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HUMANIZING E-MAIL PROCESSING FOR PERSONAL INFORMATION MANAGEMENT WITH SEMANTIC WEB AND SPEECH ACT THEORY[1]

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Abstract

With the rapid progress of information technology, Internet and people's lives are combining closely with versatile communication ways now. Among these ways, the most popular one for knowledge workers is e-mail. People use it to deal with business affairs or receiving information in daily life. That gradually induces every knowledge worker has to handle many grueling e-mails every day. As a result, knowledge workers may be stuck most of their time with the e-mail distention problem. Although there are growing e-mail management systems, most of them are still short of freeing user to set, reply or retrieve related information with customized personal dexterity. That is, the data or information in the e-mail system is still obstinate for most of the knowledge workers.

To mitigate this problem, we rethink the spirit of an e-mail system from the perspectives of speech act theory, and use the six ethics of heart to construct the kernel of the social network with data provenance to help users reduce the gap between current e-mail routine process and their own personal information management. Together with the customized Semantic Web construction, our approach hopefully helps knowledge workers establish a more efficient e-mail processing model with humanity consideration.

Keywords: Email Manage System, Speech Act Theory, Data Provenance, Personal Information Management, Semantic Web.

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1   INTRODUCTION

1.1   Motivation

With the speedy proliferation of Internet, e-mail has becoming a main stream media for linking people. Knowledge workers now use e-mails to deliver almost everything, including trifles, chores, bloviating to high quality accomplishments. They also employ e-mail system as the most commonly used off-line communication tool. But the blossom of e-mail communication also gives rise to an inevitable problem of e-mail glutting. This vital situation may cause knowledge workers to spend more valuable time on dealing with e-mails together with everyday's hustle and bustle. Even there are so many e-mail management systems been developed, the data or information in the e-mail system is still independent and obstinate for most of the knowledge workers.

To alleviate the above dilemma, the concept of Personal Information Management (PIM) proposed by Lansdale (1988) will be employed in this paper. The main idea is to expect the surroundings around a working environment can help us store and retrieve data more efficiently with customized dexterity. It is similar to the morality of Order, which Benjamin Franklin advocated in his autobiography in 1726. That is, not only the data itself, but also the related data should be well-arranged together, otherwise it will waste time in finding the gruelling data for e-mail forwarding or replying.

Recently, PIM is a promising topic, which intends to support the activities people perform to organize their daily lives through the acquisition, maintenance, retrieval, and sharing of information (Teevan, *et al.*, 2006). The main goal of combining e-mail with the PIM concept is to expect that when users need some data, the data will appear on the right position in the right format, and ready for delivery to the right people.

Wittaker, *et al.* (2006) pointed out that although the e-mail has already appeared for twenty years, it still suffers from the following two kinds of problems:
- **Fragmentation**: In e-mail systems, all related information is independent, and there is no functions offered for connecting with each other.
- **Lack**: In e-mail systems, there is still no functionalities can support the aims of PIM.

Although we cannot solve these problems completely, Wittaker, *et al.* (2006) advocated that we should still investigate how to reduce the impacts of these problems for contemporary knowledge workers.

Following that, Sauermann *et al.* (2007) further proposed using semantic technology to solve the problem of PIM. They develop the concept of Semantic Desktop, such that it can be customized to connect with all related data on the desktop application by semantic concepts, and allows users to use their intuition of memory to find the data. However, Kettler *et al.* (2005) and MacGregor *et al.* (2004) argued that the tools may be hard to use for the general users.

Based on the above research findings, we recommend using the concepts of Semantic Web and Web 2.0 to improve the fragmentation problem in e-mail systems. Besides, some helpful concepts, such as speech act theory (Searle, 1979), data provenance and the six ethics of heart proposed by Master Sheng-Yen (http://en.wikipedia.org/wiki/Sheng-yen), also help us combine the concept of Personal Information Management with e-mail systems. Hopefully, our approach could help knowledge workers establish a more efficient e-mail processing model with humanity consideration.

1.2   The Objectives

Based on the discussion mentioned above, our research is expected to achieve the following objectives:
- Displaying metadata automatically to save more time for forwarding and replying operations.
- Let users use their intuition of their memory to construct a customized ontology, which stores all the relationship of data.

- Record the frequency of data and help to reduce the time of processing.
- Let users set up personalized conditions, such that e-mails can be replied or generated automatically.

