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# Big Data: Understanding how Creative Organisations Create and Sustain their Networks.

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**Abstract:** Big data is an evolving term used to describe the variety, volume and velocity of large amounts of structured and unstructured data. It can offer useful insights at both operational and strategic levels, thereby helping organisations to move forward in times of rapid change and uncertainty. However, there are challenges in terms of how best to capture, store and make sense of data. Many cultural arts organisations generate value through the relationships they create and the networks they sustain, but far too often this data is not clearly articulated or evidenced to leverage insight, support and business opportunities. The ArtsAPI project aimed to understand the connections that underpin the 'relational value' within the arts sector. The R&D project resulted in the development of a proof of concept business modelling and analytic tool to enable arts organisations to generate new insights through data capture, visualisation and analysis. The numerical/analytical technique of Social Network Analysis (SNA) was used to visually map and analyse network structures and relationships found within and across the extended boundaries of five cultural arts organisations located in the UK. Based on the 'blue print' from the SNA research, seven scenario-based insights were generated that offered impact measures for debates around evidencing forms of cultural value. These scenarios were later mapped onto a semantic ontology to create a 'SNA lite' web-based tool. In the paper to be reported here, we will set the context and background of the project, briefly describe the research methodology and the outcomes that influenced the development of the ArtsAPI tool.

**Keywords:** Big Data, Value, Social Networks, Relationships & Creativity.

## 1. Big Data and Cultural Organisations

Most people would acknowledge that the creative industries drive economic growth. Indeed, it is now estimated that the industry is worth over £84 billion to the UK economy (UK Economic Growth Media and Creative Industries, 2016). The driving force behind the industry's continued success is the growth in digital

content consumption, along with the rapid development of new platforms and digital technologies, especially through the expansion of devices connected to the internet (Design Commission, 2014). New trends like the Internet of Things (IoT) and Big Data will undoubtedly transform the way we live and work in an increasingly open and networked world (Greengard, 2015). To capture the full potential of these new trends, digital technology will rely on:

“...the increasing integration between devices, and the nature and quality of our reception and interpretation of this content. It is the case, then, that ‘the digital revolution’ pivots on user experience and the effective use of design” (Design Commission, 2014).

Big data is an area that is increasingly being used to make economic, cultural, social and policy decisions. However, despite notable efforts being put in place by the UK Government (for example open data such as the UK.GOV resource), there is still a gap between industry and the user’s capability to make informed decisions on how big data is being collected and used. Big data is an evolving term used to describe the variety, volume and velocity of large amounts of structured and unstructured data. It is used in a variety of fields like computing, healthcare, manufacturing, finance and organisational design. It can offer useful insights at both operational and strategic levels, thereby helping organisations to move forward in times of rapid change and uncertainty. Boyd and Crawford (2011) usefully point out that the value of big data:

“comes from the patterns that can be derived by making connections between pieces of data, about an individual, about individuals in relation to others, about groups of people, or simply about the structure of information itself” (Boyd and Crawford, 2011).

However, the challenges for any organisation is how best to capture, store and make sense of the data, and none more so for micro and small-enterprises run by artists and other creative professionals.

Arts organisations create art and are the lightning rods that help shape new ideas and practices into compelling works, that inspire and change the way people see the world. Crucially, arts organisations generate more than the output of their formal programmes. They are nurturers of people and of communities, offering a way of doing things, attitudes, values, and vision. To enable such activities to happen Gaggioli, et al, (2013) suggest that “actions of the individuals and those of the collective are in balance, and a sense of mutual trust, sharing, and empathy is established.”

Arts organisations working on the boundaries of sciences, or immersed in technical innovation, bridge between dissimilar people, professions, sectors and societies. For a few, this is now central to how they and others see them and what they do. These arts organisations have become new kinds of intermediaries and brokers, generating connectivity and interfaces between creatives, communities, companies and cities. Many of these cultural arts organisations generate significant value through the relationships they create and the networks they sustain (Oehler and Sheppard, 2010), but far too often this data is not clearly articulated or evidenced to leverage insight, support and business opportunities. It is possible for arts organisations to generate an income by creating new networks and relationships, by acting as a broker and intermediary. Gaggioli, et al, (2013) recognise “that individuals are situated in social environments, which can either facilitate or obstacle their creative potential.” It must also be acknowledged that creativity “is never the result of [an] individual acting alone.”

