Improving Usability of Online Historical Map Collections

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Introduction

In the last two decades, the world has experienced a proliferation of online collections of high-resolution digital scans of historical maps. Technologies for imaging, organizing, and delivering files to the public have improved rapidly. As the number of maps increased, host institutions devised novel methods for presenting and viewing digital objects from their collections. (Crane, 2017) We are living in a time of great abundance where massive quantities of archival resources are more available than ever before but decentralized rapid growth has resulted in an unwieldy lack of standardization.

Meanwhile, K-12 students in the United States are underperforming in geography and arrive in undergraduate programs unprepared (Nation's Report Card, 2018). Those who choose to major in geography will learn about spatial literacy and take classes in GIS, but scholars from outside of the field of geography are increasingly utilizing spatial analysis in their academic work and are in need of technical training that in most cases will not covered by their core curriculum (Appel, 2019).

Libraries are expected to connect students to resources and help them build skills needed to be able to work with these materials. The implication is that librarians must develop expertise with an array of tools and skills which are not generally included in a typical MLIS program, (Slayton & Benner, 2020) a problem compounded by the fact that many of these librarians are the products of our educational system so are undereducated about geography themselves. It is also difficult to suggest universal best practices for core skills for geo-educators when there is so much variety in size, structure, and resourcing at institutions (Dodsworth, 2018). Many

institutions are not staffed or funded in a way where they can meet this need, and professional support in the form of a robust external community doesn't yet exist.

In this paper I discuss online collections of historical maps and limitations to access and use that exist with current technology. I argue that in parallel with reduction of technological barriers to access there is a need for more instruction in libraries and for librarians. A solution that will help with many of the issues surfaced in my research is the use of presentation standards like the International Image Operability Framework and the ongoing development of the capability of adding geospatial information to that protocol. I will argue that universal adoption of IIIF + navPlace protocol would allow educational materials and discovery tools to be made more widely available and usable by educators with a range of geo-spatial experience.

I pursued this research topic after attempting to wade through available instructional and discovery tools related to historical map collections and experiencing first-hand the obstacles preventing easy distillation of best practices. I then learned about the IIIF framework and discovered that the IIIF community which is working to address this exact issue. This research will help me in my future role as part of this community and as an advocate for ongoing efforts to connect a broader audience with geospatial material and historic maps in a meaningful way.

Background

Digitization of historical map collections and creation of online portals for access have brought the public into closer contact with the historic cartographic record than at any time previously in history (Sweetkind-Singer, 2000). Curious people outside of academia can peruse the fine detail of maps that are hundreds of years old anywhere in the world from their personal devices. Visits to unfamiliar map libraries or brief and distant interactions with rare, fragile material are no longer required. Access to digital materials in the public domain and advances in

Geographic Information System (GIS) technology together have created unprecedented opportunities for scholars, artists, and journalists to remix, reinterpret, and otherwise combine old with new in the creation of important cultural products that help us understand the past, challenge us to think more critically about the present, and inspire expansive speculation about potential futures (White, 2010; Zacek, 2016).

In recent years the number of online map collections has increased dramatically as digitization technology has improved (Dodsworth, 2018). At the same time, host institutions have developed unique and novel methods for presenting and viewing digital objects from their collections. In 2017, Tom Crane described the situation as follows:

> For years, institutions have been building and buying image servers, image viewers, page turners, discovery applications, learning environments and annotation tools to make their content accessible to the world, and to let the world interact with it. Many wonderful software tools have been made, and many beautiful websites enjoyed by scholars and the interested public. (Crane, 2017)

Those endeavoring to meet the needs of end users of digital material have attempted to keep up with this proliferation by curating lists of interesting digital collections, evaluating available tools, and creating compelling instructional materials (Dodswoth, 2010, 2018; Fleet & Pridal, 2012; Hurley, 2013, Siabato et. al., 2011, Slayton & Benner, 2020). However, as projects get wrapped up and are no longer maintained, “formats and technologies ossify and become obsolete” (Crane, 2017). Linkrot begins to set in (Zittrain, 2021), and searches for usable tools and relevant examples related to this topic often result in dead ends and frustration. Crane (2017) again offered an eloquent summary of the phenomenon:

