An Evaluation Agent System for Enhancing Wikipedia Management

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ABSTRACT : *Wikipedia has recently become a popular platform for knowledge sharing and creation. However, the enormously increasing amount of editing has caused management problems with efficiency, accuracy, and convenience for Wikipedia administrators. This study, therefore, aimed to develop an intelligent agent system based on Web 3.0, the evaluation agent system (EAS), to solve these problems. The EAS is characterized by hybrid Web techniques, artificial intelligence, integration of management guidelines, retrieval of real-time information, and the transfer of cross-platform data and includes the following three systems: the testing agent, the wiki agent, and the rule-based expert system (RBES) agent. Because the RBES was central to the EAS, 29 university students were included in the study to examine the effectiveness of the RBES compared to the conventional approach to administration. The findings revealed that the RBES was better than the conventional approach in accuracy, efficiency, operation convenience, and fatigue strength.*

Keywords *- Wiki, Web 3.0, agent, Knowledge management applications, Maintenance*

1. INTRODUCTION

Wikipedia is one of the best-known wikis. In Wikipedia platforms, Wiki bureaucrats and administrators are authorized to manage content in the Wikipedia system. Wiki bureaucrats are users who can grant and revoke an account's robot status, rename user accounts, and upgrade users to administrators [25]. On the other hand, Wiki administrators comprise a group of volunteers who are not employees of the Wikimedia Foundation, which develops Wikipedia. Both Wiki bureaucrats and administrators, however, are authorized to protect, delete, and restore pages, to delete page revisions, and to block editors from editing.

To date, the most well-known Wikipedia platforms have used MediaWiki as their major engine. The Web 2.0 MediaWiki conveniently allows users to edit their pages of interest and immediately post comments on other pages [28]. Although Wikipedia administrators can currently use MediaWiki to examine updated pages and use web robots to manage the pages, they cannot effectively tackle problems with guideline violations, especially with the dramatically increasing number of pages. Therefore, Wikipedia administrators must handle these problems via human operation, which is both time consuming and prone to errors. To enhance Wikipedia's functions, we developed the evaluation agent system (EAS) as a Web 3.0 method of improving the accuracy, efficiency, and convenience of Wikipedia management. Moreover, because the rule-based knowledge system (RBES) was central to the EAS, we examined its effectiveness compared to the conventional approach to administration.

2. IMPORTANT FEATURES AND CURRENT ISSUES OF WIKIPEDIA MANAGEMENT IN WEB 2.0

A. Wikipedia and MediaWiki

Wikipedia is a collaborative multilingual encyclopedia created by users [6]. Internet users can interact with people who like to share their knowledge or create specialized domain knowledge on the Wikipedia platform. Moreover, Wikipedia provides an easy-to-operate platform that can be used to search, create, modify, discuss, and translate information. For example, it allows users to co-author information via instantaneous login. It also allows users to edit, revise, or delete their previously edited content without logging in [26]. Accordingly, users can conveniently and instantly update their edits in response to controversial issues and record all their content revisions for the purposes of data searching and recovery. Because Wikipedia is a noncommercial platform, the cost of creating and publishing information continually decreases. As a result, hundreds of articles, ranging from general information to specific knowledge, are added and revised daily. In this way, specific web communities are created, and web traffic to these communities is constantly increasing.

Among the major engines employed in the well-known Wikipedia platforms, MediaWiki has been the most popular. MediaWiki offers a special format in which users can easily edit a page

without any knowledge of XHTML or CSS. XHTML (eXtensible HyperText Markup Language) is a markup language which is extended from HTML (Hypertext Markup Language) and CSS (Cascading Style Sheets) is a style sheet language. Both languages can be used for creating a style sheet for Web documents by Web designers [30]. When a user submits a page, MediaWiki can transfer the content into its database without deleting the previously edited page. Despite its convenience [28], MediaWiki cannot integrate information from different pages simultaneously to check whether specific pages violate the user guidelines. As a result, Wikipedia administrators must check for such problems via human operations, which has caused serious management problems for Wikipedia.

