학문적 협력을 돕기 위한 구조적 전자저널

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Structured Electronic Journal for Scientific Collaboration

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〈Abstract〉

Thesedays more collaboration is required of scholars than before, because some complex problems are beyond the individuals' research capability. Traditional print-based journal systems have been playing a role of supporting scientific collaboration, in that they provide the state-of-the-art knowledge. Those journal systems, however, are known to have some problems. To cope with some of those problems of the print-based journal systems, electronic journal systems have been suggested and implemented. Investigation shows us that electronic journal systems still have some problems. This paper proposes a new form of electronic journal system, structured electronic journal system, which is believed to better support the scientific collaboration. It is designed so that it is easier to figure out the synopsis of an article and so that authors and referees of a submitted paper can participate in the discussion for verifying the significance of the paper. Object-oriented design of a structured electronic journal system which is to be built on top of a object-oriented database system is explained with example structures.

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1. Introduction

We are living as a member of a variety of societies, whatever they are, and as such we are continuously influenced by other members of the societies we belong to. As such, it can be said that what we have achieved is not the accumulation of individual work of ourselves but the results of collaborative efforts by many. Even famous figures outstanding in the history of science may not be able to stand out without the achievements of their fore-runners. James Watson, co-winner of Nobel Prize for the discovery of double helix, said "Nothing new that is really interesting comes without collaboration." [Schr90]. Since problems around us become more and more complex, collaborative approach to problem solving will be required more extensively in the near future.

In scientific community, tacit collaboration among scholars has taken place to achieve its single, ultimate goal, that is, to produce scientific knowledge. Collaboration occurs through communication. In an ancient time of Greece, face-to-face discussion in a large open forum is a way of communication and thus a way of collaboration among scholars. Later, scholars exchanged their thoughts and ideas by sending letters to their peers. For example, it is known that Darwin had corresponded with other scientists for a long time to claim the origin of species [Vorz70]. Then, for more than 300 years, journal systems have been a major way of communication among scholars. Through journals, they come to share their research results, which in turn arouse their passion for new scientific knowledge.

Traditional journal systems, however, leave something to be desired, because of the long-recognized problems. To name just a few of them, we have these: the gap between submission and publication is rather long; the published article may not contain 'objective, fairly-validated knowledge'; many of the articles are not interesting to most subscribers; locating interesting articles is not an easy job at all; library costs are soaring due to too much publication [Gain93]. These problems are impediments to scientific collaboration. As a means to cope with some of these problems, a new form of journal, electronic journal, has been suggested, but it was once reported that none had been successfully implemented [Free87]. However, there are several electronic journal systems that currently draw attention of scholars in specific fields of science such as communication [Harr95], earth system sciences [Simp95], toxicology [Gard95] and so on. This paper proposes an alternative form of electronic journal, structured electronic journal, as a better way of supporting scientific collaboration.

The remainder of the paper is organized as follows. Section 2 looks into scientific community, scientific process, and scientific collaboration. Section 3 reviews electronic journals, with respect to the reasons of failure and a few cases of running examples, and it suggests a few as principles for implementation. Next comes the design description of a structured electronic journal system, proposed in this paper. Basic constructs for the two phases of scientific process and an object-oriented modeling for implementing structured electronic journals, are described in sections 4 and 5, respectively. Finally, concluding remark is given in section 6.

2. Scientific collaboration

It seems to be in order to try to understand the scientific community at this point. So, this section first examines the characteristics of scientific community, surveys the literature briefly to clarify the scientific process, and then elaborates the term, scientific collaboration.

2.1 Scientific Community

Scientific community is characterized by such properties of open systems as decentralized control, asynchrony, concurrency, continuity, inconsistency and arm's length relationship [Hewi86]. Scientific community consists of many autonomous agents (e.g., research teams, or individual scientists), each of which carries out its own research projects, with little or no interference by other agents. Each agent may, however, influence other agents indirectly by exchanging with limited agents, papers, insights, and equipments, or by publishing research results. Activities of an agent have nothing to do with those of other agents. And it is usual that research of one agent is passed on to its followers, so that continuous research on the same or similar topic can be performed by them. Since agents have different background and experience in general, agents are likely to be inconsistent with each other in their world of knowledge and belief. This implies that they may take different approach to the same problem and thus have different opinions on other agents' work.

