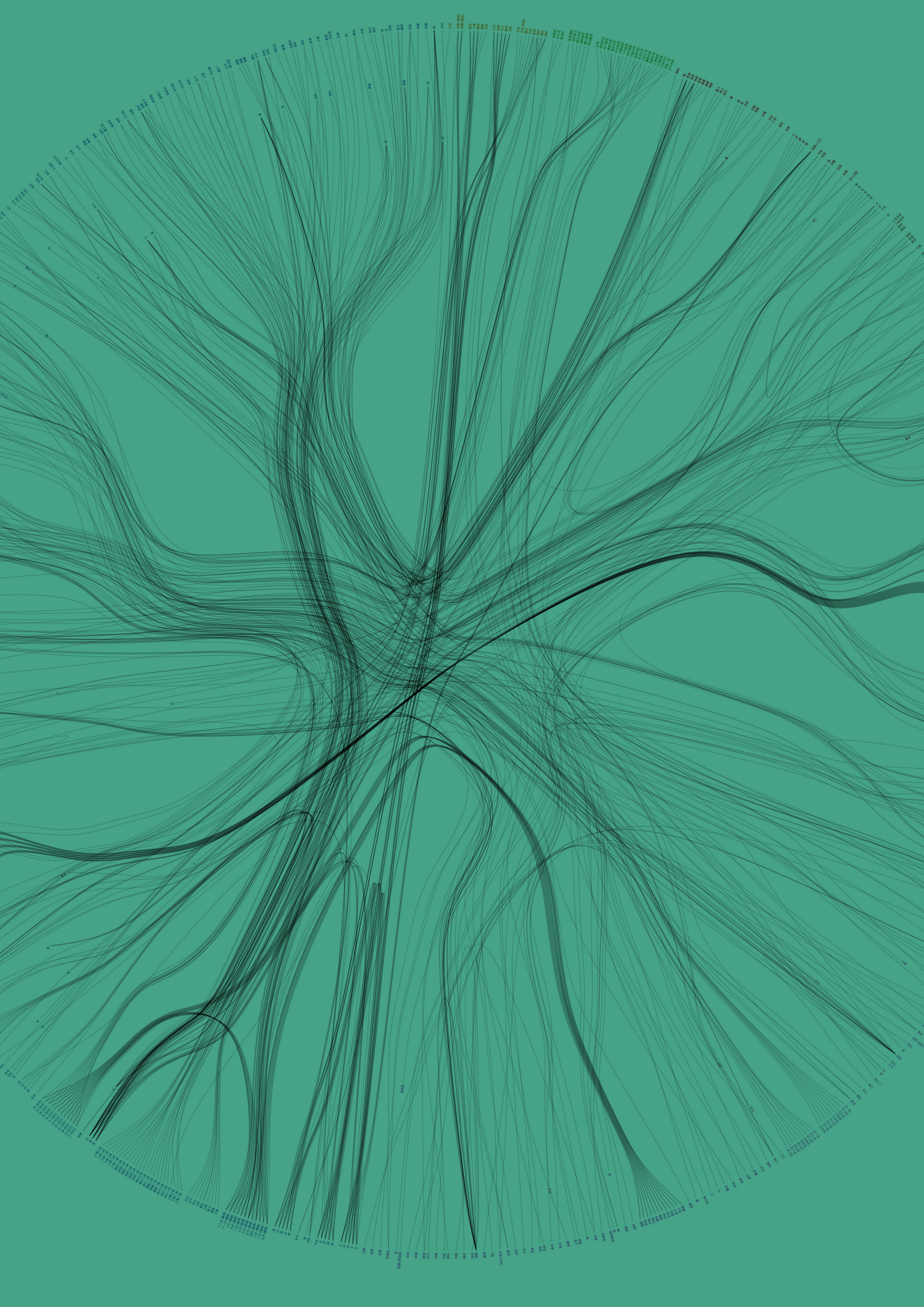

NETWORK ANALYSIS + DIGITAL ART HISTORY. A ROUNDTABLE ON A COLLECTIVE SCHOLARLY EXPERIENCE

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ABSTRACT | In this multi-authored essay, thirteen participants in the 2019-2022 Getty Advanced Workshop on Network Analysis + Digital Art History (NA+DAH) discuss their experiences learning and working together at the intersection of these two fields of inquiry. The piece begins with a preface offering background on the workshop, continues with a series of "project biographies" for the NA+DAH teams participating in this roundtable, and then proceeds to the teams' reflections on a series of probing questions crafted by the participants themselves. The authors reflect on what the NA+DAH Workshop has meant for their scholarship and their community-building efforts, hoping that these insights, acquired over years of productive discussion, can serve as a foundation of knowledge for other scholars who are interested in bringing these areas of study together in their research and teaching.

KEYWORDS | cultural analytics; DAH community; data visualization; interdisciplinary collaboration; network analysis

Introduction

Network science operates on the fundamental assumption that a system is never simply a sequence of discrete, independent parts. It deals with the mathematical properties of complex, interlocking systems and investigates not only the characteristics of a set of objects, people, and/or ideas but also the nature of the relationships that bind them together. In the last decade, network science has grown from a small but cutting-edge subsection of the digital humanities to a central, well-established approach to studying objects and their connections. Model projects in the humanities, such as Six Degrees of Francis Bacon (Carnegie Mellon University) and Mapping the Republic of Letters (Stanford University), have demonstrated the value of this approach as an investigative tool.[1]

Art history itself has long been the study of objects, people, and ideas that demonstrate just this sort of networked, interdependent complexity. Indeed, network analysis has already served as a method for groundbreaking art-historical research by scholars such as Pamela Fletcher, Anne Helmreich, Béatrice Joyeux-Prunel, Matthew Lincoln, and Maximilian Schich.[2] Each has taken their own approach to these methods and to their material, offering numerous pathways into understanding the history of art as a system of interconnections. The goal of the NA+DAH workshop was to build on this foundational work by bringing together a set of projects from across the field of art history (institutionally, intellectually, geographically), and sharing advanced network analytic techniques in order to discuss and implement productive approaches at this juncture of digital method and humanistic inquiry.

The international character of the cohort of projects assembled for the Getty Advanced Workshop on Network Analysis + Digital Art History meant that we had an exceptional opportunity to bring scholars from different perspectives and formations together. We were also able to bring in a wide range of guest speakers, technical experts, and graduate student assistants to assist the projects and enrich discussion, including S.E. Hackney, Pamela Fletcher, Ruth Ahnert, Cosma Shalizi, Charles van den Heuvel, David Newbury, Tina Eliassi-Rad, Kit Messick, Tim Tangherlini, Sarah Reiff Conell, and Meredith North, among others.[3] An environment of experimental exploration and scaffolded support was cultivated so the various teams could lay a

foundation for their projects on which they could build and pursue multiple directions of investigation, without fear of penalties for dead-ends.

What follows are introductions and reflections from three of the NA+DAH project teams, as well as the NA+DAH Leadership Team, on what this workshop has meant for their scholarship—and community-building efforts—at the intersection of network analysis and art history. We hope that these insights, gained from years of productive discussion and community conversation, can serve as a foundation on which others can build, particularly for those scholars interested in bringing these two productive areas of study together in their research and teaching.

Project Biographies

The Getty Advanced Workshop on Network Analysis + Digital Art History brought together scholars of art history and network science within a structured, supportive, and persistent environment to encourage and advance research inquiry at the intersection of these fields.[4] Originally proposed by Alison Langmead, Anne Helmreich, and Scott B. Weingart—all scholars with their own long-standing research engagements in digital art history and/or network analysis—the workshop was supported by a grant from the Getty Foundation (2018) as part of the Digital Art History Initiative, and was originally planned to take place over a single calendar year. We met once in the summer of 2019, but following the uncertainty of the COVID-19 pandemic, the workshop transformed into three years of intellectual community-building online and in-person. The workshop eventually ran as a series of convenings that began in July 2019 and concluded in December 2022.

