The use of global maps of science in management and policy contexts

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Maps of science based on bibliometric data have been widely used as a tool for science policy and management since the late 1970s. However, until recently science maps were based on similarities in the citations or publications of authors in a specific area of science, providing only local representations that were highly dependent on the subsets selected. In the last few years, advances in computing power and new visualisation tools have allowed the mapping of “all” science -- i.e., all the publications contained in the Web of Science (e.g. Boyack et al. 2005; Leydesdorff and Rafols, 2009, among others).

In principle one might expect these maps to be highly dependent on the classification of publications, and the clustering and visualisation techniques used. However, recent studies comparing maps created using different methods revealed that the maps are surprisingly robust (Klavans and Boyack, forthcoming; Rafols and Leydesdorff, 2009). As is the case in geographic portrayals (e.g. in Mercator vs. Peters projections), many details of the maps depend on representational choices. Nevertheless, a consensus is emerging regarding the basic structure of the global map of science, in terms of the relative position of scientific disciplines. We believe that this (still precarious) stability in the representations, together with new visualisation tools that make them accessible to lay users, make these global maps of science potentially useful for the science manager or policy-maker.

In this paper, we focus on the utilisation of the maps of science as a base map on which to “overlay” the location of a body of research.1 We briefly introduce the steps to visually represent a body of research (as reflected in a set of publications) over the map of science (detailed in Leydesdorff and Rafols, 2009). The overlay technique starts by generating a backbone of the relative position of disciplines and their most important connections. The maps then represent the size of a discipline in the map as proportional to the number of publications or citations of a research theme, investigator or organisation.

The overlay maps can be used for various types of analyses. First, they allow one to intuitively localise areas of activity (citations to, citations from, or publications) of organisations and individuals2. This is particularly important for emerging technologies, such as biotechnologies or nanotechnologies, that do not conform to traditional disciplinary boundaries. Second, thanks to the comparative frame provided by the global map, the overlays allow tracking of changes over time (Porter and Rafols, forthcoming) -- which is useful both for analysis of trends or as one research evaluation tool to see the effects of programmatic activities. Third, the overlay maps offer a subtle description of the cognitive diversity (one aspect of interdisciplinarity) of the topic under analysis -- portraying not only the number of disciplines involved (variety), their relative proportions (balance), but crucially, also to which extent the areas of activity are dissimilar to each other (disparity) – which can be describe by diversity indicators (Rafols and Meyer, 2009).

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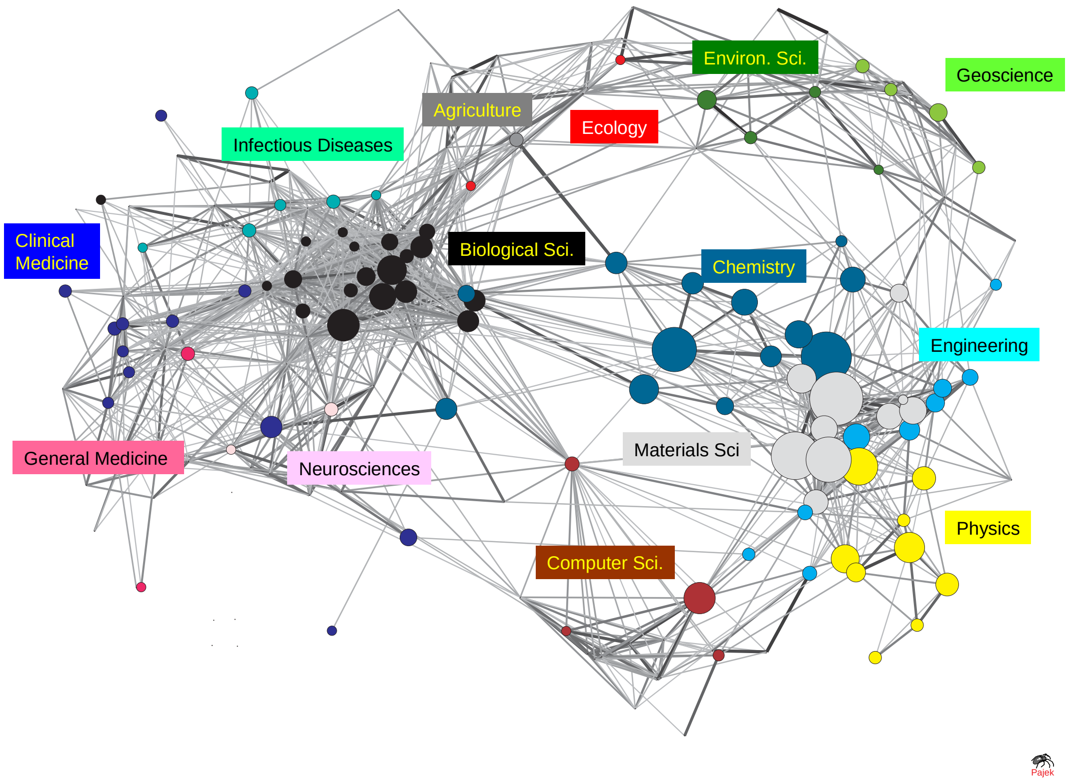
1 The method for mapping can be freely reproduced, using data made available in our webpages (www.sussex.ac.uk/spru/irafols) and the freeware *Pajek* (http://pajek.imfm.si/).