Scientific community is also viewed as 'an invisible college' [Cran72], in which individual scientists form an informal network through various social activities and they invisibly collaborate to keep themselves up-to-date in their field of interest. This view bears a resemblance with the concept of 'national collaboratory' [Lede89]. Collaboratory, a word coined from two words, collaboration and laboratory, as is implied by the two words, is a virtual laboratory for collaboration among the scientists in the nation. It is a network of scientists, hardware and software, scientific databases and other instruments that will help them collaborate in some sense. Its goal is to achieve an improved productivity by allowing access to such resources, shared through the network. It may be accomplished by integrating computer-supported collaboration technologies on top of an infrastructure which consists of networks of high-speed communication and computing facilities.

A similar idea of 'an electronic scientific community' was envisioned in [Scha91]. An early prototype system to support scientific collaboration, called Telesophy, was developed. It allowed scientists in the area of molecular biology to collectively build an information space, in which they capture domain knowledge and store it for later access by others. It seems that this system could be extended to include other research fields. It is, however, not easy to compare the format and representation of the stored knowledge with those of other related information. Another view of scientific community is that it is a discourse community whose members know what is worth communicating, how it can be communicated, how other members can be persuaded [Harr95]. They make use of a shared set of symbols and norms for communication through which the routine discourse takes place.

2.2 Scientific Process

Literature survey shows different but similar definitions of scientific process. Popper described the scientific process as follows [Popp68]: scientists put forth a new idea in the form of hypothesis or theory; then they draw conclusions in some way, such as through logical deduction; such conclusions are compared with other pre-accepted statements or with the results of practical applications or experiments. In [Korn81], the scientific process was described as a continuous iteration of proposal (e.g., new theories are proposed), refutation (e.g., anomalies, if any, of the new theories are detected), and adjustment (anomalies are modified or compromised into a new theory).

The scientific process can be described as a dialectical process, in which a new theory (anti-thesis) put forth as the result of individual research is compared with already-accepted theories (theses) and then transformed, if necessary, into a new theory (synthesis). The new theory (anti-thesis) may be rejected, modified in part, or a totally new theory can be formed as a result of synthesis. So, the interplay between a new theory and established theories is essential for the advancement of science. In [Craw90], it is mentioned that science is a continuous process and theories must survive new facts and verification.

Based on the literature survey, it can be said the scientific process consists of two phases: 1) first phase for individual research by a research agent, (which can be an individual scientist or a research group) and 2) second phase for significance test by the scientific community. During the first phase, scientists identify and formulate research questions, review the literature for the state-of-the-art knowledge, related to the research questions, collect various data and conduct experiments, analyze data obtained from the experiment, and finally draw some conclusions. During the second phase, the results obtained from the first phase are tested against some canonical criteria for checking its validity and significance. They might be presented first to peer scientists for feedback and then modified version of them are submitted to a journal for publication. According to the opinions of the referees, the submitted articles may be rejected or accepted. (Peer scientists and Referees of the journal have a sort of canonical criteria of their own.) Research results thus published in turn stimulate other scientists to carry out further research.

2.3 Scientific Collaboration

Collaboration can be defined as a purposive relationship under some constraints [Schr90]. The purpose may be to solve a problem, or it could be to create or discover something new. Collaborators may have constraints such as time, competition, and money. An example of requiring collaboration which can be seen easily in an academic community is the relationship between a professor and his students. The purpose of their collaboration is to perform an academic research within a limited time, specified by the university regulation. Chorus is another example of requiring collaboration. Collective efforts are expected of all the members of the chorus to create a value, which is, in this case, to sing a song in a complete accordance. Collaboration naturally requires communication among the collaborators, during which they are building a shared understanding about the problem, through the process of repetitive argumentation. What is important in a collaborative approach is to dissolve individuals' talents, skills, and ideas to get to a shared understanding. We should note that an individual genius who is not ready to dissolve himself for the whole, is not ready to participate in collaboration. Maintaining an environment in which indifferent argumentation can be carried out is a precondition that must be satisfied to build a shared understanding.

The same discussion as above applies to scientific collaboration, by which we mean the collaboration among scholars with a single purpose of discovering scientific knowledge. Sharing various resources such as scientific data or rare machines (e.g., supercomputers) is an example of scientific collaboration, but we are more interested in another form of scientific collaboration, which is releasing and verifying research results, so that other scholars acquire the state-of-the-art knowledge in an area of their interest or they can take over the same or similar stream of research thereafter.

Whatever technologies we are counting on, we believe at least the two phases of scientific process which we mentioned earlier should be supported by the technologies, and that in an atmosphere of free argumentation. This paper suggests the use of structured electronic journal to support the scientific collaboration. So, we first review some electronic journal systems in the next section to see the cases of failure and success, and then provide principles for implementation of a structured one.