B. Knowledge management system

With the rapid development of Web 2.0 and e-learning, effective knowledge acquisition and management has become a popular research topic. Numerous software systems have been built and used extensively for knowledge management. However, only a few open-source systems are available to small research communities. Using knowledge management systems (KMS) both facilitates the accumulation of personal knowledge and group knowledge and allows Web 2.0 administrators to share their domain knowledge and management guidelines. These functions are important because exchanging knowledge between experienced managers and junior managers can help avoid the use of inappropriate management methods [3]. Moreover, KMS can incorporate Wikipedia's management principles into its own system, which enhances knowledge sharing, knowledge reuse, and knowledge creation. As a result, KMS has been employed in a variety of cases, and many empirical studies have been conducted to investigate factors that influence the effectiveness of KMS, especially those relating to the correction of functions and the efficiency of execution [12].

However, the widely used KMS has encountered three major problems: (1) bot approvals: web robots can automatically execute instructions, but their instructions may cause crashes and damage data; (2) article problems: conflicts between users frequently occur when they discuss sensitive issues; (3) anonymous editing: anonymous users are permitted to edit pages in current Wiki systems, which could cause serious problems and decrease the efficiency of the Wiki systems' functions.

3. COMPARISONS OF WEB 2.0 AND WEB 3.0

Some researchers argued that both Web 2.0 and Web 3.0 methods enable users to achieve large-scale data integration [20]. However, while Web 2.0 data are not generally available in forms that can be easily interlinked and reused, Web 3.0 has yet to embrace the ease of participation that makes Web2.0 the more popular choice [31]. Web 2.0 is a technique used to reuse or retrieve user-generated content; it also supports social and collaborative interaction on the Web. These advantages have made Web 2.0 a popular approach in Wikipedia, Google Maps, Facebook, and etc. On the other hand, Web 3.0 methods, which are generated through the use of XML, RDF, OWL, SPARQL [5] and other technical standards, can be an intelligent agent; it combines with the databases used in other Web techniques. For example, the Semantic Web method can automatically search for information that matches the given conditions or human logic of various pages.

Web 3.0 is the extension and further development of ontology technology and knowledge organization in cyberspace [29]; it is a relatively new concept in Wiki technology. Web 3.0 is characterized by providing Internet users a personalized, intelligent, and accurate information platform in addition to all the features offered by Web 2.0 [31]. Accordingly, Web 2.0 is gradually developing into Web 3.0 to achieve automated information retrieval, semantic interference, machine learning, rule-based expert systems, and other artificial intelligence applications [31]. Based on Xiong and Xu's (2010) viewpoints, we proposed the following arguments:

(1). Web 3.0 provides highly authentic knowledge that improves the quality of Web 2.0. In Web 2.0, users edit collaboratively to produce domain knowledge. When administrative mistakes occur, users may receive wrong information because the contents have been maliciously edited, illegally updated via web robots, or incorrectly cited from published information. These problems can be

solved by providing users with administrative suggestions to maintain the quality of knowledge in Web 2.0. The high level of authentic property in Web 3.0 can prevent users from receiving such erroneous information and help them more efficiently acquire knowledge.

(2). Web 3.0 enables cross-platform data transfer that makes Web 2.0 information universally available. To make the knowledge in Web 2.0 universally available, the development of a knowledge database system should take such mobile devices as a smart phone or PDA into account so that data can correctly be transferred between various platforms or devices.

(3). Web 3.0 uses real-time information retrieval that increases the efficiency of management in Web 2.0. Information management in Web 2.0 is usually achieved through human operations. For both administrators and users, these human operations are very time-consuming. On Wikipedia, for example, users must wait for permission from the administrators to make significant edits. Web 3.0 automated management can immediately retrieve real-time information and update information edited by users, which can increase the efficiency of administrative mechanisms in Web 2.0.

(4). Web 3.0 integrates administrative guidelines that can improve on the original limitations of Web 2.0. Effectively integrating information across pages and sharing knowledge are important administrative tasks in Wikipedia. Unfortunately, the integrative function is not achieved well in Web 2.0. The integrative property of Web 3.0 can improve this shortcoming of Web 2.0. Web 3.0 techniques are capable of producing inference rules based on edited information in knowledge databases, which assists in the sharing of information among administrators.

