

Introduction

In the days following the 9/11 terror attack, an FBI agent visited the Whitney Museum of American Art to see Mark Lombardi's 1996 drawing 'BCCI-ICIC & FAB, 1972–91 (4th version)' (Figure 1) (Hobbs, 2003: 11–12, 95–8). The web-like image comprises a meticulously researched diagram of individuals and groups with ties to a money-laundering organisation that operated under the name of the Bank of Commerce and Credit International (BCCI), which included Osama bin Laden and others associated with al-Qaeda. As Lombardi himself described, BCCI 'was used not only by drug dealers and con men but also by the governments of the US, UK, Saudi Arabia and the Gulf Arab states to funnel support to Afghan guerrillas fighting Soviet occupation, to pay off friends and adversaries alike and conduct secret arms sales to Iran' (Lombardi, 2001). In other words, in black and red ink, Lombardi traced a terrorist network that reached the centres of government. He had grasped the power of the network perspective to reveal conspiracy, adapting graphical traditions associated with the study of social networks developed in the first half of the twentieth century. Tragically, the significance of his research would be uncovered only after his death: in early 2002, a year after the artist's suicide, the FBI's Operation Green Quest raided the offices of several Virginia-based Islamic charities whose Saudi funders, including Mahfouz and prominent Bush backers, featured in Lombardi's work (Goldstone, 2015).

Three years after Lombardi produced his artwork, Albert-László Barabási and Réka Albert published a scientific article entitled 'Emergence of Scaling in Random Networks' (Barabási & Albert, 1999). It argued that a wide variety of seemingly heterogeneous networks, such as power grids, social networks, and the World Wide Web, exhibit nearly identical distributions of connectivity, and it offered an elegant model that explained how these distributions might arise.¹ This particular distribution of connectivity was different from those most scientists expected at the time.² The significance of Barabási and Albert's findings was that they provided a compelling case for analysing seemingly disparate systems and kinds of data using the same mathematical models and

¹ For the debate around this thesis, see Broido and Clauset (2019) and Holme (2019).

² For an earlier precedent, see Price (1965).

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978-1-108-79190-8 — The Network Turn

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Excerpt

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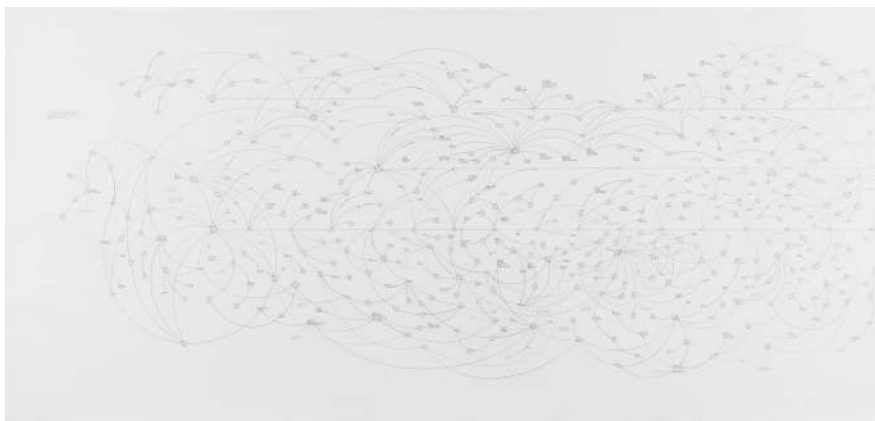


Figure 1 Lombardi, Mark (1951–2000), ‘BCCI-ICIC & FAB, 1972–91 (4th version)’ from FAB, 1996–2000. Graphite and coloured pencil on paper. New York, Whitney Museum of American Art. [View image](#). Whitney Museum of American Art / Licensed by Scala.

tools. For this reason, their article is regarded as one of the founding publications of the interdisciplinary field of modern network science. The argument for the application of analytical tools across domains was extended in Barabási's best-selling book *Linked*, in which he argued that many challenges in our world, such as managing the spread of epidemics, fighting terrorism, and handling economic crises, can be cracked by understanding these systems as networks (Barabási, 2002). As such, networks appear in Barabási's study as a kind of Rosetta Stone. This message reached 70,000 readers and thus played a small part in the rise of the 'network' perspective in the modern consciousness following the new millennium.

