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Brette et al.

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(54) **USER INTERFACE FOR POLYMORPHIC LOOKUP**

(71) Applicant: **salesforce.com, inc.**, San Francisco, CA (US)

(72) Inventors: **Marc Brette**, Montbonnot (FR); **Glenn Sorrentino**, Oakland, CA (US); **James Vogt**, San Bruno, CA (US); **Naveen Veeravalli**, San Francisco, CA (US)

(73) Assignee: **salesforce.com, inc.**, San Francisco, CA (US)

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G06F 16/2457	(2019.01)
G06F 3/0484	(2013.01)
G06F 3/048	(2013.01)
G06F 16/9535	(2019.01)

(52) **U.S. Cl.**

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CPC G06F 17/30067; G06F 17/30126; G06F 17/30321; G06F 17/3053; G06F 17/30613; G06F 17/30619; G06F 17/30622; G06F 17/30831; G06F 17/30867; G06F 17/30873; G06F 17/30946; G06F 3/01; G06F 3/048; G06F 3/0481; G06F 3/04817; G06F 3/0482; G06F 3/0484; G06F 3/04842

See application file for complete search history.

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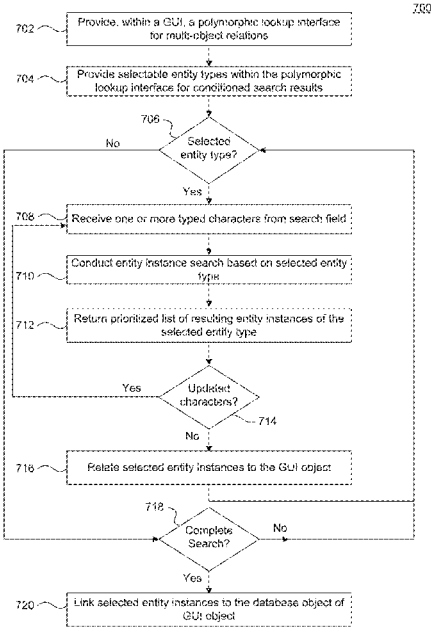
Primary Examiner — Diedra McQuitery

(74) *Attorney, Agent, or Firm* — Sterne, Kessler, Goldstein & Fox P.L.L.C.

(57) **ABSTRACT**

System, method, and computer product embodiments for proving a graphical user interface (GUI) for a GUI object are described. A computing device provides, within the GUI, a polymorphic lookup interface for retrieving a plurality of entity instances to relate to the GUI object. The computing device provides a plurality of types of entities within the polymorphic lookup interface. A type of entity selected from the plurality of types limits the possible entity instances that may be returned. Through the polymorphic lookup interface, the computing device enables a user to select two or more entity instances to relate to the GUI object. Each of the selected entity instances may be selected from a plurality of possible entity instances that are returned, where each possible entity instance is a same type of entity.

20 Claims, 8 Drawing Sheets



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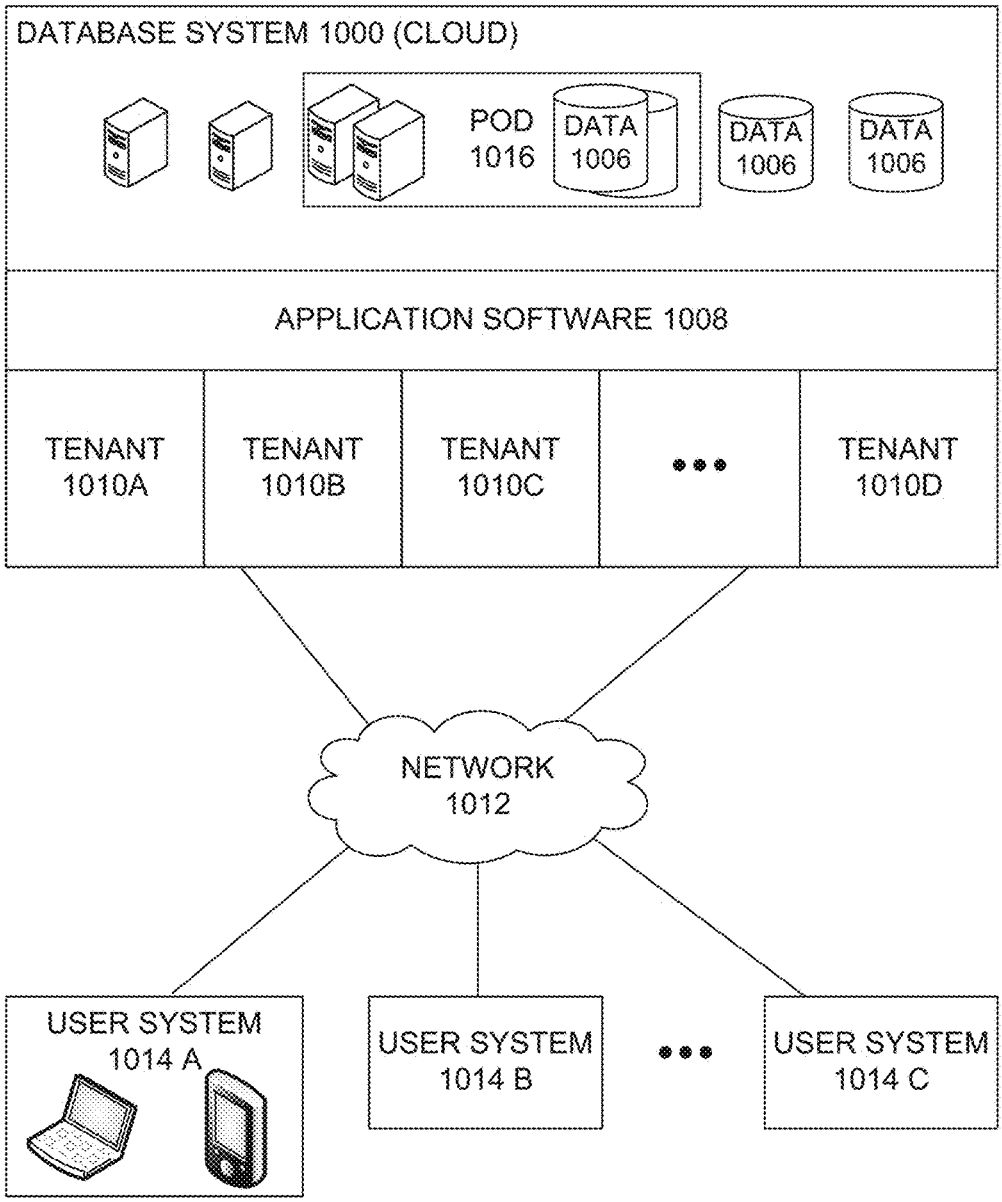
DATABASE SYSTEM 1000 (CLOUD)
POD
1016
DATA
1006
DATA
1006
DATA
1006
APPLICATION SOFTWARE 1008
TENANT
1010A
TENANT
1010B
TENANT
1010C
TENANT
1010D
NETWORK
1012
USER SYSTEM
1014 A
USER SYSTEM
1014 B
USER SYSTEM
1014 C

