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(54) **AGGREGATING EVENTS ON ONLINE SOCIAL NETWORKS**

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G06F 17/30	(2006.01)

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

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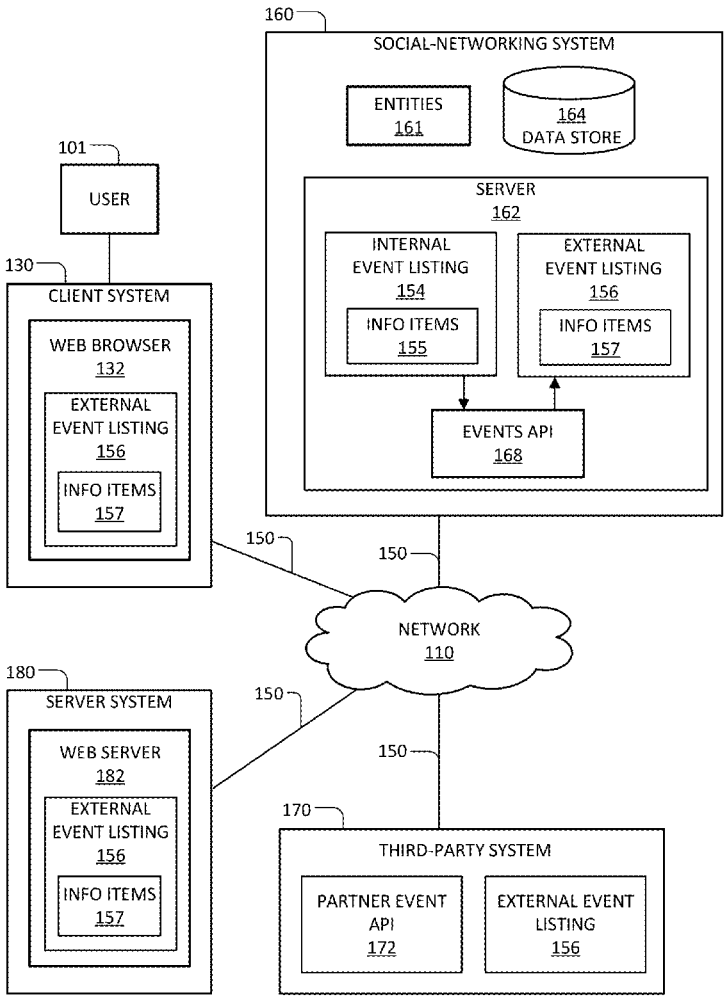
(57) **ABSTRACT**

In one embodiment, a method may include, by one or more computing systems of an online social network, receiving, from an external event system, one or more external event listings corresponding to one or more events, respectively, wherein each external event listing comprises one or more items of event information, and, for each of the external listings: identifying one or more entities of the online social network associated with the external event listing, and determining whether the external event listing corresponds to an internal event listing on the online social network based on an analysis of the event information associated with the respective external event listing, and, if so, updating the internal event listing to include one or more items of event information associated with the external event listing, wherein the internal event listing is associated with one or more entities of the online social network.



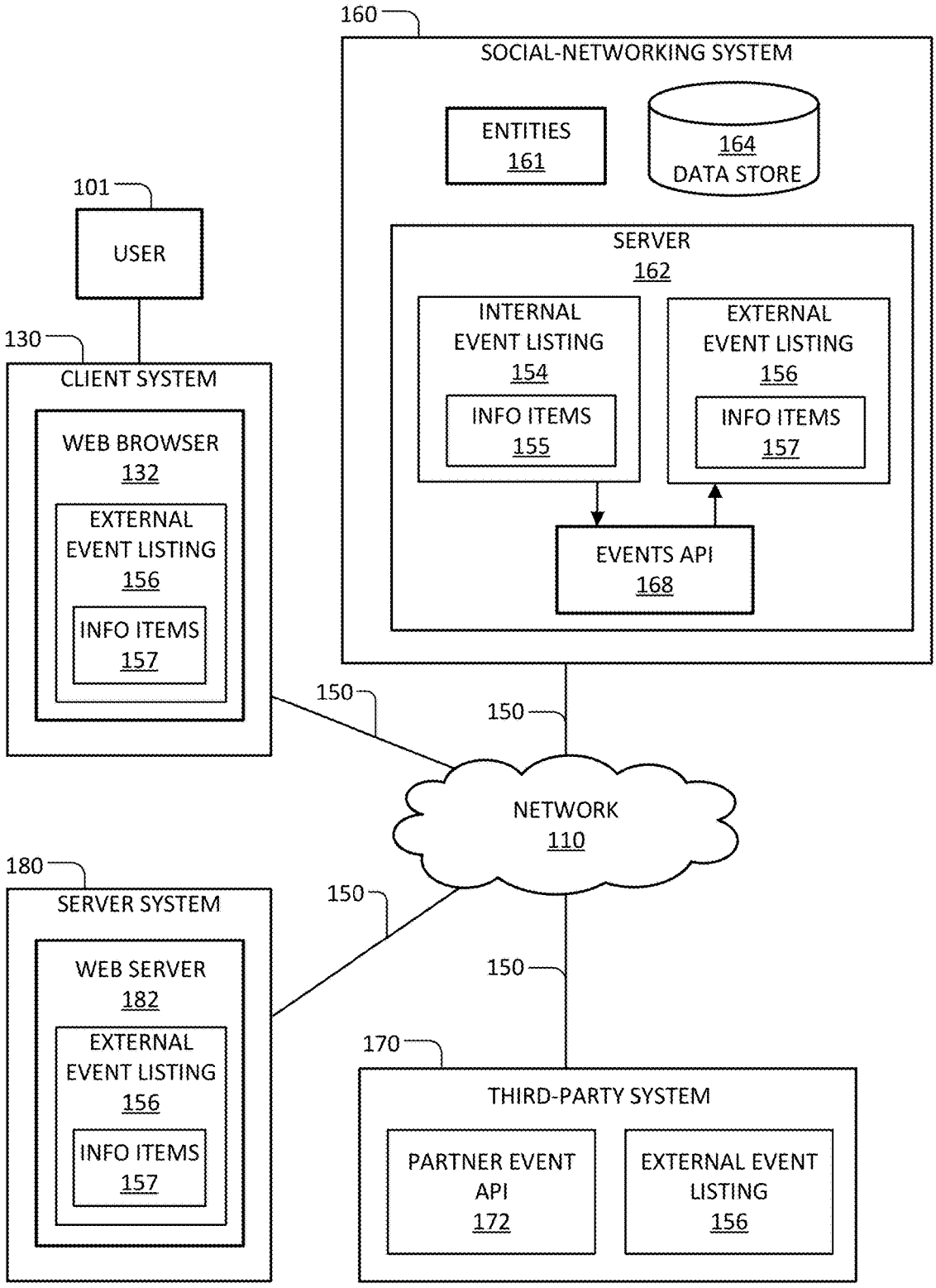

160
SOCIAL-NETWORKING SYSTEM
ENTITIES
161
164
DATA STORE
SERVER
162
INTERNAL
EVENT LISTING
154
INFO ITEMS
155
EXTERNAL
EVENT LISTING
156
INFO ITEMS
157
EVENTS API
168
101
USER
130
CLIENT SYSTEM
WEB BROWSER
132
EXTERNAL
EVENT LISTING
156
INFO ITEMS
157
150
150
NETWORK
110
180
SERVER SYSTEM
150
150
WEB SERVER
182
EXTERNAL
EVENT LISTING
156
INFO ITEMS
157
170
THIRD-PARTY SYSTEM
PARTNER EVENT
API
172
EXTERNAL EVENT
LISTING
156

FIG. 1

200

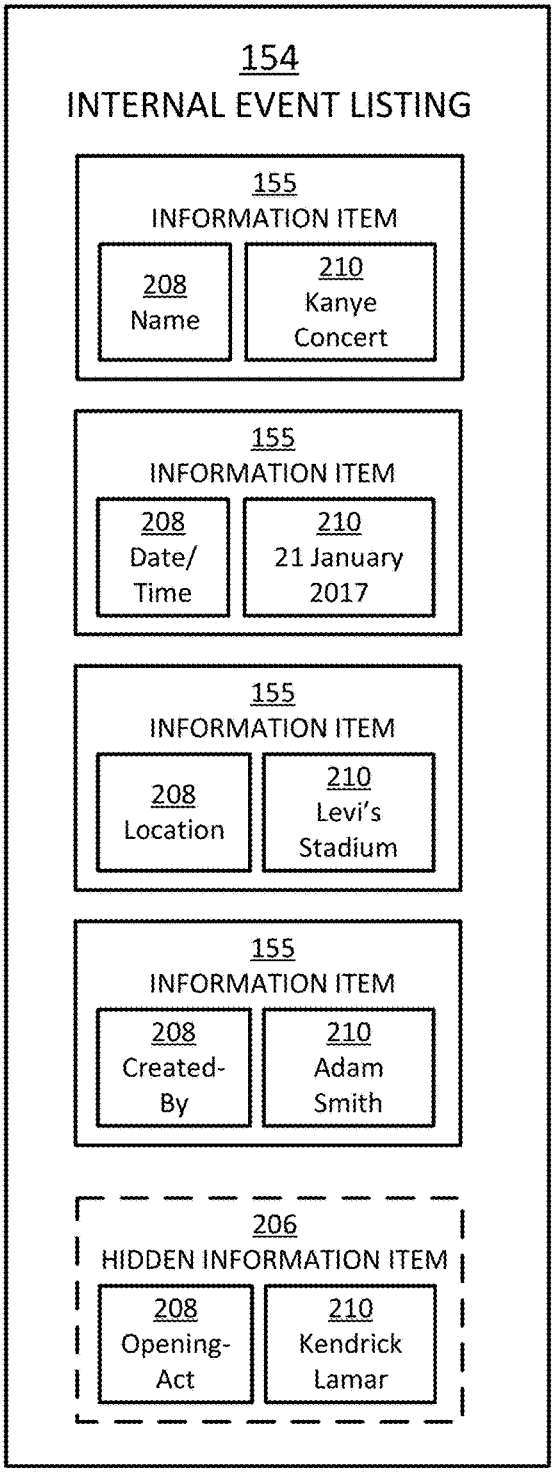


FIG. 2A

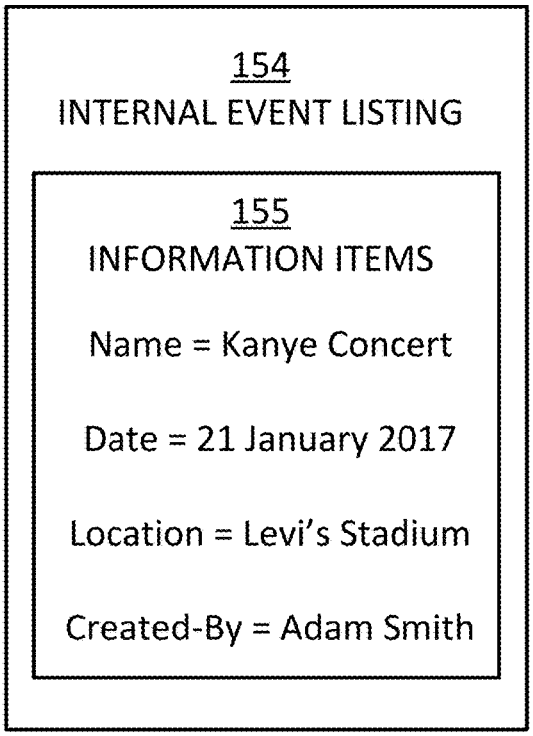


FIG. 2B

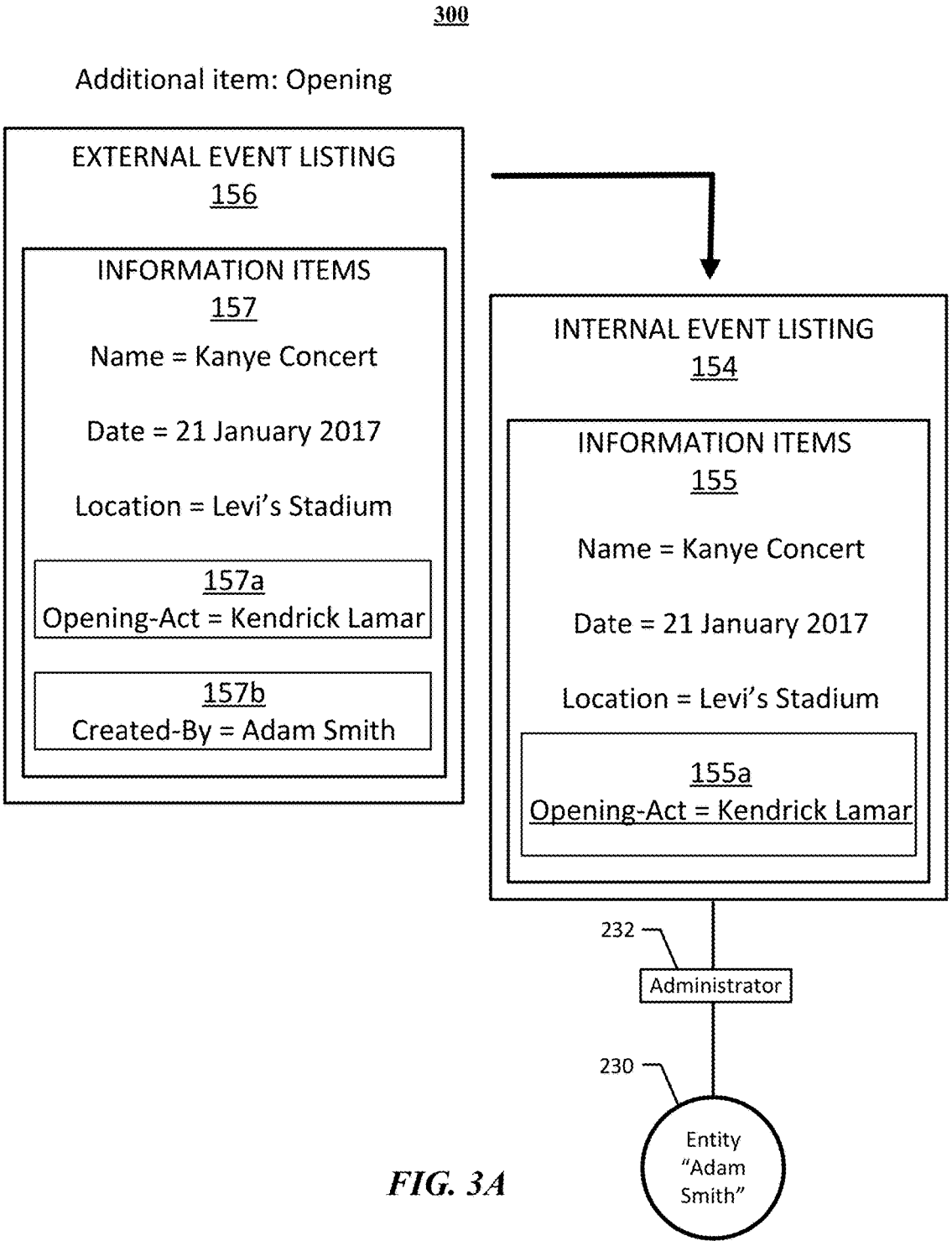

300
Additional item: Opening
EXTERNAL EVENT LISTING
156
INFORMATION ITEMS
157
Name = Kanye Concert
Date = 21 January 2017
Location = Levi's Stadium
157a
Opening-Act = Kendrick Lamar
157b
Created-By = Adam Smith
INTERNAL EVENT LISTING
154
INFORMATION ITEMS
155
Name = Kanye Concert
Date = 21 January 2017
Location = Levi's Stadium
155a
Opening-Act = Kendrick Lamar
232
Administrator
230
Entity
"Adam
Smith"

