Dynamic Generation of Museum Web Pages: The Intelligent Labelling Explorer

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Abstract

The first phase of the Intelligent Labelling Explorer project has built the ILEX-1.1 system, which uses artificial intelligence technology to generate descriptions of objects displayed in a museum gallery. Each description appears on a World Wide Web page, and the user can move from page to page, viewing the objects in any order, mimicking the experience of someone walking through the museum. Crucially, these descriptions aren't simply retrieved from a storage space, but are generated on demand by combining canned text with fully generated text in a coherent way. This use of DYNAMIC HYPERTEXT allows ILEX-1.1 to generate descriptions appropriate to the expertise level of the user and to refer back to objects the user has already seen or to suggest objects the user might be interested in based on what objects they've chosen to look at so far. This paper discusses the advantages of dynamic hypertext and issues related to generating a text that hangs together well.

Walking alone through a museum can be an enjoyable and educational experience, but if you could have a curator walk around with you, giving you a guided tour of whatever caught your interest, your visit could have a much more positive impact on your enjoyment and on the knowledge that you take away with you. Perhaps you are an expert, a child, or an average adult, and perhaps you are more interested in the designers of the artifacts than in the materials; since this tour is designed just for you, the curator

would talk to you at your level of expertise, focusing on your main interests, giving you as much or as little detail as you like. From the perspective of the museum visitor, this type of tour is ideal. From the perspective of the curator (with an infinite amount of time on her hands) such a tour would also be ideal in that it would allow her to get across the points that she wants to make with the advantage of knowing enough about the visitor to present the information at the right intellectual level rather than relying on the labels on each object, which are necessarily directed towards one type of target audience. Another advantage for you, as the visitor, is that the curator knows what items you have already seen, and so can relate them to other objects in the museum as well as suggest related objects that you might be interested in.

We are a group of researchers based in the University of Edinburgh's Department of Artificial Intelligence and Human Communication Research Centre. We work in the area of natural language processing, a branch of artificial intelligence that is concerned with developing a computational model of how humans use language in order to perform automatic translation, understanding, and generation of texts and speech. To be able to automatically generate a personalised tour of a museum with its curator is an endeavour with many interesting research issues but also one that is constrained enough that it is possible to get good results. The interesting issues range from educational issues such as how best to get across the messages that the curator feels are important, to linguistic issues such as how to make a text hang together well, and how to automatically lengthen or shorten a text as required.

1 The project

The purpose of the ongoing ILEX project is to explore the benefits of DYNAMIC HYPERTEXT, which combines hypertext with automatically generated text so that the user sees a text that is appropriate for his level of expertise and that takes into account his interests and what information he has already been presented with. A museum was a natural choice as a domain in which to work because there are many types of people interested in the contents of a museum, and dynamic hypertext has the potential for providing great improvement over the descriptive label on an object by adapting that description to the needs of each individual, as the curator would.

We took as a starting point the 20th Century Jewellery Gallery of the

National Museums of Scotland. To get an understanding of how the ILEX system works, you must first imagine a set of hypertext web pages, each of which describes an artifact, a style/technique, an artist/designer, or another topic relevant to the items in the museum. The "visitor" can move from page to page via links, reading the description and moving in any direction toward whatever topic seems most interesting. Typically, a web page is a piece of hypertext containing links to take you to other web pages. When you ask for a particular web page or click on a link, you are shown a page of text and/or graphics that has been prepared in advance. For the ILEX project, however, these texts are not simply stored on some computer system, but are generated on the fly each time the visitor clicks on a link. The system has a "user model": it has been told something about the expertise of the visitor, and it keeps track of what the visitor has seen. The system also has a model of the artifacts and related topics: it knows about everything in the museum's database describing its artifacts, and it has been told what the curator thinks are the most important lessons for the visitor to take away.

With this notion of an "artificial curator", the current version of the ILEX system (ILEX-1.1) generates descriptions such as the one shown in Figure 1.

