



Activity Report 2019

Team DATASPHERE

Economie des données et des plateformes

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
Security and Confidentiality

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Team DATASPHERE

Creation of the Team: 2017 January 01

Keywords:

Computer Science and Digital Science:

- A1.5. - Complex systems
- A3.1. - Data
- A3.5. - Social networks

Other Research Topics and Application Domains:

- B3. - Environment and planet
- B8.2. - Connected city
- B8.5. - Smart society
- B9.6. - Humanities
- B9.11. - Risk management

1. Team, Visitors, External Collaborators

Research Scientist

Stephane Grumbach [Team leader, Inria, Senior Researcher, HDR]

PhD Student

Colin Gerard [Inria, PhD Student]

Administrative Assistant

Sylvie Boyer [Inria, Administrative Assistant]

External Collaborators

Frederick Douzet [Univ Vincennes-Saint Denis]
Olivier Hamant [INRA, HDR]
Kavé Salamatian [Univ Savoie Mont-Blanc, HDR]

2. Overall Objectives

2.1. Overall Objectives

The past decade have witnessed an explosion of the amount of data harvested through digital systems and produced by human activity or from the large set of environmental sensors (IoT). These data are collected, analyzed, correlated and transformed to enable innovative services, which have strong, often disruptive, impact on societies. The datasphere is the new space resulting from these data, considered as a whole, independently of their control. It constitutes a dynamic complex system, much like the hydrosphere, where the basic constituents are bits of data in place of water molecules. Although the date of the inception of the datasphere can be debated, it is really at the turn of the century that its role became dominant and challenged the legacy organisation of societies.

The objective of the Datasphere team is to study the transformation of socio-economic and socio-ecological systems triggered by the diffusion of digital services. We propose a holistic view of the datasphere to apprehend global changes at a planetary scale, with a long term perspective, sometimes with a teleologic vision to understand the phenomena at play and model the interactions of the future. We also consider the digital transformation of socio-economic systems in relation with the challenges that the threats on the natural ecosystem of our planet impose on human societies. Both transformations happen contemporarily, and share parallel impact on the tension between local and global, vertical and horizontal.

A major goal of the project is to develop tools and methodologies in order to observe and analyse the ongoing changes induced by digital transformations. These tools are generally software systems that have to process large volume of heterogeneous data in order to harvest relevant metrics. For this purpose we are pursuing big data processing, machine learning, data visualization, cartography and graph analysis methods that are applicable to our specific needs and can be used in broader scopes.

From a methodological point of view, we aim (i) at interdisciplinary research with all relevant disciplines, and in particular social sciences, and (ii) when possible, analysis of large datasets, such as those from network activities, to investigate quantitatively global phenomena. The first aim raises classical difficulties of interdisciplinary research, but is carried on in a very favorable environment, namely the complex system institute, IXXI. For the second aim, we need to develop original data analysis techniques, new metrics on data flows related to social activities, as well as new visualisation methods to show the interdependencies between entities, from States to people and devices.

3. Research Program

3.1. Dynamics of digital transformations

The research program of the Datasphere team aims at understanding the transformations induced by digital systems on socio-economic and socio-ecological organizations. These transformations are very broad and impact a large part of society. Understanding these changes is very ambitious and would require much more resources than those of the team. Interactions with other teams in other disciplines is thus of strategic importance. The research directions we have worked in and will continue to in the coming years are the following.

- The legal and strategic implications of the development of networks, the growing global interdependencies, and the increase of digital flows beyond control.
- The geopolitics of digital systems, data flows and cyber control, the raise of new strategic imbalances, and digital powers (US, China, Russia, etc.)
- The structural consequences of the translation of governance to digital actors, their inclusion into diplomatic forums, and the weakening of sovereignty over territories.

3.2. Foundations of digital economy

- The economy of intermediation and the progressive control of all two-sided and multi-sided markets by remote digital platforms.
- The methodologies for assessing the strategic value of data and evaluating its leverage for the political economy.
- The analysis of Online Advertisement/tracking ecosystems.

3.3. Ecosystems and Anthropocene

- The interdependencies of natural ecosystems and socio-economic systems, and the role of digital systems on measuring and controlling the global natural/social system.
- The role of digital actors in the adaptation and mitigation of climate change.
- The information economy of planetary challenges related to global warming, biodiversity, health monitoring.

3.4. Large scale graph analysis

- Community analysis and extraction, spectral methods.
- Manifold based approaches to large scale graph analysis, optimal transport.

- Information/rumor/fake news propagation in social networks.

3.5. Cyberstrategy

- Geopolitics of BGP
- Cyberstrategy of infrastructures
- Internet content control

4. Application Domains

4.1. Governance

- City governance, local democracy and interaction with citizens.
- Local governance versus global norms and control.
- Strategy beyond public open data.
- Smart city governance.