FIGURE 1

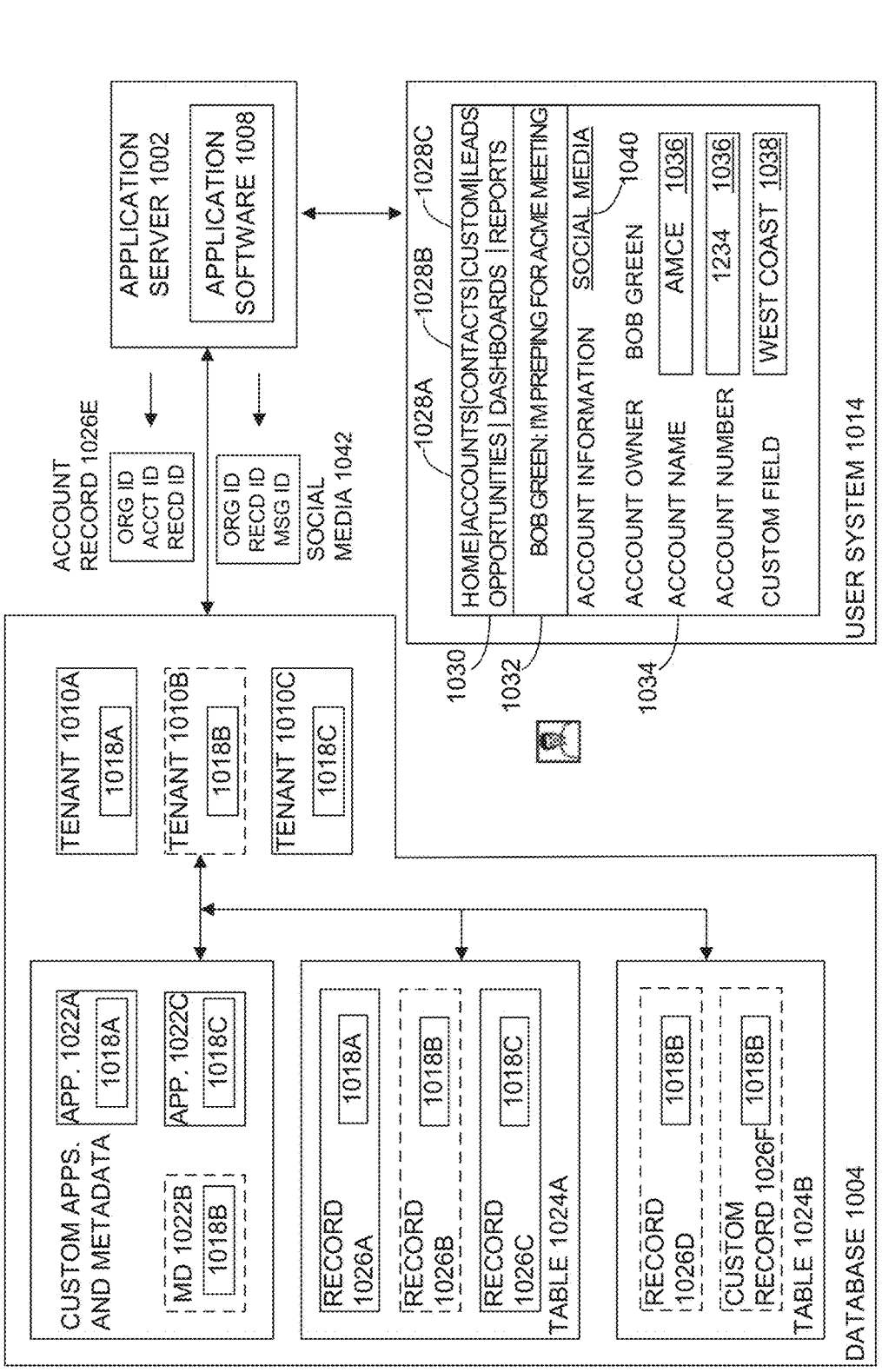
MULTI-TENANT SYSTEM 1020
APPLICATION SERVER 1002
APPLICATION SOFTWARE 1008
ACCOUNT RECORD 1026E
ORG ID
ACCT ID
RECD ID
ORG ID
RECD ID
MSG ID
SOCIAL MEDIA 1042
TENANT 1010A
1018A
TENANT 1010B
1018B
TENANT 1010C
1018C
1028A
1028B
1028C
HOME|ACCOUNTS|CONTACTS|CUSTOM|LEADS
OPPORTUNITIES | DASHBOARDS | REPORTS
BOB GREEN: I'M PREPING FOR ACME MEETING
ACCOUNT INFORMATION
SOCIAL MEDIA
1040
ACCOUNT OWNER
BOB GREEN
ACCOUNT NAME
AMCE
1036
ACCOUNT NUMBER
1234
1036
CUSTOM FIELD
WEST COAST
1038
USER SYSTEM 1014
1030
1032
1034
CUSTOM APPS. AND METADATA
APP. 1022A
1018A
APP. 1022C
1018C
MD 1022B
1018B
RECORD 1026A
1018A
RECORD 1026B
1018B
RECORD 1026C
1018C
TABLE 1024A
RECORD 1026D
1018B
CUSTOM RECORD 1026F
1018B
TABLE 1024B
DATABASE 1004

FIGURE 2

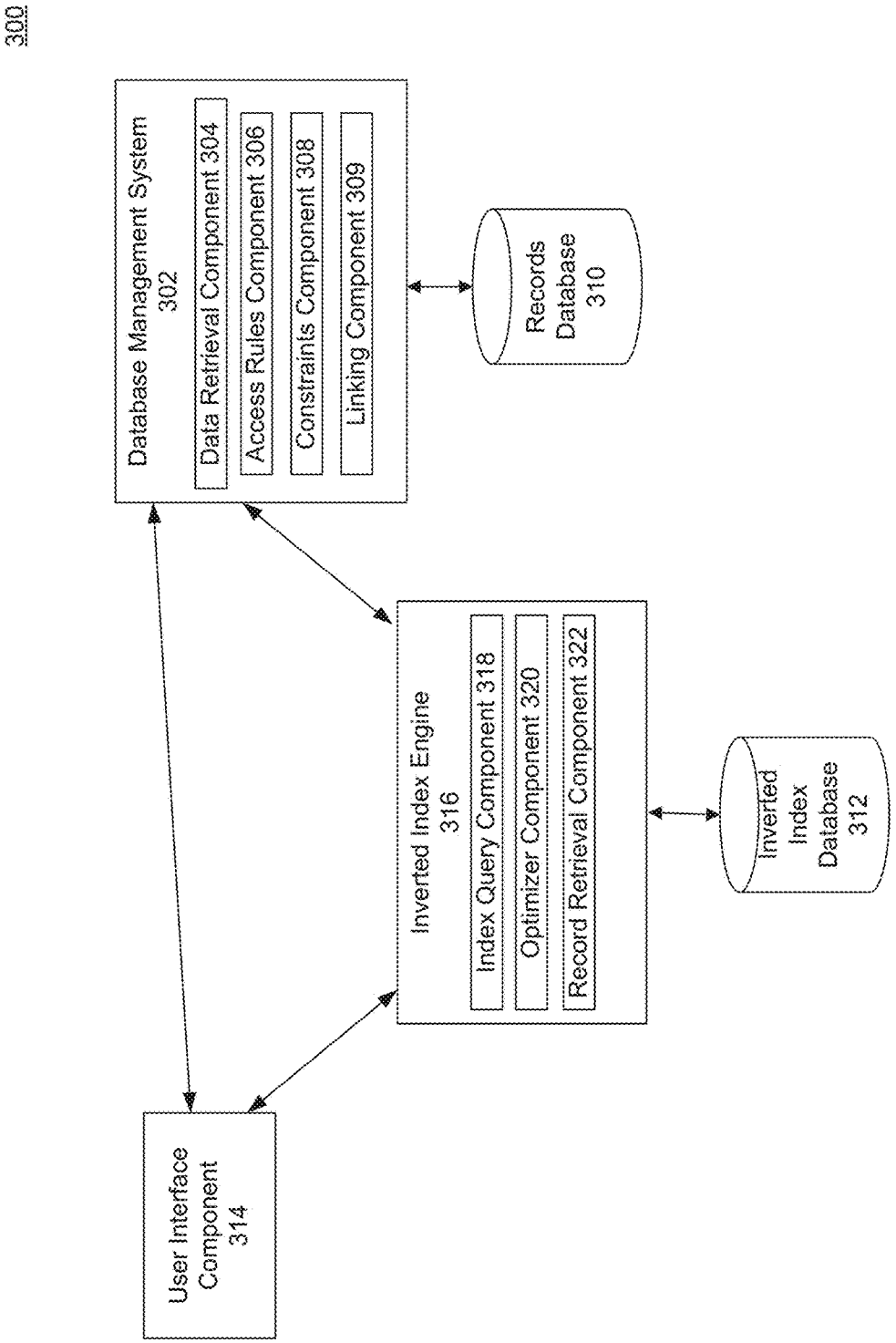
300
Database Management System
302
Data Retrieval Component 304
Access Rules Component 306
Constraints Component 308
Linking Component 309
Records Database 310
Inverted Index Engine
316
Index Query Component 318
Optimizer Component 320
Record Retrieval Component 322
Inverted Index Database 312
User Interface Component 314

FIGURE 3

400

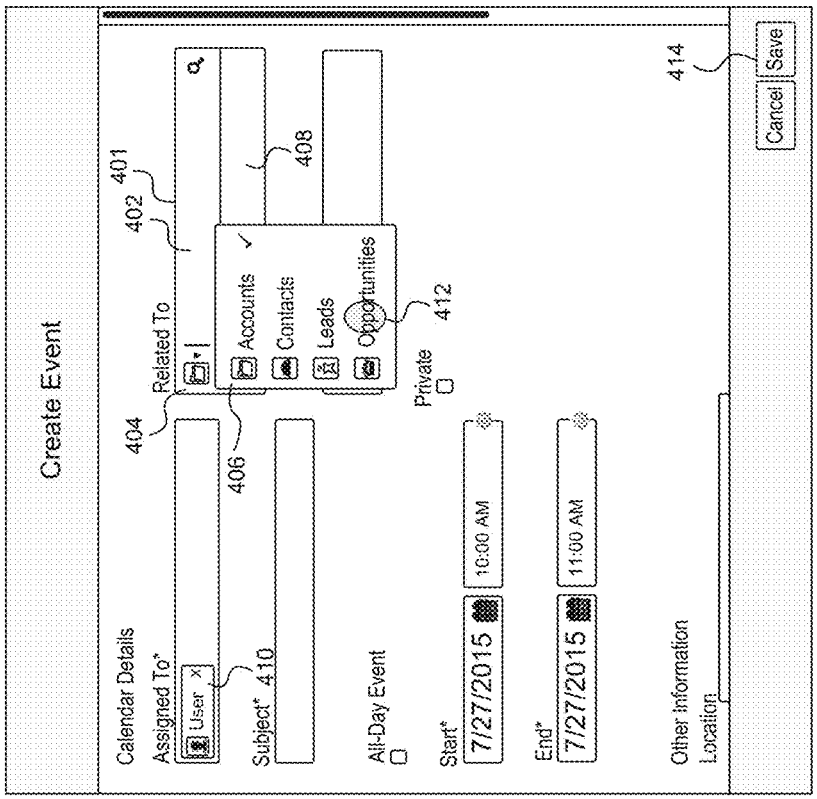
Create Event
Calendar Details
Assigned To*
User
Subject* 410
All-Day Event
Start*
7/27/2015
10:00 AM
End*
7/27/2015
11:00 AM
Other Information
Location
Related To
Accounts
Contacts
Leads
Opportunities
Private
404
406
401
402
408
412
414
Cancel
Save

