Research Project

Epidemiology of Representations: An Empirical Approach

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1 Introduction

TODO: Faire attention à attacher aussi un peu dans le champ de l'anthropologie culturelle, pas que psycho-cog (pas du temps perdu car utile pour l'état de l'art de la thèse) si jamais les Gutachterinnen ont l'heur d'être SHS

Recent years have seen several attempts to bring cognitive science and social science together. "Social cognition", "cognitive economy" and "cultural evolution" are examples of such fields having recently emerged, approached from multiple viewpoints and involving a variety of disciplines. The project we put forward focuses on a subject formalised by Dan Sperber in the mid-nineties: in a series of innovative articles gathered in Sperber (1996), the author suggests a research program called *cultural epidemiology*, which aims to provide the cognitive and social sciences with a common framework to address a long-standing anthropological question: how can societies be so diverse when the people that form them are all made of the same psychological substrate? The framework Sperber suggests starts from an ontology made only of "mental representations" (those from cognitive science) and their expressions in the outer world, "public representations". The core principle is then to characterise societies by the distribution of public representations that circulate in them, and combine knowledge from cognitive science and anthropology to explain their evolution. As Sperber argues, this naturalistic approach builds on cognitive principles while at the same time allowing anthropological questions to be rephrased in terms of epidemiology of representations. For instance: what types of representations are only weakly transformed as they are interpreted and produced anew by successive people? Those representations, spreading wider than the others, become *cultural*. Are they attractors for the interpretation-reproduction process of representations? If so, which cognitive modules are involved in the stability of such representations?

This research program provides a framework to explore the interactions between evolution and culture (as exemplified in Baumard, André, & Sperber, 2013), and has recently seen several theoretical developments with genuine mathematical models (see for instance Claidière & Sperber, 2007). A number of other works also explore these questions with empirical approaches. Artificial transmission

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chains in the laboratory, for instance, have been used extensively to study iterated language evolution, as Tamariz & Kirby (2016) review. That paradigm has also been used to study the evolution of short audio loops (MacCallum, Mauch, Burt, & Leroi, 2012), of risk perception (Moussaïd, Brighton, & Gaissmaier, 2015), and of abstract visual patterns transmitted by apes (Claidière, Smith, Kirby, & Fagot, 2014). Another approach is the meta-analysis of a large number of anthropological or historical works on a given subject to rebuild the evolution of a representation as it happened. This technique has been used by Morin (2013) in his study of how painted portraits change over the centuries, and by Miton, Claidière, & Mercier (2015) in their examination of the practice of bloodletting. A third approach crawls online content and communities in order to study the spread and propagation of representations in human networks. While earlier works were based on atomic propagation and exposure models where simple entities such as URLs and innovations were the central object (see J.-P. Cointet & Roth, 2007 for a discussion), this stream of research is increasingly modelling representations as deep objects with complexity of their own, improving on simpler virus-like models. Several works have now studied large quantities of meaningful sentences, showing that their propagation depends heavily on context (Bakshy, Karrer, & Adamic, 2009) and semantic content (Danescu-Niculescu-Mizil, Cheng, Kleinberg, & Lee, 2012), as well as on competition between items (Weng, Flammini, Vespignani, & Menczer, 2012).

The wide array of disciplines studying these complimentary questions, and the variety of techniques used in the process testify to a major obstacle: collecting relevant data in usable amounts to analyse cultural evolution is not easy. The works cited above develop several strategies to face the problem, yet invariably leave core aspects of the question aside: transmission chains operate on extremely simple representations; recompiling historical and anthropological works uncovers trends with many explanations competing for causality; models of online content propagation overlook cognitive levels of explanation by and large. It is possible, however, to combine the advantages of these techniques into new methods that significantly expand what empirical studies can tackle. By applying the tools of psycholinguistics to the study of online communities on one side, and enabling transmission chains to benefit from widespread computing power and internet infrastructure on the other side, we are able to collect massive amounts of usable data for the empirical and quantitative study of out-of-laboratory epidemiology of representations.

2 Scientific goals

This research project, which, with the support of the DAAD, I will be able to conclude within my PhD, develops empirical approaches for the study of cultural evolution with the following two broad goals:

1. Dramatically increase the amounts of data collected in order to improve experiments' resolving power, and
2. Diversify data sources to open the study of out-of-laboratory quantitative questions on cultural evolution.

We accomplish this by bringing data mining and psycholinguistics together through the possibilities of modern browsers and computing platforms. A first approach builds on the vast amounts of digital traces available online: by applying data mining techniques to filter and extract relevant information from large data sets, it becomes possible to ask quantitative cognitive-cultural questions to traces of activity from everyday lives. Our second approach connects fields the other way around: by using the potential and ubiquity of modern browsers, we lift a number of constraints on cognitive science and cultural evolution experiments in the laboratory. In particular, we develop transmission chain experiments as real-time web applications in the browser. This lets us work on ecological content with a much shorter transmission cycle and a diversified and easily scalable subject pool, while still keeping full control over the complexity of cognitive tasks implemented. Alongside this empirical

work, we review the main critiques of the *epidemiology of representations* program, both from social anthropology and non-classical streams of cognitive science, which frame the questions of cultural evolution differently and pinpoint debated assumptions in need of further work.

Upon completion, this project will have shown a path to analyse the evolution of real linguistic content, and the links it has with overall cultural change, with a set of workable constraints compared to previous techniques. By fruitfully combining social science, psycholinguistics, and large scale modelling, it significantly widens the field of empirical possibilities and allows the various disciplines involved to address new and debated questions on the links between cognition and cultural evolution. As Greenwald (2012) has argued, "there is nothing so theoretical as a good method".

