Finding Linking Opportunities through Relationship-based Analysis

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ABSTRACT

Many techniques exist for analyzing information domains in preparation for systems design. No systematic technique exists, however, for analyzing a system or domain in terms of its relationships. This is especially important for hypermedia and World Wide Web applications, which (should) provide a high degree of linking and navigational support. RNA (Relationship Navigation Analysis) provides a systematic way of identifying useful relationships in application domains. Developers can then implement each relationship as a link. Viewing an application domain from the relationship management point of view and modeling from a philosophy of maximum access provides a unique vantage point for application design. We present RNA and its generic relationship taxonomy, focusing upon their use for system analysis. We provide a long example in the domain of an on-line bookstore.

KEYWORDS: relationship analysis, hypermedia analysis, hypermedia design, relationship management, relationship attributes, World Wide Web applications, book store

MOTIVATION

Many techniques exist for analyzing information domains in preparation for systems design. How does a systems developer determine what to link? No systematic technique exists for analyzing a system or domain in terms of its relationships. This is especially important for hypermedia and World Wide Web applications. When reengineering a legacy system for the World Wide Web or developing a new Web application, A vital aspect of hypermedia system design is identifying relationships and implementing them as links [6]. Yet, many relationships in applications—including analytic applications—are poorly identified or ignored in current hypermedia design methodologies [10, 12, 14, 25]. Furthermore, many Web applications do not take advantage of the major hypermedia features of the Web—linking, structural and navigational features. Few designers explicitly think about their applications' interrelationships and whether users should access and navigate them directly.

RNA (Relationship Navigation Analysis) was developed to solve these problems. RNA provides systems analysts with a systematic technique for determining the relationship structure of an application, helping them to discover all potentially useful relationships in application domains. These later may be implemented as links. RNA also helps determine appropriate navigational structures on top of these links. RNA enhances system developers' understanding of application domains by broadening and deepening their conceptual model of the domain. Developers can then enhance their implementations by including additional links, metainformation and navigation.

In next section we introduce the philosophy of maximum access and the hypermedia philosophy of design. The following section gives an overview of RNA's steps. The rest of the paper focuses on the third step: relationship analysis. First, we introduce RNA's generic relationship taxonomy. Second, we describe a deeper layer of the taxonomy: the domain independent categories. Third, we present an example case study. Fourth, we present some future directions. Finally, we close with a review of the contributions of this research.

2. HYPERMEDIA AND DESIGN

Hypermedia can be thought of as the discipline of relationship management [10]. This view of relationship management follows two philosophies: the "philosophy of maximum access" and a hypermedia philosophy of design. The philosophy of maximum access grants users full freedom to access and explore at will, helping them better understand a domain as a whole and build confidence in application results. Under this philosophy, any element of interest to a user should be a candidate for linking. Under the hypermedia philosophy of design, hypermedia analysis should play a part in the design of every application with user interaction. Also, hypermedia access should supplement many application's feature sets [1].

RNA provides a systematic approach to realizing a philosophy of maximum access within computer applications, supporting a hypermedia philosophy of design. RNA has the potential to establish new standards for designers in the application development process and for users' interaction with applications. Designers should do a relationship analysis in order to understand the relationship structure of their applications. Users should be able to point to any object of interest and find out whatever they want about it [1].

RNA employs hypermedia as an information modeling tool not just a view of an underlying information model. This employment of hypermedia as an information modeling tool is " a hypermedia philosophy of design". RNA enables users to access any item of interest by providing linking opportunities for it through generic relationships. This capability to access any item of interest is the essence of "a philosophy of maximum access". This philosophy does not advocate the idea of as many links as possible in the applications, but it promotes the benefit of the potentially applicable, meaningful links based on generic relationships without omitting the important ones in the applications.

OVERVIEW OF RNA STEPS

A Relationship-Navigation Analysis can be conducted both for describing a system or domain (steps a - d) or for analyzing a system being designed (steps a - e). All steps can be performed in an incremental and iterative fashion. When tasks or system's responsibilities are considered in each step, the scope of analysis can be curtailed reducing the complexity of the analysis.

