Overview of the Smart Internet

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Abstract. The aim of this chapter is to introduce the key characteristics of the Smart Internet, envisaged as addressing the current problems reviewed in the introduction to Part 1 of this book. After introducing the key principles of the smart internet, a distinction is made between smart interactions, and smart services, each of which are then dealt with in Parts 2 and 3 of the book.

Keywords: Smart internet, interactions, user models, web.

1 Introduction

Research work in context-aware computing [1] the Semantic Web [2] and personalization [3] has made advances with respect to some of the shortcomings of the Internet identified earlier in this book. However, without a cohesive and advanced *user model* at a macro level (not just at the individual site level), and without a *web model* to capture the conceptual structure of Web content and services, these types of incremental advances will not lead to significant change.

This chapter proposes an extension to the web, referred to as the *smart internet,* which includes a new user model of the web, *smart interactions*, that is centered on the perspective of the user instead of the server. This advanced user model is enabled by a new web model, referred to as *smart services*, that provides the integrated web infrastructure necessary to support the technical requirements of the smart interaction user model.

The notion of a smart internet requires a transformation in our understanding of the web and its architecture – a complete change of perspective, from a server-centric understanding to a user-centric one. This change will be much like the Copernican revolution, where the presumed structure of the solar system changed from an Earth-centric one to a Sol-centric one.

Three major extensions are called for in this transformation. First, a new "Copernican" *user model for the web* is needed that is centered on the users' concerns and cognition. Second, a new kind of *session concept* is required that centers on the user's perspective and her situation rather than the server's perspective of user interactions. Thirdly, the *concept of dynamic social binding of web interactions*, to

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turn what is currently a single user web interaction model into multi-users' collaborative web interactions under the user's control, is also needed.

In essence, the *smart internet* supports an instinctive *user model of the web*, one in which the discovery, aggregation and delivery of services and resources results in rendered content that is optimal for each user or group's situation.

Formulating a user model could potentially benefit from empirical studies of web browsing. Beauvisage [4] includes a survey of many such studies, and his own study, based on his approach of "web territories". These "territories" includes three dimensions related to browsing behavior: navigation dynamics, user dynamics, and content dynamics. He used statistical classification for the purpose of describing those dimensions.

This chapter presents our vision for the *smart internet,* and outlines some of the research challenges posed by the two complementary aspects, *smart interactions* and *smart services*. The making of this vision into a reality will require many kinds of expertise and technical solutions. It is our hope that this book will encourage researchers to address these challenges.

2 The Smart Internet Vision

The smart internet will be an evolving extension of the internet in which online services and resources are discovered, aggregated and delivered dynamically, automatically and interactively in response to a user's or group's evolving concerns and situations, which may involve real time or proactive performance of tasks that address users' goals.

All aspects of this interaction must be conducted with awareness of, and adaptation to, the user's personal and group context, task requirements and characteristics. The resulting aggregation of resources and content will be delivered in a manner appropriate to the user's current concerns or situation, and as a unified entity abstracting relevant content and services from a single site, or from multiple sites and organizations.

To be practical, the smart internet must be an evolution and extension of the current internet, building on the existing basic architectural elements of HTML, URLs and HTTP, while hiding these techno-centric elements behind objects and interactions that are more appropriate and intuitive, tailored to the end user's current domain, goals and concerns. Rather than the user initiating interactions to accomplish tasks themselves, the smart internet should allow the user's current concerns to drive the implicit discovery and aggregation of services and resources to serve the user and support the user's cognition and action.

This section highlights the three distinct principles of smart internet that set it apart from the internet today: an *instinctive user model, sessions for users and their matter of concerns,* and *collective and collaborative web interactions.*

Each of these principles is described below.

2.1 Principle 1: A User-Centric Model for Instinctive Interaction

The term "user model" has been used in a number of different ways in the literature on human-computer interaction [5]. Norman [6] distinguished between three different

conceptual models relating to use of interactive systems: the user model; the design model; the system image. While the latter terms represent the designer's model of the system and how the system presents itself to the user, the term "user model" can refer not only to the user's model, but also to a model of the user (closer to Norman's concept of design model). In the present discussion, user model refers to the model of the user and her tasks that is assumed in designing systems, methods of interaction, and in guiding specific interactions.

Identifying and applying appropriate user models is essential, in keeping with the requirements of user-centered design (e.g., [6]). Instead of being user-centered, the user model of the internet today is by and large techno-centric, exposing the fundamental components of the web architecture, resulting in a "one HTML page at a time" interactive model convenient for the server. The widespread use of the Internet should not be taken as proof that the techno-centric user model is sufficient. Users adapt to fit what the web has to offer, and in order to use valued content and services, they are willing to connect to myriad web sites, filtering the relevant information for their own context in order to address the task at hand. But this causes a great deal of inconvenience and wasted effort. What we seek instead is an alternative user-centric model that leads to interactions that are instinctive for the user, rather than being fitted to the server and awkward for the user.

There are three critical implications of the principle of instinctive user model for the web.

