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Challenges and Solutions in Online Usability Mining for End-to-End Content Management and Global Mass Personalisation

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Abstract

At the current pace of growth and innovation, electronic commerce sites will find it increasingly difficult to give customers the feeling of a personal and directed service that will ultimately make the difference. Content management and personalisation pose some of the most important challenges for online businesses, E-Society, E-governance and E-government. The increasing need in the design of advanced interactive hypertext systems such as closed corpus (eg multimedia courseware) and open corpus (eg WWW) is for the user to access and manipulate large heterogeneous digitised resource bases efficiently, effectively and comfortably. Research in content management, usability mining, personalisation models and ontologies will crucially underpin the 21st century personal and business computing environment for knowledge discovery, access, manipulation, learning and management. To cope with the massive rates of information exchange in the new digital economy, the emergent IS environment will need to be able to rely on efficient contextually aware navigation, retrieval and transaction systems. These capabilities will have to be made available on both multicasted or on-demand media services, to serve a wide variety of social and business needs such as Electronic and Mobile Learning and Commerce as well as life-long e-foraging for leisure, cultural and general interests by anyone, anywhere through any terminal world-wide. We outline the central technical, social and ethical issues in capturing, managing and interpreting usability data intelligence *on the roots of, and the routes* to, user (dis)satisfaction. We describe the current technical shortcomings of browser, navigation and traffic management technology. We present our research focus in seeking to take a transformative step towards the development of a new *IS persona* for computer-aided navigation systems (eg CAIN, Lamas et al '99) or Workflow-embedded document retrieval systems (eg SmartDoc, Badii '97) as integrated with our online usability evaluation systems (PopEval_MB, WebEval_AB, Badii & Murphy '99, Badii, '99b, 2000 a,b,c).

Background and Motivation

Currently, access to both the closed and open corpus hypertext systems eg the Web, is often associated with high levels of information overhead and cognitive overload; with the attendant frustration, confusion and inefficiencies for all types of users. For example zero-hit outcomes can occur on a considerable number of searches whilst the huge number of hits obtained in many other cases can be very distracting for users. Naturally most users would prefer more information and control over their

searches. Recently there has been a surge of research interest in content management for a variety of applications notably in Integrated Data Discovery, Exchange Engineering and Mining Management Architectures (IDDEEMA, Badii '96), Workflow-embedded Document Retrieval and Management Architectures (SmartDoc, Badii et al '97) and Computer-Aided Navigation as in CAIN (Lamas, Jerrams-Smith, Gouveia,'96-'99) as well as Automated Usability Evaluation for capturing and tracking online user preferences/(dis)-satisfaction as in PopEval_MB/ WebEval_AB (Badii & Murphy '99, Badii '99b, 2000a,b,c). Although improved user interface design is clearly part of the solution, a universally applicable end-to-end content management framework of standards, ontologies, and tools needs to be adopted so as to minimise, rather than merely shift, the current bottlenecks in network traffic (Badii 2000c, Badii & Martland 2000d). The wide diversity of the user community, which for example can access a web-site, will mean that computationally efficient information systems have to be devised to elicit, track and update usability and mass personalisation data intelligence globally and continuously (Badii 2000c,d; Badii & Martland 2000d).

This is a vital requirement if the interfaces were to remain contextually aware in the face of continuous shifts in users' focus and interests and the requirements for multi-modality, multi-linguality and seamless cross-cultural inter-operation. It is important to note the many levels in an integrated intelligent information network at which usability data intelligence would need to be represented, indexed, stored and accessed semantically and by content and teleological context. For example such dynamic user profiles would need to be made available at the network meta-model control level for reasoning over content push vs content pull in network traffic management optimisation (Badii & Martland 2000). Dynamically updated interpretation of fast captured without causing user annoyance. It exploits the results from Judgement and Decision Making theory, and, Pleasure & Pain Recall theory (J/DM–PPR) regarding user biases (Badii 2000b,c, Badii& Murphy '99). This enables the application of judgement-theoretic insights to online usability evaluation of interactive systems (Badii et al '99b,c; Badii 2000a,b,c). PopEval_MB facilitates the bias-free elicitation of the dynamic knowledge on users' changing preferences, life style and *patterns-of-relating* (P*oR), (Badii & Rolfe '96, Badii'99c, 2000a,b,c).

