

# Artificial Intelligence for Cultural Heritage



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Edited by

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and Antonio Sorgente

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# TABLE OF CONTENTS

Preface .....	vii
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## **Part I: Narrative and Interpretation**

Chapter One.....	3
Modelling Museum Narratives to Support Visitor Interpretation <i>Paul Mulholland, Annika Wolff, Eoin Kilfeather, Mark Maguire and Danielle O'Donovan</i>	

## **Part II: Semantic and Annotation**

Chapter Two.....	25
A Domain Ontology for Historical Research Documents <i>Giovanni Adorni, Marco Maratea, Salvatore Mura, Laura Pandolfo, Luca Pulina and Francesco Soddu</i>	
Chapter Three .....	49
Building Multimedia Dialogues Annotating Heterogeneous Resources <i>Antonio Sorgente, Antonio Calabrese, Gianluca Coda, Paolo Vanacore and Francesco Mele</i>	

## **Part III: Augmented Reality and Robots**

Chapter Four.....	85
Augmented Reality Without Barriers: Dematerializing Interfaces in Cultural Heritage Applications <i>Francesco Cutugno, Davide Maria Calandra, Dario Di Mauro and Antonio Origlia</i>	
Chapter Five .....	121
Robots for Exploration, Digital Preservation and Visualization of Archeological Sites <i>J. Serafin, M. Di Cicco, T. M. Bonanni, G. Grisetti, L. Iocchi, D. Nardi, C. Stachniss and V. A. Ziparo</i>	
Contributors.....	141



## PREFACE

The research paths of Cultural Heritage (CH) and Artificial Intelligence (AI) have increasingly found shared interests, leading to a successful merge of these two disciplines.

New applications of AI have provided opportunities to produce innovative tools for documenting, managing, and visiting cultural heritage. They make it possible to tackle cultural heritage management, adopting innovative methods with a greater awareness of the needs of operators working in this sector.

The key role of the user springs from the importance of the interaction and use of the cultural heritage – a notion that is changing the areas of action as regards relations between cultural assets and users. Therefore, there is a need to explore and arrive at various levels of knowledge of the asset, be it a work of art, an architectural artifact, or a complex system such as an area of the town. In this context, the AI is the key discipline since it amplifies the development of innovative technologies, tools, and their effective application to the whole humanistic area.

We expose in this book a selection of original articles presented to AI\*CH 2014 Workshop, held in Pisa (Italy) and co-located with the XIII AI\*IA Symposium on Artificial Intelligence. The AI\*CH aimed to provide an international forum to discuss and investigate the latest research results in the application of AI to improve the fruition and promotion of cultural heritage. The book is focused on research and study of new challenges and emerging ideas in the sphere of cultural assets. It is intended for researchers, practitioners, and experts of ICT and cultural heritage domains (museums, archives, libraries, and more).

The articles presented in this book address topics such as the representation of cultural history, digital semantic archives, analytical tools to support visitor's interpretation, and augmented reality and robotics. In Part 1: Narrative and Interpretation, Paul Mulholland (invited talk at AI\*CH 2014) et al. investigate how museum narratives can be associated with online data sources, other narratives and museum artifacts in order to assist with interpretation and storytelling. In Part 2: Semantic and Annotation, semantic web technologies to improve the structure and the usability of cultural heritage applications are presented. Giovanni Adorni et al. report on a semantic digital archive aimed to provide effective and

efficient search and retrieval capabilities in a user-friendly way. Antonio Sorgente et al. present an approach to construct a multimedia dialogue in the domain of cultural heritage, reusing existing multimedia and textual resources. The two articles in Part 3: Augmented Reality and Robots provide some solutions to visiting cultural heritage sites. Francesco Cutugno et al. explore the domain of Natural User Interfaces (NUI) applied to cultural heritage, and propose the design of this NUI semi-virtual environment. Jacopo Serafin et al. present the ROVINA project. It aims at developing autonomous mobile robots to make the monitoring of archaeological sites faster, cheaper, and safer.

We hope that researchers and experts of ICT and Cultural Heritage domains will enjoy these scholarly articles, and that the connection between Artificial Intelligence and Cultural Heritage is growing stronger.

Luciana Bordoni, Francesco Mele and Antonio Sorgente



# **PART I**

## **NARRATIVE AND INTERPRETATION**



# CHAPTER ONE

## MODELLING MUSEUM NARRATIVES TO SUPPORT VISITOR INTERPRETATION

PAUL MULHOLLAND, ANNIKA WOLFF,  
EOIN KILFEATHER, MARK MAGUIRE  
AND DANIELLE O'DONOVAN

### **Introduction**

Narratives are often used within the museum environment to assist the interpretation of museum artefacts. A narrative can provide one or more contexts within which an artefact or collection of artefacts can be understood. For example, a narrative may be used to frame an artefact in the context of the life of the artist, the social and political context in which the work was created, or what is depicted in the work. Narratives are not only used by museums to assist interpretation, but are also told by the visiting public. Visitors often tell stories to each other to express a personal interpretation and to make connections between the artwork and their own concerns, knowledge and interests.