2 RELATED WORK

2.1 Personal Information Management

Teevan, *et al.* (2006) described that PIM is using information technology to promote the acquisition, maintenance, retrieval, and sharing of information in a more intuitive and efficient way. Now there are three main key factors in combining the e-mail and PIM (Whittaker, *et al.*, 2006):
- **Task Management:** the main concept is to remind users about the status of current tasks, task tracking, and relevant information maintenance.
- **Personal Archiving:** the main concept is that the data which is about the user can be stored and retrieved more efficiently.
- **Contact Management:** the main concept is that every contacting data and related information can be stored and retrieved more efficiently.

2.2 Semantic Web

Berners-Lee (1998) inspired the idea of Semantic Web. The main concept is all data on the Internet can be added with some information, which is supposed to be understood by computers, and then users can exchange data freely through the Internet.

Furthermore, World Wide Web Consortium (W3C) also offered the formal definition of Semantic Web, which includes two views of semantic web: one is integrating different data, and generates a general way for presentation; the other is connecting with the digital and real data, and let machine and human can understand the same things.

2.2.1 Semantic Desktop

Woerndl & Woehrl (2008) proposed the concept of Semantic Desktop, which regards an application using semantic technology to improve PIM. The main idea is using the metadata and let users to set up their own configuration files intuitively, such that every file can be connected with each other by that information. If the semantic desktop was well-constructed, then users will enjoy reusing them very easily.

2.2.2 Semantic Navigating and Searching

Iturrioz *et al.* (2008) bring up two ideas about searching data:

Semantic Navigating: In general desktop surroundings, if a user wants to find the related files of a file, the user has to remember the filenames, file extensions or the absolute paths. Otherwise, the needed files cannot be found easily. To mitigate this problem, the concept of semantic navigating was proposed, such that files are augmented with spaces to record the metadata. Users can assign some key words to these spaces based on their experience about memorizing something important. Therefore, if a user wants to find the related files of a file, he/she could utilize the metadata to achieve the goal. Figure 1 illustrates an example, which shows the metadata of File 1. Under such situation, when a user tries to find the related files of File 1, three files (i.e., Files 2, 9, and 17) containing one or more the metadata items of File 1 will be discovered.
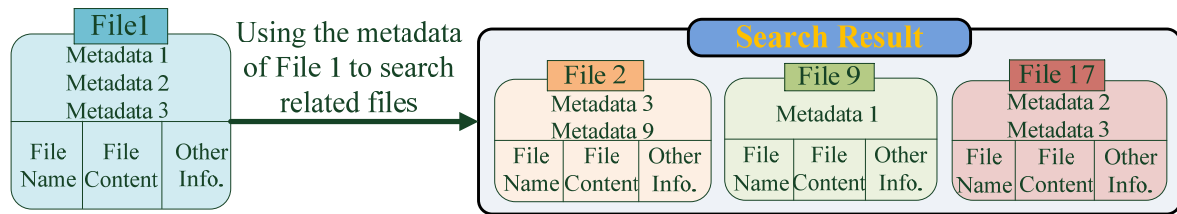
Figure 1.   The diagram of Semantic Navigating

- **Semantic Searching:** By Semantic Searching, users can pose some metadata as the search criteria to find related files containing some of these metadata. To support this concept, there will be an interface for users to type key words for the metadata. Suppose a user types three key words for the metadata, namely Metadata 1, Metadata 3 and Metadata 9, then three related files containing one or more such metadata will be presented as Figure 2 depicts.
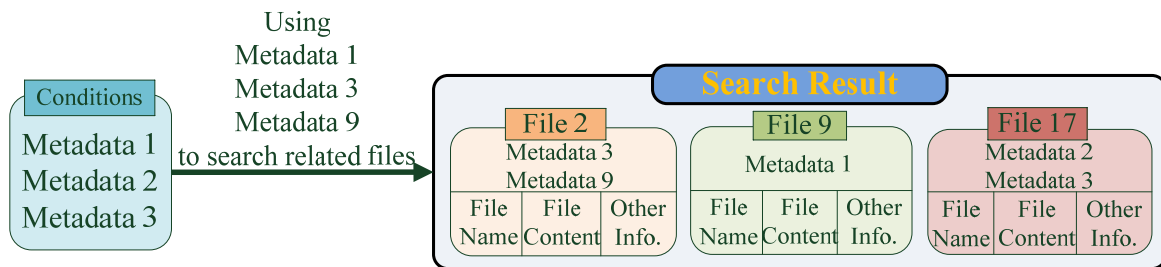

