Visualizing Cultural Digital Resources using Social Network Analysis

Antonio Capodieci[1], Daniele D'Aprile[1], Gianluca Elia[1], Francesca Grippa[2] and Luca Mainetti[1]
[1]*University of Salento, Via per Monteroni snc, Lecce, Italy*
[2]*Northeastern University, 360 Huntington Avenue, Boston, MA, U.S.A.*

Keywords: Information Extraction, Information Gathering, Cultural Heritage Objects, Real-Time Data Extraction, Social Network Analysis.

Abstract: This paper describes the design and implementation of a prototype to extract, collect and visually analyse cultural digital resources using social network analysis empowered with semantic features. An initial experiment involved the collection and visualization of connections between cultural digital resources - and their providers - stored in the platform DiCet (an Italian Living Lab centred on Cultural Heritage and Technology). This step helped to identify the most appropriate relational data model to use for the social network visualization phase. We then run a second experiment using a web application designed to extract relevant data from the platform Europeana.eu. The actors in our two-mode networks are Cultural Heritage Objects (CHOs) shared by institutional and individual providers, such as galleries, museums, individual experts and content aggregators. The links connecting nodes represent the digital resources associated to the CHOs. The application of the prototype offers insights on the most prominent providers, digital resources and cultural objects over time. Through the application of semantic analysis, we were also able to identify the most used words and the related sentiment associated to them.

1 INTRODUCTION

The role of social media in distributing travel-related information can no longer be ignored by tourism marketers. Involving the crowd allows managers and policy makers to identify potential customers' needs and, via participatory activities, to interact and retain those members of the crowd who are mostly interested in visiting particular points of interest (Miguens et al, 2008). More and more, user-generated content is complementing traditional sources of information, creating an unexpected competition among service providers such as travel agencies, travel guides, or territorial development agencies. Online social travel networking is changing the way tourists plan their trips. Crowdsourcing websites such as Triptease, Find My Itin, Stackla, Gogobot, Geeks on a Plane, offer users an interactive and visual experience to plan a trip based on what peers suggest.

Collecting and recombining this ever-changing knowledge base created by customers, suppliers, or the general public, is facilitated by the creation of informal communities that share common interests, learn, interact and collaborate towards common goals. In the context of creating and nurturing these informal communities, social networking platforms enable the creation of relationships with important stakeholders. The biggest value of social networking sites is represented by their ability to act as channels to foster collaboration and innovation. Social networks play now a key role in planning strategies to engage communities within and outside the organizational boundaries, recruit employees with the right skill-set, and develop innovative ideas.

The goal of our research is to design and test a prototype to extract, collect and visually analyse cultural digital resources using social network analysis (SNA), empowered with semantic features. The research questions leading our study are: How to identify the most active providers of digital resources in an online platform? How positive or negative is the content shared by these providers to illustrate a cultural resource? What types of cultural resources are exchanged by online communities during a specific timeframe? Which is the historical period that attracted most of the attention within an online community sharing digital cultural resources?

The experiment we describe in this paper provides a valuable perspective on the evolving

Capodieci, A., D'Aprile, D., Elia, G., Grippa, F. and Mainetti, L..
Visualizing Cultural Digital Resources using Social Network Analysis.
In *Proceedings of the 7th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2015) - Volume 1: KDIR*, pages 186-194
ISBN: 978-989-758-158-8

interests of online communities towards cultural heritage. Our research relies on the results of DiCet, an Italian research project which sets the ground of a Living Lab focused on Culture Heritage and Technology. The DiCet project defines and implements models, processes and ICT tools for sustainable development of an intelligent territory through the exploitation of its cultural heritage and environmental resources. The project adopts the Future Internet paradigm and social networking techniques to realize an ecosystem of cooperating heterogeneous entities such as companies, government, citizens and tourists. DiCeT aims to define and develop an open enabling platform of intelligent services for cultural heritage capitalization, able to enhance cultural experience by leveraging on social inclusion, interaction and augmented reality. The project aims to build innovative services for improving the knowledge shared by tourists, citizens, operators, and researchers, as well as the cultural heritage fruition, its conservation and preservation. The project benefits from a multi-stakeholder partnership composed of Italian universities, private companies and research centres (i.e. University of Salento, IBAM CNR Engineering Ingegneria Informatica SpA, Open 1, Expert System, etc.).