Lombardi and Barabási's work is part of what we call the 'network turn'. This turn cannot be attributed to either the artist or the scientist; they are but two examples of a whole host of converging thoughts and practices around the turn of the new millennium – the zeitgeist of the networked age. The World Wide Web had become available to the public only in 1991, but by 2004, the web-based view of relations manifested itself in an entirely new kind of communication platform when 'TheFacebook' was launched. The subsequent proliferation of social networking platforms has profoundly shaped the way we understand connectivity in the world today.

Another key driver of the network turn, highlighted by the FBI's interest in Lombardi's work, is terrorist activity – both in terms of the perceived threat of terrorist networks, and in the new technologies available to security agencies to mitigate against them. Following 9/11, using data-gathering approaches very similar to Lombardi's combined with computational analysis, Valdis Krebs used public information and newspaper clippings to produce a partial map of the social network behind the attack. His network analysis showed that all nineteen of the hijackers were within two email or phone call connections of two al-Qaeda members already known to the CIA before the attack. According to three common network analysis metrics, the network's most central figure was Muhammed Atta, who turned out to be the ringleader (Krebs, 2001). Krebs' findings raised the important question of whether the attack could have been predicted. Shortly after posting his analysis online, Krebs was invited to Washington, DC to brief intelligence contractors. The extent to which Krebs' insight about the power of network analysis fed into the existing methods that intelligence agencies employed is hard to gauge, but by

2013, as the leak by Edward Snowden brought to light, the National Security Agency was engaged in massive-scale network analysis using data from nine internet providers.

The study and critique of networks has predominantly taken place within the domains of computer science and related scientific fields, the military, and the tech sector due to the scale of digital data being analysed and the nature of the investigations prompting their study. This book not only argues that arts and humanities scholars can use the same kind of visual and quantitative analysis of networks to shed light on the study of culture; it also contends that the critical skills native to humanistic inquiry are vital to the theorisation and critique of our networked world. Network analysis, as we define it in this book, is a set of practices and discourses that sit at the interface of the natural sciences, humanities, social sciences, computer science, and design. We contend that networks are a category of study that cuts across traditional academic boundaries and that has the potential to unite diverse disciplines through a shared understanding of complexity in our world – whether that complexity pertains to the nature of the interactions of proteins in gene-regulatory networks or to the network of textual variants that can reveal the lineage of a poem. Moreover, this shared framework provides a compelling case for collaboration across those boundaries, for bringing together computational tools for quantitative network analysis, together with theories, discourses, and applied techniques from the social sciences, the humanities, visual design, and art practice.

The cases of Lombardi and Barabási provide an instructive way of grasping that shared framework because, superficially, their work has very little in common. Barabási and Albert explicitly cite the computerisation of data acquisition as essential to their research. By contrast, Lombardi's research process was analogue. He gathered his data on three-by-five notecards. There is no evidence that Lombardi read Barabási and Albert's groundbreaking work in statistics and physics; rather, his inspiration was panorama and history painting. He used the term 'narrative structures' to describe his hand-drawn webs of connection. Produced through an iterative process of refinement, the work is human in scale, legible visually in its entirety. Perhaps more importantly, it is his interpretation of a carefully researched but inevitably incomplete record. It does not pretend to objectivity. In stark contrast, Barabási

and Albert's method is scientific: it proposes a model to predict the behaviour of systems and to understand complex topologies 'independent of the system and the identity of its constituents' (Barabási & Albert, 1999). Thus, where Lombardi is analysing past events, Barabási and Albert offer a predictive model; where Lombardi is visual, Barabási and Albert use algorithms designed to detect patterns in data sets too large or complex for the human eye to detect. These approaches seem to occupy two very separate worlds.

