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(54) **ADAPTIVE GROUPING IN A FILE NETWORK**

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(51) **Int. Cl.**
G06F 17/30 (2006.01)

(52) **U.S. Cl.** **707/4**; 707/3; 707/5; 707/6; 707/7; 707/8

(58) **Field of Classification Search** ..... None
See application file for complete search history.

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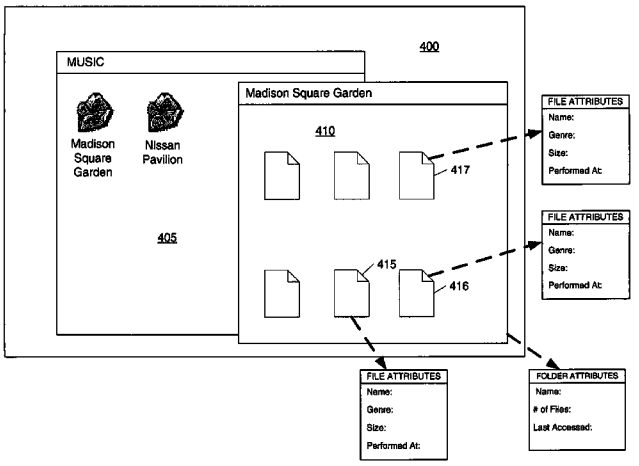
Assistant Examiner—Mohammad S Rostami
(74) *Attorney, Agent, or Firm*—Perkins Coie LLP

(57) **ABSTRACT**

Extraction of semantic information and the generation of semantic attributes allows for improved organization and management of data. Semantic attributes are automatically generated and eliminate the need for manual entry of attribute information. A semantic file network may further be constructed based on similarities between files that are based on the semantic attribute information. Semantic links representing a semantic relationship may be built between similar or relevant files. In addition, user operations and user operation patterns may also be considered in building the file network. Semantic attributes and information may further facilitate browsing the file systems as well as improve the accuracy and speed of queries.

11 Claims, 15 Drawing Sheets



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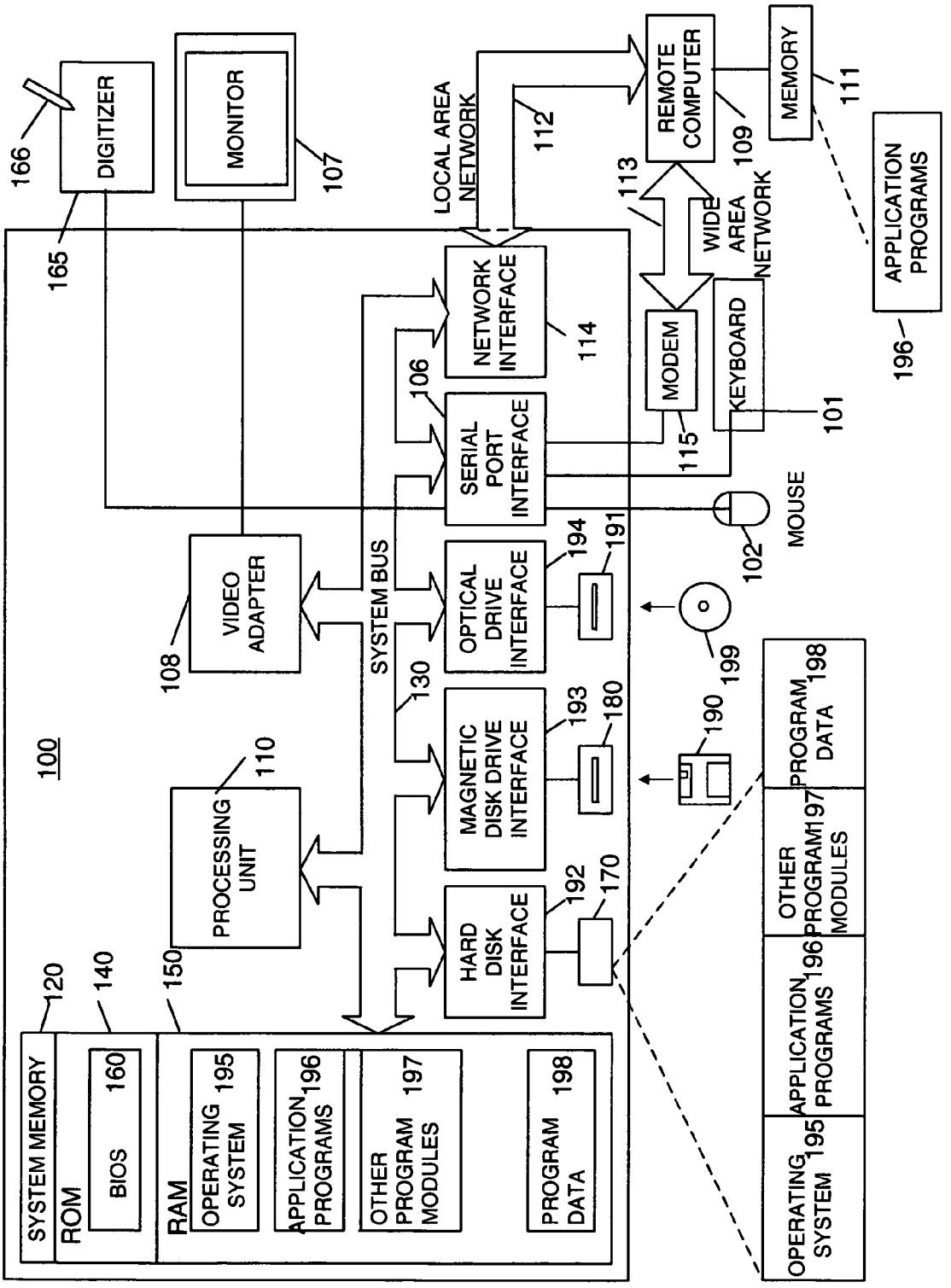
100
SYSTEM MEMORY
ROM
BIOS 160
RAM
OPERATING SYSTEM 195
APPLICATION PROGRAMS 196
OTHER PROGRAM MODULES 197
PROGRAM DATA 198
120
140
150
PROCESSING UNIT 110
VIDEO ADAPTER 108
SYSTEM BUS
HARD DISK INTERFACE 192
MAGNETIC DISK DRIVE INTERFACE 193
OPTICAL DRIVE INTERFACE 194
SERIAL PORT INTERFACE 106
NETWORK INTERFACE 114
MODEM 115
LOCAL AREA NETWORK
WIDE AREA NETWORK
REMOTE COMPUTER 109
MEMORY 111
APPLICATION PROGRAMS 196
DIGITIZER 166
MONITOR 107
KEYBOARD 101
MOUSE 102
165
112
113
170
180
190
191
199
OPERATING SYSTEM 195
APPLICATION PROGRAMS 196
OTHER PROGRAM MODULES 197
PROGRAM DATA 198

FIG. 1

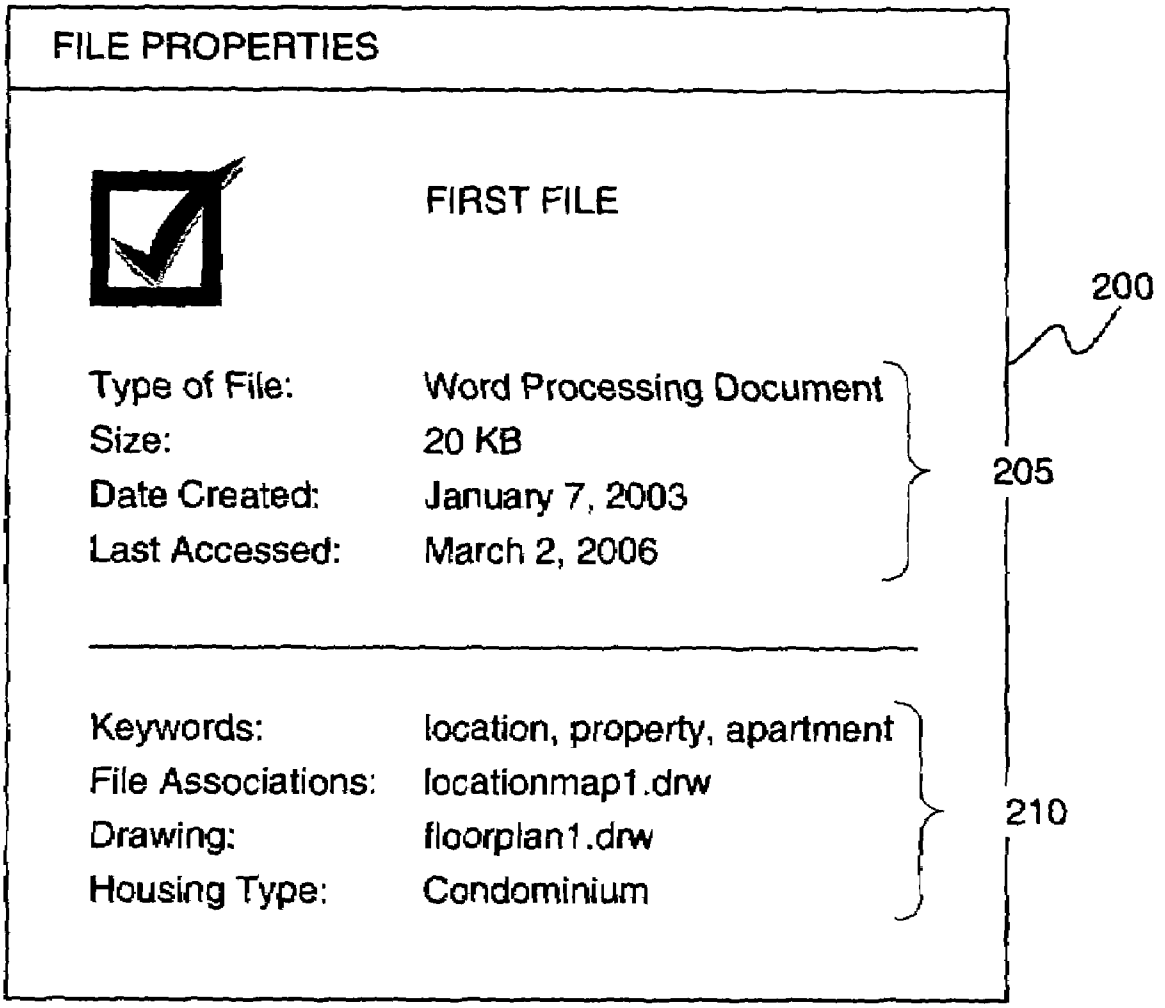
FILE PROPERTIES
FIRST FILE
200
Type of File: Word Processing Document
Size: 20 KB
Date Created: January 7, 2003
Last Accessed: March 2, 2006
205
Keywords: location, property, apartment
File Associations: locationmap1.drw
Drawing: floorplan1.drw
Housing Type: Condominium
210

FIG. 2

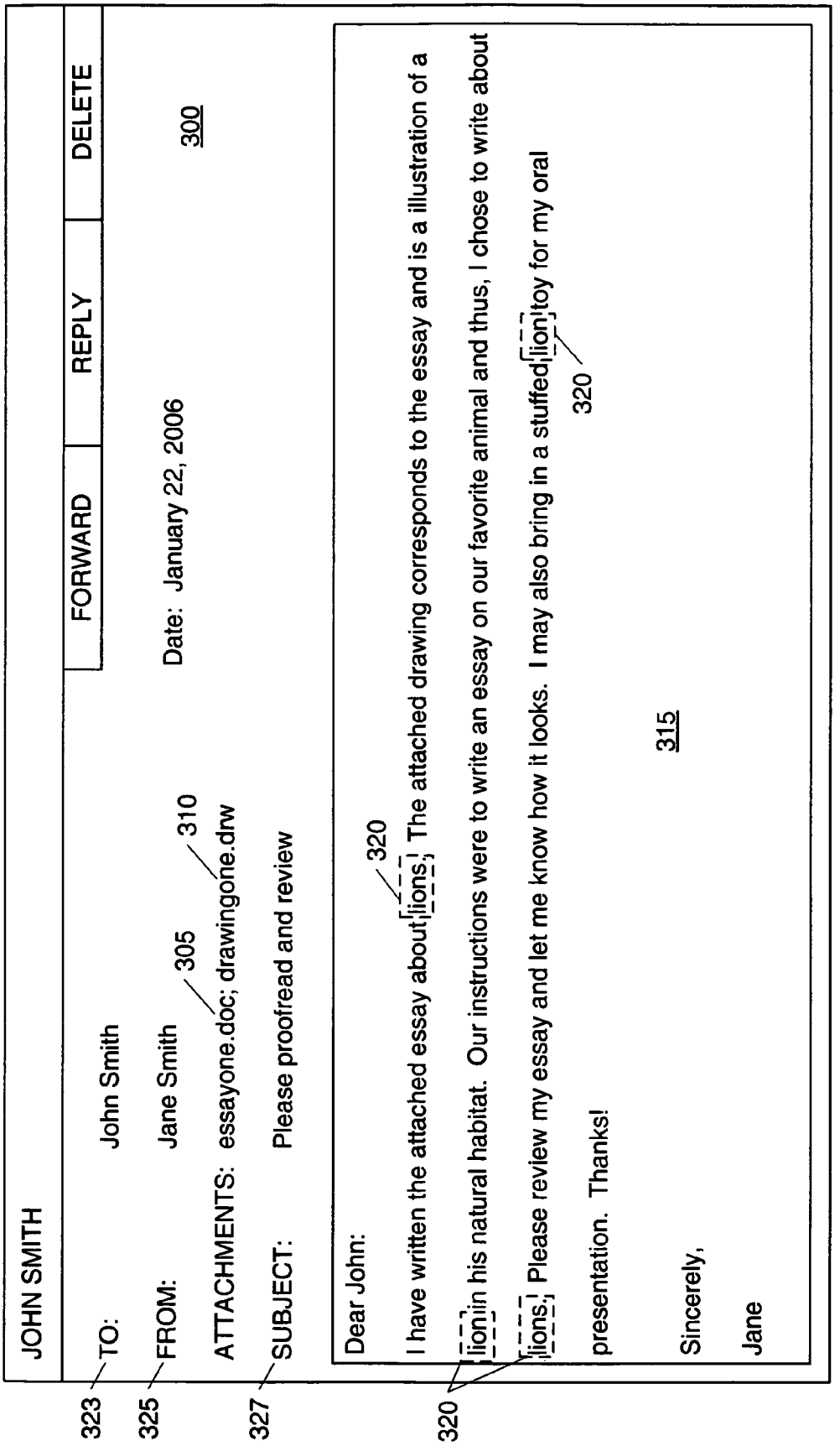
JOHN SMITH
FORWARD
REPLY
DELETE
TO: John Smith
FROM: Jane Smith
ATTACHMENTS: essayone.doc; drawingone.drw
SUBJECT: Please proofread and review
Date: January 22, 2006
300
305
310
323
325
327
320
315
Dear John:
I have written the attached essay about lions. The attached drawing corresponds to the essay and is a illustration of a lion in his natural habitat. Our instructions were to write an essay on our favorite animal and thus, I chose to write about lions. Please review my essay and let me know how it looks. I may also bring in a stuffed lion toy for my oral presentation. Thanks!
Sincerely,
Jane

