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Masao Kakihara

Yahoo! JAPAN Research, mkakihar@yahoo-corp.jp

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# UNDERSTANDING REAL-VIRTUAL DYNAMICS OF HUMAN BEHAVIOR FROM THE ACTION STREAM PERSPECTIVE

Masao Kakihara, Yahoo! JAPAN Research, Tokyo, Japan, mkakihar@yahoo-corp.jp

## Abstract

*This paper proposes a radical extension of our perspective for analyzing human behavior in the networked age. Online activities should be understood not as being only inside the virtual world but rather as initiated by people with real-world intentions for the purpose of bringing about certain real-world consequences. To grasp the whole stream of human behavior flowing from real-world intentions to virtual-world activity and back to real-world consequences, we propose the 'action stream' concept. The paper details the conceptual framework of the action stream and discusses theoretical and practical obstacles affecting its utilization. It also proposes a novel method for analyzing action streams by taking advantage of web search log data and Internet survey infrastructures.*

*Keywords: Human behavior, Web, Search, Methodology.*

# 1 INTRODUCTION

In the last decade, we have witnessed a dramatic expansion of online service businesses such as portals, search engines, photo sharing, online commerce and auction, and so on. Emerging online services are enabling us to experience our lives in radically novel ways. Freed from geographical and temporal constraints, our online activities supported by these services have given rise to fundamentally new behaviors. The ways in which we access the Web have also diversified, from accessing with the traditional desktop PCs to accessing with PDAs, cellular phones, smart phones, and tablet devices. The emerging ‘ubiquitous information environment’ (Lyytinen & Yoo, 2002; Sorensen et al., 2005) will entwine the Web into our everyday lives to such an extent that the boundary between our real-world activities and our virtual activities will become blurred.

In contrast to the dramatic changes in the social disposition of the Web, our understanding of web users’ behavior has basically remained unchanged. The perspective through which we view the behavior of web users is inherently ‘web-oriented’; we see web users as though they lived only in the virtual world and their activities were totally isolated from the real world. Despite that the Web has penetrated into the real world and our usage of the Web is dynamically embedded into our real-world lives, how we understand web user behavior is still confined to the virtual world. Because of this confined perspective, vast opportunities of web usage have remained unexplored, and monetization potentials have been limited.

To cope with this problem, this paper proposes a theoretical perspective of looking at web user behavior more broadly, called the ‘action stream’ perspective. It aims at unleashing our confined perspective by grasping the dynamic behavior of today’s web users and offering practitioners a thorough framework for designing various online services. The paper also discusses various monetization potentials for online services based on the action stream perspective. Through an extended perspective, many more monetization approaches besides the advertising model can be realized and applied to various online service practices.

# 2 THE ACTION STREAM PERSPECTIVE

The early stage of the Web was isolated from the real world. In fact, the Web was used by a limited number of people in limited social contexts for limited amounts of time. However, these days we use the Web extensively. Our web activities are no longer only ‘virtual’ and should rather be seen as inseparably connected to the real world. Nevertheless, our perspective on the web user behavior is still confined to the web world. This is ironically because of the rapid development of web mining (Etzioni, 1996; Srivastava et al., 2000). Statistically analyzing a vast amount of access log data stored in the web servers can illuminate the complex online behavior of web users, how they click hyperlinks on web pages and how they migrate from one page to another. However, it offers no clue about origins and ends of those streams; log data analysis cannot reveal why a user clicked a link, opened a page, or moved to another page.

Here, we propose a radical extension of our perspective on web user behavior: from click streams to action streams. Given that the Web is used in various ways and contexts, online behavior should be understood not as only inside the web world but rather as initiated by real-world intentions and in turn bringing about certain real-world consequences. What is important for researchers is to be able to grasp the whole stream of actions flowing from real-world motivations and intentions to virtual activities on the Web and back to consequences and resultant activities in the real world (see Figure 1).

