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Towards a Relational Model of the Holocaust Geolocalized Approaches to Perpetration, Complicity, and Knowledge

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Research Article

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Towards a Relational Model of the Holocaust

Geolocalized Approaches to Perpetration, Complicity, and Knowledge

Abstract

This article proposes Historical Network Analysis (HNA) as a methodological framework for Holocaust research that complements narrative historiography and testimony by reconstructing the spatial, institutional, and relational contexts through which persecution, complicity, and – most imprtantly – historical knowledge were produced. While personal testimonies remain indispensable for understanding individual experiences, they are less suited to revealing the broader structures that connected perpetrators, victims, bystanders, institutions, and places across time and space. HNA addresses this gap by integrating heterogeneous archival sources into a common relational model that makes these historical connections analytically accessible.

Drawing on transport records, administrative documents, survivor testimonies, and other archival materials, the article outlines how geolocalized historical networks can reconstruct deportation routes, forced labour systems, prisoner transfers, and other interconnected processes that shaped the implementation of genocide. Beyond modelling movements and institutional relationships, the proposed framework also reconstructs knowledge contexts by relating testimonies to contemporary documents, publications, and spatial environments. Rather than determining what particular individuals knew, these models establish the historical contexts within which knowledge circulated, providing an empirical basis for analysing civilian exposure, complicity, and post-war narratives of ignorance.

The article further argues that spatial modelling and interactive visualisation are not merely tools of representation but analytical instruments that reveal patterns of proximity, coordination, and visibility that remain difficult to identify through conventional source analysis. Such approaches do not replace established historical methods but extend them by connecting fragmented archival evidence into coherent relational structures while preserving uncertainty and source criticism.

Finally, the article discusses methodological and ethical challenges arising from large-scale historical modelling, including incomplete data, artificial intelligence, and the responsible handling of personal information. It argues that Historical Network Analysis expands the methodological repertoire of Holocaust studies by providing new ways of analysing the relational structures

through which persecution, complicity, historical knowledge, and remembrance can be investigated.

Keywords: Holocaust studies; digital history; historical network analysis; geospatial modelling; entity-relationship modelling; complicity; memory studies.

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1 Introduction

One of the enduring challenges of Holocaust historiography is reconstructing the historical knowledge contexts within which persecution, complicity, and bystanderhood unfolded. While historians have reconstructed the history of the Holocaust with remarkable precision, it remains considerably more difficult to understand the environments within which ordinary people observed, interpreted, ignored, or participated in persecution. This article proposes Historical Network Analysis (HNA) as one methodological response to this problem. By integrating fragmented archival evidence into geolocalized historical networks, HNA reconstructs the spatial, institutional, and relational contexts through which persecution was organised and experienced. Rather than replacing narrative historiography or survivor testimony, it complements them by making relationships between people, places, institutions, and events analytically accessible.

A persistent tension in Holocaust research concerns the relationship between individual testimony and the broader historical record. Post-war narratives frequently contain recurring claims of ignorance, retrospective surprise, or limited awareness of the persecution of Europe's Jews. While personal testimonies remain indispensable for understanding individual experiences, they are less suited to reconstructing the wider environments within which information circulated. Because testimonies are themselves embedded in changing cultures of remembrance, they cannot be treated as transparent records of historical knowledge. Instead, they simultaneously document

past experiences and the subsequent social processes through which those experiences were remembered, interpreted, and, at times, selectively forgotten. By connecting transport records, administrative documents, contemporary publications, survivor testimonies, and other archival sources, Historical Network Analysis provides a framework for modelling the events and the corresponding historical knowledge contexts. Such reconstructions cannot determine what particular individuals knew. They can, however, establish the historical conditions under which knowledge was more or less likely to circulate, thereby providing an empirical framework for analysing civilian exposure, complicity, and post-war narratives of ignorance.

The principal innovation proposed here is therefore not merely the reconstruction of historical events but the reconstruction of historical knowledge contexts. Spatial modelling and geolocalized visualisation are important components of this framework because they transform dispersed archival evidence into relational historical models that make patterns of proximity, movement, visibility, and institutional coordination analytically accessible. Rather than serving simply as visual representations, these models function as research instruments that reveal historical structures which remain difficult to reconstruct through conventional source analysis alone. In this sense, Historical Network Analysis extends the methodological repertoire of Holocaust studies by complementing narrative interpretation with relational forms of historical analysis.

The need for such a framework became apparent during my research on the *Westerborkfilm*. Only towards the end of several years of investigating the film's production, circulation, and subsequent memory did I notice, while exploring the interactive visualisation of Yad Vashem's Deportations Project “Transports to Extinction”, that the deportation train depicted in the film's most iconic sequence – carrying, among others, Settela Steinbach – passed along the railway line less than a kilometre from my office in Berlin Prenzlauer Berg. The transport itinerary had always been documented; what was new was the ability to perceive its spatial relationship to my own surroundings. This moment of recognition immediately raised broader historical questions. How many deportation trains passed through this neighbourhood? How frequently were local residents exposed to these transports? Which districts of Berlin witnessed them regularly, and which remained comparatively unaffected? Although the underlying transport records, railway itineraries, and geographical data exist, answering such questions still requires laboriously connecting information dispersed across separate archival collections. Historical Network Analysis seeks to address precisely this problem by linking fragmented evidence within a common relational framework, allowing historical processes and knowledge contexts to be explored as interconnected networks rather than isolated records.



Figure 10: Route of the deportation train on the 19.5.1944 (the one with Settela, that was filmed by the SS in Westerbork while departing)

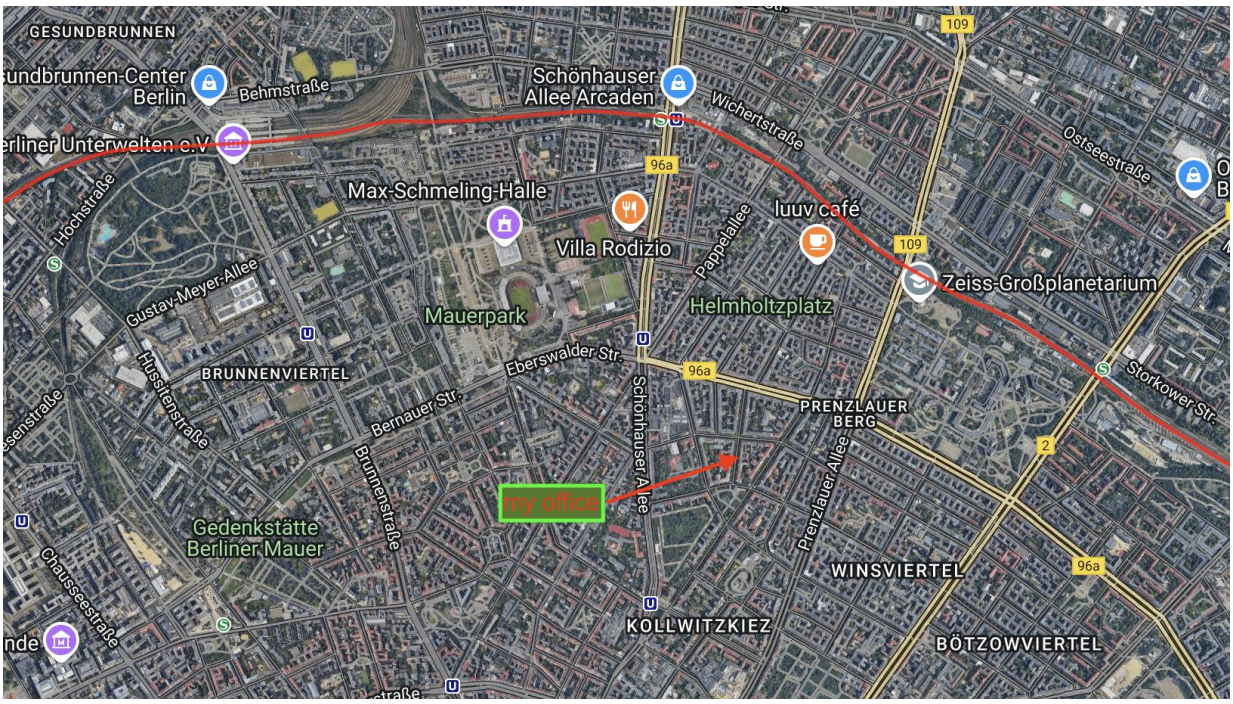


Figure 11: Route through Berlin in relation to my office in Prenzlauer Berg (about 1,1 km walking distance).

Unlike existing historical network studies, which primarily reconstruct social relations, the framework proposed here integrates spatial, institutional, and temporal relationships in order to analyse perpetration, complicity, and historical knowledge. The following pages outline its

theoretical foundations, discuss its methodological possibilities and limitations, and explore how geolocalized historical networks may contribute to future research, public history, and Holocaust remembrance.