DiCet leverages the federated architecture of Europeana, the largest European digital library (http://www.europeana.eu), which allows to flexibly manage cultural content in the cloud. In the context of the emerging Internet of Things (Xia et al., 2012), Europeana represents an important effort to link cultural heritage objects (CHOs) and their metadata across several cultural institutions. This has the potential to provide policy makers, researchers and tourists with the opportunity to explore cultural heritage in a more enriched way.

Europeana connects more than 2,000 European institutions, from regional archives to local museums. These providers contribute to feed this open library with digital objects, thus sharing cultural and scientific heritage items from prehistory to modern era. Europeana introduces the Europeana Semantic Elements, a common standard to facilitate information retrieval of cultural items at European level. The Europeana Data Model introduces a richer metadata standard that helps users to receive more and better quality digital content. Despite the recent interest in capturing data on the creation of cultural digital resources, there seem to be still issues concerning the quality and quantity of the information found in the descriptive metadata associated with the digital representations of cultural heritage objects (Beaudoin, 2012). This information is often considered inadequate to make sure users understand the nature of the cultural object and its digital representation (Tsirliganis et al., 2004). The goal of developing a web application to collect data from Europeana is to analyse how different providers (e.g. galleries, foundations, individual experts) interact, co-create knowledge, and share cultural digital resources.

Our quasi-experimental design (Shadish et al., 2002) involved collecting insights to address the issues of metadata interoperability within DiCeT, thus designing a "Semantic Enterprise Service Bus for Cultural Heritage" to access data and information coming from multiple data sources. The service bus uses an ontology-based approach to integrate different and heterogeneous data sources (Wache et al. 2001; Gawinecki, 2008; Shi et al. 2014; Zhu 2012). We first run a pilot experiment with all the data stored in the DiCet platform in order to visualize and measure the structure, content and sentiment of social communication networks by using the software suite Condor. Then, we built a web application to collect data from the Europeana portal, and process cultural objects using the same approach and methodology. To this purpose, we selected a sample of cultural objects to demonstrate the potential of the web application.

2 SOCIAL NETWORK ANALYSIS IN THE TOURISM INDUSTRY

An important aspect of social media applications is the wealth of user generated content. This can prove highly beneficial in directing tourists' choices, and can be of extreme value for the understanding of market preferences and needs. New opportunities for research are now available considering the growing online connectivity of individuals, as well as the development of APIs allowing more directed data collection (Miguéns et al., 2008; Schoder et al., 2013). Recent experiments are proposing new systems to build new type of communities based on physical proximity. Pietilainen et al. (2009) designed and implemented a mobile social networking middleware named "MobiClique" that creates and exploits ad hoc social networks to disseminate content using a "store-carry-forward technique". SNA techniques and tools have been demonstrated to be useful to dynamically assess the value created by social interactions. Some of the most commonly used metrics of social network include indicators of

individual prominence such as contribution index, closeness and betweenness centrality, as well as group level indicators like density, group degree or betweenness centrality (Borgatti and Everett, 2006).

Researchers have been analysing social networks by mining e-mails, forum posts, mailing list archives, hyperlink structure of homepages, or co-occurrence of text in documents (Erétéo et al., 2008). Social Network Analysis offers a well-established set of tools and techniques to monitor the emergence of social interactions (Wasserman and Faust, 1994). By mapping social networks of online users and the content they exchange it is possible to recognize emerging communities based on specific aggregation criteria, such as virtual and physical proximity, data sharing, or access to common services. It is also possible to monitor how preferences and needs change over time and locate the community members with high betweenness centrality or degree centrality (Wasserman and Faust, 1994), who have the potential to provide access to a large number of members with similar needs, preferences or skills.

Despite the interest in adopting a network approach to study interactions in the tourism industry (Tonti and Baggio, 2012), there is still a lack of empirical research on the benefits of monitoring the evolution of networks of people interacting on social media with a touristic vocation. D'Agata, Gozzo and Tomaselli (2012) employed measures derived from Social Network Analysis to create territorial networks. The authors used survey data from a sample of tourists leaving from airports and ports of the main cities in Sicily (Italy). Despite the interesting results, the work still relies on traditional approaches, such as surveys and questionnaires, to understand how people and places interact with each other. In our research we use data shared directly by users on a platform. Digitally-enabled SNA affords relatively unobtrusive and objective measurement of interaction behaviours of individuals and groups. By observing their evolution in terms of structural properties (e.g. degree centrality, density) as well as content creation, it is possible to recognize how positive and negative opinions are disseminated and how they influence people in the context of online communities. Given the importance of collaborative relationships to act as critical channels for knowledge search, transfer and creation, policy makers and cultural institutions might benefit from developing networks with other users that may represent valuable sources of knowledge.