Stories therefore play an important role in connecting museum objects to personal human experiences (whether, for example, of the artist, visitor or other person associated with the work) and also to wider social and political contexts. Those social and political contexts could be historical (using the artwork to understand the context in which it was created or the historical context it reflects) or contemporary (using the artefact as an opportunity to look at current issues from a new perspective).

Web and mobile technology offers new ways of presenting narratives to visitors either to augment the physical museum environment or as part of a virtual museum experience. Social media platforms and museum websites that support visitor contributions offer new ways for visitors to share their interpretations and responses with others. Online narratives can be associated with other online sources of information, for example,

providing additional detail about characters or places mentioned in the narrative. This could assist the reader of the narrative in understanding connections between people, places, or things within the narrative that may be implicit. For example, it may not be explicitly stated that two artists were part of the same movement, educated at the same institution, or active at the same time. Similarly, connections revealed by online data sources could provide the authors with new ways of extending their narrative.

Online narratives can also be linked to other narratives, as well as physical and virtual museum objects. This can assist the visitor in pursuing trails across available physical and virtual resources, piecing together information across multiple narratives and artefacts. The value of a trail may be affected by the nature of the relationships between its constituent elements. For example, a transition across closely related or even overlapping narratives may be easy to follow but may be perceived as repetitive or lacking novelty.

This paper reports on our recent work investigating how museum narratives can be associated with online data sources, other narratives, and museum artefacts in order to assist interpretation and storytelling. A key aim of this work was to explore how narrative theory could be used to address these challenges, in particular:

- How can an understanding of the nature of narrative be used to inform how to provide context or additional information for readers and writers of museum narratives?
- How can an understanding of the nature of narrative be used to support cross-narrative navigation in a museum space?

In this chapter we will first consider what is known about narrative, how they are structured, constructed, and interpreted. We will then take a look at the types of narrative found in museum settings and how they can be understood from the viewpoint of narrative theory. We then describe some previous examples of how technology has been used to provide or augment museum narratives. After this, we describe our work on how narrative theory can be used to connect museum narratives to online data sources in order to help readers and authors. Finally, we will look at how similar narrative principles can be used to connect narratives and artefacts in a physical museum space.

## **What do we know about narrative?**

Structuralist theories make a distinction between narrative and story (Chatman 1980). A narrative can be understood as the telling of a story. A narrative comprises both the story (what is told) and the discourse (the means by which it is told). According to the structuralist tradition (Chatman 1980), events are seen as key constituents of the story or fabula, as well as existents such as the setting and characters of the story. Bruni and Baceviciute (2014), drawing on the work of Ryan (2006), describe events as the raw material from which stories are constructed, though they do argue that the story itself is not necessarily made up of events. Whether events comprise the story or somehow constitute the materials from which the story is made, events are nonetheless understood to play an important role in story construction.

The process of authoring can be seen as assembling a story and using this to construct a narrative to communicate to the reader. A number of theories have been proposed to understand the process of narrative construction. One of particular relevance to work in a museum context is the theory of narrative inquiry (Polkinghorne 1988), given its focus on interpreting the past and communicating those interpretations in narrative form. The narrative inquiry process comprises four main stages. First, relevant events are identified from the historical period of interest and organised into chronological order. This is termed a chronicle. Second, the chronicle is divided into separate strands of interest. These strands could be concerned with particular themes, characters, or types of event. Third, plot relations are imposed between the events. These express inferred causal relations between the events of the chronicle. Finally, a narrative is produced communicating a viewpoint on that period of history. Narrative inquiry is therefore not just a factual telling of events, but also makes commitments in terms of how the events are organised and related to each other.

Many accounts also exist of how readers interpret narratives. Gervás and León (2014) describe some of the types of inference that can be made when reading a story. These include inferring: causal relations between events, themes, the goals of the characters, and the author's intent. Therefore, the reading process can be thought of as the reader constructing his or her own story from the narrative.

This suggests that the author and reader may have different stories associated with the same narrative. The author may imply some causal relation between the events of the story. However, the reader may infer an alternative causal network due to their viewpoint and the inferential

processes they apply to the narrative. Despite the potential differences between the stories developed by the author and the reader, certain constructs can be seen as important to both activities. In particular, the construction of events, their interrelationship in a causal network and organisation into themes can be seen as important to both the construction and interpretation of narrative.

Unsurprisingly, many computational or formal models of narrative represent the underlying story in terms of its events and interrelationships between those events. Within the heritage domain, Mele and Sorgente (2012) describe an approach to formally representing the events of a story. A type of complex event, termed a causal event, is used to represent causal relations between an event constituting the cause, and another event constituting the effect. The events acting as a cause or effect may be either physical or mental. Similarly, Mulholland, Wolff, and Collins (2012) describe an ontological approach for describing museum stories, in which plot relations (such as cause and effect) can be expressed between events.