2 The Holocaust Seen as a Historical Network

Holocaust remembrance has long been shaped by a tension between reconstructing the historical reality of genocide and negotiating post-war narratives of innocence. This tension is reflected in enduring claims of ignorance, popular conceptions of bystanderhood, and testimonial forms that often present Holocaust knowledge as something revealed only retrospectively.[1] While testimony remains indispensable for understanding individual experiences, it is less suited to reconstructing the broader relational structures through which persecution was organised, experienced, and observed. The theoretical premise of this study is that the principal contribution of Historical Network Analysis lies not in accelerating established historical methods or replacing narrative interpretation, but in making these relational structures analytically accessible. By connecting dispersed archival evidence within spatial, social, and institutional networks, HNA provides a framework for analysing perpetration, complicity, and everyday participation as interconnected historical processes. Rather than replacing narrative historiography, it complements it by revealing patterns of coordination, proximity, and interaction that remain difficult to reconstruct through conventional approaches alone.

The US-American non profit association Denshō[2] documents the testimonies of Japanese Americans, mostly from the West coast, who were unjustly incarcerated during World War II before their memories are vanishing. This example appears to be fitting not only because of the partial similarities to the Holocaust: a minority being deported and housed in camps, but equally because the fate of these Japanese Americans is until today mostly unknown to Europeans and was, until the 1980s, a widely repressed memory within the US society. At a first glance, Denshō's person-oriented database and encyclopedia looks like a typical approach of commemorating, not unlike similar efforts in the Holocaust context, such as the Kindertransport Association or other, regional committees commemorating the fate of the Jewry in a certain town or district. But by visualising the itineraries of Japanese American deportees during WW2, Denshō's website Sites of Shame[3] adds a layer to the usual approach of dealing with individual stories, that we are familiar with from remembrance projects such as Stolpersteine[4] and that we find in the genre of survivor documentary films, which both approach the Holocaust from a micro history perspective. Historically, this focus on individual fates in Holocaust memory is the outcome of two developments: on the one hand, historiography has long focused on the Holocaust as a mass phenomenon, often solely relying on the bureaucratic records left by the perpetrators, which

[1] See among others: Kansteiner, Wulf. 2018. Hidden in Plain View: Remembering and Forgetting the Bystanders of the Holocaust on (West) German Television, DOI: 10.2307/j.ctvw04hm8.18.
[2] https://densho.org/
[3] https://maps.densho.org/sitesofshame/
[4] https://www.stolpersteine.eu/

fostered a detached and technical perspective – a critique particularly directed at Raul Hilberg's *The Destruction of the European Jews* (1961), the first comprehensive historical account of the Holocaust.[5] With some exceptions, it was not until the 1990s that a significant shift emerged, as Holocaust historians began to incorporate ego documents and explicitly integrate oral history into their research.[6] The second reason is a more general shift towards an empathic Holocaust remembrance that per se favors remembering the persecuted as individuals rather than as amorphous group. While this is a fortunate development for many reasons, it has led to a lacuna in further assessment of the Holocaust as a phenomenon that also exists in form of data. While today almost all fields of society work with and rely on models that visualise e.g. traffic density, frequency and direction, passenger movement, consumer behavior, but also historical contexts such as routes of slave trade, movement of tank armies during WW2, for the Holocaust, none such models exist. The website Sites of Shame, to come back to the initial example, tries to apply such an approach. It visualises the records of ten thousands of survivors (anonymized by only showing their family names) and aggregates the routes of their deportation, the locations they were incarcerated in during WW2 and the places they moved to after the war. This visualisation right away reveals one of the basic trajectories of the deportations: the majority of Japanese American deportees before the war lived in California, mostly in the L.A. area. The camps are situated in the Midwest, so the deportation routes all bundle from various locations around San Francisco and L.A. towards a few camps East of the Rocky Mountains. Intriguingly, after the war, most of the interned do not go back to their original living areas, but the migration arrows point from the former camps to the East coast, mostly to locations in the rust belt and in and around New York. This movement is of course contained in the many single memoirs, but only becomes visible in the data visualisation done by Denshō. This makro-vision on the data, aligned with geo locations and timelines, reveals a historical process that now can be scrutinized. Why didn't the deportees return to their old home areas? Why did they chose Chicago, Detroit and New York? Is this a trend that was obvious to the Japanese Americans as a remembrance community before these itineraries were collected and made acessible? A comparable mapping of the Holocaust would make visible numerous of such patterns of survivor migration within and beyond Europe, many of which remain largely confined to small remembrance communities.

[5] cf. among other critics of Hilberg: Bauer, Yehuda. Holocaust in Historical Perspective. Seattle, WA: University of Washington Press, 1978.

[6] cf. general about ego documents: Benigna von Krusenstjern (1994) and typical for the shift to micro history in Holocaust studies can be seen in Friedländer, S. (1997). Nazi Germany and the Jews: Vol. 1. The years of persecution, 1933–1939. HarperCollins.

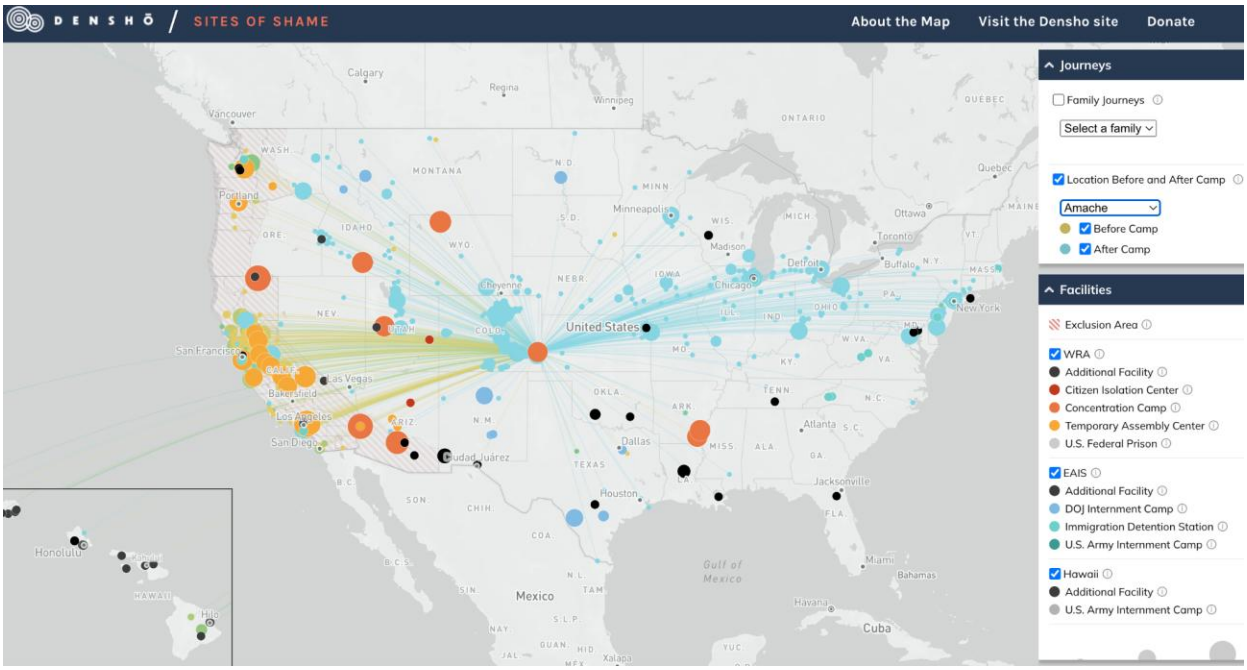


Figure 1: *Deportations routes of Japanese Americans during WW2 (Densho: https://maps.densho.org/sitesofshame/)*

A second example of spatially modelling data of a violent past are slave trade routes during the 18th century.