FIGURE 4

500

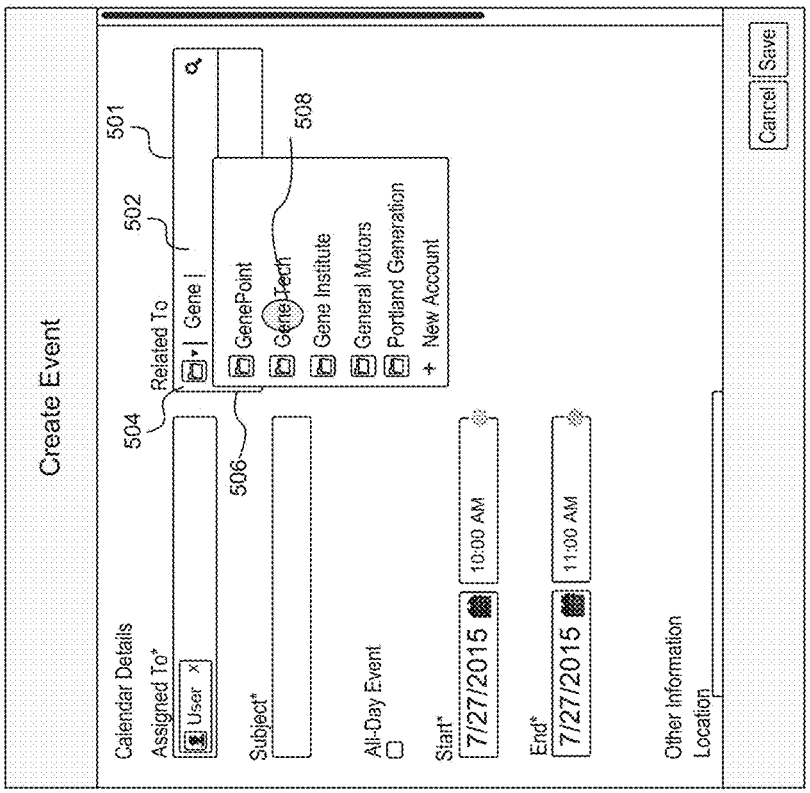
Create Event
Calendar Details
Assigned To*
User
Related To
Gene
GenePoint
Gene Tech
Gene Institute
General Motors
Portland Generation
+ New Account
Subject*
All-Day Event
Start*
7/27/2015
10:00 AM
End*
7/27/2015
11:00 AM
Other Information
Location
Cancel
Save
501
502
504
506
508

FIGURE 5

600

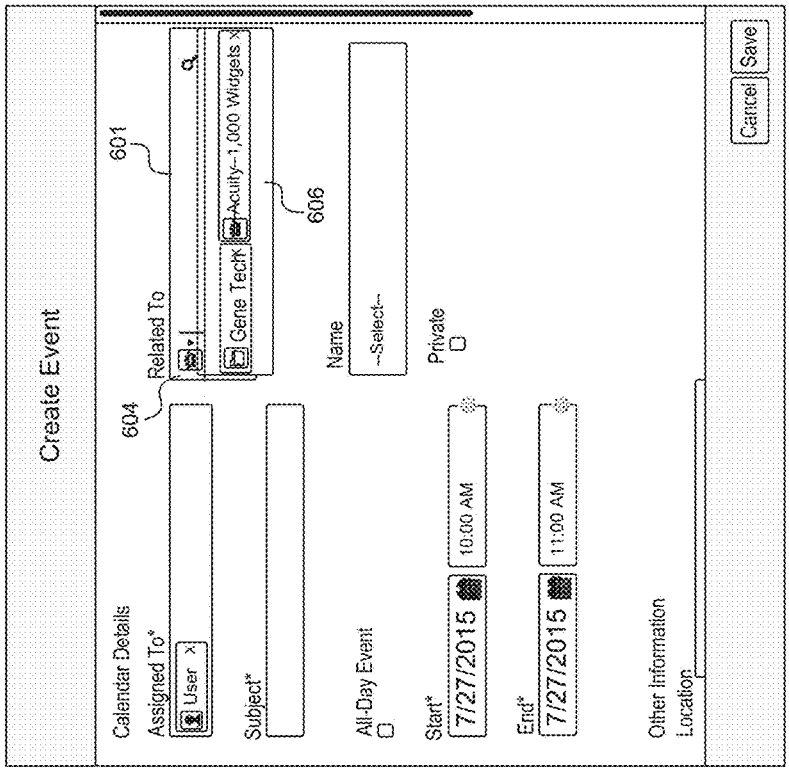
Create Event
Calendar Details
Assigned To*
User x
604
Related To
601
Gene Tech
Acuity--1,000 Widgets x
606
Subject*
All-Day Event
Name
--Select--
Private
Start*
7/27/2015
10:00 AM
End*
7/27/2015
11:00 AM
Other Information
Location
Cancel
Save

FIGURE 6

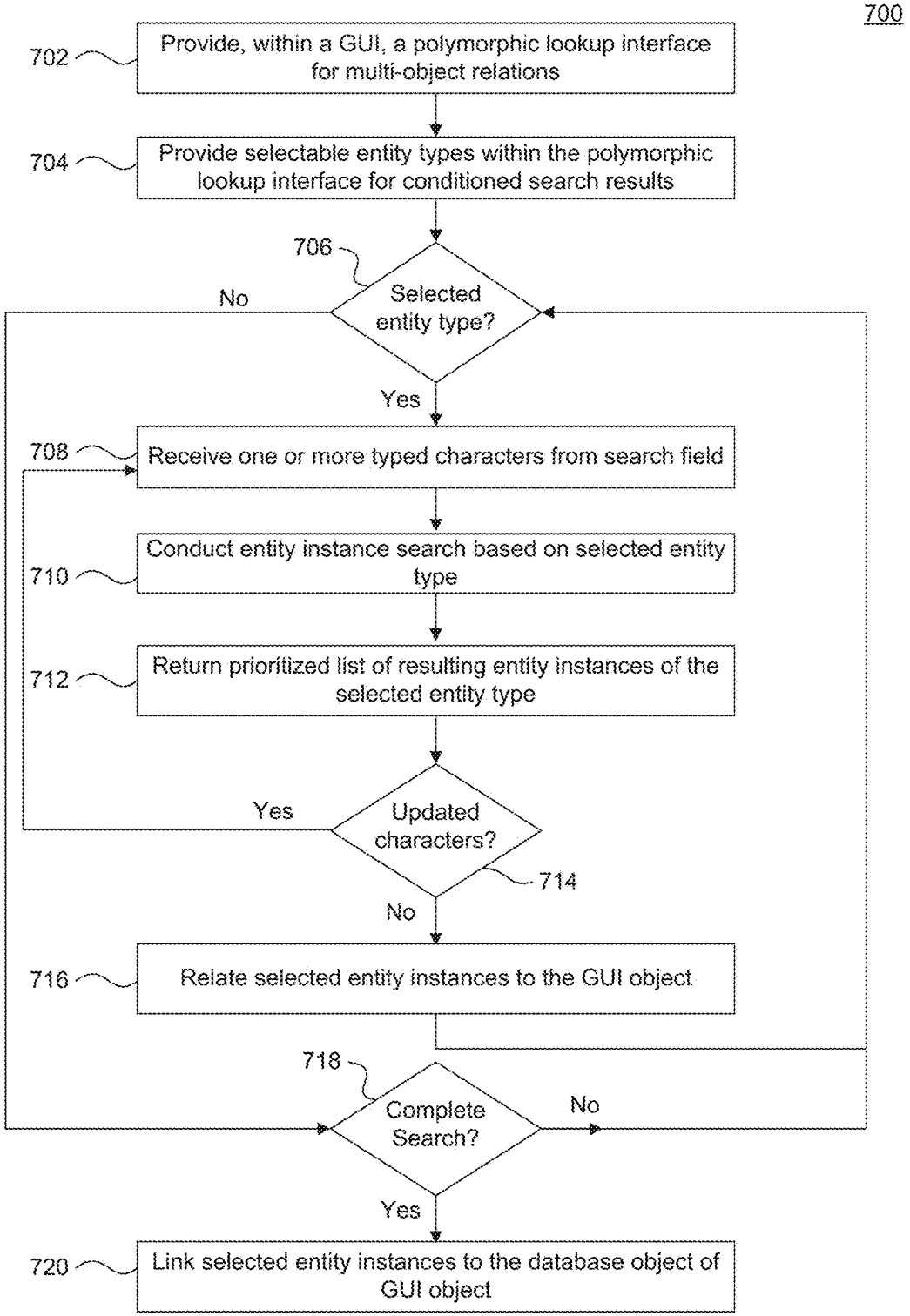
700
702
Provide, within a GUI, a polymorphic lookup interface for multi-object relations
704
Provide selectable entity types within the polymorphic lookup interface for conditioned search results
706
Selected entity type?
No
Yes
708
Receive one or more typed characters from search field
710
Conduct entity instance search based on selected entity type
712
Return prioritized list of resulting entity instances of the selected entity type
Updated characters?
Yes
714
No
716
Relate selected entity instances to the GUI object
718
Complete Search?
No
Yes
720
Link selected entity instances to the database object of GUI object