3 A NETWORK APPROACH TO VISUALIZE CULTURAL RESOURCES

In this study, we combine SNA with semantic analysis to overcome the intrinsic limitation of traditional SNA studies that consider all the ties in a network as homogeneous in content. Content analysis and other text analytics techniques are complementary research methods useful to make inferences from texts about the context of their use.

Campbell and Pennebaker (2003) have implemented a probabilistic computational system called Linguistic Inquiry and Word Count (aka LIWC) that counts all the words in a body of text and classifies each word as belonging to one or more "dictionaries", including positive and negative words. Gloor et al. (2009) have used a bag-of-words approach similar to LIWC. The bag-of-words model is a simplifying representation used in natural language processing. In this model, text such as an e-mail or a forum post is represented as an unordered collection of words, disregarding grammar and overall meaning. Gloor et al. (2009) have classified and counted the number of words in each actor's email communication that reflects positive or negative emotion, or the use of an ego word, and then aggregated individuals' data to the team level. Zhang et al. (2013) used sentiment analysis to assess teams using dynamic SNA.

Figure 1 describes the methodology we followed to extract data initially from the DiCet platform, and then from the Europeana portal. In order to visualize and analyse the relational data, we selected social network metrics and semantic indicators to represent both structural properties of social networks, and the semantic associated to each object.

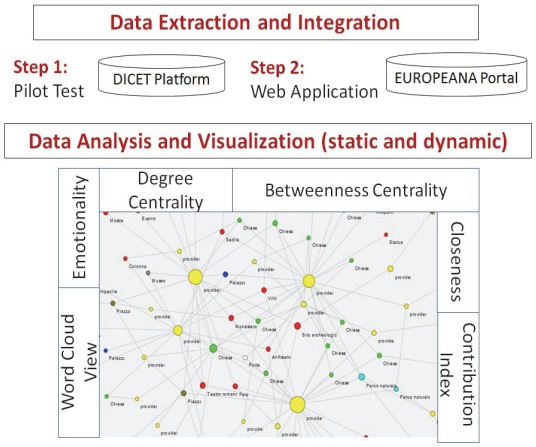


Figure 1: Steps of the methodology.

Specifically, we used actor betweenness centrality, actor degree centrality, density and word usage, which offered meaningful insights to address our research questions. Betweenness centrality is calculated as the fraction of shortest paths between every possible pair of nodes that pass through at least one node in the group (Wasserman and Faust, 1994). Actor degree centrality is the total number of other points to which a point is adjacent. We also looked at density of the graphs, calculated as the total number of ties divided by the total number of possible relational ties (Wasserman and Faust, 1994; Borgatti and Everett, 2006). We finally looked at the sentiment conveyed by the providers in describing the cultural heritage objects (CHO). Sentiment is a measure with a value between 0 and 1, where 0 indicates that the message is very negative and 1 very positive (Brönnimann, 2014, Pang et al., 2002). Sentiment of the message is calculated from a specially developed multi-lingual classifier based on a machine learning method with data coming from Twitter. In this study we calculate positive and negative sentiment in the comment left by users using a simple "bag-of-words" approach (Whitelaw et al., 2005), employing user-generated mood word lists relevant for the domain area. This approach has been developed initially looking at large e-mail archives (Gloor et al., 2009). For each e-mail, "emotional words" matching a pre-loaded list were counted and then normalized by the total number of words in each message (Brönnimann, 2014). Following this approach, each e-mail or any other text is assigned with a positivity value and a negativity value ranging from 0 to 1.

Another metric of sentiment analysis that we used in this research is the "word usage over time" based on the most frequently used term saved by the providers to describe CHO and its digital resources (Gloor et al., 2009).

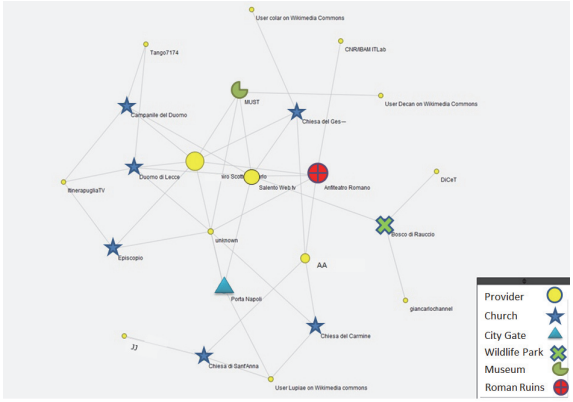


Figure 2: Visual Maps of users and points of interest.