The Leadership Team designed the workshop around the intersection of network analysis and art history because the time seemed right for a sustained engagement given the state of the respective fields. And, indeed, at the conclusion of the extended workshop, it has become apparent to all participants that many useful findings had emerged. Three NA+DAH project teams, as well as the NA+DAH Leadership Team (see the Project Biographies below), contributed to the following roundtable discussion—having collaboratively composed both prompts and responses. The piece is intended to be a candid reflection on the journey we shared together and what we have learned about the ways that network analysis can be used to advance art historical inquiry. The roundtable format reflects well the ways in which we worked over the life of the project: coming together to share lessons learned and benefiting from the expertise generated across our community. That is, the roundtable allows us to preserve the voices of individual teams while identifying leading issues shared across our undertakings.

Chinese Iconography Thesaurus Project

Traditionally, visual taxonomies have been designed and used to index and access iconographic information about European art. In its typical display, a thesaurus is represented as a tree-structure in which the hierarchical relationship between concepts is foregrounded. As a result, the motifs and subject matters of non-Western art objects have typically been annotated according to these Eurocentric models of classification. The Chinese Iconography Thesaurus (CIT) project aims to fill this gap.[5] Since 2016, we have created an alternative iconographic classification scheme to annotate motifs and subject matters of Chinese art objects in a way that acknowledges the specificity of Chinese visual culture. An early version of the CIT classification was released in 2019 and it is freely accessible and continuously expanded.[6] In conjunction with this release, the CIT team organized a symposium to debate the past, present and future of iconographic archives. Eminent scholars from several centers for iconographic taxonomies presented research papers who included Paul Taylor from the Photographic Collection of the Warburg Institute at the University of London, Pamela Patton from the Index of Medieval Art at Princeton University, and Hans Brandhorst of the ICONCLASS in Netherlands.[7] By joining the NA+DAH Workshop, our team hoped that engaging more directly with network analysis would develop a greater understanding of our thesaurus dataset to point towards directions for its future development and raise further research questions. In the NA+DAH context our question was: to what extent can network analysis help reveal hidden networks of associative relationships among CIT concepts?

With the help of John Ladd, Technical Advisor and member of the NA+DAH Leadership Team, we successfully applied a data visualization technique called "hierarchical edge bundling" to create a chord diagram comprised of over 600 pairs of terms that are symbolically related (see Figure 1). This diagram, which is also available online as a fully interactive visualization, reveals the hidden patterns of symbolic relationships among related terms in the CIT hierarchy.[8] For instance, in Figure 1, nearly half of the related terms belong to the category of "Nature," within which the terms for seasons (i.e. spring, summer, autumn, and winter) have more symbolic relationships than the rest of the terms. The colors represent a top level of seven categories (Nature, etc....), and the wavy lines connect a user to their related terms. When a mouse hovers over a term, the webpage highlights the line(s) that connect related terms in blue. At the end of each line, a text box displays the term.

The CIT project was launched in 2016 with a grant from The UK Department for Digital, Culture, Media and Sport (DCMS) and subsequent sponsorship from the Bei Shan Tang Foundation in Hong Kong. The project is supported by a team of specialists from several departments at the Victoria & Albert Museum

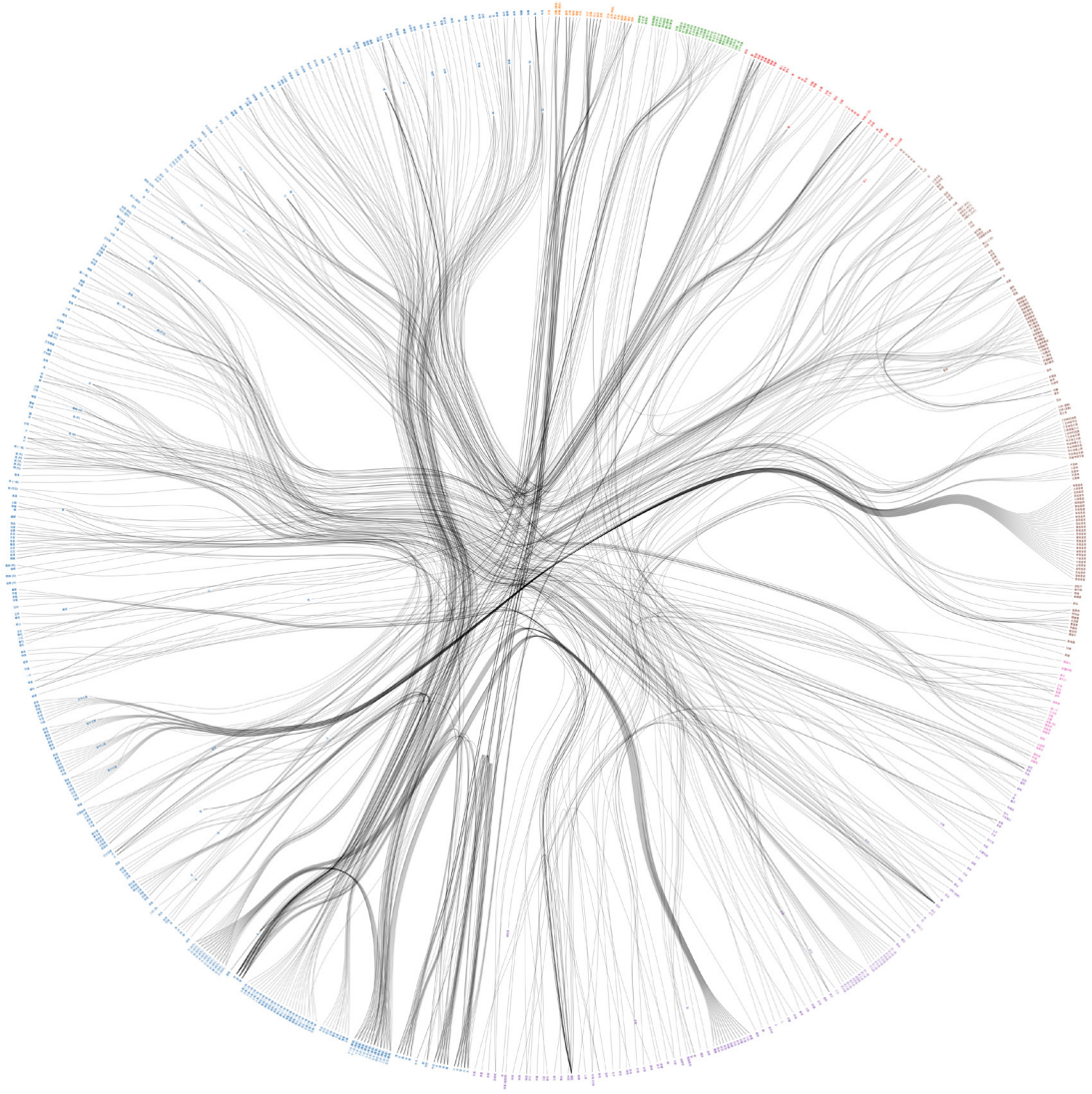

Figure 1. This chord diagram reveals otherwise hidden patterns of symbolic relationships among related terms in the CIT hierarchy. Screenshot taken from the interactive visualization created by John Ladd, and found at https://observablehq.com/@jrladd/cit_hierarchical.
Image Credit: John Ladd and the Chinese Iconography Thesaurus Project.

(V&A) in London, including Collection Management, Digital Media, International Initiative, and Research, as well as by external partners. In creating the CIT network visualization, Hongxing Zhang (V&A) was responsible for the data cleaning and reconciliation of the symbolic relationships between the concepts. Jin Gao (V&A/University College London) was responsible for testing different network approaches and researching the chord diagram as our final product. The NA+DAH technical advisor, John Ladd, assisted in the production of the chord diagram. Our CIT digital specialist, Etienne Posthumus (ICONCLASS), worked to implement the visualization on the CIT website where the chord diagram was to be published. Yi-Hsin Lin and Richard Palmer (both from the V&A) provided feedback that helped direct the team's goal for the workshop.