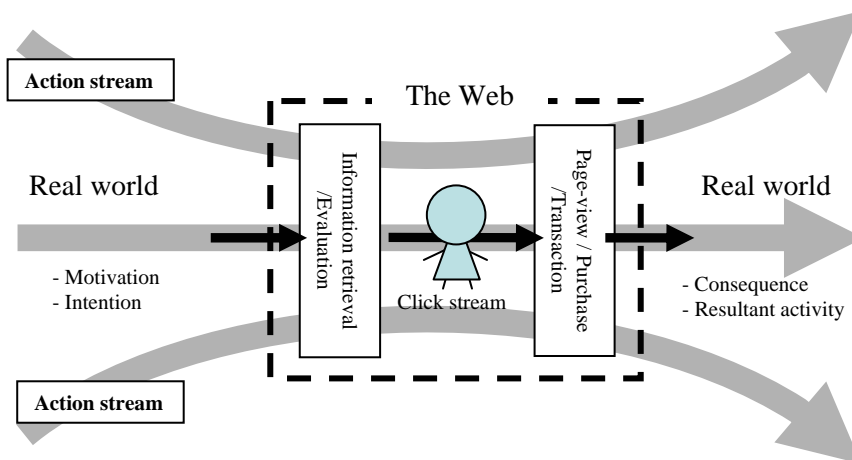


Figure 1. Framework of the action stream perspective

Web mining, i.e., looking in detail at users' click streams in the virtual world, is an extremely useful way to understand user behaviors on the Web on the basis of detailed metrics such as page-views, number of visiting unique users, click-through rate, conversion rate, etc. (Bucklin & Sismeiro, 2003; Cooley, Mobasher, & Srivastava, 1997; Moe, 2003; Moe & Fader, 2004). However, it offers us few insights on what users do in the real-world environments. The web mining approach is clearly not enough for understanding why users visit particular websites, what motivates their visits and usage, and what they do before/after their website usage. To do so, we need the action stream perspective, a radical extension of analytical scope that can capture a dynamic flow of human activity in the real and virtual world. Moreover, it should be clear that our web usage is so much more socially diversified that offline, real-world factors and their influence on online factors must be considered if we are to understand the complex behavior of today's web users.

The action stream perspective aims at not only expanding the scope of web mining approaches but also problematizing conventional research approaches of behavioral sciences. Social sciences looking at human behavior in various social contexts such as microeconomics, psychology, and sociology have long attempted to capture actual human behavior in a 'snap-shot' way. By using traditional data collection and analysis methods such as surveys and laboratory experiments, researchers have tried to find static patterns of human behavior in a given context. Whereas behavioral sciences have sophisticated analytical methods for understanding human behavior in quantitative ways, they are incapable of grasping the dynamic and fluid nature of human behavior that continuously adapts to changes in social environments. Faced with such limitations, some scholars interested in understanding how human behavioral and organizational patterns change continuously in certain technological contexts have resorted to ethnographic methods (e.g. Barley, 1996; Orr, 1996; Schultze, 2000). However, those methods are also problematic in the sense that they are very qualitative and interpretative in nature and require so much time that they cannot be easily applied to dynamic settings, particularly in fast-moving business environments.

The action stream perspective removes those obstacles to the study of human behavior. What social scientists exploring the dynamic nature of human behavior need now is a standpoint from which they can see human behavior as continuous streams of actions rather than as mere aggregations of actions. As discussed above, click stream analysis of web user behavior has rapidly developed and enables us to track and analyze every stream of the user's actions on the Web in great detail. The action stream

perspective radically expands the click stream perspective to include the click streams in a larger stream of human actions that flow through real-virtual boundaries.

The concept of the action stream is important in today's social environments because our everyday activities are continuously connected with and influenced by various human and non-human factors in the real and virtual worlds. In ubiquitous information environments where we human constantly interact with a variety of ICT systems and services such as emails, websites, SNS, and twitter, People's behavior is transient and constantly being redirected by the socio-technical environments. The action stream perspective is a lens for grasping the dynamic nature of human behavior that cannot be even perceived from 'snapshot' approaches. It opens up the new possibility of understanding human behavior in the constantly changing, dynamic socio-technical environments of our time.