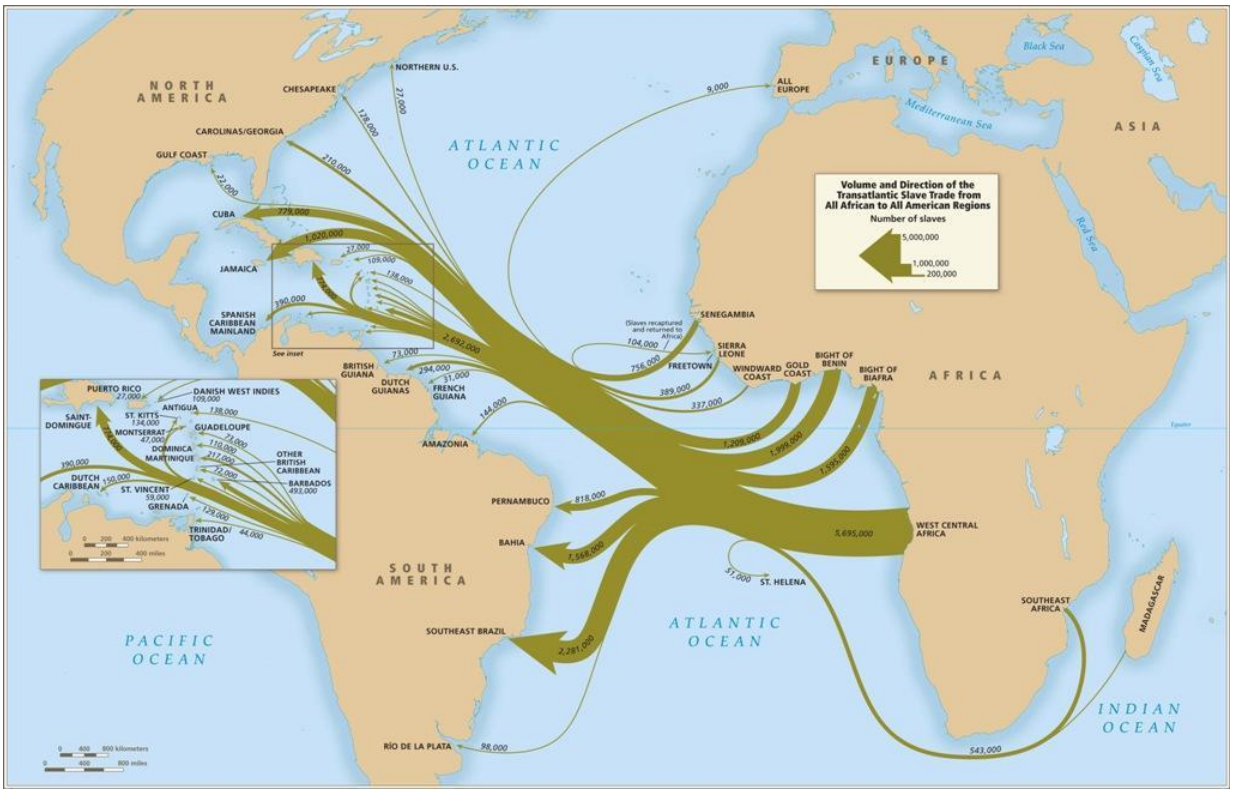


Figure 2: *Slave trade routes. Screenshot from* https://www.slavevoyages.org/blog/volume-and-direction-trans-atlantic-slave-trade

At first glance, the map of the transatlantic slave trade challenges common knowledge. Many of us imagine the slave trade primarily as the deportation of enslaved individuals from the West African coast to Caribbean colonies or, more prominently, to the cotton plantations of South Carolina, Virginia, and Georgia. However, for every second of those forcibly transported, the journey led to South America.

If we reverse this perspective and ask what kinds of historical networks could be reconstructed from existing scholarship, it becomes apparent how such models might reveal dynamics that remain largely absent from collective remembrance. The transatlantic slave trade, for example, was not limited to the transportation of enslaved people from Africa to plantations in the Americas. A substantial internal trade also existed, with enslaved individuals repeatedly transferred between plantations and colonies. As described in *The Many-Headed Hydra*,[7] those involved in uprisings were often relocated in order to suppress resistance. A historical network model could visualise these secondary deportations by linking transfers to specific acts of resistance, thereby revealing patterns that are difficult to recognise through isolated case studies alone.

What this example also illustrates is the importance of spatial modelling. Statistically, these secondary transfers represent only a small fraction of the overall movements within the plantation system. Most enslaved people either died during transport, succumbed shortly after arrival, or were killed within the regime of exploitation. Yet once the entire network of movements is visualised, these apparently marginal trajectories emerge as historically significant irregularities. Rather than merely illustrating known facts, such models generate new historical hypotheses. In this case, they suggest that the repeated transfer of surviving labourers may have formed a structural mechanism through which systems of mass exploitation maintained emotional distance between exploiters and the exploited while simultaneously responding to resistance. Whether such hypotheses withstand historical scrutiny remains a matter for further research, but network modelling provides an empirical framework within which they can first become visible.

Now imagine applying a similar approach to concentration camp inmates in Europe during World War II – a map akin to the slave trade route map (Figure 2), but with the irregularities mentioned above. Such a model could address questions like: Where did inmates come from? How often did they change camps, potentially accumulating knowledge about the camp system? How far were they deported? Where did survivors move after liberation? How frequently did deportation routes intersect with public traffic routes? How many forced labor camps existed near civilian neighborhoods, and how close were they? The data for such a map already exists but is dispersed across dozens of databases, archives, document collections, oral histories, and memoirs – many of which remain undigitized or unanalyzed using tools like Natural Language Processing (NLP) or semantic parsing. These tools are increasingly applied in fields like Narrative Network Theory (NNT) and support methodologies such as Entity Relationship Modeling (ERM) and Historical Network Research (HNR). HNR is already used for Historical Network Analysis (HNA), which breaks down complex events into agents, locations, entities, and their relationships over time.

[7] Linebaugh, Peter, and Marcus Rediker. 2000. The Many-Headed Hydra: Sailors, Slaves, Commoners, and the Hidden History of the Revolutionary Atlantic. Boston: Beacon Press.

Today, most bystander witnesses have passed away, but their knowledge hasn’t disappeared entirely; it exists implicitly within disparate pieces of data that can be connected to it, and thanks to NLP, also individual memoirs can be scrutinized for relevant events. For example: Inmate databases from labor camps provide names and locations; Records from German industries show which companies employed forced laborers (as wages were paid per worker per day); Memoirs or oral histories may describe specific routes taken by workers. By combining these fragments into a network model, we can reconstruct relatively dense networks of forced labor movements. Take another example: train stations at major junctions west of Kassel. Deportation trains often stood idle for hours waiting for priority trains carrying soldiers or war goods to pass. Residents near such stations would have had more exposure to deportations than others living elsewhere. Mapping these clusters of potential knowledge could reveal areas disproportionately exposed to Holocaust events. Such "memory maps" would not only enhance our understanding of bystander memories but also provide new tools for interpreting historical texts more effectively.

The possibilities outlined here should not obscure the ethical dimension of historical modelling. Visualisation is never a neutral act. The perpetrators themselves produced maps, diagrams, transport schedules, and films that visualised persecution as a rational administrative process. The animated diagram in the *Westerborkfilm* (Fig. 3), for example, transformed deportation into an apparently orderly logistical operation while concealing its genocidal purpose. Historical Network Analysis therefore pursues a fundamentally different objective. Its purpose is not to optimise, simplify, or aestheticise historical processes, but to reconnect the fragmented traces of persecution in ways that make their human, spatial, and institutional dimensions historically visible again. The value of such models ultimately lies not in their visual sophistication but in their ability to support critical historical interpretation.

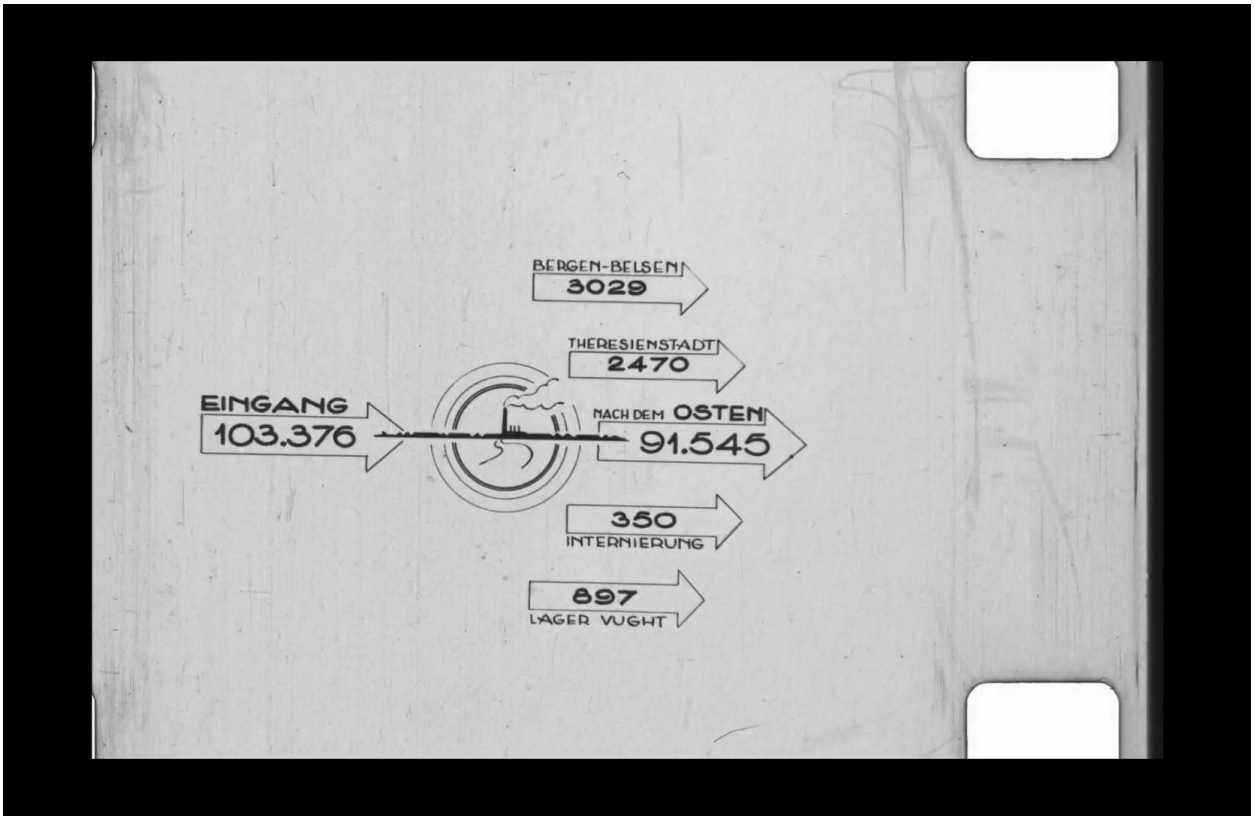


Figure 3 - statistic from the Westerbork film (1944)

