The Limits of GIS: Towards a GIS of Place

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1. Introduction

Reflecting on the limits of GIS is not a new exercise. In the late 1980s and early 1990s, both the representation model of GIS and its worldview—who did GIS benefit?—came under scrutiny by geographers writing under the broad umbrella of "critical GIS." (See Schuurman (2000) and, more recently, O'Sullivan (2006) and Thatcher et al. (2016) for a summary and an historical overview of the debate.) Early NCGIA Technical Papers from this period explored topics that include the language of spatial relation, cognitive science and GIS, and public participation GIS, while seminal works by Pickles (1995) and others (Curry 1998; Obermeyer 1995; Sheppard 1995) questioned the ideological foundations of the field. As a response from within the field, several academic GIS authors—for the debate barely registered outside of universities—attempted to re-envision GIS from alternative perspectives, including Kwan (2002) from a feminist one. Especially relevant to our objectives in this paper is the discourse around qualitative GIS (Cope and Elwood 2009)—which is largely internal to geography—and, in a much broader context, the increased use of computational technologies and big data methods in the digital humanities and the spatial humanities (Bodenhamer, Corrigan, and Harris 2010; Drucker 2012; Travis 2015; Dear et al 2011).

But relevant developments took place well beyond initiatives rooted in the spatial humanities. Emerging in the context of computer science and AI as an extension of qualitative reasoning (QSR), qualitative spatial reasoning is concerned with representing continuous properties of the world by discrete systems of symbols (Cohn and Hazarika, 2001). Cohn and Hazarika (2007) outline the major axes of QSR including the choice of a representational formalism, the ontology of spatial entities, and the definition of primitive relations and operators. As Hazarika and Cohn (2001, 2) note, being multidimensional, space is not adequately represented by a single scalar quantity. The goal of QSR is then to design representations that can answer qualitative queries without much numerical information and to derive and manipulate qualitative spatial representations that efficiently and correctly abstract important spatial aspects of the underlying data (Bailey Kellog and Zhao 2004). It is important to note that these research questions—in

particular the focus and concerns on spatial ontologies and the search for framework for formal representations—are not new in geography and GIScience, but refer back to the early days of GIScience and the pioneering work of David Mark and others on spatial cognition and language (see, for example, Frank and Mark, 1991; Egenhofer and Mark, 1995; Smith and Mark 2001). What is new is the integration of AI methods and tools in the context of geography and for the specific representation and analysis of qualitative spaces. Of particular importance given our own interests is how QSTR (qualitative spatial and temporal representation and reasoning) extends QSR to incorporate a temporal element (for a brief review, see Klippel and Wallgrün 2017).

Another relevant area of developments, that we return to below, is the intersection of corpus linguistics and GIS, seen for example in the work of Ian Gregory and others at Lancaster on geographical textual analysis, and especially in the Corpus of Lake District Writing project, which focuses on place-names and on the identification of geographical features such as waterfalls, woodlands, or farms (Gregory et al 2015; Gregory and Donaldson 2016; Rayson et al 2017; Donaldson et al 2017). Similar questions are tackled by Kim, Vasardani, and Winter (2017), who focus on the question of resolving ambiguous place-names by exploring their relations with other spatial features, and Song et al (2017), who developed and tested a method for detecting and extracting vague cognitive regions.

With a somewhat broader perspective—ie, with the objective of providing an analytical and conceptual framework—is the idea of geo-narratives as developed by Kwan and Ding (2008) as a distinctive qualitative GIS approach, and Mennis et al (2013) work on combining qualitative and quantitative data and methodologies within the context of geographic information systems (GIS), using visualization as the means of inquiry. For a more explicitly cartographic perspective, see the idea of deep mapping and spatial narratives (Bodenhamer, Corrigan, and Harris 2015), inductive visualization (Knowles et al 2015) and from an ethnographic perspective, Kawano et al. (2016) look at how "rich media"—maps, photography, video composition, big data, and interactive Web platforms—can serve as representations to communicate the study of spaces and urban life.

While recognizing the validity and relevance of the issues raised by these and other authors, and the overall positive contribution they have made to the academic field of GIScience, here we want to focus on one aspect, namely the relationship that exists—or does not exist—between

GIS and place. While place has been a major subject of geographical research for decades, the subject matter of GIS, the methods of GIScience, and much of the research in the field have concentrated and revolved around the concept of space, intended as an abstract container framed by the Cartesian grid of scientific cartography (Goodchild 2004). When it comes to representing social relations and the dynamics of social power, which are the basis for one theory of place that may be particularly relevant to developing a GIS of place (Lefebvre 1974/1991), the spatial perspective of GIS appears lacking, a point certainly not lost in the debates on "critical GIS." As other researchers do, Pavlovskaya (2017) links qualitative GIS with the emergence of the digital humanities and the geospatial humanities, noting how the "field of geohumanities … focuses on the meaning of place" (5437).