FIG. 3A

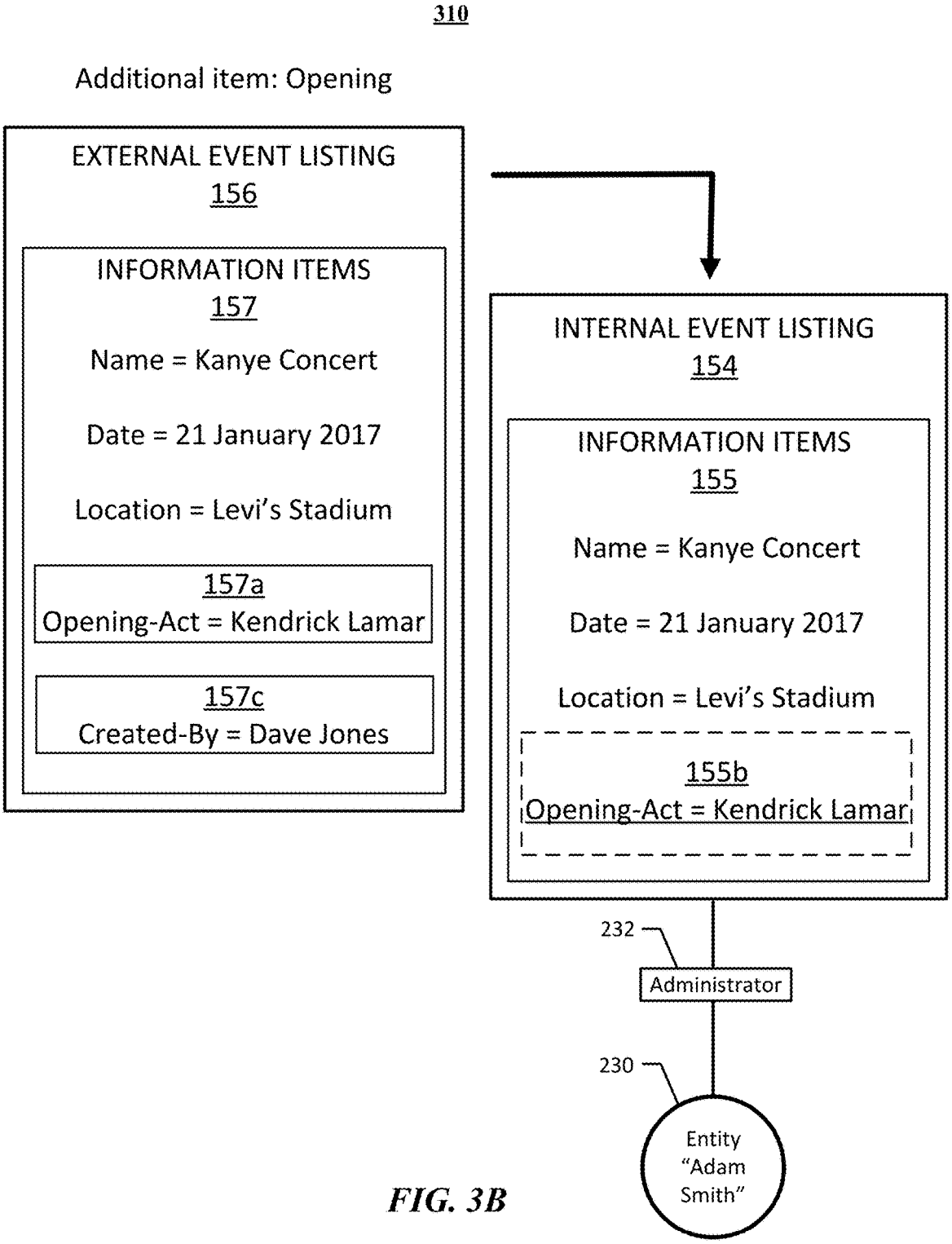

310
Additional item: Opening
EXTERNAL EVENT LISTING
156
INFORMATION ITEMS
157
Name = Kanye Concert
Date = 21 January 2017
Location = Levi's Stadium
157a
Opening-Act = Kendrick Lamar
157c
Created-By = Dave Jones
INTERNAL EVENT LISTING
154
INFORMATION ITEMS
155
Name = Kanye Concert
Date = 21 January 2017
Location = Levi's Stadium
155b
Opening-Act = Kendrick Lamar
232
Administrator
230
Entity "Adam Smith"

FIG. 3B

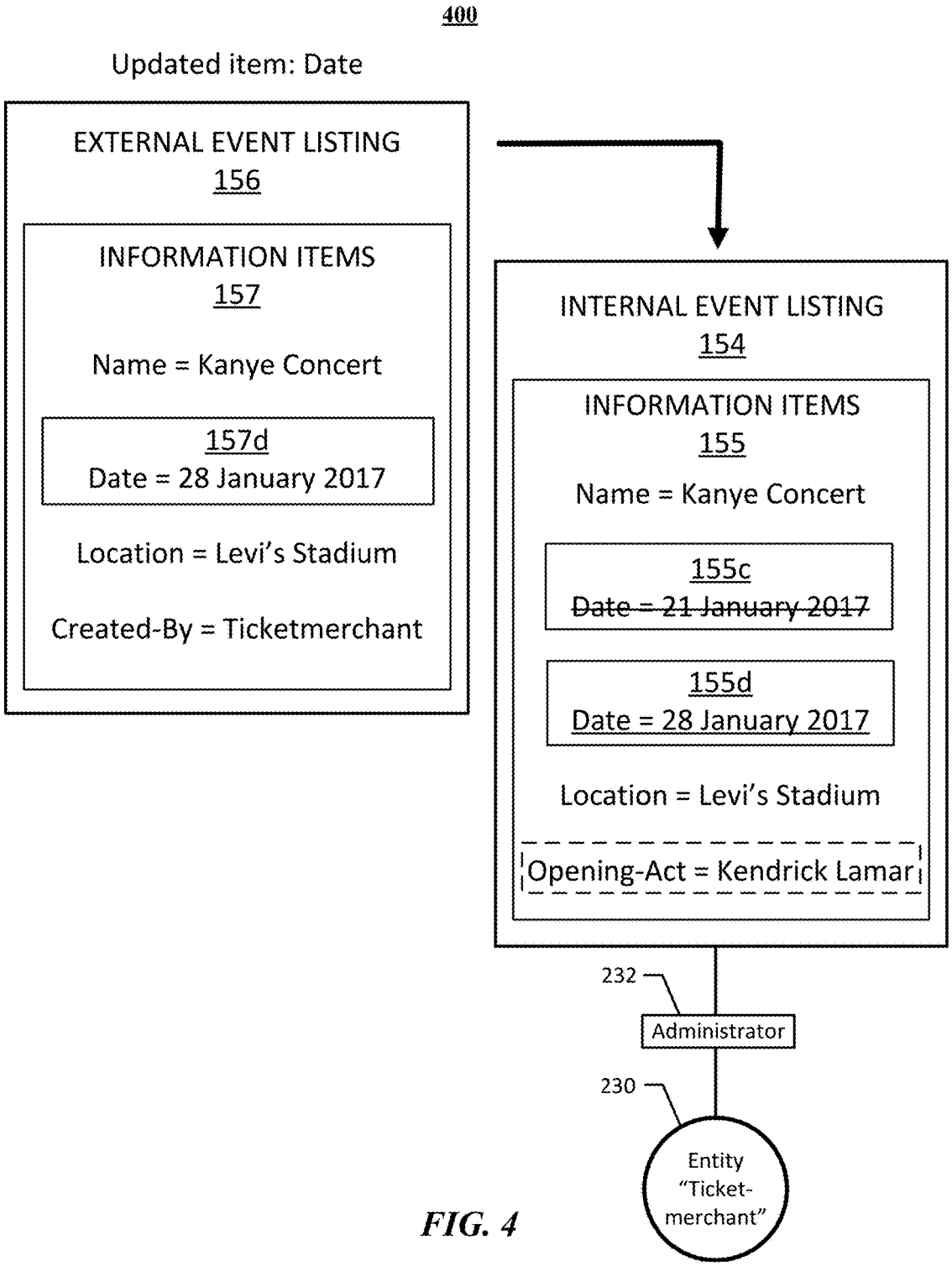

400
Updated item: Date
EXTERNAL EVENT LISTING
156
INFORMATION ITEMS
157
Name = Kanye Concert
157d
Date = 28 January 2017
Location = Levi's Stadium
Created-By = Ticketmerchant
INTERNAL EVENT LISTING
154
INFORMATION ITEMS
155
Name = Kanye Concert
155c
~~Date = 21 January 2017~~
155d
Date = 28 January 2017
Location = Levi's Stadium
Opening-Act = Kendrick Lamar
232
Administrator
230
Entity "Ticket-merchant"

FIG. 4

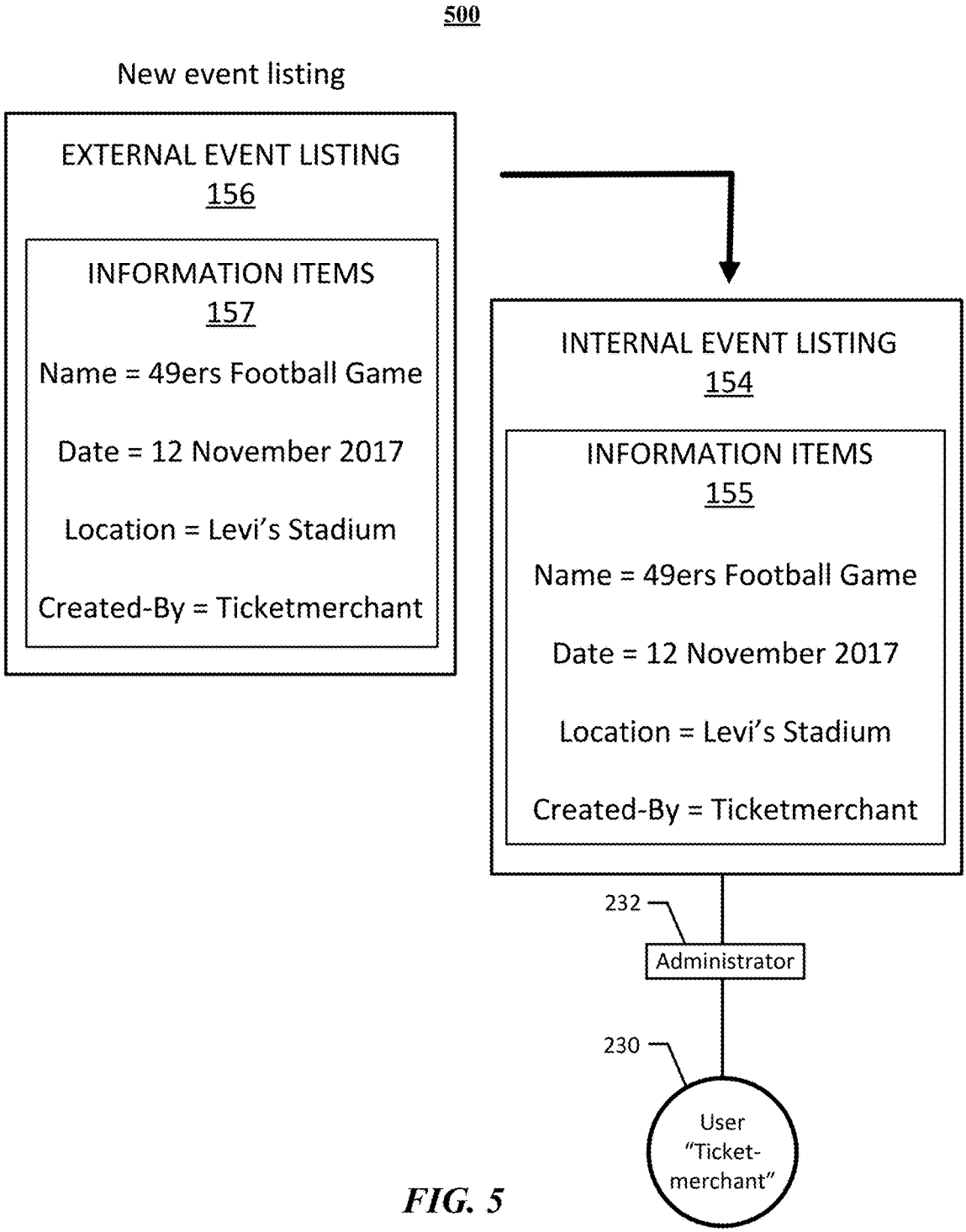

500
New event listing
EXTERNAL EVENT LISTING
156
INFORMATION ITEMS
157
Name = 49ers Football Game
Date = 12 November 2017
Location = Levi's Stadium
Created-By = Ticketmerchant
INTERNAL EVENT LISTING
154
INFORMATION ITEMS
155
Name = 49ers Football Game
Date = 12 November 2017
Location = Levi's Stadium
Created-By = Ticketmerchant
232
Administrator
230
User
"Ticket-
merchant"