3. Electronic Journals

3.1 Electronic Journal Systems: failure and success

Electronic journal systems were believed to replace the traditional print journal systems to overcome some of the problems of the latter, mentioned earlier. For example, the problem of time gap between submission and publication and the problem of enormous amount of published articles most of which are not interesting to readers seemed to be resolved to some extent by resorting to electronic journal systems. However, some of the electronic journal systems started over more than a decade ago, but now most of them are no more alive. Then, why they failed? It may be useful to investigate why.

Investigation of some of earlier electronic journal systems shows that there were many reasons for their failure. BLEND and EIES experimental projects on electronic journal systems (at the University of Birmingham and at New Jersey Institute of Technology, respectively), which attempted to replicate a print-based journal, were not successful due to cumbersome user interface, lack of recognition within the scientific community, and lack of cooperation among international telecommunication companies [Free87]. Some other reasons of failure are the immature technology at that time, such as low speed transmission [Hilt84], poor text-processing capability of not fully supporting the tasks of referees and editors [Cowa85]. Others may be due to social and cultural reasons, such as low participation (because most users do not like changes).

With the advancement of computer and communication technologies, positive, to some extent, reports can be found in literature on some of currently running electronic journals or those in plan. Toxicology Abstracts has been serving as a print journal for toxicologists. Beginning in 1995, it can be accessed electronically on the Internet to retrieve articles of interest [Gard95]. Search by keywords or by specific topics can be made to access the whole contents of the journal before printing it. A new electronic journal in the field of earth system sciences, named Earth Interactions, has just started by the collaborative effort of AMS (American Meteorological Society), AGU (American Geophysical Union) and AAG (Association of American Geographers) with the financial support of NASA [Simp95].

Some other electronic journals are introduced in [Harr95], such as Surfaces, Postmodern Culture, Psycholoquy, EJC (Electronic Journal of Communication) and so on. It is argued that this new media has changed the way of practicing traditional journals. For example, Journal of Statistics Education and Journal of Fluids Engineering, build a database of articles, together with associated data, if any, so that readers, if they want, can access and examine the data. Psycholoquy automatically delivers research reports and peer responses, expediting interactions between authors and peers. Postmodern Culture makes use of self-nominated peer reviewers, to verify the significance of submitted articles, thereby driving more scholars to participate in various activities of electronic journals. Electronic journals, in fact, not only eliminated some of the problems of traditional printed journals, but also they have created a new environment, in which more collaborative activities can be supported, such as allowing authors and readers to prepare texts together.

3.2 Introduction of EJC

More details are given in [Harr95] on EJC, which originates from their ComServe experience, since 1986. ComServe is an electronic center, accessible only through computer networks. It provides various resources for communication faculty and students, such as electronic conference, electronic library (of bibliographies, syllabi, conference announcements, newsletter, and others useful to scholars) and journal index to over 50 scholarly journals. Using electronic conference, they can discuss, ask/give advice, pose questions, and so on. Later, a part of ComServe users evolved into a scholarly association, CIOS (Communication Institute for Online Scholarship). EJC is the electronic journal of CIOS, offering a series of topic-oriented issues. Respected scholars in the field of each issue form an editorial board, solicit submissions and review them. They are free to choose the whole procedures for the issue. When announcing the release of an issue, readers receive a table of contents, together with the articles and their abstracts, so that they can choose and peruse articles of interest. Readers can jump within the text using the hypertext-style links. Besides, they can choose to highlight and/or create marginal comments for a section of a text, which does not necessarily imply that the contents of original text have changed.

The software associated with EJC consists of two parts: one for subscribers (DISPLAY) and another for journal staffs such as referees and editors (MARKUP). On starting DISPLAY, readers are allowed to transit among three environment: table of contents, author, and read-article environments. In the read-article environment, readers are able to highlight a section of an article; put comments on a section; create a bookmark for fast return; create link among tables, figures, reference list and various notes (e.g., footnote, endnote, etc): search text for specific keywords. Major functions of MARKUP are: translation of articles into a format that prevents alteration of articles; preview of a translated article: creation of a journal release: editing the data that the journal releases. EJC is just one of many experiments in electronic journal publication.

3.3 Basic Principles on Implementation

We have examined the various reasons of failure and some examples of running electronic journal systems introduced in literature. For a successful implementation of an electronic journal system, here we suggest on the basis of the examination that implementers of an electronic journal system should take into account the following principles:

1) They had better make an effort to reduce the feeling of disparity between the two journal systems. That is, whatever good features of the print journal systems should be supported in an electronic journal system. It is not necessary just to replicate all the features of the print journal systems.
2) Electronic journal systems should provide some unique services that cannot be enjoyed in traditional print journal systems, as is mentioned in [Free87]. Olsen studies the scholars' requirements of an electronic journal system, mainly from the users' perspectives of locating and reading articles [Olse92].
3) Conferences have been providing a place for social interaction among scholars. There should be some alternative of this function in an electronic journal system.
4) Technological support for the two phases of scientific process mentioned earlier should be recognized as natural by the users of en electronic journal system.