Figure 2.   The diagram of Semantic Searching

2.3   Ontology

Gruber (2008) defined *ontology* as a word list, together with the relationships between the words contained in the list. Figure 3 shows a simple ontology, which makes the relationships among all the elements be figured out directly.
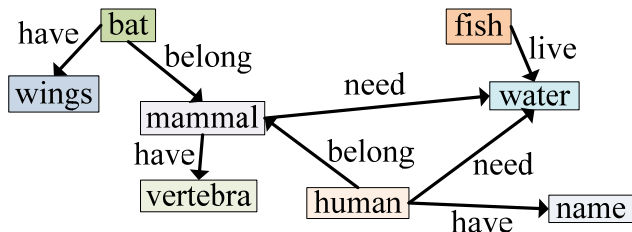

Figure 3.   The diagram of ontology

In this paper, to humanize e-mail processing, we distinguish the ontology of an e-mail system into five classes: E-mail class, Person class, Team class, Task class, and File class. Each class contains zero or more objects, and has one or more relationships with the other classes. The relationship rules about classes are explained as follows:

- Each object of these classes can be assigned with the relationship 'Related_With' to an object in the same class by the user.
- An object of E-mail class can be assigned with the relationships 'Associated_With', 'Connected_With', or 'Attached_with' to some objects of Person, Team or Task, or File classes by the user, respectively.
- An object of Person class can be assigned with the relationship 'Join_in' to an object of Team class or Task class by the user. Besides, an object in Person class can be assigned with the relationship 'Own' to the object of File class by the user.
- An object of Team class can be assigned with the relationship 'Participate' to an object of Task class by the user. Moreover, an object of Team class can be assigned with the relationship 'Own'

to an object of File class by the user.

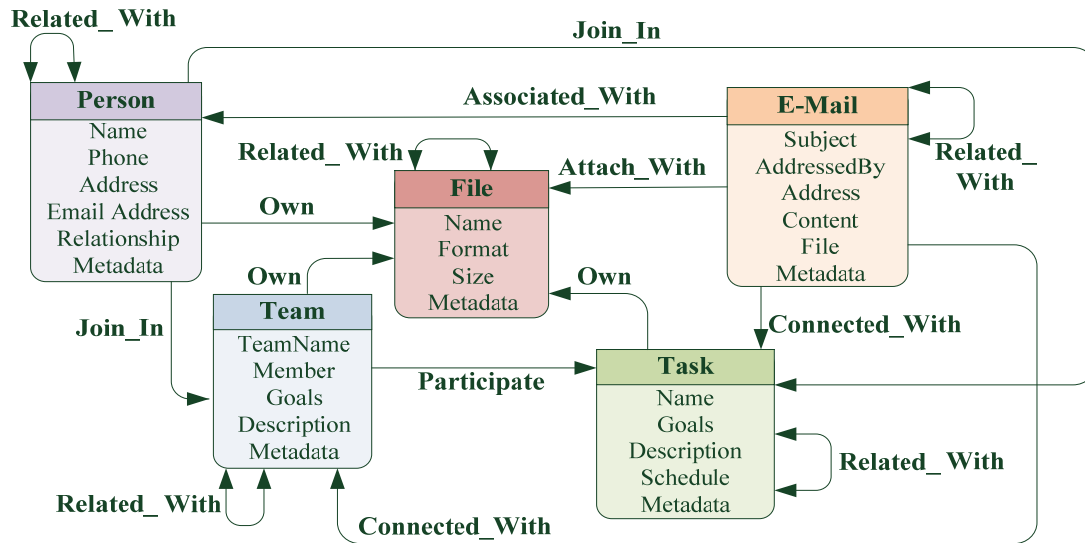Figure 4 illustrates an ontology diagram to show the above rules.

Figure 4.   The diagram of our research ontology

2.4   Data Provenance

Moreau *et al.* (2008) pointed out that data provenance is a progress of a data, and the progress contains all related information since the data was been generated. But in electronic data, it typically does not contain the necessary historical information that would help end-users, reviewers, or regulators make the necessary verifications. Therefore, they introduced the concept about the provenance system. Based on their concept, a data provenance lifecycle is composed of four phases: creating, recording, querying and managing.

In our research, we intend to bring up a model called 'E-mail Provenance Model.' It is employed to provide some functionalities which allow a user to archive his/her e-mails more smoothly, and from time to time, if a user wants to write a similar e-mail, then he could retrieve the past experience more quickly.

2.5   Speech Act Theory

Austin (1962) proposed the Speech act theory and categorized speech act into the following three types:
*   *Locutionary* act is the act of uttering words, phrases, and clauses. It is the act of conveying literal meaning by means of syntax lexicon and phonology.
*   *Illocutionary* act is the act of expressing the speaker's intention; it is the act performed in saying something.
*   *Perlocutionary* act is the act performed by or resulting from saying something; it is the consequence of, or the change brought about the utterance; it is the act performed by saying something.