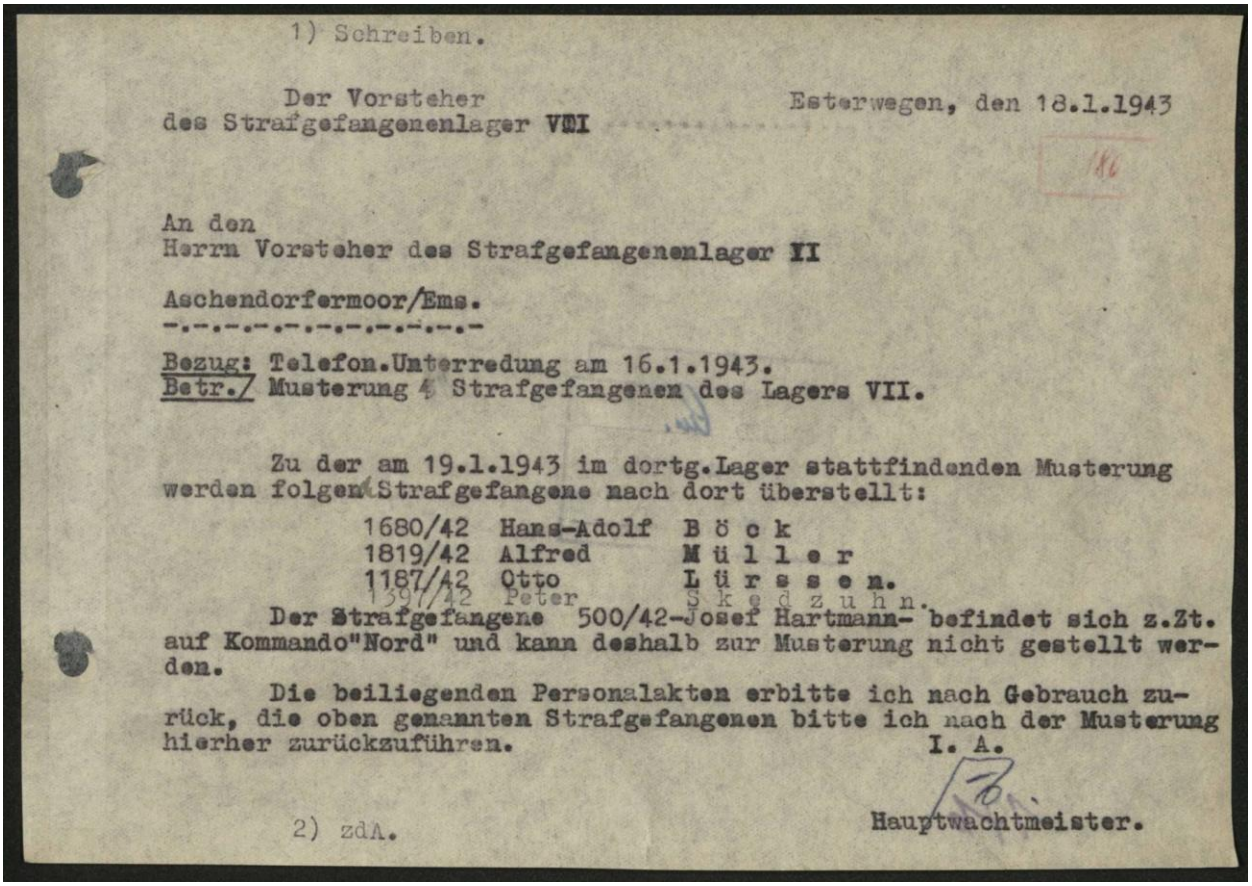
3 Theoretical basis

Entity-Relationship Models (ERM) were first introduced to computer science in 1976 by Peter Chen[8] as a way to structure “interrelated things of interest” in business contexts. These models represented relationships between entities at a given moment but lacked a historical dimension. However, the concept of network modeling has much older roots. As early as the 1930s, sociologists such as Jacob Moreno and Helen Jennings[9] developed analog social network models, building on 19th-century research by scholars like Émile Durkheim. By the 1970s, social network analysis had become an established field in sociology, and since the 1990s, historical and political science have also incorporated network theory as a research method. Despite these developments, network modeling has remained primarily associated with business applications, largely due to the core objectives of economic theory, which focus on process optimization. While the ability to visualize entity-relationship models may have enhanced their appeal, visualization was never a central feature of their use in business. Beginning in the 1970s and 1980s, historians increasingly adopted network-based approaches, giving rise to what is now commonly referred to as Historical Network Analysis (HNA). Building on entity-relationship modelling (ERM) and related methods, HNA differs from earlier sociological applications in that its primary strength lies not in generating statistical correlations but in integrating heterogeneous archival sources into coherent relational models. Rather than reducing complexity, it enables historians to connect dispersed references to the same people, places, events, and institutions across multiple collections and to explore these relationships spatially and temporally through digital visualisations.

This potential is particularly relevant to Holocaust research. Holocaust historiography and memory studies seek not only to reconstruct historical events but also to preserve their complexity while acknowledging the traumatic dimensions of persecution. Spatial modelling and network visualisation can support this objective by revealing relationships that remain difficult to perceive through textual sources alone. Yet despite the growing availability of machine-readable archival data, Holocaust studies have only begun to explore the possibilities of relational network models. Many archival records describe the same events, locations, and individuals, but these references remain dispersed across separate collections. Historical Network Analysis provides a framework for reconnecting these fragments. Even a seemingly simple transfer record from the labour camp at Esterwegen (Fig. 4), for example, links multiple individuals, locations, institutions, and related documents, illustrating how apparently isolated records can become nodes within much larger historical networks.

[8] Chen, Peter (March 1976). "The Entity-Relationship Model - Toward a Unified View of Data". ACM Transactions on Database Systems. 1 (1): 9–36.

[9] Cf. Moreno, Jacob L. *Who Shall Survive? A New Approach to the Problem of Human Interrelations*. 1934; Jennings, Helen. Statistics of Social Configurations. In: Sociometry, Vol. 1, No. 3/4 (Jan. - Apr., 1938), pp. 342-374.



1) Schreiben.

Der Vorsteher
des Strafgefangenenlager VII

Esterwegen, den 18.1.1943

An den
Herrn Vorsteher des Strafgefangenenlager II

Aschendorfermoor/Ems.

Bezug: Telefon.Unterredung am 16.1.1943.
Betr./ Musterung 4 Strafgefangenen des Lagers VII.

Zu der am 19.1.1943 im dortg.Lager stattfindenden Musterung werden folgen Strafgefangene nach dort überstellt:

1680/42 Hans-Adolf B ö c k
1819/42 Alfred M ü l l e r
1187/42 Otto L ü r s s e n.
1397/42 Peter S k e d z u h n.

Der Strafgefangene 500/42-Josef Hartmann- befindet sich z.Zt. auf Kommando"Nord" und kann deshalb zur Musterung nicht gestellt werden.

Die beiliegenden Personalakten erbitte ich nach Gebrauch zurück, die oben genannten Strafgefangenen bitte ich nach der Musterung hierher zurückzuführen.

I. A.

Hauptwachtmeister.

2) zdA.

Figure 4: Record about the physical examination of prisoners in Esterwegen

Mapping these relationships reveals five events that are not explicitly stated – such as prisoner transfers, phone calls, and administrative processes – which, when analyzed together, offer deeper insights into historical realities.