FIG. 5

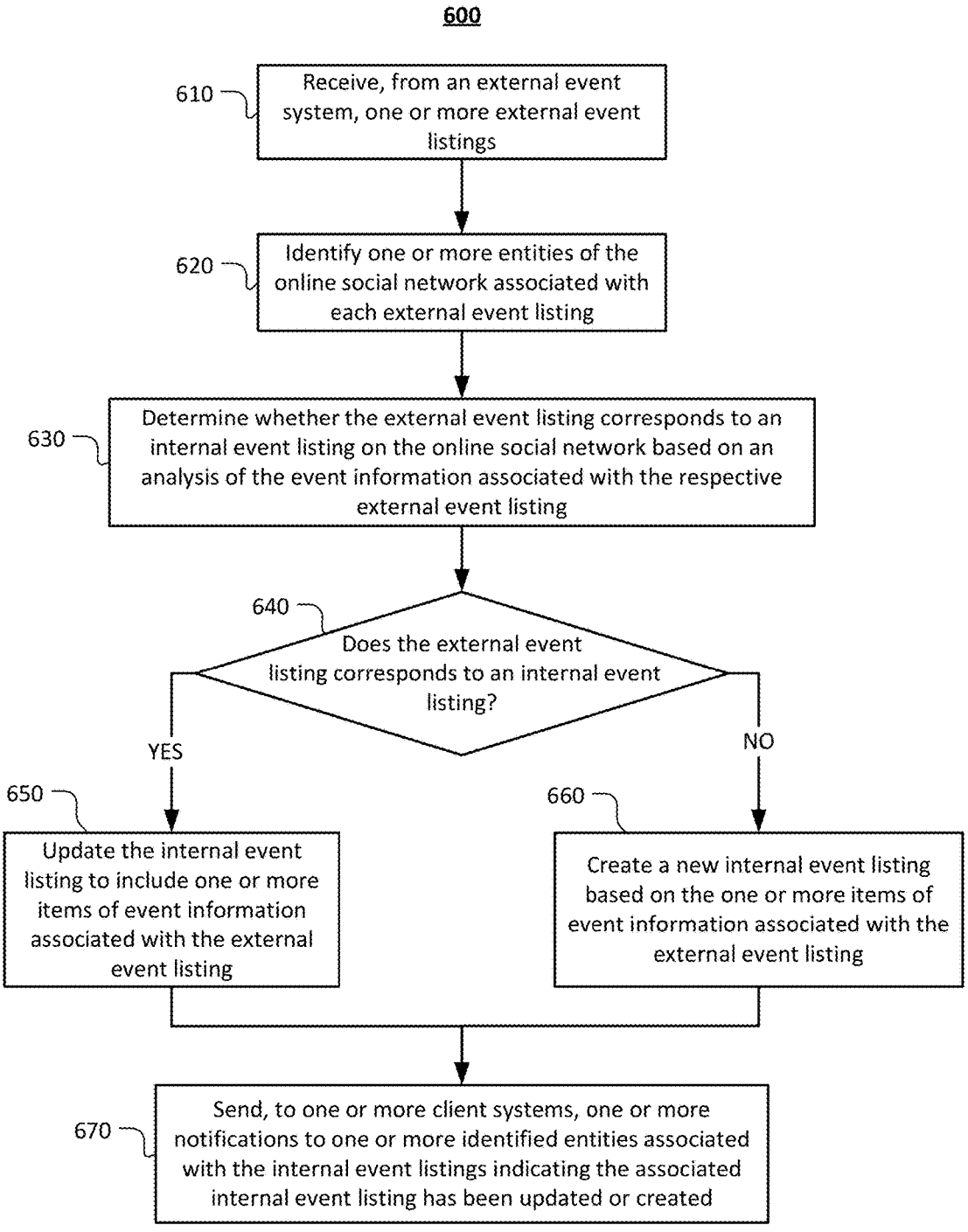

600
610
Receive, from an external event system, one or more external event listings
620
Identify one or more entities of the online social network associated with each external event listing
630
Determine whether the external event listing corresponds to an internal event listing on the online social network based on an analysis of the event information associated with the respective external event listing
640
Does the external event listing corresponds to an internal event listing?
YES
NO
650
Update the internal event listing to include one or more items of event information associated with the external event listing
660
Create a new internal event listing based on the one or more items of event information associated with the external event listing
670
Send, to one or more client systems, one or more notifications to one or more identified entities associated with the internal event listings indicating the associated internal event listing has been updated or created

FIG. 6

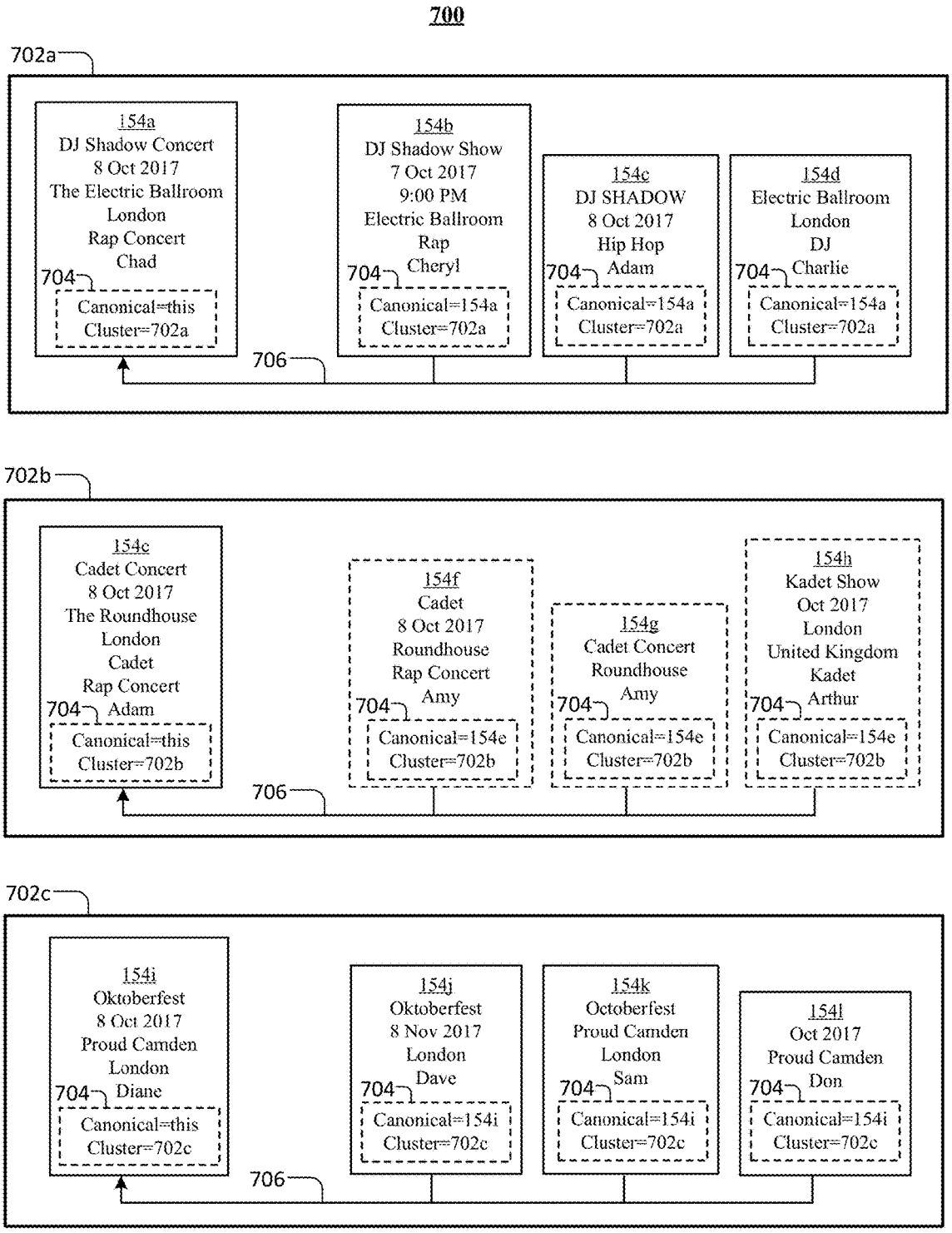

700
702a
154a
DJ Shadow Concert
8 Oct 2017
The Electric Ballroom
London
Rap Concert
Chad
704
Canonical=this
Cluster=702a
154b
DJ Shadow Show
7 Oct 2017
9:00 PM
Electric Ballroom
Rap
Cheryl
704
Canonical=154a
Cluster=702a
154c
DJ SHADOW
8 Oct 2017
Hip Hop
Adam
704
Canonical=154a
Cluster=702a
154d
Electric Ballroom
London
DJ
Charlie
704
Canonical=154a
Cluster=702a
706
702b
154e
Cadet Concert
8 Oct 2017
The Roundhouse
London
Cadet
Rap Concert
Adam
704
Canonical=this
Cluster=702b
154f
Cadet
8 Oct 2017
Roundhouse
Rap Concert
Amy
704
Canonical=154e
Cluster=702b
154g
Cadet Concert
Roundhouse
Amy
704
Canonical=154e
Cluster=702b
154h
Kadet Show
Oct 2017
London
United Kingdom
Kadet
Arthur
704
Canonical=154e
Cluster=702b
706
702c
154i
Oktoberfest
8 Oct 2017
Proud Camden
London
Diane
704
Canonical=this
Cluster=702c
154j
Oktoberfest
8 Nov 2017
London
Dave
704
Canonical=154i
Cluster=702c
154k
Octoberfest
Proud Camden
London
Sam
704
Canonical=154i
Cluster=702c
154l
Oct 2017
Proud Camden
Don
704
Canonical=154i
Cluster=702c
706

FIG. 7

800

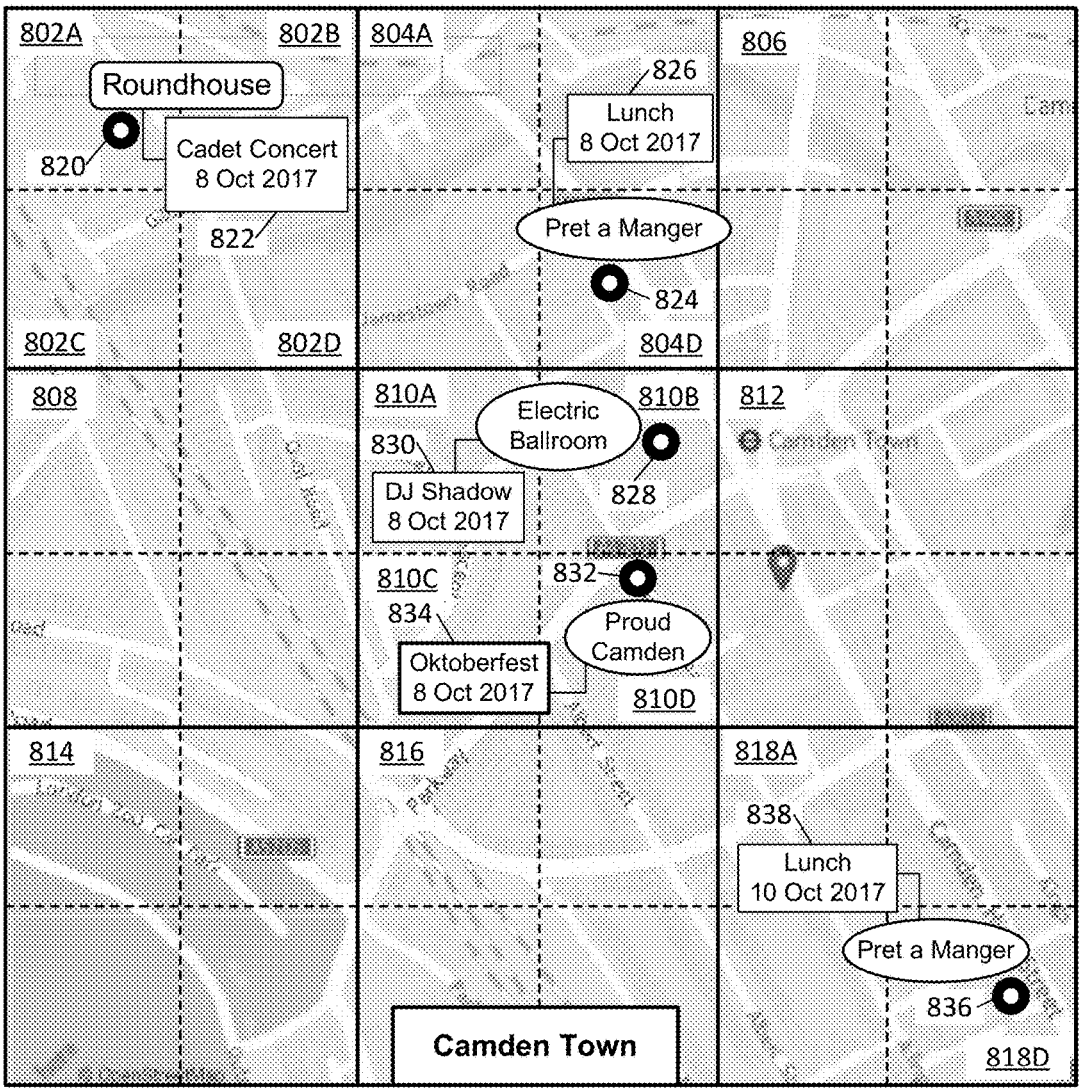


FIG. 8A

850

852 6 OCT 17	854 7 OCT 17	856 8 OCT 17	858 9 OCT 17	860 10 OCT 17	862 11 OCT 17
		822, 826, 830, 834		838	

FIG. 8B

880

866 TIME / 864 MAP TILE	852 6 OCT 17	854 7 OCT 17	856 8 OCT 17	858 9 OCT 17	860 10 OCT 17	862 11 OCT 17
			822, 826, 830, 834		838	
802 822			882a 822			
804 826			882b 826			
806						
808						
810 830, 834			882c 830, 834			
812						
814						
816						
818 838					882d 838	

