Bayesian TV: A Concept of Real-time Media for Emergency Information

Asanobu KITAMOTO
National Institute of Informatics
2-1-2, Hitotsubashi, Chiyoda-ku, Tokyo, Japan
kitamoto@nii.ac.jp

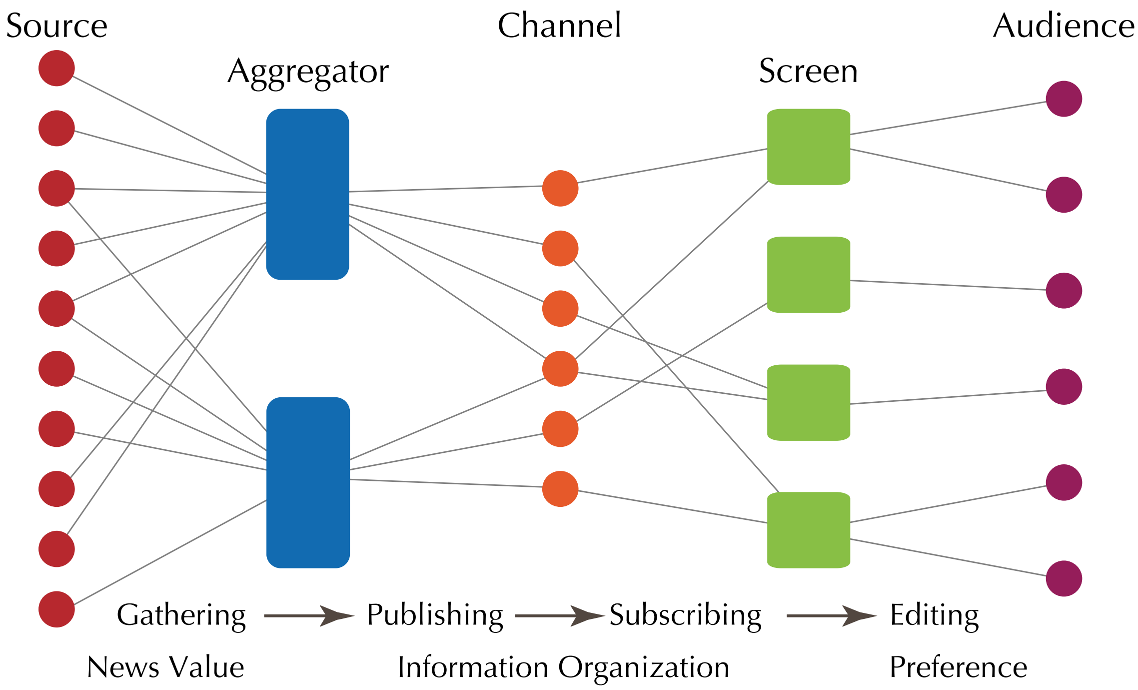

Figure 1: Architecture and components of Bayesian TV.

Statement of Interest

What is TV or television? My definition of TV is as follows.

1. Content is pushed to the audience based on the preference of channels.
2. Content is presented in an audio-visual form.
3. Content is presented as the series of programs in the form of time division rather than space division.

TV, or television, literally means visual information sent from a remote station. The architecture of TV has evolved for several decades, but the present TV is not the only solution for sending visual information. World Wide Web is transforming the style of communication and the emergence of real-time Web indicates the convergence of TV and Web in the near future. To reinvent the TV in the Web era, however, just mimicking the TV on Web standards is not enough. We believe that "what is TV?" is an important question to have a unified view on TV on Web and Web on TV, or a new name for a thing that integrates both worlds.

The present Web and the present TV both have problems from the viewpoint of emergency information, which is the target of this paper. Firstly, the present Web does not satisfy the needs of users in emergency situations as follows.

1. Users do not have time to make queries for search engines by a trial-and-error approach. They need answers as soon as possible.
2. Due to an uncertain situation, appropriate actions of users are not clear; hence users may not come up with right queries.
3. Observation data such as rainfall and water level are important sources of information, but they are not friendly with text-based search.

The present TV satisfies those needs, because users just need to turn on the TV set, and get relevant information from the screen, which is recommended by people in a broadcasting station. Users can just "entrust" the TV set, and watch the screen to pick up relevant information from the stream of programs. Here a big difference between TV and Web is that Web is based on the "pull" model of information access which is useful under normal circumstances, but TV is based on the "push" model of information access which is more useful under emergency circumstances. We hope that Web also offer the push interface of emergency information by automatically recommending relevant information for the audience.

Secondly, the present TV has different problems as follows.

1. TV communication channels are designed for "mass media" so it is limited in customization, localization and personalization.
2. Due to the limited number of reporters and operators, it has limited capacity for following many events that occur simultaneously and evolve in parallel.
3. Due to the limited interactivity of mass media, feedback from the audience is not integrated for improving the quality of information.