FIG. 3

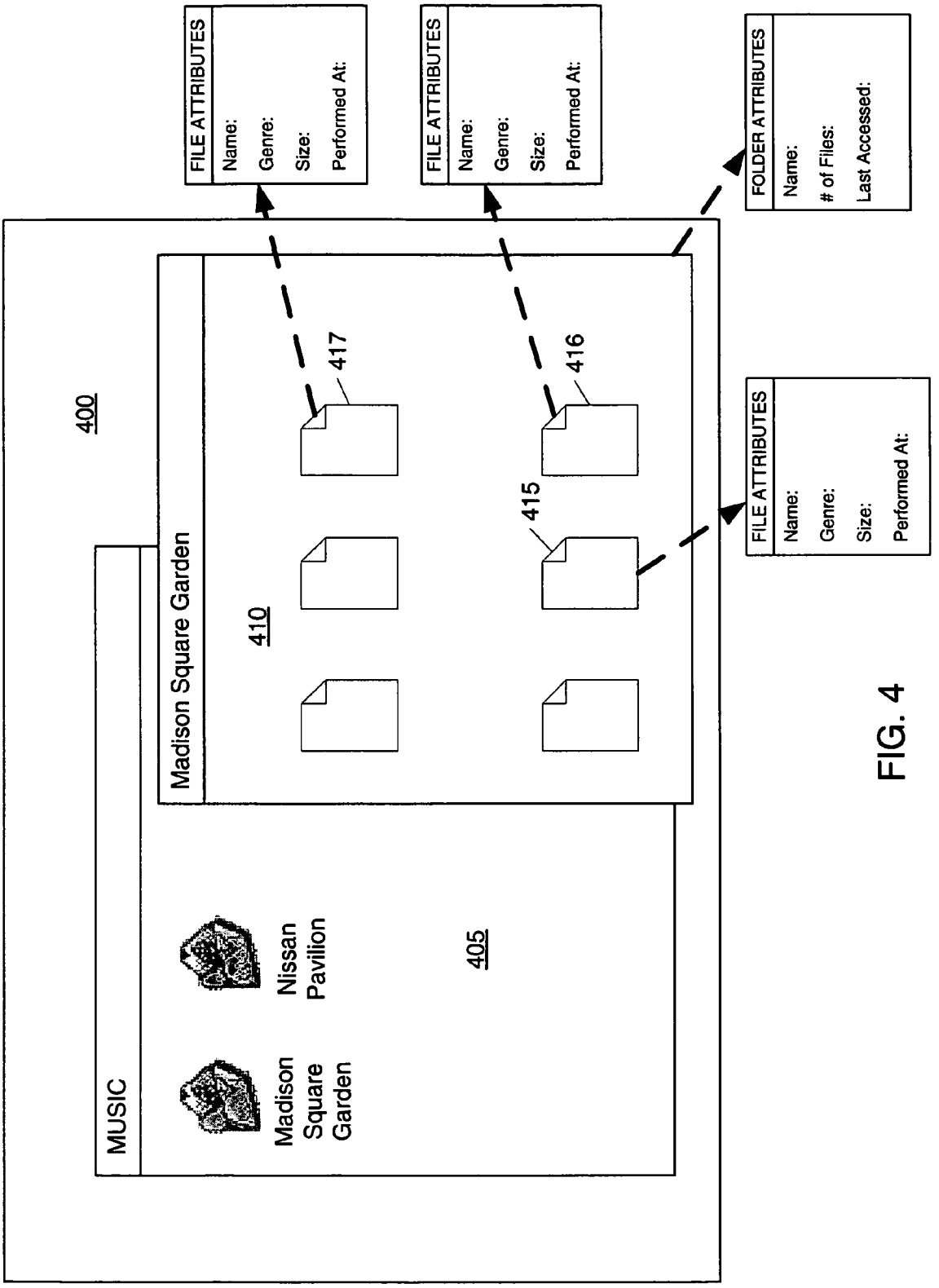
FILE ATTRIBUTES
Name:
Genre:
Size:
Performed At:
FILE ATTRIBUTES
Name:
Genre:
Size:
Performed At:
FOLDER ATTRIBUTES
Name:
# of Files:
Last Accessed:
400
417
416
415
410
Madison Square Garden
FILE ATTRIBUTES
Name:
Genre:
Size:
Performed At:
MUSIC
Nissan Pavilion
Madison Square Garden
405

FIG. 4

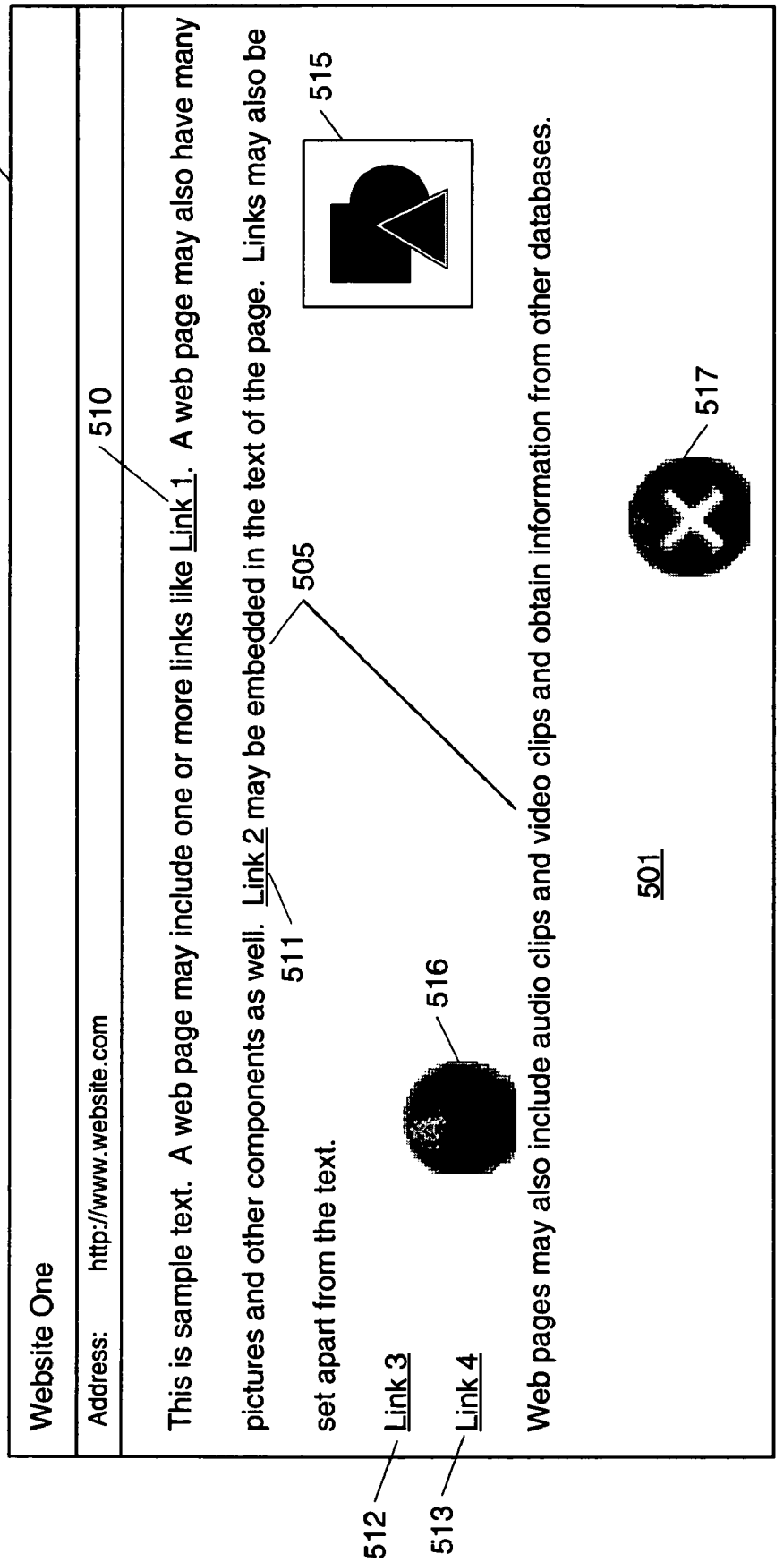
500
Website One
Address: http://www.website.com
510
This is sample text. A web page may include one or more links like Link 1. A web page may also have many pictures and other components as well. Link 2 may be embedded in the text of the page. Links may also be set apart from the text.
505
511
515
516
517
Link 3
Link 4
512
513
Web pages may also include audio clips and video clips and obtain information from other databases.
501