## 1.1 Background and Context

In partnership with Nesta, the Arts & Humanities Research Council (AHRC) and the Arts Council England, and funded through the Digital R&D Fund for the Arts, the ArtsAPI project brought together FutureEverything, an innovation lab for digital culture; a design research team at the University of Dundee; and leading semantic data specialists, Swirrl (Nesta, 2014). This transdisciplinary R&D project investigated the connections that underpin the ‘relational value’ that art organisations

generate and the ‘impact networks’ they sustain. In the context of this project, we describe relational value as the nature of the relationship based on an ontology developed through Social Network Analysis (see sections 2.1 & 2.2). We define impact networks as a combination of the strength of the connection defined through the level of contact, the number, type, geographical location of organisations, businesses and other key influencers in a social network. This ambitious and exploratory R&D project resulted in the development of a proof of concept business modelling and analytic tool to enable arts organisations to generate new insight through data capture, visualisation and analysis. This insight can be used for business planning, marketing, programming and as a way of demonstrating impact.

## 2. Research Methodology & Methods

Gaggioli, Riva, Milani and Mazzoni (2013) suggest that analysing the “sociocultural nature of creativity has also contributed to underlining the importance of financial, economic and historic factors in the development of creative progress”. Observing the dimensions of a creative ecosystem (by this we mean the wider ecology and economy of the arts sector) a set of questions were generated to explore patterns within networks to identify the flow of activity and observe how organisations interact with each other. SNA as a tool for visualising and analysing creative ecosystems provided the research with a robust mechanism and process. SNA was conducted with five arts partners across the UK to identify scenarios that could, not only inform the development of the ArtsAPI tool, but also encourage arts organisations to explore the hidden potential within their networks.

### 2.1 Social Network Analysis (SNA)

SNA is regarded as a mapping technique and is defined by Krebs (2013) as:

“...the mapping and measuring of relationships and flows between people, groups and organisations, computers, URLs and other connected information/knowledge entities. The nodes in the network are the people and groups while the links show relationships or flows between the nodes. SNA provides both a visual and mathematical analysis of human relationships.”

SNA can capture an overall representation of a social system in a visual format whilst deriving insights at the next level of complexity through quantitative analysis. In this research, the creative networks within and across the extended boundaries of five UK arts organisations were explored in order to understand the complexities in which they operate, bounded by the environments in which they exist.

Connectivity can have an impact on “performance, learning and innovation” (Cross and Parker, 2004). In particular, the ability of an organisation to be ‘creative’ relies on its ability to nurture and sustain relationships within a network (Gaggioli, et al, 2013). How ‘nodes’ and ‘cliques’ interact within a system, can provide insights into the way in which they can nurture creativity (Mazzoni, 2014). Moreover, the overall robustness or vulnerability of a network can be explored to establish its ‘health’ within a given context. This project adopted the technique of SNA to help examine the complexities of the arts partners’ creative ecosystems and identify the value of big data to the organisations.

### 2.2 SNA Methodology

The development of the ArtsAPI tool utilised the technique of SNA to establish the strength (or frequency) of network connections within an organisation, thereby, identifying hidden connections and key influencers within a distributed network. Initial research focussed on working with partner organisations to ‘model’ their existing network structures and to provide a blueprint using standard SNA techniques. Based on the ‘blueprint’ from the SNA research, a data model (implemented as a

Resource Description Framework (RDF) ontology) was produced that represented the essential features of an arts organisation. The goal was to replicate this modelling process digitally by developing prototype software that could gather data from a range of sources such as email. The outcome of this process fed into the development of the ArtsAPI tool and automated aspects of SNA processes in order to visualise organisational structures. In turn, this information could then be examined strategically by the organisations, as a way to monitor their business and determine hidden vulnerabilities within their network structures.

