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# Lessons from an Integration of Scientometrics, Cartography, and Contemporary GIS Platform Technology

André Skupin [a,*]

[a] *San Diego State University, San Diego, USA, skupin@sdsu.edu*

* Corresponding author

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## Introduction

The application of geographic principles, cartographic design, and GIS technology to non-georeferenced data – through a process called *spatialization* (Skupin and Fabrikant 2003, Fabrikant and Skupin 2005) – has been the subject of cartographic research for more than a quarter-century. Early work addressed conceptual underpinnings, such as the relationship of metaphors and space when non-georeferenced spaces are involved (Kuhn and Blumenthal 1996). Much nuanced insight was provided by research investigating cognitive factors in spatialization through human-subject experiments, such as the differences among various geometric and topological configurations (Fabrikant 2001, Montello et al. 2003). Another research direction has involved the algorithmic choices and the cartographic and GIS workflows through which virtually any dataset can be transformed into a visualization (Skupin 2001). Map-like visualization has matured into a diverse set of principles, techniques, and tools (Hogräfer et al. 2020) that could now be woven together into interactive web applications and made accessible to non-specialist user populations. However, geographic information science has rarely injected itself directly in that endeavour aimed at broader impact (e.g. Lafia et al. 2021).

It is in this context that I present lessons learnt from an effort to more fully leverage the power of contemporary GIS platform technologies in the service of spatialization. Specifically, this involves a spatialization of the coronavirus research domain developed in 2020, involving a data set of 15,500 research papers dealing with coronavirus in some manner, going back more than fifty years to the late 1960s. The resulting web applications have reached significant audiences and continue to tangibly impact the aims and educational outcomes of related university coursework in knowledge analytics.

## Scientometrics with a GIS Twist

In its initial steps, the project mirrored common scientometric workflows that have become popular thanks to such tools as CiteSpace (Chen 2006), Sci2 (Börner 2011), and VOSviewer (Van Eck and Waltman 2010). A major issue in the observed deployment of those tools is that users rarely use them to the full intended extent. That is why the literature is replete with hugely interconnected scientometric networks that range from being illegible to indecipherable, even though tools like Sci2 provide plenty of means for boiling networks down to structures that can then be effectively communicated. When creators correctly apply these tools, they tend to lead to one-off, static visualizations in the form of figures in scientific publications, similar to the left panel in Figure 1. The approach taken here departs from that by significantly refining the network layout using various operators provided by off-the-shelf GIS, from generating polygon structures to multi-scale clustering and label placement (Figure 1, middle panel). While this handling of a scientometric network is reminiscent of Skupin (2014), there are now a much greater array of options available for deploying these GIS-based representations. The project did this by *(a)* curating a narrative about the topical structure of the coronavirus research domain, deployed as a story map (Figure 1, top-right panel), and *(b)* developing a more exploratory dashboard interface (Figure 1, bottom-right panel). The latter includes an integration of various API services, including a lookup of Wikipedia content and a live search among several hundred thousand scientific papers.

## Impact

The choice of story mapping and dashboarding in deploying the "Coronavirus SoS" visualization was aimed at exposing scientometric analysis to larger audiences, with a focus on the topical structure of coronavirus research. Developed through an analysis of the body of research literature existing *before* the pandemic, the project happened to illustrate the "shoulders of giants" that researchers came to stand on, as they developed policies, treatments, and vaccines in record time. This approach has been well received. Within a few months of deployment at

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https://bigdata.sdsu.edu/coronavirus, the apps recorded visitors from 70+ countries. More recently, the project was selected for the 19th iteration of the "Places & Spaces" exhibit (Skupin 2023), together with three other macroscopes.

Used as an end-to-end example for a scientometric workflow leading to GIS integration and web app deployment, the project has positively impacted the educational experience of students enrolled in a seminar on *knowledge analytics*. Graduate students in particular have come to realize this as an opportunity to understand – by seeing – the non-obvious structures existing in their domain of interest, from influential papers to authors, institutions, and emerging topics. The diverse research areas recently analysed by students in this manner have ranged from *alternative food systems* to *community-based participatory research* (*CBPR*) and the impact of GIS industry authors on the research community.

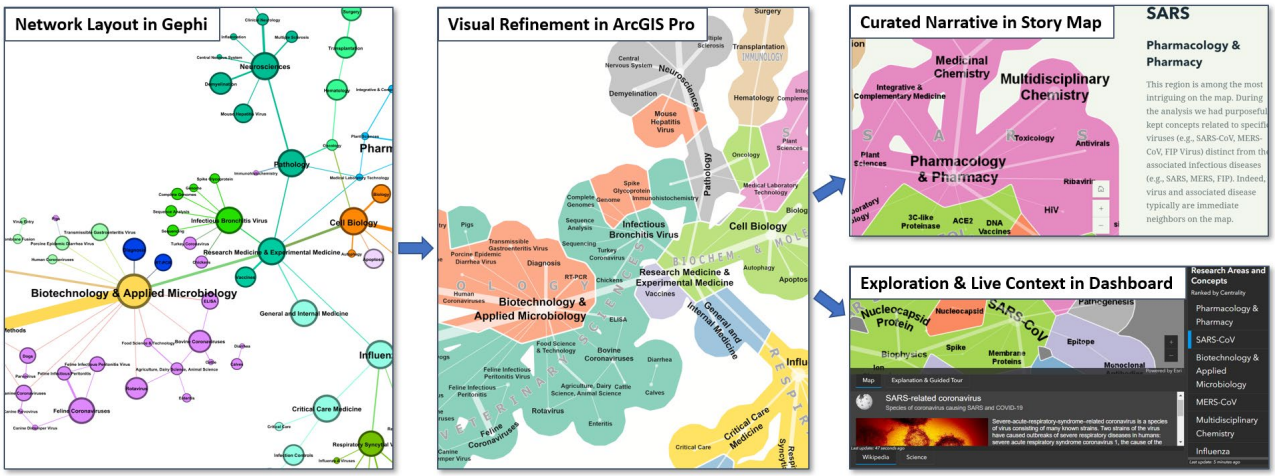


*Figure 1. GIS platform technology in the service of refinement and deployment of scientometric network visualization.*

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