4. DEVELOPMENT OF THE EAS

A. Characteristics of the EAS

To conquer the aforementioned limitations of the current Wiki systems and to enhance the efficiency, accuracy, and convenience of Wikipedia management, we developed the EAS based on the framework of Web 3.0. The EAS was composed of a testing agent, a Wiki agent, and RBES. The main characteristics of the EAS are as follows:

1. Employment of hybrid Web techniques and artificial intelligence

- EAS incorporates such hybrid Web techniques and artificial intelligence as XML, XSL, and CLIPS. These technologies can generate syntax automatically, which contributes to the efficiency of creating knowledge-based systems.
- EAS incorporates the Web-based logic editor and Web robot to achieve the goals of Wikipedia administration.
- It integrates multi-agent technology with RBES.

2. Integration of administrators' management guidelines

- EAS includes a RBES that integrates knowledge from wiki administrators, users, and related experts; the integrated knowledge then provides feedback to the agent system by which rules of knowledge can be built.
- EAS emphasizes three key factors of a successful KMS: accuracy of goal achievement, efficiency in task performance, and the creation of collaborative knowledge.
- EAS addresses the common KMS problems. To solve the bot approval problem, the EAS requests users to apply for web bot approval. To improve the article problem, administrators are required to evaluate the rationality of each page. To prevent excessive anonymous editing or editing abuse, administrators should follow the management guidelines set out by Wikipedia. More specifically, when an anonymous user excessively edits different pages simultaneously, administrators actively advise that user to register for a new account.

3. Retrieval of real-time information

- Its edited pages can be immediately monitored by administrators.
- It is user friendly and provides rule descriptions of domain knowledge, which help users describe the rules even when they are not familiar with the CLIPS syntax.

4. Transfer of cross-platform data

- It includes a logic-editing model that facilitates knowledge acquisition via XML and XSL technologies.
- It is compatible with various platforms.

B. Rule-based expert system (RBES)

The most critical component of the EAS is the RBES. In this study, we integrated the multi-agent system and CLIPS to construct our RBES. In

the RBES, users can set up customized attributes and construct their domain knowledge; the RBES then makes inferences based on the constructed knowledge and provides immediate feedback to the administrator. CLIPS is a productive development and delivery expert system tool that provides a complete environment for the construction of rule- and/or object-based expert systems. Created in 1985, CLIPS is now widely used throughout the government, industry, and academia. Its key features are as follows [9]:

(1). Knowledge representation: CLIPS provides a cohesive tool to support three different programming paradigms: rule-based, object-oriented, and procedural programming for handling a wide variety of knowledge. Knowledge specifies a set of actions to be performed in a given situation, and it can be represented as heuristics by rule-based programming. The procedural programming capabilities provided by CLIPS are similar to those found in such languages as C, Java, Ada, and LISP. CLIPS can be modeled as modular components that can easily be reused to model other systems or create new components using object-oriented programming.

(2). Portability: CLIPS has been widely employed in operating systems, such as Windows XP, MacOS X, and UNIX. When a system has an ANSI compliant C or C++ compiler, CLIPS can be ported to any systems. Therefore, all the source codes can be tailored or modified to meet the user's specific needs with the portability of CLIPS.

(3). Integration/Extensibility: Programming languages such as C, Java, FORTRAN, and ADA can be integrated by CLIPS. Based on the use of well-defined protocols, CLIPS can be easily extended by users and embedded within procedural codes.

(4). Interactive development: CLIPS can function as a basic compiler and offers debugging aids, online help, and an integrated editor. It also provides an interactive- and text-oriented development environment and the interfaces that provide menus, integrated editors, and multiple windows.

(5). Verification/Validation: CLIPS can support the verification and validation of expert systems to prevent a rule from generating an error. Our RBES supports the function of modular design, partitioning of a knowledge base, constraint checking of slot values, and semantic analysis of rule patterns.