FIG. 5

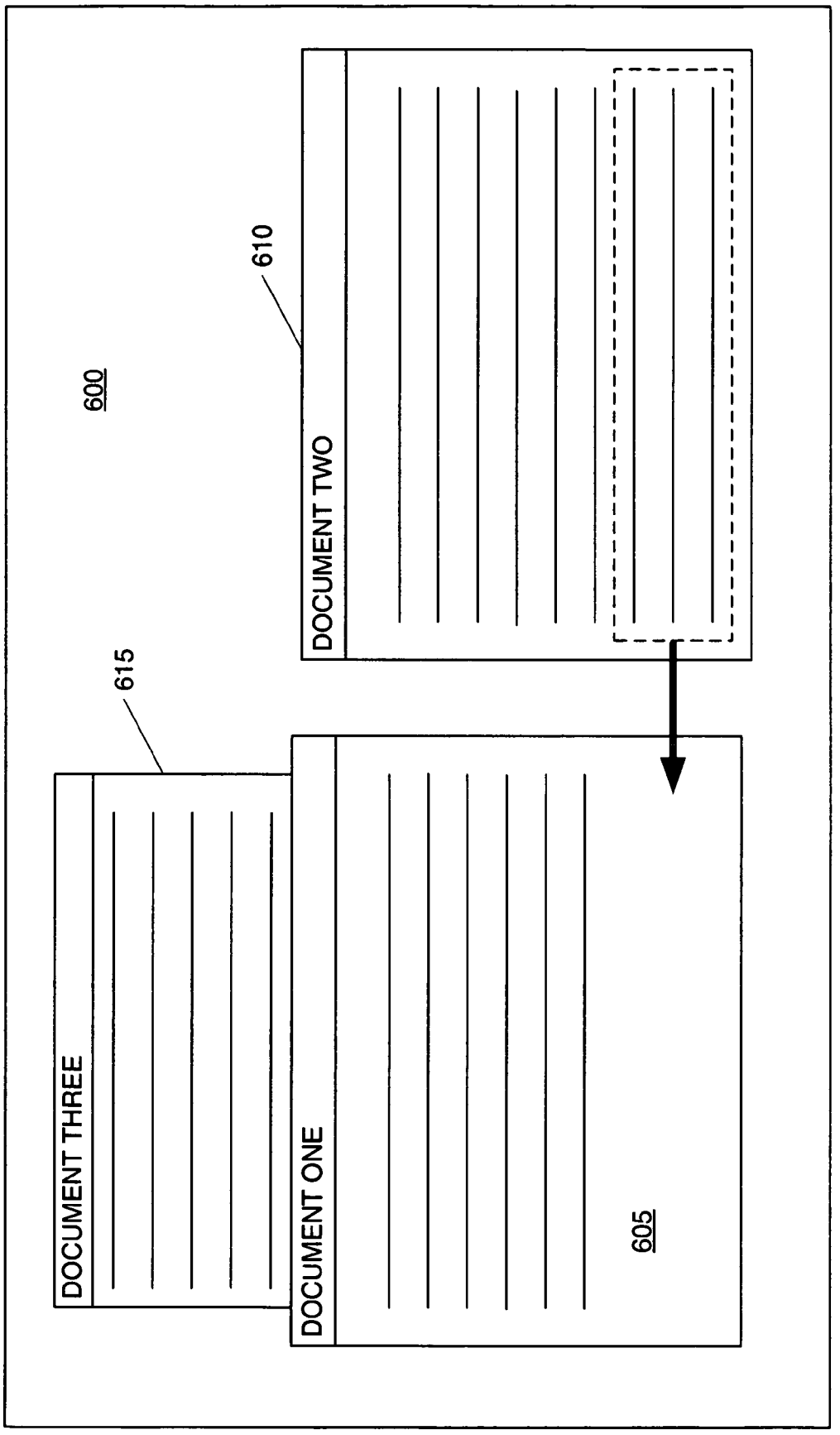

FIG. 6

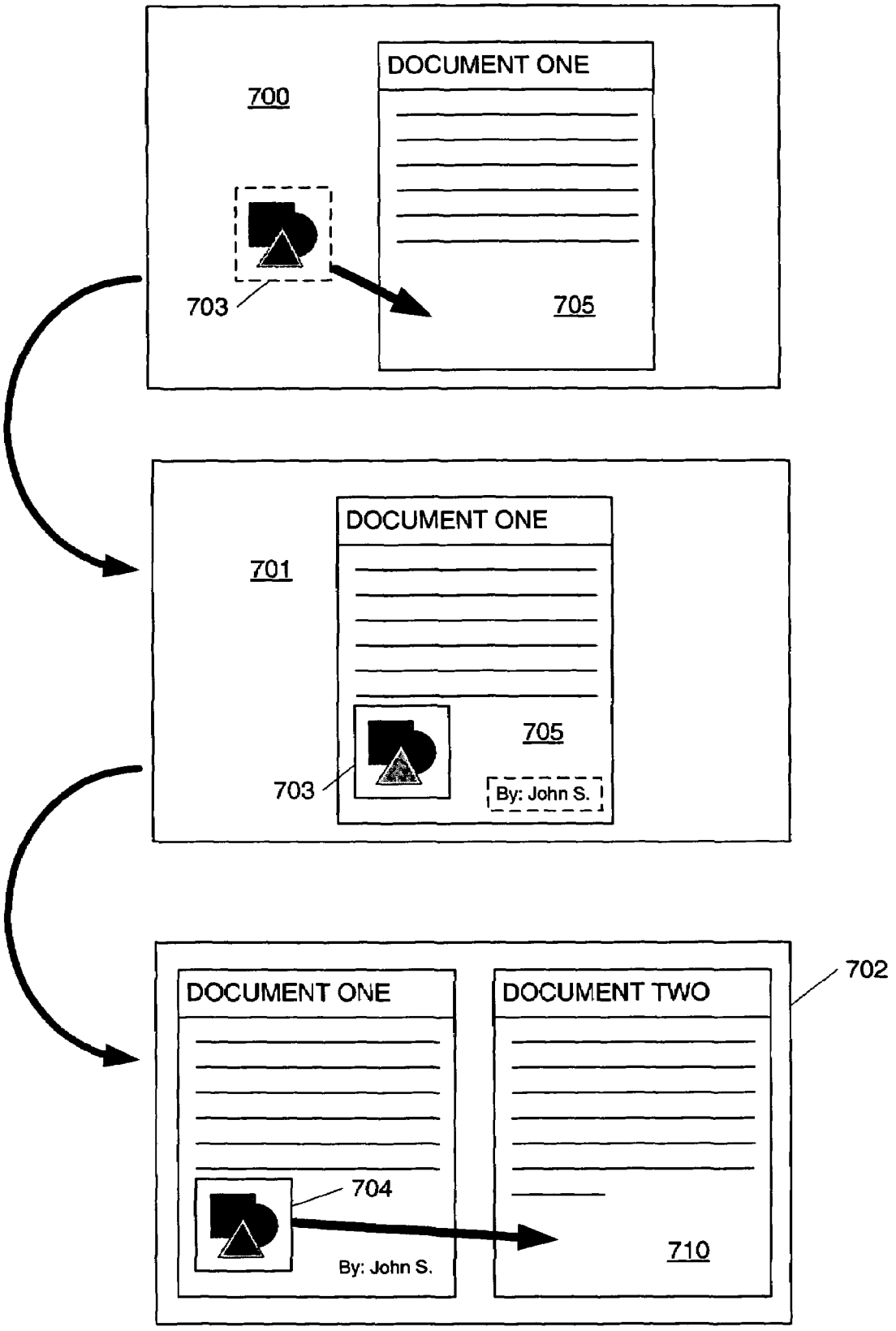
DOCUMENT ONE
700
703
705
DOCUMENT ONE
701
705
703
By: John S.
DOCUMENT ONE
DOCUMENT TWO
702
704
By: John S.
710

FIG. 7

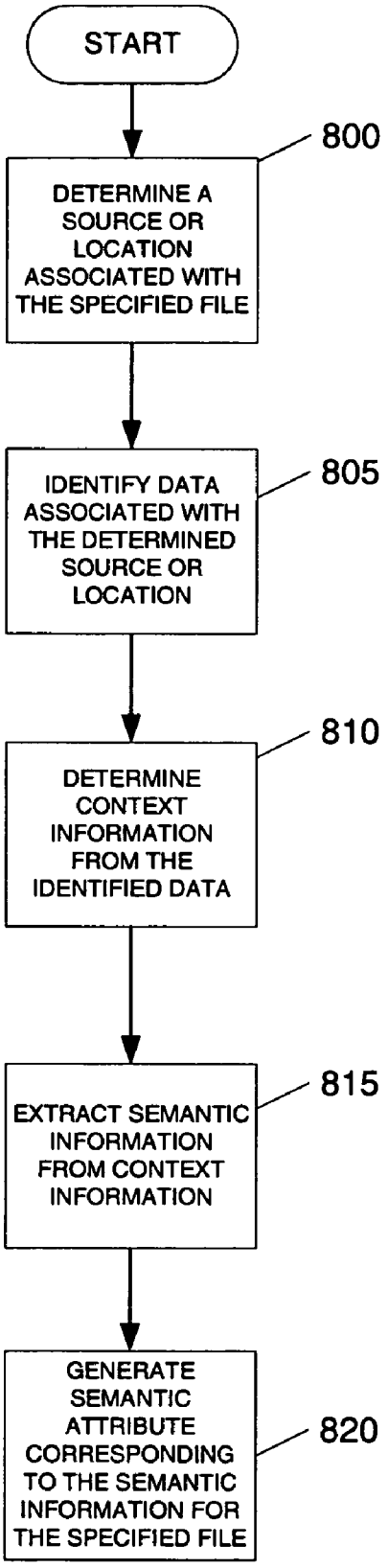
START
800
DETERMINE A SOURCE OR LOCATION ASSOCIATED WITH THE SPECIFIED FILE
805
IDENTIFY DATA ASSOCIATED WITH THE DETERMINED SOURCE OR LOCATION
810
DETERMINE CONTEXT INFORMATION FROM THE IDENTIFIED DATA
815
EXTRACT SEMANTIC INFORMATION FROM CONTEXT INFORMATION
820
GENERATE SEMANTIC ATTRIBUTE CORRESPONDING TO THE SEMANTIC INFORMATION FOR THE SPECIFIED FILE

FIG. 8

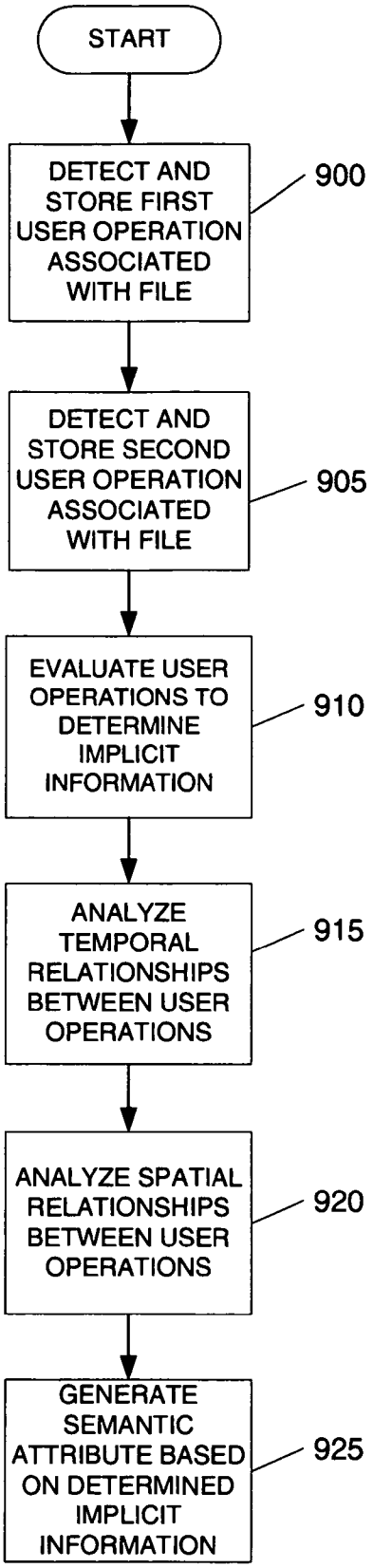
START
DETECT AND STORE FIRST USER OPERATION ASSOCIATED WITH FILE
900
DETECT AND STORE SECOND USER OPERATION ASSOCIATED WITH FILE
905
EVALUATE USER OPERATIONS TO DETERMINE IMPLICIT INFORMATION
910
ANALYZE TEMPORAL RELATIONSHIPS BETWEEN USER OPERATIONS
915
ANALYZE SPATIAL RELATIONSHIPS BETWEEN USER OPERATIONS
920
GENERATE SEMANTIC ATTRIBUTE BASED ON DETERMINED IMPLICIT INFORMATION
925

FIG. 9

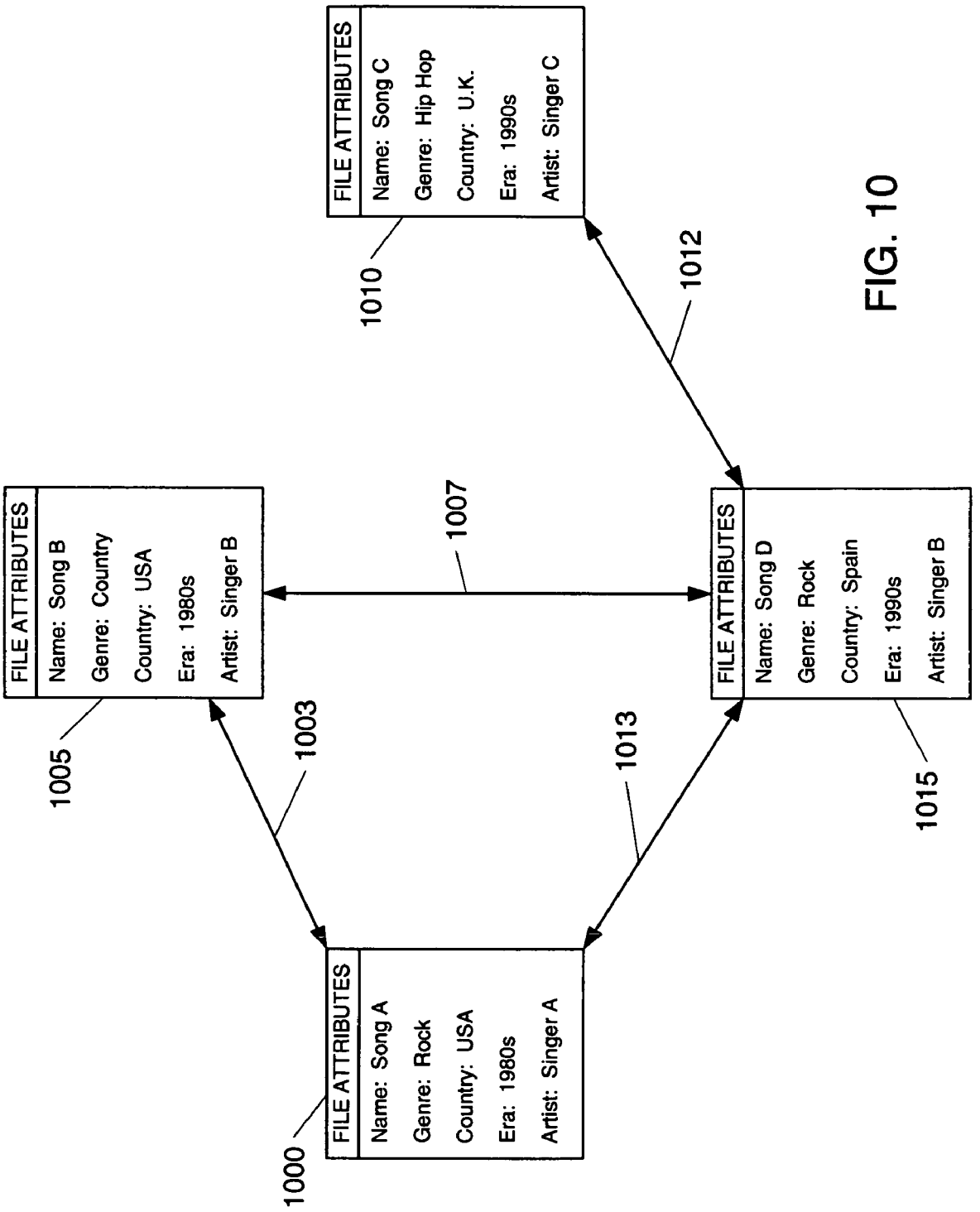
FILE ATTRIBUTES
Name: Song A
Genre: Rock
Country: USA
Era: 1980s
Artist: Singer A
1000
FILE ATTRIBUTES
Name: Song B
Genre: Country
Country: USA
Era: 1980s
Artist: Singer B
1005
FILE ATTRIBUTES
Name: Song C
Genre: Hip Hop
Country: U.K.
Era: 1990s
Artist: Singer C
1010
FILE ATTRIBUTES
Name: Song D
Genre: Rock
Country: Spain
Era: 1990s
Artist: Singer B
1015
1003
1007
1012
1013

FIG. 10

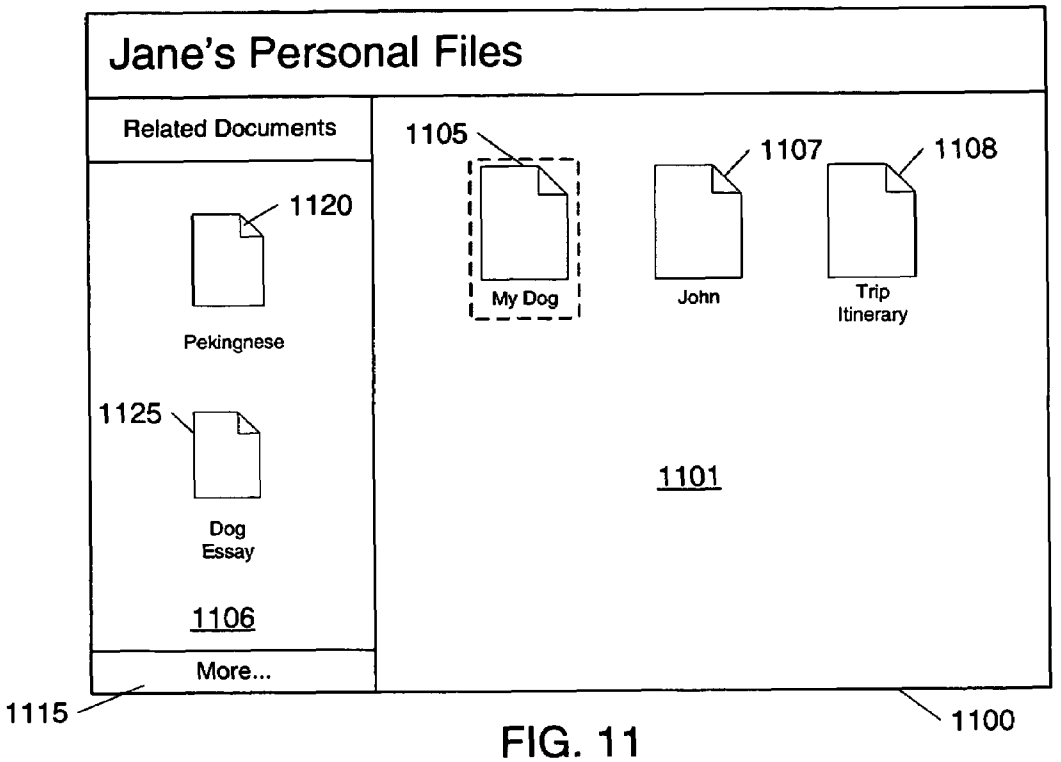
Jane's Personal Files
Related Documents
1105
1107
1108
1120
My Dog
John
Trip Itinerary
Pekingnese
1125
Dog Essay
1101
1106
More...
1115
1100