### **3 ANALYTICAL AND PSYCHOLOGICAL OBSTACLES**

The problem of extending our perspective on human behavior is not a new issue and a number of researchers and practitioners have tried in one way or another to understand the dynamic nature of human behavior especially in relation to technology usage. In recent years, mobile devices such as mobile phones, smart phones, PDAs, and netbooks have rapidly diffused into our ordinary lives, and these devices enable us to track dynamic human behaviors by taking advantage of location-aware systems and various sensing technologies. By utilizing GPS-based location detection systems and Bluetooth-based proximity sensors, even consumer devices can offer us rich behavioral data about users. 'Reality mining' (Eagle & Pentland, 2005), an emerging research area attempting to analyze real-world activities by collecting behavioral data from certain sensing devices, is a new approach that shed light on streams of human behavior in the real world.

However, when we try to take the action stream perspective for analyzing dynamic human behavior, we are immediately faced with two significant obstacles; analytical and psychological: discontinuity in user identity data and users' privacy concerns.

The web mining approach is powerful largely because it can track a particular user's micro-activities on the Web in great detail. As click stream data can offer us extra-detailed pictures of what each user does on the sites based on user identification data such as user IDs and browser cookies, a wide range of researchers and practitioners have been actively utilizing it for analysis of web user behavior. On the other hand, for analysis of user behavior in the real world, researchers and practitioners have to use traditional marketing research methods such as surveys, interviews, and observations. In the last decade, traditional methods have been further supported by the Internet survey techniques. However, these methods cannot be connected to behavioral data from web mining methods because they for analyzing real-world behavior use 'ad-hoc' user identification data. This means that it has thus far been practically impossible to capture and analyze continuous action streams flowing through both the real and virtual worlds.

Besides this analytical obstacle, there is also a psychological obstacle regarding privacy (Johnson & Nissenbaum, 1995; van Wel & Royackers, 2004). As explained above, the concept of the action stream is straightforward: actions cannot be separated by the boundary of the real and the virtual worlds and should rather be understood as a continuous flow of action dynamically running through both worlds. The concept is so simple and powerful that it also raises worries about privacy. That is, if all the action streams of behaviors could be tracked and analyzed in great detail, people's privacy would be completely invaded. Absolute traceability of human behavior creates not only great analyzability for understanding people's activities but may also jeopardize their privacy. Without properly coping with such concerns, the action stream concept for studying human behavior would entail significant risks for ordinary people.

## 4 A PRACTICAL SOLUTION: ‘SEARCH INSIGHT’

It is obvious that the action stream concept offers us a novel perspective for capturing and analyzing the dynamic nature of human behavior in emerging ubiquitous information environments today. However, the analytical and psychological problems discussed above need to be resolved if we are to use it in actual business and research settings.

We have developed a practical method for studying human behavior from the action stream perspective by taking advantage of various resources of a search engine service in Japan. Yahoo! JAPAN is the largest web portal site in Japan, gathering 40 billion monthly page-views, hosting 120+ online services including Japan’s leading email, search, news, and auction services, and accommodating 25 million active user accounts and 16 thousand online stores. We have been granted wide access to Yahoo! JAPAN’s extensive log data infrastructure and 2 million research panels for Internet surveys hosted by Yahoo! JAPAN, and we have developed a new method, called ‘Search Insight,’ for analyzing the behavior of web users (See Figure 2).<sup>1</sup>