Most of the technologies that are used for electronic libraries or digital publication sysrems [Phil91] such as multimedia data management, hypertext, CD-ROM, multidatabase, GUI, and so on seem to be useful for an electronic journal system.

4. Structured Electronic Journals for Scientific Collaboration

So far, we have discussed electronic journal systems. This section introduces a new form of electronic journal systems, that is, a structured electronic journal, which will hopefully expedite collaboration among scholars. The basic idea behind the structured electronic journal systems is that structural representation of both phases of the scientific process makes it easier to understand the results obtained during the first phase of individual research, and to figure out the dialogue captured during the second phase of verifying the results.

4.1 Preliminaries

To repeat what was said earlier, we suggest the shift to the structured electronic journal systems in hopes of encouraging scientific collaboration. And we believe that scientific collaboration can be encouraged: by helping scholars to locate papers of interest with ease which deal with the same or similar problems; by helping them to figure out the synopsis of the research results of each of the papers; and by making the process of significance test transparent to the submitters of the papers for fair treatment of them.

One way of encouraging the scientific collaboration is to build a structured electronic journal system on top of a database system, so that scholars locate papers of interest with ease and both authors and referees of papers can participate in the verification process. Becides, the structured electronic journal system provides various services, including, for example, one which displays on demand the status of a submitted paper (e.g., whether it is received, being processed, accepted, or rejected).

Therefore, staffs of the structured electronic journal systems are required to prepare the followings before launching them:

1) Classify research areas into a hierarchy of them. This hierarchy may vary with time, as a single research area may be divided into several later. As such, this hierarchy should be available to the users of the structured electronic journal system, so that whenever they need to know the hierarchy, they can do that using the system.

2) Determine the structure for each research area in the hierarchy and make it known to scientific community by some means, say, by declaring it in "call-for-papers" for the structured electronic journal, or by registering the structure in the structured electronic journal system, so that whenever they need to know the structure of a research area, they can refer to the system. Once the structure is determined, submitters of papers are supposed to represent their papers in that structure.
3) Determine sequences of moves that can be taken by the referees and authors during the verification process. These sequences need to be captured and stored into the database with the corresponding paper. The captured sequences of moves will be used as a basis for deciding whether the paper is to be accepted (with or without modification) or rejected.
4) Determine a set of criteria, in terms of which each referee can put his opinions on the submitted paper, significance of which is already tested during the verification process. For example, the criteria may include HasNewIdea, WellWritten, Verified, etc.

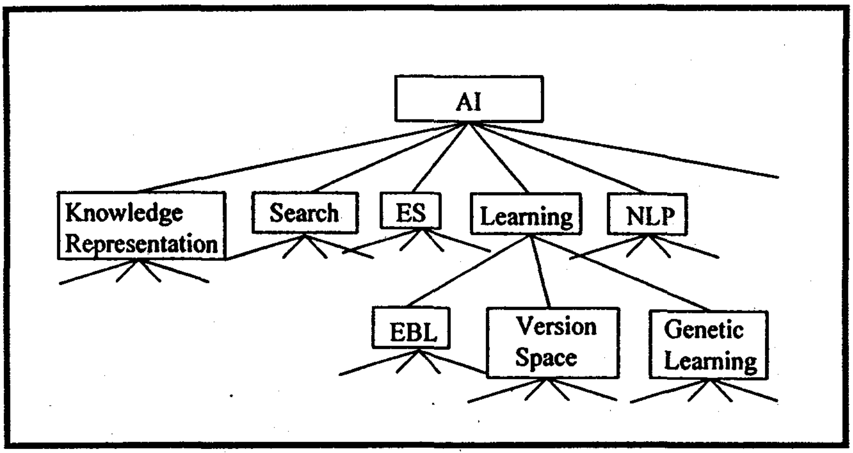
Structured electronic journal systems require the authors of papers to submit their papers in two formats: one in a structured format and another in a linear format as in traditional journal systems. And in the database, they should be linked in such a way that reference from one to another can be made easily. The next two sections show an example of structures for a structured electronic journal system. Note, however, that it is just an example and there can be a better structure appropriate for each different research area, which should be sought by the staffs.

