



Mission pour les
Initiatives
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80 | PRIME Appel à projets 2019

Formulaire de candidature

Ce formulaire doit être libellé « 80PRIME_Formulaire_Nomcandidat »
et obligatoirement être déposé par le porteur du projet sur [SIGAP](#) en format pdf.

Date limite de candidature : 30 janvier 2019 à midi

IDENTIFICATION

Civilité/NOM/Prénom du porteur du projet	M. FRASCA Paolo	
Section du comité national de la recherche scientifique	07	
Etablissement de rattachement (CNRS, Université de Nantes, CEA, etc.)	CNRS	
Code Unité (UMR, UPR, EA, etc.)	UMR5216	
Nom du laboratoire et/ou de l'équipe	GIPSA-lab, équipe NeCS	
Rattachement de l'UMR	Institut principal	INS2I
	Délégation régionale	Alpes

Projet

Titre long du projet (150 caractères maximum)	Systems-theory for the Disorders Of Online Media
Acronyme du projet	DOOM

Identification des équipes travaillant sur le projet

Code Unité (UMR, UPR, etc.)	Nom du laboratoire	Rattachement*		Civilité/NOM/Prénom des personnes impliquées
		Institut principal	Délégation régionale	
UMR 5216	GIPSA-lab	INS2I	DR11 Alpes	M. FRASCA Paolo
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* Pour être éligible le projet doit impliquer *a minima* deux laboratoires issus de différents instituts.

PROJET DE RECHERCHE

1 - Résumé (10 lignes maximum)

Online social media have a key role in contemporary society and the debates that take place on them are known to shape political and societal trends. For this reason, pathological phenomena like the formation of “filter bubbles” and the viral propagation of “fake news” are observed with concern. The scientific assumption of this proposal is that these *information disorders* are direct consequences of the inherent nature of these communication media, and more specifically of the collective dynamics of attention thereby. In order to capture these dynamics, this proposal advocates the mathematical modelling of the interplay between the medium (algorithmic component) and the users (human component). The resulting dynamics shall be explored by a system-theoretic approach, using notions such as feedback and stability. This quantitative and rigorous approach will not only unlock fundamental insights but also deliver suggestions on suitable policies to manage the media.

2 – Mots-clés

Social media, sociology of media, dynamical systems, automatic control

3 - Exposé scientifique du projet explicitant les points suivants (4 pages maximum) :

- L'état de l'art,
- Les verrous scientifiques et les objectifs mettant particulièrement en évidence le caractère interdisciplinaire, structurant, exploratoire du projet ainsi que la prise de risque associée,
- Les méthodologies à mettre en place,
- Les résultats attendus,
- L'implication des équipes et la contribution des participants,
- Le rôle du doctorant **si un accompagnement du projet par une allocation de thèse de 3 ans** est demandé (1/2 page max)

Scientific context and description of the object of our study

Online social media have a key role in contemporary society and the debates that take place on them are known to shape political and societal trends. For this reason, concerns are growing¹ about the potential consequences of their perceived malfunctioning, which we may broadly call *online information disorders*². Yet, in the absence of a full understanding of these disorders, policy responses may be missing the mark. We shall concentrate here on two of these disorders: the formation of “filter bubbles” that surround users and the viral propagation of “fake news”. In order to properly describe and understand them, we first need to give a broad description of how online social media work.

Online social platforms broker the interactions between the users and manage the diffusion of contents. Crucially, users have **limited attention** to devote to online contents and therefore social platforms assume the task of orienting it. In order to feed users with updates that match their tastes and interests³, online social services rely on elaborated **recommendation algorithms**. While some kind of selection mechanism is plainly necessary due to overwhelming volume of information that is potentially available online, in the

¹ R. Faris, H. Roberts, B. Etling, N. Bourassa, Y. Benkler, and E. Zuckerman. 2017. “Partisanship, Propaganda, and Disinformation: Online Media and the 2016 U.S. Presidential Election.” Vol. 7641. Cambridge Mass.