> For anyone trying to use the accumulated wealth of digitised resources from around the world…the lack of standardisation has meant that each digitized collection needs to be worked with on its own terms. One institution's image delivery is not compatible with another's. The same problems are solved over and over again in different silos of non-interoperable content. (Crane, 2017)

We are living in a time of unprecedented possibility for access to images of cultural objects, but an impenetrable thicket of options can render important information essentially inaccessible for many people. This period of rapid proliferation of resources has similarly led to a plurality of approaches for managing cartographic digital objects. Top among the challenges reported by the geo-educators surveyed in Slayton & Benner's 2020 report on libraries and geography and GIS education was that of the "growing number of tools available to manipulate spatial data," (p 6). The authors noted that the field suffers from not having a centralized repository of tools, educational guides, and other instructional materials. They found that people are often duplicating efforts at their own institutions where resources are ample, and institutions who lack resources are faced with combing through a dizzying array of options distributed widely across the web and customized for their respective collections. (Slayton & Benner, 2020)

In their 2022 study, Novak and Ostash identified a wide variety of different approaches to storing, organizing, describing, and delivering maps, and note difficulties non-specialists can face in working with different collections, or even navigating the options available within one. Of the Rumsey Collection, one of the largest and oldest repositories of scanned historical maps, they note the following:

> Because of these different ways and the structure of the website, it is difficult for new users to find their way around the website and get the maps in the format that they want. (Novak & Ostash, 2022)

This is but one example of how abundance and complexity can inadvertently obscure access to the source materials that users seek.

Spatial Literacy and Instruction

In our society people are exposed to maps in their daily lives in an unprecedented way. With navigational maps ubiquitous on mobile phones, maps used frequently in online advertising and social media, and the rise of so-called "volunteered" geographical information harvested by corporations online, being a good citizen increasingly means, among other skills, having the ability to think critically about maps. At the same time, Geographic Information Systems (GIS), the software programs that enable complex geospatial data analysis and map making, have moved from the realm of exclusive commercial software products to being available to the public in a variety of readily accessible forms. (Novak & Ostash, 2022).

While there is a demonstrated need to promote spatial literacy, K-12 geography education has been de-emphasized in the United States in recent years. The 2018 National Assessment of Educational Progress (NAEP, 2018) on geography found only 20% of eighth grade students surveyed had taken a class focused on geography, with an additional 43% reporting having had some geography instruction in a non-geography focused class. This begs the question of where learners should turn for necessary support. Undergraduate students who decide to major in geography will almost certainly learn about spatial literacy and take classes in GIS, and for them, working with digitized historic map collections will pose few challenges beyond finding the right map in the haystack of online options. However, scholars from outside of the field of geography

are increasingly utilizing spatial analysis in their academic work, with great potential to unlock new information about the past through interpretation of historical maps but are arriving in academic programs underprepared and in need of technical training that in most cases will not covered by their core curriculum (Appel, 2019).

Though digitization has vastly increased the accessibility of historical maps, libraries must still employ various outreach methods to encourage engagement with historical material. Even within academia, students – especially those new to the field of digital humanities– face barriers to engagement with historical map collections (Dodsworth, 2010). They may be overwhelmed by the size of collections or have expectations that collections require deep historical expertise to use and make sense of the materials. The skills required to successfully interact with this material, like those needed to use traditional desktop GIS applications, may seem out of reach. Historical maps may feel at best irrelevant to their everyday experiences, and may even represent painful legacies of oppression, enslavement, and displacement.

Map libraries must devise simple, repeatable discovery activities which can be communicated through clear tutorials, and which employ tools that are easy for students to access and master. Additionally, librarians should work to ensure that methods and materials chosen are optimally inviting to a diverse student population and be sensitive to the impact of certain topics on student feelings of belonging and representation in the library. By doing so, libraries can continue Dodsworth's work of extending an invitation to those who are hesitant, in turn broadening the range of perspectives represented in the field.

