KŌRERO: AN INTEGRATED COMMUNITY-BASED PLATFORM FOR COLLABORATION

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Various types of community-based systems including blogs, wikis, file sharing tools, tagging systems, and social networks have emerged recently. These services are usually only loosely connected and rarely make use of synergetic effects. In this paper, a concept for a platform that adds value by integrating the benefits of existing community-based systems is proposed. The concept we propose is user-centred and puts an emphasis on communication and collaborative content development. Our approach facilitates the discovery of implicit knowledge by making proactive, personalised suggestions about content and the availability of experts. Application areas include learner-support systems, corporate and organisational environments, and communities sharing common interests.

1. Introduction

Recent developments on the World Wide Web have yielded systems and services with unprecedented qualities. These environments foster collaborative work, and allow users to express themselves, participate in the development of content, and enable new forms of communication among individuals. A brief overview of a selection of these services including blogs, wikis, and social networks is given in the following sub-sections. A comprehensive survey of recently developed services on the Web can be found in (Kolbitsch and Maurer, 2006).

1.1. Blogs

Weblogs, or simply blogs, are web pages on which information is posted on a regular basis, typically once a day. Blogs consist of newsgroup-like entries that are displayed in a chronological order with the newest article listed first. Postings on blogs are usually written by a single author or by a small group of authors. Entries frequently refer to a current event such a news story or the release of a new product, and provide additional information and commentary on the event.

In content and style blogs resemble a combination of newsgroups, diaries, personal journals, and hotlists (Blood, 2002). Two major blog styles can be distinguished (Herring et al., 2004): diaries and filters. In diaries or journals, users post information on their social life, their work, etc. When blogs are used as filters, authors post links to external web-sites and complement them with abstracts or brief comments on the content of the corresponding web pages. A well-known filter style blog is Slashdot, a news service specialising on technology (Slashdot, 2006).

The concept of blogging is not restricted to textual content but can also, for instance, be used in conjunction with images, audio or video content. The currently most popular form of blogging non-textual documents is podcasting, for distributing audio content.

1.2. Wikis

The term wiki wiki is Hawaiian for "quick". It was used by Ward Cunningham in 1994 to define a concept for rapidly and collaboratively developing content on the Web (Leuf and Cunningham, 2001). Wikis are web-based, self-organising content management systems where users participate in authoring content. Anyone on the Internet can edit existing pages and add new documents to most wikis, i.e., every reader can instantly become an author. The basic idea of this concept is that content is read and edited by a large number of users. Therefore errors are found and corrected and eventually, the information on the web-site becomes complete and accurate.

Wiki users can register so that their actions are accountable. Alternatively, authors can work anonymously, only being identified by their IP addresses. An inherent feature of wikis is version tracking. Wiki articles are usually retained in a database, where not only their current versions but their entire revision history is stored. Most wikis provide a "recent changes" page that lists the most recent modifications made to articles together with the authors' names or IP addresses.

1.3. Social Networks

Social networking services provide individuals a space for maintaining their relationships with friends and acquaintances, for chatting with them, and for sharing information. Moreover, social networks offer a platform for establishing new relationships (O'Murchu et al., 2004).

When registering with a social networking service, users are required to provide a profile that contains personal information such as their name, their date of birth, and a photo. This information is publicly available in the system and the prime resource for finding friends in the network. Once identified, friends are usually added to a list of contacts. Most social networks allow users not only to display information about their friends, but also about second degree friends (friends of friends).

Most social networking services include a set of tools that facilitate communication and information exchange among users. Blogging functionality and file sharing are two common features that can be found in many systems. Moreover, instant messaging or chat features are offered for direct, synchronous communication among users.

1.4. Blended Systems

With millions of users participating and millions of information objects produced, the technologies introduced above are quite popular and successful. A previously conducted survey shows, however, that each of these developments—blogs, wikis, social networks—are independent and autonomous systems (Kolbitsch and Maurer, 2006).