2 Since the method relies on Web of Science categories, it may not be accurate when dealing with small numbers, due to the know problems in assignations of publications to ISI Subject Categories (Rafols and Meyer, forthcoming; Rafols and Leydessdorff, forthcoming).

Figure 1. Publications on nanomaterials in the global map of science

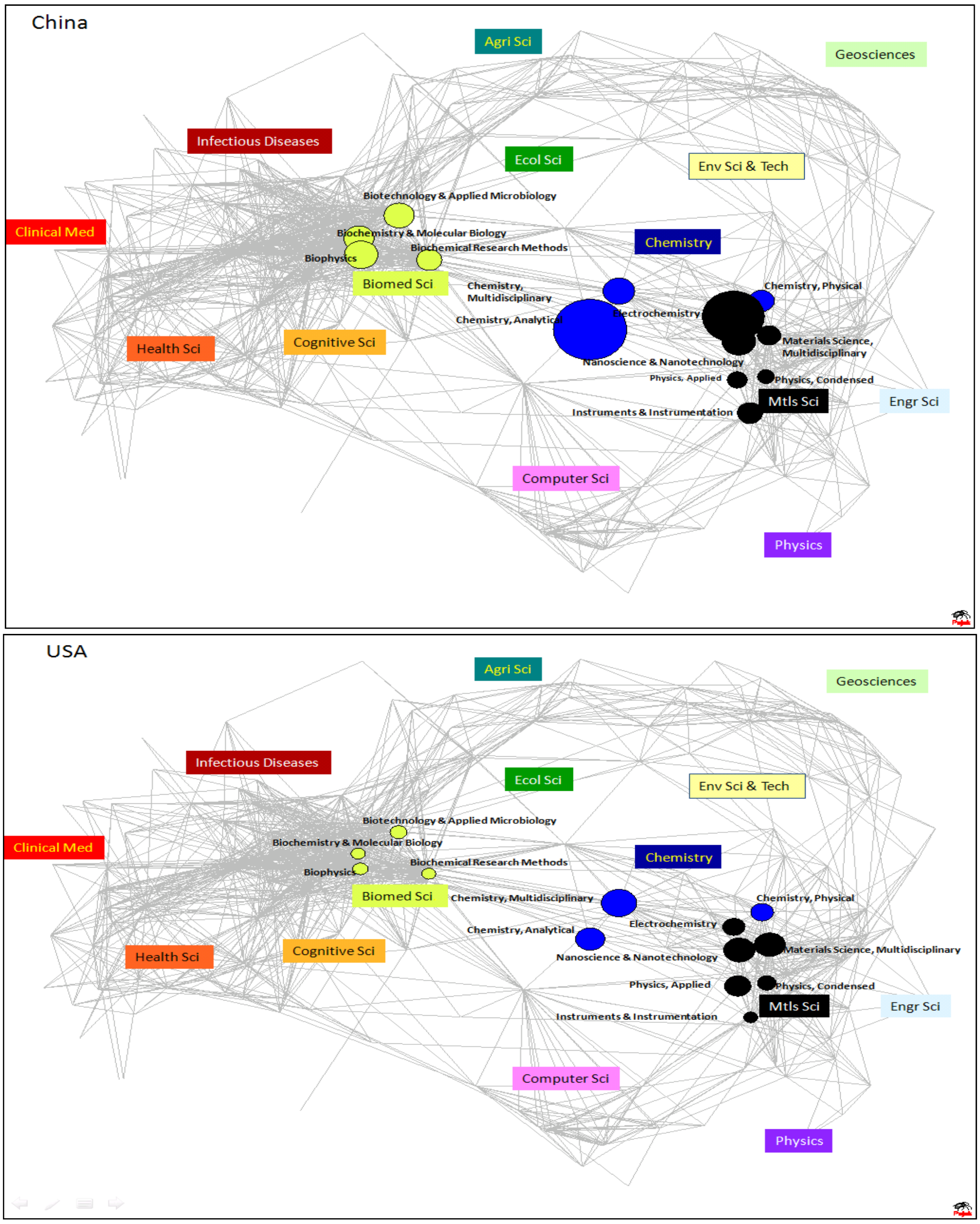


However, these maps also present problems that need to be considered when they are used for management and/or policy advice. First, there are the usual caveats, namely that these maps are 2 dimensional projections of multidimensional maps and distances are merely indicative. Second, the lack of agreement (only in the 40-60% range) between different classification systems regarding the assignation of journals to disciplinary categories means that the positions of paper/references in the maps has a limited range of accuracy –and certain large number are needed to overcome noise. Third, the overlay maps need to be complemented with arrows or other maps in order to show the local interactions.

The paper will illustrate the advantages and problems with a variety of examples:

- Differences in the knowledge base of different materials (e.g. quantum dots, carbon nanotubes) in the emergent area of integrative chemistry.
- Evolution of disciplines over time (1975-2005).
- Disciplinary specialisation of countries in a given topic field (nano-particle enhance biosensors, see Figure 2)).
- Knowledge base of an university or research institute.

Figure 2. Comparison of China and US strength in Nanoparticle-enhanced Biosensors



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