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(54) Title: AUTOMATED ADAPTIVE CLASSIFICATION SYSTEM FOR BAYESIAN KNOWLEDGE NETWORKS

(57) Abstract: A method and apparatus for use in an information retrieval system which derives related informational items that have a usage based relationship strength and results in a more dynamic relationship association between informational items. The system comprises the steps and means for detecting a selection of at least a first and second informational items in an information retrieval session. A relationship type and strength are assigned based on the characteristic similarities and the frequency of selection of the first and second informational items. Also in accordance with the principles of the present invention, the extraction of textual database fields; the application of multiple text classification algorithms; the merging of the algorithm results; the encoding of the merged results as a Bayesian-type link; the use of feedback methods to weight, prune and age the relationship link serves to automate and enhance the process of classification in the system.

AUTOMATED ADAPTIVE CLASSIFICATION SYSTEM FOR BAYESIAN KNOWLEDGE NETWORKS

TECHNICAL FIELD

The present invention generally relates to information search and retrieval systems. More particularly, the present invention relates to automation of classifying related informational items during an information retrieval session to enhance the performance and efficiency of an information retrieval system.

BACKGROUND ART

A database is useful only if a desired item can be efficiently found and retrieved therefrom. To locate and retrieve a desired information item in an information database, a search of the database, e.g., based on a keyword or a text string, may be required. The search typically involves finding entries matching the keyword (or string) in an index created from parsing the information items into searchable words and the location in which the word appears in the database. For example, the Internet, or the world wide web (WWW), may be considered as a very large database of information items, in the form of web pages, distributed over a very wide network. Currently available search engines, e.g., the YAHOO™, EXCITE®, and the like, maintain an index of a large fraction of the content of the WWW parsed into searchable words and corresponding locations, e.g., the Uniform Resource Locators (URL).

However, as the size of a database becomes very large e.g., the number of web pages in the WWW is currently in the hundreds of millions, and growing fast, a user may have to navigate through, select and review a significant number of informational items before arriving at the one desired informational item. The navigation through the ever-increasing number of informational items is often proved difficult, and requires a considerable investment of time, effort, and sometimes even good fortune, on the part of the user.

Unfortunately, in a conventional information retrieval system, even after finding the sought after information once, to find the same information again, unless the user remembers the location of the information, the user may have to follow the same navigational trail, again spending the required considerable investment of time and effort. Moreover, a subsequent user looking for the same information would have to duplicate the time and effort, i.e., must

re-invent the wheel, in order to find the information. The subsequent user often ends an information retrieval session in frustration without finding the desired information. This duplicated effort is wasteful and inconvenient, and thus diminishes the usefulness of the database.

Moreover, in a conventional help information retrieval system, the help information items are fixedly mapped, requiring a user to always follow the same help menu path to arrive at a particular help item of interest. Even if the path is ultimately proven to be inefficient, the inefficient path, nevertheless, must always be followed in order to retrieve that particular item. The efficiency of a particular path to be taken may depend on the context in which the help item is sought. Because the fixed mapping cannot account for the various contexts, it is inefficient, and thus diminishes the usefulness of the help information retrieval system.

Thus, what is needed is an efficient system and method for the convenient and economical retrieval of a desired informational item in an informational retrieval system that allows leveraging of the time and effort invested during prior information retrieval sessions.

What is also needed is an automated classification system for textual databases where an innovative method is employed to enhance the accuracy and efficiency of the system.

SUMMARY OF INVENTION

Generally, a system of the present invention utilizes a method and apparatus for use in an information retrieval system that provides related informational items that have a usage based relationship strength, and which results in an efficient and more accurate dynamic relationship association between informational items. This system comprises the steps and means for, respectively, detecting a selection of at least a first informational item and a second informational item in an information retrieval session. A relationship type is assigned based on characteristic similarities between the first informational item and the second informational item. Additionally, a relationship strength is assigned based on historical frequency of the consecutive selection of the first and second informational items and providing an access to

the second informational item upon detection of the first being accessed by a user of the information retrieval system.

In addition, in accordance with the principles of the present invention, an information retrieval system comprises a plurality of informational items and a database having a relational association among at least two informational items of the plurality of informational items. The relational association includes respective relationship types and the relationship strengths. The relationship strength is based on historical frequency of at least two informational items being selected together in one information retrieval session.

Also, in accordance with the principles of the present invention, the extraction of textual database fields; the application of multiple text classification algorithms; the merging of the algorithm results; the encoding of the merged results as a Bayesian-type link; the use of feedback methods to weight, prune and age the relationship link serves to automate and enhance the process of classification in an information retrieval system.

It is also an object of this invention to provide a computer readable storage medium having stored thereon a computer program for implementing a method of providing related informational items that have a usage based relationship strength in an information retrieval system, the computer program comprising a set of instructions for detecting a selection of at least a first informational item and a second informational item in an information retrieval session, followed by an assignment of a relationship type based on characteristic similarities between the first informational item and the second informational item. The program also assigns a relationship strength based on historical frequency of the first informational item and the second informational item being selected together during a single information retrieval session. Additionally, the program provides access to the second informational item upon detection that the first informational item has been accessed by a user of the information retrieval system.

DESCRIPTION OF DRAWINGS

Features and advantages of the present invention will become apparent to those skilled in the art from the following description with reference to the drawings, in which:

FIG. 1 is an exemplary block diagram of the information retrieval system in accordance with the principals of the present invention;

FIG. 2 is an exemplary table showing the relevant portions of the relationship database shown in Fig. 1;

FIG. 2A is an exemplary table showing one possible example of the contents of the table shown in Fig. 2;

FIG. 2B is an exemplary table showing a change in the contents of the table shown in Fig. 2A as a result of a user action;

FIG. 3 is an exemplary block diagram of the present invention and its components.

FIG. 4A is a flow diagram showing an exemplary embodiment of the related clustering merge and output to a Bayesian-type Network method in accordance with the principles of the present invention;

FIG. 4B is a flow diagram showing an exemplary embodiment of the related data aging and pruning method in accordance with the principles of the present invention;

FIG. 5 is an exemplary table showing the relevant portions of the relationship database shown in Fig. 1, as modified to include the help relationship type for the help information retrieval system in accordance with the principles of the present invention;

FIG. 6 is a flow diagram showing an exemplary embodiment of the related help information database update method in accordance with the principles of the present invention; and

FIG. 7 is a flow diagram showing an exemplary embodiment of the related help information provision method in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

For simplicity and illustrative purposes, the principles of the present invention are described by referring mainly to an exemplary embodiment, particularly, with references to the Internet and the WWW as the exemplary databases of informational items. However, one of ordinary skill in the art would readily recognize that the same principles are equally applicable to, and can be

implemented in, other informational databases, and that any such variation would not depart from the true spirit and scope of the present invention.

An information retrieval system in accordance with the principles of the present invention allows a user to navigate through a plurality of informational items for a desired informational item, and upon selection of an information item, presents other informational items related to the selected informational item. The information retrieval system in accordance with the principles of the present invention maintains a database that defines a relational association between a plurality of informational items in the system.

The relational association is based on historical navigational behavior of users of the information retrieval system and includes a relationship type, which is based on the characteristic similarities between the informational items and relationship strength. These similarities are based on the historical frequency of any related informational items being selected by a user within the same information retrieval session.

