porary works for specific component materials to have tremendous implications for the overall meaning. These issues are shared by digital materials more generally – they regularly exhibit complexity of interpretation, consumption and application in excess of those physical materials with implicit, unambiguous usefulness. Of critical importance is the extent to which information and the associated means of representation or experience are tightly or loosely coupled. Numerous logical and physical layers must exist to support the presentation and understanding of digital information: this is in contrast to analogue information, which exists largely atomically. More layers introduce more complex dependencies between those layers; any preservation action (to alter the format of a digital image component for example) can have implications far in excess of the intended extent of the intervention. From the artist's perspective, complexity creates opportunities for variation of behaviour and performance. While this contributes to, rather than detracts from, the significance and impact of the creative expression, it introduces difficulties for those seeking to characterize and preserve that which is definitive in and around a digital work.

Further complications arise from the often modular nature of contemporary installations, whereby components operate based on inputs from discrete linked systems. Lynn Hershman Leeson's 'Synthia' is a good example. In this work the mannerisms of an animated character rendered onscreen are influenced by live stock market data. Partly contextual, partly intrinsic, the flow of data must be made persistent for the piece to be correctly exhibited. We see similar phenomena within the digital context more generally; applications and file formats are increasingly networked, and are more and more reliant on decentralized services. How we deal with the preservation challenges associated with maintaining third-party services or user contributions is particularly challenging. Web archiving appears trivial when dealing with simple networks of linked, static Web pages. When the relationships between scripts, users, Web services, databases and rights management systems become more intricate and integral, preservation becomes less akin to photocopying and more like performing organ transplant surgery, with all of the risks that digital materials will be 'rejected' within their anticipated preservation environment.

From the conservator's perspective, documentation takes on a critical role. In those cases where art relies on bespoke, deteriorating materials, externally managed and originating services or a critical mass of community involvement there may be no way to ensure its availability. Nevertheless, the maintenance of appropriate linkable and navigable documentation can assist conservation and preservation strategies, most notably offering opportunities to characterize value and formulate priorities for individual examples. This can then inform the selection of subsequent conservation or restoration strategies, and ensure their consistency with the spirit of the piece.

This work was funded by the Planets (IST-2006-033789) Project, funded by the European Commission's IS&T 6th Framework Programme.

Links:
http://www.planets-project.eu/
http://www.hatii.arts.gla.ac.uk/

Please contact:
Andrew McHugh
University of Glasgow, UK
Tel: +44 141 330 2675
E-mail: a.mchugh@hatii.arts.gla.ac.uk

User-Centered Digital Preservation of Multimedia

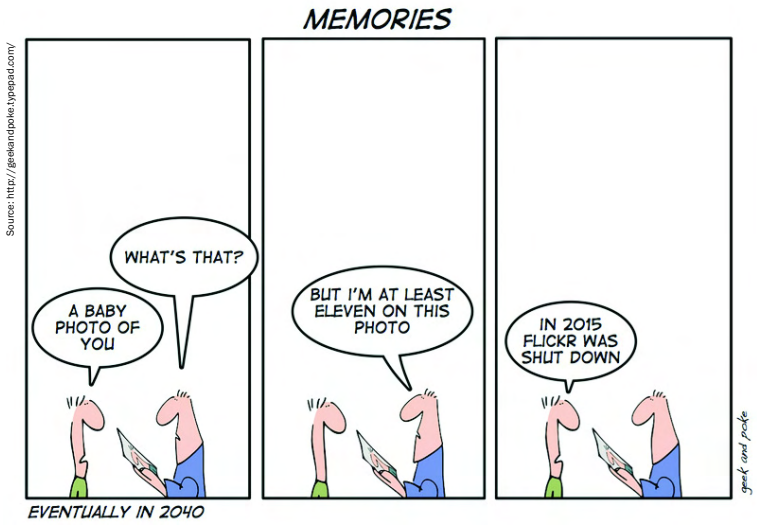
by Egon L. van den Broek, Frans van der Sluis and Theo E. Schouten

Everything expressed by humans in whatever form, arouses emotions in every one, who witnesses that expression. Those emotions are dependent on the witness and vary over time. For instance, an expression like "I'm now going to smoke a cigar in my office" uttered today brings about other emotions than 10 years ago. To really preserve (digital multimedia) expressions, the different kinds of emotions it arouses have to be preserved.