² C. Wardle and D. Hossein. 2017. “Information Disorder: Toward an Interdisciplinary Framework for Research and Policymaking (Report to the Council of Europe).”

³ M. Bressan, S. Leucci, A. Panconesi, P. Raghavan, and E. Terolli. The limits of popularity-based recommendations, and the role of social ties. In ACM SIGKDD, 2016

last decade political activists have expressed the concern that the hedonistic objective of these recommendation systems could lower the diversity of opinions to which users are exposed⁴. Recommendation systems could potentially enclose users within “*filter bubbles*” that distort their perceptions of reality, by pleasing them with contents aligned with their prejudices. Such bubbles could consequently favor the emergence of opinion polarization and radicalization. These questions have motivated a large and growing stream of research spanning from mathematics⁵ to social science⁶.

More recently, mainly in the aftermath of the 2016 US elections, even bigger concerns have grown about the wide diffusion and perceived far-reaching impact of so-called “fake news” that poisons the political debate. The scientific literature on fake news, however, is largely negative and advises against this notion, mainly because of its vagueness and of its simplistic reliance on true/false distinction. At a more careful look, *spreadability*, rather than *fakeness*, is the birthmark of online misinformation, which should then rather be called “*junk news*”, for (just as junk food) it is consumed because addictive, not because appreciated⁷.

To understand why junk news propagates “virally”, we *should not focus on their contents, but on the mechanisms* that foster their propagation. In online social media, users compete for attention, that is, compete to attract the attention of their peers. The platform provides the users with live information on their ability to attract attention and this constant awareness orients their online behaviors: “vanity metrics”⁸ are made extremely salient encouraging users to pursue some form of “micro-celebrity” that is precisely characterized by the capacity to spread viral contents. Crucially for this project, this metrological system is especially sensitive to actions, such as viewing, liking, scrolling or clicking, which correspond to an extremely shallow form of engagement. Ephemeral but synchronised attention has become the currency of media economy and is promoted through filtering and recommendation software. Indeed, the market for online attention could not have developed without technologies capable of tracking the behaviours of Internet users⁹ and infrastructures allowing the aggregation and brokering of this information^{10 11}.

This discussion leads us to our main point about junk news and more generally attention dynamics. A dominant narrative builds upon epidemic metaphors that present digital media as a healthy ecosystem infested by pests – a problem, therefore, that can be cured by the simple removal of the virulent contents. Besides being worryingly close to censorship, we believe that this solution is likely to be ineffective because online misinformation is a communication disorder, but it resembles more to a metabolic rather than an infective one. In other words, the spreading of junk news is a condition created by the pathological amplification of dynamics that are inherent to the contemporary media system.

In conclusion, junk news and filter bubbles should both be understood as **online collective attention disorders**. Filter bubbles originate when the combined effects of user biases and personalized recommendations restrict the users attention to information sources that are not diverse and representative enough. Junk news originate when online public debate is seized by ephemeral issues, which capture a disproportionate amount of onscreen attention, but not long enough to generate meaningful discussions.

⁴ E. Pariser. *The Filter Bubble: What The Internet Is Hiding From You*. Penguin, 2011.

⁵ R. Durrett, J.P. Gleeson, A.L. Lloyd, P.J. Mucha, F. Shi, D. Sivakoff, J.E.S. Socolar, and C. Varghese. Graph fission in an evolving voter model. *PNAS*, 109(10): 3682-3687, 2012.

⁶ E. Bakshy, S. Messing, and L. A. Adamic. Exposure to ideologically diverse news and opinion on Facebook. *Science*, 348(6239): 1130–1132, 2015

⁷ H. Jenkins, S. Ford, and J.B. Green. *Spreadable Media*. New York: New York University Press, 2013.