When a navigation from one informational item to another item is detected, the relationship type and the relationship strength of the two informational items are determined and stored in a database. During a subsequent selection of an informational item, any informational items related to the selected informational item may be presented to the user, sorted based on the respective relationship types and relationship strengths, and may be provided in a sorted list from which the user can select.

In an aspect of the present invention, the informational retrieval system is utilized in a help information retrieval system to provide a dynamic context sensitive mapping of help informational items.

In particular, Fig. 1 shows an illustrative embodiment of the information retrieval system **100** in accordance with the principles of the present invention, which may comprise, in relevant part, *inter alia*, an information requester **101**, a navigation interface/server **106**, a search engine **102** and an information server **104**. The information retrieval system **100** may be any system in which a plurality of informational items are available to be searched and retrieved. For example, the entire information retrieval system **100** may be housed within a single computer system, wherein the information server **104** may

comprise a database containing a plurality of informational items stored in a mass storage device, e.g., a hard disk, and where the information requester **101** may be a user interface through which a user may initiate a search and retrieval session with the search engine **102**. This in turn may be an application program running on the computer. In this example, the communication interfaces **105** and **108** may be the busses within the computer system.

Alternately, the information retrieval system **100** may even comprise a single computer program. In this case, each of the information server **104**, information requestor **101** and the search engine **102** may comprise a sub-component of the single computer program and wherein, the communications interfaces **105** and **108** may themselves be computer routines acting as program interfaces.

In yet another alternative embodiment, the information retrieval system **100** may comprise a plurality of computers connected via a computer network. For example, the communication interfaces **105** and **108** may be a Wide Area Network (WAN), the Internet, the WWW, Public Switched Telephone Network (PSTN), or the like, through which each of the information requester **101**, the navigation interface **106**, the search engine **102** and the information server **104** communicate. The information requester **101** may be, e.g., a personal computer connected to the Internet via a modem, or the like. The information server **104** may comprise a plurality of computers, e.g., web servers, distributed over the WAN **105**, **108** or the Internet. The search engine **102** may comprise any currently available and known search engines, e.g., YAHOO™, EXCITE®, and the like, and may maintain an index **103** of a portion of the content of the WWW parsed into searchable words and corresponding locations. An example of a known search engine and the associated index may be found in US Patent No. 6,021,409 issued February 1, 2000 to Michael Burrows, the entirety of which is hereby incorporated by reference herein.

Significantly, the information retrieval system **100** may further comprise a navigational interface **106** having a relationship database **107**. The navigational interface **106** provides an interface between the information requester **101** and the rest of the information retrieval system **100** that may comprise a server, e.g., one or more computers. This allows the information

requester **101** to establish an information retrieval session, and to navigate through the various informational items in the information retrieval system **100**. A navigation refers herein to generally the process of selecting and viewing one or more informational items.

Alternatively, the navigational interface **106** and/or the relationship database **107** may be implemented as a part of the user interface, e.g., a web browser, of the information requester **101**, or even as a part of the search engine **102**.

Fig. 2 shows an exemplary table illustrating the relevant portions **200** of the relationship database **107**. The relationship database **107**, in accordance with one aspect of the present invention, comprises, *inter alia*, an informational item field **201** that uniquely identifies information items **INFO Item 1** to **INFO Item N**, which may preferably be the location pointers, e.g. the URL in the case of WWW pages or in the case of actual informational items, a related informational item field **202**. A related informational item field **202** may contain one or more informational items, e.g., **INFO Item A** to **INFO Item Z**, that are related to an informational item in the informational item field **201**.

The relationship database **107** may further comprise a relationship type field **203**. This field defines the similarities between the respective characteristics of the informational items that are related. Another field in the database **107** is a relationship strength field **204**, which indicates the strength of the relationships between a pair of informational items based on the historical frequency of the pair being selected by a user during a single information retrieval session. In a preferred embodiment of the present invention, the relationship strength **204** comprises a value indicator represented as an integer, e.g. 1, 2, 4, etc.

According to the principles of the present invention, a related informational item record in the table **200** is created when at least two informational items are selected by a user during an information retrieval session. For example, during an information retrieval session, the user has navigated through informational items, **INFO ITEM 1**, **INFO ITEM A** and **INFO ITEM B**, a relational record for each of the pairs, **INFO ITEM 1/INFO ITEM A**, **INFO ITEM 1/INFO ITEM B** and **INFO ITEM A/INFO ITEM B**, may be

created if the respective records do not already exist in the database **107**. Alternately, an embodiment of the present invention may create records only for information pairs which are selected consecutively, i.e., only for the pairs, **INFO ITEM 1/INFO ITEM A** and **INFO ITEM 1/INFO ITEM B**, in the proceeding example. Yet another alternative embodiment of the present invention may create records for any pair of informational items which are viewed during the information retrieval session. For example, a record may be created between the first and last informational items to indicate a relationship from the start of the session to the finish of the session.

The relationship type, by way of example only, may be in an information retrieval system comprising informational items regarding a book collection of a library; a common author; a common publisher and a common subject, or the like, shared by the related pair of informational items.

According to a preferred embodiment of the present invention, a "general" relationship type is provided, and whenever a pair of informational items are selected during an information retrieval session, a record for the general relationship type is always created in addition to the possible record with respect to the above described common trait relationship type.

The relationship strength may initially be assigned a value of, e.g., 1, the first time the record is created, and adjusted based on the subsequent frequency of the pair being selected together or adjusted on the basis of the number of simultaneously executed algorithms that find the existence or a relationship in an information retrieval session.

FIG. 2A shows an example of the contents of the table shown in Fig. 2. In this example, the informational item "Rose" has a number of informational items related thereto, i.e., the informational items, "Fire Truck", "Daisy" and "Shakespeare", which share some common traits. For example, the informational item "Rose" and the related information item "Fire Truck" are both red in color. The example also shows that the relationship strength of the informational item "Rose" and the related informational item "Fire Truck" sharing the same color red has a current relationship strength value of 4.

In operation, when a user selects an informational item, e.g., the information item "Rose" during an information retrieval session, the navigation

interface **106** displays a list of informational items that are related to the selected informational item "Rose".

The inventive process of providing related informational items by the automated clustering of algorithm outputs into a Bayesian-type Network will now be described with references to FIGS. 3, 4A and 4B. The process is accomplished by feeding the output result of an information retrieval system into a Bayesian-type Belief Network and utilizing continuous feedback to fine tune the strength of the derived links between informational items. A traditional Bayesian Belief Network includes a set of random variables that make up the nodes of the network, a set of directed links that connect pairs of nodes, a conditional probability associated with each node to quantify the effect that parents have on a node and a directed acyclic graph i.e a graph with non directed cycles. By modifying the traditional Bayesian Belief Network, the present invention is able to automate and accurately classify relationships between informational items. In other words, the present invention incorporates a Bayesian-type Belief Network, which includes a set of random Frequently Asked Questions(FAQ) or Data, a set of relationships between nodes, a weight which describes the strength of relationship between each node, and a network structure which allows cycles and other structures with no limitations.Generally, as shown in Fig. 3, in step **301**, the textual data relating to informational items are first extracted. A number of independent algorithms in steps **302A – 302D**, are applied to the two or more extracted informational items to determine the existence, if any, of a relationship link between the items. It should be noted that the number of individual algorithms **302** is open ended that is, there can be anywhere from 1 to N algorithms applied for the purpose of finding a relationship link. The output of the algorithms are first merged in step **303**, and then fed into a Bayesian-type Knowledge Network in step **304**. The merging of the algorithm outputs in step **303**, initially serves the purpose of allowing a certain weight or strength value to be associated with a particular relationship link. The weight or strength assigned to a particular link is directly proportional to the total number of individual algorithms at step **302A - 302D** that determine the existence of a relationship link between individual informational items. A second purpose of the merged algorithm outputs is to enable the creation of a Bayesian-type link

within a database. When a link has been created, the usefulness and relevance of the link must be periodically checked and updated in order to prevent wasteful storage and processing.