FIGURE 7

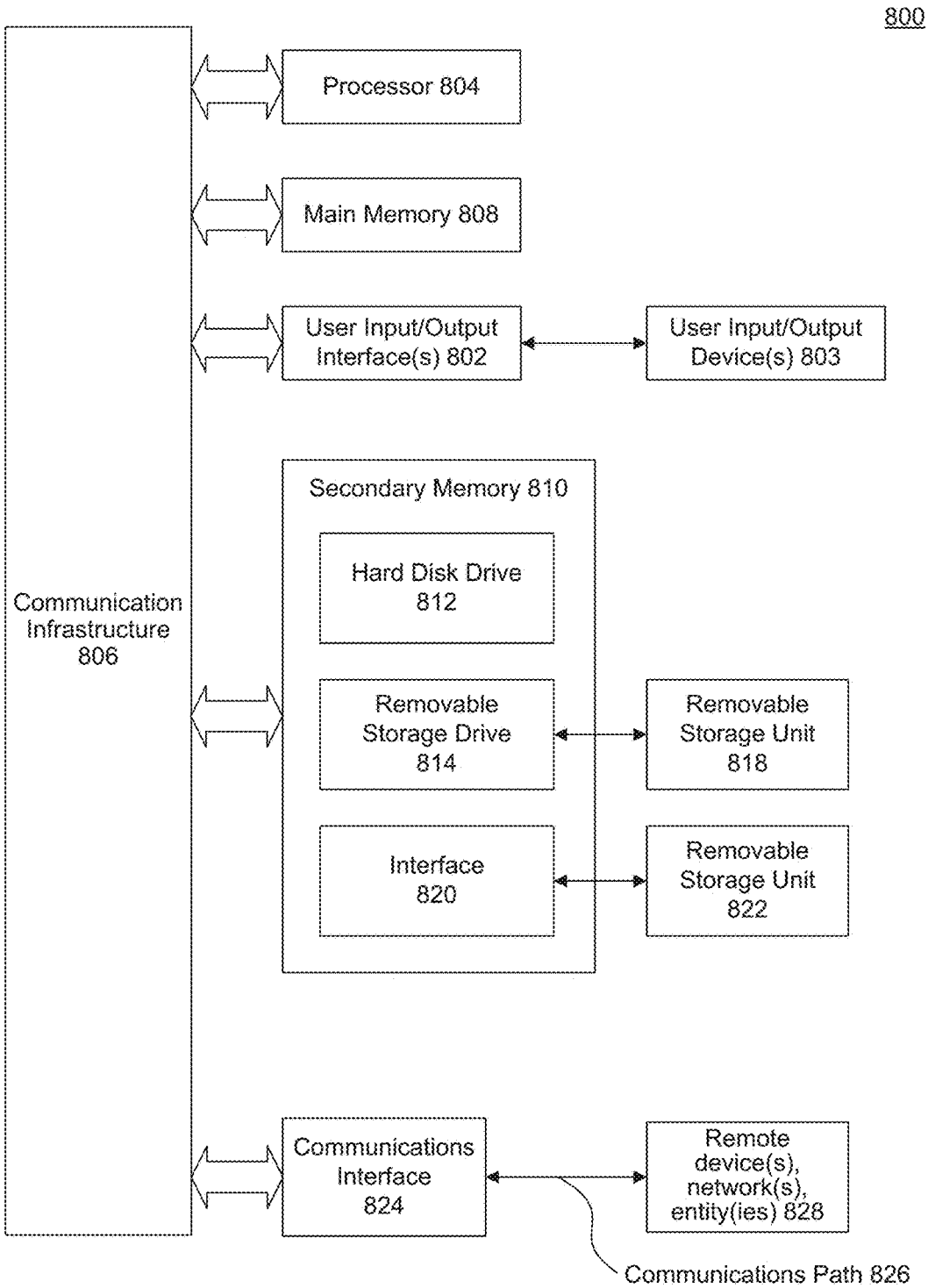
800
Processor 804
Main Memory 808
User Input/Output Interface(s) 802
User Input/Output Device(s) 803
Secondary Memory 810
Hard Disk Drive 812
Removable Storage Drive 814
Removable Storage Unit 818
Interface 820
Removable Storage Unit 822
Communication Infrastructure 806
Communications Interface 824
Remote device(s), network(s), entity(ies) 828
Communications Path 826

FIGURE 8

USER INTERFACE FOR POLYMORPHIC LOOKUP

BACKGROUND

A user interface is commonly implemented within a software application to enable users to communicate with database systems. Particularly, a user interface may include lookup functions to enable users to quickly query information from the database. But, current database systems include vast amounts of data of diverse types, which may delay how efficiently the user interface can provide a result to the user through the lookup functions. Additionally, current user interfaces are limited in scope and are inflexible, which further reduces the usefulness provided by the lookup functions.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows an example database system according to some implementations.

FIG. **2** shows an example multi-tenant system according to some implementations.

FIG. **3** shows an example of an application server for providing a polymorphic lookup interface according to some implementations.

FIGS. **4-6** show example graphical user interfaces implementing polymorphic lookup interfaces according to some implementations.

FIG. **7** shows an example method for providing a polymorphic lookup interface according to some implementations.

FIG. **8** shows an example computer system according to some implementations.

DETAILED DESCRIPTION

I. Example System Overview

FIG. **1** shows an example database system **1000** used in accordance with some implementations. Database system **1000** may include different application servers **1002** and databases **1004** connected together by networking equipment. Different combinations of application servers **1002** and data servers may execute different application software **1008** and access data **1006** stored in databases **1004**.

User systems **1014** connect to application servers **1002** and databases **1004** through a network **1012**. Network **1012** and the networks connecting together application servers **1002** and databases **1004** may include any combination of local area networks (LANs), wide area networks (WANs), telephone networks, wireless networks (Wi-Fi), cellular networks, or the like, or any combination thereof. Database system **1000** and user systems **1014** may operate within a private enterprise network and/or may operate within a publically accessible web-based network.

User systems **1014** may include desktop computers, personal computers (PCs), work stations, laptop computers, tablet computers, handheld computing devices, mobile cellular phones, smartphones, terminals, or any other device capable of accessing network **1012** and database system **1000**. User systems **1014** use different protocols to communicate with database system **1000** over network **1012**, such as transfer control protocol and Internet protocol (TCP/IP), hypertext transfer protocol (HTTP), and/or file transfer protocol (FTP). In one example, user systems **1014** may operate a web browser or operate applications for sending and receiving HTTP signals to and from an HTTP server operating in database system **1000**.

Database system **1000** in conjunction with application software **1008** may provide an almost limitless variety of different services, such as providing software as a service (SaS), customer relationship management (CRM), enterprise resource planning (ERP), file sharing, web-based commerce, social networking, cloud-based computing and/or storage, or the like, or any combination thereof. Database system **1000** and/or network **1012** are alternatively referred to as the Internet, the cloud, and/or a cloud based computing system.

Multi-Tenant System

In one example, database system **1000** and application software **1008** may operate as a multi-tenant system (MTS). A multi-tenant system refers to a database system where different hardware and software are shared by one or more organizations represented as tenants **1010**. For example, database system **1000** may associate a first tenant **1010**A with an organization that sells airline services, associate a second tenant **1010**B with an organization that sells widgets, and associate a third tenant **1008**C with an organization that sells medical administration services. The multi-tenant system effectively operates as multiple virtual databases each associated with one of tenants **1010**.