A Relationship-Navigation Analysis comprises the following steps:

a. Stakeholder Analysis
b. Element Analysis
c. Relationship Analysis
d. Navigation Analysis
e. Implementation Feasibility Analysis

Stakeholder Analysis

Stakeholders—anyone using some aspect of the application—are identified using an initial list of standard user types. An initial list could include software designers, systems analysts, technical authors, user representatives, training and user support staff, business/market analysts, and project managers [15]. Additional stakeholders are identified through the iterative process of goal, task, and domain analysis [23]. Also, stakeholders can be identified through the scenarios in the process of developing the requirements for the systems being developed.

Transition From Stakeholder Analysis to Element Analysis

Stakeholders have different needs according to their goals, tasks, and environments. Stakeholders' task needs reveal what kinds of elements they might be interested in. We can identify stakeholders' needs by performing task analyses. Also, stakeholders' characteristics show their potential elements of interest. One way of identifying stakeholders' characteristics is to focus on the differences that might appear to exist among different stakeholders.

Element Analysis

This step identifies what each stakeholder might want to find out more about. There would be different elements of interest for each class of stakeholders. The stakeholders themselves identified in the previous step can be elements, too. For new systems, stakeholders' interests could be identified using mechanisms such as scenarios [9]. For existing systems, stakeholders' interests could be identified from the system's display screens. Potential elements include:

- domain objects for which a definition, attribute value or other metainformation could be available, including events, products, executable programs, agents, commands, and parameters [11];
- components (model, data, comments, and descriptions);
- aggregates of individual components (short unstructured lists, linear structures, array or tables, hierarchies, trees, paths, tours, webs, networks, and navigational aids (indexes, maps, table of contents, fisheye views)); [8, 22]
- properties of entities such as attributes, component formats and structures, and network topology;
- spatial arrangements of icons in spatial hypermedia model (indicating an implicit relationship among them); [20]
- rhetorical composites (specific constellations of nodes and links that form logical units for manipulation and navigation); [21]
- results of any operation (an explanation, calculation, and error messages).

Transition from Element Analysis to Relationship Analysis

Elements identified in the Element Analysis step do not exist in isolation. They are related with each other in some fashion. We perform relationship analysis by considering each element as a source element and applying relationships to this source element. This leads to identifying destination elements. One element can have multiple relationships with multiple destination elements. In some cases, one element can have multiple relationships with a single destination element.

Relationship Analysis

This step identifies relationships for each element of interest. In this step, each generic relationship prompts a series of questions which designers can ask themselves about each element of interest for each class of stakeholders. Table 1 in the Generic Relationships section shows RNA's generic relationships. Table 2 in the Conducting a Relationship Analysis section lists sample questions for each generic relationship.

Relationship analysis can be done at the three levels of detail. At the topmost general level, analysts use the broad generic relationship categories to examine each item of interest. Generic relationships are described using theoretical labels that capture the breadth of each generic category. The generic taxonomy includes several sub-levels, as shown in Table 1. While analysts can work at any of these generic sub-levels, we believe the bottom leaves will prove the most useful.

When analysts want to examine part of their domain more deeply for a particular generic relationship type, they can then use a more detailed set of categories at the domain-independent level. Domain-independent categories use more concrete, specific terms. The Domain Independent Categories section gives an example.

When analysts apply a domain-specific set of terms that maps to one of the domain-independent categories, they then are operating at the third level of relationship analysis. Due to space limitations, we do not discuss domain-dependent categories further.

Navigation Analysis

This step identifies possible navigational structures for each stakeholder. In this step analysts think of each element of interest in terms of how the stakeholder might usefully access it.

RNA's generic relationships provide a guide for deciding what else would be on a specific navigational structure if this element were in that structure, i.e., they provide a source of navigation in each navigational context, no matter what navigational structures would be used. For example, in a guided tour or an index, membership and ordering relationships can identify elements that would be on that navigational structure. Similar relationship is useful for query navigation while ordering relationship is useful for history navigation no matter what navigational structure would be used to implement that navigation.

Implementation Feasibility Analysis

In this step, analysts and designers do an informal cost/benefit analysis to decide which relationships would be useful and feasible enough to include in the application. Analysts should feel cognitively unbounded during the first four stages of the analysis, putting off practical constraints to this last stage.

Task considerations can always limit the scope of the first four steps of the analysis. For example, designers could decide to implement only those relationships which serve a recognized stakeholder or task (if deemed cost effective).

For the remainder of this paper, we concentrate on step (c), the relationship analysis.

GENERIC RELATIONSHIPS

Table 1 presents our generic relationship taxonomy.

