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Complex Network Visualisation for the History of Interdisciplinarity: Mapping Research Funding in Switzerland

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Introduction

In Switzerland, the panorama of scientific research is deemed to be deeply affected by language barriers and strong local academic identities. Is this impression confirmed by data on research projects? What are the factors that best explain the structure of scientific collaborations over the last forty years? Do linguistic regions (Switzerland is divided into three principals) or local academic logics really have an impact onto the mapping of research collaborations and to what extend are they embedded in disciplinary, historical and generational logics?

We focus on the very large database of the Swiss National Science Foundation (SNSF), the principal research funding agency in Switzerland, which lists all the 62,000 projects funded between 1975 and 2015. While scientometric studies generally focus on measuring work – and financial – performance, we aim to raise awareness on pursuing a socio-history analyse of Swiss academic circles by crossing the SNSF data with a prosopographic database of all Swiss university professors in the twentieth century provided by the Swiss Elite Observatory (OBELIS). Beyond the interest for the history of science and universities, we explore the noteworthy technical challenge of a network analysis of nearly 88,000 researchers and more than a million of collaborations.

By combining those two databases, we measure the temporality and spatiality of academic collaborations, *i.e.* to define a way to deal with the volume of information in order to provide not only a global vision but also to enable a fine processing of personal trajectories.

Sources

The SNSF database has been placed under an Open Data licence in spring 2016. Called “P3” for “Projects, People, Publications”, it contains detailed information on all the projects funded since 1975 (around 500 per year in the beginning, almost 3,000 per year today, see *Fig.1*), as well as the whole list of people involved in the projects. The database can sometimes be incomplete about the discipline and institutional affiliation of individuals, since it depends directly on the project submission interface where some fields may be left empty. Thus, this gap is partly offset by the junction with the Swiss professors database that provides systematic data on Swiss professors. Thus, the projects are classified according to a standard tree of scientific disciplines.

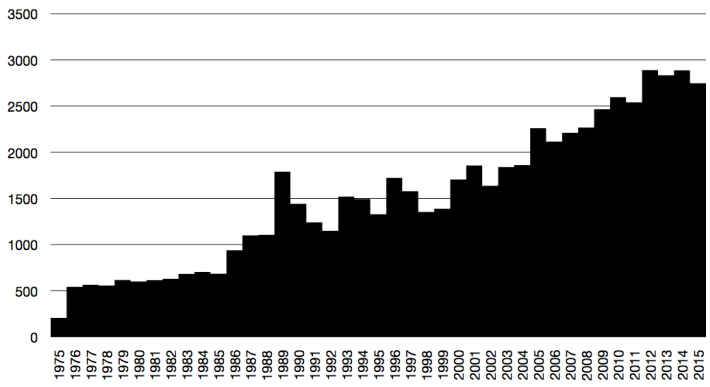


Figure 1. *Evolution of the number of projects funded by SNF annually from 1975 to 2015.*

Methodology

We are interested in the 2006-2015 period, ten years during which 25,000 projects involving 45,000 people produce a graph of more than 350,000 edges. On the one hand, this short periodization allows us to confront our assumptions to our data before analysing the full corpus. On the other hand, it helps to test the effectiveness of our tools and the interoperability of the two databases to prepare a complete and longitudinal modelling.

We therefore extracted a 2-mode network of people and projects from the database and then projected it into a 1-mode network of people only (the nature of the link being to be affiliated as collaborators to the same research project). If usually a relatively simple task, the transformation of a 2-mode graph into a 1-mode graph is here greatly complicated by the mass of information to process: when the graph matrix contains billions of positions, most softwares are reaching their limits. We will then divide the dataset into smaller units (here, transforming the network year after year helps make it bearable to a standard processor).

Analysis and Visualisation

The topography of the network obtained for 2006-2015 (*Fig.2*) is quite remarkable. The center of the network is not, as it is often, the densest region, which would have meant that a single discipline or field of study was likely to play a role of interface between others. Instead, we observe an almost circular distribution of individuals, recalling other “science maps” based on the organization of institutions of bibliometric analysis (Rafols et al. 2010). Data visualization, and in particular the representation of complex networks, is not an end in itself but a tool for questioning the structure of the dataset (Grandjean 2015). But while a further research will focus on more detailed indicators to qualify individual positions (in particular, centrality measures, as detailed by Koschützki et al. 2005 or Newman 2010), this first overview still shows that some groups of disciplines form very obvious clusters. This is the case of physics (right), medical sciences (bottom left) or earth sciences (top right). Others are sparsely connected or dispersed within other communities, as is particularly the case for disciplines like economics/business studies or chemistry, which seem to be more engaged in interdisciplinary collaborations or projects that include a limited number of employees (large experimental science projects partly explain the density of these groups). We also assume the structure of the network to differ among disciplinary specificities and temporality (Bourdieu, 2004; Gingras, 2012; Heilbron & Gingras, 2015). Are most connected disciplines also the most prestigious ones?