3 Project breakdown

TODO: Privilégier une présentation séquentielle : les fonds français m'ont permis de réaliser toutes ces étapes jusqu'ici, et d'en arriver à me dire que l'Allemagne pourrait mettre au pot pour finaliser cette dernière partie dont je vous parle là

3.1 Transformations of quotations in blogspace

The first stage of this project focused on the analysis of *in vivo* interpretation-reproduction process by which representations evolve.

As alluded to in the introduction, several works have explored cultural evolution in other settings, starting with the *Dual Inheritance Theory* first introduced by Boyd & Richerson (1985) and Cavalli-Sforza & Feldman (1981). More recent models now include the notion of cultural attractor (see for instance Claidière & Sperber, 2007 ; and Claidière, Scott-Phillips, & Sperber, 2014). Empirical techniques include transmission chain experiments, the use of which is discussed by Mesoudi & Whiten (2008) and Tamariz & Kirby (2016) (for the case of linguistic evolution), and compilations of anthropological and historical works such as those made by Morin (2013) and Miton et al. (2015). To our knowledge however, the evolution of linguistic content out of the laboratory – which constitutes an important milestone in the empirical testing of epidemiology of representations – has not yet been studied.

We decided to study the following specific case in order to keep our analysis manageable: quotations on blogs and media websites. These short linguistic utterances additionally had a number of advantages:

- While quotations should normally not suffer any transformation when copied from website to website, actual observation shows that they do change regularly: they are sometimes cropped, but are also transformed by replacement, deletion, or insertion of words, or even by more substantial grammatical changes. This phenomenon is standard and well known in the oral case (Potter & Lombardi, 1990), and Simmons, Adamic, & Adar (2011) have shown that is it also common in blogspace (see Lauf, Valette, & Khouas, 2013 for a typology of the most frequently observed transformations).
- Quotations are usually quite short, and thus well suited to Natural Language Processing techniques, as opposed to more elaborate types of representations one could consider analysing.
- A reference data set, gathering a very large amount of online quotations from a million sources over nine months, has been made available by Leskovec, Backstrom, & Kleinberg (2009) – a unique situation compared, again, to other representations one could study.

Given that quotations in blogspace are gradually transformed, when copied from website to website, through exactly the kind of cognitive bias suggested by Sperber as a mechanism for epidemiology of representations, we investigated to what point the theory accounts for transformation patterns observed in the data collected by Leskovec et al. (2009). In particular, we tested if cultural attractors appear in the dynamics of online quotations, and examined the role of cognitive biases in their emergence.

The research developed to answer theses questions is presented in the article "The semantic drift of quotations in blogspace: a case study in short-term cultural evolution", submitted in August 2016 after major revisions to the journal *Cognitive Science*. It consisted in applying psycholinguistic knowledge (in particular the effects of known word features on recall, for instance Yonelinas, 2002 ; and Zevin & Seidenberg, 2002) in a *data mining* approach as is commonly used in the study of online communities (for instance J. P. Cointet & Roth, 2009 ; Danescu-Niculescu-Mizil et al., 2012 ; and Gruhl, Guha, Liben-Nowell, & Tomkins, 2004), to analyse word substitutions in the MemeTracker data set collected by Leskovec et al. (2009). Using this technique we show that the way online authors replace words is heavily biased, consistent with known effects in psycholinguistics, and compatible with the existence of cultural attractors.

We also demonstrate is it possible to study epidemiology of representations on complex linguistic content out of the laboratory, by doing the equivalent of a large scale psycholinguistics experiment on data from blogspace. Finally, the manuscript discusses the cost that such a study faces in dealing with the compexity of *in vivo* data, be it through the necessary filtering techniques to remove spam or the reconstitution of missing information in the data.

3.2 Semi-controlled transmission chains: Gistr experiment

Because of the constraints of the data set used in the previous study (notably missing information that had to be inferred), a number of questions were left unanswered and warranted further exploration.

Planned work

ADD:

- Elements of the Gistr Whitepaper (not limited to quotations),

- Details on the first launch,

- Work remaining, which will be finished by November

La deuxième consiste à reproduire le processus et ces effets dans une série d'expériences de chaînes de transmission pour en examiner les déterminants en situation contrôlée. Cette partie permet d'examiner les effets accumulés de la cognition sur l'évolution du contenu ainsi que les rétroactions que cette évolution génère sur le processus de transformation lui-même. Elle permet également de mettre en lumière le rôle de la tâche de reproduction dans le type d'évolution à long terme qu'on observe. Ce travail crée les conditions pour une modélisation réelle du processus dans des travaux futurs, intégrant les principes et rétroactions identifiés dans des simulations à comparer aux phénomènes réels, pour identifier ainsi le rôle des transformations dans l'évolution du paysage global.

3.3 Discussing empirical works in the context of current debates

ADD: Elements of the epistemological paper (shortcomings), and how we show that the previous works open these questions to scrutiny

Social anthropologists and unorthodox streams from cognitive science in particular (extended, embodied, enactive, and embedded cognitive science), debate the notion of *cognitive representations*, and criticize the boundaries it defines between biological, psychological, and cultural [see in particular ingold; as well as cuffari].

Important when you touch the relationship with context, which is what underlies meaning, and this surfaces is current experiments.

La troisième étape consiste à faire l'examen critique des apports et des limites de ces approches, notamment dans le cadre du débat sur les façons de lier sciences sociales et cognition, dans lequel de nombreuses disciplines proposent des points de vue différents.

4 Planned work

ADD: Remind last steps for Gistr

ADD: Explain an outline for the manuscript

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