Networking a National Collection: Freer's Diaries, Objects and Photographs

Our project examines key developments in Charles Lang Freer's collecting activities over a three-year period (1907-1909) through the prism of his diaries, photographs, and acquisition of Islamic and ancient Near Eastern Art. This period is notable as it follows the Smithsonian's acceptance of Freer's gift of his collection to the nation, which opened to the public as the Freer Gallery of Art in 1923 (known today as the National Museum of Asian Art). The period also saw the significant expansion of Freer's collecting of ancient Near Eastern and Islamic art.[9]

Our network research was based on three datasets: the recorded objects and acquisition sources for Freer's collecting from 1893 to 1919 as recorded in the collections database (The Museum System); over 2,000 diary entries for the period 1907-1909 as recorded as spreadsheet data; and additional research used to reconcile, confirm, and add to this body of information. Engaging with network analysis in the context of the NA+DAH Workshop allowed for a renewed focus on the multitude of individuals involved in Freer's social circles, the importance of specific cities, and how layered these networks were. It complements existing scholarship that has focused on Freer's personal biography and those he interacted with by taking a macro-approach. Yet the study is limited by our primary data source that serves as the foundation for all of our datasets: Freer's diaries. Our analysis is based solely on the individuals Freer noted. This excludes his staff, travel companions, and, perhaps, close friends whose relationships are better glimpsed in Freer's correspondence.

With our available data, we have been able to gather information on Freer's travel patterns, the routines he established in each city, the amount of time he spent visiting collections, observing sites, and meeting with key figures or conducting business transactions in more quantifiable ways. In doing so, we have new insights on the construction of the National Museum of Asian Art's collection of Islamic, Egyptian and Ancient Near Eastern art. As a result, project has exposed a wealth of possibilities for further research, most notably expanding the parameters of this project to build and link the networks of other major collectors and museum founders.

At the beginning of the project, team members came together to bring complementary skills and content knowledge. Sana Mirza (Smithsonian Institution) explores long distance circulation of objects through her academic work and works on a variety of digital projects, programs and publications across the museum. Zeynep Simavi's (American Research Institute in Turkey) research focuses on the formation of the field of Islamic art, particularly in the context of museums. Jeffrey Smith (Smithsonian Institution) is the museum's database expert, and actively supports NMAA's provenance research program. He is a key advisor and museum representative on large-scale collaborative projects, particularly online scholarly catalogues and data sharing. Nancy Micklewright (Smithsonian Institution) is an expert on the history of photography in the Islamic world and has worked extensively with travel literature from the 19th and early 20th century Middle East.

As the project has evolved, the team members have served specific, but overlapping, roles. Each has been responsible for stewarding an aspect of the data: Jeff stewarded the object provenance data, Zeynep, the data on Freer's contemporaries, Nancy, the data on photographic material, and Sana, the data on Freer's diaries and letters. Jeff also served as the project's technologist while Zeynep and Nancy focused on the contribution of their content specializations. Sana also served as project manager.

Project Cornelia

Project Cornelia is a multidisciplinary research project developed at the Department of Art History of the University of Leuven (KU Leuven) in close collaboration with the university's Department of Computer Science. Taking its impetus from Howard Becker's Art Worlds (1982), in which he argued that "works of art [...] are not the products of individual makers [...] they are, rather, joint products of all the people who cooperate via an art world's characteristic conventions," the project tries to reconstruct and understand the interplay between artistic (iconographic and stylistic) developments in 17th-century painting and tapestry in Antwerp and Brussels alongside the dynamics and governance of how family, social and professional networks underpin the period's creative communities.[10]

To do this, Project Cornelia is data-driven. It collects a wide array of attribution and relational archival data on the participants in the art worlds of 17th-century Antwerp and

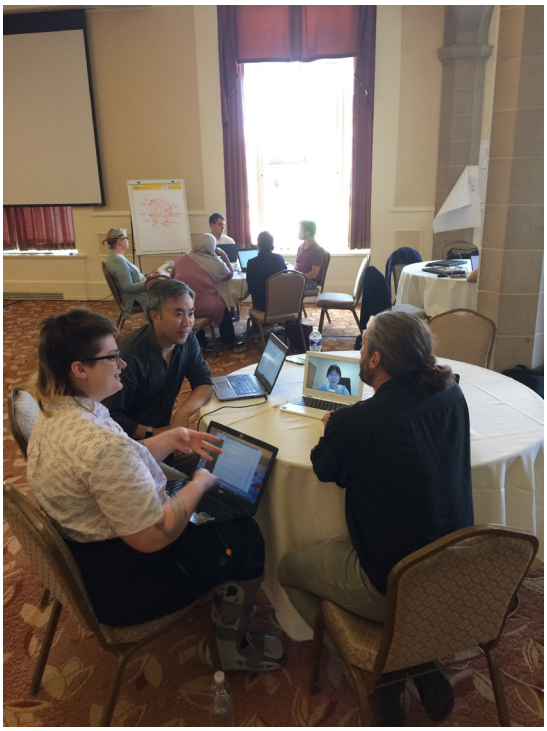

Figure 2. Members of the CIT team, Hongxing Zhang, Étienne Posthumus, and Jin Gao (on the laptop screen), meeting with NA+DAH Project Associate, S. E. Hackney, on July 31, 2019 during consultation time. In the background, the members of the Freer team can be seen meeting with John Ladd to discuss their project's needs. Image Credit: Anne Helmreich.

Figure 3. In the foreground, members of the Freer team, Jeffrey Smith, Nancy Micklewright, Zeynep Simavi and Sana Mirza are working on identifying their project's audiences during a collaborative session on August 1, 2019. Koenraad Brosens and Rudy Jos Beerens of Project Cornelia can be seen working on the same task for their team in the background. Image Credit: Anne Helmreich.

Figure 4. The NA+DAH community gathering on July 30, 2019 to attend a group presentation session. Image Credit: Alison Langmead.

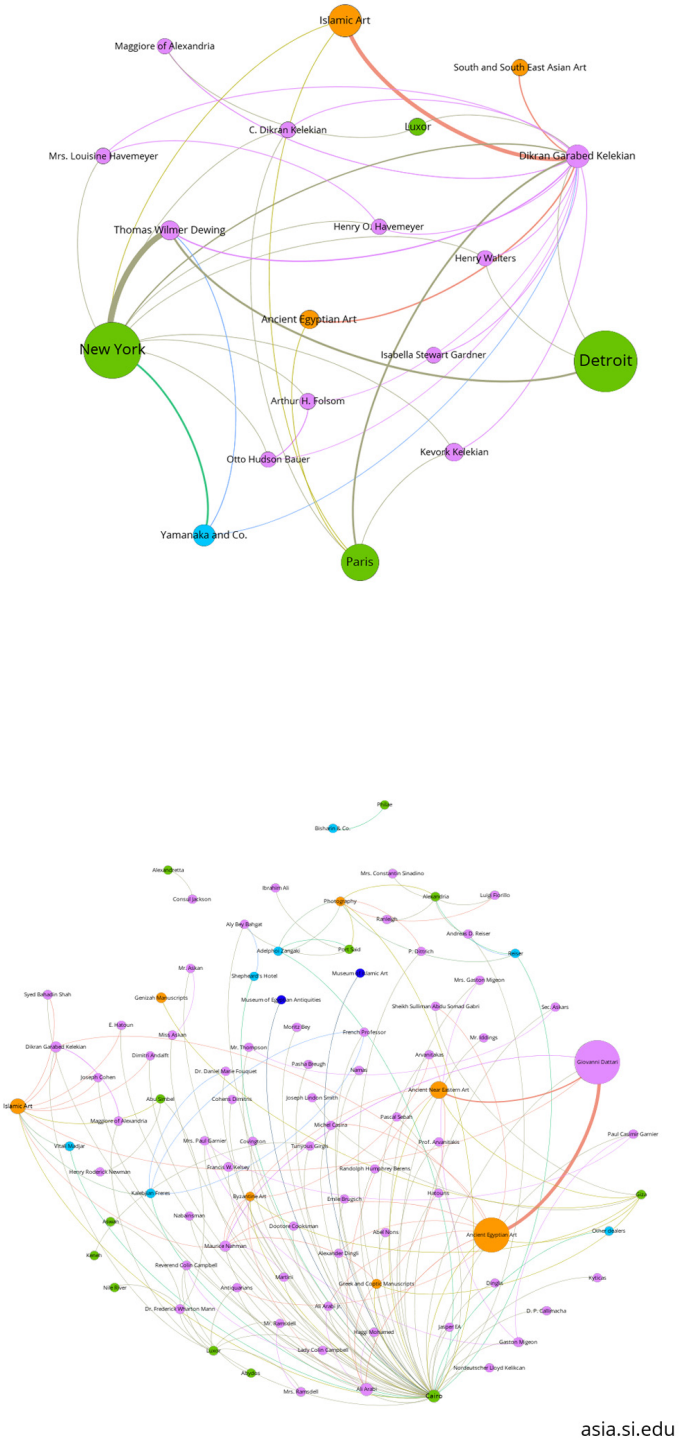

Figure 5. Two snapshot graphs from the Freer research project, 1907-1909. Top: Freer's network in Egypt. Bottom: The network around Freer's interactions with Dikran Garabed Kelekian, an important dealer during the period. Image Credit: Jeffrey Smith.