This usefulness checking and control mechanism is implemented by means of a data aging and pruning feedback process **305**. The method of using feedback that results in data aging enhances the efficiency and effectiveness of the current invention. In general, the data-aging step involves an algorithm that runs as a function of traffic load to age relationship links according to their relevance. The purpose of this process is to keep the knowledge network current.

A further aspect of the present invention with the same ultimate goal, is the pruning process, which is also a part of the feedback step **305**. Pruning of relationship links occurs following the second pass through of the data aging feedback process and results in the removal of irrelevant relationship links.

The particular steps for the clustering and output merging of the independent algorithms mentioned earlier, are depicted in Fig. 4A. In step **401**, the present inventive navigational interface **106** detects a navigation from one informational item to at least one other informational item, e.g., from the informational item "Rose" to the informational item "Daisy", then to the informational item "Fire Truck".

In step **402**, a cluster of algorithms is applied to determine if a relationship between the two or more informational items can be found.

In step **403**, a determination is made whether any one or more algorithms detected a relationship for any of the **ROSE/DAISY**, **ROSE/FIRE TRUCK** and the **DAISY/FIRE TRUCK** pairs found in the database **107**. If any of the informational items do not already have a relationship record in the database **403**, a relationship type is determined for the missing pair. In an embodiment of the present invention, a record for each informational item pair with the "general" relationship type is created. In addition, a new record for each identified common trait of each pair is created. It is possible that a pair may have no common trait (e.g., the **DAISY/FIRE TRUCK** pair), in which case only the general relationship type record is created. It may also be possible that a pair

may share more than one common trait (e.g., the **ROSE/DAISY** pair may share traits, "flower" and "scent").

In step **404**, a determination is made of whether any relationships were found in the previous step **403**. If there were no relationships found, then the process ends **408**. Otherwise, in step **405**, a determination is made whether the relationship has previously been pruned. If this link has never been pruned or is not currently pruned, a strength is assigned to the relationship link **406**.

In step **406**, for each newly created record, an initial value for the respective relationship weight is assigned, e.g., an initial value of 1. For example, if none of the pairs has an existing relationship record, then after the operations of steps **403** and **404**, the resulting new records may be as shown in Table I below:

Table I

Informational Item	Related Informational	Relationship Type	Relationship Strength
Rose	Fire truck	General	1
Rose	Fire truck	Red	1
Rose	Daisy	General	1
Rose	Daisy	Flower	1
Rose	Daisy	Scent	1
Daisy	Rose	General	1
Daisy	Rose	Flower	1
Daisy	Rose	Scent	1
Fire Truck	Rose	General	1
Fire Truck	Rose	Red	1
Daisy	Fire Truck	General	1
Fire Truck	Daisy	General	1

In step **407**, the Bayesian-type Network database **107** is updated to reflect the newly created records and/or the relationship strength(s) adjustment(s). In one embodiment of the present invention, the database **107** is updated in real time, whenever a new record is created or a relationship strength adjustment is made. In an alternative embodiment, the database may be updated off-line by collecting the navigational history of users of the information retrieval system in one or more history log file.

As can be appreciated, the relevant informational item provision system described above, provides an efficient and economical navigational tool by which a user of an information retrieval system may find a desired informational item with less effort and time. By suggesting related informational items which historically proved useful and by allowing the user to reap the benefits of the efforts that they or a prior user made during a prior information retrieval session, the effectiveness of the system is also enhanced.

Figure 4B is an exemplary flow chart of the data aging and pruning process discussed earlier. This process both streamlines and enhances the quality of the information that is recorded in the database. As will be appreciated by one skilled in the art, the continuous collection and updating of data without any method for ensuring the relevance, reliability and usefulness of the data will result in a sluggish and cumbersome system. A process to overcome these problems is a feature of the present invention.

In one embodiment of the present invention, a periodic review of the established relationship links is conducted at step **410**. Relationship link items that have not been utilized over a predefined threshold period **411** are marked as aged at step **412**. When a particular link that was previously aged is determined to have no link i.e. link strength = 0, as determined at step **414**, the link is pruned at step **416**, i.e. the record of that relationship link is removed from the database and at step **418** the link is marked as pruned, i.e. the link is placed in a separate table/list of unused links. It should be noted that the table/list of unused links is periodically purged from the system. This process is automatic and does not require any user initiation.

The process of providing context sensitive help items will now be described with references to FIGS. 6 and 7. As shown in Fig. 6, in step **601**, the inventive help information retrieval system detects a selection of a help item, e.g., the help item **INFO ITEM R**, by a user during a help session, which was initiated when the user was viewing an informational item at a location, e.g., **ITEM LOC N**.

Upon the detection, in step **602**, a determination is made of whether a help relationship record for the **ITEM LOC N/INFO ITEM R** pair already exists in the table **500**. If the help relationship record does not already

exist in the table, in step **603**, a new help relationship record is created, and an initial value of the relationship strength therefore is assigned, e.g., the initial value is set to a one (1).

If, on the other hand, in step **602**, a determination is made that the help relationship record already exists in the table, then, in step **604**, the relationship strength for the existing record is increased by a predetermined amount, e.g., by 1.

In step **605**, the table **500** is updated to reflect the newly created record and/or the relationship strength adjustment. In one embodiment of the present invention, the table **500** is updated in real time, i.e., whenever a new record is created or a relationship strength adjustment is made. In an alternative embodiment, the database may be updated off-line by collecting the help session history of users of the information retrieval system in one or more history log file. The history log file may be examined periodically, i.e., daily, monthly, etc., to determine the originating informational item(s) and any help item(s) selected to generate new relationship records and/or make relationship strength adjustments therefrom.

Fig. 7 shows an exemplary embodiment of the inventive related help information provision process. In this embodiment, when a user initiation of a help session is detected at step **706**, the help information retrieval system of the present invention performs a look-up operation at step **707**, of the table **500** to determine whether any help relationship records exist for the location corresponding to the informational item from which the help session originated. If a determination is made that one or more help relationship record(s) already exist (step 708) in the table **500**, the matching help items are sorted (step 709) based on the relationship strengths, and may be displayed.

If, on the other hand, no help relationship record exists for the originating informational item location in the table **500**, in step **710**, a conventional help topic contents, as is well known, is provided for the user to select a help item therefrom. When the user selects a help item from the help topic contents, the selection is detected at step **601**, and the location/info item pair of the originating informational item and the selected help item is processed

through steps **602** to **605** to create and store a new help relationship record in the table **500**.

As can be appreciated, this help information retrieval system described above allows a mapping of help items, which is sensitive to the context within which a user is seeking help, i.e., by providing originating location specific selection choices of help items. Moreover, the mapping is allowed to be dynamically updated based on the usage behavior to provide more relevant selection choices and thus a more efficient use of the help information retrieval system.

While the invention has been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments of the invention without departing from the true spirit and scope of the invention. The terms and descriptions used herein are set forth by way of illustration only and are not meant as limitations. In particular, although the method of the present invention has been described by examples, the steps of the method may be performed in a different order than illustrated or simultaneously. Those skilled in the art will recognize that these and other variations are possible within the spirit and scope of the invention as defined in the following claims and their equivalents.