Slayton and Benner argue that the ease of access to spatial information and tools drives an increased responsibility for libraries and other "geo-educators" in informal settings to

"facilitate the literate use of these tools" with a firm "socio-contextual view of spatial datasets" (Slayton & Brenner, 2020 p3), going on to state:

> Libraries are uniquely suited to act as a springboard for teaching spatial literacy and critical engagement with geographic concepts, in part because these institutions serve a wide swath of the population, even beyond traditional geography programs. (p 5)

Undergraduate students interested in doing spatial analysis for digital humanities projects often need to build those skills through library-based instruction (Slayton & Brenner, 2020). Usability studies suggest that so-called "GIS-Lite" or web-based mapping and map manipulation tools may be sufficient for many student needs, and that training on full GIS applications may not always be necessary. Kong, et al. (2015) evaluated web GIS applications for how well they supported "discovery and access" and conducted usability studies with students in academic libraries. Their results indicated students could be successful with only a handful of key affordances, stating that "a user-friendly web GIS application should provide users a clear starting point, predictable map interaction, flexible customization capabilities, and familiar web experiences." (Kong, 2015)

Students may not require expertise with full-service GIS software packages, but nonetheless the implications for librarians and the range of relevant knowledge required to provide support are broad. Weessies & Dotson (2013) exhort librarians to step up to meet this challenge, stating that "new technologies and access to deeper data resources…have raised the bar for librarians' responsibilities for curating, serving, and aiding patrons in its use. Rather than be passive shepherds of information resources, librarians are now active participants and even

information partners" and suggest that librarians "with map and GIS skills…can directly enhance the quality of student scholarship across academic disciplines" (p 25). Setting aside the questionable idea that effective shepherding of information is a passive activity, the implication remains that librarians must develop expertise in an array of geospatial tools and skills which are not generally included in a typical MLIS program. Most participants in Slayton & Benner's 2020 survey reported feeling an expectation to "be something akin to a polymath, with at least a deep awareness of multiple disciplines." (p 12) The study's authors frame the issue as follows:

> Libraries serve whole communities and when that community is anyone who wants to make a map, find specific datasets, practice spatial data management, learn to use a tool or apply a method specific to their interests, the requirements for the geo-educator are broad." (p 12)

While this may be the case, in practice librarians face non-trivial obstacles to acquiring skills and providing instruction on these tools.

It is difficult to suggest universal best practices for core skills for geo-educators when little standardization exists across institutions. Dodsworth's 2018 survey of map collections in North America found a wide range of services offered by the holding libraries and lack of consistency in what the facilities that house them are even called, noting that "there is no universal name for a map collection" (p 3). The majority of Slayton and Benner's geoeducators "indicated that they were in a small department or in a solo position" and the authors note important distinctions to be made between "libraries who have dedicated funding to support physical and digital collections and those that do not." (p12) Furthermore, they note that "due to the varied professional backgrounds of

geo-educators, there isn't a unified community space or organization where people can share their work or discuss challenges they encounter as a profession." (p 13)

It stands to reason those institutions with significant numbers of staff and budgets for robust digital curation projects should generate tools and material that can be easily repurposed by geo-educators on smaller teams, and this is happening, to an extent. But just as not all libraries have GIS specialists, not all have programmers available either, and some technical skill may be necessary to implement open-source software solutions created by other entities (Fleet & Pridal, 2012). This is an additional argument for simplification and standardization, and for the technical lift required for things like georeferencing, file formatting, and the creation of plug-and-play tools which don't require technical knowledge to originate from those more well-resourced institutions. Ideally the discovery and instruction tools created by institutions with the resources to invest in development should be easy to stand up and maintain without much technical knowledge and allow for interchangeability of content. This would allow for librarians and geo-educators to use maps of their local area to engage students and other learners in open-ended inquiry-based activities. The ability to employ local information in geography instruction is key because the existence of "strong regional and local variation in the availability of geospatial data," means that "familiarizing students with data sources for their local region is important" (Appel, 2019).