Problems and Possible Solution Systems

As far as E-Business is concerned some notable trends in the pattern of systems, services and requirements are emerging. Simple, anonymous, secure and reliable payment schemes will find the mainstream and will eventually be adopted; electronic wallets and micro-payments are among the most promising (Choi et al. '97). An information-based economy will enable consumers to also be producers (prosumers), and trading of information will take off. Information about what is on the Web, where it is, and how much it is worth, can be a catalyst for micro-payments to take place between prosumers. Automated services, such as intelligent agents, webcrawlers, and search engines, will be increasingly disappointing as **i)** firewalls and other security features will prevent them from entering web-sites, **ii)** unstructured information is and will be difficult to filter and process automatically, and **iii)** more and more information will be stored in server databases and will be inaccessible in HTML pages. Educational applications need to facilitate integration and sharing of content: of educational modules, of learning strategies, of evaluation methods and skills certification etc. With web-supported course delivery becoming dominant, large scale sharing and modularity will need to cater for different learning needs, different paces of self-managed learning and personal resource linking (aggregation) to allow the creation of personalised subject specific portals, learning resources and notes. Further, content management in educational applications, needs to consider a number of user and stakeholder categories; such as the providers of information (skilled professionals), the consumers of

changing needs and interests of every individual user must also be made available at the user's click-stream history level so as to control and plan to accommodate user demands with efficient and effective user flow whilst hyper-searching the Web (Badii 2000c, 2000d). PopEval_MB was motivated by a meta-methodology of frameworks and tools for IS impact analysis and cultural compatibility management. This meta-methodology is referred to as Cultural Accommodation Analysis with Sensitised Systems for User/Usability Relationships and Reachabilities Evaluation (C-Assure). This has been studied at P3*i* since '96. C-Assure offers a coherent framework aimed at ensuring that the highest quality usability data is information (students), certification bodies (eg e-university consortia), delivery methods and payment schemes. There are already some partial solutions to the problems outlined above: strong cryptography allows for digital cash to be a reality; Internet communities exist linked either by interest or by other social factors and Internet auctions are a success. Directory services, such as Yahoo, although facing the overwhelming task of manually indexing up to 300 million web pages, are the preferred starting point for navigation as they are perceived to be more reliable (Chakrabarti, '99). There is however as yet no dominant paradigm to resolve how content will be presented and delivered to consumers and visitors. Some of the efforts to-date can be categorised into: **a)** Providing "understandable" information models and semantics to be used across the Web - XML from W3C, and RDF, also from a W3C Working Group as described eg in (Lassila & Swick '98); **b)** Providing "inner", deeper, richer representations that can be used to model, within a site, consumer interaction, knowledge about the business, and information about consumer profiles; **c)** Ontologies have been reported as one of the solutions to build and maintain knowledge about site contents (Rabarijaona et al '99); **d)** Providing models of consumer interaction and behaviour, such as in Maes et al '99, by means of intelligent agents that automate most of the boring tasks and learn from consumer preferences and interaction. These approaches will certainly make their contribution towards building a reliable, fast, accurate, pleasant, and worthwhile e-commerce experience for consumers. However such experiences will remain an unattainable ideal without robust, flexible and unobtrusive usability evaluation and mining systems. These need to be enabled by mass-personalisation tools running in evaluation servers and client sides throughout the network to help optimise end-to-end content and traffic management (Badii 2000c). Thus piecemeal approaches to content management, ie running personalisation tools to serve certain clients or parts of the network will only amount to shifting some bottlenecks with unstable and diminishing improvements for most users. We view the real answer as being the establishment of a trusted and culturally interoperable system of standards, ontologies

and tools subject to global consensus-driven E-governance to safeguard privacy and ethical conduct in capturing and utilising personalisation data intelligence. This will allow the safe and seamless world-wide deployment of emerging end-to-end network content management technology. It will thus accelerate the development and integration of Point-of-Click Automated Usability Evaluation and Mining to serve the global digital economy (Badii 2000c).