(6). Fully documented and low cost:
A Reference Manual and User's Guide are included in the extensive documentation available for CLIPS. Moreover, CLIPS is maintained as public domain software; therefore, its cost is low.,

C. Illustrations of the RBES procedures

The general RBES procedures are depicted in Figure 1 and Table 1. First, the user can choose the main task that they wish to achieve and decide to read the information in which they are interested. Next, the RBES automatically sets the goals of the assigned tasks. The logic editor built into the RBES then begins to judge the conditions of the rules, such as if...else. The rules are then generated and sent to XML descriptions. It follows that the XML files are transferred to CLIPS rule descriptions via the XSL technique [14,16]. In this way, the CLIPS rule database is constructed.

Meanwhile, the user can examine whether the logic descriptions match his/her requirements and update or delete the desired logic descriptions. In addition, the agent can assign tasks to a Web robot to detect exceptional events based on the rules built into the expert system.

To summarize, the main benefits and characteristics of the EAS are captured in Figure 2.

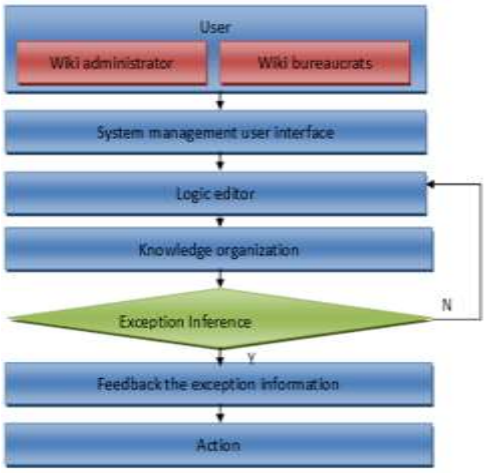

Figure 1. Flowchart of the RBES.

Table 1: The pseudo-code of the RBES procedures

Input: The administrative task for the Wiki administrative group

Output: Provide advice on solutions to the user and detect exceptional events in the RBES

Set up the goals:

The system customizes the administrative function (administrative task);

Develop the expert system

Knowledge acquisition (XML files, XSL codes);

Knowledge transfer (CLIPS rules);

Construction of the CLIPS database (rules);

Choose the target of the object function;

Use the expert system to estimate the possible outcomes (rules);

Detect special events based on the rules in the expert system (agent);

Use logic editor to determine the procedure for implementation (web robot);

if (the frequency of editing pages exceeds n times || the number of words less then K word)

then instruct the user to address this exception.

Figure 2. The main benefits and characteristics of the EAS

5. METHODS FOR VALIDATING THE EAS

A. Participants

To solve the current management problems of accuracy, efficiency, and convenience in Web 2.0 systems, this study developed the EAS, which included the aforementioned characteristics of the effective management of Web 2.0 services based on the framework of Web 3.0. To further investigate the effectiveness of the EAS, 29 university students (5 males and 24 females) aged from 18 to 22 years old were included in this study. They were participants in the control group, which adopted the conventional approach (human labor) to conduct the experimental tasks. On the other hand, 29 participants simulated by computers were included in the experimental group, which adopted the RBES approach to conduct the experimental tasks.

B. Instruments and the framework of the experimental design

The developed EAS in this study included the following three systems: the testing agent, the Wiki agent, and the RBES agent. Because the RBES was central to this system, its effectiveness was evaluated in this study by empirical data. We evaluated the performance of the RBES based on four criteria: (1) accuracy of inference; (2) performance efficiency; (3) operation convenience for users; and (4) fatigue strength (see Figure 3). In this study, accuracy infers to the correctness of inferences, and efficiency infers to the speed of operation time (seconds). While the first two criteria were evaluated by completing six testing tasks, the latter two criteria were evaluated by a 5-point Likert-type questionnaire that included 11 self-reflection questions. The response options ranged from "Strongly disagree" to "Strongly disagree" [32].

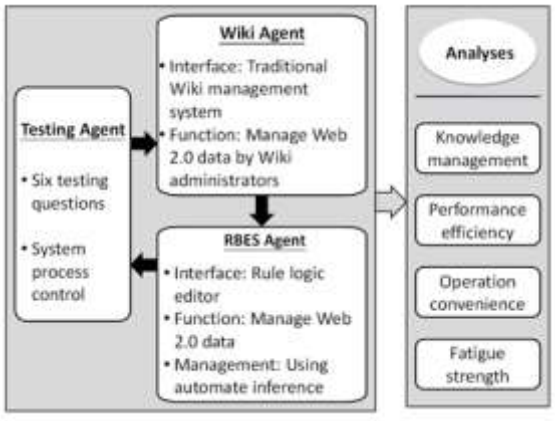

Figure 3. The framework of the EAS.