There are a few software packages that can deal simultaneously with several sources of data and combine them in a way that is easily available for visualization to final users. In this study we used the software program Condor, which allows to visualize and measure the structure, content and sentiment of social communication networks over time. Condor creates static maps and movies of relationships that can come from social networks, web site link structures, and concept maps of unstructured documents, online forums, phone archives, or e-mail networks.

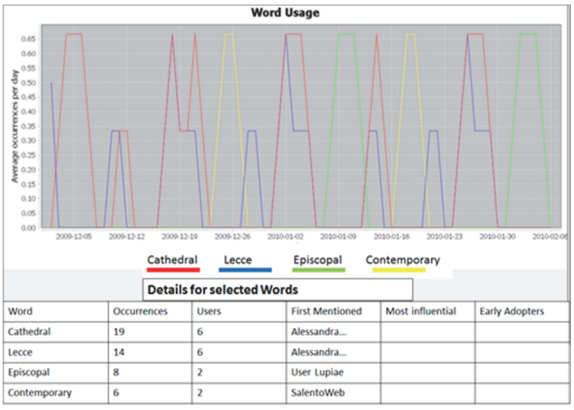
4 BUILDING THE PROTOTYPE

4.1 Pilot Test with the DiCet Platform

In this study, a provider is a generic entity that can provide content to the platform. A provider can be a museum, a cultural expert, or a tourist. In that sense, it will be treated either as a string of text or as an URL. Figure 2 illustrates an example of a two-mode network where nodes represent both the digital contents and points of interest (resources), and the individuals or organizations uploading them into the system (providers). Definitely, two mode networks are characterized by actors who belong to two different sets (Wasserman and Faust, p. 29) that are providers or resources.

In the sociogram shown in Figure 2 the size of the node represents the betweenness centrality, which offers initial insights on the most active contributors in the DiCet platform. Bigger nodes represent resources or providers that connect more resources/providers who would not be otherwise connected (Wasserman and Faust, 1994). In other words, the size of the node represents the most active users/data providers, or the most talked about and discussed resources. For example, by looking at Figure 2, the Roman Ruins and the city Wildlife Park were the points of interest that mostly attracted the attention of users who posted more photos or more comments about them.

Figure 3 illustrates the evolution over time of words used by providers of digital resources in order to describe points of interest. The graph identifies the words that were most frequently used every day by the users of the DiCet platform. It also detects who was the first provider to use that word and when this occurred. This representation used a Bag-of-Word approach (Gloor et al., 2009) to calculate the word usage and offer some insights about the extent of language complexity used to describe the



Word	Occurrences	Users	First Mentioned	Most influential	Early Adopters
Cathedral	19	6	Alessandra...		
Lecce	14	6	Alessandra...		
Episcopal	8	2	User Lupiae		
Contemporary	6	2	SalentoWeb		

Figure 3: Word Usage (DiCet platform) – hypothetical timeframe.

digital resources/points of interest. Looking at indicators such as "deviation of word usage", we can determine how complex or essential the communication is and we can observe new ideas being generated over time. In the example presented in Figure 3, we were able to identify the most popular concepts over time, based on their occurrences. For instance, "cathedral" and "Lecce" were the most talked about terms (19 and 16 occurrences) and the user "Alessandra A." was the one to introduce those concepts for the first time.

The sentiment classifier used in the Condor software is able to determine positive, negative or neutral sentiment of documents in various languages, though the most reliable results are still based on the use of English words. The sentiment classifier is currently in a training phase for the Italian language. This is the reason why we did not conduct a complete sentiment analysis for the DiCet posts. Nevertheless, we were able to identify the most frequently used words over time (see Figure 3).

The next sections illustrate how we used the insights from the DiCet pilot test to build an application that can extract data from the portal Europeana.eu.

4.2 Development of the Europeana Web Application

Europeana.eu is an Internet portal that acts as an interface to millions of books, paintings, films, museum objects and archival records that have been digitised throughout Europe. Mona Lisa by Leonardo da Vinci, Girl with a Pearl Earring by Johannes Vermeer, the works of Charles Darwin and Isaac Newton, and the music of Wolfgang Amadeus Mozart are some of the highlights on Europeana. Europeana gives access to different types of content from different types of heritage institutions. The digital objects that users can find in Europeana are not stored on a central computer, but remain with the cultural institution and are hosted on their networks. Europeana collects contextual information – or metadata – about the items, including a small picture. Users can search this contextual information and, once they find what they are looking for, they can access the full content of the item by clicking through the original remote site that holds the content.