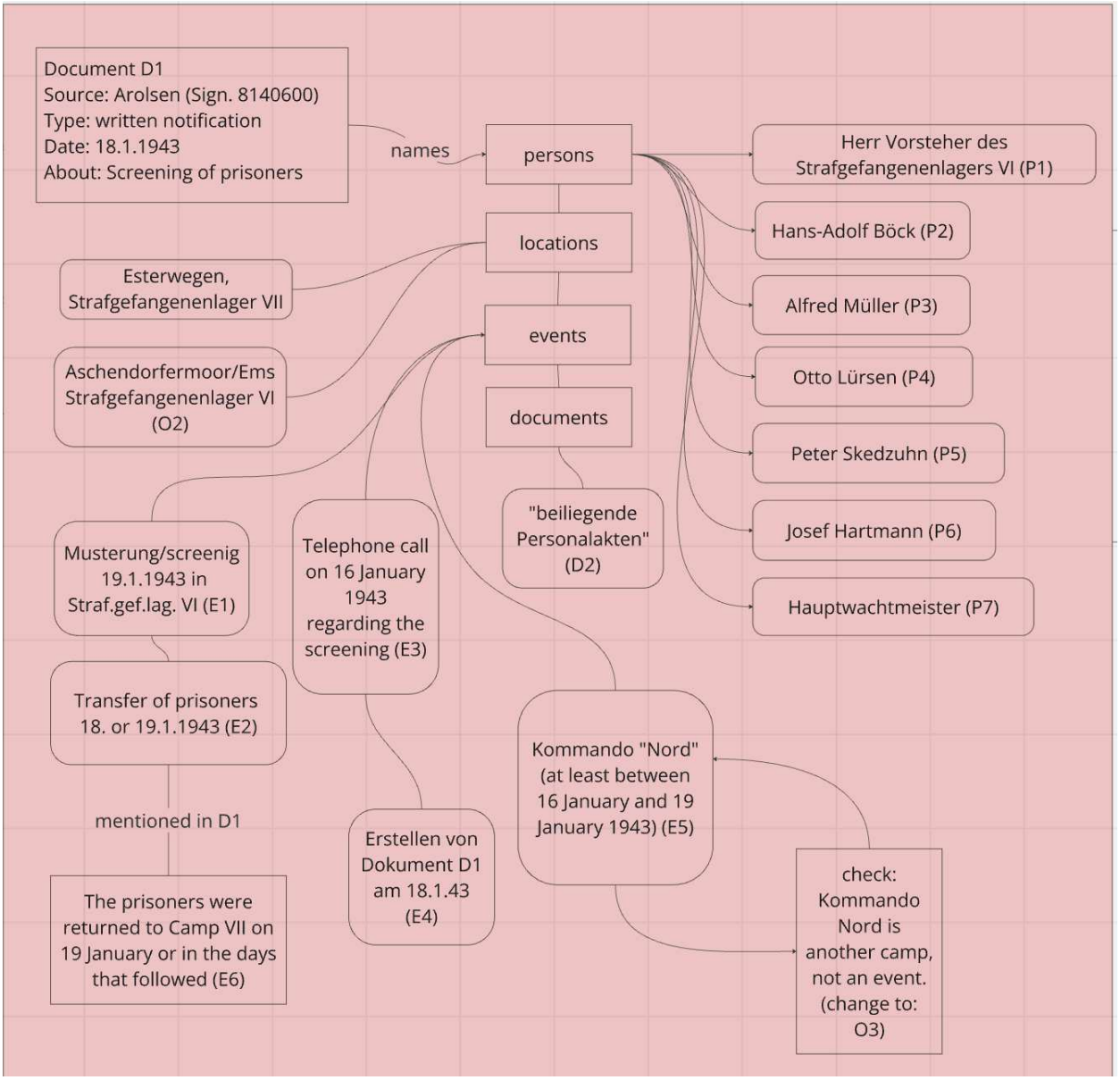


Figure 5: NLP-extraction of information for a network model

One of the most significant contributions of such modeling is its ability to reconstruct historical processes that were either deliberately obfuscated due to their incriminating nature or left undocumented because they were considered routine. Consider the frequent transfers of prisoners between camps – while rarely recorded in detail, they may have left an impression on local civilians. A network-based approach can help assess the extent to which these movements were visible, thereby shedding light on patterns of bystander awareness and complicity. The model would integrate both administrative and personal sources. Alongside deportation records and documents such as the transfer record shown in Figure 4, it could incorporate diaries, letters, and survivor testimonies whenever they contain sufficiently precise dates, locations, or identifiable relationships to be represented within the network.

With a clearer understanding of the goals for the envisioned network model, the question of methodological implementation comes into focus. Three fundamental challenges emerge: first, identifying the specific contexts to be examined or modeled; second, determining which sources or datasets are suitable for network modeling – both in general and for the chosen subject in particular; third, designing a model that allows to visualise and localise the historical processes in a meaningful way.

4 Methodological approaches

Before we delve deeper into the question of relevant contexts and documents, we will take a look at a very similar, if much smaller project, done in 2022 by Saara Kikko. In *Japanese Americans at Heart Mountain - Networks, Power, and Everyday Life*[10] Kikko maps the relations of roughly 14,000 Japanese Americans who were interned in camp Heart Mountain. Merging 26 different sources, among them statal records but also the camp's newspaper the *Heart Mountain Sentinel,* the study examines the social, political, and economic networks that emerged within the camp, using historical "big data". Kekkis's Historical Network, due to the author the first that was done in this scale (and fortunately applied on a context with many similarities to the deportations and the camp system in Europe) provides detailed information about who was member of which social club or institution, where people originated from and where they moved after the war. Her approach is simple. The existing data is broken down to *nodes* (which are mostly individuals but also can be institutions) and *edges* which are the relations between the nodes. Edges can be qualified by *edge weight* and differentiated into categories by *edge kind*. For example "primary" (i.e., birth family), "adopted," and "marriage"[11] would be typical edge kinds, while friendship or marriage could be further qualified by weights such as "married longer than 20 years" or "schoolfriends", or by a simple taxonomy along duration in years. Finally the *path length* defines, how many nodes have to be passed in order to connect to individuals. A typical result of this mapping is a visualisation of the connections between institutions and clubs in the camp (see figure 6). The research project is employing a Dynamic Network Analysis (DNA) model, exploring "the networks of Japanese American inmates at the Heart Mountain, Wyoming incarceration camp throughout its existence from 1942 to 1945".[12] It therefore not only remodels a status quo but compares the evolution of such networks in time.[13]

[10] Kekki, Saara. *Japanese Americans at Heart Mountain: Networks, Power, and Everyday Life*. Norman: University of Oklahoma Press, 2022.
[11] Kekki 2022, p. 176.
[12] Kekki 2022, p. XVII.
[13] Further interactive network models can be found on the author's website: https://saarakekki.fi/japanese-americans-at-heart-mountain/

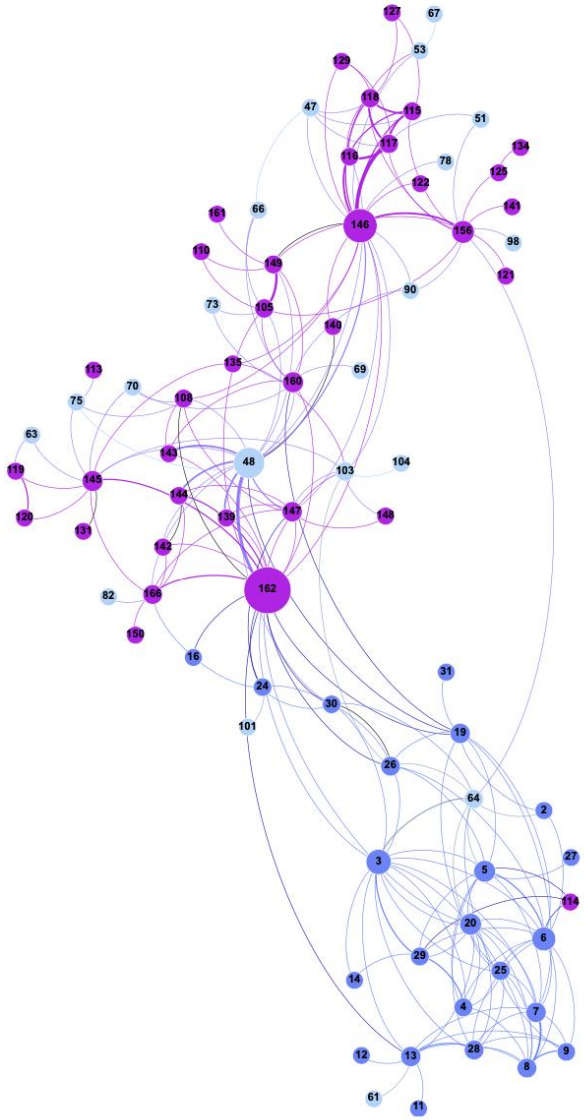


Figure 6: Connections between various institutions at Heart Mountain. A connection appears when two institutions share a member. Source: Kekki 2022.

A way to visualise such a DNA-model is through layered grid charts.