### **The nature of museum narratives**

Museums can provide their visitors with narratives for a number of different purposes. Glover Frykman (2009) performed an analysis of a range of museum educational texts and identified a number of distinct aims, including: describing something; offering an interpretation of what happened or what might happen; constructing reality; stimulating imagination; making learning more entertaining; or facilitating interaction or communication. Van Vliet and Hekman (2012), in their investigation of social tagging and storytelling in museums, found that viewing, listening to, or reading stories led to a more positive attitude toward the museum visit. Museum narratives can therefore be seen to enhance the museum experience in a number of ways.

The types of narrative found in a museum vary considerably in scale. Rowe, Wertsch, and Kosyaeva (2002) distinguish between big and little narratives. The big narratives are the overall, official accounts of, for example, a period in history, communicated by the museum. The small narratives are the first person accounts from that time in history or personal responses offered by visitors to the museum. Within a museum context these big narratives can be on the scale of the exhibition, and the exhibition itself can be thought of as a form of narrative.

A distinction can often be made between the narrative structure of a museum's permanent collection and thematic exhibitions. Exhibitions of the museum's permanent collection generally organise artefacts according

to features such as artist, artistic movement, and chronology. For example, a museum may situate a series of impressionist artworks within the same gallery space, organised by chronology. A permanent exhibition may even only use chronology as the organising principle. The permanent exhibition *A Walk Through British Art* at Tate Britain (Curtis and Stephens 2013) organised work from British art chronologically. This can bring works that may have been assumed to be from different time periods due to their differences in style into close proximity.

Thematic exhibitions, unlike the permanent collection, are usually on display at the museum for a limited period of time. The artefacts in the exhibition are generally organised by themes defined by the exhibition curator. This could bring together artworks that, for example, depict similar scenes or evoke similar subjects, despite differing in artist school or chronology. Thematic exhibitions may also reveal other types of relationships. For example the exhibition *Turner, Whistler, Monet* (Lochnan 2004) at the Tate Gallery suggested influences between the three artists featured in the exhibition.

When experiencing a museum exhibition, the visitor draws relationships between the exhibits, reconstructing for themselves the exhibition story (Peponis 2003), whether those relationships are, for example, thematic or chronological. The physical structure of the museum can affect how visitors perceive the exhibition narrative. Tzortzi (2011) argues that the physical structure of the museum can serve to either present (i.e. give access to the exhibition in a way that is independent from its underlying logic) or re-present (i.e. have a physical structure that reinforces the conceptual structure of the exhibition).

As well as reconstructing the exhibition narrative for themselves, visitors also tell their own “small” narratives (Rowe, Wertsch, and Kosyaeva 2002) that link elements of the exhibition to their own experience. Museums also produce small narratives to help visitors make a more personal connection to the subject matter. For example, an exhibition related to a historical period may describe a day in the life of a possibly fictional character in order to help the audience make a personal connection. In using such techniques, museums aim not only to convey narratives but also to encourage visitors to produce their own narrative. Wyman, Smith, Meyers, and Godfrey (2011) see this as part of a shift away from a voice of authority towards a multi-faceted experience, inviting conversation and interaction with visitors. Similarly, Kelly (2010) argues that museums should tell stories not to impart meaning but to encourage visitors to make their own meaning.

## Museum narrative applications

Museums increasingly make use of technology to interact and communicate with the public both inside and outside the physical museum space. Here we consider some representative examples of how technology has been used to produce, augment, or facilitate museum narratives.

In terms of the “big” museum narrative, technology has been used to suggest tours or routes through museum spaces, and also to assist visitors in producing their own trails through museum spaces. Lim and Aylett (2007) describe an AI model for a virtual tour guide. Designed for use on PDAs within the museum, the system drew on a knowledge base of story sections to construct stories connecting a number of artefacts within the exhibition. Walker (2006) investigated the use of mobile technology by visitors to create, edit, and share their own trails through a museum space. Visitors could capture images of artefacts and add voice recordings and texts to create their own coherent narrative of the museum experience.

In terms of the “small” museum narrative, technology has been used to provide first-person narratives or to encourage visitor contributions. Ciolfi and McLoughlin (2012) describe the use of QR codes in a living history museum to associate personal reminiscences with artefacts on display. These reminiscences helped visitors to understand the context, for example how a particular object was used or what happened in a particular type of building. Callaway et al (2011) describe a mobile system for delivering narratives related to an artefact to each member of a group visiting an exhibition together. The narratives given to each person provided a different, incomplete account from a particular perspective. Building a complete account required conversation among the visitors. Therefore, in this example, technology is not only used to convey narrative but also encourage the visitor’s active involvement.