FIG. 8C

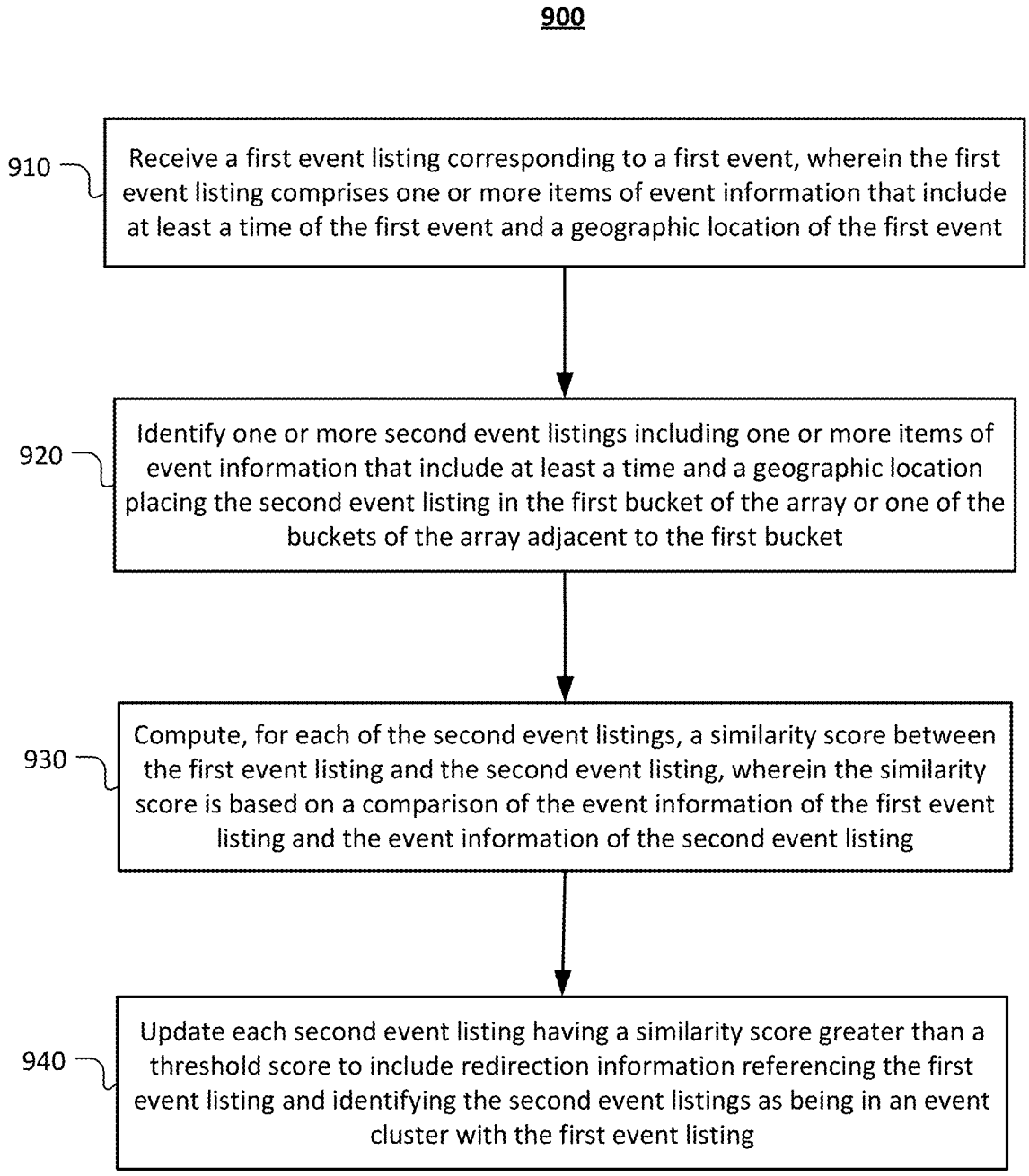

900
910
Receive a first event listing corresponding to a first event, wherein the first event listing comprises one or more items of event information that include at least a time of the first event and a geographic location of the first event
920
Identify one or more second event listings including one or more items of event information that include at least a time and a geographic location placing the second event listing in the first bucket of the array or one of the buckets of the array adjacent to the first bucket
930
Compute, for each of the second event listings, a similarity score between the first event listing and the second event listing, wherein the similarity score is based on a comparison of the event information of the first event listing and the event information of the second event listing
940
Update each second event listing having a similarity score greater than a threshold score to include redirection information referencing the first event listing and identifying the second event listings as being in an event cluster with the first event listing

FIG. 9

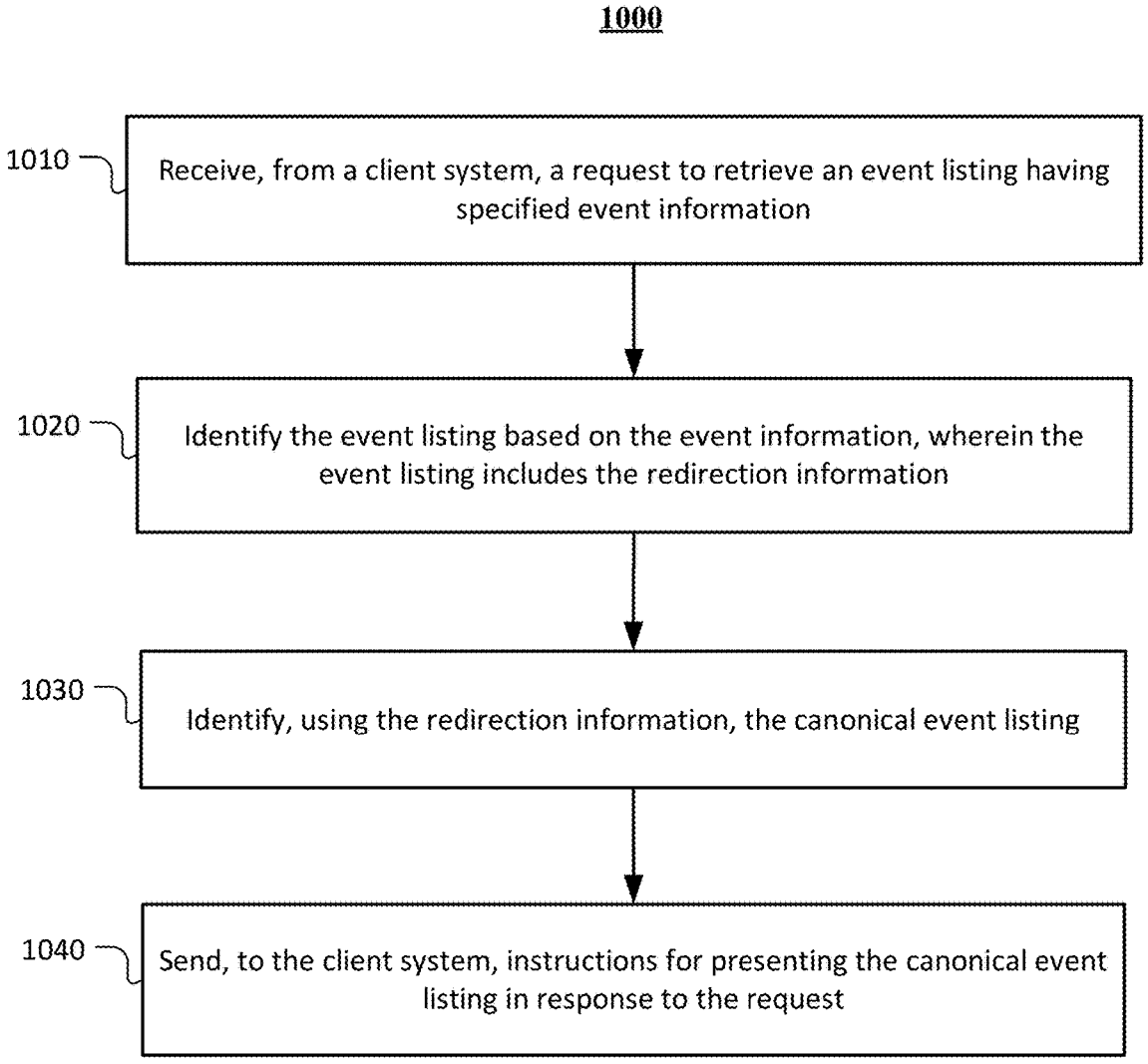

1000
1010
Receive, from a client system, a request to retrieve an event listing having specified event information
1020
Identify the event listing based on the event information, wherein the event listing includes the redirection information
1030
Identify, using the redirection information, the canonical event listing
1040
Send, to the client system, instructions for presenting the canonical event listing in response to the request

FIG. 10

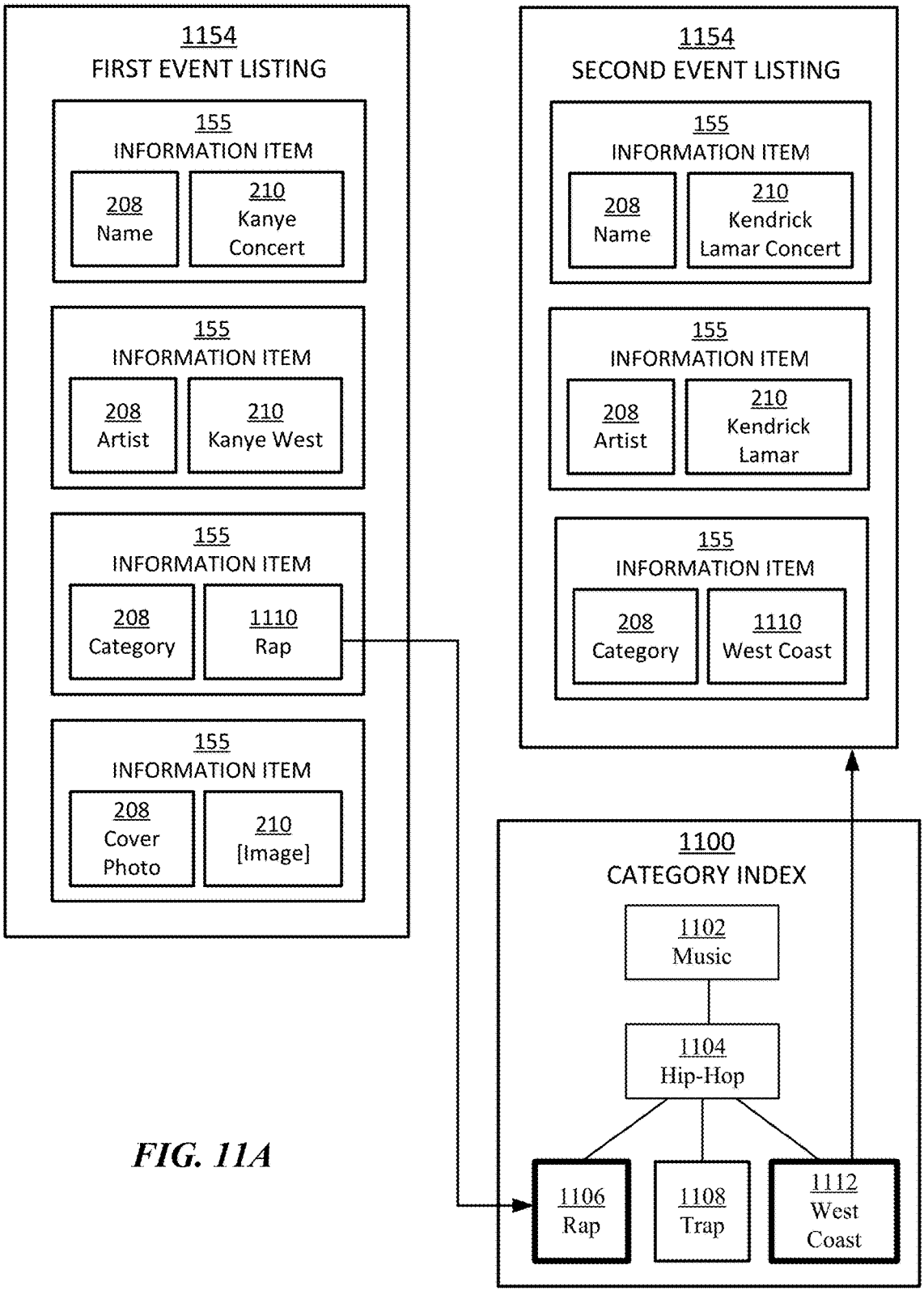

1154
FIRST EVENT LISTING
155
INFORMATION ITEM
208
Name
210
Kanye
Concert
155
INFORMATION ITEM
208
Artist
210
Kanye West
155
INFORMATION ITEM
208
Category
1110
Rap
155
INFORMATION ITEM
208
Cover
Photo
210
[Image]
1154
SECOND EVENT LISTING
155
INFORMATION ITEM
208
Name
210
Kendrick
Lamar Concert
155
INFORMATION ITEM
208
Artist
210
Kendrick
Lamar
155
INFORMATION ITEM
208
Category
1110
West Coast
1100
CATEGORY INDEX
1102
Music
1104
Hip-Hop
1106
Rap
1108
Trap
1112
West
Coast

