Amherst, USA (march 15 - june 15, 2018).
- Alexandre Brandwajn, University of California Santa Cruz, USA (march 2018)

9.5.2. Visits to International Teams

9.5.2.1. Research Stays Abroad

- Philippe Nain visited the University of Massachusetts at Amherst (Sep. 1, 2018 - Jan. 31, 2019). He taught a graduate course on Performance Evaluation of Computer and Communication Systems and collaborated with Prof. D. Towsley and some of his students/collaborators on several research projects.
- Christophe Crespelle is on leave with a Marie Sklodowska-Curie Grant from EU. He is currently at the University of Bergen (Norway) until the beginning of 2020.
- Christophe Crespelle visited the Institute of Mathematics of the Vietnam Academy of Science and Technology, Hanoi, Vietnam (Nov. 6 - Dec. 6, 2018).

10. Dissemination

10.1. Promoting Scientific Activities

10.1.1. Scientific Events Organisation

10.1.1.1. General Chair, Scientific Chair

- Márton Karsai was in the organizing team (general chair) of the Computational Social Science Satellite of the CCS'18 Conference in September 2018 in Thessaloniki
- Márton Karsai was in the organizing team (general chair) of the Machine Learning and Network Science Satellite of the NetSci'18 Conference in June 2018 in Paris

10.1.1.2. Member of the Organizing Committees

- Éric Guichard was the chair and organiser of the summer school *Cartography and visualisation 2018* [3].
- Márton Karsai was in the organising team (sponsor chair) of the NetSci'18 Conference held in June 2018 in Paris
- Márton Karsai was in the organising team (poster chair) of the Complex Networks Conference held in December 2018 in Cambridge

[3] http://barthes.enssib.fr/ECV-2018

10.1.2. Scientific Events Selection

10.1.2.1. Member of the Conference Program Committees

- Thomas Begin was on the PC of the 43nd IEEE Conference on Local Computer Networks (LCN).
- Isabelle Guérin Lassous was, in 2018, a member of the program committee of the conferences ACM MSWiM, IEEE ICC and Globecom.
- Philippe Nain was a member of the program committee of the IFIP Performance 2018 conference (Toulouse, France, december 2018) and of the MAMA 2018 workshop (Irvine, CA, USA, June 2018).
- Márton Karsai was a member of the program committee of the following conferences in 2018: Complenet 2018, MLSN2018, LADAS2018, ICCS2018, Dyno 2018, COMPLEX NETWORKS 2018, NetSci 2018.
- Christophe Crespelle was a member of the program committee of the 10th International Colloquium on Graph Theory and Combinatorics (ICGT 2018).

10.1.3. Journal

10.1.3.1. Member of the Editorial Boards

- Isabelle Guérin Lassous is member of the editorial boards of Computer Communications (Elsevier), Ad Hoc Networks (Elsevier) and Discrete Mathematics & Computer Science.
- Anthony Busson is member of the editorial boards of Computer Communications (Elsevier).
- Márton Karsai is member of the editorial boards of Advances in Complex Systems (World Scientific).
- Márton Karsai was the invited editor of the Special Issue on Complex Networks and Their Applications, Applied Network Science, Springer (2018)
- Philippe Nain is a member of the Advisor Board of Performance Evaluation (Elsevier).

10.1.3.2. Reviewer - Reviewing Activities

- Márton Karsai was acting as a reviewer for the journals of Nature Communications, PNAS, PRL, PRX, PRE, Scientific Reports, EPJ Data Science, SNAM, EPL, EPJ B, PLoS One, Journal of Statistical Mechanics, Physics Letter A, Advanced in Complex Systems, Journal of Physics: Condensed Matter, Complex Networks, New Journal of Physics, Physica Scripta, Network Science; and for project agencies as ANR, FET-H2020 RIA.
- Paulo Gonçalves was reviewer for the following journals: IEEE Transactions on Signal Processing, IEEE Signal Processing Letter, Signal Processing (Elsevier).
- Christophe Crespelle was a reviewer for Algorithmica (Springer) and Theoretical Computer Science (Elsevier).

10.1.4. Invited Talks

- Éric Guichard gave a talk at the one-day conference *Humanités et numérique: vers plus de confiance dans la production du discours scientifique*: Les humanités numériques, un slogan creux? (Paris, Dec 4, 2018).
- Éric Guichard gave a talk at the international conference in honor of Gérard Noiriel, called *Héritages et actualités de la socio-histoire*: Comment l'informatique et les statistiques ont aidé à penser l'histoire des catégories juridiques et sociales de l'immigration? (June 14, 2018, Ehess, Paris).
- Éric Guichard gave a talk at the seminar of the PhD students of LIRIS (Univ. Lyon-1): Numérique et fracture sociale (April 3rd, 2018.)
- Éric Guichard gave a talk at the conference « Quelle est l'utilité d'un produit digital connecté dans le monde du sport? », rencontres *maths et industrie* (institut Henri Poincaré, Paris, March 13, 2018).