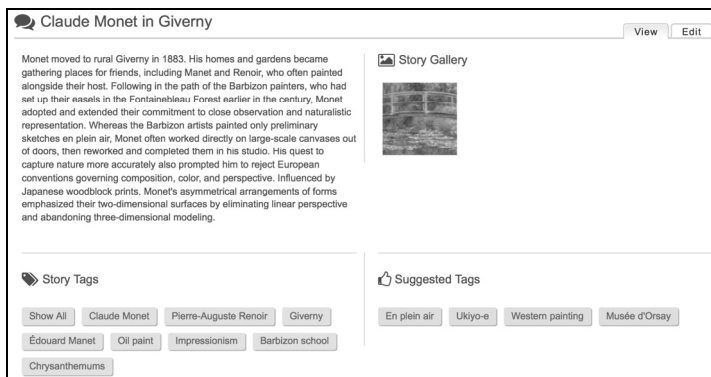
Systems have also been developed that allow visitors to use the constituent elements of narratives, such as events, to chart their own path through historical information. These generally take the form of web-based applications such as Timeline Gazetteer (Hyvönen, Lindquist, Törnroos, and Mäkelä 2012), Reasonator (<https://tools.wmflabs.org/reasonator/>), and Histropedia (<http://www.histropedia.com>). These tools can aggregate data from different sources and represent them as a series of events that can then be navigated and viewed in different forms such as on a timeline. From a narrative inquiry perspective (Polkinghorne 1988), these tools can be thought of as giving access to the raw materials from which stories and narratives can be constructed.



We will now describe two of our experiments in using narrative concepts to support the construction and use of museum narratives. First, we will look at how narrative principles can be used to tie museum narratives to other online data sources in a way that has a better cognitive fit to the activities of the reader or author. Second, we will look at how similar narrative ideas can be used to link narratives together for use by visitors in a mobile museum setting.

## Modelling museum narratives to support their interpretation

In order to devise ways in which online data could be used to support the reading and authoring of stories, we first had to develop an environment for the reading, publishing, and management of museum stories. Storyscope (Mulholland, Wolff, and Kilfeather 2015) was developed using the Drupal open source content management platform. Storyscope organises stories into a set of dossiers. This is a metaphorical reference to the type of cardboard dossier a curator may use to assemble material for an exhibition. Each dossier is made up of a number of museum narratives (termed stories within the Storyscope interface). Each narrative comprises a title, text, image gallery, and set of tags (figure 1-1). The tags are associated with the narrative using a variant of the Freebase suggest widget. Each tag comprises both a text label and a Freebase topic. Additional tags are suggested for the narrative from its text using the Alchemy API (<http://www.alchemyapi.com>).



The screenshot shows a web interface for a museum narrative titled "Claude Monet in Giverny". At the top right, there are "View" and "Edit" buttons. The main content area is divided into two columns. The left column contains a paragraph of text describing Monet's move to Giverny in 1883, his artistic style, and his influence. The right column features a "Story Gallery" section with a small image gallery. Below the text, there are two sections: "Story Tags" and "Suggested Tags". The "Story Tags" section includes buttons for "Claude Monet", "Pierre-Auguste Renoir", "Giverny", "Édouard Manet", "Oil paint", "Impressionism", "Barbizon school", and "Chrysanthemums". The "Suggested Tags" section includes buttons for "En plein air", "Ukiyo-e", "Western painting", and "Musée d'Orsay".

Figure 1-1: A narrative with image gallery, tags and additional suggested tags from the text.

Online data associated with each tag is imported into the Storyscope installation. The current Storyscope installation uses Freebase as a source of online data. All imported data is mapped to a simple standardised internal structure of facts and events. All facts are represented as subject-property-object triples. If the tag represents a person (such as an artist) facts are used to represent, for example, their place and date of birth. Events use a simple who, what, where, when style structure, consistent with existing event ontologies such as LODE (Shaw, Troncy, and Hardman 2009). The type property is used to indicate the type of activity undertaken in the event such as “object created” or “place lived”. If the tag represents an artist, then events are used to represent, for example, artworks they have created, exhibitions of their work, where they have lived, and their education history. There is no clear rule that determines what should be represented as a fact or event. The birth and death of an artist could equally be represented as events. However, museum professionals participating in the design of Storyscope expressed a clear preference for dates of birth and death to be used as identifiers of the person - and therefore represented as facts rather than as events.

When a Storyscope user selects one of the tags associated with a museum story, a panel is generated below the narrative, providing additional information associated with the tag (figure 1-2). The panel of information contains facts such as associated artistic movement and place and date of birth. At the bottom of the panel, the events associated with the tag are organised as a table. The columns correspond to the who, what, where style properties of the event schema. The table can be sorted (e.g. to view events by date) and filtered (e.g. to show only events associated with a particular person). All events, or events of a specific type (e.g. “object created”) can be visualised on a timeline (figure 1-3).