CLAIMS

We claim:

1. A method of classifying a plurality of informational items in an information retrieval system, comprising the steps of: detecting an access of a first informational item; detecting an access of a second informational item; applying an ensemble of clustering algorithms; and creating a relationship link between said first informational item and second informational item.

2. The method as recited in claim 1 wherein said step of detecting the second informational item includes the detecting of a plurality of informational items.

3. The method as recited in claim 2, further comprising the step of: determining a weighting or strength for said relationship link.

4. The method as recited in claim 3, further comprising the step of: applying an algorithm for data aging wherein the usage of the relationship link is monitored and used as feed back for the weighting associated with the relationship link.

5. The method as recited in claim 4, further comprising the step of: applying a pruning algorithm wherein external information regarding the usefulness of at least one relationship link is utilized to modify weighting/strength or existence of a recorded relationship link.

6. The method as recited in claim 5, wherein said pruning algorithm is repeatedly applied to determine if a recorded relationship link should be ignored or placed in a list of bad links.

7. The method as recited in claim 5, wherein said pruning algorithm makes use of a user determined feedback of the usefulness of a relationship link.

8. The method as recited in claim 2, wherein said ensemble includes a plurality of algorithms and wherein said relationship link is weighted in direct proportion to the number of algorithms within said ensemble of algorithms that determine the existence of said relationship link.

9. The method as recited in claim 2, wherein said relationship link is positioned in a list in direct proportion to the degree of consensus among said ensemble of algorithms.

10. The method as recited in claim 2, wherein said ensemble includes a plurality of algorithms and wherein each algorithm within said ensemble of algorithms runs independently of all other algorithms.

11. The method as recited in claim 2, further comprising the step of merging the outputs of said ensemble of algorithms.

12. The method as recited in claim 2, further comprising the step of recording said relationship link in a Bayesian-type Belief Network.

13. A Bayesian-type Belief Network wherein the traditional Baysian Belief Network components are modified, the modification comprising: a set of random Frequently Asked Questions(FAQ) or Data; a set of relationships between nodes; a weight which describes the strength of relationship between each node; and a network structure which allows cycles and other structures with no limitations.

14. An apparatus for providing classification of informational items in an information retrieval system comprising: means for detecting an access of informational items; means for applying an ensemble of clustering algorithms; and means for creating relationship links between said informational items to enhance the effectiveness of said system.

15. The apparatus of claim 14 including: means for aging said relationship links; means for pruning said relationship links; means for weighting said relationship links; and means for arranging said relationship links in direct proportion to the outcome of said ensemble of algorithms.

16. The apparatus of claim 15 including means for merging the resulting output of said ensemble of algorithms into a Bayesian-type Belief Network.

17. A computer readable storage medium having stored thereon a computer program for implementing a method of classifying a plurality of information items in an information retrieval system, said computer program comprising a set of instructions for implementing the steps recited in claim 2.

18. The computer readable storage medium according to claim 17, wherein said computer program further comprises one or more instructions for clustering the resulting output of said ensemble of algorithms into a Bayesian-type Belief Network.

19. The computer readable storage medium according to claim 17, wherein said computer program further comprises one or more instructions for improving the usefulness of said relationship links through weighting of said relationship links.

20. The computer readable storage medium according to claim 17, wherein said computer program further comprises one or more instructions for improving the usefulness of said relationship links through pruning of said relationship links.

21. The computer readable storage medium according to claim 17, wherein said computer program further comprises one or more instructions for improving the usefulness of said relationship links through aging of said relationship links.

22. The computer readable storage medium according to claim 17, wherein said computer program further comprises one or more instructions for improving the usefulness of said relationship links through weighting, pruning and aging of said relationship links.

23. A method for retrieving help information in a system where informational items are not fixedly mapped to one another comprising the steps of: determining an efficient path to arrive at a particular help item of interest; and storing a context in which a help item is sought as well as the path to said help item.

24. The method as recited in claim 23, further comprising the step of reexamining and dynamically changing said efficient path to a particular help item upon subsequent help item searches or retrieval.

25. The method as recited in claim 23, wherein said efficient path is determined based on said context in which said help item was sought.

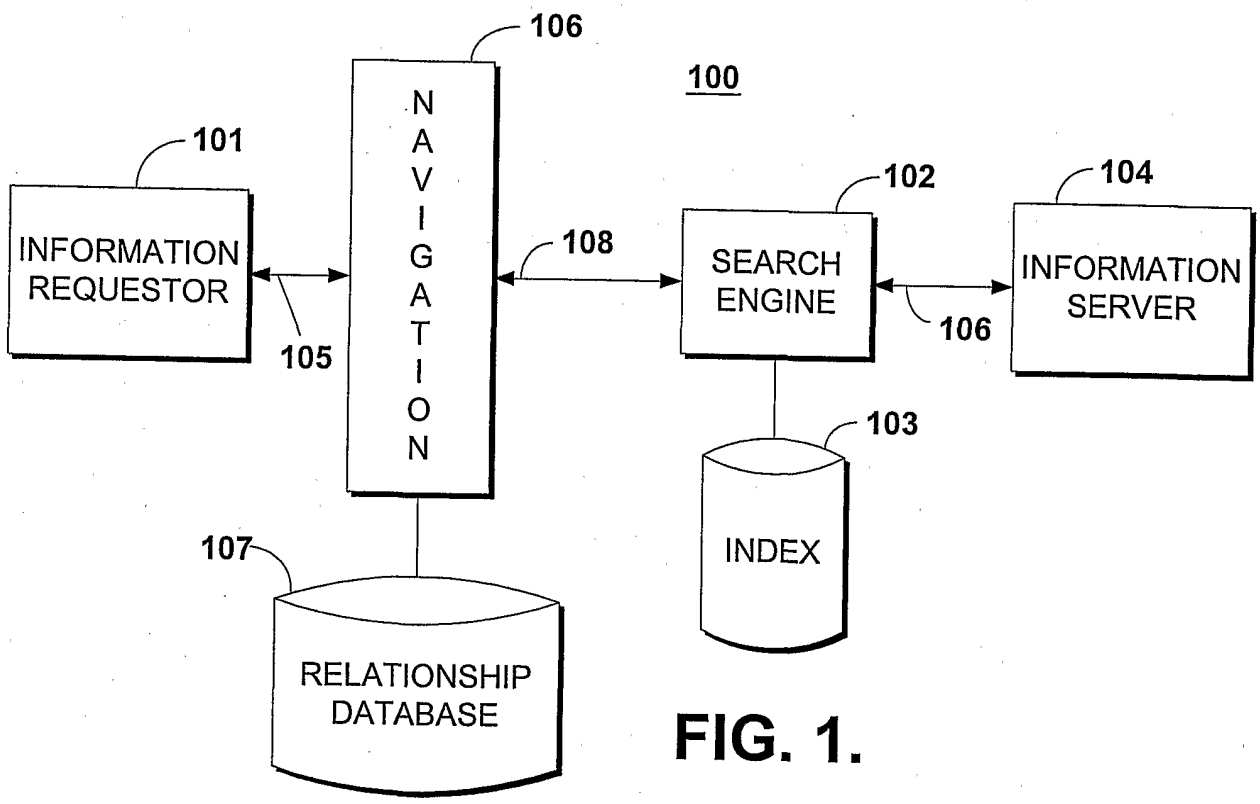

106
100
101
NAVIGATION
INFORMATION REQUESTOR
105
108
SEARCH ENGINE
102
104
INFORMATION SERVER
106
103
INDEX
107
RELATIONSHIP DATABASE