Measuring creativity is complex and we cannot isolate individuals and their work from the environment and social landscape in which they exist (Csikszentmihalyi, 1999; Gaggioli, et al, 2013). From a research perspective, the main goal of the ArtsAPI project was to understand the constituent parts and processes that underpin the relational value within the arts organisations. In other words, to understand the value of relationships that arts organisations manage, both internally within their organisation, and externally with partners and audiences, as they go about their activities. An online questionnaire was used to gather meaningful data about organisational networks. This data was then transferred into an SNA software package ready for direct processing as outlined below:

- **Stage1:** Identify the roles and responsibilities of individuals within organisations in order to establish the context for an investigative relationship.
- **Stage 2:** Develop and administer the online questionnaire to collect data.
- **Stage 3:** Map and visualise the network connections that are internal and external to the organisation based on the data.
- **Stage 4:** Analyse the data to explore the intra/inter-relationships of organisations in order to identify strengths and weaknesses based on SNA measures such as degree of connectedness, strength of connections and distance between connections.
- **Stage 5:** Use the results of the analysis as a 'blueprint' for the development of the prototype software, establishing the key components [ontology] that the software must be able to filter for, within alternative sets of data.

The SNA process was crucial in establishing key scenarios deemed to be valuable for arts organisations when analysing data produced by the ArtsAPI tool, allowing them to understand their creative ecosystems. These scenarios were defined by attributing characteristics to the data to give further analysis to the networks. These attributes were as follows:

1. Filtering networks by 'sector', to provide evidence of the interdisciplinary working and knowledge exchange of an organisation.
2. Filtering networks by 'country', to provide evidence of the international impact/reach of an organisation.
3. Filtering networks by 'activity' to provide different views of who is involved in key aspects of organisational activity across the network.

Such filters within the SNA data is useful when considering a creative organisation's business model and how the flow of information might pass through a network.

### 3. Project Outcomes

To understand the landscapes in which creative ecosystems perform, the project identified what characteristics the ArtsAPI tool needed to incorporate. If ArtsAPI allowed the arts organisations to visualise their network by sector, country and activity, the networks could then be analysed to ascertain the strengths and weaknesses of their business. Identifying vulnerabilities could therefore allow arts organisations to identify connections where information passes quickly through the system, but also consider how to strengthen the more vulnerable connections that could be crucial to support the network.

### 3.1 Project Outcomes (Tool Development)

One of the key challenges of the project was to establish how to operationalize notions of relational value and impact. Table 1 identifies the initial exploration of what the tool should be able to achieve.

*Table 1. Initial Exploration of Relational Value and Impact*

Aim	Mechanism
Provide evidence of the way in which Arts Organisations establish partnerships.	Visually map all existing partners & connections.
Provide evidence of the way in which Arts Organisations grow partnerships and connections.	Visually identify new network connections within the network.
Provide evidence of the way in which Arts Organisations encourage and promote knowledge exchange amongst partners.	Visually identify who the arts organisations are regularly exchanging and sharing information with, through email, social media and calendar events. Visually identify who the arts organisations are regularly collaborating with on projects.
Provide evidence of the way in which Arts Organisations collaborate with social, health, educational and cultural services.	Visually differentiate partners into sectors to highlight diverse cross sector relationships where they exist.
Provide evidence of the way in which Arts Organisations have internationalised their network.	Visually map international partners and their country of origin.
Provide evidence of the way in which Arts Organisations support progress in developing countries.	Visually map links with organisations in developing countries.

Further research established several scenarios for the use of ArtsAPI, whereby the key ‘impact measures’ could be incorporated into the tool. These were as follows:

- **Scenario 1 Connectedness to different sectors:** Being able to demonstrate that you are connected to many different sectors is itself an impact that could be used to leverage funding or support from a variety of organisations. Acting as a relationship broker and an intermediary shows you are introducing artists to industry and vice versa, as well as generating a culture of interdisciplinary working and thinking. Analysing networks will show how well you are connected to different sectors and who is playing an active role in generating those connections, allowing you to strengthen your resources in key areas like sponsorship, programme development and/or PR.
- **Scenario 2 Connectedness to different cities and countries:** Demonstrating you have international impact could be used to leverage funding or support from a variety of organisations. Analysing networks will show how well you are connected regionally and internationally and who is playing an active role in generating those connections. This would then allow an organisation to understand the extent of their international relationships and identify strategic areas for future investment. This would also highlight the presence and prestige of an organisation within a global context.
- **Scenario 3 Connectedness to people with different skill sets and positions:** Demonstrating that you not only have good connections with different sectors, both