⁸ R. Rogers. “Otherwise Engaged: Social Media from Vanity Metrics to Critical Analytics.” *International Journal of Communication* 12 (732942): 450–72, 2018

⁹ J.R. Mayer and J.C. Mitchell. “Third-Party Web Tracking: Policy and Technology.” *Proceedings - IEEE Symposium on Security and Privacy*, 413–427, 2012

¹⁰ G. Anthes. “Data Brokers Are Watching You.” *Communications of the ACM* 58 (1): 28–30, 2015

¹¹ M. Crain. “The Limits of Transparency: Data Brokers and Commodification.” *New Media and Society* 20 (1): 88–104, 2018

Scientific hypotheses and objectives

This proposal rests on a threefold scientific assumption, which builds on the phenomenological description that we have given above:

- (1) Online interactions are mediated by the online platform and therefore shaped by it.
- (2) Pathological phenomena in online platforms originate from the inherent nature of these communication media and more specifically from the dynamics of attention thereby.
- (3) Mathematical models can capture the essence of these dynamics and provide insights for their management.

Consequently, the project's objective can be spelled out into the following triple:

- (a) Move from our current sociological understanding to develop mathematical models of attention dynamics;
- (b) Study these models by a system-theoretic perspective, that is focusing on their properties in terms of input-output relations, stability, sensitivity to disturbances and uncertainties;
- (c) Derive a deeper sociological understanding from the system-theoretic results.

Such deeper understanding shall include insights on how online media disorders can be "cured", that is, how to soothe the pathological amplification of the inherent social media dynamics.

Methodologies and expected results

Building upon our perspective on online media disorders¹², the modeling effort will target the various aspects of the dynamics of the attention in social media, in order to translate the phenomenological understanding into dynamical systems that can be rigorously studied. The mathematical models shall include variables to describe the network structure, the attention given by the users, and other user features such as their attitudes, preferences and opinions. The interplay of these variables can be delicate to describe: we already know that including limitations of attention has radical effects on otherwise simple systems of opinion dynamics¹³.

The purpose of these dynamical systems is to describe the interplay between the medium (algorithmic component) and the users (human component). The resulting closed-loop dynamics shall be studied by means of system-theoretic tools and notions, such as feedback and stability. In this perspective, Frasca has recently developed a toy example of recommender system that feeds into a dynamics of user's opinion¹⁴.

The **system-theoretic framework** shall shape both the modeling and the investigation, in constant dialogue with the **sociological interpretation**. Which variables can be measured and thus be seen as outputs? What are the possible inputs? Which actions are available for control? What are meaningful control objectives? How does the system react to external influences?

Even though a satisfactory answer to these questions cannot be given at this stage, we are able to sketch some preliminary reflections that will be developed in further detail in our full proposal.

1. In our perspective, control actions should not involve the injection or the removal of external inputs. Such actions would correspond to propaganda/advertising/trolling and to censorship, which we should refrain from for ethical reasons and which we consequently prefer to see as uncontrolled disturbances. Instead, control actions should consist in merely "tuning the knobs" of the attention brokerage.
2. The question of the control objectives is especially thorny, both from an ethical and a scientific perspective. Clearly, classical definitions of control as driving the full system state to a desired value make no sense in this context. In this project perspective, objective shall be to avoid "excessive" dynamics where the collective system over-reacts to normal stimuli.
3. The multiple and possible rapid time scales of the users behaviors and of the dynamics of their attention make control methods attractive, in contrast to other management approaches that might, instead, emphasize optimization in a static context.