2 Why dynamic hypertext?

There is a lot of information out there, and no one has enough time or interest to read it all. Hypertext allows the reader some control over what information is presented next, but there is still great potential for saving wasted time (and wasted "clicks") if the system has some understanding of what the reader is looking for. If you search the web for cookie recipes, for example, the search engine will come back with 1000 sites. If the system knows you're allergic to nuts, however, and that you're partial to chocolate, the list will be shorter and appropriately ordered. ADAPTIVE HYPERTEXT was developed as a means of using a "user model" to filter information and control how it's presented to the user (See Brusilovsky, 1996).

Although adaptive hypertext improves upon simple hypertext, it retains certain limitations. The main limitation is that the text is still written beforehand, and therefore, although the page may be structured according to the user model, the text itself does not change; it is written for only one type of audience, just as the labels in museums must be written for a very general audience so they can be understood by everyone.

DYNAMIC HYPERTEXT takes adaptive hypertext one step further: Part of

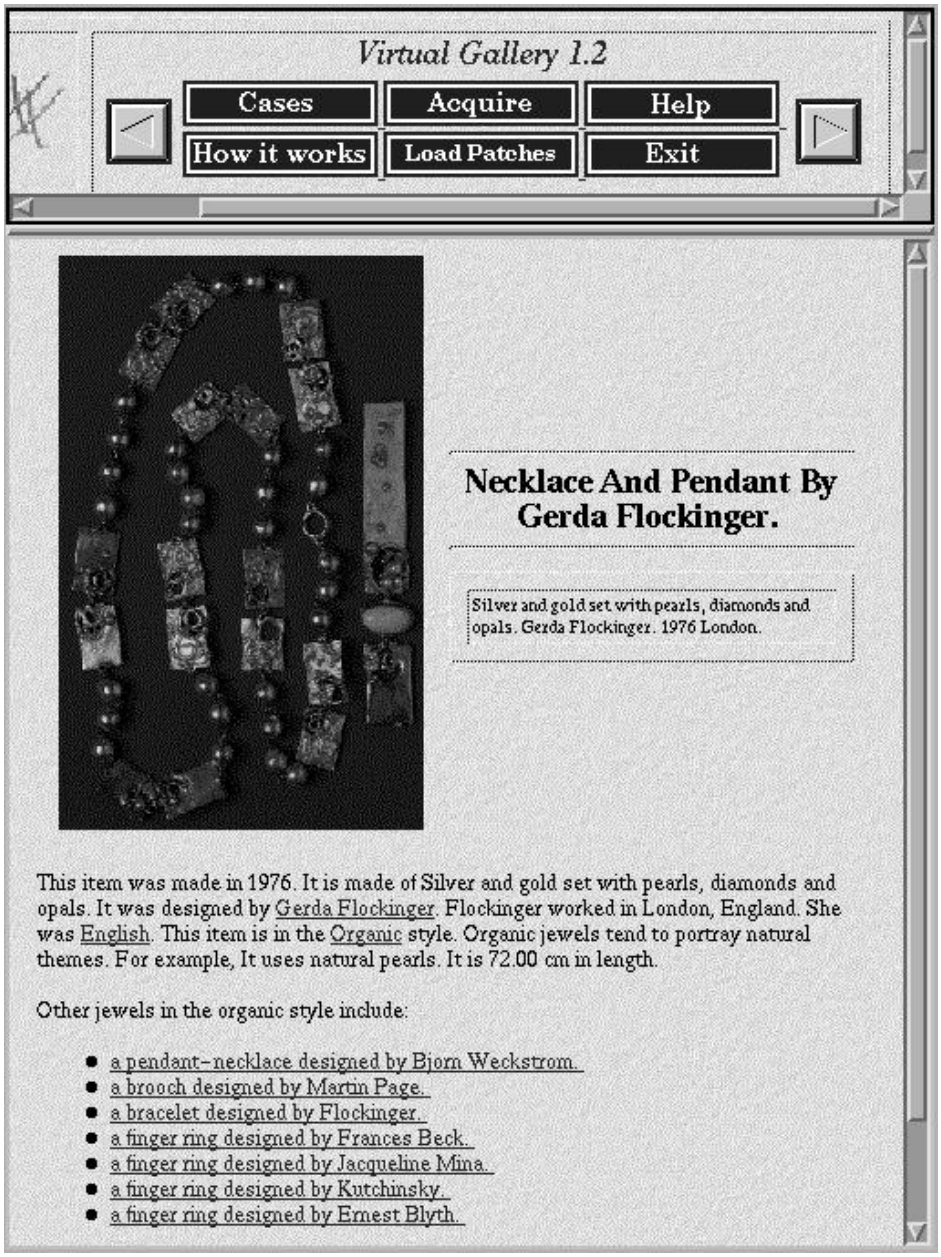

Figure 1: Description of the Flockinger necklace and pendant.

the text that is presented to the user is "canned text"— pre-written text as is used in hypertext and adaptive hypertext— and part is text that is generated on the fly based on information about the object to be described, the user model— including expertise level— and a "discourse history". By gathering and studying transcripts of the curator of the 20th Century Jewellery Gallery giving tours to experts and to novices, we have learned that she tells more anecdotes concerning the jewels when she's talking to an expert, and she works harder to get across messages concerning the different styles and the relationships between jewels when talking to an adult novice, and our user model allows us to take these preferences into account.

The "discourse history"— a part of the dynamic hypertext system that keeps track of what the user has been shown, what links he has followed, and what text has been presented to him— allows the user to be consistently presented with new information. If you return to a particular painting by Matisse, you are likely to want to see the painting again but not to want to read the same description you read the first time. Instead, by returning to the same painting, you show a particular interest in it and are likely to want more information about it that another visitor may not care about. By keeping track of the objects you've seen, the ILEX system can generate a page that's appropriate for you at any point in your (virtual) museum visit. If the system has determined that you're particularly interested in Matisse, when generating text for you to read it can also generate links to places where you can get more information about Matisse or see more of his artwork— either existing pages or pages it will generate dynamically for you.

3 How ILEX works

The design of the ILEX system required detailed knowledge about the artifacts in our museum and related topics such as designers, collectors and manufacturers. We also needed to know how the curator would present this knowledge to different types of visitors in order to make it interesting and to get across the educational messages she wants the visitor to walk away with. We began by taking the information stored in the museum's databases describing the artifacts in the jewellery gallery and organising it into a hierarchy of jewels, designers, locations, materials, etc. which we could use to form descriptions of the jewels. We also made transcripts of the museum's curator giving tours to novices and experts, and from these dialogues we

