Context Awareness for MOBIlearn: Creating an engaging learning experience in an art museum

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Abstract

The MOBIlearn project aims to develop a re-usable architecture for delivering mobile learning experiences. A key component of this architecture is a context-awareness subsystem that is intended to tailor the content and options made available to a learner, depending on their current situation, preferences, and learning history. The context awareness subsystem has been developed alongside a hierarchical model of context, and has been subjected to formative evaluation. With reference to our context model, preliminary user trials, and input from museum staff, we describe the planned deployment of this system in an art museum learning scenario.

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1. Context awareness for m-learning

Context aware computing (for a recent review, see Chen and Kotz, 2000) has a lot to offer to mobile learning. By taking account of the learner's surroundings, we can create engaging learning experiences, providing content and options that are tailored to the current context.

One of the aims of the MOBIlearn project (http://www.mobilearn.org) is to create an architecture for mobile learning that includes context aware recommendations of content, options, and services. Work so far has produced a hierarchical model of context (Lonsdale et al., 2003) and we have performed some preliminary formative studies of the system (Beale and Lonsdale, to appear).

Within the MOBIlearn project we have developed several learning scenarios designed to allow to the deployment and testing of the system, including the context awareness subsystem. Here we present our plans for deploying and evaluating our context awareness architecture for students in an art museum. This research is work in progress, currently being developed and planned for deployment in a local museum in September 2004.

1.1. Museum scenario

In our art museum scenario, two students visit the museum with a number of goals. Our aim is to support them in carrying out the following activities:

- Planning the visit according to personal interest and requirements.
- Reaching the area of interest as quickly as possible.
- Knowing exactly where a co-learners, guides, etc., are located the museum.
- Viewing a catalogue of works by a particular artist.
- Receiving detailed information about the work.
- Receiving information about the artist.
- Receiving information on other artists belonging to the same period of history.

- Using an audio guide on the mobile device.
- Downloading and saving information relating to the work of art.
- Adding comments/notes next of each work.
- Communicating with other learners and sharing opinions.

2. Implementation

The context awareness system is implemented as a web service in Java, running under a Tomcat server. We have defined appropriate XML schemas for sending and receiving contextual information, and for providing recommendations to the context delivery subsystems. This work has been driven and informed by our original context model, web services architecture standards, and pragmatic concerns for the MOBIlearn architecture as a whole.

2.1. Context Model

There is growing recognition of the need for flexible, scalable, re-usable models of context that can be deployed for a range of applications. In MOBIlearn, we have been working to produce a re-usable model of context for mobile learning applications (see Beale and Lonsdale, 2004, Lonsdale et al., 2003). There have also been calls for a reconceptualisation of context to better represent the socio-cultural aspects of activity, moving away from the pre-dominantly technology centred approaches to context (Lueg, 2002a, Lueg, 2002b, Dourish, 2004).

For MOBIlearn, the purpose of context awareness is to enable learning on mobile devices, and so our approach to describing context and applying this description to producing a usable software architecture is based on this focus. Figure 1 shows the basic hierarchy for our description of context.

Instead of a rigid definition, our intention is to provide a hierarchical description of context as a *dynamic process with historical dependencies*. By this we mean that context is a set of changing relationships that may be shaped by the history of those relationships. For example, a learner visiting a museum for the second time could have his or her content recommendations influenced by their activities on a previous visit. More details of our context model can be found in Beale and Lonsdale (2004)

Contextual information is made available to other components of the MOBIlearn system by means of XML (eXtensible Mark-up Language) documents in an agreed format. At any given time, the current context state is represented as a nested set of context features, all described in XML form. An XML schema for this XML object is an agreed format that allows all components of the MOBIlearn architecture to access this information as and when it is required. Storage of a set of timestamped XML context objects provides the historical context trace that can be inspected and used by subsequent sessions.

2.2. Approach

Much of the current work on context awareness is technologically driven – that is, systems are developed to take into account of the capabilities of the available technology, but there is currently a debate about the exact nature of 'context' for context aware computing (for example, see Dourish, 2004). Our aim, in MOBIlearn, is to produce a learner-centred approach to context awareness by including contextual elements that are usable and useful for the a given learning scenario. These elements also need to be available from either the environment, a learner model/profile, or directly from the learner themselves. We aim to involve the user in the process of determining and using contextual information by consulting them for information and by making their current derived context both inspectable and modifiable.

2.3. Elements of Context

What is becoming clear is that there are difficulties in implementing context-awareness. Firstly, how do we get hold of contextual information; and secondly, what do we do with it once we have it?

Within the MOBIlearn project, we are centring our designs around specific learning scenarios. At present we are working on deploying the system in an art museum setting.

For this scenario, the context awareness system is being set up to take account of several contextual elements from both the environment and the learner themselves. These contextual elements will be used to derive a usable *context substate* (see Lonsdale et al., 2003). Elements to be used in the context awareness subsystem include:

- current learning topic: this will be either explicitly indicated by the learner, or obtained from their profile

- time spent on each artefact: our location tracking system not only tracks learner's locations, it also times how long they spend in any one position. Standing in front of an artefact for a longer period is used to infer a higher level of interest, and content recommendations are updated accordingly

- artefacts or content annotated (through MOBIlearn system on handheld device): the MOBIlearn system supports the annotation of content and also artefacts themselves (a form of virtual graffiti) – this information will be tracked by the context awareness system to provide relevant recommendations (for example, recommending items that have been annotated by friends)

- content items shared with others (through MOBIlearn system on handheld device): the MOBIlearn system supports the sharing of content with other learners – this activity will be tracked and used as a source of contextual information

These elements of context will interact to give us a useful way of determining what is appropriate to show the user. For example, the time spent looking at each painting will be used to derive a measure of 'interest'. A low level of interest will mean that only the title and artist of the current artefact will be shown. However, if the subject of the current artefact matches the user's current learning goal, then the system will assume a higher level of interest and show more detailed information. The user will also be able to over-ride the system. For example if their goals change during the session and this is not reflected by their current profile then they will be able to specify their interests, or revert to default content delivery that is not customised in any way.