regionally and internationally, but that you also have strong connections with influential people who have a variety of skills, can suggest your organisation is influential within a creative ecosystem, thereby gaining the respect of other art partners. There are positive benefits of knowing the positions and skill sets of the people you have in your networks, as this provides an organisation with an opportunity to nurture and build new partnerships with key individuals and groups. Indeed, organisations have many connections with a variety of sectors geographically dispersed, but the connections are with individuals who may not have any influence.

- **Scenario 4 Generating and sharing ideas:** Art organisations promote and disseminate new creative ideas, practices and outcomes. A large part of their work consists in generating and sharing ideas. Representing the way in which organisations generate and share ideas internally and externally with partners, can demonstrate impact and value. This allows an organisation to understand how its team is operating, enabling an organisation to plan, allocate resources and support team members.

### 3.2 Project Outcomes from SNA (Useful to Arts Organisations)

The aim of the research was twofold. Firstly, it aimed to establish which elements of SNA practice might be valuable to the development of the ArtsAPI tool by considering how applicable the outcomes were to the arts organisations involved in the project. Secondly, it aimed to benefit the wider arts sector by promoting a better understanding of data specific to the arts, in turn generating new business models and opportunities. By identifying who key decision makers and enablers are within arts organisations could provide an opportunity for organizations, within the wider arts community, to make decisions and operate on a more evidence based, commercial and entrepreneurial basis. To this end, detailed SNA reports were produced for the arts organisations and presented in feedback sessions with each one. Some of the key findings are as follows:

1. Arts organisations live and die through working with partners beyond their own internal structures. This makes connections to people in other organizations vital, as they collaborate to develop their portfolio of activities (e.g. festivals, events, workshops, exhibitions, projects and art works).
2. The expectation then, is that arts organizations would have strong links to external bodies in order to make vital collaborations possible. In contrast, we found through SNA that those links between organisations were often quite weak in terms of frequency of interactions (or strength).
3. Additionally, we found that these weak ties were centred around key individuals within the arts organisation. There were very few cases where connections between organisations were many-to-one or indeed many-to-many. The overwhelming pattern across all the organisations we worked with was a one-to-many (i.e. a correspondence between one key individual within the arts organisation and multiple external partners). The consequence of this is that arts organisations are particularly vulnerable if something should happen to those key members of staff (e.g. illness or resignation). Interestingly, the value of key individuals could be measured by contacts they have with external partners, so when recruiting new members of staff, arts organisations might want to know what kind of connections that person brings with them, especially in regard to replacing someone who has just left.
4. We also found that information flow between organisations varies from project to project e.g. when an arts organization is involved in either project delivery or the evaluation of the project, the level of communication goes up with external partners and thus the strength of connection is visibly increased. This suggests that areas, of

what appear at first to be, a loose network of lightly connected nodes become 'fired-up' (much like neurons in a neural network) during particular kinds of activities. In a sense, the multiple weak connections are essential to arts organisations because they bring a special kind of flexibility and agility that allows an arts organisation to respond to particular situations or project proposals by 'switching on' the right network connections at the right time. So, while they are potentially vulnerable to the loss of key nodes, the many-to-one connections provide for the necessary quick response adaptability that is at the heart of their business activities.

### 3.3 Impact of SNA on ArtsAPI Tool Development

As a result of the SNA research, we were able to inform the design of the ArtsAPI tool through the use of a variety of measures that provided an understanding of arts organisations, their internal and external networks and the way in which they engage with each other through particular aspects of a project. Using algorithms developed from SNA we were able to provide information about a network in relation to vulnerability, influence and power.

The following measures were embedded within the ArtsAPI software:

**Density** is a measure of the sum of all the ties in a network divided by the number of possible ties in a network. A highly dense network would be a network where most of the nodes are connected to one another. Density then is a measure that provides insights into the speed of information handling within the network. Networks with high-density can exchange information in a more timely manner than low-density networks.