Brussels and stores it in Cornelia, i.e., the custom-built relational database at the heart of the project. As of April 2022, the Cornelia database includes approximately 12,500 entries in which we have identified over 14,000 distinct actors and no fewer than 350,000 time-dependent edges linking the actors to other actors, groups (i.e., cultural, economic, political, social and/or religious bodies), places (i.e., countries, towns, parishes, streets, and/ or houses), and/or works of art. The insights gained during the NA+DAH Workshop help us examine these relationships more systematically and to, therefore, answer art historical questions about social structures and patterns on a scale that was previously difficult or perhaps even impossible.

Project Cornelia also addresses more than art historical research questions. Working with existing digital tools and developing new ones, it aims to gain a better understanding of how the digital can better support art historians asking both traditional and new questions fueled by complex and substantial amounts of ('biggish') archival data. The Cornelia database serves as a medium for the experimentation of visualizations and interaction designs that can support scholars in their exploration archival material. As a result, it has prompted the use of various techniques including immersive game design (such as KUbism) or multi-dimensional network visualizations (such as the NAHR interface, see Figure 3), while supporting themes of playfulness, messy data, and user perception.[11] With these digital explorations, Project Cornelia contributes to the research domains of Information Visualization and Human-Computer Interaction, while remaining at its core a Digital Art History research project.

Project Cornelia is funded by the University of Leuven and the Flemish Fund for Scientific Research–Belgium (FWO-Vlaanderen), and all members of the team are affiliated with KU Leuven. The project's PI is Koenraad Brosens, professor of Art History and vice dean of education at the Faculty of Arts. Co-directors are professor Fred Truyen, who is head of the Digital Humanities program, and professor Katrien Verbert, who leads the AugmentHCI research group. Core members of the Project Cornelia team are three researchers who have recently defended or are about to defend their PhDs at KU Leuven: Rudy Jos Beerens (Art History), Inez De Prekel (Art History) and Houda Lamqaddam (Computer Science & Art History). They are joined on an ad hoc basis by postdoc researcher Bruno Cardoso (Computer Science) and professor Katlijne Van der Stighelen (Art History).

NA+DAH Leadership Team

From its planning to conclusion, the Leadership Team for the Getty Advanced Workshop in Network Analysis + Digital Art History served as the catalysts for this project over the course of four years. In 2017, Alison Langmead (University of Pittsburgh) began having conversations with the Getty Foundation about the possibility of focusing a large, international, and hands-on workshop that explored the intersections of network analysis and art history. Quite quickly, Scott B. Weingart (then at Carnegie Mellon University) and Anne Helmreich (then at Texas Christian University) joined the team. More recently, John Ladd (Washington and Jefferson College) transitioned from a Technical Advisor on the project to a welcomed addition to the leadership during our final year.

Alison's role on this team was to be the central liaison for planning and design. As the University of Pittsburgh was the grant recipient responsible for disbursing funds, the original plan was to host all in-person events in Pittsburgh. Even after the Covid-19 pandemic disrupted these plans, Alison continued to coordinate logistics, catalyze conversations, and ensure things ran to plan for all events whether synchronous or asynchronous. She holds a PhD in art history and her current academic work focuses on the teaching and use of digital methods. Her ongoing research that examines the creation of effective interdisciplinary collaborations was central to a number of conversations held over the course of the NA+DAH Workshop.[12]

Trained as a historian, Scott Weingart was able to bring his broad digital humanities expertise and experiences in leadership roles in various digital humanities centers and programs to help the project teams situate their work within this larger community. Weingart's training as a digital humanist and network analyst positioned him to directly assist the project teams during our onsite and online convenings. He also connected with researchers within the network analysis community with his "Demystifying Networks" blog series that has become standard reading for network analysts in the humanities. Also during the period of this workshop he, along with three other NA+DAH contributors (Ruth Ahnert, Sebastian E. Ahnert, and Catherine Nicole Coleman), published the book The Network Turn: Changing Perspectives in the Humanities.[13]

Anne Helmreich and Scott Weingart first met at the NEH Advanced Institute "Networks and Network Analysis for the Humanities," which inspired, in part, Network Analysis + Digital Art History. In particular, they shared the desire to connect humanists with specalities in network analysis and methodologies that combinine introductory or theoretical lectures with hands-on workshops and technical support.[14] As an art historian who has applied network analysis in her research on the history of the art market, Anne collaborated with both Alison and Scott, and later John Ladd, to organize and implement the advanced workshop, and offer guidance to the project teams. In addition, she facilitated access to and understanding of relevant art historical resources, such as the Getty Vocabularies.

Over these years, we were happy to be joined by a number of talented speakers, workshop presenters, and two critically important technical assistants. One of these, S. E. Hackney, who works at the intersection of cultural heritage, library and information science, and technology and is currently a faculty member at the Graduate School of Library and Information Studies at Queens College, City University of New York, served as the project manager for the teams, and worked on an ongoing basis through consistent remote meetings to ensure their work was proceeding to plan. The second, John Ladd's role expanded from offering technical, network-analytic advice at the outset, to helping teams proactively realize their plans for final research outcomes. His experience on large-scale text and network analysis projects, such as Six Degrees of Francis Bacon, equipped him to contribute his computational and project management expertise to the teams.[15] He also joined the Leadership Team's larger conversationsfocused on how to design and maintain a workshop of this kind within the field of art history.

Here, at the end of this journey, through all the ups-and-downs associated with an international workshop interrupted by a global pandemic, we are pleased to acknowledge that the Leadership Team has completed what we came to this project to accomplish: the creation of a scholarly community centered on the use of network analysis as a method in the discipline of art history. We are also pleased to recognize that the project teams also achieved what they came to the workshop to accomplish—and now reap the scholarly rewards of participation in a dedicated, intellectual community that created tangible project deliverables and successfully disseminated their findings.

The NA+DAH Roundtable

What is network analysis, and what are some of the challenges facing network analysis as a coherent method? As a method for art history?

[Leadership Team]
Network analysis is a method for modeling relationships between things in the world, but the network analytic framework itself is large enough to sustain several distinct categories of work and research. First, networks can be used as a visualization method in which the creation of a node-link diagram for display or exploration is often the final goal of the work. Second, network analysis can be implemented as a computational and statistical method, drawn from the mathematics of graph theory, in which the goal is to use network metrics to advance claims about the historical record in/as a network. Finally, a network can be a conceptual or theoretical framework for understanding archives and collections, and in this case the formal methods of network visualization or graph theory may or may not be employed; ultimately the purpose of this approach is to more accurately describe the state of the world through the concept of networks.

The Leadership Team noticed that the projects brought together in this advanced workshop tended to look toward just one of these modes, but sometimes took up two or more in combination. Regardless of the different methods used by each of these projects, we saw firsthand how scholars working within the various areas of network analysis were able to share and collaborate. While some produced stunning and convincing quantitative network analyses, we recognize that because the quantitative method requires training in computation and statistics it is not immediately accessible to most art historians. It is with this in mind that, at least for now, more visually and conceptually focused approaches to networks may fit better into art historical practice.