2.4. Issues from stakeholders – what do we know about people's behaviour in museums?

Museum curators

We have engaged with the stakeholders of the museum experience by inviting input from the curators of the museum in which we plan to deploy the system. Several characteristics of visitor behaviour lend themselves to context-aware support:

- *No follow-up, no introduction*: visitors to a museum typically have little or no lead-up to their visit, and are subsequently unprepared for the materials they encounter. Similarly, there is no opportunity for them to follow-up their visit. The visit itself must be designed to accommodate the lack of lead-in and lead-out activities.
- *Lack of focused interest*: museums contain many items, relating to wide range of topics. Visitors enter exhibition spaces, and take in the collection, but often fail to give any specific attention to particular items. Being able to point them in the right direction with context awareness will hopefully be an effective way of focusing their attention.
- *How can we present the right level of information to each person?* Museum visitors come from many different backgrounds, and have different goals, interests, and experience. It is impossible to pitch the information provided at the right level to satisfy all visitors. The key to this problem is personalising the information we provide, using whatever contextual information we can gather about the visitor.

Issues from user trials

To better understand the impact of context aware content delivery in an art museum setting we ran some user trials where learners were given the chance to receive recommendations from the context awareness system.

The system provided recommendations of content, questions, and communication with other learners, depending on the participant's current location and question (selected from a pre-defined list). For example, a learner standing in front of La Primavera would see content relevant to that painting near the top of their content list, with the top item being most relevant to the La Primavera *and* their current question. If another participant who had already answered the current question was also at La Primavera, the system would suggest talking to them in order discuss the answer.

During the session the experimenter employed a "Wizard of Oz" evaluation method, monitoring each participant's location and updating their client software using a remote management application. The experimenter was also able to monitor which question each participant was currently working on and which questions had already been answered. At the end of the session, the concept of context aware content delivery was discussed with the participants and they were asked for feedback about their use of the system in an informal, free-form interview.

Feedback was gathered from users about the usefulness and usability of the system. This feedback was used to derive a formative evaluation of our current implementation. The following issues were identified:

- *It worked*: Most users were able to quickly find relevant information and successfully answer the questions.
- *Interface and representations:* Many users were confused about what we were trying to represent with the interface, and were not sure why their recommendations were changing or how they could best use the recommendations list to answer the questions.
- *Understanding*: some people weren't quite sure why the system did what it did, and were surprised by the constantly changing list of options. Demonstration and explanation did not seem to help with this – when there was a misunderstanding it was due to a lack of intuitiveness about the display of the context-dependent recommendations
- *Distraction vs Engagement*: offering multiple choices either led to sidetracking or encouraged people to further their exploration of the content. Both of these suggest that users were engaging with the experience, but this could become a concern if we are trying to design a specific programme of learning. Options that distract users from their current task focus need to be avoided, and so it is possible that some limits need to be set on exactly how much contextually based recommendation is done.
- *Mixed content:* there is a need to distinguish questions, content, physical resources. Offering recommendations of all of these in a single, integrated display seemed to be confusing, especially in combination with the lack of an intuitive, easily grasped model of what was actually going on and why.
- *Temporal context*: Context is often used in a snapshot sense: what is happening now, where am I at this moment, and so on. However, there are many much longer-term aspects to context (e.g. task, learning progress, life goals) and it is not clear how to best represent and use this information in the context system. The fundamental issue is that we need to be able to model and then provide support for users across multiple activities, episodes and projects, with the history of previous support playing an integral role in determining future actions.

3. Next steps

Several specific challenges for implementing this kind of context aware experience are apparent:

- How can the context-aware system be supportive in a non-intrusive way?

- How can we make suggestions about content or activities without causing distraction?
- How can we effectively combine various sources of contextual information to provide recommendations appropriate to the goals of i) the learners; ii) the experience designers, iii) the system designers; and iv) the teachers/docents?

The context awareness system, along with the other major components of the MOBIlearn system, will be deployed in a local museum in September 2004. There are also ongoing trials of various context sensing mechanisms at the University of Birmingham.

4. References

Beale, R and Lonsdale, P (2004) Mobile Context Aware Systems: the intelligence to support tasks and effectively utilise resources. In *Proceedings of MobileHCI 2004 (to appear)*.

Beale, R and Lonsdale, P (to appear) Mobile Context Aware Systems: the intelligence to support tasks and effectively utilise resources. In *Proceedings of MobileHCI 2004*.

Chen, G and Kotz, D (2000) *A survey of context-aware mobile computing research*. Technical Report TR2000-381, Dartmouth College, Hanover, NH.

Dourish, P (2004) What we talk about when we talk about context. *Personal and Ubiquitous Computing,* 8(1), 19-30.

Lonsdale, P, Baber, C, Sharples, M and Arvanitis, T (2003) A context awareness architecture for facilitating mobile learning. In *Proceedings of MLEARN 2003*, London: LSDA, 36-37.

Lueg, C (2002a) Looking under the rug: on context-aware artifacts and socially adept technologies. Workshop on *"The Philosophy and Design of Socially Adept Technologies"*, ACM SIGCHI Conference on Human Factors in Computing Systems, 20-25 April, Minneapolis, Minnesota, USA.

Lueg, C (2002b) Operationalizing context in context-aware artifacts: benefits and pitfalls. *Informing Science: Human Technology Interface,* 5(2).