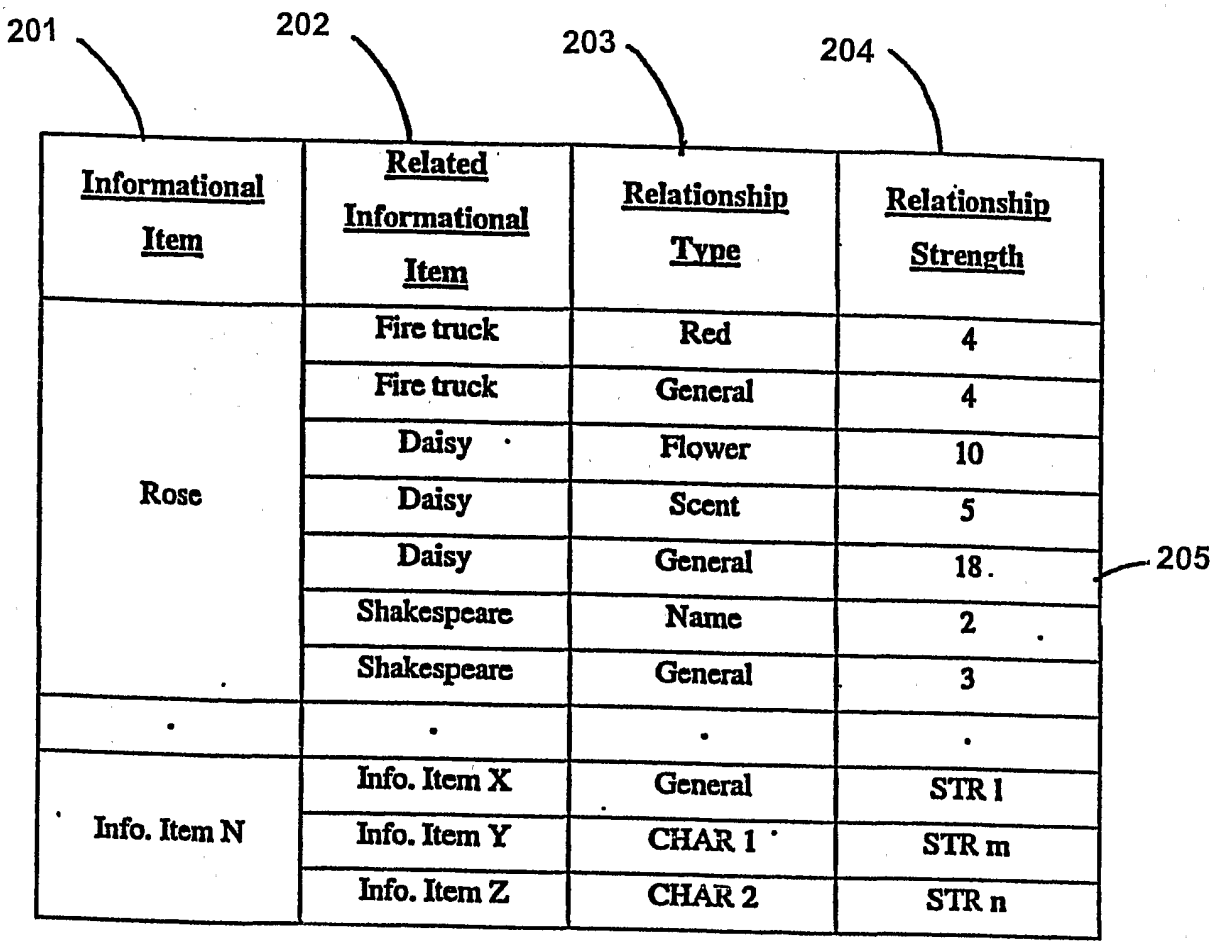
FIG. 1.

200

201 202 203 204

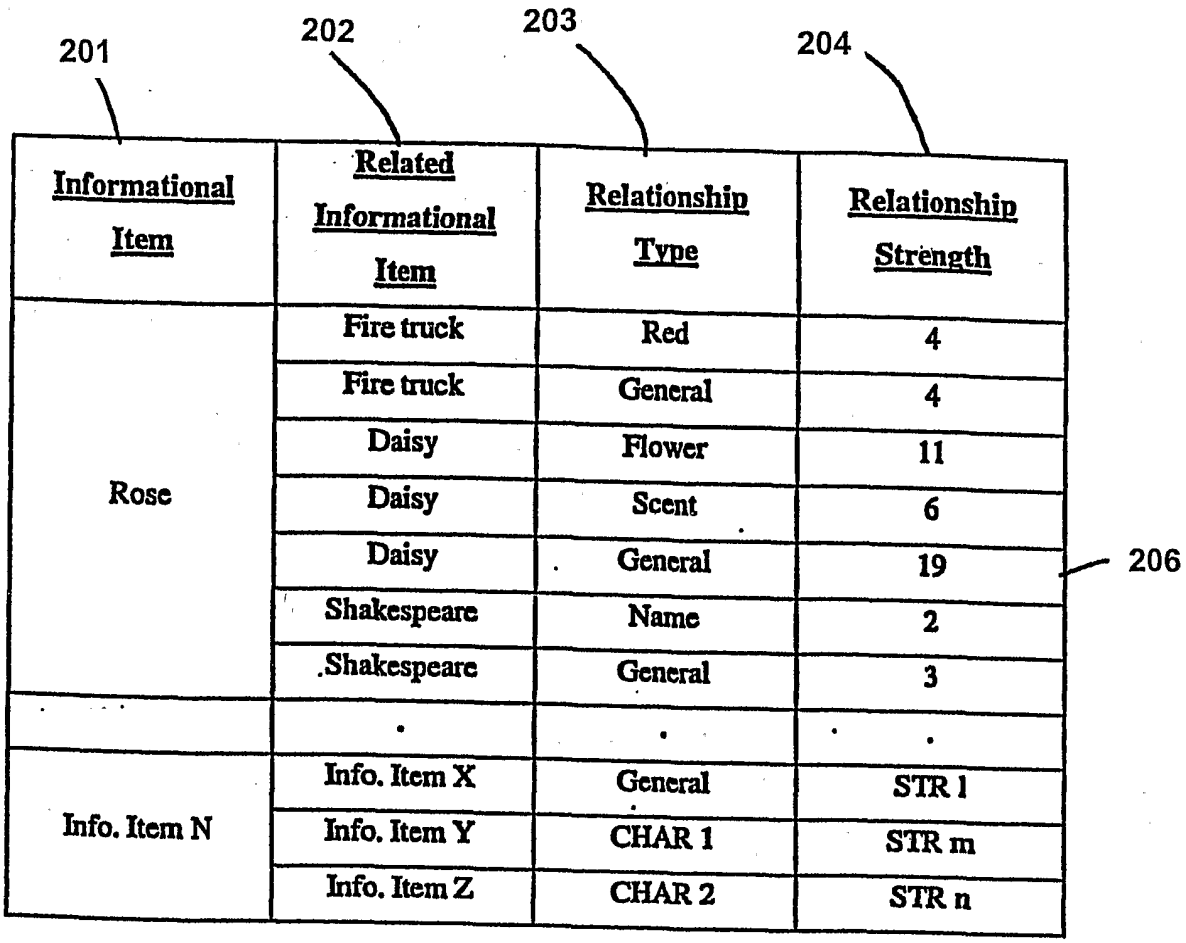
Informational Item	Related Informational Item	Relationship Type	Relationship Strength
Info. Item 1	Info. Item A	General	STR 1
	Info. Item B	CHAR 1	STR 3
	Info. Item C	CHAR 2	STR 9
Info. Item 2	Info. Item D	General	STR 4
	Info. Item X	CHAR 1	STR 15
	Info. Item C	CHAR 2	STR 3
	Info. Item D	CHAR 3	STR 7
	Info. Item A	CHAR 3	STR 2
.	.	.	.
Info. Item N	Info. Item X	General	STR 1
	Info. Item Y	CHAR 1	STR m
	Info. Item Z	CHAR 2	STR n

FIG. 2.