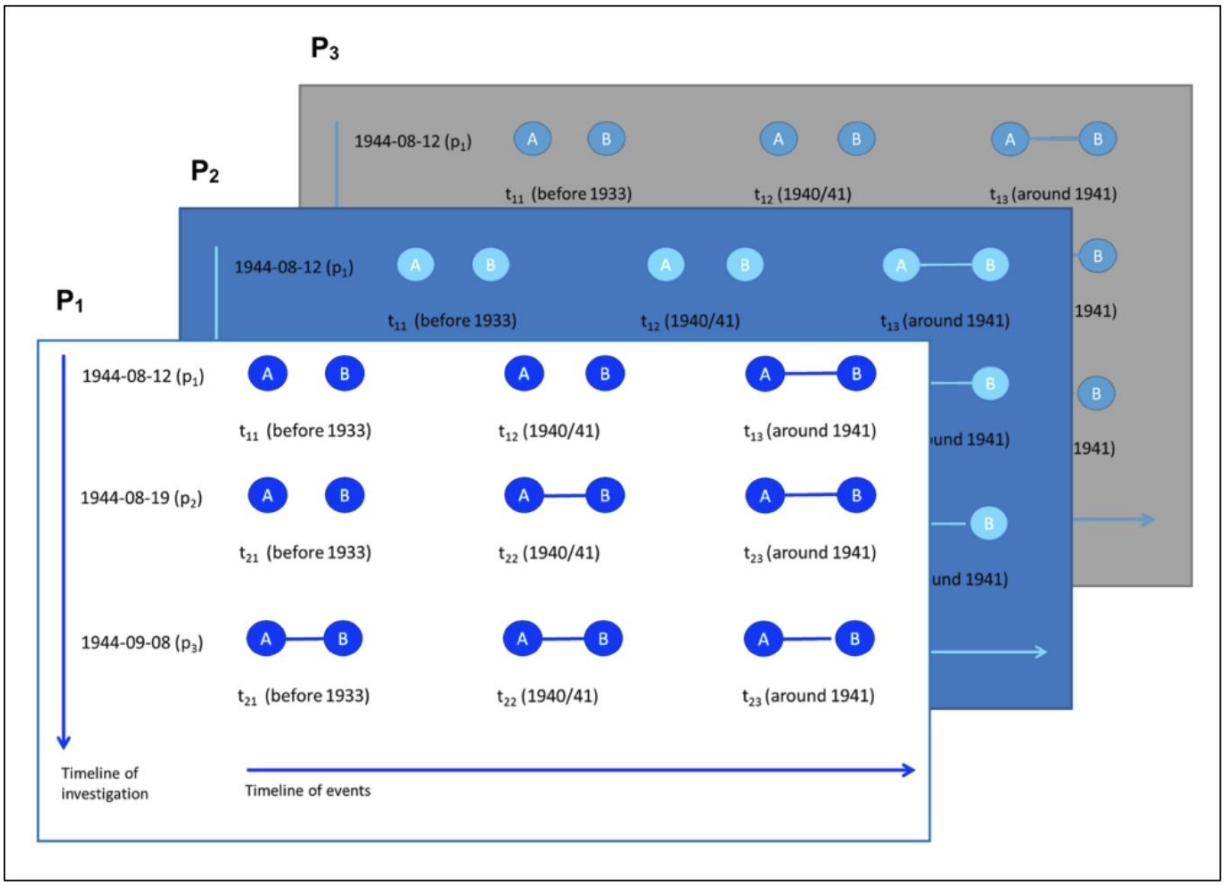


Figure 7: Model of a Layered-Grid-Ghart (Time-Perspective-Matrix).[14]

While such visualizations are highly practical for the HNA of a single camp as in the example of Heart Mountain, a Holocaust HNA intended for educational and memorial contexts requires a less technical, more narrative-driven approach – one that in addition prioritizes geographical spatiality over the purely relational three-dimensional modeling of networks.

One crucial factor influencing the feasibility of the envisioned HNA model for the Holocaust is determining which specific contexts can be effectively modeled and, consequently, which texts/ datasets are applicable. And in contrast to the case of the Japanese Americans, the Holocaust poses some additional obstacles, not just because of the far larger numbers, but also because many of the sources available were created in the context of discourses about guilt emerging soon after the war. This also brings up the question of what should be included or excluded from machine analysis. Some texts are inherently difficult to integrate into a network model and would be automatically omitted, while others may have the right format and structure but remain unsuitable due to their content – for instance, if they propagate misinformation or deliberate deception. The selection of sources is therefore determined less by their narrative value than by

[14] Cf. Conroy, Melanie and Kimmo Elo, Malte Rehbein, Linda von Keyserlingk-Rehbein. Visualizing the Evolution of Historical Networks Using Small Multiples in Grid Charts. In: Journal of Historical Network Research 7 (2022) 86–113.

whether they contain sufficiently explicit temporal, spatial, and relational information for network modelling. Sometimes Holocaust-era accounts may be sufficient detailed, but stretch the boundaries of plausibility. For instance, Jan Karski's autobiographical book, that in fact has many very detailed memories and would be a valuable source for such a network analysis, recounts a story he heard about Jews being crammed into cattle trains murdered with "quicklime and chlorine",[15] left for two weeks until the bodies were not only lifeless but partially decayed. Another story, widely circulated from 1943 onward, describes a metal conveyor belt allegedly used both for transporting Jews to cremation and for electrocuting them en route.[16] Both of these accounts are likely fabrications – there is no evidence that such methods were ever part of a systematic killing routine, nor do they seem to be isolated cases of specific atrocities. That said, the presence of dubious accounts does not mean that all extraordinary survival stories are false. Some seemingly improbable events – such as individuals surviving mass shootings by crawling out of mass graves or jumping off stakes at execution sites – have been verified. One of the key differences is that these accounts are typically anchored to a specific time and place, making them more believable and more suitable for integration into a network model. Verifiable events, rather than generalized or implausible rumors, would form the basis of a meaningful Holocaust network model. However, this requires a sensitive Natural Language Processing that is aware of the typical forms of deceit and denial in this context.

Beyond the question of source selection, 3D modeling plays a crucial methodological role, particularly in Holocaust research. A notable example of spatial network modeling in Holocaust studies comes from the MEMORIZE[17] project, which transforms two-dimensional prisoner drawings into three-dimensional reconstructions. By translating details such as the relative size of individuals and occluded architectural elements, these models enable immersive spatial exploration of camp environments.

[15] Karski, Jan. Story of a Secret State. Penguin Classics 2011 (1944), p. 388.
[16] Van der Hal, Isidor. The Pocketknife. The war of a Jewish doctor. Van Gelder Publishers 2014 (1997), ebook.
[17] See https://memorise.sdu.dk/3d-prisoner-paintings/.

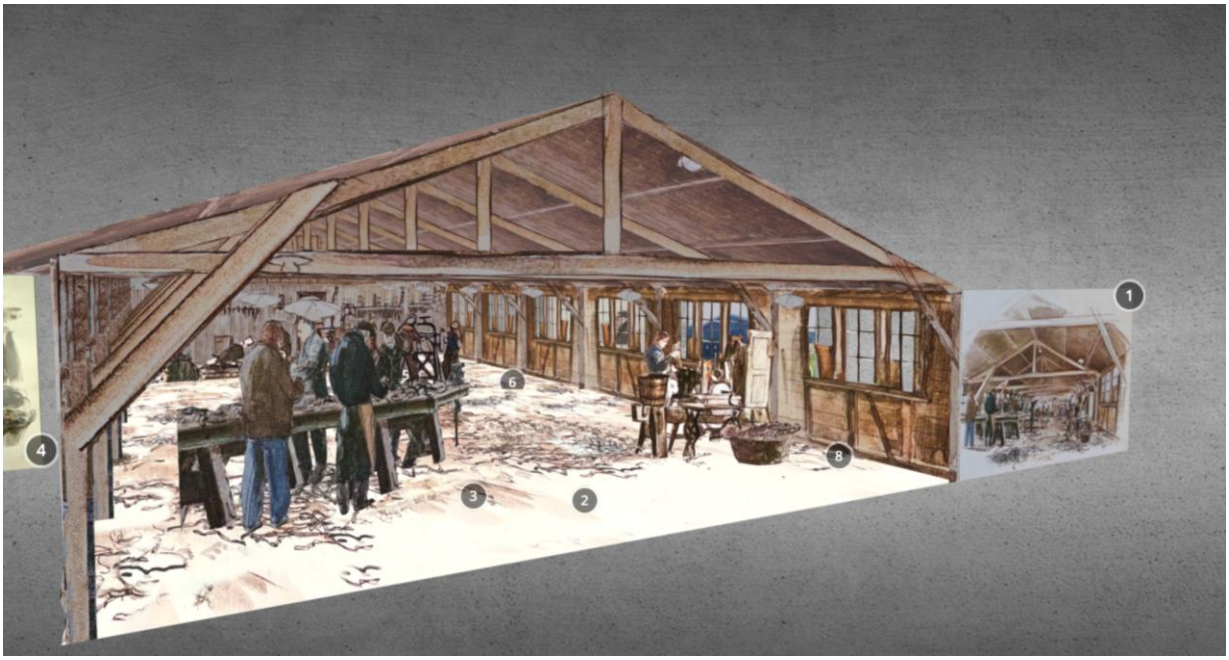


Figure 8: 3D reconstruction of a prisoner's drawing (original sketch on right). Source: MEMORIZE Project https://memorise.sdu.dk/3d-prisoner-paintings/

This approach makes spatial relationships tangible in ways static drawings cannot. While viewers cannot physically "enter" a drawing, the extrapolation of scale and implied structures (e.g., barracks, guard towers) clarifies spatial hierarchies that might otherwise remain abstract. However, most 3D Holocaust visualizations today favor internet accessibility over new insights – for instance, virtual tours like MEMORIZE's Bernburg Euthanasia Centre[18] or Dachau's virtual tour[19] prioritize emotional resonance through historical juxtaposition rather than analytical depth. The HORIZON application,[20] developed by SPUR.lab at the Film University Babelsberg KONRAD WOLF, uses augmented reality to connect historical sites with the documented trajectories of individual victims across deportations, camp transfers, forced labour assignments, and death marches. While primarily designed for education and public history, it demonstrates the interpretative potential of georeferenced historical networks by reconstructing persecution through relationships between people, places, and events rather than through isolated historical facts.