1. *Metaphors as Cues for Instinctive Response*

The system image of the smart internet should use metaphors based on objects and operations from real world analogies that are familiar and appropriate to users and map well to the user's current domain of concern. Well-chosen metaphors hide the techno-centric elements of the system, while promoting a good mapping between the concerns of the user and the functionality of the system.

Meaningful user interactions are driven by goals that are then reflected in the things that matter to the user when interacting with the system. These "matters of concern" ("*moc*") should drive the design of interactions, so that users no longer deal directly with URLs and logon forms for secured sites, not because they are not needed but because they are handled for them behind the scenes, just as people can drive cars without having to worry about all the details of how the engine is working.

Google maps "points of interest" are an example that illustrates the type of interaction envisaged, where the prime metaphor for user interaction is based on objects and operations like "Interest Category" and "Find Direction" that are in the user's domain.

2. *Web Page Content and Control by and for Users*

Another implication of instinctive interaction is the transfer of control of the rendered HTML page to end users so that individualized content is dynamically and adaptively aggregated for effective interaction with the user's *mocs*. Content and services could then be placed in individualized contexts based on the current collection of *mocs* applicable to the current persona (e.g., a user may have different personas depending on whether she is at home, at work, or mobile).

a. *Aggregative Content*

Currently online users have to deal with the one page per response per domain server request-response model of web interaction. The principle of instinctive interaction requires a completely different method of interaction.

In the smart internet, the rendered response is *aggregated for the purpose of the user* as a whole person with multiple current matters of concern. Transforming from *the users for the web* to *the web for the users* means providing *moc*-relevant resources and content extracted and abstracted from one or more servers and tailored to the concerns of the individual.

b. Adaptive to system of interactions

Instinctive interaction should be tailored not to a device or situation, but to a lifestyle and *the user's systems of interaction and other elements of context that are part of that lifestyle*. Adaptation to user's multiple systems of interaction is not just in form factor (e.g., different devices) but also in function. Traditionally, mobile devices provide a squeezed miniature of their desktop counterpart, resulting in inferior user interfaces. Instinctive interaction requires a different approach where subset units of functions that are optimal for the device of interaction; persona in context and other factors of context are adapted for the user's *moc.*

3. *Control*

The control of the HTML page as rendered response is transferred from the server to the user. Web application development for the smart internet enables users to control the form and content of web pages so as to suit their own purposes and context. For example, users can specify different preferences, rules and policies for aggregation for their various personas (personal, professional etc.) and *mocs*. These pre-set user rules and conditions then control how pages are put together.

4. *Calm, Instinctive, Cognitively Compatible*

Not only should the metaphors and entities of smart internet interactions match key features in the user's problem domain, but the methods and style of interaction should be compatible with *the user's cognition.* This is in sharp contrast to existing internet interaction, which requires its users to initiate and drive interactions with the web to accomplish their tasks. Such interactions are synchronous in nature, and users bear all the cognitive burden of initiating actions and remembering where related information is located.

In contrast, smart interaction, while still leveraging the web as a platform, provides better support for the user's cognition, reducing the amount of information that has to be held in prospective memory, reducing the complexity of tasks to be performed by the user, and so on.

The concept of *calmness* has emerged as a key aspect of ubiquitous computing which relates to how users' attention is engaged. Human attention has a number of key properties (e.g., [7]), including limited capacity, and differences in types of attentional resource (with a key distinction being between verbal and visuo-spatial attentional resources). In order to be calm, interactions should engage both the center and the periphery of the user's attention moving back and forth between the two. Peripheral attention does not require the executive processing of focal attention but

allows a person to maintain awareness of information in the environment. The periphery at a given moment may be the center of attention in the next and smart interaction should exploit the properties of cognition to provide information and options in a way that it easy for people to perceive and assimilate while going about other activities. By loading more processing in to the periphery, smart interaction informs without overburdening, freeing users' cognitive capacity to handle more things [8] while making tasks calmer and less disruptive.

Calmness in the smart internet may be achieved in many different ways, such as by adding asynchronous interfaces to allow *mocs to move* back and forth between the periphery and the center of attention depending on user specified rules, and aggregating and adapting based on the user's changing personas and context.

2.2 Principle 2: Session for Users and Their Matters of Concern

Today, the notion of session keeps track of the user and their interactions from the perspective of the server. The session ends when the user stops interacting with the site. Traditionally, a user session is defined as "a series of requests issued by a user to a web site in a single visit to the site" [9]. Technically, user sessions are HTTP sessions used to preserve the conversational state between a given server site and connection with a browser instance of a client device. Important session information such as user account and password are preserved and associated with the corresponding client, avoiding the need to ask for the same required information in a given request-response dialogue, resulting in better user experience. The existing concept of session, (i) is associated with one particular server, and (ii) is bounded by user's real time synchronous interactions.

When the web's center of gravity is re-focused on the user, the concept of session must be extended beyond the server site view of user initiated real time synchronous interaction. In the smart internet, sessions are oriented to the perspective of users and their matters of concern, rather than simply being states that the server site wants to keep track of. Two major implications follow from this shift of emphasis.