In this article, we argue for a GIS of place that combines the quantitative perspective of spatial analysis with qualitative methods and data, and we see as our research agenda for the future the building of a bridge between "traditional" GIS—a "GIS of space"—and a "GIS of place"—more specifically, a GIS of place *and* space. Our starting point is a multi-year collaborative work on the geographies of the Holocaust, as it is while studying the Holocaust that we have become convinced of the necessity to integrate and enrich the analytical powers of GIS with other types of data and voices. Such an integrated framework has a correspondent in Holocaust scholarship. As Saul Friedländer pointed out in the first of his two-volume history of *Nazi Germany and the Jews*, "Establishing a historical account of the Holocaust in which the policies of the perpetrators, the attitudes of surrounding society, and the world of the victims could be addressed within an integrated framework remains a major challenge" (Friedländer 1997, 1). Friedländer's call for integrated histories reflected broader concerns with the way that the historical literature on the Holocaust had tended to follow separate paths. On the one hand, an ever-growing literature—building on the ground-breaking work of Raul Hilberg (Hilberg 1961)—drew on the paperwork of the perpetrators to understand both how and why the Nazi German state implemented a policy of persecution and ultimately mass murder of European Jews. However, the voices of those persecuted and murdered were almost entirely absent from this burgeoning historiography. Bringing the voices of the victims together with the paperwork of the perpetrators, was for Friedländer more than simply ethical necessity. It was also a way to better narrate the complex history (and geography) of the Holocaust (Friedländer 1997, 2).

Rather than an "integrated" history—or an "integrated geography–being a seamless blending of these two sources, bringing them together in "integrated" methodologies and texts reveal key tensions in experience and understanding place. As Paul Jaskot has illustrated in examining the architecture of Auschwitz, "the structures that served as sites for the persecution of the European Jews were designed by the SS, built by forced laborers, and experienced by camp inmates; each category of participant bore a particular relationship to each building. The tension between these varied meanings needs to be reflected in any integrated history of the Holocaust." (Jaskot 2015, 4) For Jaskot, "it is only by thinking relationally that we do not lose the survivor's story in the vast abstraction of a systemic analysis of the concentration camp network. Each records its side of the history, each remains distinct, and each is necessary to explaining the Holocaust" (Jaskot 2015, 5). The idea of thinking relationally is one that we return to later on in this paper as it is key, we argue, to thinking about a GIS of place as "occupied space" that foregrounds topology (Bodenhamer, Corrigan, and Harris 2015, 2). Before we outline such perspectives, we briefly introduce earlier work in working with GIS methods to uncover the spatiality of genocide during the implementation of the Holocaust in Italy and Hungary.

2. Examples from Italy and Budapest

The Historical GIS of the Holocaust in Italy (HGIS Italy) (Giordano and Holian, 2014) includes the names of 6,116 victims for which the location of arrest was known, along with information regarding their *Last name, First name, Place of birth, Nationality--Italian or foreign, Date of birth, Mother, Father, Spouse, Place of arrest, Date of arrest, Place of internment in Italy, Convoy of deportation, Date of deportation, Destination camp,* and *Fate*. The database also includes the *Nationality of the perpetrator*—Italians, Germans, or Italians with Germans—the *Last place of residence of the victim before the arrest*, and any additional *Place(s) of internment of the victim in Italy*. The starting point for the construction of the HGIS was a list of approximately 9,000 Jews deported from Italy during the Holocaust (Picciotto Fargion 1991 and 2002).

The HGIS allows for the representation and exploration of the spatial patterns of the Holocaust in Italy, which have not simply a pedagogical value but also value as a research tool. A summary of these patterns is presented in Figure 1. The solid circles on the map indicate the number of arrests in each place and portray the Holocaust at the local scale: we can see the ubiquity of the

event, the fact that arrests were conducted in all parts of northern and central Italy, and in centers small and large. The number of arrests was especially high in traditional centers of Jewish life in Italy—like Rome, Florence, Venice, and Trieste—and in places where the contingencies of the war found an unusual concentration of victims—like Borgo San Dalmazzo (Jews escaping from France) or the area north of Milan (Jews escaping from Italy into neutral Switzerland). The five clusters in grey—generated through a k-means clustering technique–provide an aggregate regional view of the local patterns.

As with any aggregation, the patterns need to be contextualized and taken with a pinch of salt. The four clusters in northern Italy can be explained and are not unexpected: this is the case for the smaller clusters in northwestern Italy centered in Turin, Genoa, and Borgo San Dalmazzo; around Milan and the Swiss border area; and around Florence. These small clusters correspond to cities of traditional Jewish presence (Turin, Genoa, and Milan) and places where Jews were arrested in large numbers (Borgo San Dalmazzo and the Swiss border area). The largest and elongated cluster in northeastern Italy includes some traditional Jewish centers and corresponds to the orientation of the principal axis of transportation across the Po plain. The fifth cluster—the area from Rome to Civitella del Tronto—simply reflects the location of these two places with respect to each other, with no major centers of arrest in between, and does not therefore constitute a meaningful cluster, one that can be explained and interpreted—and perhaps produce new knowledge—by the known characteristics of the Holocaust in Italy. (The two locations are separated by the Apennine Mountains, a barrier that slowed at the time—and still slows to some extent—physical communications between the two sides.) An additional step towards exploring the spatial patterns of the Holocaust in Italy at different scales—e.g., at the scale of the city, or the province—is to add interactivity to it, allowing viewers to explore the dataset on their own. This is the objective of the online geovisualization "Arrests of Italian Jews, 1943-1945" (https://web.stanford.edu/group/spatialhistory/cgi-bin/site/viz.php?id=383&project_id=0), created by Erik Steiner, Alberto Giordano, and others. In addition to offering interactivity and a possibility of exploring the dataset at different scales and by selected variables associated with the victim, a timeline at the bottom of the geovisualization allows viewers to explore the spatio-temporal patterns of the Holocaust in Italy, thus allowing for a chronological perspective that a single static map is unable to offer.