Which Holocaust contexts are applicable for network modeling? A primary example is deportation networks. These are straightforward case studies because much of the required data does not need to be extracted from textual sources but already exists in structured forms, such as geolocated deportation routes (e.g., Yad Vashem's transport databases) and extensive records about deportees from transport lists, transit camps, extermination camps, and Red Cross archives. Post-war migration routes present slightly more challenging datasets, but such

[18] Cf. https://memorise.sdu.dk/bernburg-3d-model/.
[19] https://www.kz-gedenkstaette-dachau.de/historischer-ort/virtueller-rundgang/
[20] https://www.spurlab.de/prototypen/horizon.

scenarios remain feasible, particularly when leveraging existing models like Denshō's Sites of Shame or transatlantic slave trade route visualizations.
Beyond reconstructing spatial relationships, Historical Network Analysis can also model knowledge contexts. By relating post-war testimonies to wartime publications, administrative records, and other contemporary sources, it becomes possible to reconstruct what information was circulating within particular social and geographical contexts. Such reconstructions cannot determine what a specific individual knew, but they can provide an empirical basis for evaluating later assertions of ignorance or, conversely, identifying accounts that display a remarkably detailed knowledge of events. These reconstructed knowledge landscapes offer a valuable framework for interpreting diaries, memoirs, and testimonies whose claims otherwise remain difficult to assess.
The vast quantities of documents and data, and the complex nature of events require systematic organization. Key thematic priorities include (but are not exhausted by):

- Deportation Networks: Routes, transit hubs, and camp systems.
- Killing Fields in the East: Spatial analysis of mass execution sites and their logistical connections.
- Occupational Terror: Public executions and violence as tools of Nazi control in occupied territories.
- Slave Labor Itineraries: Movement of forced laborers between camps and industrial sites.
- Civilian Proximity: Settler communities near camps (e.g., Flossenbürg) and their awareness of atrocities.

4.1 Modelling memory

What immediately comes to mind, particularly in relation to the entity network projects mentioned above, is a model that visualizes and defines entities, relationships and historical knowledge within the context of deportations and incarcerations. Such a model could address key questions: Who was deported? When? From where to where and through which territorries? How publicly visible or noticeable were the deporations? At its most basic level, this type of query would reveal general deportation routes to and from labor and extermination camps. However, it would also provide an overview of areas where bystanders and victims were likely to intersect – such as train stations where deportation trains passed through or halted regularly – and areas that remained untouched by such actions. By analyzing the frequency and extent of exposure over time, such a model would generate a map indicating the likelihood of public awareness about genocidal proceedings. Expanding the focus beyond deportations to include public executions – such as the one filmed in Liepāja by Reinhard Wiener – could offer further insights into the proximity of these events to civilian life. Instead of relations like membership, *edges* (relations) between events and individuals could be weighed along taxonomies of visibility (the higher the weight, the better the visibility). Alternatively *edge kinds* could be defined along categories such as "public", "semi-public" – in the yard of a prison for example or in the cellar of a public building, you can hear things but not see them, a setting not unusual for local concentration camps and torture

rooms, also applies for the Aktion 1005 actions whose stakes made a lot of smoke and stench, though most of the action was hidden by high fences –, “secret” for entirely hidden atrocities. Such qualifications could serve as the foundation for models estimating, for example, what types of conversations might have been typical in a local pub during that time. For the Holocaust, as a repressed and often selectively remembered reality, such a "memory map" would be a powerful tool for examining bystander memories. It would enable researchers to assess the extent to which perpetrators and bystanders distorted or bent their recollections to align with personal narratives or societal expectations. The data processed in the envisioned model ultimately represents individual fates. Integrating this information into a digital history model does not diminish the necessity of acknowledging and reflecting on these human experiences. While some of the processes enabled by this approach involve statistical operations that focus on overarching patterns rather than individual stories, this does not mean that personal suffering is overlooked. On the contrary, by aggregating and interconnecting vast amounts of data on individual fates, the model not only preserves their memory but also makes their experiences visible in new ways. Crucially, this approach highlights the spatial dimensions of the Holocaust, offering a perspective that goes beyond numbers and tables to create a more tangible historical understanding. By visualizing events within their spatial and temporal contexts and structuring them according to a taxonomy of visibility, the model allows users to, for example, critically engage with the realities of the Holocaust in their home regions. This method enables spectators to consider how they might have perceived these events as bystanders. Rather than focusing solely on individual trajectories, the envisioned Historical Network Analysis (HNA) model will integrate these narratives into a multi-layered, dynamic representation of unfolding events – providing a more comprehensive and nuanced understanding of history and therefore adding also a layer of remembrance and commemoration.[21]

[21] For a more outlined basic model, see Appendix A.

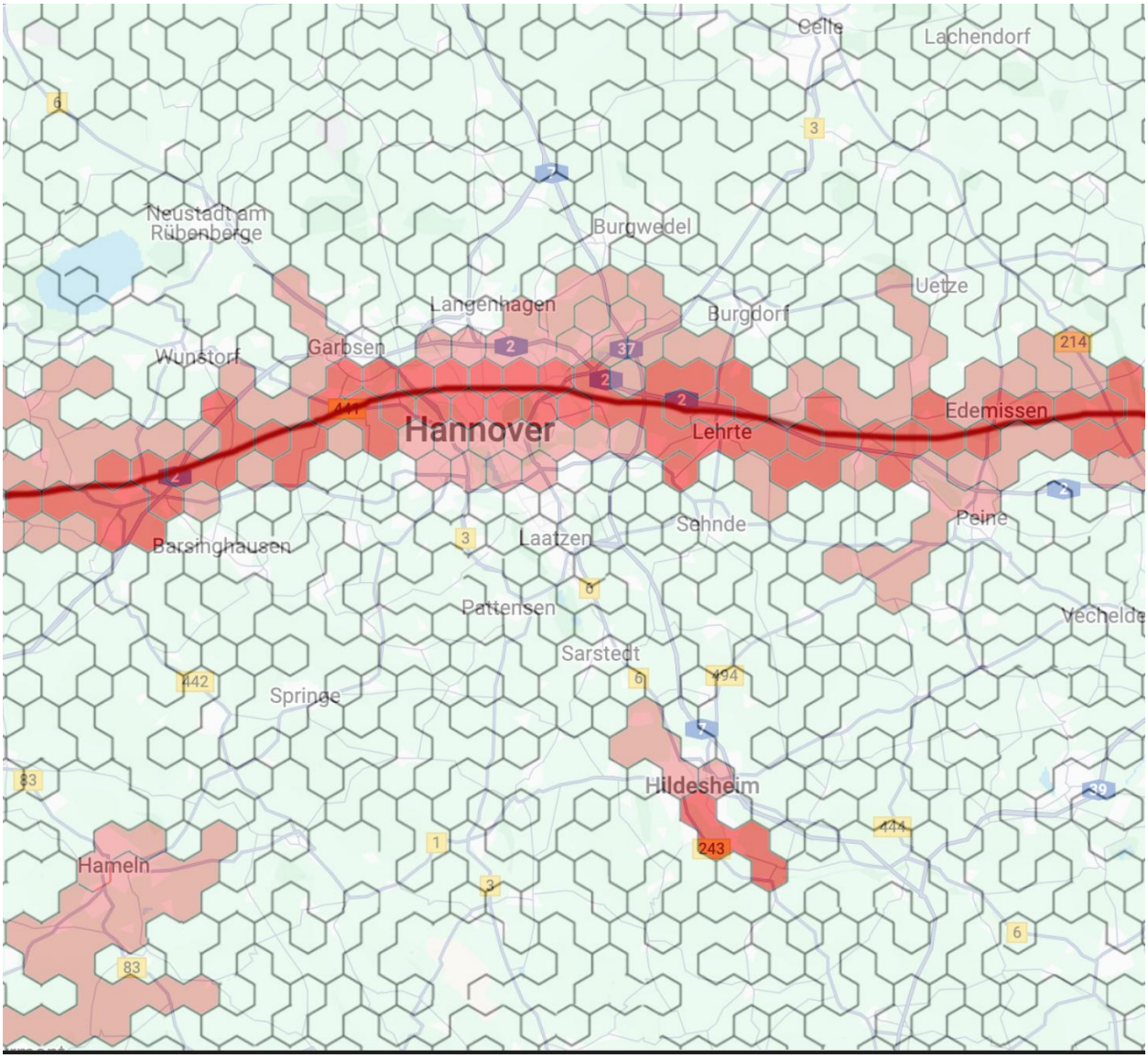


Figure 9: Deportation train route through Hanover with an overlay of population density tiles. The red tiles along the railway indicate areas where civilian encounters with deportation trains were more likely.

5 Ethical implications

Beyond the question of what we aim to discover, analyze, and visualize lies the issue of what we are permitted to process. Even within legal boundaries, ethical considerations often impose additional restrictions – many of which remain undefined as of yet. This is particularly challenging in Holocaust research, where ethical norms that apply elsewhere are frequently suspended, such as the general agreement not to display images of corpses. Furthermore, even within legally permissible and ethically justifiable frameworks, there remains a heightened sensitivity regarding the exposure of data, particularly concerning the involvement of relatives. Because European

data protection law applies only to living persons, the use of historical records relating to Holocaust victims is generally governed not by the GDPR (General Data Protection Regulation, in German: Datenschutz-Grundverordnung (DSGVO)) but by archival legislation, personality rights, and ethical considerations.[22] Though the legal framework is not clear, many memory institutions remain reluctant to support on site applications that allow unrestricted access to personal information. However, while reconstructing individual fates may be valuable for commemoration, the envisioned historical network analysis does not require the disclosure of names. Anonymization and pseudonymization are not only feasible but advisable methods for handling this data. Although disambiguation may require cross-referencing names to merge or differentiate records, this does not mean that names must always be visible. As shown in the data model (Figure 5), each individual is represented by a unique identifier (similar to a Q-ID in Wikidata), effectively functioning as a pseudonym. Any platform utilizing the network model could reveal names when necessary, but always in a controlled manner that respects personal dignity and allows for intervention by relatives. A second challenge is the lack of curation inherent in the process. The machine-generated network of relationships is too complex to be fully verified by humans. While an AI-driven filtering system will be in place to detect and remove predictable nonsensical outputs, unforeseen errors may still occur. These could confuse users or even lead to misleading, counterfactual, or problematic interpretations of historical records. This can be mitigated to some extent by adopting a more nuanced and carefully worded presentation of the results. Nonetheless, these considerations make it advisable to establish an ethical advisory board, comprising not only academics but also representatives from memorials, remembrance institutions, and survivor communities.