Several approaches to combining the various community-based technologies in a single system exist. Examples are environments employing both wikis for the actual development of content and blogs for discussion and commentary (e.g., Su (2005)). However, this results in a system where blogs merely complement wikis. A system implementing a similar approach is Elgg, a feature-rich learning environment (Elgg, 2006; Anderson, 2005). It includes a wiki, blogs, and podcasting. Moreover, it makes use of external systems for sharing images, for social bookmarking, directories, and news, for example. Elgg, however, does not integrate these "modules" in a unified system but is a framework that allows administrators to combine individual systems under a single user interface.

2. Motivation and Concept

The motivation of this paper is to bring together the various collaborative technologies described in section 1 and to form a coherent environment for the user. When the technologies are not only combined but *integrated* in a consistent environment, synergetic effects can be obtained. These include the guided discovery of knowledge, system generated knowledge, forming relationships with friends and experts who otherwise would be overlooked. The aim of this paper, however, is not to (primarily) use methods from machine learning and AI to reveal implicit links and make recommendations, but to use the data on users and authors readily available in the system (e.g., which users are connected in the social network, which users edit which pieces of content, etc.).

The information stored in a wiki, for example, consists basically of the actual content and data on its authors. This elementary set of information on its own can be of relatively limited value. In conjunction with data from other content generating components and a social network that contains relations among users the significance of this information can be increased. In this case, techniques from knowledge management can be applied to generate the new information (e.g., Maurer and Tochtermann (2002)).

Methods employed in well-accepted knowledge management systems and CSCW environments make use of explicit relations (such as the names of blog authors and the names of their friends) to find implicit linkages among information entities and make them accessible (cf., Novak and Wurst (2004)). Hence, tacit knowledge that might otherwise be lost is communicated. This approach can, of course, not only involve textual content but also other media such as images and more abstract information objects such as users in a social network.

2.1. System Generated Information

When connections among information entities are generated, the users' relationships in the social network, the data they produce and the information they consume are analysed. Moreover existing links between pieces of content are examined: the links from blog entries to wiki articles, the links between blogs, etc. By creating a graph containing all

explicit connections, implicit connections can be found. The information discovered in this process is retained and can be used for further inferences.

Figure 1 elaborates this approach and highlights a number of features of a system implementing our proposal. The illustration contains four users named *A* through *D*, two blogs b_m and b_n, and two wiki articles w_x and w_y. In the social network, direct connections between users *A* and *B*, *B* and *D* as well as *C* and *D* exist (black lines in Figure 1). Since *D* is directly connected to both users *B* and *C*, there is an indirect relation between *B* and *C*. This means that *B* and *C* are second degree friends in the network (wavy line in Figure 1).

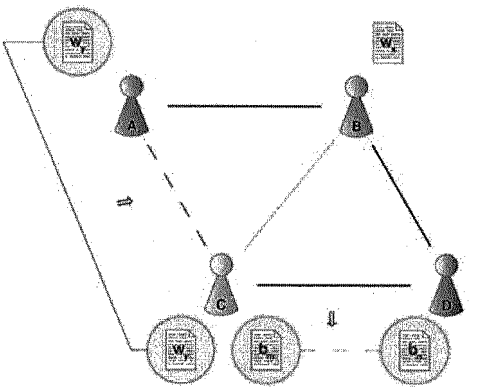

Fig. 1. Social network with four users *A* through *D*, two blogs b_m and b_n, and two wiki articles w_x and w_y.

Users *C* and *D* maintain blogs b_m and b_n. Although the two users are explicitly connected through the social network, there is no link between the two blogs. The system can, however, deduce a connection between the two blogs, based on the relation between their owners. Consequently, links between b_m and b_n can be inserted automatically into the blogs, and their owners can be notified of the implicit connection between the blogs.