A pod **1016** may include groups of application servers **1002** and databases **1004** that share an instance of the multi-tenant system. Different pods **1016** may operate independently but may share some processing equipment, such as routers and storage area networks (SANs). For example, tenants **1010**B and **1010**C may operate within pod **1016** and a user associated with tenant **1010**C may use user system **1014**A to access the multi-tenant system operating in pod **1016**. User system **1014**A sends requests from the user to a load balancer in pod **1016** and the load balancer forwards the requests to one of application servers **1002** within pod **1016**. Application server **1002** services the requests by executing application software **1008** within pod **1016** and/or accessing data **1006** from databases **1004** within pod **1016**.

Database system **1000** may include hundreds of pods **1016** and a database administrator may assign thousands of tenants **1010** to the same pod **1016**. The database administrator may add new pods **1016** for servicing additional tenants **1010** or may reassign tenants **1010** to different pods **1016**. For example, one of tenants **1010** may use a relatively large amount of processing bandwidth and/or use a relatively large amount of storage space. The database administrator may reassign that tenant **1010** to a different pod **1016** with more processing and/or storage bandwidth. Thus, the multi-tenant system may scale for almost any number of tenants and users.

FIG. **2** shows a platform for a multi-tenant system (MTS) **1020** that may operate within database system **1000** of FIG. **1**. Multi-tenant system **1020** may comprise a collection of objects. The objects may refer to entities such as users, tenants, accounts, contacts, leads, opportunities, reports, cases, files, documents, orders, price books, products, solutions, forecasts, or any other definable category. Objects also may refer to instances of the entities such as the data for the individual users, tenants, accounts, contacts, leads, opportunities, reports, cases, etc.

Objects also may refer to tables **1024** that include fields or a schema describing the entities. For example, table **1024**A may define fields for customer contacts such as name, address, phone number, fax number, etc. The same or another table **1024**B may define fields for purchase orders such as customer, product, sale price, date, etc. Objects also

may refer to records **1026** that contain data or instances for the entities and fields. For example, record **1026**A may contain the specific name, address, phone number, fax number, etc. for a particular customer contact and record **1026**C may contain the specific customer, product, sale price and date for a particular purchase order.

Multi-tenant system **1020** may use identifiers to maintain relationships between different objects. For example, application software **1008** may assign unique organization identifiers (org ids) **1018**A, **1018**B, and **1018**C to tenants **1010**A, **1010**B, and **1010**C, respectively. Application software **1008** then associates other objects with org ids **1018**.

For example, a user may log into multi-tenant system **1020** via user system **1014**. Application software **1008** accesses one of tables **1024** that associates a password for the user with tenant **1010**B. Application software **1008** then identifies different records **1026**B, **1026**D, and **1026**F associated with org id **1018**B and displays data from records **1026**B, **1026**D, and **1026**F to the user via user system **1014**. Application programmer interfaces (APIs) also may access data in multi-tenant system **1020** via user system **1014** in a same manner as users to maintain similar security protocols and access privileges.

In one example, application software **1008** may display a toolbar **1030** identifying different entities **1028** associated with tenant **1010**B. The user may select tabs in toolbar **1030** to view, edit, and/or create instances (data) of entities **1028**. For example, the user may select a tab associated with accounts entity **1028**A and select options for creating a new account **1034**. The user enters data for new account **1034** into fields **1036** and application software **1008** creates a record **1026**E containing the data. Application software **1008** assigns record **1026**E org id **1018**B for tenant B, an account identifier (acct id), and a record identifier (recd id) before storing record **1026**E in one of tables **1024**.

Multi-tenant system **1020** may establish relationships between different entities **1028**. For example, the user may associate different contacts **1028**B with account **1034**. The user may select a tab in toolbar **1030** associated with contacts **1028**B and enter contact information for a customer. Application software **1008** creates another record **1026** containing the contact information that includes the record id for account **1034**. Users accessing account **1034** can then also view associated contacts **1028**B.

Multi-tenant system **1020** enable users to create custom metadata **1022**B for tenant specific functions, objects, entities, categories, and/or data. For example, an administrator for tenant **1010**B, or a third party vendor, may create a custom entity **1028**C with a unique combination of fields **1036** and **1038**. Application software **1008** creates metadata **1022**B defining custom entity **1028**C and then accesses metadata **1022**B enabling users for tenant **1010**B to view, edit, and create custom records **1026**F for custom entity **1028**C.

Multi-tenant system **1020** also enable users to create and execute custom application software **1022**A and **1022**C. For example, the organization associated with tenant **1010**C may provide medical administration services. The administrator for tenant **1010**C, or a third party vendor, may create custom application software **1022**C that generates medical reports and/or manages medical records. Application software **1008** associates custom application software with org id **1018**C allowing users for tenant **1010**C to access custom application software **1022**C and generate and/or manage the medical reports and records.

In some implementations, multi-tenant system **1020** may associate users with user profiles and assign the users unique user identifiers (user ids). The user profiles may include a collection of data about a user, such as a name, a title, a phone number, a photo, a biographical summary, or a status. Multi-tenant system **1020** also may associate the users with permission profiles that determine which records **1026** and application software **1008** and **1022** the users may access. For example, a permission profile for a first user may allow access to data and software for a salesperson and a permission profile for a second user may allow access to data and software for an administrator.

A group may refer to a collection of users within an organization. In some implementations, a group may include users with a similar attribute or a similar membership or subscription. Multi-tenant system **1020** may assign groups of users unique group identifiers (group ids) and provide the groups various visibilities. For example, some groups may be private while others may be public. To become a member within a private group, users may request subscription to the group and acceptance by an administrator or group owner.

Social Networks

Multi-tenant system **1020** may associate social media with different records **1026**. For example, a user may select an icon **1040** to post a message **1032** relating to account **1034**. Application software **1008** generates social media data **1042** that includes message **1032**, org id **1018**B for tenant **1010**B, the record identifier for account **1034**, and a unique message identifier (msg id). Users associated with tenant **1010**B then may access account **1034**, view associated message **1032**, and create other related messages. For example, another user may access account **1034** and post a comment to message **1032**. Application software **1008** creates additional social media data that includes the comment, org id **1018**B for tenant **1010**B, and the msg id for message **1032**. Thus, users accessing account **1034** may not only view, edit, and/or create account **1034**, but also may view and/or post social media, such as message **1032**, associated account **1034**.

Message **1032** is alternatively referred to as a feed item and may include any type of information viewable in a feed, such as user-generated textual posts or comments, documents, audio data, image data, video data, or any other type of data. Feed items **1032** may include links or attach to other documents or files. Feed items **1032** may be associated via identifiers with one or more objects, entities, users, groups, records, or other feeds. Multi-tenant system **1020** also may transmit email notifications or other types of network communications to users associated with any object, entity, group, record, or feed.

More details regarding database system **1000**, multi-tenant system **1020**, and social networks are described in U.S. Pat. No. 7,730,478, titled METHOD AND SYSTEM FOR ALLOWING ACCESS TO DEVELOPED APPLICATIONS VIA A MULTI-TENANT ON-DEMAND DATABASE SERVICE, by Craig Weissman, issued on Jun. 1, 2010; U.S. Pat. No. 7,779,039, titled CUSTOM ENTITIES AND FIELDS IN A MULTI-TENANT DATABASE SYSTEM, by Weissman et al., issued on Aug. 17, 2010; and U.S. Pat. No. 8,478,722, titled ENTERPRISE LEVEL BUSINESS INFORMATION NETWORKING FOR CHANGES IN A DATABASE, by Peter Lee et al., issued on Jul. 2, 2013 which are all hereby incorporated by reference in its entirety and for all purposes.

FIG. **3** shows an application server **300** for providing a polymorphic lookup interface according to some implementations. In an embodiment, application server **300** may be an implementation of application server **1002** of FIG. **1**. In an embodiment, application software **1008** may implement

some or all of the functionalities of application server **300**. As shown, application server **300** includes user interface component **314**, inverted index engine **316**, inverted index database **312**, database management system (DBMS) **302**, and records database **310**. For ease of reference, descriptions of FIG. **3** may refer to FIG. **4**, which depicts an example graphical user interface (GUI) **400** including polymorphic lookup interface **401**.

In an embodiment, application server **300** may provide GUI **400** for a GUI object, for example, "Create Event," to a user via, for example, user system **1014** of FIG. **1**. As shown in GUI **400** of FIG. **4**, application server **300** may provide user field **410**, polymorphic lookup interface **401**, and save option **414**. In an embodiment, polymorphic lookup interface **401** may include visual icons for selectable entity types **406**, selected entity type **404**, and selected entity instances **408**. Polymorphic lookup interface **401** may also include search field **402** for receiving, from the user, a series of characters used in looking up possible entity instances.