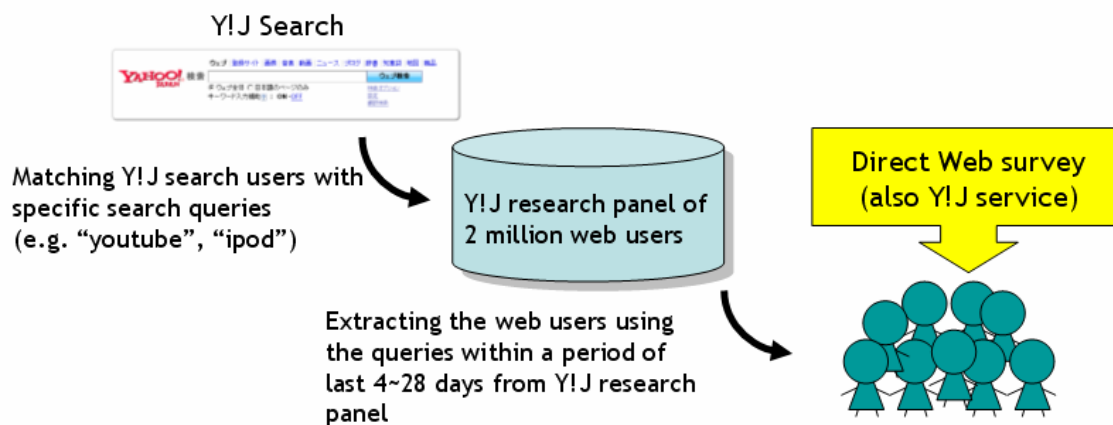


Figure 2. Overview of the ‘Search Insight’ method

With ‘Search Insight,’ researchers can examine individual web users who used specific search queries at the search engine of Yahoo! JAPAN during a particular time period and match 2 million research panels who have already agreed to participate in Internet surveys upon request. With this data, researchers can conduct direct Internet surveys on users to ask them various questions. This method is a novel way of analyzing user behavior by effectively utilizing their web search activities (search query) that can illuminate the users’ motivations and intentions of their particular web search actions and their resultant activities after the online behavior (See Figure 3).

<sup>1</sup> ‘Search Insight’ is operated by Yahoo! JAPAN and offered only in Japan. ‘Search Insight’ does not use any privacy information of the web users (name, address, etc.). [http://research.yahoo.co.jp/customer/special/search\\_insight/](http://research.yahoo.co.jp/customer/special/search_insight/)

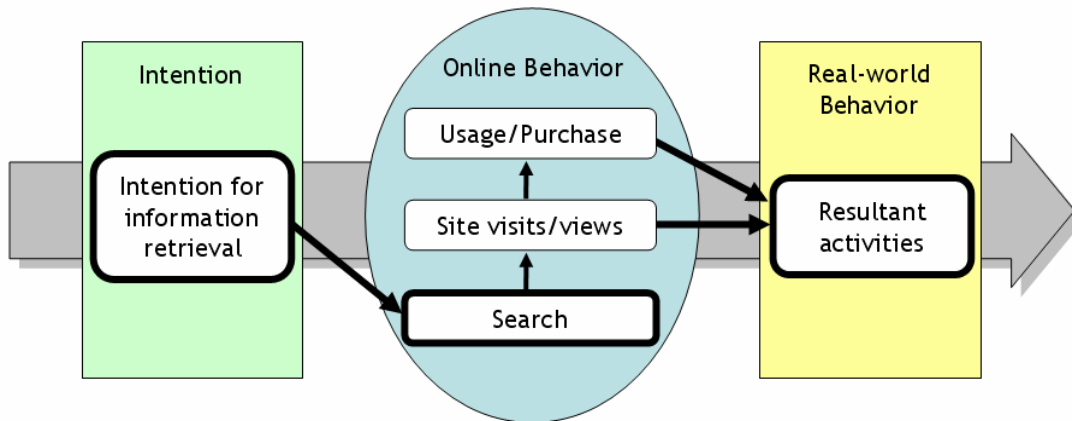


Figure 3. Action stream in the 'Search Insight' method

## 5 EXPLORATORY STUDY

With great support from Yahoo! JAPAN's engineering and marketing teams, we developed the 'Search Insight' systems in the summer of 2008 and conducted an exploratory study in October 2008. The purpose of this study was to shed light on dynamic flows of web user's search activities based on the categorization of search intention proposed by Broder (2002). Broder argues that search queries can be classified into three classes according to search intent:

1. Navigational: The immediate intent is to reach a particular site.
2. Informational: The intent is to acquire some information assumed to be present on one or more web pages.
3. Transactional: The intent is to perform some web-mediated activity.

Based on this categorization for search queries, we chose one particular query from each category, three in total, for this study. For the navigational category, we chose "mixi," the name of the largest SNS in Japan. For the informational one, we chose "Nobel prize," because the several Nobel Prize winners had just been announced at the time of the study. For the transactional one, we chose "iPod," since it was, and still is, one of the best-selling products in the market. For each query, 100 Yahoo! JAPAN web search users who had used that query from the 1st to 15th October 2008 were identified from 2 million opt-in research panels. On 300 samples in total, we conducted an online survey asking the following questions:

- Factors that initiate web search usage
- Contextual aspects (situation, device, etc.) of web search
- Intention of search
- User satisfaction for search results
- Post-search actions on the Web
- Post-search actions in the real world, etc.