FIG. 11A

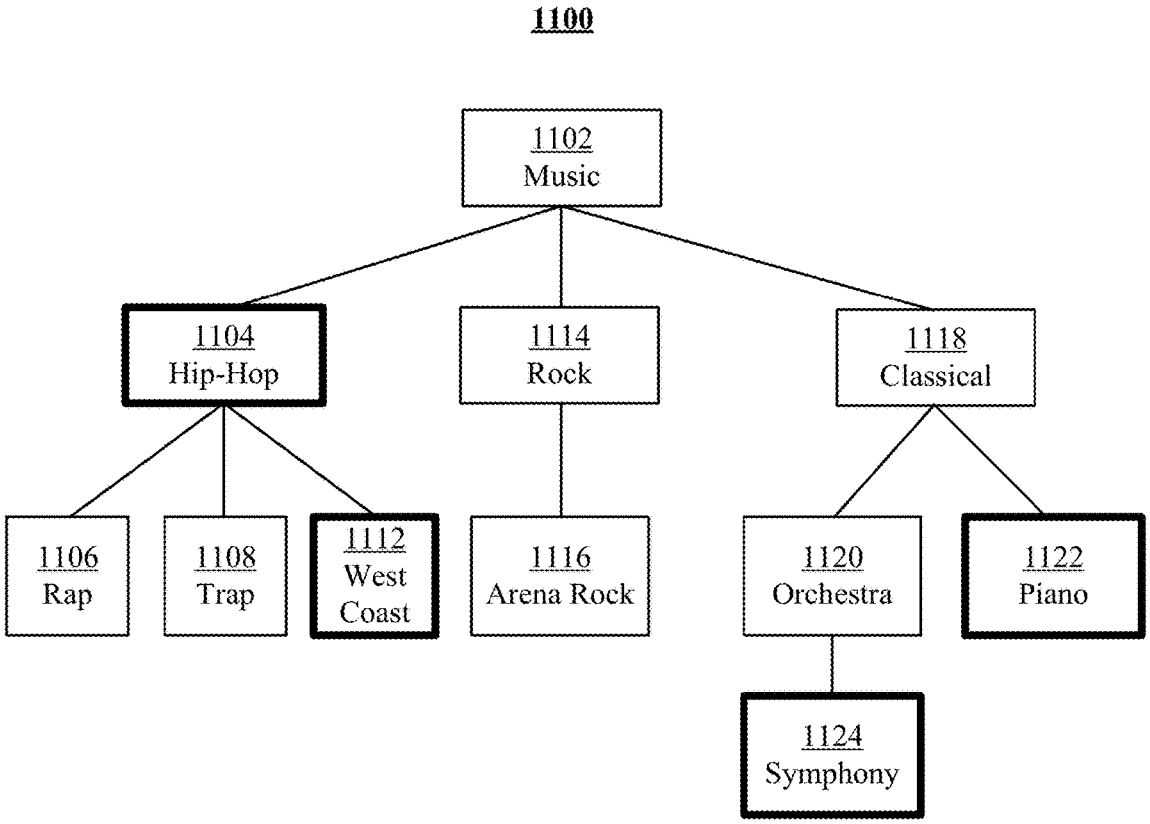

1100
1102
Music
1104
Hip-Hop
1114
Rock
1118
Classical
1106
Rap
1108
Trap
1112
West
Coast
1116
Arena Rock
1120
Orchestra
1122
Piano
1124
Symphony

FIG. 11B

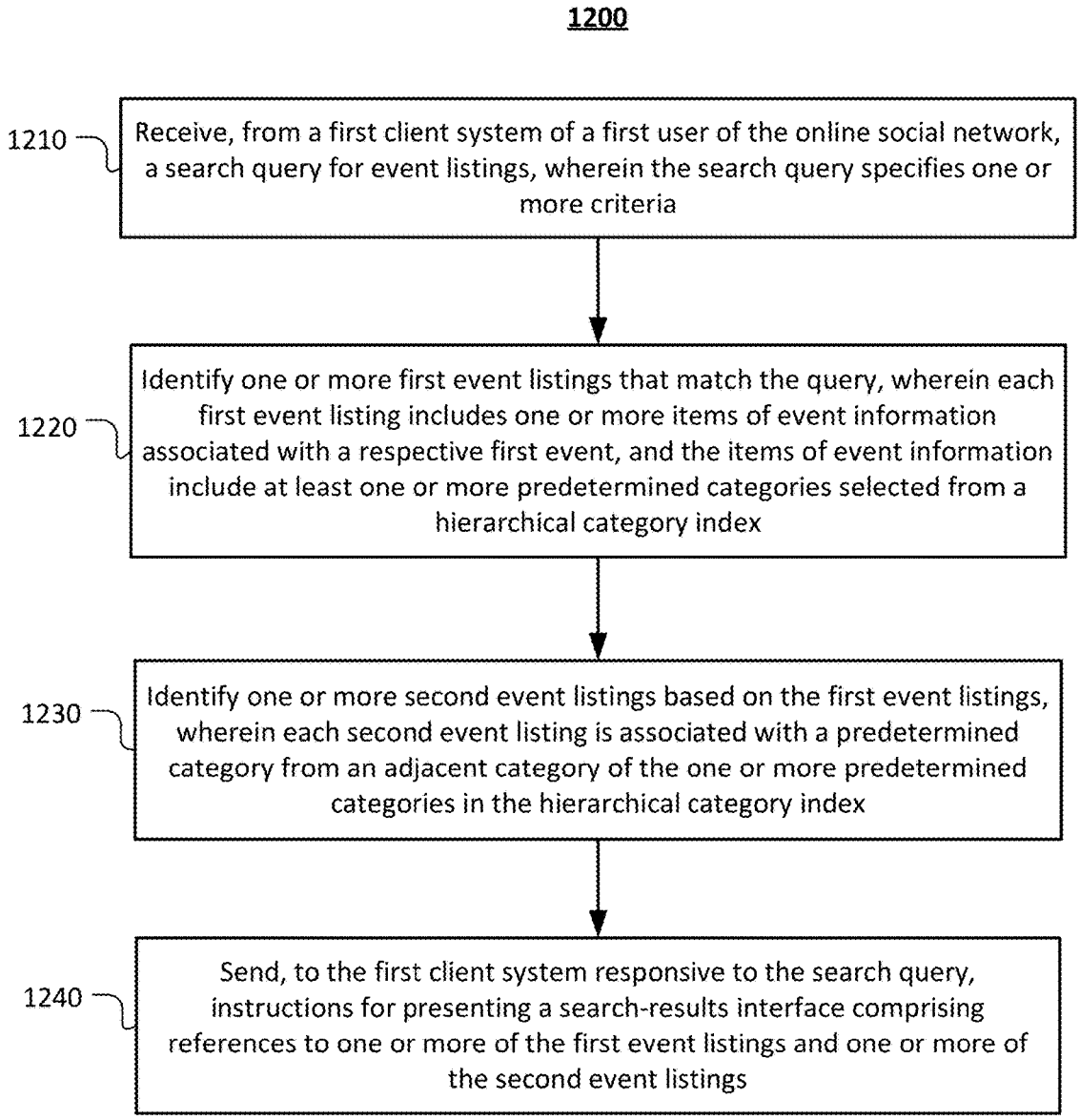

1200
1210
Receive, from a first client system of a first user of the online social network, a search query for event listings, wherein the search query specifies one or more criteria
1220
Identify one or more first event listings that match the query, wherein each first event listing includes one or more items of event information associated with a respective first event, and the items of event information include at least one or more predetermined categories selected from a hierarchical category index
1230
Identify one or more second event listings based on the first event listings, wherein each second event listing is associated with a predetermined category from an adjacent category of the one or more predetermined categories in the hierarchical category index
1240
Send, to the first client system responsive to the search query, instructions for presenting a search-results interface comprising references to one or more of the first event listings and one or more of the second event listings

FIG. 12

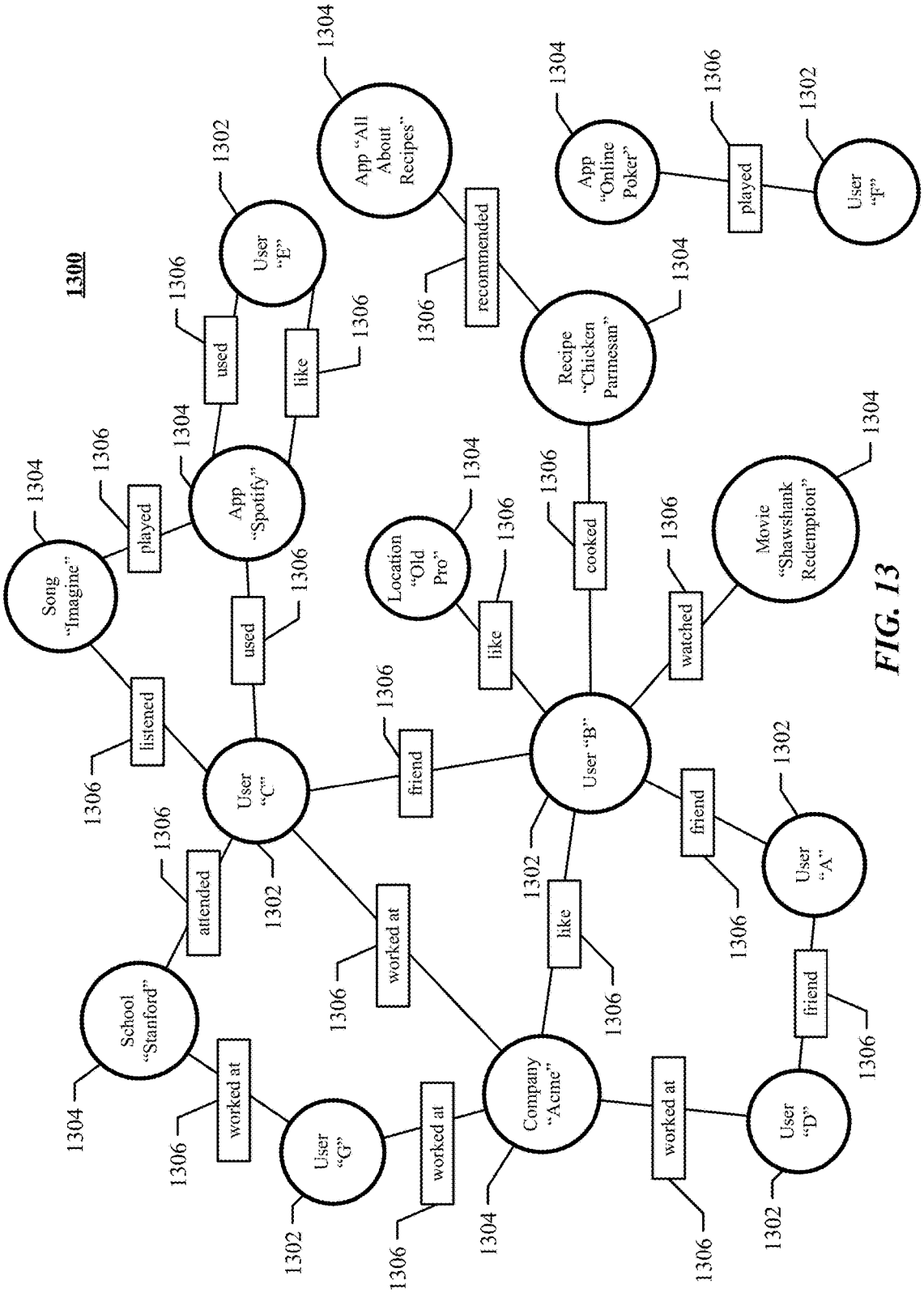

1300
User "A"
User "B"
User "C"
User "D"
User "E"
User "F"
User "G"
App "Spotify"
App "All About Recipes"
App "Online Poker"
Song "Imagine"
Location "Old Pro"
Recipe "Chicken Parmesan"
Movie "Shawshank Redemption"
School "Stanford"
Company "Acme"
friend
played
used
like
listened
cooked
watched
recommended
attended
worked at
1302
1304
1306

FIG. 13

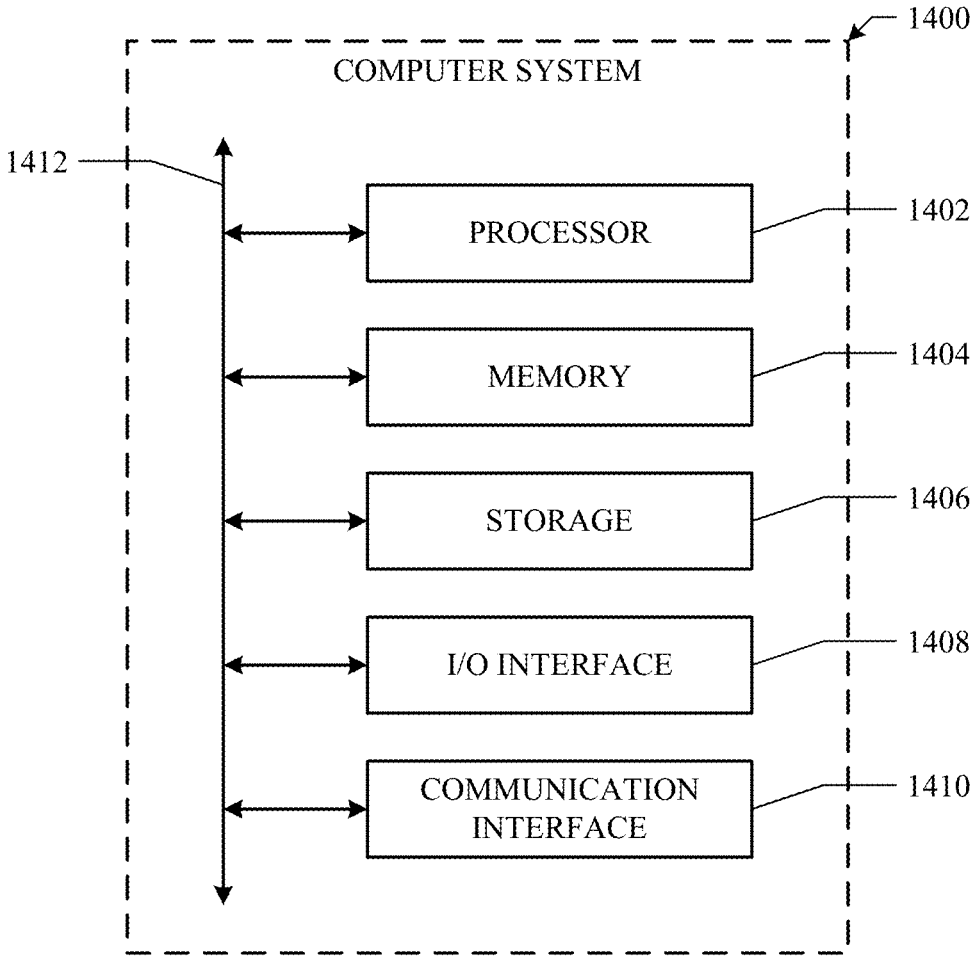

1400
COMPUTER SYSTEM
1412
PROCESSOR
1402
MEMORY
1404
STORAGE
1406
I/O INTERFACE
1408
COMMUNICATION INTERFACE
1410

FIG. 14

AGGREGATING EVENTS ON ONLINE SOCIAL NETWORKS

PRIORITY

[0001] This application claims the benefit, under 35 U.S. C. § 119(e), of U.S. Provisional Patent Application No. 62/569982, filed 9 Oct. 2017, which is incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure generally relates to processing event listings on online social networks.