The Historical GIS of the Budapest Ghetto (Cole and Giordano 2014a) differs from the Italian HGIS in important ways. First, it is at the urban scale; second, it is a GIS of buildings and not people. Created from a variety of primary sources—the Italian HGIS relied on secondary sources—and superimposed on a map of Budapest circa 1944, the HGIS shows the location of over 3,300 individual residences and of over 100 public places. Identified by an address, these individual buildings were designated for residences and patronage for the Jewish population of Budapest (close to 200,000 at the time) during the second half of 1944 (see Figure 2). Mapping the various stages of the ghettoization process in Budapest allowed us to highlight its spatial and temporal patterns at different scales of analysis, from the building to the district, for Buda and for Pest, and then for the whole city. Thus, we determined that the location of Jewish-designated residences corresponded for the most part to the traditional geography of Jewish Budapest, thus leading to the assertion that Nazi perpetrators in Budapest "brought the ghetto to the Jews" rather than the other way around. We also determined that while the reconfigurations of the ghetto over time were substantially different from earlier plans, these successive implementation stages (see Figure 2) did not significantly alter the level of spatial concentration of residences, and, by extension, the concentration of the victimized population (Cole and Giordano 2014a).
Network analysis allowed us to focus on the scale of the street and on people's movement from their place of residence to key public places, including market halls for buying food, hospitals for receiving care and, crucial to the establishment of the so-called "International Ghetto," the location of the Swedish and Swiss legations for acquiring protective papers. What emerged clearly from the analysis were the differential constraints that Jews lived under because of the importance of physical distance from people and resources. Similar to what we did for Italy, an interactive animation showing Jews walking to market halls, with a commentary from the authors, adds interactivity to the static map and the ability for the user to explore the geography of food access (https://web.stanford.edu/group/spatialhistory/cgi-bin/site/viz.php?id=411&project_id=0). It is looking at the maps, static and dynamic, that we hypothesized that Jews living in District V were subject to more potential competition for food there than in other parts of the city, while suburban market halls in Buda seem better positioned to serve the Jewish population than market halls in Pest. Similarly, locational advantages emerged for access to the offices of the Swedish legations.

Overall, network analysis revealed the existence of "invisible walls," which we defined as the result of the potential for accessing places and people key to survival; this, in a condition of almost total control of the victimized population, was largely determined by location (Giordano and Cole 2011; Cole and Giordano 2014b). However, and here is one of the key moments that led us to rethink and redefine the potential of GIS and GIScience for studying the Holocaust, these "invisible walls" could be breached by socio-economic status, and the existence of pre-ghettoization social networks of support. This is clear not only from testimonies but also, for example, by examining the lists of some of the Jews admitted into the "International Ghetto"—a "privileged" ghetto, in the sense that it was envisioned as the waystation to emigration rather than deportation —as a result of the acquisition of papers from the Swedish legation: a majority of people on the lists we examined lived quite far from the legation and were instead from areas of the city near the "International Ghetto" and in general from more affluent neighborhoods (Cole and Giordano 2014b; Cole 2016).

3. The limits of GIS representation

As the example above from the Budapest's "International Ghetto" makes clear, spatial barriers such as the physical distance between home and the Swedish legation buildings where paperwork was given out could be overcome by friendships, contacts, and in general social networks that predated the implementation of the Nazi-era ghettos. What is especially relevant is that these networks of social relations occur *in place*—in the case of the Budapest Ghetto, the building and the apartment within the building. So, for example, interviewing Jewish survivor Judit Brody, when asked whether it mattered that the family was able to stay within their own apartment, she replied that staying put meant "everything." It was not only the importance of remaining in a physical and material place, but also the significance of remaining in a social place that mattered (Cole and Giordano 2014b).

The importance of place as site of social relations also emerged in the testimony of one of the 6,116 victims recorded in the Historical GIS of the Holocaust in Italy: Gilberto Salmoni. Arrested in April 1944 and deported to Buchenwald in August 1944 with his brother, Gilberto's story is, in a sense, a mirror of Judit's: whereas Judit stayed in Budapest, and actively tried to "stay put" to take advantage of pre-existing social networks, Gilberto and his family left their hometown, were arrested while trying to escape to Switzerland, were moved to several prisons

and a camp (Fossoli) in Italy, and were finally deported to Buchenwald (Gilberto and his brother) and Auschwitz (Gilberto's mother, father, and sister). (See Figure 3 for the entire family trajectory). Gilberto's narrative is one that alternates movement *between* places with, once at a place (for example, once at Buchenwald), the identification of a place *within* the place (for example, a certain barrack in Buchenwald) that maximized chances for survival, and that is where he and his brother—for the limited degree of agency they were able to retain—"stayed put." Here again, the social networks he and his brother were able to create *in place* played a key role as a strategy of survival. In Gilberto's testimony, the camp, the sub-camp, the *Appelplatz* [roll call square], the barrack, the half-barrack, the table he and other prisoners had dinner at, and the bunk bed, were not only where different things happened, but even more importantly they were the loci of social relations, which appear to be highly spatialized and are indeed explicitly discussed by Gilberto as happening not only "in place," but explicitly "of place," in the sense that they could only occur in those specific places and times (Giordano's interview with Gilberto Salmoni, January 8, 2017. See also Salmoni 2016.)