The concept space of facts and events can be generated for any of the tags of the narrative. Additionally, events associated with all tags can be combined into a single view (by selecting the “Show all” button directly below the “Story tags” heading shown in figure 1-1). This combined set of events can also be sorted, visualised, and represented on a timeline.

The purpose of producing the concept space of facts and events for each tag and the combined space of events for all tags of the narrative is to allow authors and readers to move beyond the text of the narrative by finding out more about the people, places, and other types of entity tagged in the narrative. A narrative may mention a person in passing, with which the reader is unfamiliar. The associated concept space allows the reader to find out more about the person, without leaving the context of the narrative. Similarly, an author may mention a location and want to find out

if there is anything else about the location that could be incorporated into the narrative.

The concept space generated for any single tag or collection of tags associated with a narrative can be potentially large. For example, a concept space for an artist could comprise over 100 events. This could make it difficult for the reader or author to identify elements from the concept space most relevant to the narrative and their activity of interpreting or extending the story.

**About : Claude Monet (Visual Artist)** 🔍

Oscar-Claude Monet was a founder of French Impressionist painting, and the most consistent and prolific practitioner of the movement's philosophy of expressing one's perceptions before nature, especially as applied to plein-air landscape painting. The term "Impressionism" is derived from the title of his painting *Impression, soleil levant*, which was exhibited in 1874 in the first of the independent exhibitions mounted by Monet and his associates as an alternative to the Salon de Paris. Monet's ambition of documenting the French countryside led him to adopt a method of painting the same scene many times in order to capture the changing of light and the passing of the seasons. From 1883 Monet lived in Giverny, where he purchased a house and property, and began a vast landscaping project which included lily ponds that would become the subjects of his best-known works. In 1899 he began painting the water lilies, first in vertical views with a Japanese bridge as a central feature, and later in the series of large-scale paintings that was to occupy him continuously for the next 20 years of his life.



**Associated period or movement** Impressionism Modern art

**Date of birth** 1840-11-14

**Date of death** 1926-12-05

**Place of birth** Paris

**Place of death** Giverny

**Themes**

Claude Monet Impressionism Landscape painting Haystacks Water Lilies Marine art Gare Saint-Lazare Camille Doncieux

Poplar Series Rail transport

**Settings**

Giverny, 1891 Giverny, 1890 to 1891 Giverny, 1908 Venice, 1908 Gare Saint-Lazare, 1877 Giverny, 1904 Giverny, 1900 to 1901

Palace of Westminster, 1904 Giverny, 1903 to 1904 Palace of Westminster, 1900 to 1901

**Timelines**

All Object creation Place lived Exhibition creation Book authoring Object ownership

**Event Space :**

Title ↕	Activity ↕	Agent ↕	Start Time ↕	End Time ↕	Location ↕	Tags ↕
The Tuileries (study)	object creation	Claude Monet		1876	Tuileries Garden	The Tuileries (study), Tuileries Garden
Garden at Sainte-Adresse	object creation	Claude Monet	1867	1867	Sainte-Adresse	Garden at Sainte-Adresse, Sainte-Adresse, Impressionism
Claude Monet lived in Paris	place lived	Claude Monet			Paris	

Figure 1-2: Facts and events related to Claude Monet presented in Storyscope.

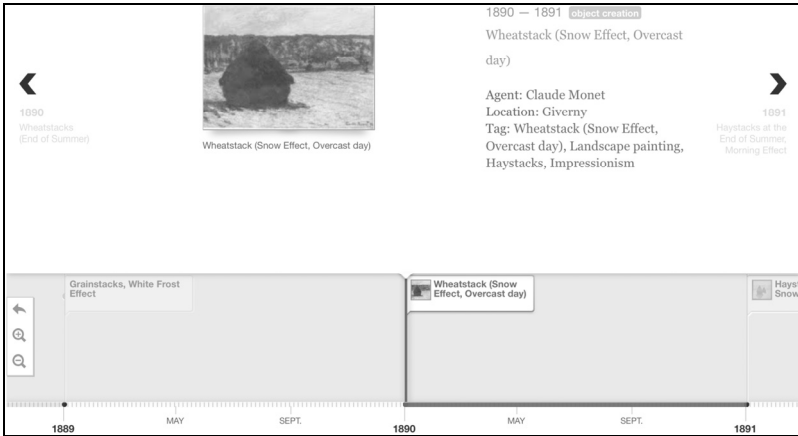


Figure 1-3: Timeline of events.

To address this problem, the narrative concepts of theme and setting were adopted to provide an entry point into the larger concept space associated with all or one of the tags. A theme might be what binds together a series of events grouped in the same storyline during a process of narrative inquiry. The binding element could be, for example, the same person featuring in each of those events. Theme is also related to the moral point of the story. This could be a more abstract concept, such as good winning through in the end, which serves to bind together all events of the story. Similarly, theme can be defined as the central concepts that bring coherence to the narrative (Wolff, Mulholland, and Collins 2013, Thomashevsky 1965). All of these definitions suggest that themes relate to the concepts or ideas that bind together the other elements of the story.