For illocutionary act, Austin (1962) further classified it into five categories as follows.
*   *Verdictives* are typified by the giving of a verdict, as the name implies, by a jury, arbitrator, or umpire.
*   *Executives* are the exercising of powers, rights, or influence.
*   *Commissives* are typified by promising or otherwise undertaking.
*   *Behabitives* are a very miscellaneous group, and have to do with attitudes and social behavior.
*   *Expositives* are difficult to define. They make plain how our utterances fit into the course of an

argument or conversation, how we are using words, or, in general, are expository.

Later, Searle (1979) criticized the categorization of illocutionary act has five disadvantages:
- Not all of the verbs listed are even illocutionary verbs.
- There is no clear or consistent principle or set of principles on the basis of which the taxonomy is constructed.
- Because there is no clear principle of classification and because there is a persistent confusion between illocutionary acts and illocutionary verbs, there is a great deal of overlap from one category to another and a great deal of heterogeneity within some of the categories.
- Not only is there too much overlap from one category to the next, but within some of the categories there are quite distinct kinds of verbs.
- Related to these objections is the further difficulty that not all of the verbs listed within the classes really satisfy the definitions given, even if we take the definitions in the rather loose and suggestive manner that Austin clearly intends.

Therefore, Searle (1979) defined his own five categories of illocutionary act as follows.
- *Assertives*: The point or purpose of the members of the assertive class is to commit the speaker (in varying degrees) to something's being the case, to the truth of the expressed proposition.
- *Directives*: The illocutionary point of these consists in the fact that they are attempts (of varying degrees, and hence, more precisely, they are determinates of the determinable which includes attempting) by the speaker to get the hearer to do something.
- *Commissives*: Austin's definition of commissives seems to me unexceptionable, and I will simply appropriate it as it stands with the cavil that several of the verbs he lists as commissives verbs do not belong in this class at all, such as "shall", "intend", "favor", and others.
- *Expressives*: The illocutionary point of this class is to express the psychological state specified in the sincerity condition about a state of affairs specified in the propositional content.
- *Declarations*: It is the defining characteristic of this class that the successful performance of one of its members brings about the correspondence between the propositional content and reality, successful performance guarantees that the propositional content corresponds to the world.

In our research, we believe when a user writes an e-mail, then we can just regard the content of the e-mail as doing some speech act. That makes the Speech Act Theory can be employed in our work, and we will try to use this theory to humanize users to process and reply their e-mails more smoothly.

2.6   Using Ethics Concepts to Define Personal Relationships

"Ethics" refers to interpersonal relationships. However, without morality we cannot speak of ethics, leaving only ordinary interactions. The formation of ethics will not be complete without norms of morality. In traditional Chinese society, the Five Ethics of ancient Confucianism refer to the ethical relationships between sovereign and subject, father and son, husband and wife, elder and younger, and between friends. But in the cyberspace, such interpersonal relationship is no longer appropriate to cover all the aspects. Fortunately, the Buddhism master Sheng-Yen, the founder of Dharma Drum Mountain, has brought up the Six Ethics of Heart for our modern-day life. In this theory, everyone plays many roles in different situations, which inspire the Family Ethics, Living Ethics, School Ethics, Environmental Ethics, Workplace Ethics, and Ethics between Ethnic Groups. No matter what roles we are playing, we should try our best to play the roles well.

In our research, we try to use the Six Ethics of Heart, except for the Environmental Ethics, to classify the concept of e-mail processing. The basic idea is allowing users to make their own interpersonal relationship maps, and humanizing their e-mail processing more smoothly and ethically.

Furthermore, we also intend to introduce a functionality of generating a social network through the e-mail address book and/or the interpersonal relationship map for users to share their e-mails or files more quickly. Such functionality could be very promising for future knowledge sharing, as Goh *et al.* (2009) have discovered that people in Internet are willing to share their knowledge and information, based on their yielded seven major motivational factors such as creating and maintaining social

relationships, emotional influence, social influence, reminder of individual and collective experiences, self-presentation, task performance and self-expression.