- Éric Guichard gave a talk at the one-day conference *Imaginaires présents, numérique à venir: impensés et idéologies*: Culture de l'écrit spatial, imaginaires et subjectivités (ESAD St-Etienne, March 7, 2018).
- Éric Guichard gave a talk at the *Séminaire interdisciplinaire PHITECO (Philosophie, Technique et Cognition)*: Epistémologie et philosophie politique du numérique (UTC, Compiègne, Jan 19, 2018).
- Paulo Gonçalves gave a talk at the seminars of the EPC Inria Maracas (Nov. 2018).
- Isabelle Guérin Lassous gave a talk at CUST and NUST in Pakistan and a seminar at the LIG laboratory on Wi-Fi association.
- Thomas Begin gave a talk at DIVA lab of Univ. of Ottawa in Canada on the modeling of DPDK-based virtual switches.
- Thomas Begin gave a talk at CITI Lab of INSA Lyon on Modeling WiFi in a multihop wireless network : feedback on experience.
- Thomas Begin gave a talk at LIP Lab of ENS Lyon on A brief tour of Machine Learning techniques.
- Philippe Nain gave a seminar on A class of stochastic multilayer networks: percolation, exact and asymptotic results, Inria Grenoble (March 22, 2018).
- Márton Karsai gave an invited talk at the Higher Order Models in Network Science, NetSci'18 Satellite (12 June 2018, Paris, France)
- Márton Karsai gave an invited talk at the Art, Networks and Technology, NetSci'18 Satellite (12 June 2018, Paris, France)
- Márton Karsai gave an invited talk at the BrainTime workshop, Institut de Neurosciences de la Timone (18 September 2018, Marseille, France)
- Márton Karsai gave an invited talk at the Language Seminar Series, Laboratoire d'Informatique de Grenoble (20 September 2018, Grenoble, France)
- Márton Karsai gave an invited talk at the Op-La-Dyn workshop, CCS'18 Satellite (26 September 2018, Thessaloniki, Greece)
- Márton Karsai gave an invited talk at the Complex systems for the most vulnerable – UNICEF workshop, CCS'18 Satellite (27 September 2018, Thessaloniki, Greece)
- Márton Karsai gave an invited talk at the SpaceNet workshop, CCS'18 Satellite (27 September 2018, Thessaloniki, Greece)
- Christophe Crespelle gave an invited talk in the Workshop on Graph Theory and Applications at the Vietnam Institute for Advanced Studies in Mathematics (VIASM), Hanoi, Vietnam.
- Christophe Crespelle gave a talk at the ICTLab of the University of Science and Technology of Hanoi (USTH), Vietnam.

10.1.5. Leadership within the Scientific Community

- Éric Fleury is Co-chair of the Networking group ResCom of the CNRS GDR ASR. He is also a member of the scientific committee of the GDR ASR.
- Philippe Nain is the coordinator of the "Strategic Technology Monitoring & Prospective Studies Inria Unit".

10.1.6. Scientific Expertise

- Isabelle Guérin Lassous is a member of the research committee of the Milyon labex.
- Isabelle Guérin Lassous is the president of the HCERES evaluation committee of SAMOVAR.
- Éric Fleury is member of the Inria Advanced and starting research position jury and junior research position (CR2/CR1)
- Éric Fleury has been an expert for the Fund for Scientific Research - FNRS.

- Éric Fleury has been a member of evaluation panels as part of the French National Research Agencys (ANR) and member of the program committee of the ANR ROSE Challenge (RObotique et Capteurs au Service d'Ecophyto)
- Éric Fleury is member of the Inria Evaluation Committee.
- Éric Guichard is a member of the scientific committee of LASCO Idea Lab of the IMT (LAboratoire Sens et COmpréhension du monde contemporain de l'Institut Mines-Télécom).
- Éric Guichard is a member of the international evaluation board of the doctoral program *Filosofia da Ciencia, Tecnologia, Arte e Sociedade* of the University of Lisbon.
- Éric Guichard is the manager of the RAIL [4] (Réseau de l'Atelier Internet Lyonnais), founded in 2017 and supported by IXXI and Enssib.