Reflecting back on the HGIS of Budapest and Italy, we became progressively convinced that the tool of GIS and the methods of GIScience are especially useful to tell the story of the Holocaust from the perspective of the perpetrator, for example through mapping out where in Italy arrests took place, or where in Budapest Jews were concentrated into ghetto houses. This does not mean that GIS and GIScience are intrinsically, inherently, or by design, tools of—and for—oppression. On the contrary, GIS and GIScience can uncover critical aspects of the geography of oppression by showing—how we did for Budapest and Italy—how widespread and systematic the spatio-temporal patterns of victimization were, at different scales and for different victims. What we hope to have shown in earlier work is the utility of GIS and GIScience to study not only the Holocaust but other instances of genocide (Burleson and Giordano 2016). In doing this we relied on spatial data with well-defined and measurable levels of thematic, temporal, and positional accuracy and that have little or no intrinsic uncertainty; this is we dare say, especially important when dealing with ethically charged topics like the Holocaust and genocide, particularly given the specific context of Holocaust denial which foregrounds the importance of accuracy—and objective truthfulness–in historical narratives. The HGIS applications we built includes records of arrest, list of buildings and public places, dates and places and names. All, of course, have their own accuracy issues, but these can generally be measured and estimated.

However, the fact is that a GIS of place, one that gives voice to the experiences of the victims, require a radical conceptual rethinking of the worldview and data model of traditional GIS. A GIS of place cannot, in our opinion, simply consist of narratives (in text or video) superimposed to the spatial abstract view of a GIS application; good examples of this approach exist, but are not what we are we are aiming for here (Watts 2010; Mennis et al 2013; Aitken 2015). Such approaches do not enable the kind of truly "integrated" or "relational" approach that scholars of the Holocaust have urged are necessary. Superimposing narratives onto a GIS map is significantly different from integrating them into—and with—the spatial analysis. For example, in order to explore place and social networks as key strategies of survival, we need to, metaphorically at least, enter into the buildings and the camps and to listen to the voices of those who lived there. This requires new sources (testimonies and memoirs), new digital methods (appropriate for studying testimonies), and a shift from spatial quantitative methods to spatial qualitative methods—or rather the integration of quantitative and qualitative methods into a mixed methods analysis.

In the Introduction, we reviewed a series of approaches and methods—including QSR, geo-narratives, deep mapping, and others—that, in the context of a mixed methods analytical approach, may contribute to the theory and practice of a GIS of place. Here we want to focus on one such approach and method—corpus linguistics, which we have used in the past. Corpus linguistics methods are useful to parse large oral history collections to identify key terms that include indicators of place characteristics such as "neighbor," "corridor," "courtyard," "apartment," and so on, as this is where social relations occur. The real question then becomes how to integrate the powerful spatial-analytical capabilities of GIS, which lead to the unearthing of patterns as shown in the preceding section, and at the same time being able to represent the voice of the victims, operationally defined as spatial strategies of survival that are the effect and results of the deployment of social relations in place. We realize this is a rather limited view of what a GIS of place may look like, but unless the task is delimited and carefully defined, the risk is vagueness and ineffectuality. The point where the policies of the perpetrator meet and interact with the victim is at the resolution of the individual. It is here, we think, that the abstract view of space—the perpetrator's policies—meets the place-making activities of victims as well as of perpetrators (e.g., a camp guard and a prisoner).

To explain and contextualize what we mean, it is important to note that in geography and GIScience the concept of resolution takes a precisely delimited and narrow meaning. At its most fundamental, resolution refers to the smallest measurement unit at which data are collected and/or analyzed. In GIScience as well as in geography, resolution has three components—one spatial, one temporal, and one thematic. Thus, the spatial resolution of the HGIS of the Holocaust in Budapest is the address of the building; the temporal resolution is the period of time the building was a designated Jewish residence; and the thematic resolution is the building itself. For Italy, the spatial resolution is the city or town where a victim was arrested; its temporal resolution is the day; and its thematic resolution, what we are collecting data on and measuring, is the individual victim. From the individual building or victim, it is possible to "scale-up" to study the spatio-temporal patterns of the Holocaust in Italy at the city, regional, and national scale and, for Budapest, at the neighborhood, district, and urban scale. At every scale, however, the resolution remained that of the individual building or person.

Gilberto Salmoni's strategies of survival, as already noted, were explicitly spatial and social, and consisted in alternate moments of movement and stasis and the construction and reconstruction of social networks explicitly dependent on—and through—place. In Buchenwald, for example, Gilberto realized that the camp was in constant movement, being reshaped continually as prisoners were reassigned to other barracks or to other sub-camps, or were sent out on constantly shifting labor assignments. As mentioned earlier, the camp, the sub-camp, the *Appelplatz*, the barrack block, the half-barrack, the bunk bed, and the table where he sat with other prisoners to eat dinner, were not only where different things happened, but even more importantly they were the loci of spatially (and temporally) specific social relations. By reducing the immensity and mystery of the Buchenwald system to the smallest and most manageable geographical units—scale after scale—Gilberto managed to make sense of, relate to, and survive in the camp. This richness of experience can be represented with GIS only formally and symbolically. In order to capture the more nuanced elements of Gilberto's spatial narrative of the Holocaust, we need to develop techniques that specifically deal with the written word, with the aim of bringing the two approaches together, in an "integrated" and "relational" way. As briefly discussed in the Introduction, we see potential for QSR in this context.

4. For a GIS of place

Building a GIS of place presents conceptual as well as practical and functional challenges. It is, first of all, a collaborative enterprise, as we envision many possible implementations of GISs of places, rather than a monolithic and general-purpose system. That is why we circumscribed it in the preceding section as a set of tools and methods to study the deployment of *social relations in place*. For this view of place, we are indebted to the work of Yi-Fu Tuan, who in his classic study of space and place, observed that "home" is not necessarily anchored in place (Tuan 1977): it can reside in a person, or a personal relationship, such as the deeply comforting bond that can exist between parent and child, or any two people who trust and rely upon one another. In other words, place and social relations are inextricably intertwined and one cannot be studied without the other (*the social is spatial and the spatial is social*). A research agenda on a GIS of place in the context of the Holocaust is one that answers questions such as: how are the places of the Holocaust formed? what kind of relationships shape and define these places? what happens in these places? how are these places connected? And, crucial not only to the Holocaust but to genocide studies as well, how does this all relate to human survival and resilience?