3 RESEARCH MODEL

Our research employs the concepts of ontology and Web 2.0 to design an e-mail system model for the Internet. There are five basic modules in our research model as shown in Figure 5. We explain these modules in the following subsections.
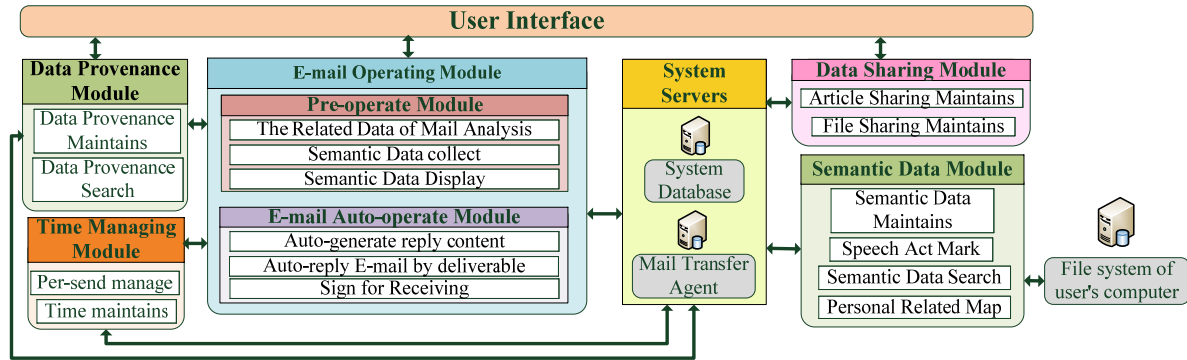

Figure 5. The diagram of our research model

3.1 E-mail Operating Module

3.1.1 Pre-operate Module

When a user opens his e-mail, the Pre-operate Module operates automatically. This module follows the processes shown in Figure 6. After finishing, the user can realize whether there are metadata on the user interface or not. If there are no metadata, the user can add his/her metadata into the e-mail system.

Figure 6. The processing diagram of Pre-operate Module

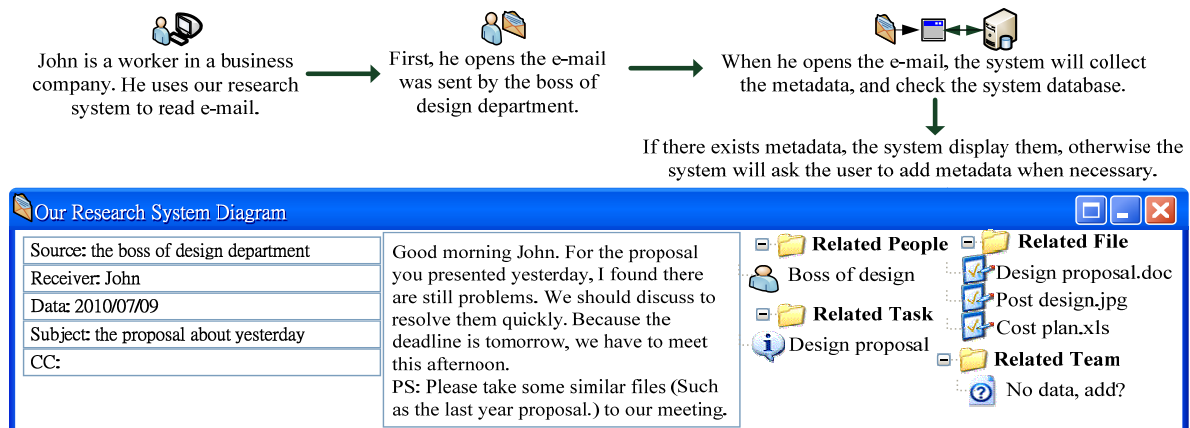Figure 7 depicts a diagram to show the scenario or our approach regarding Pre-operate Module.

Figure 7. The scenario of Pre-operate Module

3.1.2　E-mail Auto-operate Module

This module allows a user to set conditions to generate some draft e-mails or reply e-mails automatically. When receiving an e-mail, the system will check the conditions. If a matching has been confirmed, the system will do the actions set by the user before. Figure 8 presents the process diagram of E-mail Auto-operate Module.
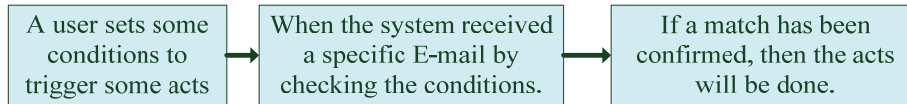
A user sets some conditions to trigger some acts	→	When the system received a specific E-mail by checking the conditions.	→	If a match has been confirmed, then the acts will be done.

Figure 8.　The processing diagram of E-mail Auto-operate Module

We use Figure 9 to show an illustrative scenario.

