Activity Report 2018

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

Table of contents

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, from May 2018]

Technical staff
Pascal Carrivain [Inria, from Jun 2018 until Nov 2018]

Intern
Titouan Poisson [Inria, from May 2018 until Sep 2018]

Administrative Assistant
Sylvie Boyer [Inria]

External Collaborators
Jean Pascal Bassino [Ecole Normale Supérieure Lyon, until Aug 2018, HDR]
Jean Sylvestre Berge [Univ de Lyon, until Aug 2018, HDR]
Frederick Douzet [Univ Vincennes-Saint Denis]
Olivier Hamant [INRA, HDR]
Kave 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.

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. CyberStrategy/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. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

Kavé Salamatian has been awarded in 2018 a President's International Fellowship of the Chinese Academy of Sciences.

6. New Software and Platforms

6.1. 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 [8].

6.1.1. BGP Geopolitics

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.

6.1.2. Atlas of Data

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

7. New Results

7.1. 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 [9], we showed how the movement above ground of the intermediation activity transforms territories. A global analysis of the geopolitics of technology was presented in [3].

7.2. 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. 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 social scoring system in China, and Society 5.0 in Japan [6]. An investigation of the world of images and photography in the time of algorithms was conducted in [2].

7.3. Laws and digital

The emergence of digital services affects the legal system. The law is always associated to a territory, while digital systems act remotely over large regions crossing borders to reach the population, imposing new norms. In [1], we suggest that a new framework is necessary to apprehend new phenomena, such as those resulting from the conflicts between global search engines and local rules with respect to the Right to be forgotten for instance.

7.4. Network data analytics

In collaboration with the Chinese Academy of Sciences, we worked on packet processing algorithmic for high speed network measurements. In [5] a packet capture archive system is developed and described. In [4] 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 [7].

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Grants with Industry

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

9. Partnerships and Cooperations

9.1. 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.

9.2. National Initiatives

- Chaire Castex, Ecole Militaire, Paris.
- AMNECYS (Alpine Multidisciplinary NEtwork on CYber-security Studies), University of Grenoble-Alpes.
- GEODE Research team on Geopolitics.

9.3. International Initiatives

9.3.1. Inria International Partners

9.3.1.1. 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.

9.4. International Research Visitors

9.4.1. Visits to International Teams

9.4.1.1. Research Stays Abroad

Stéphane Grumbach has been visiting scientist at the Research Institute on Humanity and Nature, RIHN, in Kyoto.

10. Dissemination

10.1. 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.

10.1.1. Scientific Events Organisation

10.1.1.1. General Chair, Scientific Chair

Kavé Salamatian Organised the 3rd French-Japan CyberSecurity workshop in Annecy in April 2018.

10.2. Teaching - Supervision - Juries

10.2.1. 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.

10.2.2. Supervision

PhD in progress: Jingxiu Su, DNS data analysis, 2016, directeur de thèse Kave Salamatian

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, Director: Frederick Douzet

10.3. Popularization

Various publications have appeared in journals accessible to a larger audience [3], [2].

11. Bibliography

Publications of the year

Articles in International Peer-Reviewed Journals

[1] J.-S. BERGÉ, S. GRUMBACH, V. ZENO-ZENCOVICH. *Datasphere, Data Flows beyond Control: Challenges for Law and Governance*, in "European Journal of Comparative Law and Governance", 2018, vol. 5, n° 2, pp. 144-178 [*DOI :* 10.1163/22134514-00502001], https://hal-univ-lyon3.archives-ouvertes.fr/hal-01846878

[2] S. GRUMBACH. *Dans les griffes des algorithmes*, in "Infra-minces: revue de photographie", June 2018, https://hal.inria.fr/hal-01927620

[3] S. GRUMBACH, C. RENAUD. *Géopolitique des technologies*, in "Questions internationales", June 2018, https://hal.inria.fr/hal-01927622

[4] P. HE, W. ZHANG, H. GUAN, K. SALAMATIAN, G. XIE. *Partial Order Theory for Fast TCAM Updates*, in "IEEE/ACM Transactions on Networking", February 2018, vol. PP, n° 99, pp. 1 - 14 [*DOI :* 10.1109/TNET.2017.2776565], https://hal.archives-ouvertes.fr/hal-01666244

[5] J. SU, Z. LI, S. GRUMBACH, M. IKRAM, K. SALAMATIAN, G. XIE. *A cartography of web tracking using DNS records*, in "Computer Communications", December 2018, vol. 134, pp. 83-95 [*DOI :* 10.1016/J.COMCOM.2018.11.008], https://hal.archives-ouvertes.fr/hal-01950449

Invited Conferences

[6] S. GRUMBACH. *Digital Control and the Earth EcosystemWill the governance of the anthropocene be designed in East Asia?*, in "RIHN - 2018 13th International Symposium Humanities on the Ground: Confronting the Anthropocene in Asia", Kyoto, Japan, December 2018, pp. 1-13, https://hal.inria.fr/hal-01927612

International Conferences with Proceedings

[7] A. MARANDI, T. BRAUN, K. SALAMATIAN, N. THOMOS. *A Comparative Analysis of Bloom Filter-based Routing Protocols for Information-Centric Networks*, in "IEEE Symposium on Computer Communications (ISCC'18)", Natal, Brazil, June 2018, https://hal.inria.fr/hal-01872303

[8] J. SU, Z. LI, S. GRUMBACH, K. SALAMATIAN, G. XIE. *Toward Accurate Inference of Web Activities from Passive DNS Data*, in "IWQoS'18 - IEEE/ACM International Symposium on Quality of Service", Banff, Canada, June 2018, https://hal.inria.fr/hal-01872310

Scientific Books (or Scientific Book chapters)

[9] S. GRUMBACH. *De nouveaux intermédiaires : les plates-formes extraterritoriales*, in "L'ère du numérique", J.-P. CHAMOUX (editor), ISTE éditions, June 2018, vol. Vol. 2: L'économie politique à l'épreuve, https://hal.inria.fr/hal-01669282