A GIS of place will require a rethinking and extension of the analytical tools and methods of GIScience towards a mixed methods approach, rather than a purely, or even prevalently quantitative approach, and an explicit link and conversation with the methods and approaches of the digital humanities and the spatial humanities. (For an example of this conversation, in a different context and with different objectives, see the idea of "deep maps" as visual spatial narratives in Bodenhamer, Corrigan, and Harris 2015.) Qualitative methods are crucial to the analysis of oral histories and, as already noted, corpus linguistics is an approach that we find especially promising to the study of narratives of the Holocaust, specifically at scale—that is, from the dozens, to the hundreds and, eventually, the thousands. Corpus linguistics and natural language processing, a related branch of computer science, use computational methods to analyze words and phrases in corpora, primarily in the context of linguistics research. However, these methods of text mining have been applied to a broader set of research questions within digital humanities research, using analytical tools that include:

1. *Concordance* – displays a select word or phrase in the sentences in which it occurs.
2. *Frequency* – how many times a word or phrase occurs in a given corpus.

3. *Relative frequency* – compares frequency in the target corpus to frequency in a larger reference corpus. For example, comparing the use by female survivors of a term to the use of male survivors.
4. *Collocation* – returns the instances where two or more words occur in proximity to one another. For example, *street* and *fear*.
5. *Annotation* – also known as tagging, annotation attaches information to words and phrases to enable semantic analysis. For example, annotation can identify parts of speech and place names. Semantic tags identify words and phrases as belonging to any of a number of preset conceptual categories, such as *movement* or *family*.

What attracts us in particular to corpus linguistics and natural language processing methods is that they enable a working at scale of hundreds, thousands and tens of thousands of transcripts of oral history interviews with survivors. Preliminary results are promising (Knowles, Jaskot, Cole and Giordano forthcoming 2019).

A GIS of place will not only necessitate a broadening of methods, but also require a rethinking of the collaborative model that the two of us and the wider Holocaust Geographies Collaborative have employed in over ten years of work together, in which we progressed (Giordano, Cole, and Knowles 2014; Jaskot and Cole 2014) from a multidisciplinary to an interdisciplinary collaboration, and a transition to a *transdisciplinary* model, in which transdisciplinarity is defined as the integration of multiple disciplines from the natural and social sciences that transcends their traditional boundaries (revised from Choi and Pak 2006). A multi-methods approach, collaborative research across fields, and the integration of disciplinary perspectives are among the key elements of the digital and geospatial humanities research model.

Spatial analysis and quantitative methods have a fundamental role to play in this research agenda, as they are the interpretive tools to approach and investigate the abstract view of geography—as exemplified in section two above with cluster analysis for Italy and network analysis for Budapest. This is a view that can be represented, measured and understood via quantitative data and methods; it is unambiguous and measurable with degrees of accuracy and precision; deals with absolute ("miles," "kilometers") rather than relative ("near," (far") space; and is by definition designed to deal with big data. It lacks, as already mentioned, the ability to deal effectively with the relative, the ambiguous, with multiple interpretations of the same data piece (e.g., a word like "near"). This is by definition the victim's view of the Holocaust:

narratives, emotions, ambiguities, social space, relative (e.g., "near") rather than absolute space. This inability has been noted already, of course, and several approaches—as discussed in the Introduction—have been proposed as a way to overcome these limitations and as a step towards the integration of quantitative and qualitative methods. We believe that steps towards this integration will require technical (e.g., new visualization methods) as well as conceptual and methodological (model of reality, data model, analytical functionalities) solutions: for example, the ability of studying simultaneously social networks and spatial networks and how these move together and at scale—Budapest and Buchenwald, the apartment and the barrack, etc.

From a methodological point of view and in the specific context of this research, in order to define and investigate the places of the Holocaust—and not only its spaces—we will need an integration of traditional spatial analytical methods with social networks analysis and corpus linguistics methods as tools to parse the testimonies of the survivors. (For a Holocaust-specific example, see Mercklé and Zalc 2014). Building a GIS of place is beyond the scope of the topics discussed in this article, but we can start to sketch some of the challenges and solutions towards achieving the objective. In general, and specifically for the oral histories of the Holocaust we have become familiar with, testimonies tend to lack the specificity of both time and place that traditional GIS requires. So, for example, for the HGIS of the Holocaust in Budapest we can tell with some certainty that on a certain date in 1944 a certain building—or an apartment in the building—was designated as a Jewish residence. This is not necessarily true for oral histories or testimonies. Thus, for example, humans tend to narrate space in terms of relative as well as absolute space: "near" as well as and, perhaps, more often than "10 kilometers." And, they are as likely to describe a certain *place of hiding* as often, if not more often, as they are to talk about the *people they are hiding with*, the latter described in qualitative terms ("friends," "foes," "he harmed me," "she helped me"). Analogous considerations could be made for time, for dates, for events, which are often ambiguous or lack precision and accuracy. We are currently working on a project to populate the buildings of 1945 Budapest—only a few months after the city's liberation in December 1944—with the approximately 75,000 surviving Jews who lived there. Our hope is to then locate enough oral histories to start and build a GIS of place for Budapest, and to tell its stories.