Relationships can be categorized broadly as hierarchical vs. non-hierarchical [19]. We consider hierarchical as internal and non-hierarchical as external. Internal relationships focus upon an object itself and its characteristics or descriptions, and among different views, occurrences or transformations of one object.

<table>
<tr><td rowspan="7">Generic Relation-ship</td><td rowspan="4">Internal</td><td colspan="2">Generalization/Specialization</td></tr>
<tr><td>Self</td><td>Characteristic
Descriptive
Occurrence</td></tr>
<tr><td>Whole-part /Composition</td><td>Configuration /Aggregation
Membership /Grouping</td></tr>
<tr><td colspan="2">Classification/Instantiation</td></tr>
<tr><td rowspan="2">External</td><td>Comparison</td><td>Equivalence
Similar /Dissimilar</td></tr>
<tr><td>Association /Dependency</td><td>Ordering
Activity
Influence
Intentional
Socio-organizational
Temporal
Spatial</td></tr>
</table>

Table 1. RNA's Generic relationships

Internal relationships can be broken down into self, generalization/specialization, whole-part/composition, and classification/instantiation relationships. This generalization/specialization, whole-part, classification/ instantiation and association relationship classification agrees with the relationship classification in object-oriented analysis [16]. External relationships can be broken down into association/dependency and comparison relationships.

RNA's generic relationship taxonomy contains the following relationships:

Generalization relationship – connects an item of interest to the items whose concepts include its concept in a taxonomy.

Characteristic relationship – connects an item of interest to its attributes, parameters, metadata and other background information.

Descriptive relationship – connects an item of interest to definitions, illustrations, explanations, and other descriptive information.

Occurrence relationship – connects multiple instances/views/uses/transformations of the same object in different parts of a system.

Configuration/Aggregation relationship – connects a part to other parts or a whole functionally or structurally.

Membership/Grouping relationship – connects a member of a collection to other members or a whole collection.

Classification relationship – connects an item of interest to its instance or class.

Equivalence relationship – connects instances of the exact same object to a given item (i.e., same copies of a book or exact match in information retrieval).

Similar/Dissimilar relationship – connects all items that share some positive or negative degree of similarity.

Ordering relationship – puts items in some kind of sequence.

Activity relationship – deals with relationships that exist among elements that are involved in some kind of activity (e.g., among an input, tools, and an output).

Influence relationship – connects an item of interest to the item over which it has some kind of influence (i.e., causal or control relationship)

Intentional relationship – connects an item of interest to the goals, arguments, issues, decisions, opinions, and comments associated with the item.

Socio-organizational relationship – connects an item of interest to the position, authority, alliance, role, and communication associated with the item in a social setting or organizational structure.

Temporal relationship – connects an item of interest to temporally related items.

Spatial relationship – connects an item of interest to related items in spatial dimensions.

CONDUCTING A RELATIONSHIP ANALYSIS

For each item of interest identified in the element analysis stage of RNA steps, an analyst employs relationship analysis as a knowledge elicitation or brainstorming tool, using it as a framework or set of categories with which to examine the application and its information environment.

Table 2 gives a series of possible questions which an analyst could ask himself or herself about each element of interest. We derived each set of questions from the domain independent categories described in Domain Independent Categories section.

Generalization/ Specialization	Is there a broader term for this item of interest? Is there a narrower term for this item of interest?
Characteristic	What attributes and parameters does this item of interest have?
Descriptive	Does an item of interest have a description, definition, explanation, or a set of instructions or illustrations available within or external to the system?
Occurrence	Where else does this item of interest appear in the application domain? What are all uses of this item of interest?
Configuration/ Aggregation	Which components consist of this item? What materials are used to make this item? What is it a part of? What phases are in this whole activity?
Membership/ Grouping	Is this item a segment of the whole item? Is this item a member of a collection? Are these items dependent on each other in a group?
Classification/ Instantiation	Is this item of interest an example of a certain class? If a class, which instances exist for this element's class?
Equivalence	What is this item of interest equal or equivalent to in this domain?
Similar/ Dissimilar	Which other items are similar to this item of interest? Which others are opposite to it? What serves the same purposes as this item of interest?
Ordering	What prerequisites or preconditions exist for this item? What logically follows this item for a given user's purpose?
Activity	What are this item's inputs and outputs? What resources and mechanisms are required to execute this item?
Influence	What items (e.g., people) cause this item to be created, changed, or deleted? What items have control over this item?
Intentional	Which goals, issues, arguments involve this item of interest? What are the positions and statements on it? What are the comments and opinions on this item? What is the rationale for this decision?
Socio-organizational	What kinds of alliances are formed associated with this item of interest? Who is committed to it in the organizational structure? Who communicates with it or about it, under what authority and in which role?
Temporal	Does this item of interest occur before other items? Does this item occur while other items occur?
Spatial	Which items is this item of interest close to? Is this item of interest nearer to destination than other items? Does this item overlap with other items?