Many of the inferences made by readers of a narrative, such as causal relations, rely on an understanding of the settings of the story. A setting is a time and location at which events of the story occurred (Wolff, Mulholland, and Collins 2013). Understanding the settings of the story allows the reader to identify potential causal relations in the story by understanding the temporal relations between events and inferring, for example, whether two characters could have met at a particular time and place.

Within Storyscope, themes are identified from the concept space of one or more tags associated with a narrative. Themes are identified from the agent and tag properties of events (pictured as columns in the event table in figure 1-2) and any fact properties (such as associated art movement)

that are specified as relevant to the theme in the Storyscope configuration panel. Candidate themes are primarily ranked in terms of the number of tags with which they are associated, and secondarily in terms of their frequency within the concept space. For example, if a narrative was tagged with three people, and one of those people was associated with the other two via events (for example as a teacher or collaborator), then this person who binds together the others would have a higher theme ranking. Themes may also be proposed that do not feature in the tag list. For example, a narrative could be tagged with three artists that were all associated with the same artistic movement. Even if the artistic movement were not mentioned in the narrative or included as a tag, it would have a high theme ranking as it binds together the tags of the narrative.

Settings are derived from the location and time properties of events. Similarly to themes, settings are primarily ranked in terms of the number of tags with which they are associated through events, and secondarily in terms of their frequency in the event space. For example, if a narrative was tagged with three people and all of those people featured in events that overlapped in space and time, then this shared setting would have a higher ranking than any setting with which only one of the three people was associated.

The themes and settings identified for the set of tags of a narrative provide an entry point into the wider concept space with which they are associated. The identified themes and settings prioritise what binds together the tags of the narrative. Selecting a theme or setting within the Storyscope interface shows the space of events associated with that theme or setting. This enables the Storyscope user to pursue thematic questions such as “what else did Claude Monet do?” or setting-related questions such as “what else was happening in Giverny in 1916?”

Evaluations of the user interface and the efficacy of themes and settings returned for a narrative, suggest that the approach can successfully support the activities of narrative authors and readers. Overall, this work suggests that ideas derived from narrative theory such as theme and setting can be successfully used to inform the design of narrative-related tools.

## **Modelling museum narratives to support their navigation**

In the previous section, we looked at how narrative principles can be used to support interpretation and narrative construction by linking a museum narrative and its tags to associated themes and settings, as well as a wider space of facts and events associated with the tags. We now consider how ideas from narrative theory can be used to link narratives to

exhibits and support navigation across narratives in the museum environment (Wolff, Mulholland, Maguire, and O'Donovan 2014).

As discussed earlier, narratives can have a positive effect on attitude toward the museum visit, and are regularly used in a museum environment for purposes including assisting interpretation and stimulating imagination. Our experiment involved the presentation of narratives on mobile devices to support the visitors of a sculpture garden within the grounds of a museum. We chose this environment as conventional forms of narrative communication through exhibit organisation, signage, and information panels can be more difficult to realise in an outdoor environment. First, from a practical point of view it can be harder to maintain narrative panels and signage in an outdoor environment. Second, permanent sculptures in an outdoor environment may have weaker narrative relationships, as they may have been accumulated over a period of time and are more difficult to rearrange than an indoor exhibition of smaller artefacts. The sculpture garden was therefore seen as a good candidate to investigate the mobile provision of narratives.

The sculpture garden contained 27 artworks. A series of narratives related to the sculptures in the garden were selected or authored and added to Storyscope. This included one initial story for each of the sculptures, giving information about the artwork and its creation. All of the narratives were described according to their constituent events using a simple event schema representing the agents, location, timing, and other entities involved in the event. Therefore, unlike the work described in the previous section, events were used to describe the stories themselves rather than additional knowledge associated with the narrative.

The event-based descriptions of the narratives were then used to recommend navigation trails using the 27 narratives directly related to the artworks as starting points. A particular question driving the experiment was what type of relationship would be most appropriate between the narratives comprising a trail. Two types of relationship were considered. First, narratives within a trail can be assessed in terms of their coherence. If the elements of the story (e.g. events) contain many of the same entities (e.g. agents, locations, objects) then they are closely bound and there is strong coherence across the narrative. Second, narratives within a trail can be assessed in terms of their coverage. If the elements or events of the narrative are few, repetitive, or only have minor variation, then the narrative can be considered to have low coverage. Narratives can often reveal a trade-off between coherence and coverage. A narrative containing many disparate elements, for example events with different settings,

characters and objects, can be expected to have low coherence and high coverage.