BACKGROUND

[0003] A social-networking system, which may include a social-networking website, may enable its users (such as persons or organizations) to interact with it and with each other through it. The social-networking system may, with input from a user, create and store in the social-networking system a user profile associated with the user. The user profile may include demographic information, communication-channel information, and information on personal interests of the user. The social-networking system may also, with input from a user, create and store a record of relationships of the user with other users of the social-networking system, as well as provide services (e.g., wall posts, photo-sharing, event organization, messaging, games, or advertisements) to facilitate social interaction between or among users.

[0004] The social-networking system may send over one or more networks content or messages related to its services to a mobile or other computing device of a user. A user may also install software applications on a mobile or other computing device of the user for accessing a user profile of the user and other data within the social-networking system. The social-networking system may generate a personalized set of content objects to display to a user, such as a newsfeed of aggregated stories of other users connected to the user.

[0005] A mobile computing device—such as a smartphone, tablet computer, or laptop computer—may include functionality for determining its location, direction, or orientation, such as a GPS receiver, compass, gyroscope, or accelerometer. Such a device may also include functionality for wireless communication, such as BLUETOOTH communication, near-field communication (NFC), or infrared (IR) communication or communication with a wireless local area networks (WLANs) or cellular-telephone network. Such a device may also include one or more cameras, scanners, touchscreens, microphones, or speakers. Mobile computing devices may also execute software applications, such as games, web browsers, or social-networking applications. With social-networking applications, users may connect, communicate, and share information with other users in their social networks.

SUMMARY OF PARTICULAR EMBODIMENTS

[0006] In particular embodiments, a social-networking system may receive external event listings from external sources, such as a third-party system, a web browser of a client system, a web server, or other suitable data sources. Each of the external event listings may describe a corresponding real-world event, and may include information such as an event name, date, location, or the like. In particular embodiments, the social-networking system may create, retrieve, update, and delete internal event listings. The information in the internal event listings may be based on the external event listings. The social-networking system may receive the external event listings and map at least a portion of the information in the external event listings to one or more of the internal event listings. The external event listings may be provided by third-party systems, which may be, for example, ticket sales organizations, performance venues, event aggregators, or the like. The third-party systems may access the event listings hosted by the social-networking system via an API. The API may be publicly-accessible or accessible by the third-party systems. The social-networking system may invoke an event aggregator's API to retrieve the aggregator's and/or partner's event inventory.

[0007] In particular embodiments, duplicate event listings representing a single real-world event may be identified and linked together, combined, or otherwise associated with each other to avoid unnecessary duplication and inconsistency. Two event listings may be duplicates if both event listings include one or more of the same information items, though duplicate event listings need not be identical. Duplicate event listings may be created separately, e.g., by different users or at different times. A user who creates a duplicate event listing may be unaware of the existence of an existing event listing, or a user may purposefully create a duplicate event listing having one or more additional information items that are not included in the existing event listing or are to be kept separate from those in the existing event listing. A selected duplicate event listing may be designated as a canonical event listing, and access to each of the other duplicate event listings, such as registering to attend an event or reading/writing event information, may be directed to the canonical event listing unless the access is specifically directed to one of the other (non-canonical) event listings. For example, a user may create a duplicate event listing intentionally to share with friends. Access to that event listing by the user and the user's friends may be directed to the duplicate event listing instead of the canonical event listing.

[0008] In particular embodiments, a machine-learning model may be used to automatically categorize event listings on an online social network. Event listings may be associated with categories such as music (jazz, rap), comedy, sports (kickball, ultimate Frisbee), e-sports (League of Legends, HearthStone), and so on. Such event categories may be useful for search and discovery features on online social networks or other user applications, such as specific event-management applications. For example, a user may click or tap on a category name in an events application to view events in that category. Event categories may be related to other event categories, so that related events may be found by searching related categories. The event categories may be arranged in a hierarchy, with the broadest categories at the top of the hierarchy and the narrowest at the bottom. For example, "entertainment" may be a top-level category, "music" may be below entertainment, and "jazz" and "rap" may be below "music." Thus, by automatically categorizing events, the event system may allow users to more easily search for and browse events, and to find events in related categories in the hierarchy.

[0009] The embodiments disclosed herein are only examples, and the scope of this disclosure is not limited to

them. Particular embodiments may include all, some, or none of the components, elements, features, functions, operations, or steps of the embodiments disclosed above. Embodiments according to the invention are in particular disclosed in the attached claims directed to a method, a storage medium, a system and a computer program product, wherein any feature mentioned in one claim category, e.g. method, can be claimed in another claim category, e.g. system, as well. The dependencies or references back in the attached claims are chosen for formal reasons only. However any subject matter resulting from a deliberate reference back to any previous claims (in particular multiple dependencies) can be claimed as well, so that any combination of claims and the features thereof are disclosed and can be claimed regardless of the dependencies chosen in the attached claims. The subject-matter which can be claimed comprises not only the combinations of features as set out in the attached claims but also any other combination of features in the claims, wherein each feature mentioned in the claims can be combined with any other feature or combination of other features in the claims. Furthermore, any of the embodiments and features described or depicted herein can be claimed in a separate claim and/or in any combination with any embodiment or feature described or depicted herein or with any of the features of the attached claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** illustrates an example network environment associated with an event system on an online social network.

[0011] FIGS. **2**A and **2**B illustrate an example internal event listing associated with a user entity of a social-networking system.

[0012] FIG. **3**A illustrates an example of updating an internal event listing by adding an information item from an external event listing.

[0013] FIG. **3**B illustrates an example of updating an internal event listing by adding a hidden information item from an external event listing.

[0014] FIG. **4** illustrates an example of updating an internal event listing by changing an existing information item to have a new value from an external event listing.

[0015] FIG. **5** illustrates an example of creating a new internal event listing from an external event listing.

[0016] FIG. **6** illustrates an example method for aggregating events on a social-networking system.

[0017] FIG. **7** illustrates an example in which duplicate event listings have been identified and linked together to form event listing clusters.

[0018] FIG. **8**A illustrates an example map divided into geographic map tiles.

[0019] FIG. **8**B illustrates an example timeline divided into time increments.

[0020] FIG. **8**C illustrates an example two-dimensional array of map tiles and time increments.

[0021] FIG. **9** illustrates an example method for de-duplicating events on a social-networking system.

[0022] FIG. **10** illustrates an example method for retrieving canonical event listings on a social-networking system.

[0023] FIG. **11**A illustrates an event recommendation example in which a first category associated with a first event listing is used to identify a second event listing having a second category related to the first category by a category index.

[0024] FIG. **11**B illustrates an example hierarchical category index.

[0025] FIG. **12** illustrates an example method for identifying event listings based on a search query and one or more event categories.

[0026] FIG. **13** illustrates an example social graph.

[0027] FIG. **14** illustrates an example computer system.

DESCRIPTION OF EXAMPLE EMBODIMENTS

System Overview

[0028] FIG. **1** illustrates an example network environment **100** associated with an online social network. Network environment **100** includes a client system **130**, a social-networking system **160**, and a third-party system **170** connected to each other by a network **110**. Although FIG. **1** illustrates a particular arrangement of client system **130**, social-networking system **160**, third-party system **170**, and network **110**, this disclosure contemplates any suitable arrangement of client system **130**, social-networking system **160**, third-party system **170**, and network **110**. As an example and not by way of limitation, two or more of client system **130**, social-networking system **160**, and third-party system **170** may be connected to each other directly, bypassing network **110**. As another example, two or more of client system **130**, social-networking system **160**, and third-party system **170** may be physically or logically co-located with each other in whole or in part. Moreover, although FIG. **1** illustrates a particular number of client systems **130**, social-networking systems **160**, third-party systems **170**, and networks **110**, this disclosure contemplates any suitable number of client systems **130**, social-networking systems **160**, third-party systems **170**, and networks **110**. As an example and not by way of limitation, network environment **100** may include multiple client system **130**, social-networking systems **160**, third-party systems **170**, and networks **110**.

[0029] This disclosure contemplates any suitable network **110**. As an example and not by way of limitation, one or more portions of network **110** may include an ad hoc network, an intranet, an extranet, a virtual private network (VPN), a local area network (LAN), a wireless LAN (WLAN), a wide area network (WAN), a wireless WAN (WWAN), a metropolitan area network (MAN), a portion of the Internet, a portion of the Public Switched Telephone Network (PSTN), a cellular telephone network, or a combination of two or more of these. Network **110** may include one or more networks **110**.

[0030] Links **150** may connect client system **130**, social-networking system **160**, and third-party system **170** to communication network **110** or to each other. This disclosure contemplates any suitable links **150**. In particular embodiments, one or more links **150** include one or more wireline (such as for example Digital Subscriber Line (DSL) or Data Over Cable Service Interface Specification (DOCSIS)), wireless (such as for example Wi-Fi or Worldwide Interoperability for Microwave Access (WiMAX)), or optical (such as for example Synchronous Optical Network (SONET) or Synchronous Digital Hierarchy (SDH)) links. In particular embodiments, one or more links **150** each include an ad hoc network, an intranet, an extranet, a VPN, a LAN, a WLAN, a WAN, a WWAN, a MAN, a portion of the Internet, a portion of the PSTN, a cellular technology-based network, a satellite communications technology-based network, another link **150**, or a combination of two or

more such links **150**. Links **150** need not necessarily be the same throughout network environment **100**. One or more first links **150** may differ in one or more respects from one or more second links **150**.

[0031] In particular embodiments, client system **130** may be an electronic device including hardware, software, or embedded logic components or a combination of two or more such components and capable of carrying out the appropriate functionalities implemented or supported by client system **130**. As an example and not by way of limitation, a client system **130** may include a computer system such as a desktop computer, notebook or laptop computer, netbook, a tablet computer, e-book reader, GPS device, camera, personal digital assistant (PDA), handheld electronic device, cellular telephone, smartphone, augmented/virtual reality device, other suitable electronic device, or any suitable combination thereof. This disclosure contemplates any suitable client systems **130**. A client system **130** may enable a network user at client system **130** to access network **110**. A client system **130** may enable its user to communicate with other users at other client systems **130**.

[0032] In particular embodiments, client system **130** may include a web browser **132**, such as MICROSOFT INTERNET EXPLORER, GOOGLE CHROME or MOZILLA FIREFOX, and may have one or more add-ons, plug-ins, or other extensions, such as TOOLBAR or YAHOO TOOLBAR. A user at client system **130** may enter a Uniform Resource Locator (URL) or other address directing the web browser **132** to a particular server (such as server **162**, or a server associated with a third-party system **170**), and the web browser **132** may generate a Hyper Text Transfer Protocol (HTTP) request and communicate the HTTP request to server. The server may accept the HTTP request and communicate to client system **130** one or more Hyper Text Markup Language (HTML) files responsive to the HTTP request. Client system **130** may render a webpage based on the HTML files from the server for presentation to the user. This disclosure contemplates any suitable webpage files. As an example and not by way of limitation, webpages may render from HTML files, Extensible Hyper Text Markup Language (XHTML) files, or Extensible Markup Language (XML) files, according to particular needs. Such pages may also execute scripts such as, for example and without limitation, those written in JAVASCRIPT, JAVA, MICROSOFT SILVERLIGHT, combinations of markup language and scripts such as AJAX (Asynchronous JAVASCRIPT and XML), and the like. Herein, reference to a webpage encompasses one or more corresponding webpage files (which a browser may use to render the webpage) and vice versa, where appropriate.

[0033] In particular embodiments, social-networking system **160** may be a network-addressable computing system that can host an online social network. Social-networking system **160** may generate, store, receive, and send social-networking data, such as, for example, user-profile data, concept-profile data, social-graph information, or other suitable data related to the online social network. Social-networking system **160** may be accessed by the other components of network environment **100** either directly or via network **110**. As an example and not by way of limitation, client system **130** may access social-networking system **160** using a web browser **132**, or a native application associated with social-networking system **160** (e.g., a mobile social-networking application, a messaging application, another suitable application, or any combination thereof) either directly or via network **110**. In particular embodiments, social-networking system **160** may include one or more servers **162**. Each server **162** may be a unitary server or a distributed server spanning multiple computers or multiple datacenters. Servers **162** may be of various types, such as, for example and without limitation, web server, news server, mail server, message server, advertising server, file server, application server, exchange server, database server, proxy server, another server suitable for performing functions or processes described herein, or any combination thereof. In particular embodiments, each server **162** may include hardware, software, or embedded logic components or a combination of two or more such components for carrying out the appropriate functionalities implemented or supported by server **162**. In particular embodiments, social-networking system **160** may include one or more data stores **164**. Data stores **164** may be used to store various types of information. In particular embodiments, the information stored in data stores **164** may be organized according to specific data structures. In particular embodiments, each data store **164** may be a relational, columnar, correlation, or other suitable database. Although this disclosure describes or illustrates particular types of databases, this disclosure contemplates any suitable types of databases. Particular embodiments may provide interfaces that enable a client system **130**, a social-networking system **160**, or a third-party system **170** to manage, retrieve, modify, add, or delete, the information stored in data store **164**.