Informational Item	Related Informational Item	Relationship Type	Relationship Strength
Rose	Fire truck	Red	4
	Fire truck	General	4
	Daisy	Flower	10
	Daisy	Scent	5
	Daisy	General	18
	Shakespeare	Name	2
	Shakespeare	General	3
.	.	.	.
Info. Item N	Info. Item X	General	STR l
	Info. Item Y	CHAR 1	STR m
	Info. Item Z	CHAR 2	STR n

FIG. 2A.



Informational Item	Related Informational Item	Relationship Type	Relationship Strength
Rose	Fire truck	Red	4
	Fire truck	General	4
	Daisy	Flower	11
	Daisy	Scent	6
	Daisy	General	19
	Shakespeare	Name	2
	.Shakespeare	General	3
. . .	.	.	. .
Info. Item N	Info. Item X	General	STR 1
	Info. Item Y	CHAR 1	STR m
	Info. Item Z	CHAR 2	STR n

FIG. 2B.

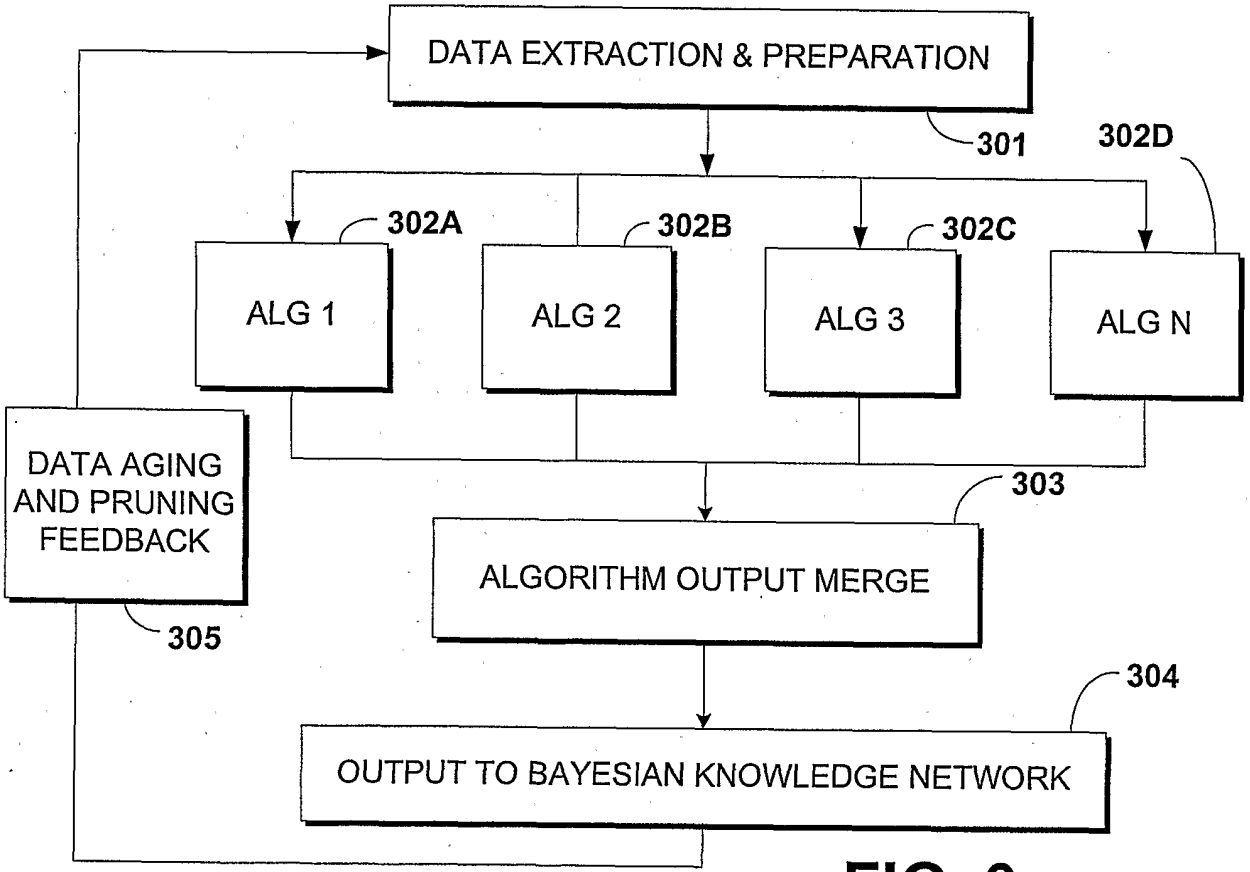

DATA EXTRACTION & PREPARATION
301
302D
302A
302B
302C
ALG 1
ALG 2
ALG 3
ALG N
DATA AGING AND PRUNING FEEDBACK
303
ALGORITHM OUTPUT MERGE
305
304
OUTPUT TO BAYESIAN KNOWLEDGE NETWORK

FIG. 3.