Recently, John wIll host a business conference. He has some documents to be sent to some specific partners, when receiving their confirmation e-mails. → John uses our research system to set the conditions. → When system receives a confirmation e-mail, the system will generate the pre-defined draft for editing, or just reply the e-mail automatically.
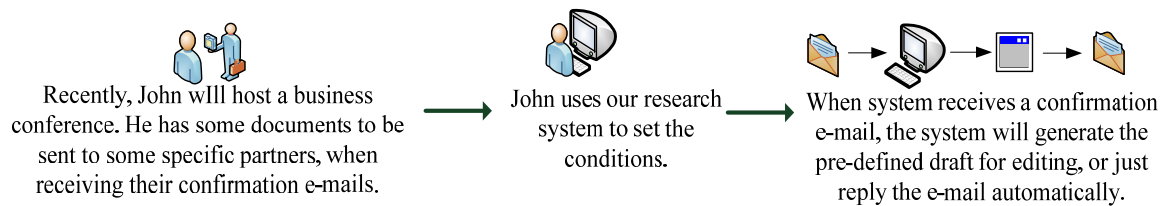
Figure 9.　The scenario of E-mail Auto-operate Module

3.2　Semantic Data Module

This module offers users to set the metadata for their data in our system as shown in Figure 10.
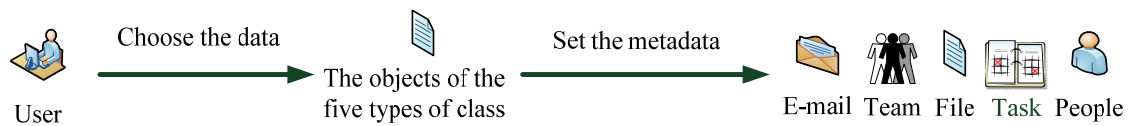
User — Choose the data → The objects of the five types of class — Set the metadata → E-mail　Team　File　Task　People

Figure 10.　The concept of semantic data maintenance

This module also supports semantic navigating and semantic search as Figure 11 illustrates.

Semantic Navigating ——→

Semantic Searching ——→ **Searching by system** ——→ E-mail　Team　File　Task　People
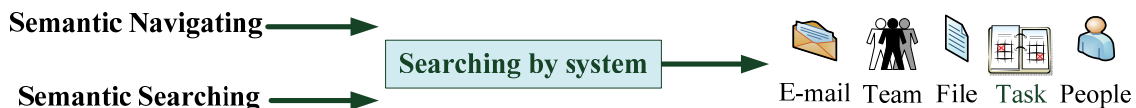
Figure 11.　The concept of semantic navigating and searching

When a user builds his/her metadata of his/her data, it can use this module to display the ontology, which we define as follows. A scenario for illustrating this function can be found in Figure 12.

- Definition 3.1 (*Ontology*): An *ontology* is a graph containing all related information, together with the corresponding status and link strength.

Someday John wants to see the ontology of a data. → John use the system to display the ontology.

Our Research System Diagram
The core of ontology map
design proposal [Browse]
☑ Metadata 1 [Display]
All Metadata
☑ Metadata 2
Choose data type
☑ Metadata 3
Choose data type

Ontology of design proposal
Strength: hard Status: belong

Before using this function, you should set the core data. Then choose the type of data you want to display. When you move the mouse to the links in the ontology, the strength and status between the items will be displayed.
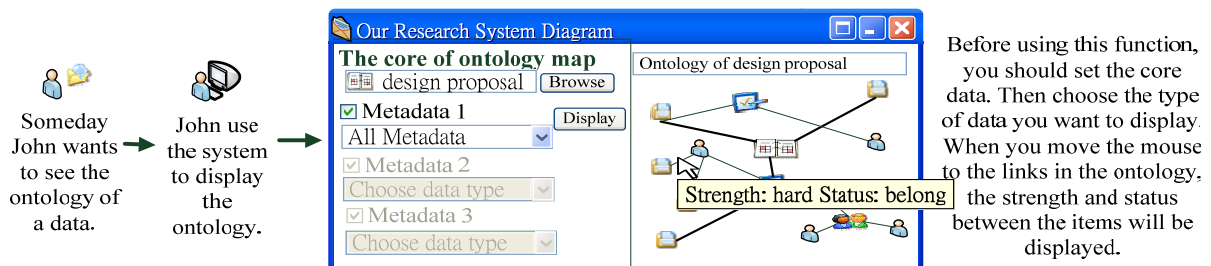
Figure 12.　A scenario for the ontological function

Based on the Speech Act theory, we propose a four-layer Relationship Speech Action Model as shown in Figure 13. We expect it can help people reply, manage, and handle the processing of e-mails more efficiently.

To discuss the model, we need some definitions to describe the elements in E-mail Relationship Speech Action Model.