Between users *A* and *C*, on the other hand, there is no explicit connection, although both users are editing the same wiki article. Particularly, when several such congruences occur the system can identify these implicit connections and point them out. These relations might indicate that both individuals share a common interest or work in the same area. Hence, the users' contact list (part of the social network) might, for instance, include a dynamically generated category of "professional colleagues".

In addition to this, the system can find somewhat weaker links among entities. User *C*, for instance, works on both blog b_m and wiki article w_y. Hence, there might be a possible connection between b_m and w_y such as a similar topic. (Note that the connection between b_m and w_y would be a strong link if one of the blog entries of b_m cited w_y.)

Further weak links could be established between b_m and users *A* and *B*. The link between b_m and *A* is based on the implicit connection between *A* and *C* due to w_y. The

relation between b_m and B can be explained by the fact that B is a second degree friend of C, the owner of blog b_m.

For the example outlined in Figure 1 only the most important connections that can be discovered are presented. Additional linkages, and thus knowledge, can be found even in such a simple setting as the one above. It should be mentioned, though, that linkages based on implicit and indirect connections may be insignificant. Therefore in these cases, links should only be created if several "indicators" for a possible connection are present.

2.2. Guided Information Discovery

In addition to the automatic generation of connections between information entities, users can be notified directly of relevant information. These notifications should be proactive, yet unobtrusive. A user reading several wiki articles on a particular topic, for instance, might be informed (verbally, visually or iconically): *"You probably haven't met user C yet. C has contributed to several articles in this field and might be a domain expert. You might also be interested in C's blog."*

With guided information discovery, the system operates the same way as described above, i.e., the system makes, for example, potential links between wiki articles, users and their blogs explicit (see section 2.1). The newly generated information, however, is not merely stored in the underlying structure or inserted into documents, but *proactively* disseminated to users. The system points out that there may be a connection between entities in the environment and lets the user observe the connection and decide whether the link is relevant. The users' feedback—following a link or not—can be utilised for improving the quality of suggestions made by the system.

By including information from the social network "personalised" data can be provided, i.e., information which users can relate to is given priority. Information not directly relevant to users, on the other hand, is de-prioritised.

2.3. Visualisation

Both explicit and implicit knowledge can be visualised in order to facilitate knowledge retrieval and understanding the complexity of information in a collaborative environment (Burkhard, 2004; Viégas and Donath, 2004). In our proposal, visualisation methods can be used to show both the most relevant connections between content and users and their significance. Extensive research has been done in this area, and therefore only one possible visualisation techniques are outlined: knowledge nets.

Knowledge nets are a technique for visualising relations among pieces of content. One node is displayed in the centre of the graph, and its connections to associated information objects are depicted in a "star topology" (Maurer and Tochtermann, 2002). The further a node is away from the centre of the graph the less it is related to the central node (see Figure 2). This visualisation technology is, for instance, successfully applied in advanced electronic encyclopaedias such as the Brockhaus Multimedial (Brockhaus,

2006). In our proposal, this method can be utilised for visualising connections from the information item currently displayed by a user to related objects and their "distance".

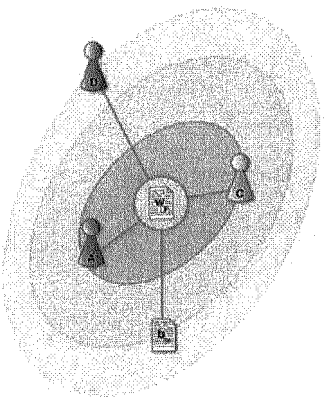

Fig. 2. Exemplary knowledge net showing the information objects connected to wiki article w_y: users *A, B,* and *C,* as well as blog b_m.