1. *Interactions need not be synchronous*

Sessions centered on the user and her matters of concern should not be exclusively real time synchronous interactions initiated by the user. To sufficiently support the user's matter of concerns, smart interaction needs to add, (i) asynchronous interaction patterns, such as events and asynchronous conversations. Examples might include setting up of monitors; reminders or alerts based on certain conditions (triggers) or the setting up of prospective memory related tasks of *mocs* such as scheduled tasks, and (ii) batch processing where sequences of service interactions within or across several server sites are remembered and repeated automatically.

2. *Session as a Cohesive Continuum across multiple systems of interaction*

Web applications in the smart internet see users, their concerns and tasks as a continuum of ubiquitous access across one or more systems of interaction. This revised concept of session has the following implications: (i) Smart internet sessions maintain *mocs* as persistent states in order to keep track of progress towards the user's goals and sub-goals and the need for user's attention for each *moc*. Smart internet sessions will involve semantic integration of a relevant set of composite services and

server site sessions to deduce and maintain (persist) overall state and progress of *mocs*. (ii) This persistence means that users will not lose or change their state or the state of their matters of concern when switching system of interactions. Thus users will always be able to continue where they last left off. (iii) This means that switching personas or context does not throw the user into a new logon session. When re-authentication is required, it will be done on the user's behalf (without requiring the user's involvement). This also means that the user's multiple systems of interaction can function as a cohesive unit, forming a continuum for the users and their *mocs*. This is very different from today, when each change of system of interaction leads to a new session that is treated as if unrelated to previous sessions.

2.3 Principle 3: Collaborative and Collective Web Interactions

The third principle of the smart internet that distinguishes it from the current internet is that it explicitly supports close collaborate between users to resolve shared matters of concern. This principle has the following implications.

1. Dynamic Social Binding

Dynamic social binding is defined as the capability to select other users dynamically to share interaction elements for different levels of interactions associated with *mocs*. Shared interactions will occur at different levels of intensity, ranging from sharing of views as read-only, to co-execution or delegation of tasks and sub-tasks of mocs, thereby turning web interactions from solitary undertakings to multi-user collaboration. Online shopping can be used to demonstrate the application of this principle. Suppose a user, A, has started a matter of concern relating to online Christmas shopping for his children. He places multiple items from the catalog into the shopping cart. Using dynamic social binding, user A selects his wife, user B, to co-execute different elements of interaction for the online Christmas shopping task as a moc. Now user B is enabled to participate and collaborate in operations of user A's *moc* such as adding items to the shopping cart. Once the collaborative work has been completed, User A can transfer the session to user B or end the dynamic social binding session and continue to checkout himself.

2. Collective Intelligence

In Smart interaction, matters of concern become the major drivers of activity, explicitly centering the processing on user needs and interests. In keeping with this focus on mocs, text and semantic search in the smart internet should return search results in units of *mocs* as a (pre-set; or ready-to-use as-is or with minor modification) purpose-built composite collection of related services and resources instead of being simply a list of unrelated single hyperlinks as in today's internet. We envision a new kind of search interface that enables users to locate, customize, consume, rate and review. Tools should also be available for users to personalize their own search interfaces based on their mocs. Queries such as "what do people with similar profiles to mine do in similar matters of concern (*moc*)?" should also be answered by the collective intelligence provided by other users with similar mocs. This functionality can be provided by harvesting statistical data concerning historical behavior, user ratings, user reviews and feedback presented to users. Proactive analysis on such

collective intelligence can be done as batch processing so that it is readily available at runtime to support new user interactions.

3 The Research Agenda

Web science studies the web as an empirical science as well as a science of synthetic formalism and algorithms, with the goals being (i) to derive hypotheses that predict and explain the web and (ii) to formalize the engineering of the web. It is intended to be a multidisciplinary science of the web [10]. Research on the smart internet fits within the scope of web science. With respect to the Web science of the *smart internet*, two major research activities are identified, namely: (i) formalizing an advanced ***user model*** of the web (for *smart interactions*) that centers around users and their matters of concern and (ii) formalizing a ***web model*** (for *smart services*) including formalizing the algorithms required to orchestrate the web as a cohesive platform that enables the advanced user models required for smart interaction. These two major research activities are addressed, respectively, in the following two parts of this book.

4 Conclusion

To be practical, the smart internet must be an evolution and extension of the current internet, building on the existing basic architectural elements of HTML, URLs and HTTP, while hiding these techno-centric elements behind objects and interactions that are more appropriate and intuitive, tailored to the end user's current domain, goals and concerns.

The research agenda for transition to a *smart internet* can be seen as falling within the scope of web science; extending the internet towards the goal of developing a new web model we call *smart services* that views web services at the macro level to support users as individuals, and the smart interactions that they require.

There are three major principles that distinguish the smart internet from the web in its current form, namely: (i) an instinctive user model; (ii) a session model focusing on the user's concerns, not just a single server site; and (iii) collective and collaborative web interactions. It is our belief that the research agenda in the smart internet will take us on a journey of transformation in re-engineering the web to focus on users rather than servers.

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