[Freer]
Network analysis is the visual and quantitative analysis of the relationships between entities in a system. It allows for a simultaneous micro and macro approach by calculating individual relationships between people and seeing larger patterns. It incorporates qualitative assessments as well as quantitative ones, and depends on how the researcher curates, organizes, structures, and determines weighting factors of their data. For each network, a certain threshold of complete data is required to adequately investigate the entities and their relationships. The patterns that emerge are, however, dependent on the data subjected to the analysis which can oftern be incomplete, reflective of historical biases, or researcher error.

As a method, network analysis has a steep learning curve which may limit its adaptation and accurate analysis. Like any tool, it will have its limits, and may not be the right choice for traditional object-based studies, but it has huge potential to highlight interpersonal dimensions within art historical studies. Its usefulness and usability depends on what questions are being asked, as ultimately, network analysis is a tool through which to ask questions.

[CIT]
What network analysis is and what it can achieve depends heavily on the project's objective. For us, network analysis is a useful tool for interrogating the data structure of our thesaurus and provides critical reflections on our construction practice and display potentials. Although network analysis is very powerful for presenting data, it is not always easy to find the most suitable representation/visualization method to meet the project's objective. CIT data is systematic, quantitative and multimodal, which, at the beginning of the workshop, made us feel that it would be easy to translate it into a visual network. We were wrong: the multimodality of our data has meant that it has taken some

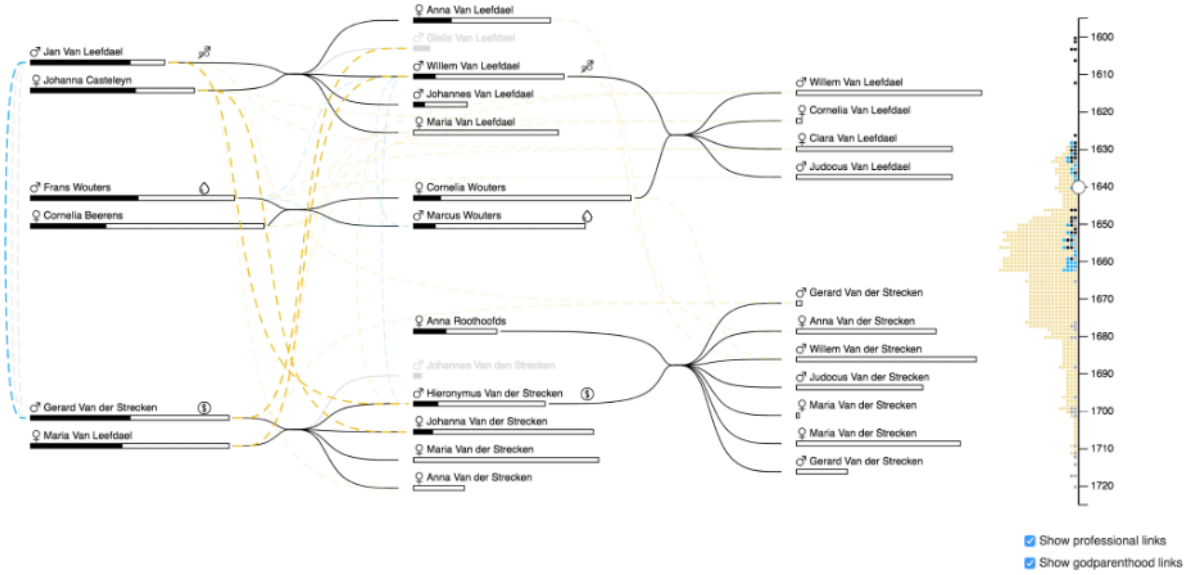

Figure 6. The NAHR visualization tool shows a simulation of a historical artistic community as a multidimensional hierarchical social network. Each vertical line represents a generation as the graph moves from left to right to display family, professional and godparenthood relationships. The timeline on the right allows an interactive view on community dynamics on a selected year. Image Credit: Houda Lamqaddam/Project Cornelia.

time for us to realize that creating a network of related terms in the CIT structure with clarity is a delicate business. We have learned that a good CIT visualization has to strike an appropriate balance between featuring the related terms and placing them within the thesaurus's overall structure.

Another challenge is how to find a way to view the network visualization on both macro and micro levels. The difficulty is that when we analyze the network as a whole and, indeed when we can see the whole picture, we are at risk of losing the explanatory details; when we focus on each individual term and its related term(s), we move into case-study mode and lose the benefit of a larger-scale network analysis.

[Project Cornelia]

In art history, the biggest challenge that we are faced with when using network analysis as a methodology is undoubtedly data. In his chapter "Tangled Metaphors" in The Routledge Companion to Digital Humanities and Art History, Matthew Lincoln warned us that network analysis not only requires enough data, it also demands data to be coherent and complete.[16] Art historical data however is far from coherent or complete and highly prone to bias, absence and misconception. With this in mind, we planned our data collection strategy accordingly. First, we opted to collect archival data only, as relying on primary sources bypasses a number of data issues inherent to the field of art history. Moreover, we focused more and more on complete archival sets – for example registration ledgers of the Brussels and Antwerp guild of painters – that produced serial data. This way, we could analyze and present creative community as a whole, rather than reinforce any bias through the collection of archival data from a selected group of actors. Though it was very interesting and quite fun to struggle with highly problematic (i.e., incomplete and fuzzy) data, and to make our data model a moving target, the explorations and iterations obviously took a lot of time and in the end did not really contribute to our attempts to develop a network analysis. Although a more disciplined and pragmatic approach from the start would have been more effective, we would have missed out on a lot of exciting conceptual and philosophical discussions.

How much is network analysis like other statistical approaches? How, in particular, does thinking of historical facts as a network impact how we see art history?

[Freer]

Network analysis combines the visual expression of data with the means to depict changes in that data over time and

space so that it can be seen as a whole. As a quantitative method, it can accommodate more dimensions than other statistical approaches. This extra dimensionality includes the interactions between entities, which can be analyzed individually and in the context of a natural group, or cluster. The importance of entities (such as collectors or dealers) can be gauged similarly, and across several sets of criteria (geographic, temporal, or culturally specific) that could be used for filtering. The process of seeing, modeling, and thinking about a set of data as a network is valuable because it provides a different kind of scaffolding from which to ask questions about interactions.

For our research project, statistical data for acquisitions and other events alone would not have told the story. With the networked approach, we could integrate this data with other contextualizing information. We could also filter our visualization by selecting a number of attributes and other weighting factors, which allowed us to see the whole through an array of different criteria. Seeing the whole helps in asking larger research questions that might not be prompted by more conventional statistical approaches.

[CIT]
Network analytic methods share many similarities with other statistical methods, and most of these methods can provide similar quantitative results (e.g., the percentage of different CIT categories, the total number of related terms). However, in our project, what we were looking for was something more visually intuitive with a high-level of comprehension for the complex relationships between individual CIT terms, something network analysis could offer.

Network analysis benefits art-historical inquiry the most when one deals with the issues concerning connections and interactions between 'things,' especially in large quantities. These things can be artists, collectors, dealers, artworks, but can also images depicted in artworks, meanings within images, and ideas or concepts. In the case of the CIT, we applied network analysis to explore the relationships between motifs and their symbolic meanings. For us, it was exciting to try network analysis in a domain beyond social networks.

[Project Cornelia]
Network analysis is one of many options when it comes to analyzing large quantities of data. It is one of few methods that highlights the collective dynamics and interactions rather than individual nodes. From the start, Project Cornelia has aimed to step away from the heavily debated 'great man' theory of history in an attempt to view history through a more inclusive lens.[17] A holistic perspective allows us to contextualize artists, and better discern the flow of information, influence, and wealth that shapes their work. As we describe in our research, it also brings overlooked actors into the spotlight.[18] Network analysis, therefore, acts as a methodological tool that supports our materialist-inspired approach by providing a computational framework through which we can look at artistic communities.