3. The Proposed Platform

We propose Kōrero—a web-based platform integrating all the most important current community-based and collaborative technologies. Kōrero is Māori for "talk, chat, communicate". The term adequatly describes the nature of the platform: users should be able to employ a single, uncomplicated user interface to meet friends and experts in the system, to communicate with them, to make personal and professional commentary, and to author and edit existing content. These diverse technologies are integrated so seamlessly that users do not "see" or "feel" that they are making use of different functional parts of a system.

The proposed platform includes several functional components and supporting technical foundations. Unlike blended systems, where a framework is provided for enabling the parallel use of existing products, we design a system that incorporates a set of functions in a unifying environment (cf., section 1.4).

The platform has a layered structure that is outlined in the following sub-sections (see Figure 3). The organisation of information and users in the system is discussed in section 4. A detailed account of the underlying technical infrastructure is presented in Kolbitsch (2007).

3.1. Core Technologies

The technology layer, the lowest layer in Figure 3, provides the underpinnings and essential infrastructure for the platform. All other components of the platform share the functionality provided and build on these foundations.

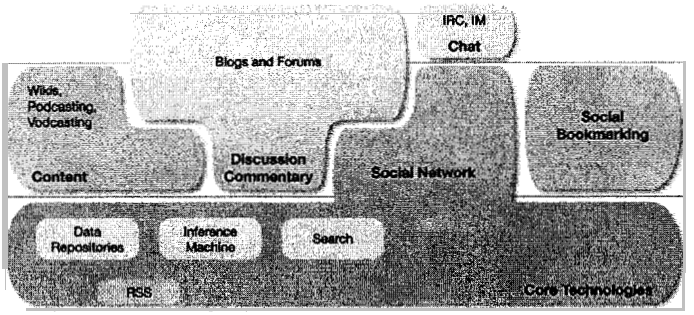

Fig. 3. Overall structure of the proposed concept. It includes wikis as the main component for generating content, blogs and forums for discussion, and a social network including communication facilities as its core component.

This layer contains repositories for the data stored in the system including content and information on users. It contains the basic functions for user management (e.g., authentication) and features such as fulltext and metadata searching. Also part of this layer are the inference machine and visualisation techniques which make the discovery of new knowledge possible (see sections 2.1 and 2.2).

The fundamental component of the system is the all-embracing social network. Since it is an essential part of the infrastructure and also generates new information at the same time, the social network is included in both the technology and the content layers.

3.2. Content Generating Components

The content layer is the second layer in Figure 3. It builds on the core technologies and contains several functional components that can be employed by users for generating new content.

These components include wikis, podcasting and vodcasting, and potentially other technologies for generating actual content. Blogging and forum components are used for commentary and discussion, and for generating supplementary content (see also section 4.1). In addition to this, the social network and further services such as social bookmarking and tagging systems can produce information in the system.

3.3. Communication Facilities

The communication layer is the third layer in Figure 3. It focuses on the direct contact and information exchange between users in the system and allows users to discuss content.

Both synchronous and asynchronous communication are supported. When multiple users are logged onto the system instant messaging, chat, and similar synchronous technologies can be employed. The system can also encourage users to communicate with each other by proactively suggesting: *"One of the authors of this article is currently online. Would you like to talk to her?"* In an advanced variant of this approach, the system can suggest an "expert discussion" on a particular topic involving, for example, the five authors with most contributions to a certain topic. (Only relatively "long-lived" contributions are considered in order to exclude users involved in flame wars.) The discussion is associated with the corresponding information objects in the system and made available to all users.

4. Aspects of Organisation

A platform encompassing various community-based technologies should take the complexities of content and user management into account. Aspects of these two fields are described in the following sub-sections. An entity relationship diagram that reflects the organisational considerations is shown in Figure 4.

4.1. Organisation of Content

As mentioned above (section 3.2), content in our proposal involves data as diverse as wiki articles, podcast and vodcast episodes as actual content, blogs and forums for commentary and discussion, or links in the social bookmarking service. Our approach to resolving this complexity is to abstract the different kinds of content in the system to a degree that they can be treated as one generalised type of content. These generalised content objects consist of a title, a "body" (the actual content), a version, at least one author, and potentially further metadata such as keywords. The body can contain text-based as well as binary data, making the approach open enough to support types of content other than the ones described above.