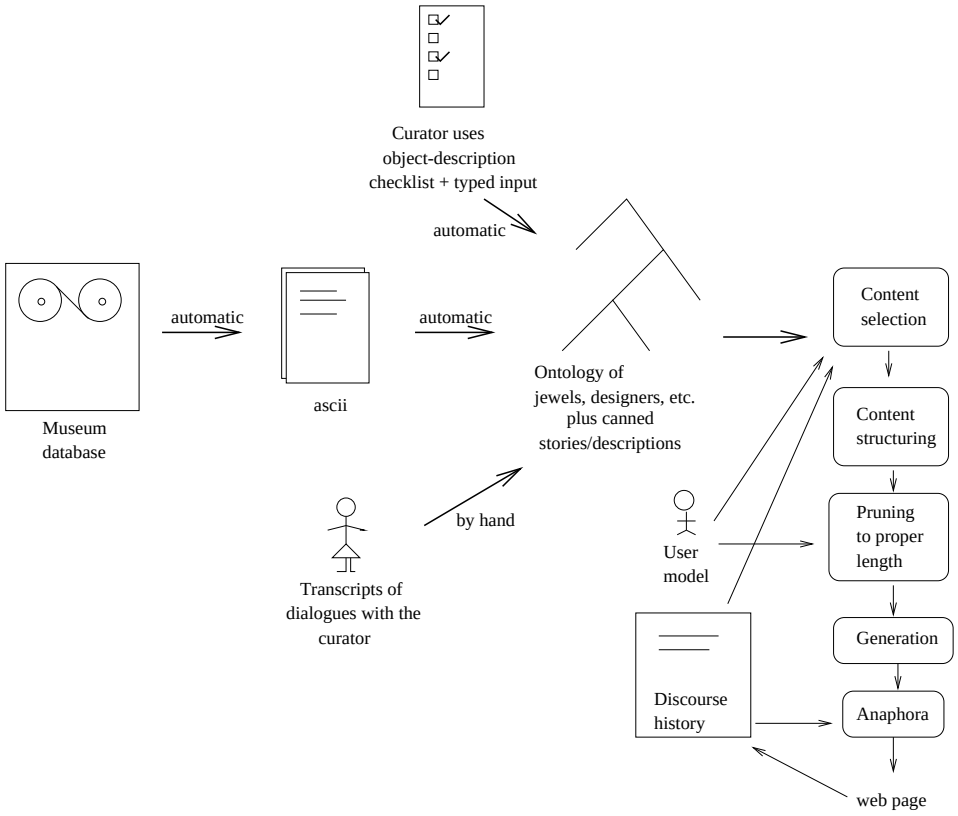

Figure 2: The ILEX system architecture

filled out our hierarchy with stories that the curator told about the jewels, relationships and contrasts between jewels that she felt it was important to get across to the visitor, and other types of information not found in the databases. Now that all the information concerning a particular object is stored in one place, it is easier to update than it would be in a simple or adaptive hypertext system, where a change in the information on one page tends to affect other pages; In ILEX the change will automatically be propogated to each page as it is generated.

Having gathered and organised the necessary information as illustrated in Figure 2, we began to construct the ILEX system. When the user selects a particular object, the system's first step is to select relevant information concerning that object. Crucially, this content selection phase involves consulting the user model and discourse history to decide what kind of in-

formation concerning this object will be of interest to the user and will meet the curator's educational goals if possible. Every piece of information has a series of ratings for "interest", "importance", "assimilation", and so on, the values of which are affected by the user model and discourse history. For example, one of the curator's goals in the jewellery gallery is to teach the visitor that not all designer jewels are made of expensive materials. They won't absorb this point properly if it is tossed at them randomly; instead, it is best to bring it up when the user encounters a jewel such as the Peter Chang bracelet, which is made of discarded materials like plastic pens and razor blades. This presentation of information at the time at which it is most useful and interesting is accomplished in ILEX by these ratings, which are assigned their initial values according to the expertise level of the user, what the user says he is or is not interested in, what the curator has indicated is particularly interesting or important about an object or its relation to other objects, and other relevant factors. As the dialogue with the user advances, the ratings are updated. "Interest" refers to how interesting a piece of information is to the user, and is determined by what the curator has told us is particularly interesting (such as the fact that a certain brooch is made of paper), what the user has told us he is particularly interested in (or not interested in), and the expertise level of the user, e.g, a child is more likely to be interested in jewels that look like cartoon characters than an adult. As we learn more about the interests of the user by paying attention to the types of objects he chooses to read about, the interest rating can be updated. "Importance" refers to the curator's agenda of communicative goals, such as getting the user to understand that jewellery can carry a political message. Another of the curator's goals is to give the visitor an idea of how certain objects are related, and the discourse history plays an important role here. "Assimilation" refers to how much the user is expected to know about the objects at any point in his interaction with the system; A child may be expected to know very little initially, and an expert quite a bit. As the dialogue progresses, information that is told to the user gets a higher assimilation rating, and, as a result, that information is less likely to be repeated.

After the content selection phase, we still don't have text; we have a collection of bits of information about the object. We then structure this information so that it can be presented coherently to the user, and discard as much information as necessary to reach the appropriate page length, keeping the information with the highest interest and importance ratings, and lowest assimilation ratings. Now that we know what we want to say,

we can generate the text. The text we've just produced will still need a bit of smoothing, and part of this smoothing process relates to NOMINAL ANAPHORA, i.e., making sure that the appropriate form of each noun phrase is used, as we will discuss below.