**Clustering** is a feature of the ArtsAPI tool that allows you to establish the connections of an organisation in relation to three different filters that are set up during the tagging process.

- By Country, reveals a ranked list of countries that your organisation is connected to ordered by the number of connections you have in that country.
- By City, reveals a ranked list of countries that your organisation is connected to ordered by the number of connections you have in that country.
- By Sector, reveals a ranked list of countries that your organisation is connected to ordered by the number of connections you have in that country.

**Out Degrees** is a measure of the number of outgoing connections from one node to many others. It tends to show whom within a network is distributing information. These nodes may be described as 'information sources'. High Out Degree scores tend to signify people who are sending information to multiple connections. Low Out Degree scores tend to signify people who send very little information to few connections.

**In Degrees** is a measure of the number of incoming connections from the network to an individual node. It tends to show whom within a network is receiving information from other nodes. These nodes may be described as 'information seekers'. High In degree scores tend to signify people who are receiving information from multiple connections. Low In Degree scores tend to signify people who receive very little information from few connections. There are three important points to take into consideration when analysing the numbers aligned to each node.

1. Firstly, it provides evidence of sources and seekers of information within a network.
2. Secondly, it can also show people who are over and under-utilised, thereby allowing the organisation to empower people or allocate tasks to others.
3. Thirdly, people with low numbers of incoming and outgoing connections may be isolated from the group, and the organisation can then make attempts to bring them back into the community.



**Degree Centrality** is a measure that establishes which nodes are central to a network in terms of control over information flow. It is calculated in relation to Out Degrees and In Degrees and like Density it determines the number of direct connections a node has in relation to the maximum number that they could have. More connections an individual has the more likely that individual will be highly central to the network. The measure is useful in that it provides a score of the central and peripheral players in the network. Its primary function is to help an organisation determine the importance, or prominence of a node within a network. By comparing centrality scores it is possible to establish who the key central connectors are within an organisation. Interestingly, the location of a node within a network can be very different from their formal position within an organisational chart. Moreover, it can also help to identify, from a relational point of view, which nodes may be over or under-utilised within a network.

## 4. Working with Big Data

Using Density, Connectivity, Centralization Index and Clique Participation Index, as measures of SNA, enabled us to draw comparisons and insights through the analysis of statistical data at a much deeper level. However, the primary aim of this paper was to discuss how the research informed the development of the ArtsAPI tool and not the detailed analysis across the five arts partners.

The purpose of the ArtsAPI project was to build and test a proof of concept business modelling and analytics tool that could change the way arts organisations approach data as part of their broader digital strategy – repositioning it as a core component of the decision-making process.

Data played a crucial and fundamental role in the development of ArtsAPI. Working out what data arts organisations collect and generate, how accessible that data is and what could be the most useful data for the project was important in the development of the ArtsAPI tool. Once we established which data to use, we considered how it could be accessed and how it could be formatted for use. Through consultation with the arts partners, it became evident that email data would be the most valuable. As a result, it brought challenges when working with personal information e.g. the social and ethical issues that were raised as well as robustly addressing privacy and related concerns in terms of data protection legislation. The size and complexity of the dataset also presented challenges, as it allowed the tool to access external links which the SNA research could not reach.

Understanding how creative ecosystems operate relies upon an understanding of how creative work gets done. This is not due to any one individual but is in fact a process that requires collaboration within 'social' and 'contextual' spaces through effective networks (Gaggioli, et al, 2013). Such networks are not currently analysed using big data, primarily due to the sensitivity, legal and ethical issues. The ArtsAPI tool demonstrated the complexity of working with email data and presented the ethical dimensions surrounding such activity. It is however possible for arts organisations to harness creative activity within their own ecosystems, recognising the drivers that create and sustain their networks, allowing them to make more strategic decisions to create robust business models. Di Maggio (1997) suggests that the "role of the individual is not diminished, but incorporated in a specific social context which acts as a 'cognitive breeding ground' for the development of ideas". This 'breeding ground' acts within a creative ecosystem, nurturing ideas, generating relationships and impacting on our social spaces and interactions. Understanding these networks and identifying vulnerabilities could offer arts organisations a chance to become more sustainable for future local, national and global developments.

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