FIG. 11

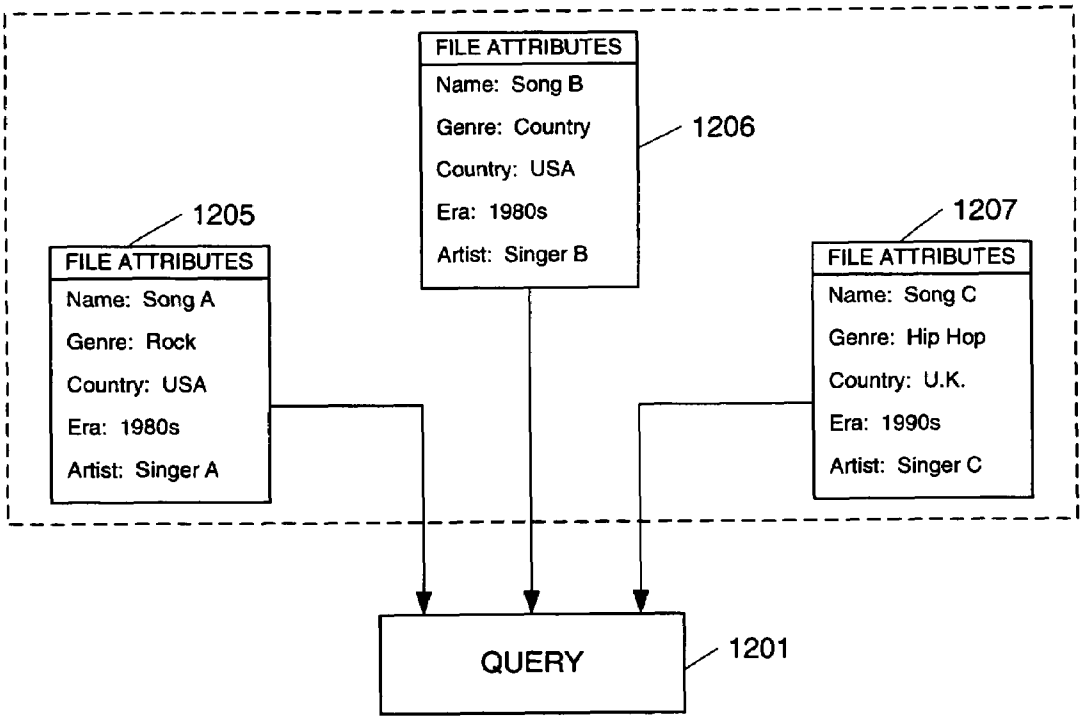
FILE ATTRIBUTES
Name: Song B
Genre: Country
Country: USA
Era: 1980s
Artist: Singer B
1206
1205
FILE ATTRIBUTES
Name: Song A
Genre: Rock
Country: USA
Era: 1980s
Artist: Singer A
1207
FILE ATTRIBUTES
Name: Song C
Genre: Hip Hop
Country: U.K.
Era: 1990s
Artist: Singer C
QUERY
1201

FIG. 12

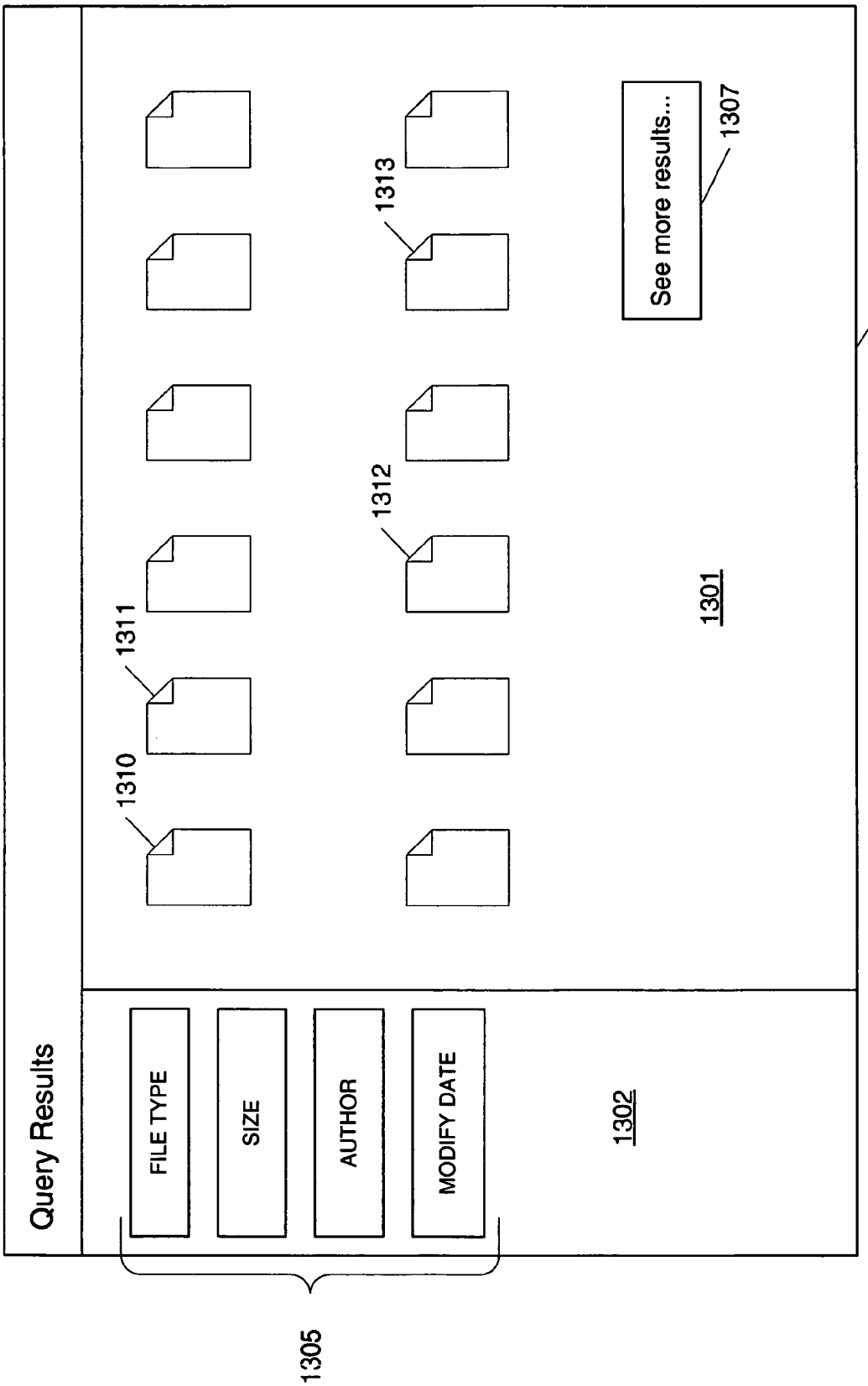
Query Results
FILE TYPE
SIZE
AUTHOR
MODIFY DATE
1305
1302
1301
See more results...
1307
1300
1310
1311
1312
1313

FIG. 13

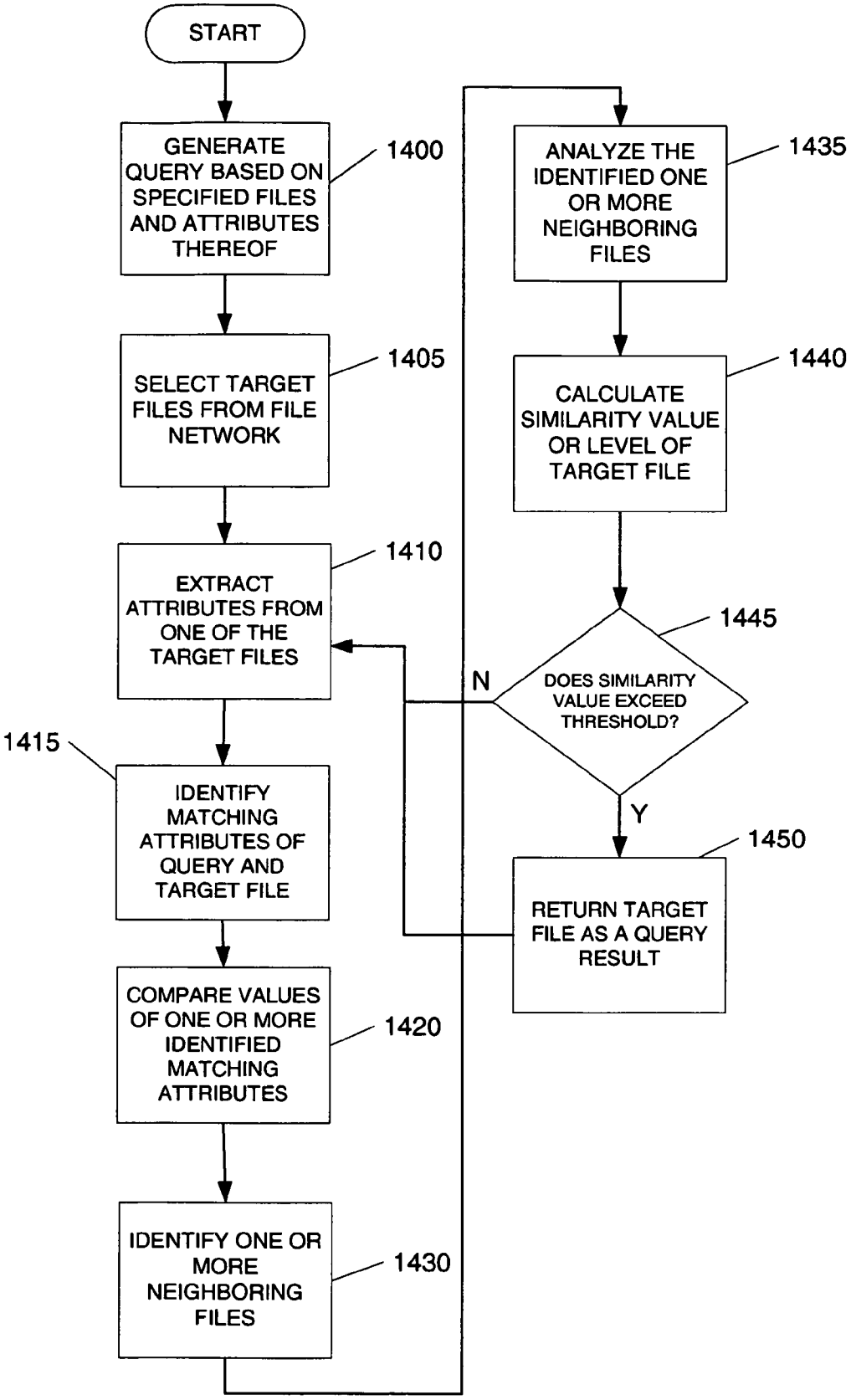
START
GENERATE QUERY BASED ON SPECIFIED FILES AND ATTRIBUTES THEREOF
1400
SELECT TARGET FILES FROM FILE NETWORK
1405
EXTRACT ATTRIBUTES FROM ONE OF THE TARGET FILES
1410
1415
IDENTIFY MATCHING ATTRIBUTES OF QUERY AND TARGET FILE
COMPARE VALUES OF ONE OR MORE IDENTIFIED MATCHING ATTRIBUTES
1420
IDENTIFY ONE OR MORE NEIGHBORING FILES
1430
ANALYZE THE IDENTIFIED ONE OR MORE NEIGHBORING FILES
1435
CALCULATE SIMILARITY VALUE OR LEVEL OF TARGET FILE
1440
1445
DOES SIMILARITY VALUE EXCEED THRESHOLD?
N
Y
1450
RETURN TARGET FILE AS A QUERY RESULT