[0034] In particular embodiments, social-networking system **160** may store one or more social graphs in one or more data stores **164**. In particular embodiments, a social graph may include multiple nodes—which may include multiple user nodes (each corresponding to a particular user) or multiple concept nodes (each corresponding to a particular concept)—and multiple edges connecting the nodes. Social-networking system **160** may provide users of the online social network the ability to communicate and interact with other users. In particular embodiments, users may join the online social network via social-networking system **160** and then add connections (e.g., relationships) to a number of other users of social-networking system **160** to whom they want to be connected. Herein, the term "friend" may refer to any other user of social-networking system **160** with whom a user has formed a connection, association, or relationship via social-networking system **160**.

[0035] In particular embodiments, social-networking system **160** may provide users with the ability to take actions on various types of items or objects, supported by social-networking system **160**. As an example and not by way of limitation, the items and objects may include groups or social networks to which users of social-networking system **160** may belong, events or calendar entries in which a user might be interested, computer-based applications that a user may use, transactions that allow users to buy or sell items via the service, interactions with advertisements that a user may perform, or other suitable items or objects. A user may interact with anything that is capable of being represented in social-networking system **160** or by an external system of third-party system **170**, which is separate from social-networking system **160** and coupled to social-networking system **160** via a network **110**.

[0036] In particular embodiments, social-networking system **160** may be capable of linking a variety of entities. As

an example and not by way of limitation, social-networking system **160** may enable users to interact with each other as well as receive content from third-party systems **170** or other entities, or to allow users to interact with these entities through an application programming interfaces (API) or other communication channels.

[0037] In particular embodiments, a third-party system **170** may include one or more types of servers, one or more data stores, one or more interfaces, including but not limited to APIs, one or more web services, one or more content sources, one or more networks, or any other suitable components, e.g., that servers may communicate with. A third-party system **170** may be operated by a different entity from an entity operating social-networking system **160**. In particular embodiments, however, social-networking system **160** and third-party systems **170** may operate in conjunction with each other to provide social-networking services to users of social-networking system **160** or third-party systems **170**. In this sense, social-networking system **160** may provide a platform, or backbone, which other systems, such as third-party systems **170**, may use to provide social-networking services and functionality to users across the Internet.

[0038] In particular embodiments, a third-party system **170** may include a third-party content object provider. A third-party content object provider may include one or more sources of content objects, which may be communicated to a client system **130**. As an example and not by way of limitation, content objects may include information regarding things or activities of interest to the user, such as, for example, movie show times, movie reviews, restaurant reviews, restaurant menus, product information and reviews, or other suitable information. As another example and not by way of limitation, content objects may include incentive content objects, such as coupons, discount tickets, gift certificates, or other suitable incentive objects.

[0039] In particular embodiments, social-networking system **160** also includes user-generated content objects, which may enhance a user's interactions with social-networking system **160**. User-generated content may include anything a user can add, upload, send, or "post" to social-networking system **160**. As an example and not by way of limitation, a user communicates posts to social-networking system **160** from a client system **130**. Posts may include data such as status updates or other textual data, location information, photos, videos, links, music or other similar data or media. Content may also be added to social-networking system **160** by a third-party through a "communication channel," such as a newsfeed or stream.

[0040] In particular embodiments, social-networking system **160** may include a variety of servers, sub-systems, programs, modules, logs, and data stores. In particular embodiments, social-networking system **160** may include one or more of the following: a web server, action logger, API-request server, relevance-and-ranking engine, content-object classifier, notification controller, action log, third-party-content-object-exposure log, inference module, authorization/privacy server, search module, advertisement-targeting module, user-interface module, user-profile store, connection store, third-party content store, or location store. Social-networking system **160** may also include suitable components such as network interfaces, security mechanisms, load balancers, failover servers, management-and-network-operations consoles, other suitable components, or any suitable combination thereof. In particular embodiments, social-networking system **160** may include one or more user-profile stores for storing user profiles. A user profile may include, for example, biographic information, demographic information, behavioral information, social information, or other types of descriptive information, such as work experience, educational history, hobbies or preferences, interests, affinities, or location. Interest information may include interests related to one or more categories. Categories may be general or specific. As an example and not by way of limitation, if a user "likes" an article about a brand of shoes the category may be the brand, or the general category of "shoes" or "clothing." A connection store may be used for storing connection information about users. The connection information may indicate users who have similar or common work experience, group memberships, hobbies, educational history, or are in any way related or share common attributes. The connection information may also include user-defined connections between different users and content (both internal and external). A web server may be used for linking social-networking system **160** to one or more client systems **130** or one or more third-party system **170** via network **110**. The web server may include a mail server or other messaging functionality for receiving and routing messages between social-networking system **160** and one or more client systems **130**. An API-request server may allow a third-party system **170** to access information from social-networking system **160** by calling one or more APIs. An action logger may be used to receive communications from a web server about a user's actions on or off social-networking system **160**. In conjunction with the action log, a third-party-content-object log may be maintained of user exposures to third-party-content objects. A notification controller may provide information regarding content objects to a client system **130**. Information may be pushed to a client system **130** as notifications, or information may be pulled from client system **130** responsive to a request received from client system **130**. Authorization servers may be used to enforce one or more privacy settings of the users of social-networking system **160**. A privacy setting of a user determines how particular information associated with a user can be shared. The authorization server may allow users to opt in to or opt out of having their actions logged by social-networking system **160** or shared with other systems (e.g., third-party system **170**), such as, for example, by setting appropriate privacy settings. Third-party-content-object stores may be used to store content objects received from third parties, such as a third-party system **170**. Location stores may be used for storing location information received from client systems **130** associated with users. Advertisement-pricing modules may combine social information, the current time, location information, or other suitable information to provide relevant advertisements, in the form of notifications, to a user.

Aggregating Events

[0041] In particular embodiments, a social-networking system **160** may receive external event listings **156** from external sources, such as third-party system **170**, web browser **132** located on a client system **130**, web server **182** located on a server system **180**, or other suitable data sources. Each of the external event listings **156** may describe a corresponding real-world event, and may include one or more information items **157**, such as an event name, date,

location, or the like. In particular embodiments, the social-networking system **160** may create, retrieve, update, and delete internal event listings **154**. The information in the internal event listings **154** may be based on the external event listings **156**. The social-networking system **160** may receive the external event listings **156** and map at least a portion of the information in the external event listings **156** to one or more of the internal event listings **154**. Each internal event listing **154** may correspond to one or more external event listings **156** and may include one or more information items **155**, which may be from the corresponding external event listing **156**. As an example, an internal event listing **154** may be a copy of or reference to a corresponding external event listing **156** received from an external data source. One or more of the internal information items **155** in each internal event listing **154** may be copies of or references to, or otherwise based on, information items **157** of the corresponding external event listing **156**. The internal event listings **154** may be stored in one or more data stores **164** of the social-networking system **160** or other appropriate storage media. Thus, external information items **157** of the external event listings **156** may be received via the network **150** and stored in the data store **164** as internal event listings **154**.

[0042] In particular embodiments, the third-party systems **170**, server system **180**, and/or client system **130** may be provided by third parties such as partners, which may be ticket sales organizations, performance venues, event aggregators, or the like. As an example, the third-party systems **170** may access the events hosted by the social-networking system **160** via an API, which may involve a web service invocation via the network **110**. The API may be publicly-accessible or accessible by partners of the third party. The partner may be, for example, TICKETMASTER, BANDSINTOWN, or other suitable third-party partners. The partner may host the third-party system **170** and cause internal event listings **154** to be created via a public API by, for example, sending messages containing external event listings **156** to a server **162** associated with the social-networking system **160**. The third-party system **170** may maintain external event listings **156** and provide a partner event Application Programming Interface (API) or other suitable communication interface via which the social-networking system **160** may request the external event listings **156**. The social-networking system **160** may send the requests to the third-party system **170** via the network **150**, and the third-party system **170** may send the requested external event listings **156** back to the social-networking system **160** as responses via the network **110**. As another example and not by way of limitation, the social-networking system **160** may invoke an event aggregator's API to retrieve the aggregator's and/or partner's event inventory. The event aggregator's API may provide operations for requesting external event listings **156** similar to those of the partner event API. Example event aggregators include BANDS IN TOWN and BOOK MY SHOW.

[0043] In particular embodiments, the social-networking system **160** may receive, from an external event system, one or more external event listings **156** corresponding to one or more events, respectively, wherein each external event listing **156** includes one or more items of event information **157** associated with the respective event. The one or more events may be, for example, real-world events that are scheduled to be held at a particular time and place. The external event system may be, for example, the client system **130** that hosts the web browser **132**, the server system **180** that hosts the web server **182**, or the third-party system **170** that may host the partner event API **172**.

[0044] In particular embodiments, the social-networking system **160** may receive external event listings **156** from a user **101** of the social-networking system **160** via a web browser **132** hosted by a client system **130**. For example, the user **101** may enter information items **157**, such as an event name, date, and location in the web browser **132** or other application executing on the client system **130**. An external event listing **156** may be created on the client system **130** from the information items **157** and sent to the events API **168** of the social-networking system **160** via the network **150**.

[0045] In particular embodiments, the social-networking system **160** may receive external event listings **156** from a web server **182** in the form of web content, e.g., HTML documents, which may be received via the network **150**. The external event listings **156** may be in any suitable data format. Each external event listing **156** may include one or more external information items **157**. The social-networking system **160** may parse the received external event listings **156** to extract external event information items **157** to be included in internal event listings **154**. In particular embodiments, the social-networking system **160** may crawl web servers **182** or perform a web search to identify external event listings **156** that include external information items **157** located on one or more web servers **182** and representing or suitable for use in external event listings **156**. The social-networking system **160** may convert such identified external information to a defined data format or structure to form external event listings **156**. Alternatively or in addition, the social-networking system may retrieve the external event listings **156**, including information items **157** in the format in which the external event listings **156** are stored on their host system. The host system may be, e.g., the third-party system **170**, the server system **180**, the client system **130**, or other system that hosts external events **156**. The social-networking system **160** may generate internal event listings **154** based on the external event listings **156**, e.g., by copying or parsing the information items **157** of the external event listings **156** from a defined data format or structure, and storing the copied or parsed information items **157** in internal event listings **154** in the data store **164**.

[0046] In particular embodiments, the network address of the web server **182** (e.g., a URL) from which to retrieve external event listings **156** may be identified using a search engine or by an existing association between the web server **182** and existing event listings. For example, existing internal event listings **154** may include information items **155**, such as an artist name, genre, location, date, that can be used to identify particular web sites that may provide information about additional events. In this example, one or more web servers **182** that host content referencing or related to the name of the artist, genre, location, or date of an existing event may be searched for event information. As another example, text in the internal information items **155** in the existing event listings **154** may be used to form search queries in web searches to identify web servers **182** from which additional event information may be retrieved. The social-networking system **160** may retrieve the event information from such web servers **182** and create internal event listings **154** based on the retrieved information. As an

example and not by way of limitation, the external event listings **156** may be retrieved from the web server **182** via an appropriate API. As another example and not by way of limitation, such event information may be in HTML or other suitable data format, and may be retrieved from the web server **182** using HTTP or other suitable protocol.

[0047] FIGS. **2**A and **2**B illustrate an example internal event listing **154** associated with a user entity of a social-networking system **160**. Although FIGS. **2**A and **2**B show internal event listings **154**, external event listings **156** may be represented similarly. FIG. **2**A illustrates the name **208** and value **210** components of the information items **155** of the internal event listing **154**. An information item **155** may be represented as a data value. For example, the value "Kanye West" may be an information item **155** in an event listing for a music event. As shown in FIG. **2**A, an information item **155** may have an associated name **208**. FIG. **2**B shows the information items **155** as name-value pairs in the format "name=value." FIGS. **2**A and **2**B show different representations of four information items **155**: an event name item (Name="Kanye Concert"), an event date/time item (Date="21 Jan. 2017"), an event location item, (Location="Levi's Stadium"), and an item identifying the user who created or is responsible for the event listing **154** (Created-By="Adam Smith"). The term "time" as used herein may refer to a time of day, e.g., 5:00 PM, or to a date, e.g., 21 Jan. 2017, or to a data and time, e.g., 21 Jan. 2017 at 5:00 PM, or "today" at 5:00 PM, or "every day" at 5:00 PM, and so on. A point in time may include or be associated with a date, such as 21 Jan. 2017. FIG. **2**A shows a first information item **155** having a name-value pair with name="Name" **208** and value="Kanye Concert" **210**, a second information item **155** having name="Date" **208** and value="21 Jan. 2017", a third information item **155** having name="Location" **208** and value="Levi's Stadium", and a fourth information item **155** having name="Created-By" **208** and value="Adam Smith" **210**.

[0048] In particular embodiments, an event listing **154** may include at most one information item **155** having a particular name **208**, so storing a different value **210** in an event listing **154** for an information item **155** using the same name **208** may have the effect of replacing the existing value **210**. For example, storing the information item **155** Opening-Act="Travis Scott" in an event listing **154** that has an existing information item **155** Opening-Act="Kendrick Lamar" may change the value **210** of the existing Opening-Act item **155** to "Travis Scott." Alternatively, an event listing **154** may include multiple information items **155** having the same name **208**, or multiple values **210** for an information item **155** having the same name **208**. For example, if multiple information items **155** having the same name are permitted, an internal event listing **154** for an event having two opening acts may include the information items **155** Opening-Act="Kendrick Lamar" and Opening-Act="Travis Scott."

