Modelling interaction with distributed information

So much information and so little time

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Abstract

This paper describes work investigating the modelling of temporal and real-time requirements within human computer interaction. One particular focus for this work is the highly interactive tools used to access widely distributed information sources on the Internet, such as 'Mosaic'. We argue that the manner in which such tools accommodate inherent communication delays can significantly influence how users cope with the mass of information available. By developing a model of temporal and real-time interaction we are able to express general usability requirements which are applicable in a variety of contexts, and can improve the design of interactive tools for accessing information.

We propose that the extent to which delays within interface behaviour hinder effective use can be assessed in terms of: (i) the generality of behaviours particular inputs can generate (termed behavioural resolution), and (ii) the degree to which inputs generate similar feedback (termed behavioural discrimination). These notions can be defined in terms of properties of an abstract model of interaction. In particular we adopt an architectural model of interaction consisting of inter-connected processing elements, termed interactors. Within this framework interactive behaviour can be specified in terms of an event algebra and system delays can be associated with the cost of communication between interactors.

We employ the notions of behavioural resolution and discrimination in the analysis of usability problems within existing tools and consider the impact of usability issues for the access of distributed information in general.

With the advent of highly connected information services and the widespread use of HyperText Markup-Language (HTML), the notion of 'interactive system' has changed dramatically. From the perspective of the user, highly-connected interactive systems offer poorly structured distributed data, which is, to all intents and purposes, infinite. The absence of any definitive logical or physical structure to information sources complicates its retrieval. In particular, information retrieval becomes a highly interactive iterative process in which the user is faced with identifying possible information sources and assessing the appropriateness of any information found. Interactive information retrieval can be characterised by Norman's interaction cycle in which users continually: re-formulate their goals, plan and perform actions at the interface, and evaluate system responses (Norman 1984). Successfully interacting with distributed and unstructured information in this manner is complicated by two factors: (i) the absence of a global logical structure means information is, not so much retrieved, but discovered; and (ii) the absence of an explicit physical
structure means unpredictable communication overheads can hinder opportunistic interaction. Hence, users are faced with too much information resulting from the lack of logical structure and too little time resulting from the overheads of a hidden physical structure. These usability problems often result in users adopting a planned/strategic mode of interaction, as opposed to opportunistic interaction (Dix 1987, Atkinson 1995).

Conventionally, within computing, the identification of levels such as the logical and physical enable the separation of design techniques and deliberations. Within the context of interacting with distributed data such as separation of concerns complicates the assessment and satisfaction of usability requirements. We take the failure to recognise the significance of temporal and real-times issues within existing interactive tools to be a reflection of inappropriate consideration of user requirements and expectations. In order to effectively use interactive tools for accessing unstructured and distributed information it should be possible for users to formulate reliable expectations about the temporal behaviour of a system (see Schneideman 1984 and Smith & Mosier 1986). We propose two factors which contribute towards whether or not reliable expectations about behaviour can be developed. Behavioural resolution refers to the resolution with which a given input determines distinct forms of system behaviour. Behavioural discrimination refers to the ease with which alternative system behaviours can be distinguished. Poor interface resolution hinders reliable prediction of interface behaviour and thus does not support planning, while poor discrimination limits the recognition of distinct system behaviour complicating output evaluation.

In order to accurately define and reason about the notions of behavioural resolution and discrimination, we employ an architectural system model consisting of inter-connected processing units, termed interactors (Paternò 1993 and Duke & Harrison 1995). Quite simply, on receiving an input from the user an interactor can generate local feedback to the user and/or communicate with other application oriented interactors which perform further processing. In addition, an interactor can receive information from application processes which may generate output to the user. A system as a whole is a network of interactors processing different classes of user inputs (and system responses) at different levels of abstraction. In order to consider the temporal behaviour of such a system we identify events that are direct user inputs ($I$) and are outputs ($O$), all other events ($T$) are considered to be internal and only influence system behaviour by having a range of durations.

Using this framework, trade-offs and dependencies between behavioural requirements and system architecture can be assessed. Hence it is possible to examine the interplay between architectural designs and the behavioural resolution and discrimination it enables. For instance, we are able to show that both resolution and discrimination benefit from interactors with deterministic behaviour. In the case of interacting with widely distributed information sources, effective use is inherently complicated by the simple fact that the mechanisms for linking and communicating with information sources purposefully hide behavioural details and are observationally non-deterministic.

By employing this framework in the analysis of particular internet tools, specific interface limitations can be identified and techniques for addressing and overcoming them are considered. The outcome of this analysis demonstrates the conflicts between system oriented and user oriented development and a class of interface design improvements. In particular, proposed improvements can be contrasted with those evident in the development of advanced browsing tools.

The work described has developed a framework which relates interface usability requirements and system oriented architectures. In general, these two perspectives represent valid concerns within system development which can often be separated. However, in the case of interacting with widely distributed information, the two
perspectives are strongly inter-related, and the framework developed enables this inter-relationship to accurately analysed. A general observation arising from this analytic framework is that architectural system components which hide distinct behaviours hinder the development of effective user interfaces. Further work in this area is to focus upon applying the framework to other domains, such as multi-media interaction and system driven interaction. In addition, we intend to develop and validate more detailed temporal usability requirements.

Bibliography


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