Table 2. Sample questions for systems analysis for RNA's generic relationships

Guidelines for conducting a Relationship Analysis

When conducting a systematic, detailed relationship analysis, it is desirable to use the above sample questions according to the following order. These guidelines are based on the relationships among RNA's generic relationships.

1. Start with characteristic relationships.
2. Use these characteristics identified in step 1 as the criteria for partitioning a super type into subtypes for generating generalization/specialization relationships between a super type and subtypes.
3. Identify classification/instantiation relationships by creating instances of types in the generalization/ specialization relationship hierarchy.
4. Identify configuration/aggregation relationships.
5. Identify membership/grouping relationships.
6. Identify similar/dissimilar relationships.
7. Identify equivalence relationships
8. Identify temporal relationships.

9. Identify spatial relationships. Temporal relationship and spatial relationship share topological dimensions.
10. Identify descriptive relationships.
11. Identify intentional relationships. Descriptive relationships that involve intents of agents can become intentional relationships.
12. Identify activity relationships. Parameters identified in step 1 can be inputs to activity relationships.
13. Identify influence relationships. Control mechanisms identified in the previous step can connect activity relationships to influence relationships.
14. Identify socio-organizational relationships. Actors identified in step 12 can connect activity relationships to socio-organizational relationships. Agents identified in step 11 can have socio-organizational relationships, too.
15. Identify occurrence relationships. Roles identified in the previous step can connect socio-organizational relationships to occurrence relationships.
16. Identify ordering relationships.
17. Finally, multiple instances of each relationship can be always a membership/grouping relationship.

As shown above, it is desirable to start with characteristic relationships because they provide clues for other relationships. Also, we recommend identifying ordering relationships after having identified the other relationships, because most of the other relationships have ordering aspects as a part of their characteristics. Once the other relationships are identified, it is relatively easy to identify ordering relationships.

Clustering Relationship Analysis Results

Relationship analysis results can be grouped into clusters according to various criteria. These clusters represent a more abstract view of relationship analysis results by grouping the results into manageable clusters. Clustering reduces the complexities of the relationship analysis results. Clustering may prove a major approach for scaling an RNA—one of our future research objectives.

1. Stakeholders – Relationship analysis results that belong to the same stakeholder can be grouped as a single cluster making stakeholders the topmost element in a whole clustering hierarchy. This is useful when stakeholders are the most salient and important criteria for access mechanisms or entry points to the systems.

2. Important elements – Any important element can become the topmost element in a cluster hierarchy if that element is essential for the problem domain understanding and is within the responsibility of the system being designed.

3. Whole-part relationship – We can use the topmost element of each whole-part hierarchy in the relationship analysis results as the root for a cluster that covers each whole-part hierarchy. This whole-part relationship is very helpful for a project that requires the modeling of few but very complex concepts. Some form of stepwise decomposition is appropriate for this situation.

4. Generalization/specialization relationships – The topmost element of each generalization/specialization hierarchy in the relationship analysis results can become the root for a cluster that covers each generalization/specialization hierarchy. This generalization/specialization is useful for a task that involves many simple but similar concepts.

5. Other generic relationships – Generic relationships can become the criteria for clustering the relationship analysis results. For example, we can use occurrence relationships as the criteria for partitioning the relationship analysis results by clustering the results according to specific instances of the same element. This occurrence relationship is useful for a project that involves heavy use of multiple descriptions of the same element, such as multiple versions of the same design or multiple perspectives of the same situation.

The above criteria can be combined to have appropriate partitions of the relationship analysis results. But, tasks to be performed should be overriding criteria for choosing clustering (and scaling) methods.

Use of Relationship Analysis for Dynamic and Functional Modeling

States of an element can be considered as elements. When occurrence or influence relationships are applied to the states of the element, state transition of the element can be figured out. This result can form the basis for the element's state transition diagram for dynamic modeling.