4.2 Structures for Representing Papers in Structured Electronic Journals

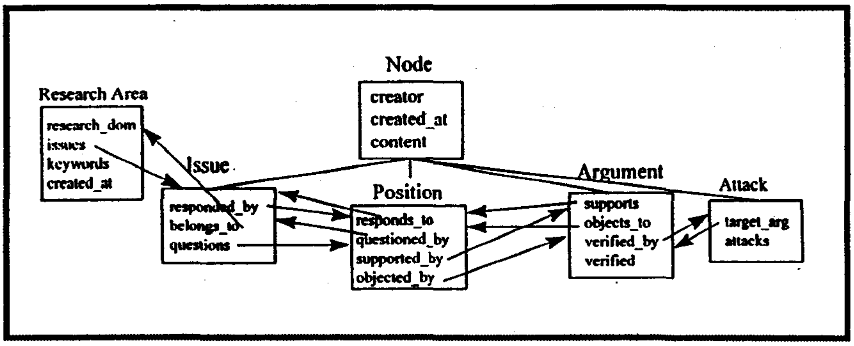
Before introducing an example structure for papers submitted to a structured electronic journal, it is in order to provide an example hierarchy of a research area. For example, suppose it is a journal on AI approach to problem solving. Then, the research areas for the journal can be classified as in the Figure 1.

We may model each research area in the hierarchy as a class in an object-oriented database, which will be explained in section 5.

Now, for each research area, we need to provide a structure. There have been lots of researches on structures for capturing continuous discussion in areas like design and policy making. One of those structures with or without slight modification may be used to represent scientific research results [Pott87,



〈figure 1〉 Hierarchy of Research Areas



〈figure 2〉 The IBIS model

McCa87, Lee90, Ritt73]. Among these, the IBIS model seems to be the best to represent the synopsis of the papers, when submitting them to structured electronic journals. In fact, a few systems were developed using the structures of the IBIS model with some extensions [Conk88, Rein90]. But they are used only to capture the dialogues during a discussion.

So, here we introduce the structure of the IBIS model, which consists of three basic constructs: ISSUE, POSITION and ARGUMENT. ISSUE represents a problem formulated in a form of a question, POSITION denotes a suggested solution to a problem, and ARGUMENT is a statement or assertion which either supports or object to a suggested solution. They are connected together by labeled links, which are explained at length in section 5. The basic constructs of the IBIS model and the relationships among them are shown in Figure 2, in the object-oriented fashion. Simple lines represent IS-A relationships, (e.g., ISSUE is a NODE), while arrows represent the relationship between an attribute and its domain.

To illustrate how to use this IBIS model to represent the synopsis of a paper, we may represent the major contents of this paper as in Figure 3. Although not all the papers can be summarized using the structure of this model (as you might feel), most of them could be, with a slight modification, if necessary.

There could be several papers that attempted to provide a solution of a common problem. If all of them are stored in the database system, we can easily find them and compare their different approaches to the same problem, thereby gaining the state-of-the-art knowledge in an area of research. This will stimulate scholars to do further research on a similar problem. It should be noted again that the structure of the IBIS model is just an example. For a research area, the basic constructs could be ISSUE, HYPOTHESIS, EMPIRICAL STUDY, and CONCLUSION, and for another, they could be PROBLEM, RESEARCH METHOD, REFERENCE (to other papers) and CONTRIBUTION.

4.3 Structures for Verifying Process

The second phase of the scientific process in a structured electronic journal starts after the structured journal systems automatically responded to the submitters that their papers have been received. This phase consists, in a structured electronic journal, of two sub-phases: one for discussion and another for comments.

During the discussion phase, each referee examines a paper submitted in structured format and attacks, if necessary (e.g., if there is ambiguity, or if the arguments in the paper seem to be spurious, and so on). Then, authors should (or even other referees could) defend the attack. Through alternate turns of 'attack and defend', significance of the paper gets tested. Authors and referees are participating in this subphase, which lasts for a certain period thoroughly anonymously. During the comments phase, each referee first makes a reference to the discussion captured during the discussion phase, and finally put his or her comments in terms of pre-determined criteria. Then, the system collects their comments and makes a decision on whether the paper will be accepted or not, based on the points calculated from the collected comments. Since the discussion phase is limited in time and each referee is informed of the time-limit at the beginning of this process of verification, this will result in the reduced the time-gap between submission and notice of acceptance or rejection, which we were complaining of.

Now, let's consider what could be the

basic constructs of a structure to capture the dialogue during the discussion phase. The attack during this phase, if we illustrate with the IBIS structure, could be made by a referee either against ARGUMENTS or against POSITIONS.