In this exploratory study, we tried to look at continuous flows of user search behaviors in both the real and virtual worlds. Conventional studies have only tried to ascertain to the user’s search behavior by mining query log data. As discussed above, web mining approaches are good for understanding behavioral patterns and there still are many open issues about them. And yet, web mining offers us little information about the user’s pre-search and post-search behaviors and disposition.

The ‘Search Insight’ method based on the action stream perspective enabled us to analyze the users’ pre-search and post-search behaviors; web mining and other traditional analytical methods have never explored such behaviors. For each of the sample categories, navigational (“mixi”), informational (“Nobel prize”), and transactional (“iPod”), we asked the same questions about their pre-search and post-search behaviors. The results of analysis are as follows (Figure 4).

	Initiating factors	Context, Device	Intention	Satisfaction with search results	Post-search actions (web)	Post-search actions (real)
“mixi”	-Talks with friends -Blog posts	-Home PC -Office PC -Mobile	-Navi: 80% -Info: 10% -Tran: 10%	High	-Website usage (visiting <i>mixi</i> ) -Blog-posting	-Talks with friends
“Nobel prize”	-TV programs -Newspaper articles -Online articles	-Home PC -Office PC	-Navi: 20% -Info: 70% -Tran: 10%	Low - Moderate	-Recursive search	-Re-search in newspaper and magazines -Talks with friends
“iPod”	-TV CM -Online articles -Talks with friends	-Home PC -Office PC	-Navi: 25% -Info: 45% -Tran: 30%	Moderate	-Recursive search -Website usage (Price comparison) -Online purchase	-Visiting stores -Offline purchase at stores

Figure 4. Outline of user behavior analysis with three sample categories

It is obvious that there are clear, unique differences between the three user categories. For example, the search results for the navigational query (“mixi”) gained high user satisfaction, whereas those for the information query (“Nobel prize”) and transactional query (“iPod”) received relatively low levels of satisfaction. Moreover, the post-search activities of the transactional query were diversified and active in both the virtual and real phases but those of the other two queries were much less active.

This exploratory study on using the ‘Search Insight’ method succeeded in illuminating continuous flows of web user behaviors running through the real and virtual worlds. By jointly utilizing log data analysis and internet surveys, this study also revealed clear differences in pre-search and post-search behaviors from search queries.

## 6 DISCUSSION AND CONCLUDING REMARKS

In summary, this paper proposed an extended perspective for understanding human behavior in ubiquitous information environments. The ‘action stream’ perspective enables us to grasp the dynamic nature of human behavior that cannot be divided into small discrete units of actions. Capturing dynamic behavioral patterns of users is crucial to the task of designing new products and/or services



in the networked age. To do so, the action stream perspective is extremely important since our social lives are more and more connected to the virtual world and cannot be neatly separated into two worlds. To support the action stream perspective, we developed a method for data collection and analysis, called 'Search Insight,' by taking advantage of the vast resources of a search engine company, and we conducted an exploratory study illuminating the dynamic nature of web user behavior.

This research is still in its early stage, and we have proposed only the conceptual framework for gaining a better understanding of human behavior in our time. Therefore, there should be many open issues to be discussed in relation to the action stream perspective and the 'Search Insight' method.

First, the 'Search Insight' method addresses only users' 'search' behavior. Needless to say, searching is one of the main activities on the Web. In a sense, the web search is the 'gateway' from the real world into the virtual world. But there are also a variety of non-search activities such as directly visiting particular sites and use of various online services such as auction and video streaming.

Second, users have different intentions that initiate different web search activities. People use web searches to find a way to visit a particular web site or to acquire information on the web related to a specific issue. As noted above, search queries can be categorized into three classes of intention: navigational, informational, and transactional. Nowadays, the notion of the web search has become so diffused and commoditized that it is difficult to identify detailed characteristics of the web search activities a priori.

There are other obstacles to the analysis of action streams. Yet, we believe that the 'Search Insight' method is a useful solution for acquiring an understanding of the dynamic behavior of today's web users and it can give us various insights that will benefit future design and operation of new services.

To conclude, we should notice that our perspective on web user behavior has been problematically confined to the virtual world. What we need is to open up our perspective and realize there is a dynamic continuity of human behaviors throughout the real and virtual worlds. The concept of the action stream it is a new way to deal with this reality.

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