Nevertheless, Lombardi's art and the scientific approaches of Barabási and Albert have much in common. Lombardi distils the composition of relationships in history painting and the comprehensive 'at one view' of the panorama into a formal abstraction rooted in the conceptual art movement of the mid-twentieth century, and reflects the overlapping concerns, discourses, and methods of art and science. The artist and scientists use connectivity to make sense out of data: a representation of knowledge that relies on abstraction. Both produce results that are seductive in their elegance and simplicity. Networks are by definition an abstraction into a system of nodes and edges. Nodes are entities; edges are the relationships between them. Two examples can be seen in Figure 2. Such an abstract system is inherently intuitive. These two elements, nodes and edges, are the simple building blocks of an obviously abbreviated rendering, a malleable geometry that can range in complexity from a direct and declarative schematic to a dense, indecipherable web of connections.

The worlds from which the artist and the scientists emerge have their own long genealogies. The standard history we tell for network science traces its lineage back through graph theory to Leonard Euler's solution of the Königsberg Bridge problem in 1736. Similarly, we might argue that artists and humanities scholars have been engaging with network-analytic approaches for at least sixty years. However, these threads have visibly come together only in the past twenty years. In the first decade following the millennium, some pioneers began to apply the methods of network science to the study of cultural artefacts, but most scholars were still learning how to query web-based digitised archives without attention to the computer networks invisibly underpinning this virtual archival experience. However, since 2010 there has been a slow but steady increase in scholars in the arts and humanities employing network visualisation, social

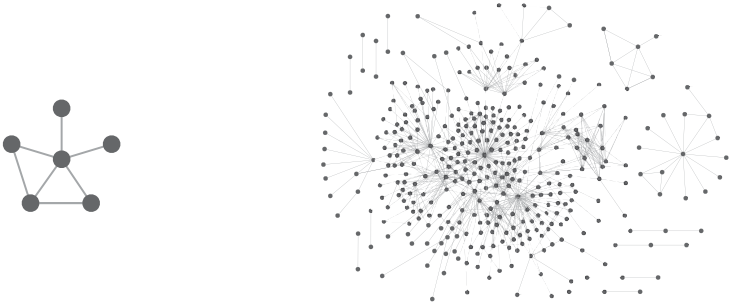


Figure 2 Networks consist of nodes and edges. On the left, a simple network of six nodes and seven edges. On the right, a more complex network (with several disjointed components) that depicts social relationships in a Protestant underground community during the reign of Queen Mary I of England (see Ahnert & Ahnert, 2015). Diagram by the authors.

network analysis theory, and quantitative measures from network science to address their research questions. In addition to a rise in the number of publications invoking these methodologies, the clear demand for workshops and training in network visualisation and analysis tailored to arts and humanities scholars is evidence of these approaches gaining traction. Such work still tends to be a fringe activity, though, and suspicion among more traditional elements within the disciplines who have interpreted the computational tools and methods associated with network analysis as part of the incursion of scientific method into their domain, which has sometimes been conflated with the neoliberal takeover of the university.

This book does not call for arts and humanities scholars to accept unquestioningly frameworks and methods developed in the field of network science. Rather, it argues that the discourse and analysis of networks can move forward only through collaboration and exchange at the interface of computational method, humanistic inquiry, and design practice. The case for scholars from the arts and humanities engaging with networks is compelling on a number of levels. The use of computational network

analysis can lead to the creation of new knowledge, and to the corroboration of theories. It makes it possible, with relative ease and speed, to measure the relationships between many entities in multiple ways, allowing a rich, multidimensional reading of complex systems never possible before. It has proven to be an effective tool for understanding metric data on a very large scale. A seemingly infinite number of calculations can be run on the resulting network to filter and parse that large-scale data, giving a more nuanced understanding of both the local and the global. The ability to analyse data across scales has been rendered increasingly necessary in light of the ever-growing quantity of information made available through the digitisation of our cultural artefacts. Networks further offer the ability to contextualise the large scale with the small and vice versa, breaking the explanatory chasm between part and whole.