4 Coherence and Anaphora

Now that we've decided on the best information to present the user with, we want to present it to him in text that not only gets the information across but gets it across in a maximally coherent fashion. It is an important advantage of dynamic hypertext that it opens up the possibility of making a text more coherent by personalising it using the user model and discourse history. The descriptions produced can relate the object being described to objects the user has seen before, giving comparisons or contrasts; it can provide additional examples to illustrate a point when the user is a child or novice; it can suggest related objects that the user might be interested in based on the types of objects he has been interested in so far. For example, ILEX-1.1 can refer to previously seen objects as in "Like the brooch you just saw, these earrings were designed by Jessie M. King" or "Other jewels in the Bohemian style include a necklace designed for Liberty & Co. and a ring made out of glass."

Another way to make a text cohere is to go through the text, from top to bottom, and make sure the appropriate form of each noun phrase is used. The NOMINAL ANAPHORA module of ILEX performs this function. For example, compare the texts in (1) and (2):

1. Jessie King was not just a jewellery designer, Jessie King was an illustrator too. In fact, Jessie King did quite a lot of different types of creative work. Jewellery is just part of it.

   The four pieces here actually show four quite distinct aspects of Jessie King's jewellery work.

2. Jessie King was not just a jewellery designer, she was an illustrator too. In fact, she did quite a lot of different types of creative work. Jewellery is just part of it.

   The four pieces here actually show four quite distinct aspects of King's jewellery work.

The text in (1) is comprehensible, but not very natural. When a text is about a particular person or object, the most natural way to speak of the person/object is to introduce it with a full noun phrase such as "Jesse King" and to refer to it subsequently with a pronoun. After a paragraph break or a move to another topic (e.g., "Jewellery is just part of it"), it is natural to use a partial noun phrase such as "King" to resume discussion of the first topic.

Having a routine that processes nominal anaphora in this way gives the ILEX system great flexibility in determining the length of a text and in tailoring the text to the user. You can't remove pieces of a canned text or add text to it and maintain coherent nominal anaphora. Consider text (3) below:

3. The illustrations were done by Jessie King. She did quite a lot of different types of creative work.

If the first sentence is removed, the pronoun "she" doesn't make sense; if a sentence is inserted between the two sentences, as in (4), again the text becomes incoherent:

4. The illustrations were done by Jessie King. They were commissioned by Liberty & Co. and are stored in the Royal Museum of Scotland in Glasgow. She did quite a lot of different types of creative work.

By processing the anaphora as a final text-smoothing stage, ILEX is able to maintain coherence after lengthening or shortening a text.

Also, consider that the first time we talk about a jewel designed by Jesse M. King we want to introduce her using her full name, tell the user that she's a designer and give some background information about her. Once we've done that, we put that in our discourse history and we don't bring it up again unless the user asks for more information about King. If we talk about her again, we can refer to her as "King" rather than returning to her full name, since we know the user has already been told her full name. An adaptive hypertext system can't do this because it lacks a discourse history which would prevent it from repeating information, and because its text is pre-written and therefore the noun phrases can't be modified before being presented to the user.

5 Summary

We've described the ILEX system, which produces DYNAMIC HYPERTEXT web pages that describe objects in a museum. DYNAMIC HYPERTEXT, using a user model and a discourse history, combines canned and automatically generated text to suit the changing needs of the user. To date, two versions have been implemented (ILEX-0 and ILEX-1.1); both describe objects in the National Museums of Scotland's 20th Century Jewellery Gallery. We hope to extend the ILEX work to produce spoken descriptions, and also to produce a hand-held device that a visitor to a museum can use to generate descriptions as they walk around the museum.

The latest version of the ILEX system (ILEX-1.1) can be found at: http://cirrus.dai.ed.ac.uk:8000/cgi-bin/jewel-start?start/Ilex1.1

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