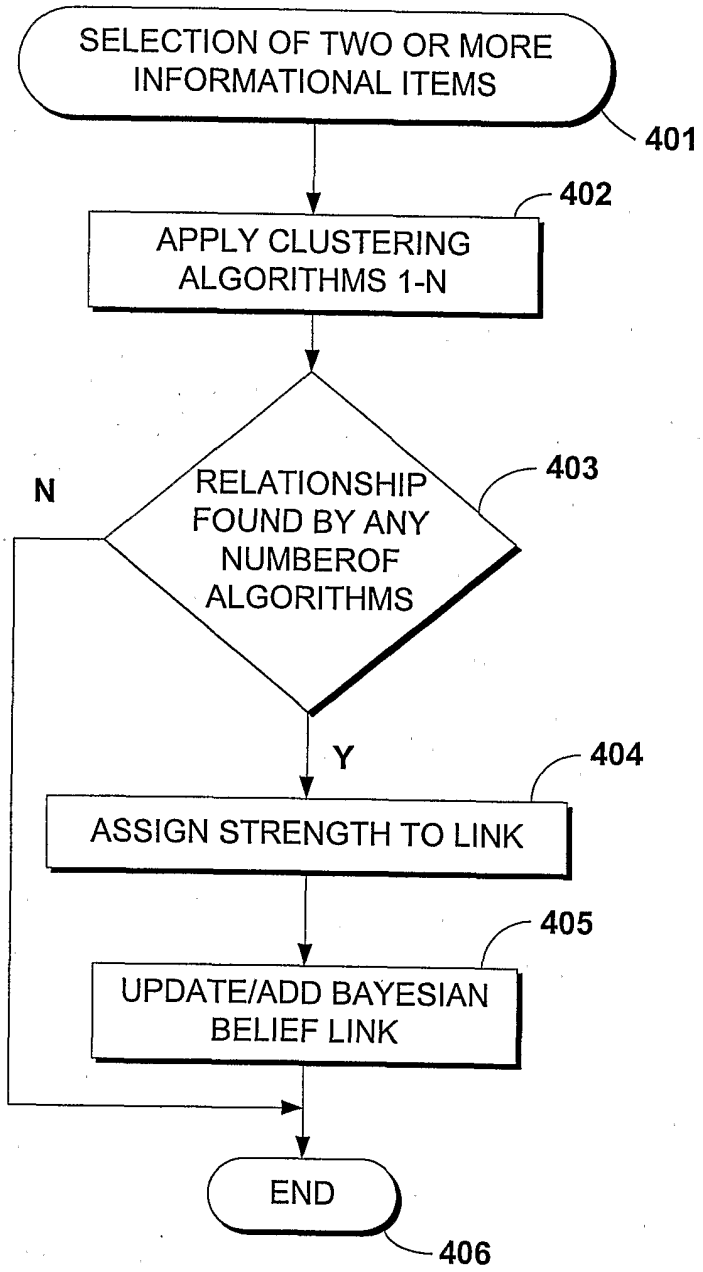

SELECTION OF TWO OR MORE INFORMATIONAL ITEMS
401
APPLY CLUSTERING ALGORITHMS 1-N
402
RELATIONSHIP FOUND BY ANY NUMBEROF ALGORITHMS
403
N
Y
ASSIGN STRENGTH TO LINK
404
UPDATE/ADD BAYESIAN BELIEF LINK
405
END
406

FIG. 4A.

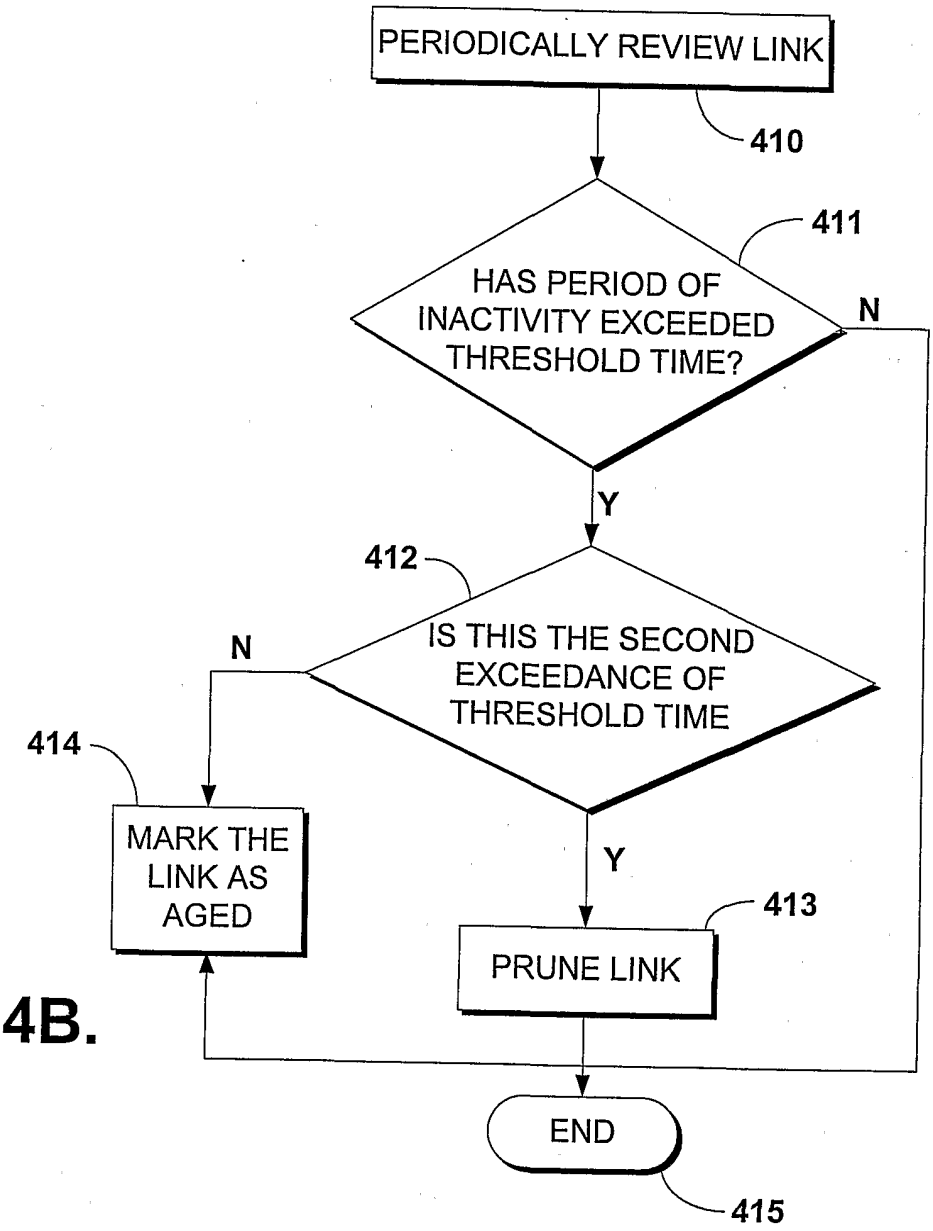

PERIODICALLY REVIEW LINK
410
411
HAS PERIOD OF INACTIVITY EXCEEDED THRESHOLD TIME?
N
Y
412
IS THIS THE SECOND EXCEEDANCE OF THRESHOLD TIME
N
414
MARK THE LINK AS AGED
Y
413
PRUNE LINK
END
415

FIG. 4B.

500

501 502 503 504

Informational Item	Related Informational Item	Relationship Type	Relationship Strength
Info. Item 1	Info. Item A	General	STR 1
	Info. Item B	CHAR 1	STR 3
	Info. Item C	CHAR 2	STR 9
.	.	.	.
Info. Item N	Info. Item X	General	STR l
	Info. Item Y	CHAR 1	STR m
	Info. Item Z	CHAR 2	STR n
Item LOC 1	Info. Item D	HELP	STR 4
	Info. Item E	HELP	STR 6
	Info. Item F	HELP	STR 9
..	.	.	.
Item LOC N	Info. Item Q	HELP	STR l
	Info. Item R	HELP	STR m
	Info. Item S	HELP	STR n

505

FIG. 5.