FIG. 14

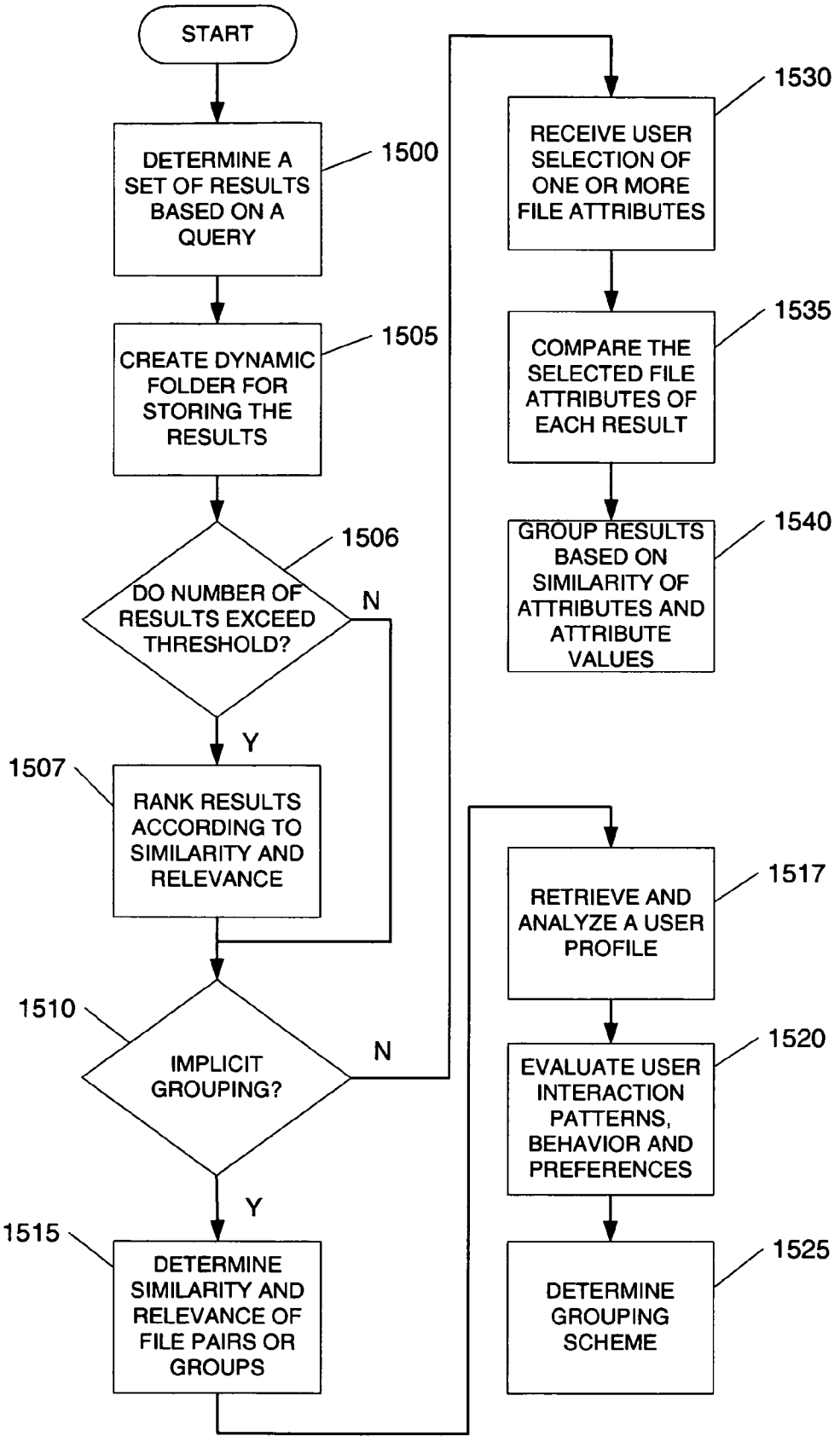
START
DETERMINE A SET OF RESULTS BASED ON A QUERY
1500
CREATE DYNAMIC FOLDER FOR STORING THE RESULTS
1505
DO NUMBER OF RESULTS EXCEED THRESHOLD?
1506
N
Y
RANK RESULTS ACCORDING TO SIMILARITY AND RELEVANCE
1507
IMPLICIT GROUPING?
1510
N
Y
DETERMINE SIMILARITY AND RELEVANCE OF FILE PAIRS OR GROUPS
1515
RECEIVE USER SELECTION OF ONE OR MORE FILE ATTRIBUTES
1530
COMPARE THE SELECTED FILE ATTRIBUTES OF EACH RESULT
1535
GROUP RESULTS BASED ON SIMILARITY OF ATTRIBUTES AND ATTRIBUTE VALUES
1540
RETRIEVE AND ANALYZE A USER PROFILE
1517
EVALUATE USER INTERACTION PATTERNS, BEHAVIOR AND PREFERENCES
1520
DETERMINE GROUPING SCHEME
1525

FIG. 15

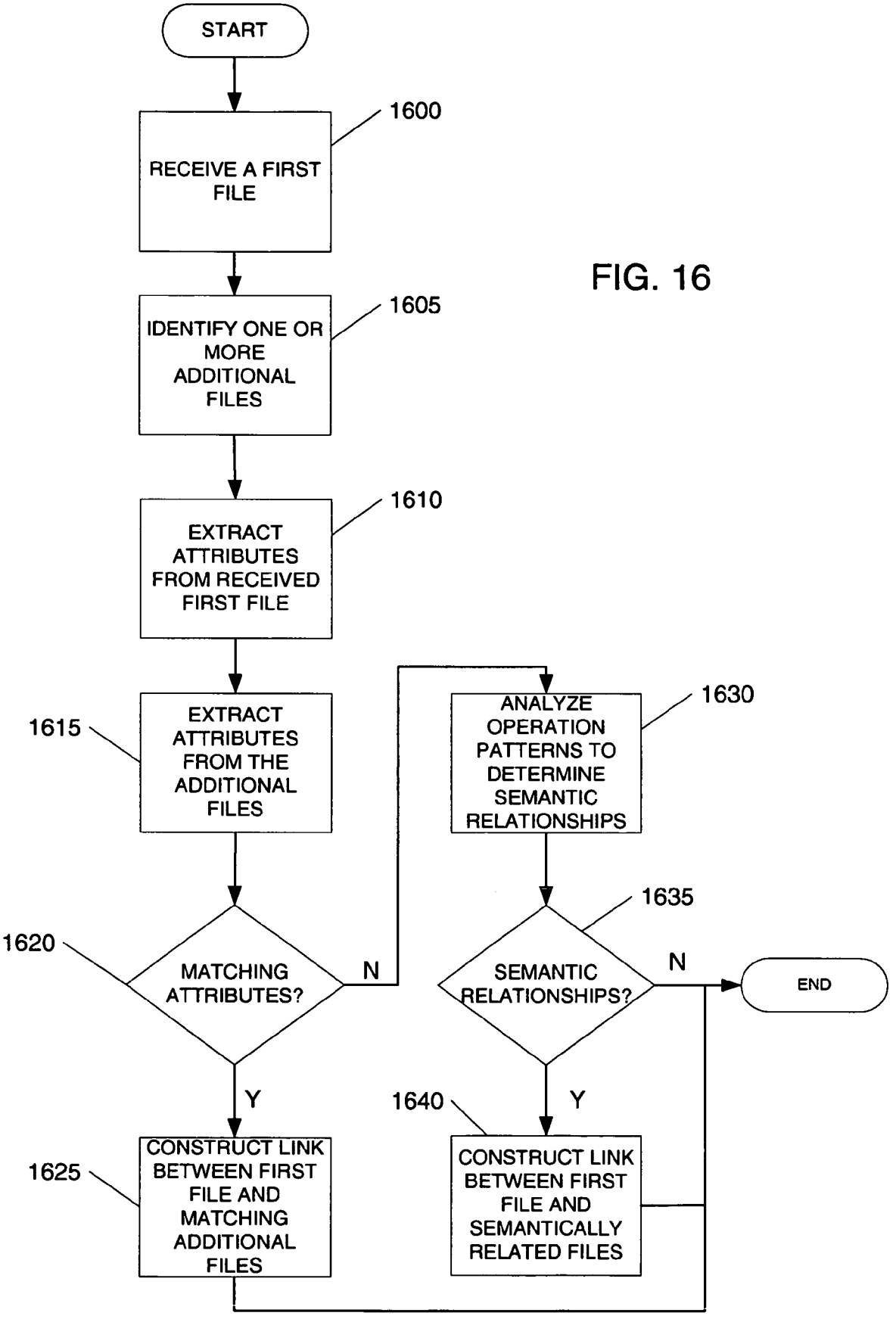
START
RECEIVE A FIRST FILE
1600
IDENTIFY ONE OR MORE ADDITIONAL FILES
1605
EXTRACT ATTRIBUTES FROM RECEIVED FIRST FILE
1610
EXTRACT ATTRIBUTES FROM THE ADDITIONAL FILES
1615
MATCHING ATTRIBUTES?
1620
N
Y
CONSTRUCT LINK BETWEEN FIRST FILE AND MATCHING ADDITIONAL FILES
1625
ANALYZE OPERATION PATTERNS TO DETERMINE SEMANTIC RELATIONSHIPS
1630
SEMANTIC RELATIONSHIPS?
1635
N
Y
END
CONSTRUCT LINK BETWEEN FIRST FILE AND SEMANTICALLY RELATED FILES
1640

FIG. 16

ADAPTIVE GROUPING IN A FILE NETWORK

BACKGROUND

Electronic file and data storage systems allow a user to save, organize and manage a substantial amount of information within a single computing device. Thus, rather than carrying the actual documents, a user may simply access a computing device such as a laptop computer. These storage systems further provide organizational systems whereby files may be arranged by the user in a meaningful way. For example, all documents relating to a planned vacation may be saved into the same folder or various subdirectories thereof. Basic attributes of the files and other data structures are also embedded in such storage systems to permit users to locate or organize data by searching for a particular attribute and/or property. Data and files may also be sorted and organized according to these properties. These attributes and properties are typically predefined by the system and are often labeled or entered by the user.

However, current file systems ultimately limit a user's ability to search and locate files since they provide only basic properties and attributes. Additionally, users must often modify attributes and properties manually to maintain proper organization in the system. Further, the organization and management of file systems remain constant regardless of a user's manipulations or interactions with a particular file. Additionally, directories of files and other organizational structures are strictly location oriented rather than usage oriented.

SUMMARY

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

In particular, file systems and networks are unable to capitalize on implicit information and inferences that may be determined or drawn from user interactions and contextual information. Implicit information, as used herein, relates to relationships and attribute information that is derived based on an interpretation of user actions or data associated with a particular file. Aspects are thus directed to a method and system for extracting semantic information from contextual information and user operations relating to a specified file and generating semantic attributes for the specified file based on such information. Semantic attributes may include information such as a publication year for a document, a conference at which a slideshow was shown and an artist that performs a particular song. Contextual information may be determined from data surrounding or otherwise associated with the specified file. Accordingly, context information and semantic attributes may be determined from a text message of an e-mail to which a file is attached. For example, if an e-mail message is determined to relate to a particular piece of real estate property, a semantic attribute may be generated for a file attached to the e-mail, identifying a relationship between the file and the specified real estate property.

Semantic information and attributes may also be extracted based on user operations and a sequence thereof. Oftentimes, user operations have an inherent meaning or purpose that may allow a system or application to interpret one or more aspects of a file associated with the user operations. For example, a user may frequently access two files simultaneously. Based on this behavior or operation pattern, a semantic attribute may be generated associating the two files (e.g., referencing one file to the other). Semantic attributes may further be generated based on a combination of context information and user operation history as well as other sources of file information.

In another aspect, semantic attributes may be automatically updated in response to detecting a change or modification in the context information or operation history associated with that particular attribute. In one instance, a semantic attribute generated for a file embedded in a word processing document may be updated if the underlying document is modified. The update to the semantic attribute may reflect the modification in context of the document or the user interaction involved in modifying the document or both.

In another aspect, the semantic attributes may be used to build a semantic file network in which files may be linked to one another based on identical or similar attributes. Relevance and similarity between files and attributes may be determined based on a similarity calculation. The similarity calculation may take into account various information including the attributes and data associated with neighboring or associated files or data. The semantic file network may further link one file to another if a user's operations support such an inference. The links between files may be static or dynamic. In other words, once a link is created, the link may continue to exist until explicitly destroyed by the user or some other process. On the other hand, dynamic links may be modified in response to a particular event such as a user modifying the attributes of a file or the links may be modified according to a predefined schedule. The semantic file network may be built with a combination of dynamic and static links that apply to different parts of the file network.

According to yet another aspect, browsing the semantic file network may be enhanced by the semantic links between files. That is, browsing clues such as related files or other data may be provided to the user based on the semantic links as a user browses or navigates through files. For example, if a user access a file or highlights a file in a folder, a list of semantically related or linked files may be presented to the user. Users may further post queries to retrieve files based on semantic attributes and information and associated semantic links. In one example, a user may post a query based on a collection of files. The file attributes of the collection of files may be automatically combined to produce a query of semantic information. A query may also be run based on a combination of semantic information and non-semantic information.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is illustrated by way of example and not by limitation in the accompanying figures in which like reference numerals indicate similar elements and in which:

FIG. **1** illustrates a block diagram of a general-purpose digital computing environment that can be used to implement various aspects of the present disclosure.

FIG. **2** is a diagram of a file properties dialog according to one or more aspects described herein.

FIG. **3** is a user interface displaying an electronic mail message with attachments according to one or more aspects described herein.

FIG. **4** is a user interface displaying multiple explorer windows corresponding to different storage locations according to one or more aspects described herein.

FIG. **5** is a user interface displaying a web browser and associated web page having text content, links and icons according to one or more aspects described herein.

FIG. **6** is a user interface displaying three file windows and a user operation associated with the file windows according to one or more aspects described herein.

FIG. **7** illustrates a series of user interfaces displaying a sequence of user operations according to one or more aspects described herein.

FIG. **8** is a flowchart illustrating a method for determining context information and extracting semantic attributes based on the context information according to one or more aspects described herein.

FIG. **9** is a flowchart illustrating a method for determining semantic attributes based on one or more user operations according to one or more aspects described herein.

FIG. **10** is a block diagram illustrating semantic links created based on similar or identical file attributes according to one or more aspects described herein.

FIG. **11** is a user interface displaying an explorer window associated with a folder having multiple files and a window pane providing related documents according to one or more aspects described herein.

FIG. **12** is a block diagram of building a query based on a collection of files and their attributes according to one or more aspects described herein.

FIG. **13** is a user interface showing the results of a query in a dynamic folder according to one or more aspects described herein.

FIG. **14** is a flowchart showing a method for running a query and determining relevance and similarity between a query and target files according to one or more aspects described herein.

FIG. **15** is a flowchart showing a method for adaptively grouping results of a query according to one or more aspects described herein.

FIG. **16** is a flowchart showing a method for building a semantic file network according to one or more aspects described herein

DETAILED DESCRIPTION

In the following description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration various embodiments. It is to be understood that other embodiments may be utilized and structural and functional modifications may be made without departing from the scope of the present disclosure.

FIG. **1** illustrates a schematic diagram of a general-purpose digital computing environment. In FIG. **1**, a computer **100** includes a processing unit **110**, a system memory **120**, and a system bus **130** that couples various system components including the system memory **120** to the processing unit **110**. The system bus **130** may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory **120** may include read only memory (ROM) **140** and random access memory (RAM) **150**.

A basic input/output system **160** (BIOS), which contains the basic routines that help to transfer information between elements within the computer **100**, is stored in the ROM **140**. The computer **100** also may include a hard disk drive **170** for reading from and writing to a hard disk (not shown), a magnetic disk drive **180** for reading from or writing to a removable magnetic disk **190**, and an optical disk drive **191** for reading from or writing to a removable optical disk **199**, such as a CD ROM or other optical media. The hard disk drive **170**, magnetic disk drive **180**, and optical disk drive **191** are connected to the system bus **130** by a hard disk drive interface **192**, a magnetic disk drive interface **193**, and an optical disk drive interface **194**, respectively. These drives and their associated computer-readable media provide nonvolatile storage of computer-readable instructions, data structures, program modules, and other data for the personal computer **100**. It will be appreciated by those skilled in the art that other types of computer-readable media that can store data that is accessible by a computer, such as magnetic cassettes, flash memory cards, digital video disks, Bernoulli cartridges, random access memories (RAMs), read only memories (ROMs), and the like, may also be used in the example operating environment.