1) in case that an ARGUMENT is attacked:
   A referee attacks an ARGUMENT of the submitted paper. Referee can be either a proponent or an opponent of the argument. Of course, authors are proponents. Between these two proponents and opponents, there will be a discussion, which needs to be captured in a structured format. The discussion through the structured electronic journal system will be similar to the discussion during a meeting, with the exception that there is no moderator. That means, there must be a set of regulating rules for the participants to follow.
2) in case that a POSITION is attacked:
   In this case, a referee puts one or more ARGUMENTs which object to the position. Then, verification process on these arguments proceeds as in the above case.

Therefore, we need a structure for the first case. To provide a cue for a proper structure in which to capture a discussion for verification of a submitted paper, we introduce a set of basic constructs, that was used to capture a discussion for planning [Dehl72]. During a discussion, participants either attack or defend. An attack is allowed to be followed by another attack or a defense. Atta ck takes one of the three forms: QUESTION (Q), CONTEST (C), and REBUT (R), and defense takes one of the two forms: DEFEND (D) and CONCEDE (Co). Here, Q is a move of questioning the validity of a proposed ARGUMENT; C is a move of offering another assertion which contradicts a proposed ARGUMENT; R is a move of presenting a demonstration of the invalidity of a proposed ARGUMENT; D is a move of offering evidence to the validity of a proposed ARGUMENT. A discussion ends when a move of Co is made.

Issue 1: How can we encourage scientific collaboration?
Position 1: Implement and use an electronic journal system.
Argument 1: It will remove some of the problems of traditional print journals:
1) it will reduce the time-gap between submission and notice of publication.
2) it will reduce the problem of soaring cost of maintenance in a library, etc.
Position 2: Implement and use of a structured electronic journal system, on top of a database system.
Argument 2: It will remove other problems of traditional print journals:
Issue 2: What are stored in the underlying database?
Position 3: Papers submitted in a structured format should be stored.
Argument 3: Structured representation of papers will help us as follows:
1) It is no more a problem to locate interesting

papers.
2) It is no more a problem to figure out the synopsis of a paper.
3) Submitted papers can be fairly treated for significance test, because authors and referees can discuss significance of the paper together.

Position 4: Captured discussion during the significance test should also be stored.

Argument 4: The captured discussion provides a good ground for deciding whether the corresponding paper is to be accepted or rejected. .

Issue 3: What should be the basic constructs for a structure of submitted papers?

Position 5: It depends on the research area. However, the IBIS model can be used with slight modification.

Argument 5: The IBIS structure is simple and it has been demonstrated that it has a good expressive power in several systems.

Issue 4: How can we capture the discussion during the significance test?

Position 6: By providing a structure, which is defined based on a set of regulating rules.

Argument 6: The structure, reflecting the regulating rules, will lead referees and authors of papers to participate in the significance test, effectively and productively.

〈Figure 3〉 a structured representation of this paper's major contents using IBIS model

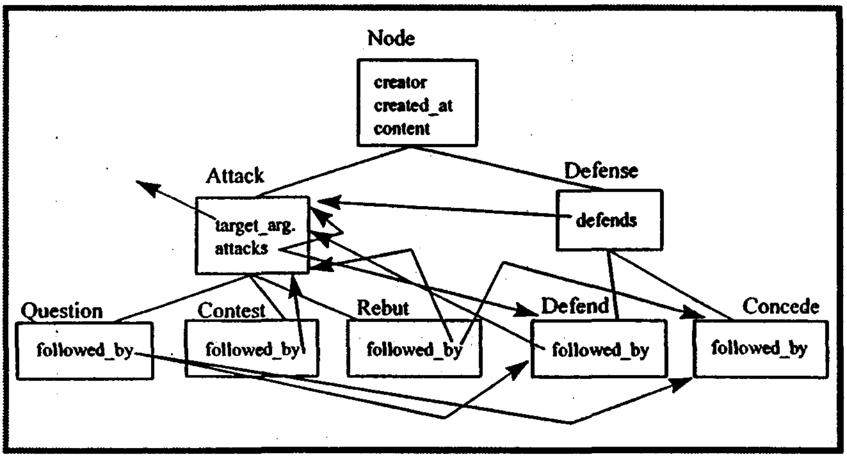
This structure may be used to capture a discussion during the first subphase for verification. The discussion proceeds by following a set of regulating rules, which must be decided for the discussion to be productive. Each rule defines what kinds of moves are allowed after a certain move. Here comes the regulating rules for our discussion, represented in the basic constructs of the structure:

Q ---〉 D | Co
R ---〉 Q | C | R | Co
C ---〉 Q | R | Co
D ---〉 Q | C | R

In the above notation, Q ---〉 D | Co implies that either D or Co can be the next move to move Q. Figure 4 indicates what is a legal move after a certain move in the scientific discussion.