Georeferencing

In Novak and Ostash's 2022 research they pinpointed a key problem for access; large collections of online map images that are not georeferenced. Georeferencing can be learned but is a skill that many users will not possess, and the authors recommend that this be considered an

essential step in the initial digitization process. Ungeoreferenced material may not present an obstacle for all users, but the fact remains that these materials are not suitable for spatial analysis without additional effort. Discovery and analysis are enabled when images are georeferenced

In a nutshell, georeferencing is the association of an image of a map with the actual location on the Earth of the place that is depicted. It lets a user take a scanned file of the 1869 US. Coast Survey map of San Francisco, which contains amazing information about the environmental conditions before urbanization of the peninsula and overlay it with a basemap of the city as it is today, and quickly make comparisons and discoveries about how the landscape has changed over time.

Users can access georeferenced maps online now using tools like Georeferencer, which is used by preeminent online map collections like the David Rumsey Map Collection and Old Maps Online (Fleet & Pridal, 2012). It supports examination and comparison through several different views (i.e. grid view, two-pane slider) and tools like transparency sliders. Participating institutions are required to provide data about maps including map title, date, URL, and coordinates of the bottom left and top right corners of the map (Southall, 2017). Data mirrored from external locations by the OldMapsOnline website also must provide information about the image viewer software used by the image host; when all repositories use the same protocol this is irrelevant. Georeferencing is crowdsourced and performed and refined by visitors to the site.

A similar interactive web app is provided by the Leventhal Map Center at the Boston Public Library. Their Atlascope tool provides access to a list of historical maps of Boston, which users select from a drop-down menu, and can explore using grid and swipe views as with Georeferencer. These are simple tools with straightforward mechanics yet empower users to

quickly develop insights about change over time. One can explore maps without first having a specific thesis, and allow questions to emerge prompted by what the maps contain.

While it does not require tremendous effort to georeference a map once the process has been learned, that step transforms what is essentially a picture into data. It is also a step where users lacking technical experience can easily become confused and give up. Considering the amount of time and energy devoted to creating digital repositories, the field should make every effort to not lose people. Institutions with the resources to execute on digitization projects should take on the extra effort to make digital objects easier to use.

Standardization

To fully realize the potential of distributed digital object resources, scholars, librarians and technologists are working to develop protocols and standards to ensure the accessibility, interoperability, and machine-readability of digital objects, including scanned historical maps. The International Image Operability Framework or IIIF (pronounced “triple-eye eff”), is both a set of APIs for accessing collections of digital objects and a community of users. The IIIF consortium was formed in 2015 and is composed of 60 institutions (IIIF, n.d.a) including Stanford, where I work, and the University of Tennessee Knoxville (IIIF 2021) where I am pursuing an MSIS degree.

The stated goals of the organization are:

- To give scholars an unprecedented level of uniform and rich access to image-based resources hosted around the world.
- To define a set of common application programming interfaces that support interoperability between image repositories.

- To develop, cultivate and document shared technologies, such as image servers and web clients, that provide a world-class user experience in viewing, comparing, manipulating and annotating images." (IIIF, n.d.b)

The premise behind IIIF is that "images are the fundamental information carriers for cultural heritage and research materials today on the web." (Cramer, 2016) The benefits of the framework are that it standardizes how digital objects are delivered and viewed, while at the same time allowing for flexibility and variety in the methods used for description of the object via metadata. The digital object and respective metadata files remain unchanged, and the APIs act as sets of instructions for what a browser or an app should do with the information in those files under various conditions.

As of March 2022, six APIs have been published, but I will focus briefly on two: the Presentation API and the Image API. The Presentation API conveys information about the presentation of a digital object and provides a format for software to "consume and render" (Crane, 2017) objects and annotations. A good way to think about this is to imagine individual pages of a book, which have a specific order and orientation in which they should be viewed. The Image API enables dynamic generation of copies of the primary image (e.g. small thumbnails, excerpts of specific details) and also enables the ability to do a deep zoom into an image without having to download a large file.