Many of the databases already exist in machine-readable form. However, their potential remains untapped as long as they remain unconnected and inaccessible as a unified resource. Additionally, while individual searches in state records are often legally permitted, large-scale data processing in my opinion requires stricter privacy measures than the legal boundaries suggest. Furthermore, such a data aggregation effort requires a dedicated responsible entity to oversee its management and hosting. It should remain accessible to both the public and academic researchers and be hosted by an educational institution to ensure its integrity and long-term availability.

6 Future Applications

The framework proposed here also opens possibilities beyond historical research. Interactive environments such as the serious game *The Darkest Files* (Paintbucket Games, 2026) demonstrate how relational reconstruction can support critical engagement with historical testimony by confronting users with conflicting evidence rather than predetermined narratives.

[22] Due to German federal law, if records contain personal information, they may generally be used only 10 years after the person's death; if the date of death cannot be established, access is permitted 100 years after the person's birth; if even the birth date cannot be determined, the protection period ends 60 years after the creation of the records (https://www.gesetze-im-internet.de/barchg_2017/__11.html?utm_source=chatgpt.com)

Likewise, advances in large language models suggest new possibilities for querying historical network models through natural language. AI systems could function as interfaces to structured historical datasets, allowing researchers and the public to formulate complex historical questions – for example concerning deportation routes, civilian exposure, or institutional relationships – that remain difficult to answer using existing archival databases. Such applications remain dependent upon carefully curated historical data and transparent source attribution, but they illustrate the broader interpretative potential of Historical Network Analysis beyond traditional archival research. Already today, such narration is possible, though it rests on a very limited dataset and only works for locations, where extensive research has been done already. When asked what one might encounter upon entering a pub in Liepāja in 1941, ChatGPT responded:

> *If you were to enter a bar in Liepāja in July 1941, you would likely find an atmosphere tense with both fear and opportunism. The city had just fallen to the German Wehrmacht in late June, following the Soviet retreat, and the new occupation was rapidly transforming daily life. Conversations would likely revolve around uncertainty about the future, the swift and violent change in power, and the harsh reprisals against perceived Soviet collaborators. Some locals, particularly those who had suffered under the prior year of Soviet rule, might express relief or even approval of the Germans, believing that their presence would restore order or protect Latvian interests. Others, however, would be more guarded, aware of the brutal reprisals already unfolding, particularly against Jews and suspected communists. By July, the first mass executions of Jews had already begun, carried out by Einsatzgruppen units and local collaborators, though these events may have been spoken about in hushed tones or euphemisms rather than open discussion. There would also be speculation about which families or individuals might be targeted next, and concern about forced conscription or requisitions affecting the local population. German soldiers and local auxiliary forces might be present, drinking alongside Latvian nationalists and those who saw the occupation as a chance to settle old scores. Amidst the uncertainty, there would still be those attempting to maintain a sense of normalcy, discussing trade, shortages, and how to navigate the new reality of occupation.*

An example from a visit to a bar in Flossenbürg, Bavaria provided by the AI-bot Perplexity sounds like this:

> *In 1944, visiting a Wirtshaus (tavern or inn) in Flossenbürg, a small Bavarian town notorious for its nearby concentration camp, would have been a complex and potentially unsettling experience. The atmosphere would likely have been tense, with a mix of local civilians, off-duty SS personnel, and possibly some trusted prisoner-workers from the camp's external work details. Conversations might have been guarded, with patrons careful about what they said and to whom. The proximity of the concentration camp would have been an unspoken presence, affecting the mood and interactions. Local residents might have displayed a range of attitudes, from willful ignorance to quiet unease about the camp's existence. The menu would have been limited due to wartime rationing, with ersatz products common. Despite the outward appearance of normalcy, the underlying current of fear, complicity, and moral compromise would have been palpable, reflecting the broader ethical challenges faced by German society under Nazi rule.*

A broader HNA model for the Holocaust would make similarly detailed descriptions possible for any part of the former German Reich and the occupied territories.

7 Conclusions

Historical Network Analysis does not seek to replace narrative historiography or survivor testimony. Rather, it complements them by reconstructing the spatial, institutional, and relational contexts through which persecution, complicity, and historical knowledge emerged. By integrating fragmented archival sources into geolocalized historical networks, it becomes possible to analyse relationships and historical processes that remain difficult to reconstruct through conventional source analysis alone.

The principal contribution of this approach lies not in visualisation itself, nor simply in accelerating historical research, but in making relational structures analytically accessible. Deportation routes, forced labour systems, administrative networks, and patterns of civilian exposure can be examined as interconnected historical processes rather than isolated events. Beyond reconstructing these structures, Historical Network Analysis also provides a framework for modelling historical knowledge contexts. While it cannot determine what particular individuals knew, it allows historians to reconstruct the environments within which knowledge circulated, thereby offering a new empirical perspective on questions of complicity, bystanderhood, and post-war claims of ignorance.

As the generation of eyewitnesses disappears, Holocaust research increasingly depends on reconstructing the historical contexts within which people acted, observed, and acquired knowledge. Historical Network Analysis is proposed here as one methodological framework for undertaking this task by connecting dispersed archival evidence into relational historical models. Rather than replacing testimony or narrative historiography, it complements them by making visible the interconnected structures through which persecution, complicity, and historical knowledge unfolded.

Appendix A. Conceptual Outline for a Historical Network Analysis of Holocaust Knowledge Contexts

One possible implementation of the Historical Network Analysis (HNA) proposed in this article would be the construction of a geolocalized entity-relationship model capable of reconstructing historical knowledge contexts surrounding the Holocaust. The objective would not be to determine what particular individuals knew, but rather to model the spatial, institutional, and social environments within which knowledge of persecution could emerge, circulate, or be suppressed. Such a model would integrate heterogeneous archival sources into a common analytical framework, allowing fragmented historical evidence to be connected across space and time. The

geographical area under investigation – for example, the territory of the German Reich – could be subdivided into spatial units whose resolution adapts to population density. Densely populated urban centres would be represented with finer spatial units than rural landscapes or sparsely inhabited regions, allowing the model to capture the differing intensity of historical interactions while remaining computationally manageable. These spatial units would function as nodes representing local historical environments rather than individual persons. Additional nodes would represent historical entities such as deportation sites, railway stations, forced labour camps, concentration and extermination camps, execution sites, Jewish homes prior to deportation, factories employing forced labour, administrative institutions, police offices, churches, newspapers, radio stations, marketplaces, and other locations relevant to the circulation of information. Where archival evidence permits, individuals – including perpetrators, victims, witnesses, local officials, or known disseminators of information such as Kurt Gerstein or Rudolf Vrba – could likewise be incorporated as individual nodes within the network.

Relationships between these entities would represent historically meaningful interactions rather than simple geographical proximity. One category would describe the visibility of persecution by connecting historical events to surrounding locations according to factors such as distance, line of sight, duration, sound propagation, repetition, and environmental conditions. Public deportations, executions, forced labour carried out in urban centres, or the passage of deportation trains through populated areas could thus be represented as events of differing degrees of civilian visibility. A second category would model the movement of people, goods, and information by incorporating railway networks, commuting patterns, military leave, administrative travel, refugee movements, and prisoner transports. These mobility networks connected otherwise distant regions and provided opportunities for observations, conversations, and the circulation of rumours. A third category would represent institutional relationships linking administrative offices, police authorities, churches, factories, newspapers, and other organisations involved in implementing, communicating, or concealing persecution.

Such a model would reconstruct historical knowledge contexts. Knowledge would not be represented as a measurable attribute possessed by individuals but as an evolving network of potential information flows generated through eyewitness observations, rumours, family relationships, workplaces, churches, schools, newspapers, foreign radio broadcasts, returning soldiers, escaped prisoners, and other forms of social communication. By connecting these diverse sources within a shared relational framework, it becomes possible to reconstruct the environments within which information about persecution was likely to circulate without reducing historical complexity to binary categories of knowledge or ignorance. If additional archival material becomes available – including transport records, administrative correspondence, newspapers, photographs, survivor testimonies, or local historical documentation – the network could be continuously refined, allowing new evidence to alter existing relationships rather than requiring the reconstruction of an entirely new historical model.

The resulting network would make it possible to investigate questions that have remained difficult to address through narrative historiography alone. Deportation systems, forced labour economies, institutional cooperation, patterns of civilian exposure, and regional differences in historical knowledge could be analysed as interconnected historical processes rather than isolated events. Equally important, such a model would provide an empirical framework for

contextualising post-war narratives of ignorance and bystanderhood by reconstructing the historical environments within which knowledge of persecution was more or less likely to emerge. Rather than replacing traditional historical interpretation or survivor testimony, this form of Historical Network Analysis would complement them by connecting dispersed archival evidence into relational structures that remain open to revision, uncertainty, and critical interpretation.

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