The idea of Bayesian TV is to take the best of both worlds, and create a TV-like media on the Web, following the "what is TV" definition introduced in the beginning of this paper. Our scenario of Bayesian TV is as follows: users launch the software, login to the TV, and watch the screen. Relevant information can then be obtained with the help of a recommender system and user interaction on the Web technology.

Motivation

The motivation behind the concept of Bayesian TV is our long experience with typhoon information [1,2]. We maintain a Website called

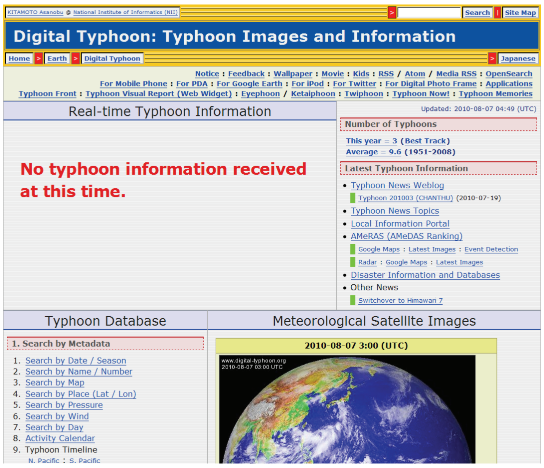

Figure 2: Digital Typhoon Website.

"Digital Typhoon"[1] since 2003 (Figure 2), and this is now regarded as one of the most popular Websites in Japan about typhoon-related information. When a typhoon makes landfall at Japan, it records the daily page views of about one million, which is a large number for an academic Website. The Website integrates various kinds of typhoon-related data such as satellite images, meteorological observations, news articles, disaster records, and user generated data such as blog entries, twitter tweets, and mobile phone e-mails. The amount of data and the types of data on the Website grows steadily, and the Website is now filled with many links to support navigation across various types of data. Users, however, have difficulty in finding data due to the lack of understanding on the overall architecture of the Website. If the Website is too complex, we have to wait until users happen to click a link, find useful information, and remember how to use it. We need to improve findability with a better interface without increasing the burden of users.

We suggest that a solution to this problem is to take advantage of "time division," which means that various types of information are presented for the temporal dimension, not for the spatial dimension. When we use a Web browser, information is presented in the form of space division with many links distributed in the

[1] http://www.digital-typhoon.org/

window. On the contrary, information in the form of time division is only obtained as a click stream that reflects the active involvement of users. Interface of Bayesian TV is more focused for time division to allow users watch information in a passive state. This interface, which might be called as an “entrustable interface,” is similar to the concept of TV.

Moreover, this service is not only limited to “Digital Typhoon,” but also can be extended to other emergency information providers. General users are not aware of the existence of those providers, because they are noticed only during emergency situations. This problem can be solved by setting up a typhoon aggregator that gathers information from “Digital Typhoon” and its partners, and making the hub of information recognized by many people.

Therefore, our motivation is to develop “Digital Typhoon TV” which is real-time media providing emergency information to the general public. The following section describes the concept of this system.

Concept

The concept of Bayesian TV is illustrated in Figure 1. The architecture consists of five components, namely source, aggregator, channel, screen, and audience.

- Source: Because our system is internet-based, a source should be connected to the internet. A source may provide text data such as news articles, user generated data, numerical data such as meteorological observations, and image data such as satellite images.
- Aggregator: An aggregator has a crawler to collect information from sources. It may be a focused crawler on typhoon information, or an active crawler considering the situation of the real world. For example, if we observe heavy rainfall in some areas, an event-based focused crawler may visit Websites related to that area. The aggregator works as not only a news aggregator such as Google News[2], but also a data aggregator for sensor data.
- Channel: Aggregated data are then processed and published to appropriate channels. Channels are represented by URI and rules are defined to specify the content of a channel in an intentional or extensional manner, where ontology might play an important role. In contrast to channels of the present TV, we could have millions of channels (hyper-channel) because there is no limitation in the number of channels. With the large number of channels, each channel should be focused on a very narrow topic (micro-channel). Programs on a channel should be fragmented into minimal segments, like network packets, to allow the recombination of programs near the audience side.
- Screen: The software edits the stream of subscribed information into an audio-visual representation. The present TV set is a “dumb” terminal designed for visualizing signal it receives from a television channel. In Bayesian TV, the screen should be more intelligent to deal with subscribing, editing and visualizing the stream of information. It is also a terminal to receive feedback from the audience, and send it to the network to improve the response of the system.
- Audience: A screen may be dedicated to one person, a family, or crowds of people gathering in front of a digital signage screen in a town. If the audience is a single person, the screen should be personalized, but if the audience is people in the town, it should focus more on localization. To support customization, we assign a login account for each user and collect the behavior of each user for recommendation.

The flow of information is represented as Gathering, Publishing, Subscribing and Editing. The last step, editing, is deferred to the audience

---

[2] http://news.google.com/

side to allow the customization of information for audience.