The Europeana portal is used to search and browse a public repository which contains many objects of various types including books, audio and video objects, photos, paintings, etc. These objects are collected from different domains, including fashion, natural history, archaeology, history, art, and so on. Users can narrow their search and filter by titles, creators, subjects, dates/periods, or places. Alternatively, they can type the words "who", "what", "where" or "when" into the Europeana search box followed by a colon.

The web application we developed provides the same search and filtering functionalities as the Europeana portal, presenting the results in a human friendly representation (html). It has been implemented in order to facilitate access to Europeana Metadata by remote invocation of Europeana Search API when using the Java programming language. This was developed by using the *Europeana4J* source code which provides a comprehensive set of features for interacting with the HTTP / REST-based Europeana API. It also exports the search results in CSV format, which is commonly accepted for SNA tools.

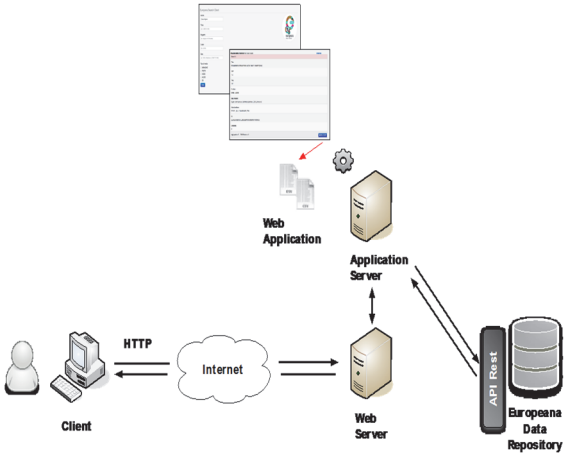


Figure 4: System architecture overview.

Figure 4 provides an overview of the system architecture that highlights the two main

components: the web application and the Europeana metadata repository. The Europeana REST API allows to build applications that use the wealth of cultural heritage objects stored in the Europeana repository. The API uses the standard web technology of REST calls over HTTP. Responses are returned in the popular JSON format. The users of this web application typically use an Internet browser to retrieve and visualize the Europeana objects. After performing a search, our application allows to export the results in .CSV format, in order to feed the social network analysis tool and proceed with data analysis and visualization.

4.2.1 Class Diagram

The web application implementation is based on the main classes of the Europeana4J framework and on some specific classes that allow users to export results in CSV format. For example the classes EuropeanaConnection and EuropeanaApi2Client implement the querying of the Europeana API, making use of the HttpConnector class, which facilitates reliable communication over the http protocol.

The class EuropeanaApi2Results deserializes the message in the response returned by the Europeana server and provides the Europeana objects. The SearchAction class handles the parsing of Europeana JSON metadata text documents and the creation of internal Java objects. Finally, the ExportAction class uses handy methods belong to CreateCSVFile class to write results into CSV files.

4.2.2 Network Visualization of Europeana Data

Using data extracted through the web application, we built two-mode networks composed of actors represented by Cultural Heritage Objects (CHO) and their digital representations (web resources), and links represented by the association between CHOs and web resources. In some cases, providers of digital resources are museums, galleries or individuals (called "data providers"); other times digital resources are provided by external aggregators who have been asked to post the resources *in lieu* of the data providers who own the resources. For instance, a CHO could be the "Mona Lisa" of Leonardo da Vinci, and the digital resources could be several Mona Lisa's replica in different formats: a Mona Lisa caricature printed on a box, sculptures inspired by the painting, or a video documentary on the painting itself.

We run initial experiments on the portal Europeana.eu using basic searching options as well as advanced ones, for example adding the string "Who" to identify a specific author. Table 1 presents a subset of keywords used to test the web application: "Divina Commedia/Dante Alighieri"; "Mona Lisa", "all the manuscripts between the 13th and the 14th century"; "King Lear" by Shakespeare and "La Dolce Vita" (i.e. the famous movie by Federico Fellini). The examples shown in Table 1 have been chosen since they are representatives of the variety of results we can obtain.