Two aspects of content storage are particularly noteworthy: versioning and link structures. All content in the system is subject to version tracking. Although this is an inherent feature of wikis, other technologies such as blogs, podcasting, links in a social bookmarking service usually do not make use of versioning. However, in our approach for every information item several versions can be retained. When a user decides to update a podcasting episode, for example, both the old and the new versions are available (cf., Nelson (1981), Haake and Hicks (1996)).

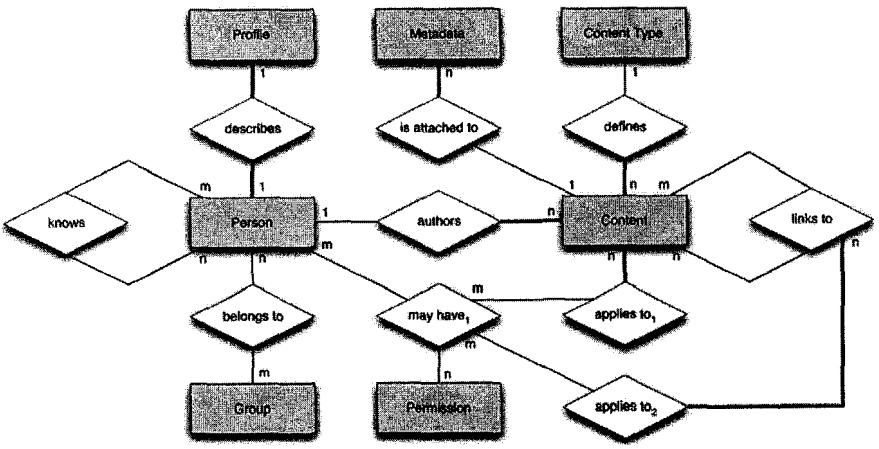

Fig. 4. Entity relationship diagram of a data structure implementing the organisational aspects of Kōrero.

Link structures in our proposal include both hyperlinks explicitly created by authors and connections discovered by the system. Links are not necessarily visible for users. While hyperlinks inserted by authors are always shown, connections encountered by the system are only displayed when they are relevant for users. (It should be noted that the relevance of linkages found by the system may change over time for one and the same user.)

Every information item in the system can be the target of a link—not only actual content but also users, for instance. Moreover, every object in the system can be the source of link. For those kinds of information that usually cannot support hyperlinks, the system attaches links to the content. A podcast episode, for instance, can have a hyperlink attached that points to a wiki article offering complimentary information.

All links in the system are bidirectional. This permits users to determine which information objects in the system link to the document they are currently viewing.

4.2. Organisation of Users

Previous research shows that anonymous authorship is a very important aspect in successful large-scale collaborative systems (Kolbitsch, 2006). Social networks, however, require registered users and are intrinsically incompatible with unregistered users.

Therefore we employ a "dual" approach: every user wishing to participate as an author has to register and log in to the system (cf., Flinn and Maurer (1995)). Once logged on, the user can edit existing information or produce new content. However, for every action in the system users can decide whether they want to perform it anonymously. I.e., a user can choose to post a blog entry, for instance, under their name while editing a wiki article two minutes later anonymously.

For such "quasi-anonymously" authored information, neither a username nor an IP address are displayed to other users. Moreover, the system does not consider actions of

anonymous authors when attempting to discover new information. So when user *C,* for example, edits wiki article wy anonymously, the system will not point out connections between w_y and *C* or w_y and *C's* blog.

With this approach, users can work anonymously while the system still "knows" the authors of information items (their usernames and potentially also their IP addresses). This makes the system accountable and can help prevent its misuse.