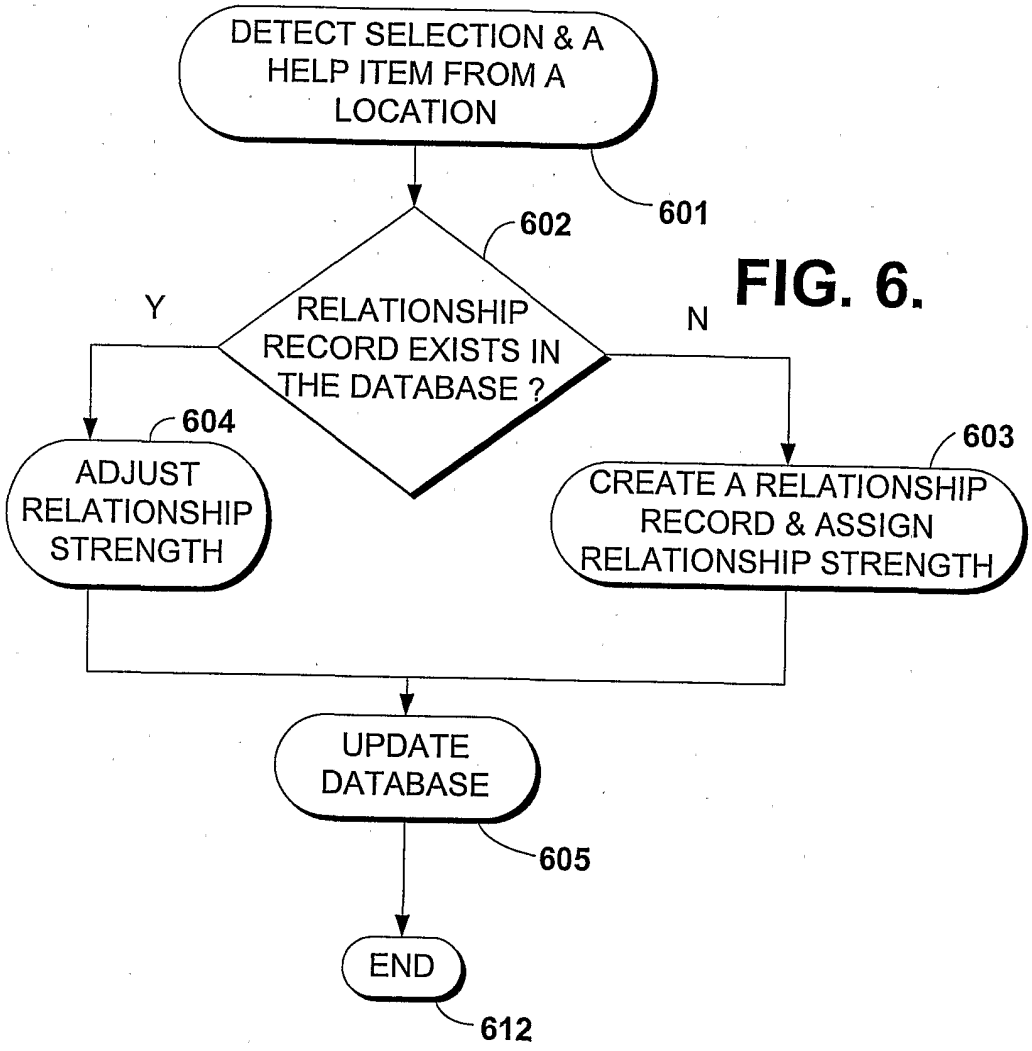

DETECT SELECTION & A HELP ITEM FROM A LOCATION
601
602
RELATIONSHIP RECORD EXISTS IN THE DATABASE ?
Y
N
604
ADJUST RELATIONSHIP STRENGTH
603
CREATE A RELATIONSHIP RECORD & ASSIGN RELATIONSHIP STRENGTH
UPDATE DATABASE
605
END
612

FIG. 6.

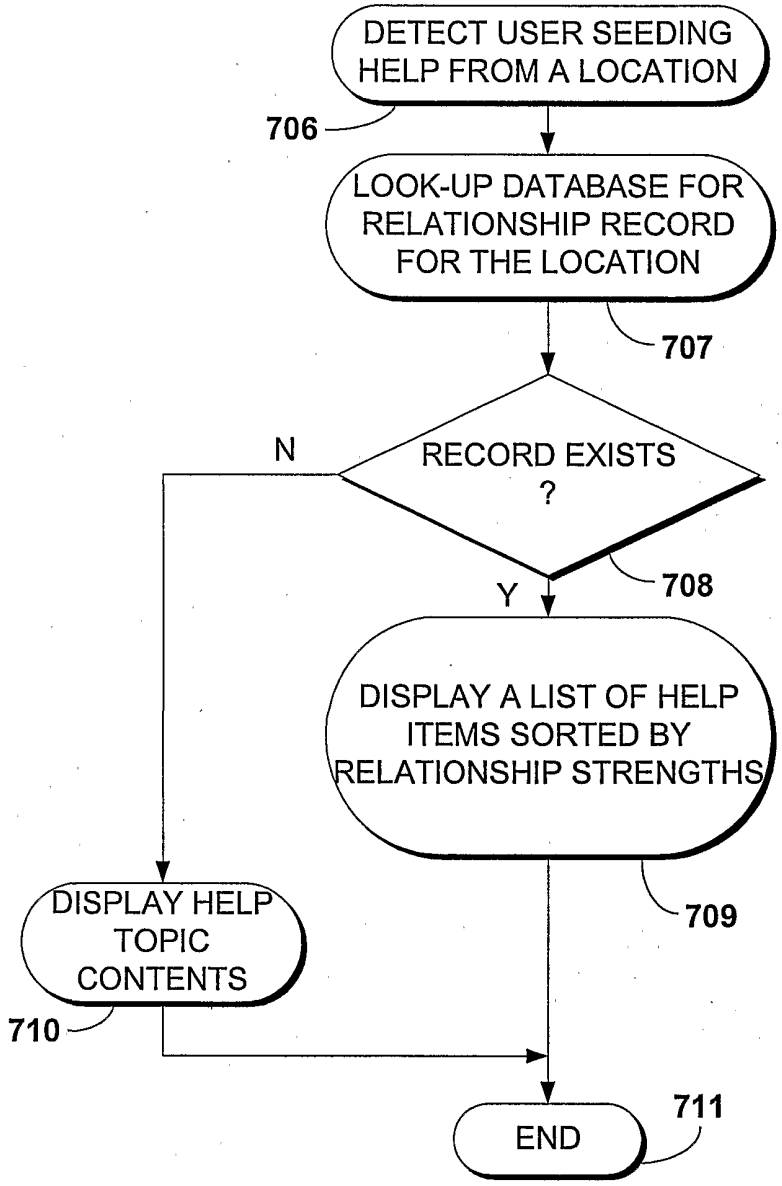

DETECT USER SEEDING HELP FROM A LOCATION
706
LOOK-UP DATABASE FOR RELATIONSHIP RECORD FOR THE LOCATION
707
RECORD EXISTS ?
708
N
Y
DISPLAY A LIST OF HELP ITEMS SORTED BY RELATIONSHIP STRENGTHS
709
DISPLAY HELP TOPIC CONTENTS
710
END
711

FIG. 7.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/46907

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G06F 17/30, 17/00
US CL : 707/5, 103R

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 707/1-5, 100-103R; 705/10, 14, 26; 709/200-203, 217, 223

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,933,822 A (BRADEN-HARDER et al) 03 August 1999 (03.08.1999), abstract, figures 1, 5A-6B, 8A-9B, column 3, lines 32-36, column 7, line 53-column 8, line 2, column 11, lines 47-51, column 13, lines 11-13, 64-65, column 25, line 41- column 26, line 7.	1-22
X	US 5,630,125 A (ZELLWEGER) 13 May 1997 (13.05.1997), abstract, figures 3, 5, 8.	23-25
A	US 6,085,226 A (HORVITZ) 04 July 2000 (04.07.2000), all.	1-22
A,P	US 6,327,574 B1 (KRAMER et al) 04 December 2001 (04.12.2001), all.	1-25

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 March 2002 (06.03.2002)	11 APR 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Te Y Chen Telephone No. (703)308-1155

Form PCT/ISA/210 (second sheet) (July 1998)