4.4 Other Things Required of the Structured Electronic Journals

Structured electronic journal systems would not be used by scholars, if they are not convenient for them to use. Therefore, they should be designed in such a way that the benefits of using the systems



〈figure 4〉 Sequences of possible moves

are greater than incurred inconvenience. In that sense, user interface of those systems are one of the most important things to which to pay more attention.

Olsen pointed out many requirements with respect to the selection of literature in electronic journal systems, and with resepect to reading of the selected text [Olse92]. Coward and Standera also enumerated some desirable characteristics, which are learned from their experience with an electronic journal, entitled Selected Papers from Social Sciences and Humanities [Cowa85]. Besides these requirements and desirable characteristics, structured electronic journal system's user interface should provide functions which can:

- display a paper in a structured way as is submitted, or display it graphically, or display it both in graphically and in a structured way, and in this latter case, when the contents of a graphic window change, the contents of a textual window should change synchronously.
- display the hierarchical structure of research areas (for the scholars who want tolocate papers in the journal of a general research field)
- display the structure in which papers of a certain research area are to be represented (for the potential submitters of papers in a specific research area)
- display the structure in which the discussion during the significance test can be captured (for the authors and referees of the paper in question)

5. Implementation of Structured Electronic Journal

This section explains how to implement the structured electronic journal systems, using the structures introduced in the previous section.

Since various types of data should be dealt with in a structured electronic journal, including tables, graphs, sounds, images, etc as well as long texts, the modeling power of object-oriented database systems is required.

5.1 Data Modeling

In order to build an object-oriented database which stores the papers represented in a structure and captured discussions represented in another structure, we have to model them.

As is said earlier, the hierarchy of research areas also needs to be modeled. The hierarchy and the two structures that were illustrated in Figures 1, 2 and 4 are modelled.

First, Figure 1 is modelled as follows[1) :

```
create  class AI
(class        research_domain    default
                                 'general AI problems',
              issue              Issue,
              origin             Paper,
              keywords           set_of (string),
              created_at         date);
create        class Paper
(             authors            set_of (Author),
              title              string,
              contents           string,
              received_date      date,
              accepted_date      date);
create        class K-representation as subclass of AI
(class        research_domain    default 'knowledge
                                 representation');
create        class Search       as subclass of AI
(class        research_domain    default 'search in AI');
create        class ES           as subclass of AI
(class        research_domain    default 'expert systems');
create        class Learning     as subclass of AI
(class        research_domain    default 'machine
                                 learning');
create        class NLP          as subclass of AI
(class        research_domain    default 'natural
                                 language processing');
....
create        class EBL          as subclass of Learning
(class        research_domain    default 'explanation-based
                                 learning');
create        class VS           as subclass of Learning
(class        research_domain    default 'version space');
create        class GL           as subclass of Learning
(class        research_domain    default 'Genetic Learning');
....
```

Note that in the above, the attribute 'creator' of the class Node should be made inaccessible, so that users (e.g., referees) are not influenced by that knowledge. Also, note that if we want to store more detail information such as name, affiliation, e-mail address etc of the creator, another class with such attributes can be defined as the domain of the attribute 'creator', as follows.

```
create      class Author
(           name            string,
            email_addr      string,
            affiliation     string,
            phone           string,
            fax             string);
```

Second, figure 2 can be modelled as follows:

```
create      class Node
(           creator          string,
            created_at       date,
            contents         string);
create      class Issue      as subclass of Node
(           responded_by     set_of (Position),
            belongs_to       AI,
            questions        Position);
create      class Position   as subclass of Node
(           responds_to      Issue,
            questioned_by    set_of (Issue),
            supported_by     set_of (Argument),
            objected_by      set_of (Argument));
create      class Argument   as subclass of Node
(           supports         Position,
            objects_to       Position,
            verified_by      Attack,
            verified         Boolean);
```

Note that in the above the relationships between two basic constructs are defined in such a way that a construct can be

1) This modeling follows the syntax of UniSQL/X, of UniSQL, Corp., with a little modification

retrieved from another by following a proper link and vice versa. For example, from an Issue node one can retrieve all the Position nodes and from a Position node one can retrieve the Issue node to which it responds.