6. METHODS FOR VALIDATING THE EAS

A. Inference accuracy

This study included six testing tasks, and each of the tasks included 40 articles. Regarding the percentage of accuracy in performing the testing tasks, the findings revealed a significant difference between the conventional approach (human operation) and the RBES approach (Ms: 84% vs. 100%), t(57) = -4.94, p = .000 (see Table 2). Accordingly, compared to the conventional approach, the RBES had better accuracy in making inferences.

Table 2: T-test of accuracy of the conventional and RBES approaches.

Variable	*N*	*M*	*SD*	*t*	*p*
Conventional approach	29	84%	0.17	-4.94***	0.000
RBES approach	29	100%	0.00		

* $p < 0.05$.

B. Performance efficiency

As for efficiency, the average performance time of the conventional approach was 332.38 seconds, and that of the RBES was 1.92 seconds. The results of the t-test revealed that the overall efficiency of the RBES was significantly better than the conventional approach: t(57) = -19.94, p = .000 (see Table 3). Therefore, the RBES is tremendously helpful in terms of saving time.

Table 3: T-test of efficiency of the conventional and RBES approaches.

Variable	*N*	*M*	*SD*	*t*	*P*
Conventional approach	29	332.38	89.02	- 19.94***	0.000
RBES approach	29	1.92	0.89		

* $p < 0.05$.

C. Operation convenience

Based on the self-reports in response to Question 1 "I think the RBES human-machine interface is easier and more convenient to operate than the conventional interface", we investigated the participants' perceived satisfaction in the convenience of the RBES compared to the conventional approach. The response options were scored from "1" to "5", representing "strongly disagree" to "strongly agree". The mean of Q1 was 4.45, which was significantly different from the median score "3", t = 9.959, p =.000. This finding revealed that the participants thought highly of the convenience of the RBES when compared to the conventional approach.

Moreover, the participants were classified into a "much experience group" and a "little experience group" based on their self-reported experiences employing Web 2.0 in Question 2 "I use Web 2.0 frequently". We then compared the levels of user satisfaction of these two groups. The results showed that both groups were more satisfied with the RBES system than with the conventional system due to its smart inference property and convenient operation interface (see Table 4).

Table 4: T-test of interface satisfaction with different levels of Web 2.0 experience.

Variable	*N*	*M*	*SD*	*t*	*P*
Much experience group	23	4.39	0.838	7.995***	0.000
Little experience group	6	4.66	0.516	7.906	

* $p < 0.001$.

7. DISCUSSION AND CONCLUSIONS

Wikipedia has been popularly employed in knowledge sharing and knowledge creation. Moreover, it facilitates users' contribution of contents, promotes collaboration and in-depth online conversations, and, most importantly, nurtures social networking [4]. Recently, the number of edited pages has increased dramatically in Wikipedia; how to conveniently maintain the quickly growing amount of information with efficiency and accuracy has become a great challenge for Wikipedia administrators. To date, most Wikipedia platforms are developed via Web 2.0 systems. Due to the limitations of Web 2.0, Wiki administrators must employ the conventional approach, human operation, to check the edited pages. This process is both time consuming and error prone. In Web 3.0, social networks or digital learning websites share the characteristics of the Semantic Web and artificial intelligence; Web 3.0 helps administrators to confront the problems they encounter. To enhance the effectiveness of Wikipedia management and to solve the current administration problems, we develop the EAS based on the advantages of Web 3.0 to provide a real-time, reliable, integrated, and cross-platform administrative system for Wikipedia. The EAS is composed of the testing agent, Wiki agent, and the core agent: the RBES agent. Because the RBES is central to the EAS, we also examine its effectiveness via real cases and computer simulations. Moreover, data are collected via experimental tasks designed in the RBES and a

self-report questionnaire recorded in the testing agent.

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