Mass personalisation here implies an interpretivist basis for building and updating reference and extant models of each user's various needs and preferences as may be applicable to their changing life-styles and interests ie dynamic user modelling. However such modelling requires a framework for maintaining a repository of traceable, justifiable and consistency-checkable usability data to be interpreted in a variety of situated contexts. It should be possible to adopt a meta-model for eliciting context-specific user-relationships and usability data from various sources, with an *enquiry methodology* (Badii '99b, 2000b,c). In this way both interpretivist and quantitative modelling of every user's for modelling of the individual user and the ethical issues in connection with the deployment of a user model. Now that there is a greater interest than ever before in mass-personalisation, especially in the domains of distance education and e-commerce, such issues have become even more relevant to research towards the development of advanced, Mutually Intelligible and Scannable (M*IS) information systems (Badii 2000c). Recent research has continued to address such issues and to extend the application of user modelling. For example user modelling has been applied to medical Telecare systems (John et al '98). As a current example, our Computer-Aided Navigation system, CAIN, deploys user modelling to increase the Web's value as a pedagogical tool by helping users to deal with the vast amount of useful information available on the Web. It provides direct guidance navigation support as a form of non-obtrusive, weak hypertext linearisation. This enables the user to follow a context-specific ranked sequence of selected Web pages without ever needing to perform any search or follow any link if they do not wish to do so. This approach does not seek to prevent goal-oriented exploration but rather to provide a guideline to help users to retain their focus. CAIN uses three user modelling techniques resulting in a hybrid user model involving stereotypes, overlays and attribute-value pairs. Navigation support is accomplished by a route-finding heuristic which selects context-specific Web model items, sorts them using associated qualitative ratings, and presents them to the user, one at the time, based on the user model attributes.

requirements can be done continuously using a reliable repository of root justifications and rationale for each element of a user profile (Badii'86, Badii and Hounat '96, Badii and Rolfe '96). One of the earliest systems for user modelling was SUSI (Jerrams-Smith, '85). This provided an intelligent interface to Unix (which was recognised at that time as being particularly difficult for novices to use). SUSI contained information about user errors, which was encapsulated in a knowledge base. It made inferences about users' mental models and used these to select appropriate tutorial advice. The performance of users of the system was found to be superior to that of users of standard Unix interfaces (Jerrams-Smith '89). So although the term "user model" has been invoked in various contexts, here for *mass-personalisation* it implies a model of each individual user of the system. In recent years there has been a growing interest in various aspects of user modelling. This includes knowledge modelling (Jerrams-Smith, '90); the attributes of the user to be modelled; the means and frequency of data acquisition

Conclusion

The required user models to serve a platform for end-to-end content management can be provided through integration with online usability evaluation tools such as PopEval_MB and WebEval_AB. This will allow server-centric mass-personalisation of usability data capture; replacing the traditional paper-based survey methods which suffer from problems of data acquisition management, distortion and unscalability. A monolithic data capture method can prove inadequate for elicitation and analysis of system specification and usability data, particularly in complex domains such as e-commerce, e-learning and online teaching resources support. A flexible and real-time paradigm for usability knowledge acquisition is required to guide the dynamic selection of appropriate techniques. This is so as to automate the continuous capture and interpretation of usability intelligence including the underlying facets of multi-modal user behaviour and processes involving different life-cycle models, sub-languages, semiotic and attitudinal contexts. We are embarking on a transformative step towards a truly innovative integration that will allow the asynchronous, point-of-click capture of more reliable data on aspects of user satisfaction and motivation. This will facilitate the automation of formative feedback through data mining; with multiplier effects in customer and learner satisfaction and thus in competitive advantage. In this way, integrated evaluation-server-centric technology will make available, to e-education and to e-commerce, all four types of evaluation (summative, formative, illuminative, and integrative) for every learner or shopper, on-line, continuously. This will support the emerging integrated models for Electronic, Geographic and Mobile Education and Commerce (EGM-Commerce, EGM-Learning, Badii 2000d).

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