A number of program modules can be stored on the hard disk drive **170**, magnetic disk **190**, optical disk **199**, ROM **140**, or RAM **150**, including an operating system **195**, one or more application programs **196**, other program modules **197**, and program data **198**. A user can enter commands and information into the computer **100** through input devices, such as a keyboard **101** and pointing device **102** (such as a mouse). Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, or the like. These and other input devices often are connected to the processing unit **110** through a serial port interface **106** that is coupled to the system bus **130**, but they also may be connected by other interfaces, such as a parallel port, game port, or a universal serial bus (USB), and the like. Further still, these devices may be coupled directly to the system bus **130** via an appropriate interface (not shown).

A monitor **107** or other type of display device also may be connected to the system bus **130** via an interface, such as a video adapter **108**. In addition to the monitor **107**, personal computers typically include other peripheral output devices (not shown), such as speakers and printers. In some example environments, a stylus digitizer **165** and accompanying stylus **166** are provided in order to digitally capture freehand input. Although a connection between the digitizer **165** and the serial port interface **106** is shown in FIG. **1**, in practice, the digitizer **165** may be directly coupled to the processing unit **110**, or it may be coupled to the processing unit **110** in any suitable manner, such as via a parallel port or another interface and the system bus **130** as is known in the art. Furthermore, although the digitizer **165** is shown apart from the monitor **107** in FIG. **1**, the usable input area of the digitizer **165** may be co-extensive with the display area of the monitor **107**. Further still, the digitizer **165** may be integrated in the monitor **107**, or it may exist as a separate device overlaying or otherwise appended to the monitor **107**.

The computer **100** can operate in a networked environment using logical connections to one or more remote computers, such as a remote computer **109**. The remote computer **109** can be a server, a router, a network PC, a peer device or other common network node, and it typically includes many or all of the elements described above relative to the computer **100**, although for simplicity, only a memory storage device **111** has been illustrated in FIG. **1**. The logical connections depicted in FIG. **1** include a local area network (LAN) **112** and a wide area network (WAN) **113**. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets, and the Internet, using both wired and wireless connections.

When used in a LAN networking environment, the computer **100** is connected to the local area network **112** through a network interface or adapter **114**. When used in a WAN networking environment, the computer **100** typically includes a modem **115** or other means for establishing a communications link over the wide area network **113**, such as the Internet. The modem **115**, which may be internal or exter-

nal to the computer **100**, may be connected to the system bus **130** via the serial port interface **106**. In a networked environment, program modules depicted relative to the personal computer **100**, or portions thereof, may be stored in the remote memory storage device.

It will be appreciated that the network connections shown are examples, and other techniques for establishing a communications link between computers can be used. The existence of any of various well-known protocols such as TCP/IP, Ethernet, FTP, HTTP, UDP, and the like is presumed, and the computer **100** can be operated in a user-server configuration to permit a user to retrieve web pages from a web-based server. Any of various conventional web browsers can be used to display and manipulate data on web pages.

Although the FIG. **1** environment shows one example environment, it will be understood that other computing environments also may be used. For example, an environment may be used having fewer than all of the various aspects shown in FIG. **1** and described above, and these aspects may appear in various combinations and subcombinations that will be apparent to one of ordinary skill. Additional elements, devices or subsystems also may be included in or coupled to the computer **100**.

FIG. **2** illustrates a file properties dialog window **200** having operating system and application defined properties **205** and semantic attributes **210**. In one or more configurations, user dialog window **200** may be displayed on a user interface of monitor **107** (FIG. **1**). System and application defined properties **205** include information such as file name, size, creation date, type of file and date of last access. Properties **205** and attributes **210** may be generated at various times including when the file is first created or received on a particular system, when the file is modified and/or when the file is accessed. The information associated with system or application properties **205** is generally automatically generated according to file types, file sizes and/or relevant applications. Some properties, such as the file name, may be either manually specified by the user or automatically generated according to a predefined naming scheme. Semantic attributes **210**, as used herein, relate to properties and characteristics which are not predefined by an underlying operating system or application and that are determined based on an interpretation or meaning of associated content or data and user interactions. Attributes **210** may include a variety of information including keywords and file associations. Some attributes **210** may be related to file specific information such as a reference to a drawing and housing type attribute for files relating to real estate. Semantic attributes **210** are generated based on the meaning and/or interpretation of data or user operations associated with the particular file. Semantic attributes **210** may further be generated based on general information such as file types, relevant applications, user labeling and/or file content. In one example, one or more semantic attributes such as music genre and song title may be generated based on an evaluation of song lyrics contained within a music file. Similarly, semantic attributes related to a song title, composer and artist may be extracted from a lyric file associated with a particular song. In another example, a user may label a digital photograph with names of people captured in the photo. Accordingly, a semantic attribute indicative of a number of people in the photo may be extracted and generated for the photo file based on the names of the people captured. Semantic attributes of a file may be stored in a variety of ways including as meta-data in a meta-data file associated with the file. The meta-data file may be stored in the same location as the file or may be stored in a designated location. Additionally or alternatively, semantic attributes may be stored in a central database and indexed according to the identity of the associated file. As such, when accessing a particular file, the associated semantic attributes may be located and retrieved from the central database.

Semantic attributes **210** may be extracted and/or generated through analyzing a context associated with the file and evaluating an operation history associated with a particular file. Context information relates to data and information surrounding a particular file or piece of content which provides meaning or interpretation to the file or content. Context information may be determined from a variety of sources including attributes or content associated with a folder in which a file is currently stored and/or an electronic mail (e-mail) message in which the file is received. As such, in one instance, an attribute identifying a document author may be determined and generated based on the contents of an e-mail message to which the document was attached. Additionally, semantic file attributes **210** may be extracted from an operation history that may include user interactions and previous file operations. User operations and interactions may be evaluated or analyzed from a temporal (historical) perspective and/or on a spatial (relational) basis. Temporal relationships relate to associations between a sequence of user interactions as they occur over a period of time. For example, a semantic file may define and generate an attribute for a file relating to a time of day that the file is most frequently used or accessed. The time of day attribute may be generated based on a historical evaluation of when a user most frequently accesses the file. Thus, if a user frequently enters time in a time worksheet in the late afternoon, a semantic attribute identifying the late afternoon as the time of most frequent use or access may be generated for the time worksheet file.

Spatial relationships, on the other hand, relate to an association between multiple files that are based on one or more user interactions between the multiple files. In one or more instances, a user may cut and paste portions of a first file into a second file thereby creating an association between the first file and the second file. As such, the association between the first and second files may be reflected in a semantic attribute. In another example, a drawing file may be added to the semantic attributes of a children's story file if the system determines that the drawing file and the story file are frequently open at the same time. One of skill in the art will appreciate that a variety of user interactions or operations may include implicit semantic relationships and information that may serve as a basis for generating semantic attributes.

FIG. **3** is a diagram illustrating an e-mail **300** and contents thereof. The e-mail, like dialog window **200** (FIG. **2**), may be displayed on a display device such as monitor **107** (FIG. **1**). E-mail **300** may further be received through a variety of networks including LAN **112** and WAN **113** (FIG. **1**). E-mail **300** includes multiple fields and components such as recipient field **323**, sender field **325**, attachments **305** and **310**, subject line **327** and message **315**. Message **315** includes a text message that contains one or more keywords such as keyword **320**. Keywords may be identified based on a frequency of use or appearance in message **315**. Identification of keywords may, additionally or alternatively, be based on the appearance of the word (e.g., font size, style, color) and/or a context in which the word is used. Message **315** may also include information of various mediums including audio, video and text.

Semantic information and attributes for e-mail **300** and/or attachments **305** and **310** may be generated based on the contents of e-mail **300**. For instance, the recipient field **323** may contain a plurality of recipients of e-mail **300**. Semantic attributes directed to a purpose for or importance of e-mail **300** may be determined based on the list of recipients. If the

recipients include high level officials of a corporation, for example, an attribute indicative of the high importance of mail **300** and attachments **305** and **310** may be extracted and generated based on the importance of the recipients. Alternatively or additionally, if mail **300** is directed to technical support staff, mail **300** may be flagged with a purpose attribute identifying mail **300** as a support request. Further, a general subject matter of message **315** may be ascertained using various semantic analysis algorithms on message **315**. The determined subject matter may then be applied as attributes to mail **300** and attachments **305** and **310**. Keyword **320** and subject line **327** may also provide relevant context information.

FIG. **4** is a diagram of a user interface displaying two file explorer windows **405** and **410** for navigating to and locating music files **415**, **416** and **417** stored in a computing device such as computer **100** (FIG. **1**). In many graphical user interfaces, graphical elements such as windows **405** and **410** are commonly used to graphically represent folders that are used for organizing and storing various data structures like files **415**, **416** and **417**. In this configuration, music files **415**, **416** and **417** are organized based on the type of data. As such, music files **415**, **416** and **417** are located and stored in 80's subdirectory **410**, which is a subdirectory of Music folder **405**. One of skill in the art will appreciate that numerous types of management schemes and methods for organizing files **415**, **416** and **417** may be used. Each file **415**, **416** and **417** of 80's folder **410** may further include one or more file attributes including system and application defined properties such as a name and size of the file and/or semantic attributes such as a genre of music and/or a performance location of a particular song.

The contents and characteristics of folders **405** and **410** provide context information from which semantic attributes for each of files **415**, **416** and **417** may be generated. Accordingly, in one instance, the name of folder or directory **410** may contribute to the creation and definition of a semantic attribute associated with files **415**, **416** and **417**. For example, the name of folder **410** is "Madison Square Garden." Based on an analysis of the name, the underlying system or application may determine that Madison Square Garden is a concert venue. An inference may then be made that each of files **415**, **416** and **417** stored in folder **410** was performed at Madison Square Garden. As such, a semantic attribute may be created that identified the performance location of each of files **415**, **416** and **417** as Madison Square Garden. Other attributes of the folder may also be used in defining semantic attributes of files **415**, **416** and **417** stored therein. For example, a folder attribute may specify a number of times folder **410** has been accessed. Specifically, the frequency of access of folder **410** may contribute to a generating a popularity attribute for files **415**, **416** and **417**. In one or more configurations, attributes may further be gleaned from attributes of parent directories and one or more relationships between the parent directories and subdirectories. In other words, one or more attributes of a parent directory may provide context information for interpreting data or attributes associated with a subdirectory. For example, in FIG. **4**, the name of Music folder **405** provides context to the name of 80's folder **405**.

Similarly, the file attributes, contents and characteristics of each file **415**, **416** and **417** may also establish a context from which semantic attributes of each of the other files **415**, **416** and **417** may be determined. In particular, a comparison and analysis of one or more file attributes of files **416** and **417** may define semantic attributes for file **415**. For example, a comparison of the attributes associated with files **416** and **417** may reveal that both music files **416** and **417** are performed by the artist New Kids On The Block and that the lyrics of each file **416** and **417** are substantially similar. Based on the result of this comparison, an inference may be made that the artist who performs music file **415** is also the New Kids On The Block if the lyrics of file **415** are also similar to the lyrics of files **416** and **417**. Accordingly, an appropriate artist attribute for file **415** may be generated based on the surrounding context information (i.e., the contents and characteristics of neighboring files **416** and **417**). In another instance, a playlist position of music file **416** may be automatically established based on the playlist positions of music files **415** and **417**. For instance, if files **415** and **417** are in consecutive positions in the playlist and correspond to the same artist, file **416** may also be placed in a consecutive position to either file **415** or **417** if file **416** is also determined to be performed by the same artist.

Semantic attributes may further originate from an analysis of the contents of each music file **415**, **416** and **417**. The contents of music file **415**, **416** or **417** may include, for example, lyrics, musical scores and the like. Accordingly, in one or more configurations, a system or application may identify the instruments used in the music and automatically classify music files **415**, **416** and **417** based on a determined instrumental composition. Additionally, lyrics may also be a source of context information. For example, a genre of music associated with file **415** may be ascertained based on a comparison of the lyrics of file **415** with those of file **416**. Numerous other aspects of how, where and when a file is stored may also be used in establishing a context for generating one or more semantic attributes of the file.

FIG. **5** illustrates a web browser **500** displaying web page **501** with several hypertext links **510**, **511**, **512** and **513**, icons **515**, **516** and **517** and text **505**. Similar to attachments in an e-mail and files in a folder or directory, the various components of page **501** may also acquire semantic attributes based on a context established by one or more associated components. For example, link **510** or **511** may be stored in a data structure of a local file system that identifies link **510** as a favorite or frequently visited link. Various attributes may be associated with the local data structure storing link **510**. One or more semantic attributes may be generated for link **510**, or the associated storage structure, based on attributes, content or data associated with links **511**, **512** and **513**, text content **505** and/or icons **515**, **516** and **517**. In one example, web page **501** may address a political issue and present arguments on the issue that appeal to a first political party, Democrats, and arguments that appeal to a second political party, Republicans. As such, each of links **510**, **511**, **512** and **513** may lead to content that is politically biased. Accordingly, a political affiliation attribute of link **510** may be determined based on the surrounding text **505** as well as icons **515**, **516** and **517** and the contents and characteristics of other links **511**, **512** and **513**. If, for example, icon **515** depicts a donkey resembling the Democratic Party mascot, link **510** may be affiliated with the Democrats instead of the Republicans. Alternatively or additionally, an analysis of text **505** may reveal that the language used and viewpoints expressed therein are heavily Republican. Thus, using contextual information from the text analysis, the political affiliation attribute of link **510** may be identified or defined as Republican rather than Democratic. Further, the evaluation and analysis of context information may be expanded to include not just the characteristics and properties of links **511**, **512** and **513**, but also the contents of the pages identified by links **511**, **512** and **513**. Semantic attributes may be generated for each of icons **515**, **516** and **517** and page **501** based on a similar contextual analysis.

In one or more configurations, semantic attributes of data such as an icon, an e-mail message or a data file may be updated in response to detecting an update to the data or context associated with the file, icon or mail message. For example, the performance location of file **415** may be modified from Madison Square Garden to the United Center in response to detecting a corresponding change in the name of folder **410**. In another scenario, page **501** may relate to a toy advertisement with icon **515** depicting the toy. Initially, page **501** may provide context information that causes a semantic attribute to be created identifying icon **515** as a toy for children ages 2 and older. However, if a correction is made to page **501** to indicate that the toy is actually for children 5 and up, the age attribute of icon **515** may similarly be corrected upon detecting the change in the context information of page **501**. As such, a semantic attribute may be adaptive and aware of changes to context information on which the creation of the semantic attribute was based.