Moreover, scholars from the arts and humanities already have the conceptual framework to make this leap: they have been writing about networks for centuries, albeit from the metaphorical perspective, examining communities of practitioners, the dissemination of ideas, or the relationships between certain texts, images, or artefacts. Although researchers with standard humanities training will likely need to acquire some new skills to engage with the computational challenges of network visualisation and quantitative analysis, we contend that they already have a set of skills that are key to the development of the interdisciplinary practice of network analysis. This is not just about receiving wholesale methods and theories developed in the computational and social sciences; rather, the critical skills developed in the arts and humanities are needed to complicate and nuance the current ways in which data are collected, modelled, and queried in the field of network science. Finally, we are at a moment in time when it is crucial that arts and humanities scholars engage critically with both the potential and the pitfalls of technological advancements. By offering an understanding of how networks work, we provide a much-needed framework to articulate how companies and governments can exploit the harnessing of large-scale data and advanced network analysis for the purposes of power, surveillance, and commercial gain.

This book is not a how-to manual: it does not provide instruction in the basics of network analysis or the use of 'out-of-the-box' tools, or an introduction to programming, as a plethora of other resources already do

this.³ Our aim here is more ideological. We seek to open up a space for exchange between the humanities, arts, and sciences – a space that is genuinely collaborative, that is mutually beneficial, and that recognises that networks present a mode of inquiry that draws on knowledge and practices from all these domains. Its combined brevity and breadth mean that it is not the final word, but rather a provocation. We hope this book will be a starting point for debate: not just in the digital humanities community (who are already used to situating themselves at the intersections of disciplines), and not just in the arts and humanities, but also in the natural, social, and computer sciences. It is the desire to engage and debate that motivated us to offer this book open access. Our most basic aim is to persuade colleagues in the arts and humanities of the value of networks as a conceptual and methodological framework that supplements (but does not replace) traditional methods of inquiry. But our intentions are broader than that: we hope for a sharing across domains to deepen our understanding of networks. That deepening is gained by combining world views we might attribute on one hand to Lombardi and on the other to Barabási, the combination of careful research and a choice of parameters at the human scale, that is not only coupled with but iteratively developed in tandem with the power of computational analysis.

Part of the argument for multiple perspectives is manifested in the way this book has been written. It is the product of a collaboration between a scholar of English literature, book history, and digital methods, a physicist specialising in network science, a historian of science concentrating in digital humanities, and a digital research architect with a background in design and tool development. We have not split the chapters among different authors; rather the arguments are the product of ongoing debate among the four of us over a period of three and a half years. Such a process of creation, like much of the work going on within network analysis more broadly, necessitates co-authorship. This is something that remains relatively rare in the arts and humanities. We seek to demonstrate the benefits of co-authorship, the insights and perspectives it brings, which can rarely be replicated by a single-authored work. It is not a shortcut or a faster route to publication. The process of gaining understanding,

³ For a useful overview of tools and tutorials, see <http://historicalnetworkresearch.org/resources/external-resources/>.

compromising, and iterating our arguments necessarily takes longer than writing a piece from a single viewpoint. However, we believe that process makes the work stronger. Genuine, deep sharing of ideas across disciplinary boundaries takes patience, goodwill, and a desire to learn and be challenged. We are therefore not simply arguing for a set of methodologies and discourses associated with the network framework. The network turn brings with it a set of research and publication practices that are inherently collaborative and dialogic.

The six chapters that follow are organised into three parts. Part I offers ‘Frameworks’ for understanding the methods developed in the natural, computational, and social sciences. To fully harness the analytical power of networks, we must first attend to the way a specific set of Western linguistic, disciplinary, and visual histories of networks frame the systems and phenomena we observe in the world, shaping, limiting, opening, and reorienting the questions we ask. Part II introduces ‘Cultural Networks’, giving an overview of the ways in which networks have already been used to examine cultural phenomena and artefacts, and the important role of design principles in both querying our data and communicating our research. Finally, Part III examines how network analysis provides a set of ‘Manoeuvres’: intellectual manoeuvres that refigure cultural objects in our minds as abstract systems of nodes and edges, mechanical manoeuvres that structure data and navigate input versus output, and manoeuvres between a landscape of abstraction and research questions that are steeped in contextual information. Taken together, these processes seek to dismantle the binaries between the ‘humanistic’ and the ‘scientific’ and, in so doing, create new norms of practice and inquiry. These new norms, however, are yet to be established. They must necessarily be shaped in ongoing collaboration and exchange. In the closing pages, we therefore suggest how different groups of scholars, practitioners, and professionals can direct the network turn as it becomes a standard part of our critical cultural apparatus.