Users not wishing to contribute content to the system, i.e., mere readers, do not have to register or log in. In this case, however, only a limited set of connections might be pointed out because of the missing "background" information on the user. Moreover, the quality of connections discovered by the system may be suboptimal because it is difficult to generate personalised information for an unknown user.

5. Scenario and Application Areas

The two following exemplary scenarios describe, from a user's perspective, the automatic generation of links and the recommendations of the system. Suppose wiki article w_y exists already, and users *A* and *C* have edited wiki article w_y several times (cf., Figure 1). User *C* appends a paragraph to w_y. This action increases the number of edits by *C* to a value above a given threshold. Hence, the system automatically generates a link between *C* and *A*, another frequent editor of w_y. Moreover, the system notifies C and A of each other and tells them that they might share an interest in the same topic.

When other users of the system access wiki article w_y, both *A* and *C* are pointed out as frequent editors of the article (and potential experts in this field). When *A*'s use profile is viewed, *C* is mentioned as a professional colleague of *A*.

Suppose *C's* blog b_m exists already, and user *D* starts a new blog. Since *C* and *D* are connected to each other in the social network, *D* is asked whether to connect the two blogs b_m and b_n automatically. Even if user *D* does not agree to the two blogs being linked automatically, the system can inform users reading b_m that a friend of the author of b_m also maintains a weblog—b_n.

The concept proposed in this paper can prove to be a valuable tool in diverse fields. Wwo potential application areas are illustrated: learner-support systems and corporate and organisational environments.

5.1. Learner-Support Systems

With functionality similar to blended systems (section 1.4), our proposal also supports similar application areas. Examples are learning environments, where our concept provides a unified platform for lecturers and students to author content collaboratively, a space for commentary and discussion, and a place for communication as well as social and professional contacts (cf., Elgg (2006) and Su (2005)).

Also in contrast to existing systems, our concept actively encourages users to discover new information and makes users aware of connections between pieces of content that might otherwise have gone unnoticed. Relatively simple visualisation

techniques can help learners to identify relations between different parts of the content and enable them to find references to associated information in the system. Furthermore, meeting new (relevant) people is actively supported through suggestions made by the system (see section 2.2).

5.2. Corporate and Organisational Environments

As mentioned above, companies make use of wikis for documentation and employ blogs, for example, for communicating news, progress on projects and similar information to employees. Rarely, however, are these technologies combined into a single application. One of the few attempts in this field is a research project carried out by the CIA. It describes a concept that utilises wikis for creating a general body of knowledge by members of the organisation, and offers blogging functionality for comments, potentially opinionated views and complementary information (Andrus, 2005). Though combined, the system does not make use of synergetic effects and cannot add value to its information in the individual components.

With our approach, users have similar capabilities for creating content and for expressing personal views. However, our system can depict explicit relations between information items and reveal implicit linkages between the objects stored in the system. Moreover, experts whose expertise in certain topics might previously have been unknown can be found. System-to-user communication keeps users informed, for example, when new users contribute to a topic or when wiki articles are updated.

6. Conclusion

Recent community-based technologies such as wikis, blogs or social networks attract millions of users that contribute their knowledge and experience to producing and maintaining content. The spectrum of these developments has evolved into a patchwork of autonomous, unrelated systems. Although a small number of approaches to combining these technologies into a framework exist, these systems have failed to make use of the synergetic effects.

In this paper, we have proposed a system that bridges this gap. Our proposal tightly integrates the currently most popular community-based technologies into a single, unified platform—Kōrero. The fundamental part of the Kōrero is a social network that connects functional components such as wikis and blogs. With the use of features from knowledge management in this integrated environment, discovery of implicit linkages and tacit knowledge can be attained. Moreover, the system can make personalised recommendations of newly discovered information to users.

Acknowledgments

The author would like to thank Jennifer Lennon for her time and support during these busy days. Thanks also to Richman Wee for his knowledge of Te Reo.

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