¹² T. Venturini. From Fake to Junk News, the Data Politics of Online Virality. In D. Bigo, E. Isin, & E. Ruppert (Eds.), *Data Politics: Worlds, Subjects, Rights*. London: Routledge, 2019

¹³ W.S. Rossi and P. Frasca. Asynchronous opinion dynamics on the k-nearest-neighbors graph. IEEE Conference on Decision and Control, Miami, FL, USA, pp. 3648–3653, December 2018

¹⁴ W.S. Rossi, J.W. Polderman, and P. Frasca. The closed loop between opinion formation and personalised recommendations. Working Paper, September 2018 <https://arxiv.org/abs/1809.04644>

High risk-high gain nature. *This proposal takes substantial scientific risks, because of its radically interdisciplinary objectives and methods, together with its original scientific assumptions. Its focus on attention dynamics is an absolute novelty. Looking at the possible scientific gains, these features imply that the proposal promises to break totally new ground. Furthermore, the project will potentially be able to disseminate its results not only to a wide range of research communities (media studies and sociology, systems theory), but also to the public at large and to policy makers.*

Collaboration and complementarity of the partners

It is apparent how the two partner researchers have been trained in two distant domains of knowledge and have had separate career paths so far. Their research methodologies are thus different and, in this project's perspective, complementary. Venturini's previous research has build on the collection of data, by classical sociological fieldwork and by digital methods like crawling, and the valorization of the collected data by visualization and analysis tools¹⁵. Conceptualization and integration have been undertaken by original quali-quantitative methods that, although combining qualitative and quantitative features, do not emphasize dynamics. Frasca's previous research has concentrated on analytical dynamical models and their rigorous study. Even though these models have provided insights into several significant features of opinion dynamics^{16 17}, they have remained too abstract to have predictive or prescriptive power in the complex reality of social media. Venturini and Frasca have recently met each other at the yearly INRIA conference in June 2018 and have been exchanging on research ideas since then: their contact point has been the shared scientific interest (and personal engagement) towards the practical understanding of the information disorders that afflict online debates.

This joint proposal combines their expertise and methods. If awarded support, the project will effectively launch their collaboration and contribute to promote a novel perspective on the dynamics of social media that would exploit the control-theoretic toolbox for their understanding and their management.

Role of the PhD student

The PhD student is expected to be the center and the driving force of the research of the project. He¹⁸ will be trained both in mathematical methods and in the sociology of media. The mathematical methods will include both network science and control systems (stability, Lyapunov methods, observers). The background on the sociology of media will also be broad and span from the fundamentals of the theory of communication to cognitive models of online interaction.

Even though we do not foresee the student to directly collect new data, he should be able to make good use of the relevant databases that will be made available at co-PI's institute (which means being aware of their origin, value, and limitations and being able to use the software tools that are necessary for visualization and analysis). His main contributions will pertain to creating, analyzing and validating dynamical models of opinion and attention dynamics. His work will be jointly supervised by the PI and co-PI and he will share his time equally between Grenoble and Paris.

We see two strong **arguments to request the award of a PhD fellowship** to support this research, both for research and education objectives. In terms of the **research**, the success of the project depends on the ability to combine tools and insights from distant disciplines with a fresh eye. We believe that this synthesis requires a full-time immersion for a considerable amount of time, hence the necessity to devote a PhD thesis to it. In terms of **education**, we believe that such a combined expertise can be an invaluable asset for the future career of the student, not only in academic research but also, for instance, in public bodies that need to deal with the new media and their pathologies.

¹⁵ T. Venturini, M. Jacomy, L. Bounegru, and J. Gray. "Visual Network Exploration for Data Journalists." In The Routledge Handbook to Developments in Digital Journalism Studies, edited by Scott Eldridge II and Bob Franklin. Abingdon: Routledge, 2018.

¹⁶ P. Frasca, C. Ravazzi, R. Tempo, H. Ishii. Gossips and prejudices: Ergodic randomized dynamics in social networks. Estimation and Control of Networked Systems 4 (1), 212-219, 2015.

¹⁷ F. Ceragioli, P. Frasca. Consensus and disagreement: The role of quantized behaviors in opinion dynamics. SIAM Journal on Control and Optimization 56 (2), 1058-1080, 2018.

¹⁸ Even if we refer to the PhD student by male pronouns, we shall actually be very vigilant on gender biases during the whole project and we shall strive to offer equal opportunity particularly during the hiring process.