To enable the addition of geographic information to digital objects, including scanned maps, the IIIF community is developing an extension to the framework called "navPlace." As their website explains, "the IIIF Presentation API does not provide a resource property designed specifically for geographic location. However, the concept of location is a first class descriptor

for many resources and thus calls for its own property by which it can be expressed." (https://iiif.io/api/extension/navplace/)

This allows for the inclusion of location information with the packet (known as a Manifest) that contains the digital object, by incorporating a tiny bit of text in the form of a JSON file with coordinates that correspond to corners of the map. A viewer that's able to read an object's manifest can determine where the area represented by the map image is located.

The Allmaps Viewer is one such example. While still under development, this webapp allows users to pull any map available through IIIF into the main window and view it warped and aligned with the basemap. Currently the needed georeferencing data is held on the Allmaps server (Spann, 2021), but with the implementation of navPlace with IIIF, this information and that which must be uploaded in a spreadsheet to Georeferencer will be conveyed in an associated metadata file, eliminating the need for the portal host to store the information locally.

As described, current applications using IIIF data use a viewing window to frame the digital object being presented. Crane (2018) described a future implementation which goes "beyond the viewer" where content is distributed across a page by "exploding" the viewing interface and "distribut(ing) interacting components for navigation, thumbnails, metadata and the content viewport around the page," a technique useful for "present(ing) the object in any special interpretive context." This vision for future implementation of IIIF is reminiscent of Vannevar Bush's 1945 Memex concept of a machine that would enable the user to seamlessly combine, annotate, and "build a trail of his interest through the maze of materials available to him" (Bush, 1945).

IIIF provides an answer to many of the obstacles revealed in the literature; a proliferation of tools serving similar purposes and the difficulty in repurposing open source code to create

sliders, overlays, side-by-side tools, etc.. The problem of linkrot in directories of sources is solved by the use of trusted digital repositories managed in perpetuity serving up content that can be used by anyone anywhere. Educators working with digital map collections have developed a wide range of instructional materials to support engagement with their respective collections. These materials are decentralized, can be difficult to locate, and typically are concerned with a specific local geography. IIIF with navPlace will support the use of high-quality inquiry-based instructional materials developed by libraries by all.

Additional Benefits

Implementation of these standards will go a long way toward addressing issues of proliferation of tools and interoperability of resources and will have the following additional benefits. Images delivered through IIIF can be retrieved through geo-search, an intuitive form of discovery using a map interface to show geographic locations of files from a collection. The products of digital humanities projects which result in the generation of new maps can be linked to their source files, preserved in the same digital repository, and be remixed in turn with historical sources. Ensuring that collections of historical maps follow the protocols established by IIIF + navPlace enables machine-readability which ultimately supports and enables initiatives like development of machine-learning techniques enabling text-based search of map imagery (Li et.al., 2020) and other computational methods of processing large collections (Chiang et.al., 2020) to create datasets which inform scientific research, e.g. about the environment (Cillis et. al., 2021). Machine readability enables user research as well. Consistent implementation of the IIIF protocol enables researchers to perform studies across collections to understand how images are being used and which specific elements within the image frame are of the most interest to viewers (Nishioka & Nagasaki, 2021).

Conclusion

In recent years, the number of digitized historical maps available online has expanded rapidly, and creators of online collections have developed a variety of methods for providing access to these materials. Despite the proliferation and the availability of resources, in many cases obstacles remain for non-specialists who need to access and use these materials in scholarship or for instruction, and careful consideration for user needs and abilities should be paramount in considerations about design and affordances of discovery tools. Geospatial education in libraries is key, and a need exists for better sharing and repurposing of educational materials. Emerging standards and protocols seek to address problems of accessibility and interoperability. The International Image Operability Framework or IIIF standardized protocols for providing access to digital objects and is currently in use at many significant online collections of cultural objects. To enable the addition of geographic information to digital objects, including scanned maps, the IIIF community is developing the navPlace extension. In addition to enabling machine-readability of historic map collections online, the implementation of IIIF with the navPlace extension will streamline access issues and allow libraries to develop interoperable inquiry activities that educators can customize for students using local geography.

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