Traditionally, digital preservation (DP) is approached from engineering rather than a user perspective. Consequently, definitions such as these have been proposed: "Digital preservation combines policies, strategies and actions that ensure access to digital content over time" (ALA, 2007). This article approaches DP of multimedia from an end-user perspective. More specifically, we suggest that users' most important association with virtually all media be taken into account and, as such, that we introduce a new dimension to DP: emotion. This article discusses how this new dimension can be integrated in traditional frameworks as used for DP; see also Figure 1.

Let us start with denoting our perspective on knowledge representation (KR), which is founded on its traditional definition. In line with AIM (1993), we argue that KR can play five distinct roles, each crucial. A KR can be (i) a substitute for the object itself; (ii) a set of ontological commitments; (iii) a fragmentary theory of intelligent reasoning; (iv) a medium for pragmatically efficient computation; and (v) a medium of human expression. This perspective on KR is already more user-centred than the ALA (2007) definition of DP.

Through traditional KR, a range of information can be captured, including multimedia; eg SMIL (2008). Regrettably, we suffer from an information overload and multimedia retrieval techniques are not as good as sometimes thought, relying on the extraction



of low level features. While more complex compounds of these low-level features enable the definition of high-level features (eg objects), the mapping of such features, either low- or high-level, on semantics is still an unsolved problem. Consequently, (semi-automatic) annotation of multimedia data is still the best solution.

As stated, we want to take multimedia KR one step further. As is now generally acknowledged by the community of artificial intelligence, emotions play a crucial role in understanding human intelligence, creating artificial intelligence, and the interaction between entities (eg human and computer). We adopt this notion and, in addition, state that it is of importance to include emotions when aiming for DP, as it is a primary form of human expression and consequently human communication; cf AIM (1993). For example, laypersons can benefit from an enriched representation of an abstract painting that describes its emotional expression.

Recently, the W3C launched the first working draft of the Emotion Markup Language (EmotionML). EmotionML is "a 'plug-in' language suitable for use in three different areas: (1) manual annotation of data; (2) automatic recognition of emotion-related states from user behaviour; and (3) generation of emotion-related system behaviour." Each of these three areas is of interest for DP, as we will explain next.

EmotionML gives concrete possibilities for capturing the emotional communication of digital art; manual (or semi-automatic) annotations can preserve a much richer representation than can be obtained solely through traditional KR means. The manual and semi-automatic annotations of the emotional expression of art is, to some extent, currently possible; see also Figure 1.

Automatic recognition of emotions - 'affective computing' - goes well beyond the scope of traditional DP. Nevertheless, it can be exploited to automatically annotate DP; see also Figure 1. Although not yet mature and struggling with various problems, affective computing is currently moving into its subsequent stage of development (Guid, 2009). Through speech signals, computer vision, movement recordings and biosignals, users' affective states can be determined (to a certain extent). EmotionML can help in automatically capturing and preserving the different

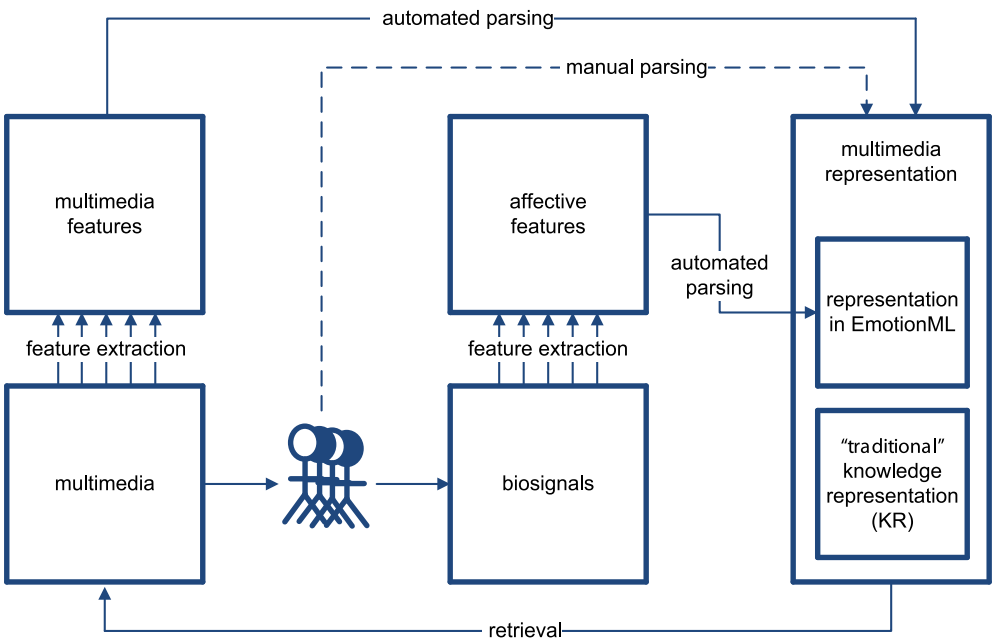


Figure 1: A scheme for the process of user-centred digital preservation of multimedia. The process starts with either an annotation of the user, which enables digital preservation, or a user's query that requires digital preserved multimedia. These users can be both the same or different persons. The boxes denote information sources. Arrows denote either core (solid lines) or optional (dashed line) processes. Further, please note that this scheme is simplified; eg fusion and classification processes are omitted.

emotional experiences, and through that various perspectives on the emotional expression.