Finally, Figure 4 can be modelled as follows:

create	class Attack	as subclass of Node
(	target_argument	Argument,
	attacks	(Attack, Defend));
create	class Defense	as subclass of Node
(	defends	Attack);
create	class Question	as subclass of Attack
(	is_followed_by	Defense);
create	class Contest	as subclass of Attack
(	is_followed_by	Attack);
create	class Rebut	as subclass of Attack
(	is_followed_by	(Question, Contest, Rebut, Concede));
create	class Defend	as subclass of Defense
(	is_followed_by	Attack);
create	class Concede	as subclass of Defense;

5.2 Example Queries

Suppose the contents of Figure 3 are entered into a database, according to the schema shown above. Now, we can make some queries against the database while using the structured electronic journal system, by invoking the underlying DBMS's query processor.

query 1: to retrieve research issues in MIS area, related to 'scientific collaboration'

select issue.content
from MIS
where keywords superseteq {'scientific collaboration'};

query 2: to retrieve all the positions responded to an issue whose contents include 'structured electronic journal'

select :P
from issue :I, :P is-in
:I.responded_by
where :I.contents like 'structured electronic journal'

query 3: to retrieve all the arguments supporting to a specific position whose contents include 'significance test'.

select :P.supported_by
from issue :I, :P is-in :I.responded_by,

where :P.contents like 'significance test'

query 4: to retrieve a position which is supported by an argument whose contents include 'problems of traditional print journals'.

select :P

from issue :I, :P is-in :I.responded_by :A is-in :P.supported_by

where :A.contents like 'problems of traditional print journals'.

In the above, we have shown how to locate a paper whose research issue is related to a set of keywords, and then how to retrieve some part of the located paper. Of course, it is possible to issue a nested query. These queries are expressed in SQL syntax, which may be difficult for scholars to use. Therefore the structured electronic journal system had better provide a feature, by which the scholars can generate a query with ease.

5.3 System Architecture

Our structured electronic journal system can be implemented, following the typical client-server architecture. Scholars all over the world are assumed to have an access to the Internet through a system at their site, which works as a client machine. Only one system connected to the communication network works as a server machine with a database.

Software of the structured electronic journal system can be designed to consist of several subsystems: 1) a subsystem that can be used to get various information such as the hierarchy of research fields or the status of a submitted paper, 2) a subsystem that is used when locating papers of interest, 3) a subsystem that will be used when submitting a paper in a structured format, which can be shown on demand, and 4) a subsystem that can be invoked when participating in a discussion for significance test.

6. Conclusion

Study on scientific process revealed that the process consists of two phases: 1) research phase, and 2) verification phase. During the research phase, scholars collect papers related to their research issues and carry out individual research. During the verification phase, results of the individual research are verified by the scientific community. These two phases of scientific process are not supported appropriately either by the traditional journal systems or by the electronic journal systems. To expedite the collaboration among the scholars using computer systems, it is argued that activities during both phases should be supported by the systems in some way. Having recognized the problems of traditional journal systems and of electronic journal systems, we gave birth to the idea of structured electronic journal system, which is to be built on top of a database system.

Here, by 'structured' it is meant that the two phases of scientific process are carried out in a structured way. That is, the results from the individual research phase are represented according to a certain structure (say, issue, position, and argument), and activities of the verification phase are governed by some structure which represents regulating rules for the phase. Compared with the traditional journal systems which provide the state of the art knowledge in a linear fashion, structured ones provide it in a non-linear, or hypertext fashion. Structured electronic journal system will remove some of the problems of print journal system. For example, it will become easy to locate interesting papers, the synopsis of a paper can be understood relatively in a short time, and significance of submitted papers will be verified fairly (these are not easy in a plain electronic journal system).

We can summarize the contributions of this paper as follows. 1) it proposes a new style of journal, which, we believe, would expedite scientific collaboration through the new way both of presenting research results and of verifying the results. 2) it shows how the new style of journal can be implemented in an object-oriented manner.

Although the design of such a system was explained with example structures for the two phases of scientific process, we believe the paper gives a good insight on how to build such a system. Implementation of a specific structured electronic journal system requires the hierarchy of research areas dealt with in the journal, a structure in which submitted papers are represented, and another structure in which the discussion during the verification process are captured, be decided a priori by the staffs of the journal.

Besides, there are lots of things to consider for a successful implementation of such a system. For example, the authorization problem (e.g., who should be allowed to access which part of the database), and new services that become available because of new media, support for social activities and so on deserve further study.

The authorization problem for the database seems to be rather simple, compared with other database, because our database of accepted papers is read-only, and our database of captured discussions is append-only. What is most important, however, is to reduce the resistance of users, because it is known that people have a tendency to stay the same as before. If gained benefits are greater than incurred inconvenience, they will move to the new system. So, the system must be developed incrementally, by adding new benefits and reducing inconvenience gradually. One of the problems of electronic journal systems raised in [Harr95] is the lack of space for social activities. This is an open problem, whose solution we have to make an effort to get.

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