Activities associated with an element can be identified with the activity relationship. Data flow can be figured out with inputs, outputs, source, destination, control, mechanism, resources and instruments that are identified in this relationship. This result can form the basis for the data flow diagram associated with the activities involving the element for functional modeling.

Relationship Attributes

Relationship attributes indicate the common properties that could be applied to all generic relationships. We have found the following relationship attributes useful:

Structural relationship – any relationship that connects related objects based on the application's internal structure.

Implemented/Operation relationship – any relationship representing menu options, command line operations, and other executable commands.

Schema relationship – any relationship that explicitly exists in a system's design documents.

Statistical relationship – any relationship giving access to any item occurring under similar conditions or otherwise statistically related to an item of interest.

Process relationship – any relationship representing processes and tasks, next step in a work flow, and subtasks in a project management system.

Coordinated relationship – any relationship in which one element occurs automatically when other elements occur. [5]

Coupling relationship **–** joins two items if a modification to one of these items could require that the other item should be checked for correctness to preserve the consistency of the conceptual model. [4]

Just as analysts and facilitators can use the questions prompted by the generic relationships in Table 2, they also can use questions based on relationship attributes as a brainstorming tool to solicit additional relationships among domain elements. Sample questions for each can be found in [26].

Other relationship taxonomies

In developing our generic relationship taxonomy, we examined as many other taxonomies as we could. Each of their relationships fits somewhere in our generic taxonomy. Because many of the other taxonomies are domain-specific and quite detailed, by necessity the corresponding relationships in our generic taxonomy often are much broader categories.

The comprehensiveness and usefulness of RNA's generic relationships

RNA's generic relationship taxonomy is comprehensive enough to cover all the aspects of system development. It covers static, dynamic, intentional and social ontology for system development. Also, it covers static, dynamic, and functional modeling aspects. In addition, it includes goal-oriented analysis as well as object oriented analysis. Abstraction mechanisms are all incorporated, too.

All generic relationships of RNA are widely used in many application domains. They are all equally generic enough to be applied across many application domains and system development stages. There are no more generic or specific relationships among RNA's generic relationships.

DOMAIN INDEPENDENT CATEGORIES

Another goal of RNA is to provide a meaningful set of domain independent categories to further specify the nature of each generic relationship. Domain independent categories are developed using examples and dimension analyses of generic relationships.

The domain independent categories are most useful when conducting a very deep analysis, or for providing useful questions at the generic relationship analysis level (as with the questions in Table 2).

In this section we show one of our domain independent categories. Other examples of domain independent categories can be found in [26]. Note that whereas the generic relationship taxonomy is meant to be complete, by design the domain independent categories can never be complete.

Domain independent categories in the Descriptive relationship

Descriptive	Explanation Illustration Definition Clarification Elaboration Evaluation Review Detail Summary Demonstration Instruction

The domain independent category for the descriptive relationship includes examples from description or explanation related activities associated with an item of interest.

AN EXAMPLE CASE STUDY

We recently applied RNA to the domain of on-line bookstores. We illustrate here with some of the relationships RNA helped us find for the element "book." Some of the relationships we found are already implemented in bookstore Web sites, but many do not appear there. An RNA implementation feasibility analysis (step e of RNA steps) would show that many either are not cost effective to provide and others might give users access to competitors, which an e-commerce Web site often will avoid. Yet, some are useful. And several of the others that the RNA implementation feasibility analysis by a bookstore would reject, provide opportunities for third parties to sell or governmental services to provide to benefit the common good. In any event, we were amazed at the scope of relationships we found that do not appear on the Web, yet seem so obvious once we performed the RNA analysis.

Generalization/Specialization

Using the <u>specialization</u> relationship, we determined that a book is an abstraction of the objects novel and short story. Often customers have a preference for collections of short stories or for full novels.

Using the <u>generalization</u> relationship, we realized that books could serve several different roles. For example, books could be generalized into "reading materials," and that many other kinds of reading materials exist besides books that an on-line bookstore could provide. Books also are a kind of product, and that an on-line bookstore could consider other kinds of products such as videos. These roles vary based on the customer's intent (looking for something quick to read, looking for something for a long trip, looking for a gift, looking for something to amuse me this evening), and an on-line bookstore could expand to serve several of these intents.