The coherence of any narrative trail was measured by first representing each event of the narratives as a vector. The coherence was then measured as the mean cosine distance between the event vectors. An alternative way of measuring coherence would be to only measure the distance between adjacent narratives in the trail. This could result in different coherence scores depending on the order of narratives within the trail. However, we decided to measure the overall coherence of the trail because, having followed the trail, the reader could be expected to make inferences and draw connections across all narratives of the trail, not only adjacent narratives. The coverage of the narrative trail was measured as the number of unique events in the trail. This could be lower than the total number of events in the trail, as an event such as the creation of a specific artwork may be mentioned multiple times across the trail.

A random hill climbing algorithm was used to produce trails from the available set of narratives. From a random starting point, the effect on coherence and coverage of adding each remaining narrative was calculated. The highest scoring narrative was selected to extend the trail and the process repeated. The process halted when any addition to the trail would lower the overall score. Random hill climbing was run with varying weightings for coherence and control. Museum professionals evaluated the resulting sets of trails. A strong preference was found for trails that weighted coherence in the overall score, that is, coherence was viewed to be much more important than coverage.

Using the random hill climbing method weighted toward coherence, 18 trails were produced. The longest trail comprised six narratives. Museum professionals selected 15 of these for use with the outdoor sculpture trail, six with minor modifications. Many of the trails included narratives associated with multiple sculptures within the garden. A QR code was situated near the base of a sculpture to indicate the availability of a narrative trail (see figure 1-4). Scanning the QR code would take the visitor to a landing page giving basic information and a link to the narrative trail (see figure 1-5). Use of the QR codes was analysed during a two-day period. In total 47 separate visitors scanned at least one QR code during this period. Of these, 29 scanned one code, 10 scanned between two and four codes, and eight scanned between six and 12 codes. An informal survey was carried out with a selection of users. The feedback was generally positive, expressing the view that the narrative trails added to the experience and provided an entertaining way to learn more about the artworks.



Figure 1-4: Museum visitor scanning a QR code.

**Art Outdoors @ IMMA**

**The Dying Fusilier**

The statue of Queen Victoria that once stood on Leinster Lawn was an elaborate affair. The Queen sat at the top with little Putti at her feet, and below this were three thematic sculptural groups. There was 'Fame' (glory achieved through order), 'Peace' (agriculture crowning with a symbol of plenty a worker wearing a leather apron such as a blacksmith's), and 'Erin and the Dying Soldier' (loyalty demonstrated by the sacrifice of Irish soldiers in the Boer War 1899–1902). The soldier is a Royal Dublin Fusilier.

**Erin Comforts the Dying Soldier**

'Fame' and 'Peace' can still be found at Leinster House, while the sculpture now widely known as 'The Dying Fusilier' can be found in the grounds of Dublin Castle.

Follow this [STORY LINK](#) to hear what happened to the statue of Prince Albert, that stood on the other side of Leinster Lawn from Queen Victoria.

Now look around! You should be able to see more artworks and QR codes from here.

If you have finished looking at the trail, please help us with our research by filling in this short [SURVEY](#).




Figure 1-5: One of the landing pages reached from a QR code.



Although the narrative trails were used and the feedback was generally positive, prompting visitors with narratives associated with other artworks in the garden did not seem to alter their route. Visitors tended to stick to the most direct physical route through the garden (see figure 1-6). Reading a narrative associated with another sculpture did not appear to encourage them to modify the journey in order to see the mentioned sculpture sooner.

This finding has certain parallels to the evaluation of Travel Teller (Mitchell and Chuah 2013). Travel Teller used themes to create a thematic narrative organisation of a tourist's photographs and suggest where they could visit next in order to develop the narrative in interesting ways. The evaluation found that tourists tended not to reach the recommended destinations, instead being diverted by other sites found along the way. This suggests that mobile narrative technology can play a role in enriching experience, without necessarily dictating the physical route.

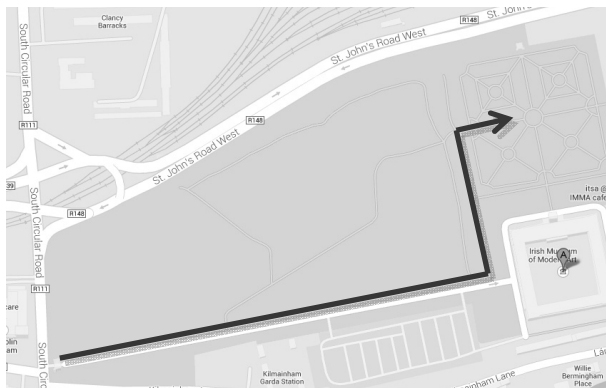


Figure 1-6: An example journey through the sculpture garden.

## Conclusions and future challenges

In this chapter we have considered the nature of narrative, and have highlighted the distinction between the story (what can be told) and the narrative (what is told and how it is told). Events can be seen to play an important role in the processes of narrative construction and comprehension. During story construction, events can be understood as constituent parts, or at least the raw material, from which the story is formed. The selection and organisation of events through, for example, a process of narrative inquiry, motivates the formation of the narrative. The process of reading a narrative involves constructing a new story through a process of interpretation.