FIG. **6** illustrates a spatial relationship between two files **605** and **610** defined by at least one user operation. Underlying user interface **600** may further display a third file **615** that is open at the same time as files **605** and **610**. Based on the simultaneous access of files **605**, **610** and **615**, a semantic attribute may be generated for file **605** that stores an association with or reference to files **610** and **615**. File associations may further depend on whether files **610** and **615** are open or active on interface **600**. If, for example, a user minimizes file **615** but leaves file **610** open when accessing file **605**, an attribute associating file **610** with file **605** may be generated, but an attribute associating file **615** with file **605** might not. Alternatively, a relationship between files **605**, **610** and **615** may be based on whether the files **605**, **610** and **615** are concurrently active or open and/or the duration of the concurrent activity or use. Thus, even if file **605** is not simultaneously accessed or opened with file **610**, as long as files **605** and **610** are open concurrently for a specified duration, a file relationship may still be established between the two files **605** and **610**. The specified duration may be defined based on user preferences or based on a default set by an underlying semantic file system.

In one or more configurations, a semantic attribute identifying the file associations might not be created until after a user has simultaneously opened the three files a certain number of times. This threshold value may be predefined by the user or set by a default value. Other algorithms may also be incorporated in determining an appropriate frequency threshold value. A history of access times and other user operations may further be saved to files **605**, **610** and **615** or, additionally or alternatively, to a separate database that is responsible for tracking user operations. The stored historical user operation data may be used, for example, in evaluating whether a semantic attribute should be generated for a given file or data structure.

One or more semantic attributes may further be extracted and generated in response to other types of user operations beyond the simultaneous access of files **605**, **610** and **615**. As shown in FIG. **6**, a portion of file **610** is copied and pasted into file **605**. The copy and paste operation may signify to the system or underlying application that the relationship between files **605** and **610** is significant. As such, the user operation increases the likelihood that a semantic attribute associating files **605** and **610** may be generated. Semantic attributes generated based on spatial relationships of user operations are not limited to file associations and may include other types of inferences. In one example, portions of multiple files may be copied and pasted into file **605**. Upon detecting the multiple copy and paste operations associated with file **605**, a semantic attribute may be generated for file **605** that identifies file **605** as a compilation document. Numerous additional semantic attributes may be extracted and generated from a vast array of spatial relationships between files or other data structures.

FIG. **7** depicts a series of user interface screens **700**, **701** and **702** that illustrate a sequence of user operations associated with files **703**, **705** and **710** from which one or more semantic attributes are extracted. Initially, picture **703** is copied and pasted into word processing document **705** in screen **700**. The original file containing picture **703** is then closed in interface **701** at the same time a user enters author information **707** into document **705**. Subsequently, a second document such as document **710** is opened simultaneously with document **705** and picture **703** is copied from document **705** to document **710**. An operating system or application may analyze this series of user operations to determine relevant semantic information. In particular, a semantic attribute identifying the author of document **710** may be extracted from the sequence of user operations including the initial copying and pasting of picture **703**, the entry of author information into document **705** and the copying of picture **703** from document **705** to document **710**. More specifically, the semantic attribute system may establish a correlation between picture **703** and author information **707** entered by the user in interface **701** based on the sequence of user operations. Accordingly, a semantic attribute may be generated for subsequent documents to which picture **703** is attached or pasted identifying the author of the document in accordance with author information **707**

Additionally or alternatively, semantic information and attributes may be extracted from a combination of context information, user operations and other associated information and actions. Thus, even if the copying of picture **703** and corresponding entry of author information **707** in document **705** has only occurred once, context information may increase the likelihood that a correlation is established between picture **703** and author data **707**. For example, an analysis of the contents of documents **705** and **710** may reveal substantially similar content. Thus, the result of the comparison may provide a proper context for establishing the correlation between picture **703** and author information **707**. Other types of information from which semantic information may be extracted or determined include user labels, file type, associated applications and file content.

FIG. **8** is a flow chart showing a method for extracting a semantic attribute based on context information of a source or location of a file. In step **800**, a source or location of a specified file is initially determined. The source may include an e-mail to which the file is attached or a document in which the file is embedded. A location may include a directory or folder in which the file is stored, a network device, a database or any one of a number of storage structures. Once the source or location has been determined, data associated with the source or location is identified in step **805**. The data may include additional files stored within the source or location, attributes and other properties and/or content such as a text message of an e-mail. The data may further include audio, video and/or text. In step **810**, a context associated with the identified data is determined. The context may be determined in a variety of ways including comparing content between the identified data and/or between the content of the file and the identified data. In addition, context information may also be determined based on attributes or characteristics of the identified data and a comparison thereof. For example, a similarity or relevance between files may be determined by comparing the similarity of the attributes or characteristics. The determination of simi-

larity and relevance is discussed in further detail below. Attributes and properties may include author information, creation time, access time, file size, file type, application associations and the like. Language, audio and image analysis may also be used to evaluate text content in the identified data and determine an interpretation or meaning of the identified data. For example, images may be determined to be similar based on an analysis of color distribution.

Using the determined context information, semantic information may be extracted or determined in step **815**. For example, if a folder in which the file is stored is named "WWW2005," an inference may be drawn that relates the file to a WWW2005 conference. A semantic attribute may subsequently be generated for the file that identifies the relationship and/or inference in step **820**. The semantic attribute may be generated in a separate database or table associated with an underlying semantic file system or the attribute may be stored within the associated file. For example, the file may contain a header that stored all property and attribute information. Thus, based on the inference of the above example, a semantic attribute such as "Conference" with an associated value of WWW2005 may be generated for the file. Similarly, if a comparison between the file and at least a portion of the identified data results in a substantial similarity, a semantic attribute may be created for the file that references the relevant portion of the identified data. Examples of other types of information that may be inferred from context information include music genre, author/artist information, a general subject matter and the like.

FIG. **9** is a flowchart illustrating a method for determining semantic attributes from user operations. In step **900**, a first user operation associated with a file is detected and stored. In step **905**, a second user operation associated with a file is received and also stored. Depending on a variety of factors including user preferences, the user operations may be stored in a temporary buffer and/or a permanent database of user interactions. For example, the temporary buffer may store user operations that occurred within the past hour. Alternatively, a permanent database may be used to eliminate temporal restrictions in storing user operations. Upon receiving and storing the two user operations, each user operation may be individually evaluated to identify implicit information in step **910**. Inferences may be also drawn from the user operations based on a temporal relationship between the operations or files involved in the operations and/or a spatial relationship between the operations or files. Thus, in steps **915** and **920**, the user operations may be analyzed both temporally and spatially to extract any implicit or semantic relationships associated with the user operations. For example, an implied relationship between multiple files may be determined in response to detecting the simultaneous addition of specific content to each of the multiple files. In another example, a user may frequently play a series of music files in a specific order. As such, the implicit position of each music file in the play order may be identified based on a temporal evaluation of the user's pattern of access/use. In yet another example, an implicit relationship may be recognized between two files that are accessed almost always at the same time.

Upon identifying one or more inferences from the user operations, a semantic attribute may be created based on the inferences in step **925** and associated with one or more files involved in the user operations. The semantic attribute may be stored in a properties section of the one or more files, or, alternatively, may be stored in a separate database that stores semantic attributes along with corresponding file associations.

FIG. **10** is a block diagram illustrating a semantic file network built based on semantic links **1003**, **1007**, **1012** and **1013** between files **1000**, **1005**, **1010** and **1015**. Files **1000**, **1005**, **1010** and **1015** include similar sets of attributes but with varying values associated with those attributes. For example, each of files **1000**, **1005**, **1010** and **1015** include a genre attribute, however, the genres of files **1000**, **1005** and **1010** are different. Similarly, although each file **1000**, **1005**, **1010** and **1015** includes a country of origin attribute, the actual value associated with the attribute differs for each of files **1005**, **1010** and **1015**. As such, by comparing the attributes and associated values of each of files **1000**, **1005**, **1010** and **1015**, a file network may be created by building links **1003**, **1007**, **1012** and **1013** between files having common attributes and attribute values. For example, link **1003** signifies a relationship between files **1000** and **1005** based on identical countries of origin. Link **1007** conveys a relationship between files **1005** and **1015** based on a common singer, Singer B. Links **1012** and **1013** define similar relationships based on common eras and genres, respectively of the associated files **1000**, **10015** and **1010**.

Files **1000**, **1005**, **1010** and **1015** may be linked to multiple other files, a single other file or even no files depending on their attributes and semantic relationships. For instance, file **1010** is semantically linked to only one file, file **1015** while file **1015** is semantically linked to all three other files **1000**, **10015** and **1010**. Alternatively or additionally, semantic links **1003**, **1007**, **1012** and **1013** may also be established between one or more files based on having a common attribute, even if the common attribute of each file does not share the same value. In one example, files **1000** and **1005** may include an additional attribute named "Dedication" that identifies a person, place or thing to which the songs of files **1000** and **1005** are dedicated. Files **1010** and **1015**, on the other hand, might not have this attribute for a variety of reasons including if the songs associated with files **1010** and **1015** are not dedicated. A semantic link may thus be established between files **1000** and **1005** signifying a relationship between files **1000** and **1005** based on the common dedication attribute.

In one or more configurations, semantic links **1003**, **1007**, **1012** and **1013** may be created based on a user operation or a sequence of operations irrespective of whether files **1000**, **1005**, **1010** and **1015** share common attributes. For example, files that are contemporaneously accessed or used by similar user operations may be semantically linked. Similarly, if content of file **1010** is copied into file **1015**, a semantic relationship and link between file **1010** and file **1015** may be inferred based on the sequence of copy and paste user operations. Semantic links **1003**, **1007**, **1012** and **1013** may further be constructed based on a combination of factors including user operations, context information and attributes of the files. Once created, semantic links **1003**, **1007**, **1012** and **1013** may be stored in files **1000**, **1005**, **1010** and **1015** or in a separate table or database that also stores an association with the relevant files.

FIG. **11** is a user interface displaying a file browser window corresponding to folder **1100**. Folder **1100** is divided into two sub-windows, navigation pane **1101** and related documents pane **1106**. Navigation pane **1101** displays the contents of folder **100**, which include files **1105**, **1107** and **1108**. Related documents pane **1106**, on the other hand, displays representations of or links to files **1120** and **1125** and/or other types of data that are semantically linked to files **1105**, **1107** and **1108** or to only selected file **1105**. Related documents pane **1106** further includes an option **1115** to retrieve additional related documents or data. Related documents pane **1106** may be populated at various points in time including when one of files

1105, 1007 and 1108 is selected or accessed by the user. Alternatively, related documents pane 1106 may be populated upon opening folder 1100.

Related documents pane 1106, in FIG. 11, is populated in response to a user selection of file 1105 in navigation pane 1101. In particular, related documents pane 1106 is populated by files 1120 and 1125 in accordance with a user selection of file 1105. Files 1120 and 1125 are retrieved and displayed in pane 1106 based on semantic links that have been established between file 1105 and files 1120 and 1125 and/or based on the results of a semantic query. Semantic queries are discussed in further detail below. In one example, semantic links exist between file 1105 and files 1120 and 1125 because the files 1105, 1120 and 1125 are all related to dogs. As such, upon selecting file 1105 in navigation pane 1101, the file system automatically determines and retrieves files 1120 and 1125 that are semantically linked based on a dog attribute. In particular, file 1120 is associated with a photo of a Pekingnese dog while file 1125 pertains to an essay about dogs. Additional files (not shown) may also be retrieved that are semantically related or linked based on one or more user operations that define implicit relationships between files. While FIG. 11 displays related documents in association with a browser window like window 1100, related and linked documents may also be provided to the user when the user is using other various applications. For example, related documents may be retrieved when a user is editing a word processing document. In another scenario, one or more linked or related files may be identified and presented to the user while a user is viewing a series of photographs using an image editing application.

Additionally, More option 1115 allows a user to view or retrieve additional files that are linked or otherwise related to selected file 1105. For example, selecting more option 1115 may open a separate related documents window or dialog (not shown) that displays the entire list of identified related files. In one or more configurations, upon selecting one of the other files 1107 and 1108, the related documents pane 1106 may automatically be modified and updated in accordance with the attributes and links of the newly selected file, i.e., either file 1107 or 1108. The detection of numerous other user operations may also trigger the update of related documents window 1106. For example, window 1106 may be updated in response to a user hovering over file 1107 or 1108.

FIG. 12 is a block diagram illustrating the formation of a query for retrieving data from a semantic file network. Queries such as query 1201 in a semantic file network may be based on traditional keyword and file type information in addition to semantic attributes and relationships. The use of semantic attributes and relationships allows a user to construct a query based on a selected file or group of files 1205, 1206 and 1207. A user is thus relieved of having to manually generate and enter keywords or define numerous parameters for the query. Instead, queries may be developed or constructed by collecting and using the attributes of the single file or the group of files 1205, 1206 and 1207 to identify related files in the semantic network. Files 1205, 1206 and 1207 include several file attributes that may be extracted or generated in accordance with the methods and systems described herein. Upon selecting the group of files 1205, 1206 and 1207 as the query parameters, the file network system may analyze each file 1205, 1206 and 1207 to determine relevant attributes for inclusion in query 1201. In one instance, all of the attributes of files 1205, 1206 and 1207 may be included. Thus, query 1201 may include parameters identifying three different artists, two different eras and three different music genres. In another scenario, the query system may only select and use file attributes or values thereof that are common to a majority of files 1205, 1206 and 1207. For example, an era attribute corresponding to the 1980s common to files 1205 and 1206 may be included in the query while the 1990s era attribute of file 1207 might not.

FIG. 13 is a user interface displaying the results of a query including files 1310, 1311, 1312 and 1313, such as the one formed in FIG. 12, in dynamic folder 1300. Unlike typical folders, a dynamic or virtual folder, as used herein, is created and defined based on one or more attributes that are not related or dictated by the underlying file system architecture. Dynamic folder 1300 is created in response to receiving a set of results from the network system based on the query. Folder 1300 stores the results as well as the original query and corresponding query parameters. As with other folders, once created, dynamic folder 1300 may be used to limit the scope of a particular search or query. For example, a user may limit a query to the results displayed in folder 1300. Dynamic folder 1300 includes two window panes, results pane 1301 and attribute pane 1302. Files 1310, 1311, 1312 and 1313 identified from the query are displayed in pane 1301 while various attribute options 1305 are displayed in pane 1302. Attribute options 1305 may include various file properties including file type, file size, author and the last modification date of the file.