10.1.7. Research Administration

- Paulo Gonçalves is scientific liaison officer for international relations in Inria Research Centre of Rhône-Alpes.
- Paulo Gonçalves is a member of the executive committee of the Milyon labex and referent for its valorisation committee.
- Paulo Gonçalves is correspondant for the theme "Big Data" of the *Fédération d'Informatique de Lyon*.
- Paulo Gonçalves is member of the Council of the LIP laboratory.
- Isabelle Guérin Lassous is member of the department council of the Computer Science department of Université Lyon 1.
- Isabelle Guérin Lassous is the managing director of the Foundation Blaise Pascal.
- Anthony Busson is member of the Thesis Commission at LIP.
- Anthony Busson is head of the computer science department at IUT (Institut Universitaire de Technologie) - Université Lyon Claude Bernard Lyon 1.
- Anthony Busson was a HCERES expert member (laboratory LMIA-MIPS - Université de Haute Alsace).
- Thomas Begin is an elected member of the Council of the LIP laboratory.
- Thomas Begin is an elected member of the department council of the Computer Science department of Université Lyon 1.
- Jean Pierre Chevrot is member of the steering committee of the IXXI - Rhône-Alpes Complex Systems Institute.
- Márton Karsai is the co-responsible for the M2 master program in Modelling of Complex Systems at ENS Lyon
- Márton Karsai is the elected council member of the Complex System Society (2015-)
- Márton Karsai is the elected member of executive committee of the Complex System Society (2018-)
- Márton Karsai is the elected member of the steering committee of the IXXI Complex System Institute (2017-)
- Márton Karsai is the member of the computational infrastructure board of LIP
- Márton Karsai is the member of the communication board of LIP
- Éric Guichard is a member of the steering committee of the IXXI Complex System Institute
- Jean-Philippe Magué is a member of the executive committee of the IXXI Complex System Institute
- Jean-Philippe Magué is a member of the executive committee of the Aslan Labex, in charge of the language complexity work package.

[4] http://barthes.enssib.fr/RAIL

10.2. Teaching - Supervision - Juries

10.2.1. Teaching

Licence :

Thomas Begin: Computer Networks, 18.5h, L3, Université Lyon 1.

Márton Karsai: Introduction to Complex Networks, 6h, L3, ENS Lyon

Master :

Thomas Begin: Distributed Algorithms, 18h, M1, Université Lyon 1.

Thomas Begin: Computer Networks, 44h, M1, Université Lyon 1.

Thomas Begin: System Administration & Security, 10.5h, M2, Université Lyon 1.

Thomas Begin: Advanced Networks, 58h, M2, Université Lyon 1.

Thomas Begin: Cloud Computing, 9h, M2, Université Lyon 1.

Isabelle Guérin-Lassous: Distributed Algorithms, 30h, M1, Université Lyon 1.

Isabelle Guérin-Lassous: Networking, 14h, M1, Université Lyon 1.

Isabelle Guérin-Lassous: Wireless networks, 9h, M2, Université Lyon 1.

Isabelle Guérin-Lassous: Quality of Service, 5h, M2, Université Lyon 1.

Isabelle Guérin-Lassous: ToIP and streaming, 12h, M1, Université Lyon 1.

Éric Guichard: Économie du web et du document, 36h, M2, Enssib & Univ. Lyon 1.

Éric Guichard: Programmation éditoriale, 18h, M2, Enssib & Univ. Lyon 1.

Márton Karsai: Complex Networks, 36h, M2, ENS Lyon

Márton Karsai: Data Bases Data Mining, 20h, M1, ENS Lyon

Philippe Nain: Performance Evaluation of Computing and Communication Systems (graduate course, Fall semester 2018), 32h, University of Massachusetts, Amherst, USA.

Cycle ingénieur (Bac+3 à Bac+5):

Paulo Gonçalves: Traitement du Signal (déterministe, aléatoire, numérique), Estimation statistique. 80 heures Eq. TD. CPE Lyon, France.

Marion Foare: Traitement du Signal (déterministe, aléatoire), Traitement d'images, Compression, Projets. 115 heures Eq. TD. CPE Lyon, France.

10.2.2. Supervision

HDR defense: Thomas BEGIN, Contributions to the Performance Modeling of Computer Networks. December 2018.

PhD defense: Mohammed AMER,WiFi network management: a SDN approach, Novembre 2018.

PhD in progress: Esteban BAUTISTA RUIZ, Statistical Graph Signal Processing. P. Gonçalves (P. Abry, co-advisor). Started Sept. 1st, 2016.

PhD in progress: Mohamed Adbelwedoud LAFDAL, Inference of conflict graph in IEEE 802.11 networks. September 2017, A. Busson and I. Guérin Lassous

PhD in progress: Samuel UNICOMB, Spreading processes on temporal networks, Oct 2016, E. Fleury and M. Karsai

PhD in progress: Jacobo Levy ABITBOL, Information diffusion and language evolution on dynamical social networks, Oct 2016, E. Fleury and M. Karsai

PhD in progress: Marija STOJANOVA, Performance Modelling of IEEE 802.11 networks , Oct 2016, T. Begin

PhD in progress: Sicheng DAI, Dynamic Multilayer Network Modelling, M. Karsai supervisor (E. Fleury director). Started October 1st, 2017.