Definition 3.2 (*Speech act actor*): A *speech act actor* is an actor classified from the speech act theory (Searle, 1979). It describes the meaning of speech act which is the writer wants to express.

In our model, we distinguish two types of speech act actor as follows.
- The first type is called *directive actor,* denoted 'S_d', which corresponds to the category *directives* introduced by Searle (1979). It plays the role of asking someone to do something imperatively.
- The other one is regarded as *expressive actor*, denoted 'S_e', which includes the remaining categories, namely *assertives*, c*ommissives*, e*xpressives*, *declarations*, which all used in expressing something.

Definition 3.3 (*Reaction*): A receiver response to a dedicated speech actor by choosing some kind of *reaction*.

In our model, both types of speech act actor have been assigned with some reaction alternatives:
- For the directive actor, we offer four reactions, namely accept, inquire, refuse and provenance recall.
- For the expressive actor, there are three reactions, namely inquire, receive and provenance recall.

When a receiver received an e-mail, he/she can choose the corresponding reaction for each speech act actor to process and reply the e-mail appropriately.

Definition 3.4 (*Relationship connector*): A *relationship connector* is a basic relationship of a people around daily life. In our model, there are five kinds of relationship connecter:
- Job: including the accounts of boss, colleague, subordinate and self-assignment. The last one represents those which can be customized by the user.
- Friend: consisting of the accounts of good friend, stranger and self-assignment.
- School: containing the accounts of teacher, senior, peer, junior and self-assignment.
- Family: comprising the accounts of elder generation, the same generation, junior generation and self-assignment.
- User-defined: this relationship connector is open for self-assignment.

Definition 3.5 (*Text template*): A *text template* is a predefined file containing e-mail template as a default of our system or prepared by a user. It can be used to help the user reply e-mails more efficiently and appropriately.

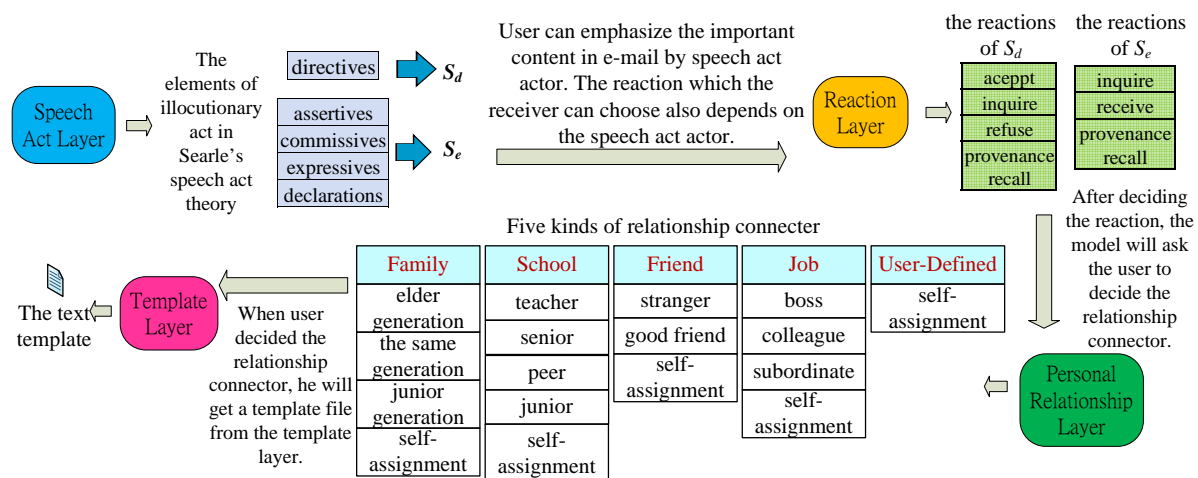Based on these elements, we present our four-layer model as follows.

Figure 13.   *The E-mail Relationship Speech Action Model*

1. The first layer is called 'Speech Act Layer,' which is composed of 'Speech Act Actor.' For a segment of an e-mail, the user can subjectively assign the suitable speech act actor (S_d or S_e) to mark the designated part to emphasize the importance.

2. The second layer is 'Reaction Layer', which is composed of two groups of reaction corresponding to S_d or S_e. After the reaction has been decided, our model will ask the user to choose the target (in the third layer) to reply.

3. The third layer is called 'Personal Relationship Layer', from which the receiver can choose the relationship connecter, which contains one or more accounts for people or teams.

4. The fourth layer is 'Template Layer', which is composed of a set of 'Text Template'. After the relationship connecter has been decided, the user will obtain some template to be extended or revised to reply e-mail quickly.