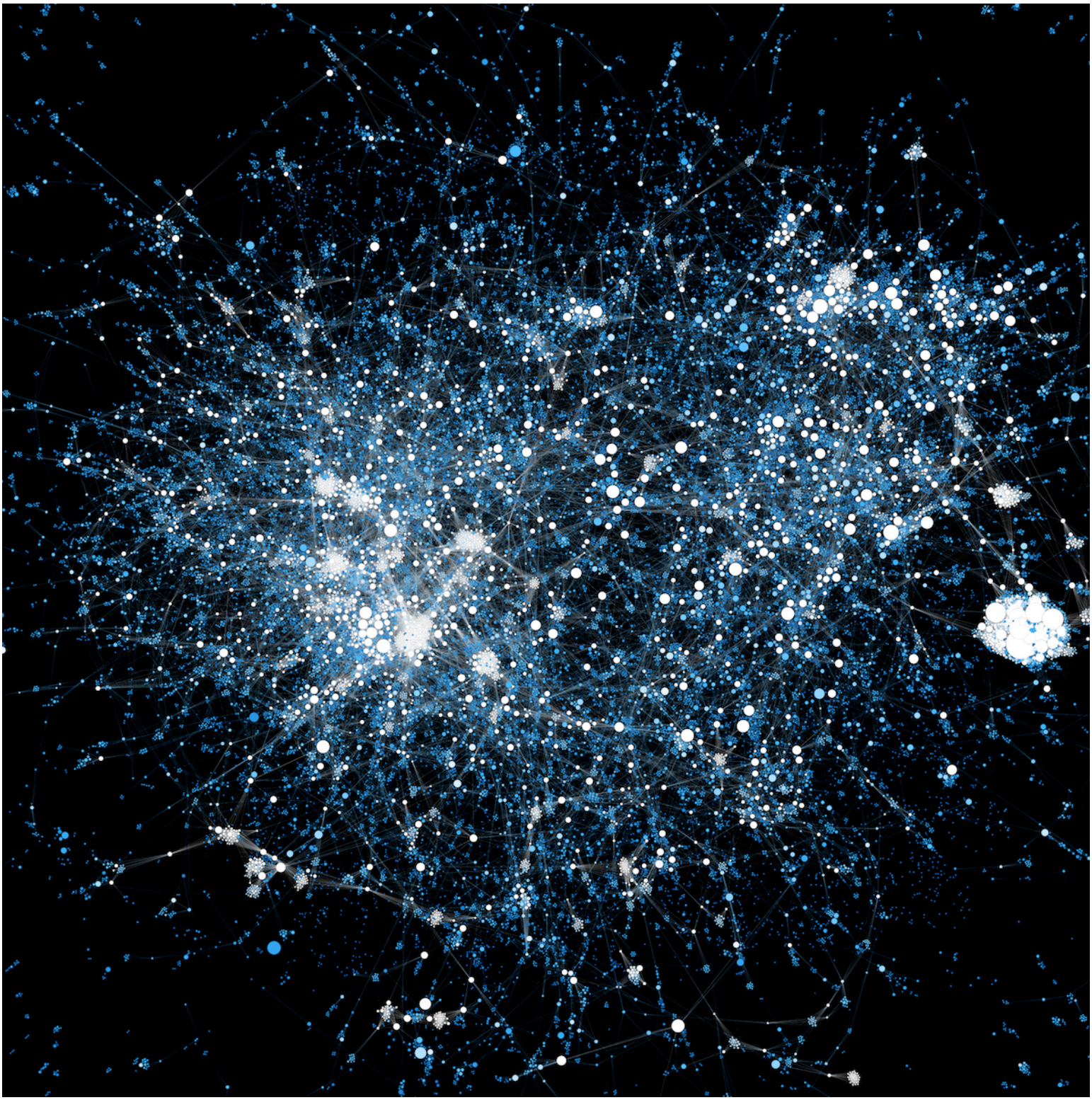


Figure 2. *The core of the Swiss network of SNF scientific collaborations 2006-2015 (Grandjean 2016).*

Perspectives

With the information contained in the list of projects, we see that it is also possible to assign individuals a disciplinary category extracted from the projects involving them. As it happens that a researcher is participating to projects labelled in different disciplines, this approach will lead to a reflexion on the measurement of interdisciplinarity within a comparative study between a selection of « open » and « closed » disciplines.

We will also see that it is possible to develop a multi-level analysis to compare the graph clustering to the many Swiss institutional and disciplinary « geographies », in order to historicize their development.

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