In our early exploration of appropriate methods for this complex data, it seems to us that relative spaces and relative times require a relative approach. In other words, a GIS of place needs to be

by definition *topological*: it is the existence of a relation between people and places that take the center stage in a GIS of place. (Note the correspondence between this view of GIS and the discussion of "integrated history in the Introduction.) The object of study in a GIS of place is therefore the relational and the topological. This is the deepest meaning of statements such as "the social is spatial" and "social relationships are explicitly spatialized, i.e., they are inextricably and explicitly described as happening in space." As a way of spatializing social networks—or, if one prefers, adding the social dimension to spatial networks—several authors have proposed methods to integrate social networks analysis and GIS: see, for example, Andris (2016), especially the idea of an anthrospace and ways to measure it; and, in the context of the transmission of disease, Emch et al. (2012) and Bian et al. (2012). We ourselves contributed to this literature with a paper on the social and spatial networks of the Budapest Ghetto (Giordano and Cole 2011).

The challenge is how to map and represent the times and places of the testimonies, and to do it at scale (for all of Budapest, for example): how do we build a GIS of place by interrogating not one or two but 2,000 testimonies and narratives? Scaling up is not at all an issue for traditional GIS—it is easy to georeference 3,000 addresses on a map of Budapest, or to map the place of arrest for 6,000 Jewish victims of the Holocaust in Italy—but it is likely to be the greatest conceptual and technical challenge for building a GIS of the places of the Holocaust. For a possible way of thinking about how to deal with this challenge, we can think of the way that the census of population is created. Census data are collected at the resolution of the individual and then "aggregated up" at different scales for different purposes and for zooming in or out of the study of a specific characteristic of the population. The aggregation is accomplished by creating a "new" geography (in the US, census blocks, blockgroups, etc.) and by "scaling up" from the individual to the creation of "new" categories of individuals (women, Hispanics, households, etc.) Thus re-categorized, the researcher asks the census dataset different questions depending on the scale of analysis, a scale that is geographical as well as it is thematic and temporal. Analogously, oral histories, testimonies, and narratives are also typically collected individually, and they too can be "aggregated "up" (this is what corpus linguistic can assist in achieving) (Shenker 2015). The job of the transdisciplinary collaborator—to use a term defined above—is to create aggregations that are both specific to the Holocaust and also rooted in a wider epistemology. For example, corpus linguistics can help us categorize the testimonies and also

provide a base topological framework to start determining the spatial scales of a certain place of the Holocaust (e.g., Budapest, Italy). The next step is which functionalities—analogous to cluster analysis or network analysis in traditional GIS—will a GIS of place possess. Some of these functionalities will be borrowed, we predict, from social network analysis, but studying and measuring *social relations in place* will require the amalgamation of GIScience, social network analysis, corpus linguistics and possibly other methods in ways that we are only beginning to explore.

To give just one very brief example that draws some of these tools and methods together, we return to the street network of Budapest, which formed a key layer of the HGIS of the Budapest Ghetto that enabled us to undertake network analysis. Working with corpus linguistic methods and oral history accounts suggests other ways of thinking about the street, not just as a network but also as a place of encounters and emotions. Budapest was unusual in having both a highly dispersed form of ghetto (spread across close to 2,000 apartment buildings that spanned the entire city) in the summer and fall of 1944, as well as being a city where the shape and form of that ghetto was in constant flux across 1944, with a shift to two more distinct ghetto areas established in December 1944 (Cole 2003). In both cases, the street network played a particular role. During the summer and fall of 1944—as we note above in Section 2—the street was the means of accessing key resources such as foodstuffs. In December 1944, the street was the site of Jews being marched from one ghetto to another. What is striking from initial work with oral histories is how the street is remembered and retold differently in these narratives across the second half of 1944. In particular, the collocation of the word "street" and words associated with "fear" of violence against self and others are found in accounts of relocation in December 1944. In short, the street network of the city which formed a key part of our GIS of space, requires also a rendering within a GIS of place as occupied space where victims were brought into intimate and potentially deadly contact with the armed perpetrators as they were marched to the Pest ghetto.

5. Conclusions

Our long-term collaboration and the work of the Holocaust Geographies Collaborative—an international network of historians and geographers interested in bringing geographical and GIScience perspectives to the study of the Holocaust—has shown that the tools and methods of

GIS and GIScience have great potential for the digital and geospatial humanities (Knowles, Cole and Giordano 2014). To more fully realize this potential, however, it seems to us we need to work towards the realization of a GIS of place, intended as the integration of the traditional quantitative spatial analytical tools of GIS with qualitative data towards the full realization of a qualitative GIS. For this article, rather than outlining the results of our working with a fully-fledged GIS of place, we have sought to articulate the necessity of new models and to articulate what some key features of those new models will be. Our hope is that developing a mixed-methods GIS of place will enable the kind of "integrated" and "relational" analysis that the complexity of place—whether historical or contemporary—demands.