Characteristic

Using the generic <u>characteristic</u> relationship led us to the following characteristics of books, in which different customers might be interested:

- condition (new/used/damaged)
- relevance (How long will this book be relevant? For example, a road map or set of statistics might be valid for a month, a year or a decade.)
- date published, edition, whether this a reprint of a recent or an old work
- date written (Did it take long to publish? Is this a reprinting of a lost or classic work?)
- owner (Who owns the copyright on this work?)
- contributors (authors, illustrators, editors, people interviewed during its authoring)
- level of reading skills required
- intent (reference, history, how to, self help, tutorial, etc.)
- typeface (fonts used)
- type of print (large print, Braille, audio)
- awards received
- ratings (from different consumer groups)
- dimensions, weight (dictating the cost of shipping)
- price (wholesale, retail, discount, bulk, educational discount)

Occurrence

Both customers and systems analysts will be interested in various occurrence relationships for books:

- Where is this book listed? (best seller lists)
- Where has this book been reviewed or discussed?
- Are there translations available?
- Are there newer/older/early/draft versions available, perhaps under a different name?
- Does this book have prequels or sequels?
- Who (else) sells this book?

The occurrence relationship also leads to warnings an on-line bookstore could provide:

- "You already have a copy of this book in your shopping basket. Are you sure you want another?"
- "You purchased this book last week, but it has not been delivered yet."
- "You purchased this book last December."

Configuration/Aggregation

Using the domain independent categories for the generic configuration/aggregation relationship, we determined that a book is related to the following objects that it contains:

- its chapters (Is the table of contents available? Can the customer read the first chapter?)
- its index (giving an indication of the book's level of detail and expertise)
- its forward (which might entice a customer)
- its introduction (giving an indication of the book's level of detail and expertise)
- its illustrations (customers may be enticed by the illustrations in a children's book or figures in a technical book, for example)

Using the configuration/aggregation relationship, we determined that a book may also be a part of a series. The customer may wish to see other books in the series.

Process

The global process relationship attribute led us to ask how the following processes work. Using good interface design, an educational description of each could be accessible from any book object:

- how a book is written
- how a book is published
- how a book is manufactured

Activity

The generic activity relationship leads us to ask who and what uses books, and how:

- which kinds of people read a certain book (Which types of customers might want to buy this book?)
- people give books as gifts (Is the bookstore's Web site set up to facilitate people looking for gifts?)
- book groups (Is the bookstore doing anything to support book groups?)

Using the generic activity relationship we also determined which objects are inputs to a book:

- paper (Is the paper good quality? Is it printed on recycled paper?)
- binding (Was the book manufactured to last?)
- cover (Is it hardcover or softcover?)

The generic activity relationship also prompts us to ask which activities a book results from:

- result of research
- result of a journey
- result of a crisis in the author's life

Influence

The generic influence relationship leads us to ask which people, events, philosophies, and other books might have influenced the author or the subject matter of a book. Customers fascinated by a book (or author) might want to learn more about these influences.

Ordering

Books can be related through ordering relationships according to the following criteria.

- reader level or difficulty of content (introductory, intermediate, advanced)
- age level preschool, teenager, senior)

-ranks on a bestseller list
-ranks on purchase circles (highly specialized bestseller lists)
-ranks on average customer review
-sales rank
-ranks on any top 10 list.
-book size (3x2", 12x7", 18x12")
-condition of out of print books (as new, fine, very good, good, fair, and poor)
-price range for out of print books or bargain books
-discount rate
-identification number (ISBN)
-collections
next volume of a collection
-continuation
serials, series, and sequel
books that continue or precede one another, as between successive titles of a serial
-successive derivations
editions – first edition, second edition, etc.

Classification/Instantiation

Whenever a specific category of books is related to instances of that category, we can find classification/instantiation relationships.

Which category does this title of the book belong to?
"Gone with the Wind" is an intantiation of novel category.

Temporal

Books are temporally related to other books in many ways. Examples are as follows.

-books taking place in a certain time period
-publication date
Which book is published earliest among these books on this subject?
Were these books published in two editions simultaneously?
-new releases
-future releases
-back issues
-past book club selections
-past reviews
-order history
the books I ordered
-editor's picks for past week

Descriptive

Books are described using description or explanation related activities as follows.