4.2. CyberSecurity

- Cyber-strategy, defense and security in an evolving world shaped by the digital in particular China/Russia/US cyber-strategy.
- Data strategy for the digital economy, cross border intermediation, platform strategie.
- Strategy of Artificial Intelligence, transparency/acceptability/explainability of AI.
- Cartography of the cyberspace.
- Network, BGP security.

4.3. Anthropocene

- Adaptation to the conditions of the anthropocene, digital control of resources and homeostasis.
- Geopolitics of the environmental challenges, adaptation and mitigation.
- Contemporaneity of the digital revolution and global warming.

5. New Software and Platforms

5.1. DNS data analysis

Data analytics tools for DNS data analysis were developed in a cooperation with ICT, Chinese Academy of Sciences in the frame of the thesis of Jingxiu SU.

5.1.1. BGP Monitoring platform

An observatory of global BGP connectivity has been developed that is used to monitor and detect in real time BGP level attacks. In addition, a set of tools were developed to analyse the structure of information propagation over social networks.

5.1.2. Atlas of Data

A platform to visualize data flows over the planet is under construction. It can be accessed online at <https://theatlasofdata.earth/>.

5.1.3. Observatory of foreign influence on social media

This observatory is monitoring on twitter and facebook the evolution of foreign influence. It is based on a twitter collection platform that is using an extensive database of foreign actors to detect and monitor foreign interference.

6. New Results

6.1. Political economy

We pursued our work on digital platforms and their impact on the structure of socio-economic systems, which results from the capacity to separate data or information from the actors of the physical world. In [5], we showed how the movement above ground of the intermediation activity transforms territories.

6.2. Anthropocene studies

We have investigated the possible similarities between biological systems and social systems facing shortage of resources, suggesting that the digital revolution might have something to do with the Anthropocene [4]. More comprehensive approaches that rely on digital systems to control society and nudge citizens to adapt their behavior have been developed in Asia. We analyse in particular the specificity of Asia in these transformations [6].

6.3. Network data analytics

In collaboration with the Chinese Academy of Sciences, we worked on packet processing algorithmic for high speed network measurements. In [1] a packet capture archive system is developed and described. a theoretical analysis of the TCAM updates delay that is the main shortcoming of TCAM usage in high speed packet processors is presented. Quality of service for network functions were considered in [3].

6.4. Geopolitics of BGP

We have investigated the logical layer of cyberspace through an analysis of the structure of connectivity and the Border Gateway Protocol (BGP). This protocol has been leveraged by countries to control the flow of information or for active strategic purposes. We focused on several countries and characterized their strategies by linking them to current architectures and understanding their resilience in times of crisis. We focus on the case of Iran and uncovered the deep changes that has happened in the past 5 years. This study was premonitory as we observed in november 2019 the full extend of the strategy with the large scale internet disruptions. This generates a lot of mediatic coverage.

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Grants with Industry

The PhD Thesis of Colin Gerard is funded through a contract with DGA (Ministry of Defense).

8. Partnerships and Cooperations

8.1. Regional Initiatives

The team is hosted by IXXI, the Complex System Institute, at ENS Lyon, and strongly involved in the interdisciplinary cooperation promoted by IXXI. Stéphane Grumbach is vice-director of IXXI. Kavé Salamatian is in the Executive committee of the Data Institute of Grenoble Alps Institute, and of the Cyber@Alps Institute of cybersecurity.

8.2. National Initiatives

- Chaire Castex, Ecole Militaire, Paris.
- AMNECYS (Alpine Multidisciplinary NEtwork on CYber-security Studies), University of Grenoble-Alpes.
- GEODE Research team on Geopolitics.
- Kavé Salamatian in co-leading the chair "AI and society" of the MIAI institute of University of Grenoble Alps.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- RIHN, Research Institute on Humanity and Nature, Kyoto.
- Information School, UC Berkeley.
- ICT, Institute of Computing Technologies, Chinese Academy of Sciences, Beijing.
- CSIRO, Sydney.
- Center for CyberSecurity, University Macquarie, Sydney.
- Center for Internet Human Rights (CIHR), Berlin.
- Nippon Institute of Computing Technology, Tokyo, Japan
- Cyber Civilisation Research Center at Keio University, Tokyo, Japan

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research Stays Abroad

Stéphane Grumbach has been visiting scientist at the Research Institute on Humanity and Nature, RIHN, in Kyoto for a semester in 2018/2019.