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FIGURES

Figure 1

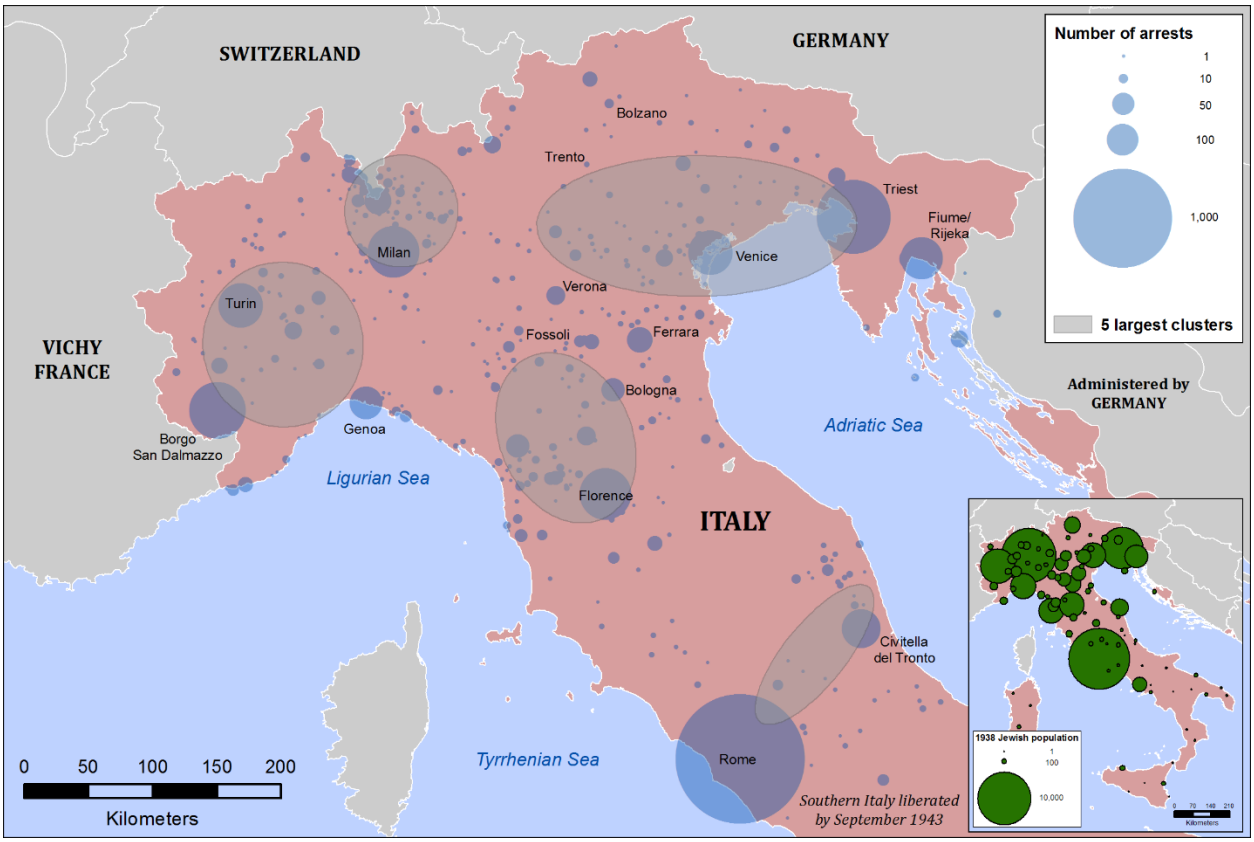


Figure 2

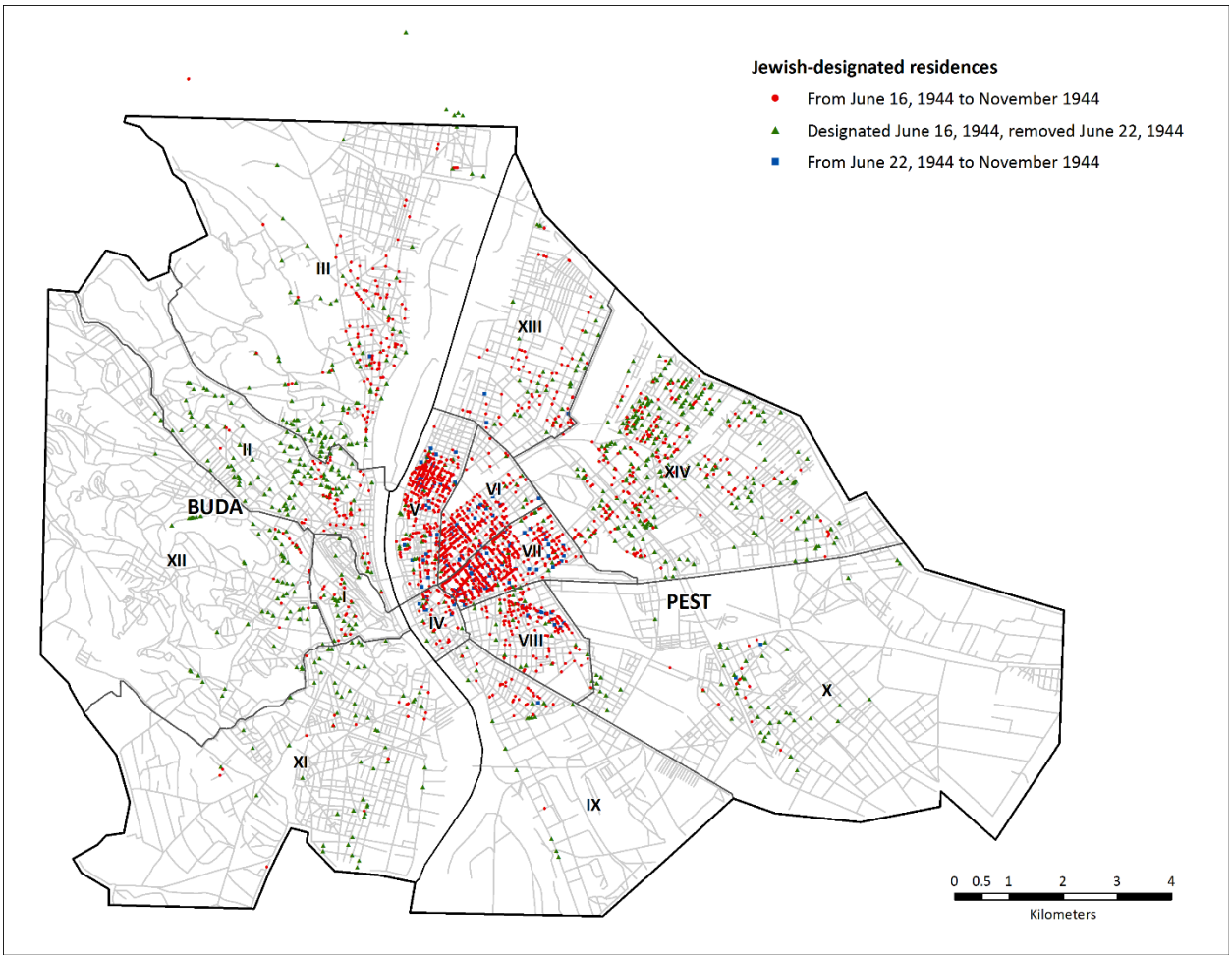
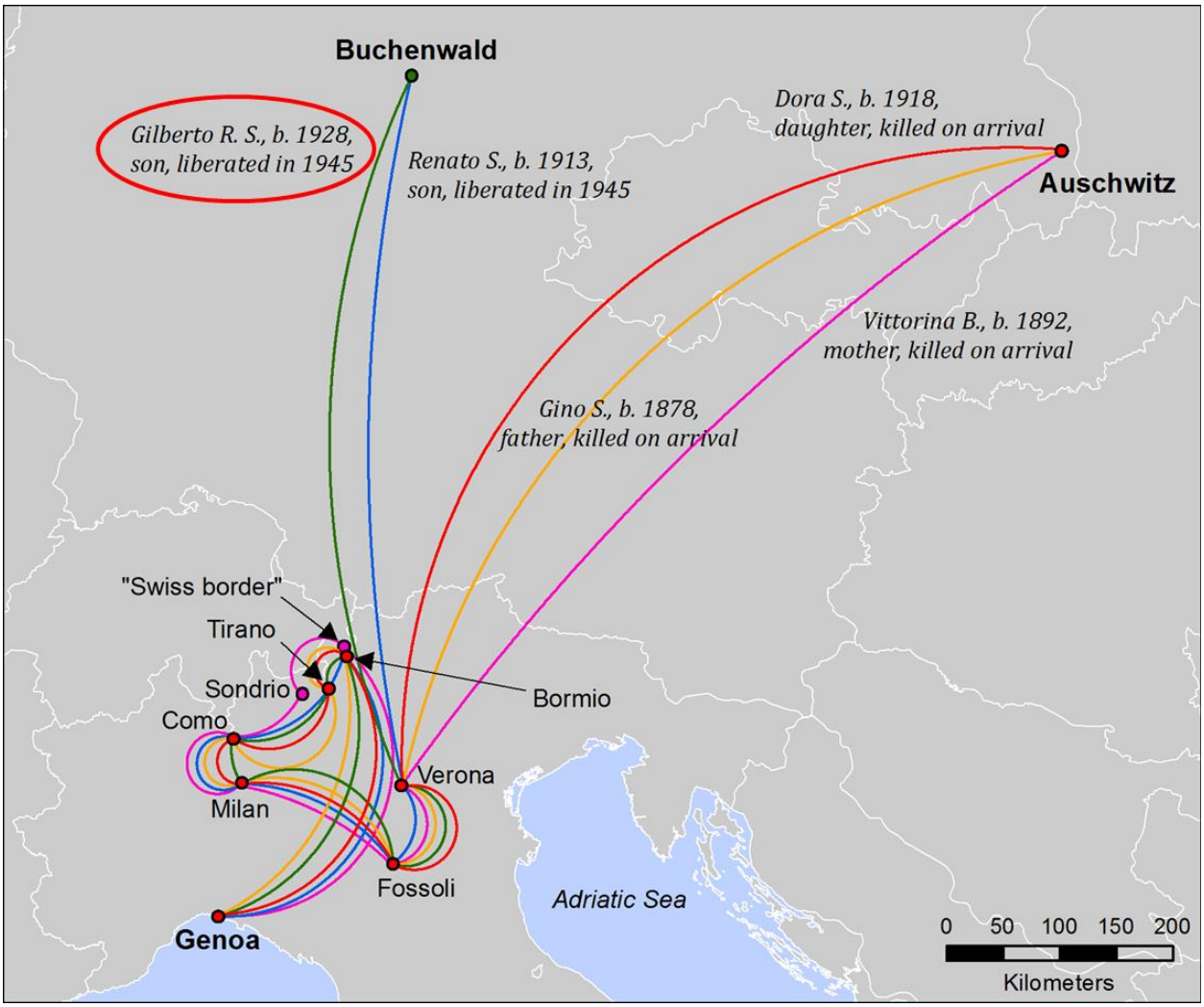

Jewish-designated residences
From June 16, 1944 to November 1944
Designated June 16, 1944, removed June 22, 1944
From June 22, 1944 to November 1944
BUDA
PEST
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
0 0.5 1 2 3 4
Kilometers

Figure 3


Buchenwald
Gilberto R. S., b. 1928,
son, liberated in 1945
Renato S., b. 1913,
son, liberated in 1945
Dora S., b. 1918,
daughter, killed on arrival
Auschwitz
Vittorina B., b. 1892,
mother, killed on arrival
Gino S., b. 1878,
father, killed on arrival
"Swiss border"
Tirano
Sondrio
Como
Milan
Bormio
Verona
Fossoli
Genoa
Adriatic Sea
0 50 100 150 200
Kilometers

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