We are also mindful that network analysis as a tool is not without its own limitations and potential biases. As Ahnert et al. describe, visual social networks can be highly clear and intuitive, but they can also be dizzyingly complex.[19] In addition to that, one should also be aware of the rhetorical and semantic function of networks, as argued by Johanna Drucker.[20] From our experience, networks need not be alien technical artifacts that threaten the very value of humanist scholarship, nor the ultimate methodological tool to cure all data ailments in digital art history, but a method that provides an additional perspective on historical material and promises a new visual medium to discuss, debate and interpret.

[Leadership Team]
The model of the world that underlies network analysis has at least two important vectors of activity: first, the thought that "this group of things can be represented as a network;" and, second, that networks have mathematical properties (i.e. graph theory) that can be used to reveal different forms of meaning between the assembled collective of items and relationships. In the first sense, networks are an extremely flexible way of modeling all sorts of systems, but just because everything can be modeled as a network doesn't mean that everything should be modeled as a network.

We maintain that art historians, and humanities scholars more broadly, should use caution when adopting network analysis over other methods and take care to justify why, say, object-human assemblages really are best understood as networks rather than another metaphor for understanding. And with that said, the graph-theoretic approach is also quite different from typical rectangular or tabular data approaches that rely on properties of objects organized into rows and columns. This traditional method of data representation h is also very flexible, and art historians may benefit from thoroughly examining the possibilities before adopting networks, which often involve more complex mathematics and more computationally intensive tools. Nonetheless these two areas of study overlap: networks can be converted into tabular data (via network metrics) and vice versa, creating opportunities for hybrid approaches that take advantage of both ways of understanding data.

Why was the conjunction between network analysis and art history compelling for your research questions and/or your research topic?

[CIT]
Since 2016 we have been creating an iconographic classification scheme rooted in the specificity of Chinese

visual culture to annotate motifs and subject matters in Chinese art objects from the 10th to the 19th centuries. For us, this classification scheme should not only function as a practical tool for image indexers: we envision it as a taxonomic vehicle or a kind of conceptual map that allows one to explore the Chinese mental world throughout this long period. As it is built from the thesaurus' model, our classification scheme follows the conventional display of a thesaurus and is represented as a tree structure in which the hierarchical relationship between concepts is foregrounded while the network of non-hierarchical associations between them is hidden and invisible. Such a display can be particularly frustrating: in our classification we have specially built the non-hierarchical connections between several hundreds of our concepts to highlight their symbolic relationships in the Chinese cultural context. By joining the NA+DAH workshop, our team was hoping that the use of network analysis could help reveal the hidden network of the symbolic relationship between those concepts in our terminology structure.

[Project Cornelia]
As art historians with an interest in the socio-economic aspects of early modern Flemish art, network analysis emerged as a natural partner to us. Inspired by the materialist perspective on art history and sociological literature on art – including, above all, Howard Becker's Art Worlds – our research questions focused on the interpersonal relationships between artists from the very start.[21] For example, we wondered how Brussels tapissiers ensured that there was enough mutual trust between them to keep their capital-intensive and risky industry going. Or, how the spatial distance between Antwerp painters influenced their stylistic choices and willingness to embrace new "fashions" in painting. Initially, we tried to answer these and similar questions on a case-by-case basis through empirical archival research. This episodic approach confirmed to us the importance of artist networks for the production of art. However, as we unearthed more and more evidence from the archives, it became increasingly clear that if we truly wanted to obtain insights into the 17th-century Flemish art world as a whole, we needed a more systematic method to organize and analyze our data. We believe network analysis is this method.[22]

[Freer]
When we as a team decided to apply to the NA+DAH program, we were interested in exploring network analysis as a new methodology and digital tool to enhance and support an already existing research interest at the museum for investigating the collection formation and collecting strategy of the museum's founder, Charles Lang Freer. Although there were studies on Freer's collecting of American, Chinese, Japanese and Egyptian art, his collecting in the Near East region, in general, had not been explored in depth. Provenance research at the museum had already resulted in the linking of Freer's acquisition sources to previous owner records. Applying network analysis to the meticulous records kept by Freer, we developed a holistic and inter-related portrayal of collection formation that highlighted the social aspects of collecting in the Gilded Age and the networks navigated by Freer.

In that sense, network analysis has allowed us to expand on a people-to-people approach, rather than being restricted by an object-to-people approach. As we processed the data, we were surprised by the scale of Freer's social interactions at a time when he dedicated his effort to building a collection that would become a national museum of Asian art. Furthermore, network analysis proved to be a particularly suitable approach, that aligned with Freer's perception of his own 'collection' where objects are in an aesthetic dialogue with each other, rather than stand-alone acquisitions.

[Leadership Team]
What we hoped to produce from this advanced workshop of art historians and network analysts was a sustainable disciplinary community. We instigated this community out of a desire to offer the art-historical discipline a thoughtfully structured opportunity not only to learn more about the nexus of network analysis and their scholarly research questions but also about the skills of producing, participating in, and nourishing a collaborative team. Planning for this Getty Advanced Workshop began in late 2017, and at that time, network analysis had already become a popular and engaging way to (re-)think and represent art-historical data in fruitful ways. Though the digital humanities often makes claims to (inter-)disciplinary breadth, different fields have taken up its methods at uneven rates and we recognized the attractive chance to develop and support productive, exciting approaches to answering art-historical questions as collaborative teams using network analysis as a methodological focus. We each had our own ways of engaging with network analysis in our research and teaching prior to this workshop, and we came together to help the NA+DAH project teams realize their scholarly potential.

What specific things about digital art history and/or network analysis did you learn from participating in the NA+DAH workshop?

[Leadership Team]
We observed that because digital art history, more generally, and network analysis, more specifically, are relatively new approaches, they put pressure on collaborative frameworks. Team members needed time to absorb new knowledge and new ways of working, in order to reassemble and refine their research questions. This same process of acquisition and assimilation of new knowledge also impacted the teams' data since, in short, network analysis is a data structure. In most cases, it took the teams far longer to assemble their data than originally anticipated, working through, in a dialectical fashion,

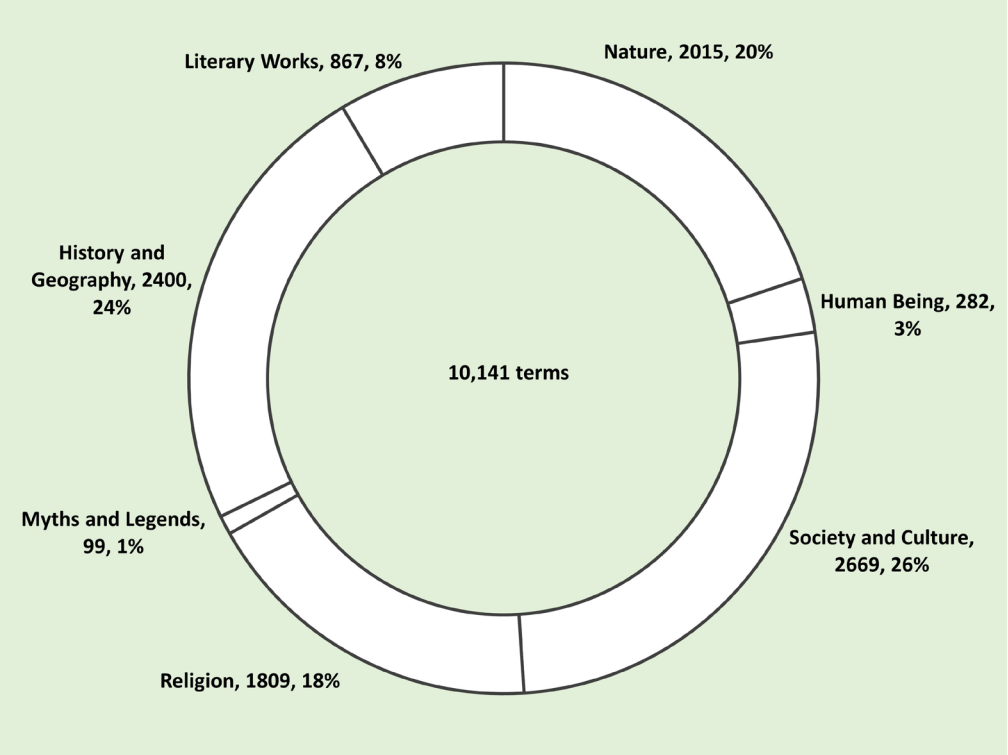

Figure 7. The number of concepts and their percentages in the seven divisions of the CIT vocabularies. Image Credit: Chinese Iconography Thesaurus Project.

the relationship between structuring and standardizing data and formulating research questions that respond well to that data. Only then were they able to begin addressing the relationship between their data and the technique of network analysis, which again required them to refine their research questions.