Dynamic folder 1300 may further display the results of the query using an adaptive grouping technique. Adaptive grouping organizes the results into groups that have associated attributes or some other semantic relationship. Additionally, adaptive grouping includes two modes, namely implicit grouping and explicit adaptive grouping. Using explicit grouping, files are grouped according to a selected attribute option 1305. For example, if a user selects the file type option from pane 1302, the results of the query such as files 1310 and 1311 are grouped according to common file types in response. Similarly, if a user selects size, the results may be grouped based on their respective sizes. Multiple attributes or properties may be selected simultaneously to generate groups of results that contain multiple similar attributes. Additionally or alternatively, one selected attribute may be given more weight than a second selected attribute.

Implicit grouping, on the other hand, seeks to group results according to user preferences, access patterns and semantic attributes and relationships. That is, the file network automatically determines a grouping scheme based on semantic information and relationships associated with each of the files in the result set as well as in accordance with user preferences and access behavior. As such, attributes of the files as well as user operation patterns may be analyzed in determining appropriate grouping. For example, two result files such as files 1310 and 1311 may be frequently accessed or opened concurrently. Thus, based on this user operation pattern, files 1310 and 1311 may be grouped together using implicit adaptive grouping. In another example, files that are semantically linked may be automatically grouped together. In yet another example, a user may prefer to group files based on file types over based on semantic relationships. This preference may be explicitly set by the user or it may be implicitly learned based on the user's manual grouping behaviors. User preferences, user operations and operation patterns may further be stored in a user profile. The user profile may then be retrieved and analyzed to determine a preferred grouping arrangement when sorting a set of query results. Further, various semantic attributes or user operation patterns may be given more weight to provide a user with desirable groupings. These weights may also be based on user preferences which may be discerned from the user profile. As such, concurrent access of files 1310 and 1311 may be given more weight than a similar

semantic attribute shared by files **1310** and **1312**. The weighing may be determined based on user behavior and preferences and/or default system settings. User behavior and preferences may further be learned over time and based on previous groupings manually set by the user. In the event that too many results are identified based on a given query, the results displayed in results pane **1301** may be abbreviated. In addition, additional results **1307** option may be included in folder **1300** to allow a user to see the rest of the results.

FIG. **14** is a flowchart illustrating a method for running a query in a semantic file network and determining a level of relevance and similarity between a target file and a query. In step **1400**, a query is generated based on attributes of one or more files associated with the query. In particular, attributes of each of the one or more files may be extracted and stored in the query. The attributes stored in the query may also be manually specified by the user. In step **1405**, a set of target files is selected from the semantic file network for analysis in response to the query. The set of target files may include all of the files within the semantic file network or, alternatively, may include a subset selected based on a variety of factors. For example, the target files may be selected based on a storage location specified by the user. Once the target files have been selected and identified, attributes are extracted from each of the target files in step **1410**. The extracted attributes are then compared to the one or more properties and/or attributes of the query. In particular, the attributes of the target file and the attributes of the query are compared to determine whether there are any matching attributes in step **1415**. If so, the values of the matching attributes are then compared to determine whether the values are the same or similar in step **1420**.

After evaluating the target file, itself, one or more neighboring or associated files may be identified in step **1430**. The neighboring or associated files are analyzed in step **1435** in a similar manner as with the target file. That is, processes similar to those of steps **1415** and **1420** are performed for each neighboring or associated file to determine similarity of each of the neighboring files with the query. Once each of the neighboring and/or associated files have been appropriately evaluated, an overall similarity value for the target file is generated in step **1440** based on the amount of mutual information between the target file and the query as well as between the query and each of the neighboring files. In one or more configurations, the similarity value may be calculated according to the following equation:

$$S(q,f) = a * I(q,f) + (1-a) * \sum_{<e,f>\in E} S(q,e)$$

The function S represents a similarity value while the function I corresponds to mutual information between two variables. The variable q represents the query and the variable f represents a target file while variable e corresponds to f's neighbors and a constitutes an adjustable weight. The equation determines a similarly value between a query q and a target file f based on mutual information I of query q and file f in addition to a summation of the similarities between query q and neighboring files e. The weight a may be modified to give more weight to mutual information between the query and the target file and less weight to the similarity value between the query and the target file's neighbors or associated files or vice versa. Variable E represents a linkage of files associated with target file f. Thus, according to the above equation, the summation of similarities includes all neighbor files with which file f is linked.

Once the similarity value has been determined in step **1440**, the similarity value or level is compared to a threshold similarity or relevance in step **1445**. If the similarity level meets or exceeds the threshold, then the target file may be returned in the query results in step **1450**. If the similarity level is below the threshold, however, the target file might not be returned. The threshold may be predefined based on a user preference or a system default. Alternatively or additionally, the threshold may be automatically determined based on a minimum number of results to return. Thus, the threshold may be adjusted downward if an insufficient number of results are produced with the original threshold.

FIG. **15** is a flowchart illustrating a method for presenting the results of a query using adaptive grouping and ranking. In step **1500**, a set of results are determined based on the query. In response, a dynamic folder is created in step **1505** that stores the set of results, the query and any other information associated with the query. In one or more configurations, the folder may store links to the results rather than the results themselves. Various other storing techniques may also be implemented. In step **1506**, a determination is made regarding whether the number of results exceeds a particular threshold. If so, in step **1507**, the results may be ranked according to a level of similarity and relevance determined from the search. A predetermined number of results are shown to the user according to the ranking and the rest may be hidden and displayed upon request.

Additionally, user feedback such as the selection of a ranked result item may be recorded to enhance future queries and result ranking. In particular, according to the above equation, the ranking function may consider the similarity S between q and f. After user select f, then the metadata of q could be saved in the metadata of f. Therefore, when the next query q is submitted, f may receive a high similarity value and consequently a high rank. In one example, a user may enter a query about dogs with short hair. In response, a system may respond with a list of ranked results including a picture of a pug. If the user selects or accesses the picture, the semantic attributes associated with the original query may be added to the picture's attribute information. Accordingly, if the user were to repeat the query about dogs in the future, the pug picture file may be ranked higher than the rank it had in the first result list.

In step **1510**, a determination is made as to whether the results should be grouped using implicit adaptive grouping or explicit adaptive grouping. The determination may be based on a user selection and/or a system default. If the results are to be implicitly grouped, attributes of each of the results may be evaluated to determine a similarity or relevance of the results in step **1515**. A user profile containing user preferences and stored user operations is further retrieved in step **1517**. Based on the user profile, the user preferences, user access and interaction patterns are then evaluated in step **1520** to determine semantic relationships between the results. User access and interaction patterns as well as user preferences may be stored in a user profile. When determining a grouping scheme for the results, a user's profile may be retrieved to provide additional considerations in how the results should be grouped. For example, a user may prefer to group files that they frequently open concurrently. This user preference may be stored in a user profile. Upon receiving a set of query results, the grouping of the results would factor in the user's preference to have files that are concurrently accessed grouped together. As such, based on the analysis of file

attributes and user access patterns as well as user preferences, a grouping scheme is determined in step **1525** for the dynamic folder.

If, however, in step **1510**, it is determined that the results should be grouped using explicit adaptive grouping, a selection of a file attribute may be received from the user in step **1530**. File attributes that a user may select may include file size, file type, author and modification date. Other file attributes may also be included in a menu of file attributes. In step **1535**, compares the selected file attribute of each of the files with the selected file attribute of each of the other files. If the values of the selected file attributes of two files match, the two files may be grouped together in step **1540**. For example, if the authors of a first file and a second file match, the first file and the second file may be grouped together in a dynamic results folder. Once a grouping scheme or plan has been generated, a user may select one of the groups of files and a new dynamic folder may be generated that contains and displays only the selected group of files. Implicit and explicit grouping may also be used in combination to generate appropriate groups of results. The grouping of results allows a user to more efficiently review the results and determine which files are most relevant.

FIG. **16** is a flowchart illustrating a method for building a semantic file network and in particular, establishing semantic links between two files. In step **1600**, a first file is received and/or identified by the network system. The file may be new to the network or may have just been updated. In step **1605**, one or more additional files that may be relevant to the first file are identified. The one or more additional files may be identified by determining files that have similar file types or other attribute information. Once the one or more additional files have been identified the semantic network may extract one or more attributes from the first file in step **1610**. In step **1615**, one or more attributes may be extracted from the one or more additional files identified in step **1605**. The attributes and the values corresponding thereto are then compared in step **1620** to determine whether there are matching attributes and/or values between the first file and the one or more additional files. If there are matching attributes and/or values, a semantic link may be constructed between the first file and the one or more additional files that have a matching attribute and/or value in step **1625**. In one or more configurations, semantic links may be created upon detecting matching attributes, but not attribute values. Alternatively or additionally, semantic links may also be created upon finding two files with matching attributes values, but not attribute names. The latter case seeks to capture files which are related to the same attribute values, but which store the values under different attribute names. If a match is not found, the semantic file network may further analyze user operation patterns in step **1630** to determine whether a semantic relationship exists between the first file and any of the one or more additional files in step **1635**. If so, one or more semantic links may be constructed from the first file to the one or more additional files with which the first file has a semantic relationship in step **1640**. User operations may be evaluated independently of the attribute analysis. As such, user operations may be considered and evaluated regardless of whether files or data with matching attributes are found.

The methods and systems described herein have been discussed, in large part, with respect to data files and semantic attributes thereof. However, semantic attributes may be generated for a variety of data structures and the methods and systems described are not limited to just data files. For example, words of a text document may include various properties such as font size and font style. The words of a text document may further include semantic attributes extracted from surrounding context information. Similarly, a first portion of a photo may have different properties than a second portion of the photo. Accordingly, semantic attributes may be generated for the first portion of the photo based on an analysis of image content and attributes surrounding the first portion while separate semantic attributes may be generated for the second portion based on an analysis of the characteristics of the images surrounding the second portion.

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

We claim:

1. A computer readable medium storing computer readable instructions that, when executed, perform a method for adaptively grouping results of a semantic query, each result representing a file, the method comprising the steps of:

providing files of a file system, the files being organized into file system folders;

identifying user operations associated with files;

generating semantic attributes based on interpretation of the identified user operations associated with the files, at least one semantic attribute being generated when the interpretation indicates a user has simultaneously opened multiple files a first threshold number of times;

associating the generated semantic attributes with the files;

identifying a plurality of files associated with a semantic query by determining whether semantic attributes associated with the files match the semantic query, wherein the plurality of files includes files from different file system folders;

adaptively generating an implicit grouping of the identified files by:

determining whether one or more semantic attributes of a first file of the plurality of files matches the one or more semantic attributes of a second file of the plurality of files, and

in response to determining that the one or more semantic attributes of the first and second files match, grouping the first and second files;

creating a dynamic folder that is associated with the semantic query and the identified files associated with the semantic query, the dynamic folder for displaying the identified files of the semantic query according to the adaptively generated grouping

such that the dynamic folder is created based on one or more attributes not related to the organization of the file system and is associated with files from different file system folders;

determining whether a number of files exceeds a second threshold, wherein the second threshold identifies a limit to the number of files that the dynamic folder is able to display; and

in response to determining that the number of files exceeds the second threshold, ranking the files based on a similarity level of each of the plurality of files determined by the semantic query.

2. The computer readable medium of claim **1**, further comprising the steps of:

determining whether the first file contains the one or more semantic attributes; and

determining whether the second file contains the one or more semantic attributes.

3. The computer readable medium of claim 1, further comprising the steps of:

determining whether the first file and second file are semantically related based on one or more user operations associated with one of the first file and the second file; and

in response to determining that the first file and the second file are semantically related, grouping the first file and the second file.

4. The computer readable medium of claim 3, wherein the one or more user operations include concurrently accessing the first file with the second file.

5. A computer readable medium storing computer readable instructions that, when executed, perform a method for adaptively grouping results from a semantic query, each result being a file, the method comprising the steps of:

providing files of a file system, the files being organized into file system folders;

identifying user operations associated with files;

generating semantic attributes based on interpretation of the identified user operations associated with the files;

associating the generated semantic attributes with the files;

identifying a plurality of files associated with a semantic query submitted by a user by determining whether semantic attributes associated with files match the semantic query;

retrieving a user profile of the user, wherein the user profile includes user preferences and user access patterns;

determining a grouping scheme for grouping the identified plurality of files based on the retrieved user profile;

grouping the identified files into dynamic folders in accordance with the determined grouping scheme such that multiple files from different file system folders are grouped into a dynamic folder; and

for each dynamic folder, displaying, in association with the dynamic folder, the identified files grouped into the dynamic folder,

determining whether a number of files exceeds a second threshold, wherein the second threshold identifies a limit to the number of files that the dynamic folder is able to display, and

in response to determining that the number of files exceeds the second threshold, ranking the files based on a similarity level of each of the plurality of files determined by the semantic query.

6. The computer readable medium of claim 5, wherein the user access patterns imply a relationship between a first file of the plurality of files and a second file of the plurality of files.

7. The computer readable medium of claim 5, wherein the user preferences include one or more preferred grouping attributes.

8. The computer readable medium of claim 5, further comprising the steps of:

extracting one or more semantic attributes from a first file of the plurality of files;

extracting one or more semantic attributes from a second file of the plurality of files; and

comparing the one or more semantic attributes of the first file with the one or more semantic attributes of the second file.

9. The computer readable medium of claim 8, wherein a relevance between the first file and the second file is determined based on the comparison.

10. The computer readable medium of claim 5, wherein the plurality of files are displayed in a dynamic window.

11. The computer readable medium of claim 10, further comprising the steps of:

grouping the first file and the second file based on the retrieved user profile;

creating a separate dynamic window; and

displaying the first file and the second file in the separate dynamic window.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,634,471 B2
APPLICATION NO. : 11/392760
DATED : December 15, 2009
INVENTOR(S) : Chen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page:

The first or sole Notice should read --

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 273 days.

Signed and Sealed this

Ninth Day of November, 2010

David J. Kappos

David J. Kappos
Director of the United States Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,634,471 B2
APPLICATION NO. : 11/392760
DATED : December 15, 2009
INVENTOR(S) : Zheng Chen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

ln column 19, line 30, in Claim 5, before "files" delete "plurality of".

Signed and Sealed this
Eighth Day of February, 2011

David J. Kappos
Director of the United States Patent and Trademark Office