Returning to FIG. **3**, user interface component **314** may interface lookup functions and results provided by application server **300** with lookup results provided to user within polymorphic lookup interface **401**. In an embodiment, user interface component **314** receives selected entity type **404** from polymorphic lookup interface **401** of GUI **400**. Selected entity type **404**, represented as an "Accounts" icon in GUI **400**, may be selected by the user from selectable entity types **406**. In an embodiment, in a business management context, selectable entity types **406** may include "Accounts," "Contacts," "Leads," and "Opportunities." Upon receiving selected entity type **404**, user interface component **314** may forward selected entity type **404** to inverted index engine **316** to condition the types of results provided to polymorphic lookup interface **401**.

In an embodiment, user interface component **314** receives a series of characters from search field **402**. As a user inputs or updates the series of characters in search field **402**, user interface component **314** may receive the updated one or more characters and perform lookup functions based on the updated one or more characters. User interface component **314** may send the series of characters to inverted index engine **316** that performs efficient lookup of relevant search results.

In an embodiment, user interface component **314** provides visual icons for selected entity instances **408** within polymorphic lookup interface **401**. Selected entity instances **408** may represent a plurality of entity instances selected by a user to relate to a GUI object, such as "Create Event." When GUI **400** is terminated, for example, when the user selects save option **414**, user interface component **314** may forward selected entity instances **408** to DBMS **302** or inverted index engine **316**. DBMS **302** may associate, within records database **310**, a plurality of selected entity instances **408** with a database object representing the GUI object of GUI **400**. Similarly, inverted index engine **316** may update inverted index database **312** to include the associations between selected entity instances **408** and the GUI object.

Inverted index engine **316** may perform efficient and fast lookup of possible entity instances desired by a user based on an input from search field **402** conditioned on selected entity type **404**. In an embodiment, inverted index engine **316** may access inverted index database **312** to speed up the processing of lookup functions. In an embodiment, inverted index engine **316** may be based on an improved implementation of an open source enterprise search platform such as, for example, the SOLR platform. These improvements may be described with respect to the functionality provided by the components of inverted index engine **316**.

Inverted index database **312** may be designed to store associations between words and record identifiers (IDs) such that each word may be associated with a plurality of record IDs. These associations may be stored in a dictionary format mapping words to respect lists of record IDs. In an embodiment, each of the record IDs may be associated with a corresponding entity instance containing the associated or mapped word. For example, a word "Gene" may be associated with a list of record IDs corresponding to the following entity instances: "GenePoint," "Gene Tech," and "Gene Institute." By storing the lists of record IDs, inverted index engine **316** may look up the word directly for possible record IDs instead of requiring DMBS **302** to scan each record from records database **310** for any record containing that word.

In an embodiment, inverted index database **312** may include separate indexes for each type of selectable entity types **406**. By providing separate indexes, inverted index engine **316** may condition the returned entity instances based on selected entity type **404**. To implement the fast lookup functions, inverted index engine **316** may include index query component **318**, optimizer **320**, and record retrieval component **322**.

In contrast, a conventional Structured Query Language (SQL) based database, which does not maintain indexes based on words, implements searching scheme that are slow and inefficient. For example, when a user queries a specific word, the SQL-based database may need to fully scan all the content of the database because the SQL database cannot ensure that an inner portion of the record does not contain the queried word. By maintaining inverted index database **312**, inverted index **316** may perform a fast lookup of a plurality of record IDs corresponding to the queried word.

Index query component **318** queries inverted index database **312** for relevant record IDs based on an inputted series of characters received by user interface component **314**. In an embodiment, in addition to maintaining an index of words, inverted index database **312** may include indexes for a series of one or more characters. For example, inverted index database **312** may include separate indexes for one character, two characters, three characters, or four characters. In an embodiment, inverted index database **312** include a hierarchy of indexes such that matching a series of one or more characters may direct inverted index engine **316** to query a separate index containing the matching series of one or more characters.

For example, inverted index database **312** may include an index for two characters. User interface component **314** may receive two characters "Ge" before a user completely inputs the complete word such as, for example, "Gene." Index query component **318** may query inverted index database **312** based on "Ge," which may match the index for two character sequences. The "Ge" entry of the two character index may be further associated with a word index having words starting with "Ge." By implementing the hierarchy of indexes, inverted index database **312** may be more efficiently maintained and more efficiently return relevant search results. Therefore, although the user has not completed typing a complete word, inverted index database **312** may return a plurality of record IDs from the word index having record IDs that corresponds to words starting with or containing "Ge."

Optimizer component **320** may implement rules for prioritizing which entity instances are returned to the user enabling the user to more efficiently select a desired entity instance. When the user selects one of the returned entity

instances, the selected entity instances may be saved in selected entity instances **408** field of polymorphic lookup interface. In an embodiment, a rule may apply to an input from search field **402** including two or more words. In this scenario, inverted index database **312** may additionally include indexes for a sequence of two more words. Optimizer component **320** may prioritize entity instance results provided by the multi-word index over entity instance results provided by the default one word index. For example, when a user inputs "John Smith" into search field **402**, optimizer component **320** may implement this rule to return "John Smith" first before returning other results, such as "Smith John."

In an embodiment, instead of utilizing multi-word indexes, optimizer component **320** may implement relevancy scores for possible matching entity instances to prioritize the entity instances returned to the user in polymorphic lookup interface **401**. For example, for multi-word inputs, such as "John Smith," optimizer component **320** may add higher scores to matching entity instances having an exact match or in the same order. Therefore, a matching entity instance having "John" appear before "Smith" may receive a higher score than another matching instance having "John" appear after "Smith."

In an embodiment, optimizer component **320** may also assign or update relevancy scores based on other attributes of the matching entity instances returned to inverted index engine **316**. For example, each matching entity instance may have an associated page view popularity metric or the number of "hits" within a period of time. Additionally, matching entity instances associated with user field **410** may also have a higher relevancy score.

Record retrieval component **322** may retrieve, from records database **310**, the records corresponding to the record IDs returned to inverted index engine **316**. In an embodiment, record retrieval component **322** issues a query to DBMS **302** to query the records corresponding to the record IDs. Then, inverted index engine **316** may receive a plurality of records from DBMS **302**. In an embodiment, when record retrieval component **322** receives the plurality of records from DBMS **302**, optimizer component **320** may prioritize the records, each representing an entity instance, returned to the user.

DBMS **302** may implement functions for retrieving records from records database **310**. DBMS may also manage the associations, metadata, and record data stored in records database **310**. To provide the lookup functionality of polymorphic lookup interface **401**, DBMS **302** may include access rules component **304**, data retrieval component **306**, constraints component **308**, and linking component **309**.

In an embodiment, DBMS **302** may receive a query issued by record retrieval component **322** of inverted index engine **316**. The query may include a plurality of record IDs, each of which may identify a record from records database **310**. Data retrieval component **304** may retrieve, from records database **310**, the data records corresponding to the plurality of record IDs. Data retrieval component **304** may also retrieve metadata associated with each record ID. For example, metadata may include a popularity metric such as a number of "hits," associated users, access permissions, creation dates, among other types of attributes of the record data.

Access rules component **306** may filter the queried record data based on access permissions to determine which records to return in the returned plurality of entity instances. For example, access rules component **306** may filter out queried record data having an associated access permission that indicate a user of user field **410** or the user operating GUI **400** does not have permission to access that record data.

Similarly, constraints component **308** may filter the queried record data based on other constraints applied to the queried record data or constraints stored within DBMS **302**. For example, a constraint may be to return the top most popular record data, e.g., record data having the most "hits."

Linking component **309** may update the associations stored in records database **310** between the object represented by GUI **400** and selected entity instances **408**. In an embodiment, when GUI **400** is terminated, user interface **314** may receive selected entity instances **408** to associate with the GUI object, e.g., "Create Event," or GUI **400**. For example, GUI **400** may be terminated when the user selects save option **414** to save the edits made to GUI **400**. The selected entity instances **408** may be forwarded to DBMS **302** where linking component **309** adds the associations to the GUI object within records database **310**. Therefore, application server **300** provides to user system **1014** of FIG. **2** polymorphic lookup interface **401** enabling a user to efficiently select a plurality of entity instances to relate to the GUI object represented by GUI **400**.

FIGS. **4-6** illustrate example GUIs implementing polymorphic lookup interfaces according to some implementations. As described above, FIG. **4** illustrates GUI **400** including polymorphic lookup interface **401** provided by, for example, application server **300** of FIG. **3**. When a user operating GUI **400** selects selected entity type **404**, represented as the "Accounts" visual icon, from selectable entity types **406**, GUI **400** may send selected entity type **404** to user interface component **314** of application server **300**. As shown, user cursor **412** indicates that the user may select the "Opportunity" entity type from selectable entity types **406**.