Helping the teams reach a deeper understanding of the archives and other forms of primary source material with which they worked, the processes of coming to terms with data, while extenuated, was also revelatory. Likewise, learning more about network analysis was transformative, allowing the teams to see how it can operate not only as a visualization tool but also to measure the behavior of communities and actors within those communities. While network analysis can be extremely complex and sophisticated, the teams also learned the benefits of simplifying—that is, not building one network that can answer all research questions but instead building multiple networks that would allow them to answer their research questions about such topics as change over time with greater clarity.

[CIT]

Thanks to the NA+DAH convenings and webinars, we were exposed to various methods and techniques of building networks. One of our most valuable lessons from the workshop is that knowing what to do with one's data is a process. Initially, we were fascinated by the myriad of possibilities for our datasets, so we asked ourselves all sorts of questions. For instance, the following chart shows the distribution of 10,141 CIT concepts among its seven top-level categories in the terminology database as it stood in 2019 (see Figure 7). The number of concepts in Myths and Legends, Literary Works, Human Beings, and Religion are disproportionately fewer in comparison. To what extent could such a distribution shed light on the characteristics of Chinese iconography as a whole? Or, instead, does it indicate the bias inherent in the main body of our literary sources - *Shiqu baoji* and *Midian zhulin*, an 18th-century series of catalogs of the imperial collection?[23]

Gradually we realized that while there were many interesting aspects of the CIT datasets that we could explore via network analysis, we needed to choose by focusing on one aspect that could contribute most to the overall goal of the CIT project set at that particular time. In the end, we decided to focus on ways to improve the display of the complex structure of our data that contained three different types of relationships—especially hierarchical and associative—between individual concepts.

[Project Cornelia]

Above all, we have learned that working together pays off. As Jim Cuno (former President and CEO of the J. Paul Getty Trust)

noted in 2012, art historians tend to be "solo practitioners" who work alone and prefer to publish "as single authors and only when all the work is fully baked."[24] Like many other digital art history projects, we have realized that individual scholars can only do so much and that combining the expertise of various collaborators from multiple disciplines can greatly benefit our research. For example, we not only work together with other art historians and historians to collect and examine our data, but also with computer scientists, biostatisticians and philosophers to analyze, model, and visualize it. In doing so, we continue to respect each other's specific specialisation. For example, we not only publish collectively in broader venues, but also regularly separately in domain-specific ones.[25]

[Freer]
At the start of this project, our team members were network analysis novices. We were learning at every step of the process, beginning with the methodology of network analysis and hand-curated data. We quickly realized the value of a collaborative approach and of well-defined roles for each team member.[26] Since our project was in the very initial stages when the initiative began, we had many opportunities as the work progressed to re-evaluate the data and to see where it was lacking. This allowed us to identify gaps, and try to fill them. The search for missing data exposed some of the differences between data-based and text-based humanities research since missing information in a text-based research project does not necessarily show up as clearly, i.e. not as empty fields in a spreadsheet. Our missing data was easily exposed and perhaps then easier to address when it was time to begin shaping our conclusions.

In terms of labor and time, what is needed to do this work? How is it differently configured in different institutional settings, given institutional priorities?

[Leadership Team]
As the principal investigators, we saw our role as catalysts for the teams, helping to spur on their work by asking questions, offering advice, and, in particular, making connections across projects, from our workshop community to experts in the field and relevant secondary literature. The teams were selected, in part, due to the relevance of network analysis for advancing their research questions and their datasets: more was at stake than just acquiring knowledge of a new method or tool. The work entailed learning in an interdisciplinary context. While all the teams self-identified to be concerned with art history, writ large, two of our workshop leaders, John Ladd and Scott Weingart, were not art historians and instead from literature and history of science. Many of the experts we invited to participate in the summer convenings and the webinars organized between the convenings came from other humanistic disciplines.

Across the teams themselves, we observed that different institutional settings and roles within those settings shaped the levels of time and labor that participants could devote to their respective projects. The Ph.D. students affiliated with project teams often had the greatest amount of time, which engendered an experimental approach, but they had to balance this flexibility with meeting expectations of their degree programs. Those participants who were in early career stages faced different challenges as they changed professional positions and, indeed, several early career participants in our workshop had to step away for these reasons, particularly as the timeframe for the workshop became extended in light of COVID. Those teams situated in museums were arguably best prepared to conceive of the various roles needed to support projects (e.g. data steward, content expert, etc.) but adopting these roles needed to be balanced with a drive to avoid silos of data or knowledge. Museum teams also had to balance institutional agendas with experimentation, without a guarantee of a deliverable, necessary to learn a new approach. Those teams located in academic institutions juggled the benefits of collaborating with others, on the one hand, and reward structures that tend towards recognizing the individual, on the other hand. Overall, because the participants in this initiative came from different institutional settings, academia and museums, the United States and Europe, and were at a variety of career stages, the workshop represented diverse perspectives and experiences that allowed participants to learn a great deal from each other.

[Freer]
Network analysis is time consuming. One needs to invest deeply in the planning stages to set up measurable research questions and create rigorous documentation of the decisions made to create and organize the data. It was essential for us to have a team with a balance of skills, different perspectives, and complementary strengths. Based within the Smithsonian's National Museum of Asian Art, planning for the long-term sustainability of this data and the application of its workflow to other research efforts related to network analysis were central components of our project. In the context of a museum, for example, it was important that our research data contributed to the collections database. As a previous effort that supported provenance research had already contributed linked records for Freer's acquisition sources, we were able to use the association feature of our system to link individuals encountered in our research data. In addition, we created a new section in our local thesaurus that allowed us to mark the records related to our project, and for subsequent research projects to use a similar approach.

[CIT]
Like other teams in the workshop, network analysis was one of several strands of activity we were simultaneously engaging with in the course of developing our project. For the CIT team, it was the period when we were most heavily engaged in

building our thesaurus as well as applying it to image indexing in order to accomplish our main objective, i.e. the soft launch of the project website in October 2019. This fixed deadline undoubtedly framed our specific goals for the network analysis workshop, but at the same time made us mindful of the time and labor available to devote to it. From the project management tips presented in the workshop, we developed a realistic plan for our network analysis and the roles individual members of the team could possibly play within it. We felt extremely fortunate that John Ladd was avalible to lend his expertise during the production of the chord diagram.

[Project Cornelia]
In project Cornelia, we saw the benefits of bringing together expertise from different fields and allowing space for different research agendas within a single overarching project. At the time of its genesis, the highly data-driven aspect of our work seemed an oddity, and required additional effort to convince funding agencies, identify technology needs, and appoint interdisciplinary positions. Our persistence appears to be justified, as the interdisciplinary make-up of project Cornelia meant that digital methods were able to be integrated - and reflected upon - throughout the process.

In this hybrid environment, our variety of backgrounds created a harmony of outcomes ranging from art historical findings and technical contributions to methodological explorations. In 2021, for instance, we leveraged the dataset to analyze the Antwerp artistic communities in the 17th and 18th centuries, and proposed an explanation for their robustness in a challenging economical context.[27] In parallel, we were able to contribute innovative techniques in digital research. For instance, we introduced the immersive data exploration tool KUBism, that proposes a playful and accessible way for scholars to explore complex digital datasets.[28]

These parallel and multi-faceted explorations allow us to represent project Cornelia in different kinds of venues, to thereby disseminate our method to readers and reviewers in both traditional art historical communities and purely computational ones.[29] We believe this approach only strengthens our methodological approach, confrontation by different perspectives has its limitations, but has gains in robustness, soundness, and integrity.