Table 1 summarizes the number of CHO shared on Europeana by different providers. The links are represented by the web resources associated to the CHO, while the network density represents the actual links between nodes out of the total possible connections. For instance, we built the Divina Commedia network based on 304 nodes (i.e. CHOs) with 204 associations based on the number of web resources associated to each CHO. The low density for the CHO Divina Commedia indicates that there are fewer resources shared on Europeana connecting the cultural objects. This means that cultural objects with a higher density are the most popular. In Table 1 most of the nodes/CHO have low density, though King Lear seems to emerge as the one with a higher relative popularity.

Table 1 presents also a comparison of the type of resources available for each CHO. Users tend to share resources that are less textual and more audio-visual when the objects are Mona Lisa or La Dolce Vita. This is not a surprise given the nature of those cultural objects.

Table 1: Search Results from Europeana.

	Divina Commedia	*Mona Lisa*	*Manuscripts [1200 to 1300]*	*La Dolce Vita*	*King Lear*
Nodes	304	239	284	150	294
Links	204	139	184	51	196
Density	0.0022	0.0024	0.0023	0.00224	0.00225
Resource Type	92 text, 8 image	85 images, 31 sound, 24 text, 2 videos	22 images, 115 text	90 images, 4 sounds,3 text, 3 videos	59 images, 40 text

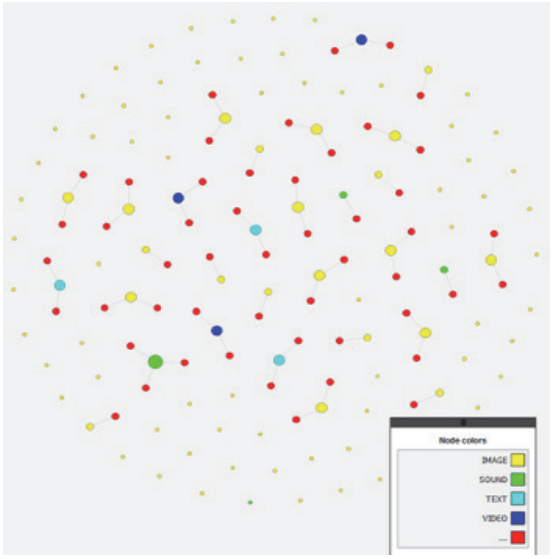


Figure 5: Graph of the CHO Mona Lisa.

Figure 5 illustrates the network of the CHO "Mona Lisa" and its digital resources. The colour represents the type of resource available for the Mona Lisa object: image, sounds, text, or video. The size of the node is based on Betweenness Centrality, so the bigger the circle, the most central is the cultural object in terms of number of resources posted on Europeana. In this case betweenness centrality can offer some insights on the ability of a CHO to connect different resources and different providers, acting as hub for other nodes (e.g. museums, experts, aggregators).

Figure 6 shows the Word Cloud View for the cultural object "King Lear". The colour settings from red (negative) to green (positive) offer a first, visual indication of the extent the words used to describe resources are considered negative, neutral or positive. In order to visualize the word cloud view, we had to run a sentiment analysis on the nodes' description (Brönnimann, 2014, p.2). In this case the text is represented by the description of cultural objects and associated resources. In Figure 6, words such as "lear", "king" or "errors" are marked as negative, while others such as "correct", or "1608" are considered positive.

5 DISCUSSION

The web application we designed, applied and described in this paper is based on a Java library developed in an open collaborative environment. Because of that, it is under continuous improvement. In this early stage it offers good potential for users to explore the wealth of cultural heritage using a single web application, which acts as interface for any social network analysis tool. We should not ignore that issues of metadata interoperability still remain a challenge, despite Europeana's efforts to help institutions and data providers to create a single metadata repository. To address these issues a "Semantic Enterprise Service Bus for Cultural Heritage" is under development within the DiCet project, in the aim to make accessible all the information and contents in the field of cultural heritage. For its design and implementation, an ontology-based approach has been adopted, in order to integrate different and heterogeneous data sources.

From a technical perspective, the novelty can be identified in the design and experimentation of a prototype that allows a controlled extraction of data and information from Europeana data source, in a format that is machine readable from the SNA tool adopted in the study (Condor). The choice to adopt infographics map (Smiciklas, 2012) to represent the results of data processing normally facilitate the interpretation of data, leaving more time and energy for action design and implementation. Finally, with very few customizations of the code, the same set of data can be generated for feeding other SNA tools.