FIG. **500** illustrates an example GUI **500** including polymorphic lookup interface **501**. As shown, the user has selected an "Accounts" entity type as represented by the "Accounts" icon of selected entity type **504**. GUI **500** may send selected entity type **504** of "Accounts" to application server **300**. Upon receiving selected entity type **504**, application server **300** may condition the returned entity instances to have that selected entity type **504**, e.g., to be an "Accounts" instance. The user may have typed "Gene" into search field **502**. Application server **300** may receive the type input characters and inverted index engine **316** may query inverted index database **312** for record IDs associated with the word "Gene." Inverted index engine **316** may query DBMS **302** for a plurality of record data corresponding to record IDs returned by inverted index database **312**. Each of inverted index engine **316** and DBMS **302** may filter or prioritize the entity instances returned to user system **1014**. For example, as shown in GUI **500**, returned entity instances **506** depicts the five most likely entity instances corresponding to the input "Gene" of search field **502**. Upon selection of "Gene Tech" via cursor **508**, the user may associate the entity instance, "Gene Tech," with the GUI object "Create Event."

FIG. **600** illustrates an example GUI **600** including polymorphic lookup interface **601**. When the user selects "Gene Tech" as a desired entity instance, GUI **600** may save the selected entity instance "Gene Tech" as one of selected entity instances **606**, each represented by a corresponding visual icon and associated entity type. For example, GUI **600** may save two entity instances, "Gene Tech" and "Acuity-1,000 Widgets," to be related to the event to be created. The "Gene Tech" entity instance may be of an "Accounts" entity type as indicated by the file visual icon. Similarly, the "Acuity-1,000 Widgets" entity instance may be of an

"Opportunity" entity type as indicated by the crown icon. Therefore, GUI **600** illustrates polymorphic lookup interface **601** enabling a user to relate two or more entity instances with a GUI object, such as "Create Event." Each of the two or more entity instances may be provided via dropdown lists of possible entity instance results as shown in FIG. **5**, from which the user may select a relevant entity instance.

II. Example Method

FIG. **7** illustrates an example method **700** for providing a polymorphic lookup interface according to some implementations. Method **700** may be performed by processing logic that may comprise hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software (e.g., instructions running on a processing device), or a combination thereof. In an embodiment, steps of method **700** may be performed by components of application server **300** from FIG. **3**. For ease of reference and without limitation, descriptions of method **700** may refer to GUI **500** and polymorphic lookup interface **401** described with respect to FIGS. **3-4**. Method **700** may apply to other GUIs, such as those described with respect to FIGS. **5-6**.

In step **702**, application server **300** provides to a user, via user system **1014** of FIGS. **1-2**, polymorphic lookup interface **401** within GUI **400** for a GUI object, such as a "Create Event" object of from FIG. **4**. The provided polymorphic lookup interface **401** enables a user operating GUI **400** to relate multiple objects, specifically entity instances, with the GUI object.

In step **704**, application server **300** provides selectable entity types **406** options within polymorphic lookup interface **401** for conditioned search results. These selectable options may condition the type of entity instances to be queried by inverted index engine **316** or DBMS **302** in determining the plurality of entity instances to return to the user in GUI **400**. For example, in a software application for business development, selected entity types **406** may include "Accounts," "Contacts," "Leads," and "Opportunities" among other types of search results.

In an embodiment, steps **706-718** describe functionalities provided by polymorphic lookup interface **401** that enables a user to select a plurality of entity instances to relate to the object represented by the GUI object of GUI **400**. Each of the selected entity instances may be assigned to a specific type of entity.

In step **706**, user interface component **314** receives a selected entity type within polymorphic lookup interface **401**. The selected entity type may be displayed as a visual icon corresponding to selected entity type **404** of GUI **400**. As described with respect to FIG. **3**, inverted index engine **316** may condition the types of record IDs to query based on the selected entity type **404** such that a returned list of possible entity instances are all of the selected entity type **404**.

In step **708**, user interface component **314** receives, in real-time, one or more characters typed in search field **402** of polymorphic lookup interface **401**. Then, user interface component **314** forwards the updated or inputted characters to inverted index engine **316**.

In step **710**, inverted index engine **316** conducts an entity instance search based on the selected entity type and the one or more received characters of step **708**. In an embodiment, index query component **318** queries one or more indexes of inverted index database **312** to determine a list of record IDs, each of which may be related to information containing the sequence of characters. Record retrieval component **322** may query records database **310** via DBMS **302** to retrieve the record data corresponding to the list of record IDs. For example, data retrieval component **304** may query records database **310** for the data records. To provide the search result back to the user, data retrieval component **304** sends the queried data records to inverted index engine **316**.

In step **712**, application server **300** returns, to the user, a prioritized list of resulting entity instances of selected entity type **400** of step **706**. Particularly, access rules component **306** or constraints component **308** may filter out the matching data records from records database **310** and queried by data retrieval component **304**. In an embodiment, optimizer component **320** may implement scoring metrics and rules to specify an order of the returned list of possible entity instances to be selected by the user. For example, as shown by returned entity instances **506**, polymorphic lookup interface **400** may display the retrieved record data as ranked information, where most relevant or likely entity instances, such as "GenePoint" and "Gene Tech," are provided near the top of the list.

In step **714**, user interface component **314** detects whether one or more updated characters have been typed into search field **402** of polymorphic lookup interface **401**. If one or more updated characters have been detected, method **700** proceeds to **708**.

In step **716**, GUI **400** relates selected entity instances to the GUI object of GUI **400**. For example, selected entity instances may be saved as selected entity instances **408** field of—polymorphic lookup interface **401**.

In step **718**, if an additional search is queried, method **700** proceeds to step **706**. Regardless of whether an additional search is queried, polymorphic lookup interface **401** displays the one or more selected entities within selected entity instances **408** field. If no more search is requested or when GUI **400** terminates, method **700** proceeds to step **720**. For example, application server **300** may detect the completion of the search when the user exits out of GUI **400** when, for example, save option **414** is selected by the user to save the information within GUI **400** for the GUI object "Create Event."

In step **720**, upon completion of the search, linking component **309** links or associates the plurality of selected entity instances **408** with the database object corresponding to the GUI object of "Create Event." In an embodiment, linking component **309** may save the relations within records database **310**.

III. Example Computer Implementation

Various embodiments, such as application servers **1002** or pod **1016** of FIG. **1**, can be implemented, for example, using one or more well-known computer systems, such as computer system **800** shown in FIG. **8**. Computer system **800** can be any well-known computer capable of performing the functions described herein.

Computer system **800** includes one or more processors (also called central processing units, or CPUs), such as a processor **804**. Processor **804** is connected to a communication infrastructure or bus **806**.

One or more processors **804** may each be a graphics processing unit (GPU). In an embodiment, a GPU is a processor that is a specialized electronic circuit designed to process mathematically intensive applications. The GPU may have a parallel structure that is efficient for parallel processing of large blocks of data, such as mathematically intensive data common to computer graphics applications, images, videos, etc.

Computer system **800** also includes user input/output device(s) **803**, such as monitors, keyboards, pointing devices, etc., that communicate with communication infrastructure **806** through user input/output interface(s) **802**.

Computer system **800** also includes a main or primary memory **808**, such as random access memory (RAM). Main memory **808** may include one or more levels of cache. Main memory **808** has stored therein control logic (i.e., computer software) and/or data.

Computer system **800** may also include one or more secondary storage devices or memory **810**. Secondary memory **810** may include, for example, a hard disk drive **812** and/or a removable storage device or drive **814**. Removable storage drive **814** may be a floppy disk drive, a magnetic tape drive, a compact disk drive, an optical storage device, tape backup device, and/or any other storage device/drive.

Removable storage drive **814** may interact with a removable storage unit **818**. Removable storage unit **818** includes a computer usable or readable storage device having stored thereon computer software (control logic) and/or data. Removable storage unit **818** may be a floppy disk, magnetic tape, compact disk, DVD, optical storage disk, and/any other computer data storage device. Removable storage drive **814** reads from and/or writes to removable storage unit **818** in a well-known manner.

According to an exemplary embodiment, secondary memory **810** may include other means, instrumentalities or other approaches for allowing computer programs and/or other instructions and/or data to be accessed by computer system **800**. Such means, instrumentalities or other approaches may include, for example, a removable storage unit **822** and an interface **820**. Examples of the removable storage unit **822** and the interface **820** may include a program cartridge and cartridge interface (such as that found in video game devices), a removable memory chip (such as an EPROM or PROM) and associated socket, a memory stick and USB port, a memory card and associated memory card slot, and/or any other removable storage unit and associated interface.

Computer system **800** may further include a communication or network interface **824**. Communication interface **824** enables computer system **800** to communicate and interact with any combination of remote devices, remote networks, remote entities, etc. (individually and collectively referenced by reference number **828**). For example, communication interface **824** may allow computer system **800** to communicate with remote devices **828** over communications path **826**, which may be wired and/or wireless, and which may include any combination of LANs, WANs, the Internet, etc. Control logic and/or data may be transmitted to and from computer system **800** via communication path **826**.