-description
publisher information
description of the condition of a book
-synopsis
short description of a book
-essays by authors on titles of their writing
-criticism
-evaluation
-review
staff review, reviewers' review, customer review
-instruction
book search tips and examples
-guidelines
guide for collecting books

Membership/Grouping

Whenever books are grouped according to some criteria, we can find membership/grouping relationships. Examples are as follows.

-the books that have a common author, title, or subject.
Which books are written by this author?
-the books that form a collection
Which books belong to this collection?
-nominees for a award
-new releases
-future releases
-recommendation list
-previews (fall previews) or forthcoming books
-awards listing
Which awards are available for the category to which this book belongs?
-comments list
-books on special sale

Equivalence

Books can be considered to be equal in terms of content as follows.

-exact copies of the same book
-reproductions from an original book
Is this book the reproduction of the book published earlier?

Similar/Dissimilar

Books can be related in terms of similarity as follows.

Similar relationship
-similar books by subject
-similar styles
-similar authors
-Which other books are written by author of this book?
Dissimilar relationship
-Which book's point of view is opposite to the point of view of this book?

Intentional

Books can be considered to be associated with intention-related activities as follows.

-customer comments on a book
-shipping policy
-returns policy

-recommendations based on readers' profile or past purchasing behaviors.

Socio-organizational

Social or organizational settings surrounding books can be considered as socio-organizational relationships. Examples are as follows.

- -Awards
- -Purchase Circles (highly specialized bestseller lists)
- -Book Club
- -agreements
  - agreements on rules of online transactions among participants in the transactions
- -strategic alliances
  - associates or affiliates
  - partners
  - online sellers
  - web site owners
- -commitment
  - safety and security guarantee
  - money-back guarantee
- -organizational structures
  - book store information
  - global organization of book stores

Spatial

When purchase circles to which a book belongs are categorized according to geography, those purchase circles have spatial relationships.

- Books with a particular shape or dinstinctive features (pop-ups, unusual layouts, cover has a "peek through" hole)
- -Purchase Circles categorized by geography (Regional bestsellers)

Statistical

Books can be related according to the probability of one belonging to some groups to which others belong. Examples are as follows.

- -What other books did customers who bought this book tend to buy?
- -Which authors' titles did customers who bought titles by this author also buy?

FUTURE RESEARCH

Future research on RNA ranges from improving the analysis to extending the approach.

Scaling RNA

Not all relationship types will apply to every application, and developers might not have time for a full RNA analysis. Thus we plan to scale RNA to serve different purposes.

As part of scaling, we need to determine which relationship types are most likely to be useful on which general kinds of elements of interest, for which general kinds of domains, and for which general kinds of stakeholders.

Integrating RNA with existing tools

RNA could be a part of any requirements analysis in system development methodologies. We shall investigate seamlessly integrating RNA into established system design methodologies [13], including hypermedia design methodologies [2].

Design patterns

Each generic relationship in RNA could be represented as specific design or analysis patterns [7, 3, 18, 24]. This would provide us a clear and well-defined technique for expressing the relationships.

Discussion & Contributions

RNA's generic relationship taxonomy is theoretically robust. It is based on existing theories, ontologies, information modeling methodologies and incorporates established taxonomies logically. It covers the various aspects of information modeling including subject world, system world, usage world, and development world [17].

RNA's generic relationship taxonomy provides a kind of relationship checklist for any application domain. RNA could be combined with conceptual modeling tools to provide a rich conceptual modeling environment.

RNA can be used as part of a systems analysis, either to thoroughly describe an existing system (or information domain) in terms of its relationships, or to understand a system being designed.

RNA contributes to hypermedia design methodologies by providing a systematic way to find a comprehensive set of linking and navigational opportunities. In addition, RNA contributes to metadata research by identifying useful generic relationships that could be considered a rich form of metadata.

Yet, in the end we hope that our most enduring contribution is successfully convincing developers of Web applications (both new and transported from other computer environments) to take full advantage of linking in their applications.

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance of Fernando Lyardet and Gus Rossi (co-developer of OOHDM) of the University of La Plata, Argentina, in performing the RNA analysis of the bookstore domain. We also appreciate funding support for this research by the NASA JOVE faculty fellowship program, by the New Jersey Center for Multimedia Research, by the National Center for Transportation and Industrial Productivity at the New Jersey Institute of Technology (NJIT), by the New Jersey Department of Transportation, and by the New Jersey Commission of Science and Technology, and by Rutgers University.

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