This work can open new scenarios of a larger research and development agenda that aims at implementing and interpreting a network representation of cultural digital resources grounded on the use of semantic technologies.

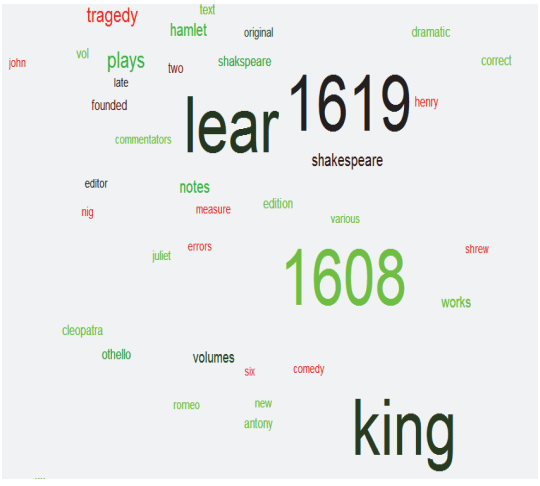


Figure 6: Word Cloud View of CHO King Lear.

The web application described in this paper gives the opportunity to explore other visualizations of search results. For example, out of N objects

authored by a painter (e.g. Michelangelo), we might be able to identify the most popular painting from that same author based on the number of resources shared by different data providers.

The research implications of this study include the exploration of a domain with high potential for regional development by adopting a systemic approach which integrates network structure-based metrics with a semantic-based approach. This paper described preliminary results that can be replicated using similar data extracted in other regions with similar cultural attraction.

In terms of implications for practitioners, the described methodology can be used to identify the most active providers in the online social network in order to engage them and learn from their experience. These online contributors feed the knowledge base with new digital contents that represent a great attractor to enlarge the community itself. Users can perform their research on Europeana by using textual queries. Unfortunately, the portal does not seem to currently allow any kind of visual interrogation using pictorial components (Boujemaa et al., 2002). Our web application uses the API available for programmers so it does not use a retrieval approach based on global visual similarity.

6 CONCLUSIONS

The application of this prototype offers the opportunity to identify "content gap" in an online platform such as Europeana, helping to complete the knowledge base with new digital resources or with improved semantic. Our work provides also the opportunity to policy makers and local or national government entities to identify clusters of interest around cultural objects, enabling the design of marketing campaigns on the territory to promote touristic products by targeting users with high probability to transform the interest in actual purchase.

Research in the area of content-based image retrieval (CBIR) has developed several algorithms that can realistically "*return a list of images that matches the visual perspective of their inventors*" (Kwan et al., 2011). However, there is still a problem known as "semantic gap" for queries based either on images or on tags, since the images or textual results often do not correspond exactly to the results expected by the users.

It would be an important development for the Europeana project to include content-based image retrieval along with text retrieval. In the future we plan to replicate the analysis with a larger sample of cultural heritage objects randomly selected on the Europeana portal, designing larger and more coordinated experiments. Further research is needed to expand on the preliminary insights that we obtained from these initial experiments.

ACKNOWLEDGEMENTS

This work is partially supported by the project: "PON04a2_D - DiCet LivingLab Di Cultura e Tecnologia – INMOTO – OR.C.HE.S.T.R.A.". The project is funded by the Italian Ministry of Education, University and Research (MIUR).

REFERENCES

Beaudoin J.E. (2012) A Framework for Contextual Metadata Used in the Digital Preservation of Cultural Objects. *D-Lib Magazine*. 11(11/12).

Borgatti, S. P., Everett, M.G. (2006). A graph-theoretic framework for classifying centrality measures. *Social Networks* 28(4): 466-484.

Boujemaa N, Gouet V, Ferecatua M (2002) Approximate Search vs. Precise Search by Visual Content. In *Proceedings of MIR Workshop ACM-MM*.

Brönnimann, L. (2014) Multilanguage sentiment analysis of Twitter data on the example of Swiss politicians. M.Sc. Thesis, University of Applied Sciences Northwestern Switzerland; retrieved from http://www.twitterpolitiker.ch/documents/Master_Thesis_Lucas_Broennimann.pdf.

Campbell, R.S., Pennebaker, J.W. (2003). The secret life of pronouns: Flexibility in writing style and physical health. *Psychological Science*, 14: 60-65.

D'Agata R., Gozzo S., Tomaselli V. (2012) Network analysis approach to map tourism mobility, *Quality & Quantity*, 47, (6): 3167-3184.