How is work like this, both in terms of the scholarship but also in terms of running a workshop along these lines, valorized in art history? What are the reward systems available that we have been able to utilize?

[Leadership Team]
As members of the Leadership Team, our response reflects upon how the work of helping our peer scholars produces richer, deeper research than that which has traditionally been valorized within the field of art history and in humanities writ large. First and foremost, we recognize that in our past there were important moments when scholars who were more advanced in their careers gave us their time and advice when we needed it most, and a sense of "paying such attention forward" is certainly one of the most rewarding components of organizing and offering workshops such as NA+DAH. Additionally, all of us have somewhat of an evangelical bent when it comes to digital methods and we truly want them to be taken up more mindfully across the humanities, but in art history in particular. Curricula at the undergraduate and graduate level are moving only very slowly to offer these approaches to students. If functionally useful computational methods are to be integrated at scale across this field, the work of training and education simply must be present throughout all phases of an academic/curatorial career.

Workshops such as NA+DAH are a prime opportunity to help new and established scholars gain new skills and expertise outside of the structure of traditional schooling. Coordinating such workshops are also valorized for the members of the leadership through the publicity and the prestige offered by the awarding of the grant, as well as the ability to draw together so many distinguished participants from around the globe to our home institutions.

[Freer]
Without having done any research in this area, our thoughts here are based on our own impressions. While the number of scholars in our subfield of art history (Islamic art history, or Asian art history more broadly) using network analysis in their research is small and many colleagues remain dubious about the value of such work, we see evidence of changing attitudes in academe towards the importance of multi-authored and digital projects. Having to rely on digital platforms for most scholarly interaction for nearly two years during the pandemic has certainly had an impact, and in that period some impressive projects have been launched. The Black Lives Matter movement and dramatically increased focus on diversity, equity, inclusion and accessibility has meant that work in public humanities has become more valued, as has the use of social media platforms as a way for academics to reach a broad public audience with their work. While not directly concerned with network analysis, these developments are creating a climate where network analysis and other digitally based research tools could become more welcome. The challenges are now to develop platforms that allow researchers to export their results in exciting, interactive ways for public consumption.

[Project Cornelia]
We found that 'success' in an academic setting was not at all easy to achieve ("yeah, yeah, we all have a database - big deal", "it would be better to focus on single-authored

publications"), yet we also see that successful digital art history initiatives and projects inspire the institutional context to question art history's traditional point of view to reshape itself. This, we believe, could be key in advancing the field further, as we are very much dependent on the next generation(s) of art historians and the ways in which they feel attracted to computational approaches. (It is an anecdote, but still: after one of Cornelia's PhD students got a job at the RKD Netherlands Institute for Art History even before he had presented his dissertation, a handful of students asked us why 'digital art history' was not a class—while two years ago, when we tried to make such a class part of the curriculum, all students yelled 'no, no computers please—that is exactly one of the reasons why we decided to study art history!')

[CIT]
We felt that in spite of the current hesitation about digital art history among art historians in general, colleagues working in museums could potentially become receptive to data-driven and collaboration-oriented digital art history as a mode of research. This is partly to do with the fact that by its very nature the museum is a multi-disciplinary and public-facing exploratory space. A collection research project that is carried out in a museum typically involves the exchanges of the curators, conservators, archivists, and collection database managers. Besides, museum staff intimately engage on a daily basis with documentation-related activities — cataloging or retrieving the information of objects and their makers etc. in the collection management system. As a result, we can foresee that in the museum environment a data-based research project can easily be accepted as part of the curator's core responsibilities and is likely to gain support within the institution. In the case of the CIT project, we felt supported not only psychologically but also in terms of technical infrastructure (e.g. the CIT team has been able to rely on the terminology module embedded in the V&A's collection management system to build the thesaurus). Given more resources to be invested in the digital, we would not be surprised to see museums begin to employ full-time data scientists to facilitate data-driven research projects in the near future.

What were the benefits of engaging with this work as a shared initiative rather than stand-alone teams?

[Freer]
As a team, although we had been working together for a long time, when we ventured on this project none of us had any previous knowledge of or experience in employing network analysis methodology and tools. We explored and learnt about network analysis together, with each team member bringing in his/her own scholarly and technical expertise, perspective, and interest, to contribute to the project accordingly. The process was therefore far more enriching than an individual effort, allowing us to complete a project that could not have been done alone. Having the NA+DAH Leadership Team and the experts they invited to the workshops as mentors were incredibly valuable as we built our knowledge on network analysis. Working along with other teams, learning about their projects, research questions, and approaches as well as their challenges helped us tremendously throughout the run of the program as we were able to see other models and examples. The information-sharing and feedback from all parties, Leadership Team, experts and peers alike, provided us with new insights, helped us to narrow our focus and make our work feasible given the amount of work and time we needed to complete our project. Having the workshop spread over intervals during which we came together as a community to discuss not only the methodological challenges but also logistical ones, such as project teams spread around the world, keeping track of progress, roles of each member etc., ensured a smooth process and successful completion of a project of this type, which requires a team of people with diverse skill sets and long term commitment.

[CIT]
Although a quite interdisciplinary team ourselves, the CIT team members benefited from face-to-face and online talks and discussions with other teams in the workshop. Different teams brought a wide range of expertise and experiences in various disciplines (information studies, art history, history, data science, web science) to the workshop sessions organized by the NA+DAH Leadership Team. This not only generated a large amount of information in a concentrated manner and in a relatively short space of time, but, more crucially, created a culture of learning through trial and error. Before we settled on the 'hierarchical edge bundling' network visualization, we tried a series of other forms of network visualizations that we learned from the workshop, such as Gephi network, R package, VOSviewer, Power BI, and Vega, etc. Through those trials, we had first-hand experience of network analysis and its capacity and limitation of helping raise research questions.

[Project Cornelia]
As art historians, we tend to dwell in rather unchanging professional circles, working alongside other (often traditional) art historians at our university department and meeting other researchers interested in the same area of expertise – in our case, 17th-century painting or tapestry – at (inter)national conferences. The NA+DAH Getty Advanced Workshop went beyond that by bringing together different projects that had very different research questions and worked in different institutions, with different content or data. Despite these differences, our shared workflow, issues and challenges created a feeling of community. Our discussions not only helped define the current state of the field of digital art history and network analysis, but also refocused some of Project Cornelia's goals and perspectives.

[Leadership Team]
Operating a Getty Advanced Workshop in a time of global pandemic was difficult for all, and the NA+DAH Leadership Team hopes that similar circumstances not rise again in the future. That said, because of the pandemic, academic communities have gained significant experience with the ways that video conferencing can form a productive part of their workflow, and we believe that our original plan to book-end a year-long series of ongoing, remote team meetings with on-site, face-to-face convenings might stand an even better chance of success in the future than it did when we first designed it in 2017-2018. Moving forward, we recommend that successful project-based workshops such as NA+DAH could thrive by balancing one face-to-face meeting for every two-to-three academic terms of remote work planned.

Thinking together within a shared initiative such as the NA+DAH workshop created a strong, clear "gravitational pull" for the teams to stay on topic and on track, even providing an ongoing reason to persist in their research through the tribulations caused by the Covid-19 pandemic. The NA+DAH workshop seemed to have a better chance of weathering this unpredicted transformation because it focused on the entire collaborative team such that the issues of teamwork and organization took center stage in a crucial way.

Working with the NA+DAH community has deepened our conviction that a healthy, diverse community of scholars actively focused on collaborating to reach a common research goal has the ability to create stronger, deeper interpretations of the human experience than any one solitary researcher striving to work alone. The NA+DAH environment not only recognized but supported these collaborations and was essential to the success of the teams. As the researchers got to know each other's work and gained trust in one another, they experienced the benefit of knowing that "they were not alone," that is, their experiences were shared—even by those working in different countries, different institutional contexts, and even different home disciplines. They were able to learn more about their own assumptions because of the thoughtful questions posed by others, to track each others' progress and understand the richness and importance of this approach, and to find inspiration from the models offered by different teams.

NOTES

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