The further DP develops, the more important the area of 'emotion-related system behaviour' will become. With DP, not only the storage of the KRs is crucial: access to the system (including its user interface) and the retrieval of the KR is of the utmost importance. In addition, non-specialists will increasingly need to be able to access the systems, to fully experience the "replay" from a wanted perspective. Affective computing can aid this interaction, as is generally acknowledged in the usability and human-computer interaction communities.

Let us consider the example of an abstract painting. The emotion will depend on the painting, the viewer, and the context (eg time). EmotionML can help in capturing the emotional expression of the painting; eg through (low-level) multimedia feature extraction. In further iterations, EmotionML can support capturing and preserving the emotional experiences through affective computing and, thereby, make emotional preservation automatic and incorporating different perspectives. However, an open issue remains in the user's perspective of the painting's expression; possible awareness for this perspective can be supplied using emotion-related system behaviour.

Taken together, fully automated generation of KRs of multimedia is beyond science's current reach. Nevertheless, we introduce a new dimension: emotion. The same holds for this new dimension as for multimedia analysis in general: semi-automatically is the best we can do. Nevertheless, developments in multimedia analysis, affective computing and in understanding humans continue to gain in speed. So, it is a matter of time before enriched digital preservation of multimedia, including its affective annotation, will evolve from theory to practice.

Links:
ALA (2007):
http://www.ala.org/ala/mgrps/divs/alcts/resources/preserv/defdigpres0408.cfm
AIM (1993):
http://groups.csail.mit.edu/medg/ftp/psz/k-rep.html
EmotionML (2009):
http://www.w3.org/TR/emotionml/
SMIL (2008):
http://www.w3.org/AudioVideo/
Guid (2009):
http://emotion-research.net/acii/acii2009/guidelines-for-affective-signal-processing-from-lab-to-life/

Please contact:
Egon L. van den Broek
Human Media Interaction, University of Twente, The Netherlands
Karakter, Radboud University Medical Center Nijmegen, The Netherlands
Tel: +43 1 956 1530; +31 24 355 8120
E-mail: vandenbroek@acm.org
http://www.human-centeredcomputing.com

Communication and Preservation in Academic Research: Current Practices and Future Needs

by Filip Kruse and Annette Balle Sørensen

Today's researchers work in hybrid environments that require, in addition to traditional, analogue methods of working, the use of an increasing amount of digital material and communication tools. This is forcing us to change our understanding of how researchers communicate, how they are connected in networks, and which parts of their research activities need to be preserved. But how should we rethink these issues? Researchers' current practice and requirements are analysed and future consequences reflected upon in a questionnaire-based survey from Aarhus University in Denmark.

According to most researchers, intermediate research results such as drafts, preliminary findings or datasets are important to preserve. Likewise, access to such results should not be restricted to the actual researchers involved. Previous research activities and professional networks are also essential to the majority of researchers, for the generation of new ideas as well as for the research process in general. Finally, communication with the network is of central importance for the entire research process including generation of new ideas as well as initiation and completion of projects.

Almost all the researchers' networks are cross-institutional and international. E-mail is the preferred form of communication with the network. Researchers generally prefer information or data in digital form rather than printed, but researchers from the arts and humanities are split down the middle on this question.

The findings of the survey highlight the importance of e-mail communication, both as a medium in itself and as an element in maintaining researchers' professional networks. The issue of preservation thus carries a double meaning, i.e. both preservation of the communication of research results from the initial idea to the final results, and preservation of the network. The first stresses the influence of preservation and dissemination on the creative flow of thoughts and ideas. The second focuses on social interactions and their role in the formative processes of the network.

Though the importance of e-mail communication is obvious, researchers from the arts and humanities and the social sciences rate its importance slightly lower than those from the health and natural sciences. The importance of e-mail communication does not imply that all e-mails should be preserved. On the other hand most researchers state that they do need to preserve more research data or information. The message from the research community is quite clear: e-mail is important, but not every e-mail related to research should be preserved; they are already critically