3.3 The Data Provenance Modules

In the data provenance module, we regard every e-mail activity as a process. Users can group the related e-mails together and build metadata for that group. From time to time, when there is a similar e-mail to be processed with similar content, the user could use this module to find the e-mails containing past experience. In the E-mail Relationship Speech Action Model, the reaction called "provenance recall" is regarded as a bridge connecting to the data provenance module, and tries to find some experience to help reply e-mail. In this module, we introduce a three-layer model called E-mail Provenance Model:

- The first layer is 'Provenance Element Layer' which is composed of 'Provenance Element.' We regard every e-mail in our system as a provenance element.
- The second layer is called 'Provenance Set Layer' which is composed of 'Provenance Set.' A provenance set is composed of some provenance elements put together by the user. Afterward, user can further group the provenance sets with the same characteristics into a 'Provenance Group.'
- Provenance groups generate the third layer which is called 'Provenance Group Layer'.

We define the definitions of the four elements in E-mail Provenance Model as follows.

Definition 3.6 (*Provenance Element*): A *provenance element* E_i is an object of the E-mail class.

Definition 3.7 (*Provenance Set*): A *provenance set* is a set of provenance elements, such that there exist some relationships (subjectively assigned by the user) among the elements. A provenance set can be regarded as a complete history of e-mail communnication between senders and receivers.

Definition 3.8 (*Provenance Group*): A *provenance group* is a set of provenance set, such that some relationships among the elements can be subjectively assigned by the user. A provenance group can be regarded as a set of similar history of e-mail communnication between senders and receivers.

Based on the data provenance lifecycle (Groth, *et al.*, 2006), which consists of four phases of creating, recording, querying and managing, users are supported with add, delete or search function to generate the e-mail provenance set or provenance group. Figure 14 shows the concept provided in the E-mail Provenance Model.
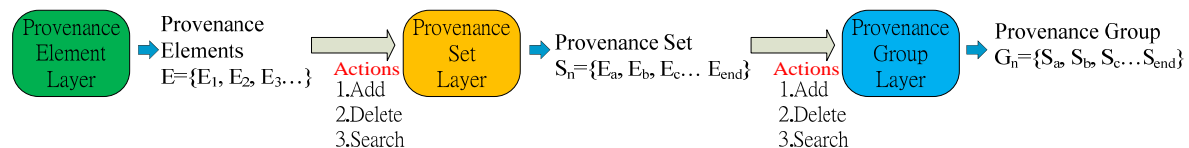

Figure 14.   The E-mail Provenance Model

3.4 Data Sharing Module and Time Managing Module

In Data Sharing Module, a user can choose the data or the content of an e-mail to be shared. Then by using our system to assign a space for the data or content, and setting the authority to decide who can read the data from the contact list, the user can share his/her favourites and improve his social network connectivity very conveniently.

In Time Managing Module, we design functionality for holidays, such that people can arrange the scheduled greeting card dispatching. With this module, users not only can arrange their tasks on the scheduled or pre-defined e-mails, but also can add pre-written e-mails for someone on some special days.

4   CONCLUSIONS

With the rapid improvement of information technologies, Internet and peoples' lives are combining closely. The number of e-mails increases day after day tremendously. How to handle e-mails with efficiency is becoming a problem for knowledge workers. Dabbish, *et al.* (2006) concluded that if knowledge workers can handle e-mails efficiently, the productivity will grow up quickly.

In our research, we use the concepts of semantic ontology and Web 2.0 to design an e-mail system for Internet. By combing some helpful theorise such as Speech Act Theory, data provenance and the six ethics of heart, we expect our system design can reduce the impact of the main problems－fragment and lack－inspired by the Personal Information Management (PIM) research.

In contemporary PIM research community, one of reasons of fragment is the data in the e-mail system are mutually independent. If a user forgot some important information, he may also miss the other related data. Hopefully, our research alleviates this situation and allows users to build a customized semantic web in his e-mail system. That reduces the time of searching on related data, and increases the efficiency of handling e-mails.

When the influence of fragment can be reduced, the ontological map built by users can be employed to provide the functions explained as follows.
- Using semantic data to provide auto or passive searching function.
- According to the rules set by the user, it can generate draft e-mail or reply e-mail automatically.
- With the concept of Speech Act Theory, users now can not only focus on some important parts when writing e-mails, but also can inspire receiver to reply more quickly.
- With the concept of data provenance, users can archive e-mails and reusing them more conveniently.
- With the idea of knowledge sharing, users now improve their own social network connectivity exponentially.

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