Research Challenges

The idea of Bayesian TV is like the reinvention of TV, so we have many research challenges. The most important challenge is the recommendation of information for the audience. The audience cannot choose channels under hyper-channel environment, so a channel recommender system must be introduced to assist the audience to find relevant channels. In the case of a digital signage screen in a town, a system should recommend localized channels such as weather and traffic information. It is important to note that a recommender system should deal with time, because the relevance of news changes over time. The configuration of channels may not be static, so the recommender should work in a dynamic environment. We believe that Bayesian probabilistic modeling will give a good solution for this problem, so we named this project as "Bayesian TV." This problem is difficult in general, and hence this has been an active area of research for more than a decade, but our focus is rather on a specific domain of emergency information, or typhoon-related information in particular.

Other research challenges include automated gathering of information from many sources, publishing information for relevant channels, the management and organization of channels, audio-visual information visualization and sonification, and markup languages for the various stages of information. The choice of markup languages is related to the main topic of this workshop. Dividing the architecture of Figure 1 into two parts, namely frontend and backend, the frontend may be implemented in HTML5[3], but the backend needs machine-readable formats such as XML. About networking protocols, the most important protocol is HTTP, but we also investigate the usage of XMPP[4], especially for publish / subscribe network around channels.

From the point of view of HTML5, the video element is regarded as an important extension toward Web on TV. In our case, however, we are more interested in the canvas element to visualize many types of information such as text, number, and map. A problem here is that the canvas element does not offer higher level languages to help information visualization. At this moment, we can choose SVG (Scalable Vector Graphics)[5] or Adobe Flash to do this kind of tasks. We hope that the canvas element of HTML5 will be sophisticated in the future so that we can visualize information using an easy-to-use language for the canvas element.

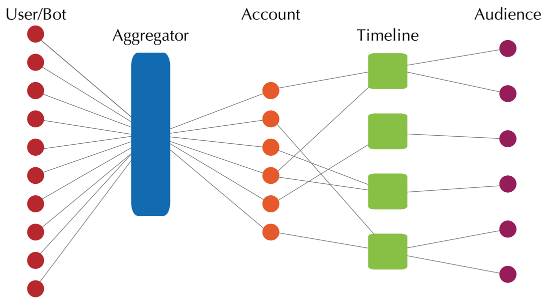

Figure 3: Twitter architecture in the analogy of Bayesian TV in Figure 1.

Related Services

We call our system as "TV" but it is not intended to be a system for broadcasting video. Surprisingly, the concept of Bayesian TV is less similar to a video sharing service such as YouTube[6], but more similar to a micro-blogging service such as Twitter[7]. Figure 3 illustrates the analogy of Bayesian TV and Twitter, and we explain how two services are similar.

Twitter consists of accounts and tweets. Information is published at an account as a tweet, a short message whose length is limited to 140 characters. An account can follow another account.

3 http://www.w3.org/TR/html5/

4 http://xmpp.org/
5 http://www.w3.org/Graphics/SVG/
6 http://youtube.com/
7 http://twitter.com/

This architecture is similar to Bayesian TV illustrated in Figure 1. “Following” is equivalent to “subscribing,” and a short message is similar to a program fragmented into a short segment. Users can make their own timeline by choosing following accounts, and this timeline is an analogy of the screen of Bayesian TV. If a Twitter client has the functionality of editing information, making stories, and visualizing information, then this is already a primitive version of the screen in Bayesian TV. An important difference, however, is that the channel in Bayesian TV is not account-based but topic-based. A screen follows topics, not accounts. But many bots in Twitter ecosystem are gathering information from the real world and publish it to Twitter, and these services are what we can also use as sources of Bayesian TV. The popularity of Twitter indicates that this kind of architecture is promising toward the real-time Web, and what we need to do is to extend it to an audio-visual representation.

Twitter is not based on push technology, but its timeline does have the taste of push. Push technology has been “the next generation Web” for more than a decade. The first movement was around the end of 1990s where PointCast started a service to push the various types of news to the client. Some time later, other types of push technology has been developed, but they failed to gain popularity. Now is the time to try the push technology once again to open up a new possibility toward the real-time Web. Our goal is to apply the idea of push to the domain of emergency information to realize easy-to-use information system for the general public. This conceptual model is still not implemented, but we will start the implementation phase soon.

Acknowledgment

This work was supported by JST PRESTO program.

References

[1] Asanobu KITAMOTO, "Digital Typhoon: Emergency Information System Enabled By Ranking and Sharing of Multimedia Data", Pacific-Rim Symposium on Image and Video Technology (PSIVT) 2009, Vol. CD-ROM Proceedings (Demo Session), pp. D-II-7, 2009-01

[2] Asanobu KITAMOTO, "Digital Typhoon: Near Real-Time Aggregation, Recombination and Delivery of Typhoon-Related Information", Proceedings of the 4th International Symposium on Digital Earth, pp. (CD-ROM), 2005-03