Erétéo G., Buffa M., Gandon F., Grohan P., Leitzelman M., Sander P. (2008). A state of the art on social network analysis and its applications on a semantic web. *SDoW2008, workshop at ISWC*.

Europeana Creative, *D2.1 – Metadata Retrieval Services Based on Semantic Web Technologies,* retrieved on 05/26/2015 from http://pro.europeana.eu/files/Europeana_Professional/Projects/Project_list/Europeana_Creative/Deliverables/eCreative_D2.1_NTUA_v1.0.pdf

Gawinecki, M. (2008). How schema mapping can help in data integration?–integrating the relational databases with ontologies. *ICT School, Computer Science.*

Gloor, P. Krauss, J. Nann, S, Fischbach, K. Schoder, D. (2009) Web Science 2.0: Identifying Trends through Semantic Social Network Analysis. *IEEE Conference*

on Social Computing (SocialCom-09), Aug 29-31, Vancouver.

Kwan P.W., Kameyama K., Gao J., Toraichi K. (2011) Content-based image retrieval of cultural heritage symbols by interaction of visual perspectives. *International Journal of Pattern Recognition and Artificial Intelligence*, 25(05), 643-673.

Miguéns, J., Baggio, R., Costa, C. (2008). Social media and Tourism Destination: TripAdvisor Case Study. *Proceedings of the IASK Advances in Tourism Research 2008* (ATR2008), Aveiro, Portugal, 26-28 May 2008, 194-199.

Pang B, Lee L. and Vaithyanathan S. (2002) Thumbs up? sentiment classification using machine learning techniques. In Proceedings of the *Conference on Empirical Methods in Natural Language Processing (EMNLP),* 79–86.

Pietiläinen A.-K., Oliver E., LeBrun J., Varghese G., and C. Diot. (2009) MobiClique: Middleware for Mobile Social Networking. In *WOSN*.

Schoder, D., Gloor, P. A., & Metaxas, P. T. (2013). Social Media and Collective Intelligence—Ongoing and Future Research Streams. *KI-Künstliche Intelligenz*, 27(1), 9-15.

Shadish, W. R., Cook T.D, and Campbell D.T. (2002) Experimental and quasi-experimental designs for generalized causal inference." *Social Service Review* 76, no. 3, 510-514.

Shi, K., Gao, F., Xu, Q., & Xu, G. (2014). Integration framework with semantic aspect of heterogeneous system based on ontology and ESB. In *Control and Decision Conference* (2014 CCDC), The 26th Chinese (pp. 4143-4148). IEEE.

Smiciklas, M. (2012). *The power of infographics: Using pictures to communicate and connect with your audiences*. Que Publishing.

Tonti, S., Baggio, R. (2012). Organizational impacts of social network analysis for an Italian multinational enterprise. *Turistica - Italian Journal of Tourism and Culture*, 21(1), 65-73.

Tsirliganis N., Pavlidis G., Koutsoudis A., Papadopoulou D., Tsompanopoulos A., Stavroglou K., Loukou Z., Chamzas C., (2004) Archiving Cultural Objects in the 21st Century, *Elsevier Journal of Cultural Heritage*, Vol. 5, Issue 4, pp. 379-384.

Xia, F., Yang, L.T., Wang, L., Vinel, A. (2012) Internet of Things. *International Journal of Communication Systems*. 25, 1101–1102.

Wasserman, S. and Faust, K. (1994). *Social Network Analysis: Methods and Applications. Structural Analysis in the Social Sciences*, Cambridge University Press, Cambridge.

Wache, H., Voegele, T., Visser, U., Stuckenschmidt, H., Schuster, G., Neumann, H., & Hübner, S. (2001, August). Ontology-based integration of information-a survey of existing approaches. In *IJCAI-01 workshop: ontologies and information sharing* (Vol. 2001, pp. 108-117).

Whitelaw, C. Garg, N. Argamon, S. (2005) Using Appraisal Groups for Sentiment Analysis, in *Proceedings of the 14th ACM international conference on Information and Knowledge Management,* p. 631.

Zhang X, Gloor P.A., Grippa F. (2013) Measuring creative performance of teams through dynamic semantic social network analysis. *International Journal of Organisational Design and Engineering*, 3(2): 165–184.

Zhu, W. (2012). Semantic mediation bus: an ontology-based runtime infrastructure for service interoperability. In *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2012 IEEE 16th International* (pp. 140-145). IEEE.