This story may differ from the one originally told, though it has the same types of constituent element such as an account of events of the story and additional inferences such as settings, themes, and causal relationships.

Narratives are employed by museums for a number of purposes, including entertainment and interpretation. Narratives can also take a number of forms. The overall exhibition can itself be thought of as a narrative. The structure of the exhibition narrative may encourage the visitor to develop stories that emphasise temporal, thematic, or other relationships, such as artistic influence across the artefacts. The museum and its visitors also produce smaller narratives. These generally take the form of text or speech, and often serve to link aspects of the overall museum narrative to the individual concerns of real or fictional characters, or the visitors themselves.

We then provided two examples of how narrative theory can be used to motivate the design of tools to support interpretation around museum narratives. Our first example looked at how the narrative principles of theme and setting could be used to link museum narratives to associated knowledge sources in order to support the activities of authors and readers. Our second example showed how the notions of coherence and coverage could be used to create narrative trails, even though the recommended trails did not appear to change the route taken through the sculpture garden.

These two examples demonstrate the potential for ideas from narrative theory to inform the design of narrative experiences, both online and within a physical museum context. Many other features of narrative could potentially be used in the design of visitor tools. For example, narrative inferences such as cause and effect could be explicitly used in tools to support the authoring and reading of museum stories. Other narrative features such as characterisation and authorial intent could potentially be foregrounded in tools to support interpretation. Such tools could potentially support both physical and virtual museum visits, as well as activities concerned with preparation for, or reflection on, a museum visit.

As well as envisaging the potential of new narrative-driven tools for interpretation, we also anticipate three new challenges. These challenges are concerned with how narrative experiences can be constructed and how, in a museum context, they can align with the narrative experiences supplied by the physical environment.

First, online cultural resources are increasingly available in machine-readable form using APIs or Linked Data principles. This means the virtual or physical visitor can potentially access a vast array of heterogeneous information to support their interpretation. However, it may

be difficult to create coherent narrative experiences from this vast and varied source of information. Geser and Nicolucci (2012) point out that although tools exist for the automatic production of presentations such as timelines from available data, meaningful relationships between the events and artefacts are often missing. Our own work, described above, showed how the narrative ideas of theme and setting can be used to provide additional guidance to readers and authors, and also draw attention to events, people, places, times, and objects that help to bind together the elements of the story. This can be used to provide a point of focus and create coherence across a varied set of data. Other ideas from narrative theory could also be applied to highlight meaningful relationships. For example, AI techniques could be used to infer candidate causal relations across a set of events, potentially indicating connections between artworks, artists, and broader social and political concerns.

Second, the availability of mobile consumer devices such as smartphones and tablets provides greater opportunities for visitors to make use of online cultural resources within the physical museum environment. Warren et al (2015) discuss the potential for museum archives to be used to create on-the-fly augmentations of the physical museum experience. They describe how museum artworks could be associated with additional information, such as a biography of the artist, presented to the visitor on a location-sensitive mobile device. Our own work on presenting narrative trails on a mobile device to visitors of a sculpture garden has also illustrated the potential to augment visits with museum resources via mobile devices. However, visitors can be expected to have limited attention available for additional resources during the visit. Narrative ideas, including coherence and coverage, have the potential to focus information delivery on resources of immediate interest.

Third, although visitors potentially have ubiquitous access to cultural resources, these need to be provided in a way that aligns with the narrative properties of the environment within which they are situated. Location-sensitive information delivery is now commonplace in which, for example, search results are optimised based on location data. Within museums, technology such as QR codes or iBeacons has been used to present information of relevance to the current location. However, the provision of information, and in particular recommendations on what to see and which route to take, need to be sensitive to the narrative context created by the museum environment, as well as to the visitor's position within it. We saw in the previous section that visitors can benefit from additional narrative services but are not necessarily inclined to change their route. This supports the argument of Sharples, Fitzgerald, Mulholland, and Jones

(2013), who suggested that the force exerted by the physical design of the museum may be too strong to be disrupted by mobile recommendations. However, an understanding of the narrative properties of the physical museum space and the types of thematic, temporal, or other organisational methods used, could be applied to create augmentations that work with, rather than against, the physical space. This could lead to forms of mobile narrative assistance that are sensitive to the narrative context rather than just to the location.

There is therefore great potential for more narrative-aware tools in both physical and virtual museum settings that can provide automated access to cultural resources across a range of devices. Selecting and organising large and varied sources of data and aligning these with the narrative characteristics of the museum environment introduces challenges in terms of narrative coherence. Ideas from narrative theory and an understanding of how museums use narratives to communicate with their audience can offer potential solutions to these challenges.

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