PhD in progress: Gaetan FRUSQUE, *Modal Decompositions of Dynamic Graphs : Application in Neurosciences*, P. Gonçalves (P. Borgnat, co-advisor). Started October 1st, 2017.

PhD in progress: Rémy GRÜNBLATT, Controlled mobility for UAV networks, October 2017, I. Guérin Lassous and O. Simonin.

PhD in progress: Dominique BARBE, From local to global learning, P. Gonçalves (P. Borgnat, co-advisor). Started October 1st, 2018.

PhD in progress: Nour el Houda BOUZOUITA, supervised by A. Busson and Hervé Rivano. Wi-Fi network Optimization through crowd sensing applications. November 2018 - November 2021.

10.2.3. Juries

Paulo Gonçalves was a member of the Ph.D thesis examination board of Jean-Charles Vialatte, IMT Atlantique, Université Bretagne Loire, December 2018.

Isabelle Guérin Lassous was a reviewer of the Ph.D thesis examination board of Jonatan Krolikowski, Univ. Paris-Sud ; Raphaël Naves, Univ. de Toulouse ; Antoine Auger, Univ. de Toulouse

Isabelle Guérin Lassous was a president of the Ph.D thesis examination board of Elodie Morin, Univ. Grenoble Alpes ; Jonatan Krolikowski, Univ. Paris-Sud

Isabelle Guérin Lassous was a member of the Ph.D thesis examination board of Narcisse Kamtchoun, UPMC

Isabelle Guérin Lassous was a member of the HdR thesis examination board of Valeria Loscri, Univ. de Lille.

Éric Guichard was a member of the Ph.D thesis examination board of Amélie Turet, Univ. Bordeaux-Montaigne.

Christophe Crespelle was a reviewer of the Ph.D thesis examination board of Thibaud Arnoux, UPMC

Anthony Busson was a jury member of Cristhian IZA PAREDES's PhD thesis. Universitat Polytecnica de Catalunya. July 12 July 2018.

Anthony Busson was reviewer and jury member of Lam-Thanh TU's PhD thesis. Université Paris Saclay. 18 June 2018.

Anthony Busson was reviewer and jury member of Nesrine KHERNANE's PhD thesis. Université de Bourgogne Franche comté. 13 November 2018.

Anthony Busson reviewer and jury member of Lucas's RIVOIRARD PhD thesis. Université de Lille. 21 September 2018.

10.3. Popularization

10.3.1. Internal or external Inria responsibilities

Isabelle Guérin Lassous is the managing director of the Foundation Blaise Pascal. The objectives of the foundation are to promote mathematics and computer science and to attract young people to scientific fields like computer science and mathematics. The actions of the FBP focus on:

- a support to actors that promote mathematics and computer science via allocated funding based on call of proposals;
- a structuring of actors to increase the impacts of their actions, to coordinate the efforts and to share experiences;
- a development of innovative experiences via summer camps and clubs of mathematics and computer science.

10.3.2. Articles and contents

- Éric Guichard wrote an article with Nicolas Schabanel in newspaper *Libération*, September 10, 2018, p. 24: « Copyright numérique: stériliser pour mieux tuer », https://www.liberation.fr/debats/2018/09/09/copyright-numerique-steriliser-pour-mieux-tuer_1677568.
- Éric Guichard gave an interview in newspaper *O Globo* (Brazil), Jan 1st , 2018.

10.3.3. Interventions

Paulo Gonçalves and Eric Guichard animated a citizen meeting on Artificial Intelligence and Social impacts. November 2018. Orliénas. https://www.vepm.net/2018/10/26/cafe-citoyen-orlienas-9-novembre-2018-lintelligence-artificielle/

11. Bibliography

Publications of the year

Doctoral Dissertations and Habilitation Theses

[1] T. BEGIN. *Contributions to the Performance Modeling of Computer Networks*, Université Claude Bernard Lyon 1, December 2018, Habilitation à diriger des recherches, https://hal.archives-ouvertes.fr/tel-01951250

Articles in International Peer-Reviewed Journals

[2] I. ACHOUR, T. BEJAOUI, A. BUSSON, S. TABBANE. *Performance Modeling of SEAD Protocol in Vehicular Environment*, in "Wireless Networks", 2018, pp. 1-18 [*DOI :* 10.1007/s11276-018-1706-3], https://hal.inria.fr/hal-01782477

[3] M. AMER, I. GUÉRIN LASSOUS, A. BUSSON. *Association optimization based on access fairness for Wi-Fi networks*, in "Computer Networks", June 2018, vol. 137, pp. 173 - 188 [*DOI :* 10.1016/J.COMNET.2018.03.004], https://hal.inria.fr/hal-01906319

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