9. Dissemination

9.1. Promoting Scientific Activities

Stéphane Grumbach has been co-director of IXXI since 2014. He is also involved in the Anthropocene Group at ENS Lyon, which promotes interdisciplinary research and teaching activities on issues related to the adaptation to the changes of the natural ecosystem. He is involved in various initiatives to promote scientific knowledge to a wider audience, as well as in cooperation with public administrations (local and national) to face the challenges of the digital revolution.

9.1.1. Scientific Events: Selection

9.1.1.1. Member of the Conference Program Committees

Kavé Salamatian has been TPC member for the below conferences:

- Infocom 2020
- Infocom 2019
- Aintec 2019

9.1.2. Journal

9.1.2.1. Reviewer - Reviewing Activities

Kavé Salamatian has been reviewer for the below journals:

- IEEE/ACM Transactions on Networking
- IEEE Transactions on Communication
- IEEE Transactions on Networked Systems Management
- Computer Communications
- IEEE transactions on Information Theory

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

Kavé Salamatian is professor at Université de Savoie.

Stéphane Grumbach is lecturer at SciPo Paris, where he teaches Master courses (M1, M2) on the Economy of Data. He also regularly gives lectures in universities, including ENA, ENS Lyon, Ecole centrale, Insa Lyon, etc.

9.2.2. Supervision

PhD: Jingxiu Su, DNS data analysis, 2016-2019, directeur de thèse Kave Salamatian. Defense 30/12/2019

PhD in progress: Colin Gerard, Stratégies d'influence de la Russie sur les réseaux sociaux, 2018
PhD in progress with Institut Français de Géopolitique, sponsored by DGA, co-Directors: Frederick Douzet, Kavé Salamatian

Phd in progress: Xinyi Zhang, IA and cybersecurity, 2019-, Advisor: Kavé Salamatian

Phd in progress: Ali Marandi, Efficient diffusion in NDN, 2016-2020, Advisor: Kavé Salamatian

9.3. Popularization

Various publications have appeared in journals accessible to a larger audience. In particular, our research work has been featured in a full page of Le Monde newspaper in July 2019 (https://www.lemonde.fr/international/visuel/2018/07/23/cyberespace-la-guerre-mondiale-des-donnees_5334901_3210.html).

Kavé Salamatian did several radio intervention, in particular, he was invited in the "Methode Scientifique" broadcasting program in November 2019.

10. Bibliography

Publications of the year

Articles in International Peer-Reviewed Journals

- [1] J. SU, Z. LI, S. GRUMBACH, M. IKRAM, K. SALAMATIAN, G. XIE. *A cartography of web tracking using DNS records*, in "Computer Communications", January 2019, vol. 134, pp. 83-95 [DOI : 10.1016/J.COMCOM.2018.11.008], <https://hal.archives-ouvertes.fr/hal-01950449>

Conferences without Proceedings

- [2] H. JIANG, Y. YANG, H. GUAN, G. XIE, K. SALAMATIAN. *A Massively Multi-Tenant Virtualized Network Intrusion Prevention Service on NFV Platform*, in "ICCCN 2019 - 28th International Conference on Computer Communications and Networks", Valencia, Spain, IEEE, July 2019, pp. 1-9 [DOI : 10.1109/ICCCN.2019.8846924], <https://hal.archives-ouvertes.fr/hal-02425277>

- [3] A. MARANDI, T. BRAUN, K. SALAMATIAN, N. THOMOS. *Pull-based Bloom Filter-based Routing for Information-Centric Networks*, in "CCNC 2019 - IEEE Consumer Communications & Networking Conference", Las Vegas, United States, IEEE, January 2019, pp. 1-6 [DOI : 10.1109/CCNC.2019.8651713], <https://hal.archives-ouvertes.fr/hal-02425271>

Scientific Books (or Scientific Book chapters)

- [4] S. GRUMBACH. *L'Entropie du Numérocène Quelques réflexions sur la Révolution Numérique et l'Anthropocène*, in "Anthropocène, à l'école de l'indiscipline", S. GRUMBACH, O. HAMANT, J. L. GALL, I. NEGRUTIU (editors), January 2019, pp. 1-13, <https://hal.inria.fr/hal-02021716>
- [5] S. GRUMBACH. *New Intermediaries: Extra-territorial Platforms*, in "The Digital Era 2: Political Economy Revisited", J.-P. CHAMOIX (editor), January 2019, <https://hal.inria.fr/hal-02411656>
- [6] S. GRUMBACH. *Digital control and the global ecosystem: can the governance of the anthropocene be designed in East Asia?*, in "M. Terada and D. Niles (eds.), Questioning the Anthropocene: From the view point of bottom up and region (tentative title), Kyoto: Kyoto University Press, forthcoming (to be published in 2020).(2020)", Kyoto University Press, 2020, forthcoming, <https://hal.inria.fr/hal-02411654>