In an embodiment, a tangible apparatus or article of manufacture comprising a tangible computer useable or readable medium having control logic (software) stored thereon is also referred to herein as a computer program product or program storage device. This includes, but is not limited to, computer system **800**, main memory **808**, secondary memory **810**, and removable storage units **818** and **822**, as well as tangible articles of manufacture embodying any combination of the foregoing. Such control logic, when executed by one or more data processing devices (such as computer system **800**), causes such data processing devices to operate as described herein.

Based on the teachings contained in this disclosure, it will be apparent to persons skilled in the relevant art(s) how to make and use embodiments of the invention using data processing devices, computer systems and/or computer architectures other than that shown in FIG. **8**. In particular, embodiments may operate with software, hardware, and/or operating system implementations other than those described herein.

It is to be appreciated that the Detailed Description section, and not the Summary and Abstract sections (if any), is intended to be used to interpret the claims. The Summary and Abstract sections (if any) may set forth one or more but not all exemplary embodiments of the invention as contemplated by the inventor(s), and thus, are not intended to limit the invention or the appended claims in any way.

While the invention has been described herein with reference to exemplary embodiments for exemplary fields and applications, it should be understood that the invention is not limited thereto. Other embodiments and modifications thereto are possible, and are within the scope and spirit of the invention. For example, and without limiting the generality of this paragraph, embodiments are not limited to the software, hardware, firmware, and/or entities illustrated in the figures and/or described herein. Further, embodiments (whether or not explicitly described herein) have significant utility to fields and applications beyond the examples described herein.

Embodiments have been described herein with the aid of functional building blocks illustrating the implementation of specified functions and relationships thereof. The boundaries of these functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternate boundaries can be defined as long as the specified functions and relationships (or equivalents thereof) are appropriately performed. Also, alternative embodiments may perform functional blocks, steps, operations, methods, etc. using orderings different than those described herein.

References herein to "one embodiment," "an embodiment," "an example embodiment," or similar phrases, indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it would be within the knowledge of persons skilled in the relevant art(s) to incorporate such feature, structure, or characteristic into other embodiments whether or not explicitly mentioned or described herein.

The breadth and scope of the invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A method, comprising:

providing, by a computing device, a graphical user interface (GUI) for a GUI object, wherein the GUI includes a polymorphic lookup interface for retrieving a first plurality of entity instances corresponding to a first entity type and a second plurality of entity instances corresponding to a second entity type to relate to the GUI object, wherein the first entity type and the second entity type are included in a plurality of entity types;

receiving a selection of the first entity type from the plurality of entity types;

in response to receiving the selection of the first entity type, returning the first plurality of entity instances in the polymorphic lookup interface;

receiving a selection of the second entity type from the plurality of entity types;

in response to receiving the selection of the second entity type, returning the second plurality of entity instances in the polymorphic lookup interface, wherein at least one of the returned first plurality of entity instances or the returned the second plurality of entity instances is

based on querying an inverted index database comprising a hierarchy of indexes, and wherein the hierarchy of indexes are searched based on a series of characters received via a search field of the polymorphic lookup interface;

receiving, within the polymorphic lookup interface, a selection of a first entity instance of the first entity type from the first plurality of entity instances and a selection of a second entity instance of the second entity type from the second plurality of entity instances;

in response to receiving the selection of the first and second entity instances, relating, by the computing device, the first and second entity instances with the GUI object; and

storing the related first and second entity instances in a database object corresponding to the GUI object.

2. The method of claim **1**, further comprising:

using the series of characters to query the inverted index database to retrieve record identifiers; and

querying a records database to obtain data records corresponding to the record identifiers.

3. The method of claim **2**, wherein the inverted index database includes an index for two or more words.

4. The method of claim **2**, wherein the series of characters includes an ordered list of words, and wherein the returned first plurality of entity instances or the returned second plurality of entity instances prioritizes possible entity instances having the same order as the ordered list of words.

5. The method of claim **2**, further comprising:

filtering the queried data records based on access rules or search constraints.

6. The method of claim **5**, further comprising:

assigning a relevancy score to each of the filtered queried data records, wherein the returned first plurality of entity instances or the returned second plurality of entity instances correspond to the filtered queried data records based on the assigned relevancy score.

7. The method of claim **6**, wherein the relevancy score is based on one or more of an order of a sequence of the series of characters, a user identifier identifying the user operating the GUI, or a page view metric.

8. A system, comprising:

a memory; and

at least one processor coupled to the memory and configured to:

provide a graphical user interface (GUI) for a GUI object, wherein the GUI includes a polymorphic lookup interface for retrieving a first plurality of entity instances corresponding to a first entity type and a second plurality of entity instances corresponding to a second entity type to relate to the GUI object, wherein the first entity type and the second entity type are included in a plurality of entity types;

receive a selection of the first entity type from the plurality of entity types;

in response to receiving the selection of the first entity type, return the first plurality of entity instances in the polymorphic lookup interface;

receive a selection of the second entity type from the plurality of entity types;

in response to receiving the selection of the second entity type, return the second plurality of entity instances in the polymorphic lookup interface, wherein at least one of the returned first plurality of entity instances or the returned the second plurality of entity instances is based on querying an inverted index database comprising a hierarchy of indexes, and wherein the hierarchy of indexes are searched based on a series of characters received via a search field of the polymorphic lookup interface;

receive, within the polymorphic lookup interface, a selection of a first entity instance of the first entity type from the first plurality of entity instances and a selection of a second entity instance of the second entity type from the second plurality of entity instances;

in response to receiving the selection of the first and second entity instances, relate the first and second entity instances with the GUI object; and

store the related first and second entity instances in a database object corresponding to the GUI object.

9. The system of claim **8**, wherein the at least one processor is further configured to:

use the series of characters to query the inverted index database to retrieve record identifiers; and

query a records database to obtain data records corresponding to the record identifiers.

10. The system of claim **9**, wherein the inverted index database includes an index for two or more words.

11. The method of claim **9**, wherein the series of characters includes an ordered list of words, and wherein the returned first plurality of entity instances or the returned second plurality of entity instances prioritizes possible entity instances having the same order as the ordered list of words.

12. The method of claim **9**, wherein the at least one processor is further configured to:

filter the queried data records based on access rules or search constraints.

13. The method of claim **12**, wherein the at least one processor is further configured to:

assign a relevancy score to each of the filtered queried data records, wherein the returned first plurality of entity instances or the returned second plurality of entity instances correspond to the filtered queried data records based on the assigned relevancy score.

14. The method of claim **13** wherein the relevancy score is based on one or more of an order of a sequence of the series of characters, a user identifier identifying a user operating the GUI, or a page view metric.

15. A non-transitory computer-readable device having instructions stored thereon that, when executed by at least one computing device, causes the at least one computing device to perform operations comprising:

providing, by a computing device, a graphical user interface (GUI) for a GUI object, wherein the GUI includes a polymorphic lookup interface for retrieving a first plurality of entity instances corresponding to a first entity type and a second plurality of entity instances corresponding to a second entity type to relate to the GUI object, wherein the first entity type and the second entity type are included in a plurality of entity types;

receiving a selection of the first entity type from the plurality of entity types;

in response to receiving the selection of the first entity type, returning the first plurality of entity instances in the polymorphic lookup interface;

receiving a selection of the second entity type from the plurality of entity types;

in response to receiving the selection of the second entity type, returning the second plurality of entity instances in the polymorphic lookup interface, wherein at least one of the returned first plurality of entity instances or the returned the second plurality of entity instances is based on querying an inverted index database compris-

ing a hierarchy of indexes, and wherein the hierarchy of indexes are searched based on a series of characters received via a search field of the polymorphic lookup interface;

receiving, within the polymorphic lookup interface, a selection of a first entity instance of the first entity type from the first plurality of entity instances and a selection of a second entity instance of the second entity type from the second plurality of entity instances;

in response to receiving the selection of the first and second entity instances, relating, by the computing device, the first and second entity instances with the GUI object; and

storing the related first and second entity instances in a database object corresponding to the GUI object.

16. The non-transitory computer-readable device of claim **15**, the operations further comprising:

using the series of characters to query the inverted index database to retrieve record identifiers; and

querying a records database to obtain data records corresponding to the record identifiers.

17. The non-transistor computer-readable device of claim **16**, wherein the inverted index database includes an index for two or more words.

18. The non-transitory computer-readable device of claim **16**, wherein the series of characters includes an ordered list of words, and wherein the returned first plurality of entity instances or the returned second plurality of entity instances prioritizes possible entity instances having the same order as the ordered list of words.

19. The non-transitory computer-readable device of claim **16**, the operations further comprising:

filtering queried data records based on access rules or search constraints; and

assigning a relevancy score to each of the filtered queried data records, wherein the returned first plurality of entity instances or the returned second plurality of entity instances correspond to the filtered queried data records based on the assigned relevancy score.

20. The non-transitory computer-readable device of claim **19**, wherein the relevancy score is based on one or more of an order a sequence of the series of characters, a user identifier identifying a user operating the GUI, or a page view metric.

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