[0049] In particular embodiments, the social-networking system **160** may identify, for each of the external event listings **156** received from the external event system, one or more entities **161** of the online social network **160** associated with the external event listing **156**. The entities **161** may be online representations of people, businesses, groups, and so on, as described with reference to FIG. **13**. Each entity **161** may correspond to an entity node **1304** in a social graph **1300**. In particular embodiments, entities **161** may be identified by data in the external event listings **156**, such as strings, photos, locations, or other type of data identifying entities.

[0050] In particular embodiments, to identify the entities **161**, the social-networking system **160** may parse the items of event information **157** of the external event listing **156** to identify one or more name strings, and identify the entities **161** of the online social network **160** that correspond to the name strings. The name strings may be, e.g., names of people, businesses, groups, and so on. As an example and not by way of limitation, an external event listing **156** containing an information item Opening-Act="Kendrick Lamar" may be parsed to extract the string "Kendrick Lamar." The social graph **1300** may then be searched for an entity named "Kendrick Lamar." If an entity node **1304** having that name is found, then that entity node **13404** may be used as an entity **161** associated with the external event listing. In particular embodiments, the name of the information item (e.g., "Opening-Act") may be used to identify a type of edge **1406**, and an edge **1406** of the identified type may be created in the social graph **1300** between an entity node **1304** corresponding to the entity (e.g., "Kendrick Lamar") and a entity node **1304** (or other appropriate type of node, such as an event node) corresponding to the event represented by the external event listing **156**. Although external event listings **156** are used in examples described herein, entities associated with internal event listings **154** may also be identified. The identified entity may thus provide a link between the event listings **154**, **156** and the social-networking system **160**.

[0051] In particular embodiments, the social-networking system **160** may receive, from a client system **130**, content posted to the online social network by a first user **101** of the online social network. The content may reference one of the internal event listings **154**. The social-networking system **160** may then send, to one or more client systems **130**, one or more notifications based on the referenced internal event listing **154** to one or more second users **101**. As an example and not by way of limitation, the second users **101** may be users **101** who are listed as attendees of the event associated with the referenced internal event listing **154**. The attendees list may be associated with the internal event listing **154** in the data store **164** or may be represented as user nodes linked to an event node that corresponds to the referenced internal event listing **154** by graph edges, e.g., edges that represent an "attendee" relationship. As another example, the second users may be friends of the first user on the online social network. As still another example, the notifications to the second users may include recommendations for the event associated with the referenced internal event listing. The recommendations may include text recommending that the second user attend the event and a link to or a copy of one or more of the information items **155** associated with the corresponding internal event listing **154**.

[0052] In particular embodiments, the social-networking system **160** may receive, from the client systems **130**, user-submitted corrections to the one of the internal event listings **154**. Each user-submitted correction may include an updated item of event information **155**. The social-networking system **160** may then update the event listings **154** to include a particular updated item of event information **155** when at least a threshold number of corrections comprising the particular updated item of event information **155** are received. As an example and not by way of limitation, if

more than the threshold number of instances of the same correction to an item of event information **155** are received, and each correction is received from a different user, then the corrections may be applied to the item of event information **155**. The threshold number may be, e.g., 2, 3, 5, or other appropriate number. An example correction may be changing the location of an event to a new location, e.g., from London to San Francisco. If this particular correction is received for a particular internal event listing **154**, then the correction may be applied to the event listing by setting the value of the listing's location information item to "San Francisco."

[0053] In particular embodiments, the one or more external event listings may be received from an external event system **170**, such as the third-party system **170**, the server system **180**, or the client system **130**, via an events application programming interface (API) **168**. As an example and not by way of limitation, the API **168** may include a set of instructions defined at the online social network **160**, the set of instructions being executable to enable the external event system to share the external event listings **156** on the online social network **160**. In particular embodiments, the API may be a partner API **172** that includes a set of instructions defined at the external event system, the set of instructions being executable to enable the online social network **160** to retrieve external event listings **156** from the external event system. In particular embodiments, the social-networking system **160** may send, to an external event system, a request for the external event listings **156** via the partner event API **172**, and the external event listings **156** may be received from the external event system in response to sending the request.

[0054] In particular embodiments, the social-networking system **160** may crawl event pages hosted by a web server **182** of the external event system (e.g., the web server **182** on the server system **180**) to identify the external event listings **156**. As an example and not by way of limitation, crawling the event pages may include searching the content of the event pages hosted by the web server **182**, as done by a web search engine. The event pages may be, e.g., web pages that include information related to events, such information items **157**. The external event listings **156** may be received by the social-networking system **160** from the external event system in response to crawling the event pages.

[0055] In particular embodiments, the social-networking system **160** may determine, for each of the external event listings, whether the external event listing corresponds to an internal event listing on the online social network based on an analysis of the event information associated with the respective external event listing. As an example and not by way of limitation, the social-networking system **160** may compare the information items **157** in the received external event listing **156** to the information items **155** in each internal event listing **154** to determine whether one of the internal event listings **154** is likely to correspond to the same real-world event as the external event listing **156**. This determination may be made based on similarities between the information items **155**, **157** in the two event listings **154**, **156** being compared, e.g., by computing probabilities that the event listings **154**, **156** represent the same real-world event, and selecting the internal event listing **154**, **156** that has the highest probability and/or satisfies a threshold condition, e.g., that the probability is greater than a threshold value such as 90%, 95%, 99%, or other appropriate value.

[0056] In particular embodiments, if the social-networking system **160** identifies a "matching" internal event listing **154** that likely represents the same real-world event as the external event listing **156**, e.g., is likely a duplicate event listing, then differences between the internal and external event listings, if any, may be resolved. The operations performed to resolve duplicates may depend on the type of source that created the existing internal event listing **154**. In particular embodiments, if the existing internal event listing **154** is created by the same source as the new external event listing **156**, then the existing internal event listing **154** may be updated as shown in FIG. **4**. In particular embodiments, if the existing internal event listing **154** is created by a partner, e.g., BANDSINTOWN or other third-party partners, e.g., through a partner event API, then performer (e.g., artist) information from the new external event listing **156** may be appended to the existing internal event listing **154** as follows. Information items **157** from the external event listing **156** that are not present in the matching internal event listing **154** may be added to the internal event listing **154**. Alternatively, a new internal event listing **154** may be created, and may include information items **155** copied from information items **157** of the external event listing **156**. The new internal event listing **154** may also include redirection information that identifies the new internal event listing **154** as being in an event cluster with the existing internal event listing **154**. The redirection information may also identify a canonical event listing in the event cluster to which the other event listings in the cluster are redirected. Redirection is described further with reference to FIG. **7**. In particular embodiments, if the existing internal event listing is created by a user **130**, then duplication may not be performed, e.g., the existing internal event listing **154** may not be updated.

[0057] In particular embodiments, the social-networking system **160** may, for each of the external event listings **156**, if the external event listing **156** corresponds to an internal event listing **154**, update the internal event listing **154** to include one or more items of event information **155** based on (e.g., copied from) corresponding items of event information **157** associated with the external event listing **156**. The internal event listing **154** may be associated with one or more entities of the social-networking system **160**. As an example and not by way of limitation, when the social-networking system **160** receives an external event listing **156** that corresponds to an existing internal event listing **154** with greater than a threshold probability, the existing internal event listing **154** may be updated to include additional information items **155** from the received external event listing **156** that are not present in the existing internal event listing **154**. The additional information items **155** may be associated with or stored in the internal event listing **154**. For example, one or more of the information items **155** shown in FIG. **2**A may have been added to the internal event listing **154** as additional information items subsequent to its creation. In particular embodiments, additional information items **155** may be added to or otherwise associated with the internal event listing **154** as hidden information items **206**. Hidden information items **206** may be hidden from (e.g., not visible to) users who do not satisfy certain criteria. For example, hidden information items **206** may ordinarily not be displayed or otherwise presented to users who are not the creator of the hidden information items **206**. As another

example, hidden information items **206** may be visible to users who are first-degree friends of the user who created them.

[0058] In particular embodiments, internal event listings **154** having hidden information items **206** may be identified by event searches that match the hidden information items **206**, but the hidden information items **206** are not presented to users. That is, event listings **154** having hidden information items **206** matching a search query may be presented as search results, though the hidden information items **206** are not displayed with the search results and are not otherwise accessible to the user who performed the search. In other embodiments, the hidden information items **206** may be presented to particular users, e.g., to a user who submitted the information that became the hidden information items **206**. In still other embodiments, the hidden information items **206** may be shown to users if a condition is satisfied, e.g., if a user specifically requests that hidden information be displayed. The hidden information items **206** may be shown with an indication that the items **206** are potentially unreliable or not applicable to the user viewing them. In particular embodiments, a user who submits information that becomes one or more hidden information items **206** may specify associated permissions, e.g., that the hidden information items **206** are not to be presented to other users, or are only to be presented to the submitting user's friends, for example.

[0059] In particular embodiments, a user **101** may request that an internal event listing **154** be created or updated. The user **101** may also specify one or more information items **155** to be included in the internal event listing **154**. As an example and not by way of limitation, a user interface provided by a web browser **132** and/or web server **182** may provide a command, e.g., a button or the like, to create an internal event listing **154** using one or more user-specified information items **155**. The user interface may receive one or more information items **155** and, optionally, additional information identifying an existing internal event listing **154**, such as a name or unique identifier for the existing internal event listing **154**. The user interface may send the information items **155** and optional identifying information to the social-networking system **160**, e.g., by invoking operations of the events API **168** over the network **110**. If an internal event listing **154** corresponding to the specified information items **155** already exists in the social-networking system **160** (e.g., is present in the data store **164**), then the user interface may request the social-networking system **160** to update the existing internal event listing **154** to include the user-specified information items **155**, and notify the user when the existing event listing **154** has been updated. The user-specified information items **155** may be added to the existing event listing as searchable-only items, as publicly-visible items, or as items having other suitable access restrictions. The user interface may notify the user about the access restrictions associated with the information items **155**, if any. The particular access restrictions may be specified by a system administrator or by the user, for example.

[0060] In particular embodiments, if a received external event listing **156** does not correspond to an internal event listing **154**, then the social-networking system **160** may create a new internal event listing **154** based on the one or more items of event information **157** associated with the external event listing **156**. The new internal event listing **154** may be associated with the one or more identified entities **230** associated with the external event listing **156**. The user interface may notify the user **101** that the new internal event listing **154** has been created. For example, a user **101** may request that an internal event listing **154** be created with the following two information items: Name="Kanye Concert" and Opening-Act="Kendrick Lamar." The user's request may include at least one "existing" information item **155** having the same value as an information item **155** in existing event listing **154**, such as the event name "Kanye Concert." The user's request may also include at least one "new" information item **155** having a value that is not included in the existing event listing **154**, such as an opening act name "Kendrick Lamar." As another example, the user may specify an "update" information item **155** having a different value for an existing information item **155** in the existing event listing **154**. For example, the date stored in the internal event listing **154** for the "Kanye Concert" event may be changed from 21 Jan. 2017 to 28 Jan. 2017 by a user command, such as an operation performed by the user in a user interface setting the date of the event to 28 Jan. 2017.

[0061] FIG. **3**A illustrates an example **300** of updating an internal event listing **154** by adding an information item **155***a* from an external event listing **156**. The external event listing **156** may be received by the server **162** via the events API or other interface to the network **150**. The external event listing **156** includes information items **157**, including a Name item ("Kanye Concert"), a Date item ("21 Jan. 2017"), a Location item ("Levi's Stadium"), an Opening-Act item **157***a* ("Kendrick Lamar"), which represents an opening act for the event, and a Created-By item **157***b* ("Adam Smith"), which represents an entity who created (e.g., performed an action that resulted in creation of) the external event listing **156**. Upon receiving the external event listing **156**, the social-networking system **160** may determine whether there is an existing internal event listing corresponding to the external event listing **156**. In this example, there is an internal event listing **154** that is sufficiently similar to the external event listing **156** to be used as the existing internal event listing. The internal event listing **154** may thus be updated based on information items **157** of the external event listing **156** that are not present in the internal event listing **154**. The Opening-Act item **157***a* and the Created-By item **157***b* are not present in the internal event listing **154**. (The Opening-Act item **155***a* is underlined to indicate that is not initially present and is being added to the internal event listing **154**.) The Opening-Act item **157***a* is thus added to the internal event listing **154** as an additional Opening-Act information item **155***a* ("Kendrick Lamar"). The social-networking system **160** may determine whether to make the additional information item **155***a* a hidden item.

[0062] In this example, the determination of whether the additional information item **155***a* is added as a hidden item may be based on whether the user who created the external event listing **156** is the administrator of the internal event listing **154**. If so, the additional information item **155***a* may be added as an ordinary (non-hidden) item. If not, the additional information item **155***a* may be added as a hidden item. Since the user who created the external event listing **156** ("Adam Smith") is the administrator of the internal event listing **154** according to the association **232** between the internal event listing **154** and the administrator **230** ("Adam Smith"), the Opening-Act information item **155***a* ("Kendrick Lamar") may be added as an ordinary (non-hidden) item. The Created-By item **157***c* is not added to the

internal event listing **154** as an information item **155** in this example because the internal event listing **154** was previously created by a different user, whose identity **230** ("Adam Smith") is associated with the internal event listing **154** by the administrator association **232**.

[0063] FIG. **3**B illustrates an example **310** of updating an internal event listing **154** by adding a hidden information item **155***b* from an external event listing **156**. The example of FIG. **3**B is similar to that of FIG. **3**A, except the Created-By item **157***c* ("Dave Jones") indicates that the user who created the external event listing **156** is different from the administrator **230** ("Adam Smith"). Because of this difference, the additional information item **157***a* (Opening-Act="Kendrick Lamar") is added to the internal event listing **154** as a hidden information item **155***b*. As described above, hidden information items are not ordinarily presented to users as part of the internal event listing **154**, though searches for event listings may access and match the hidden event listing **155***b*. For example, a search for "Kendrick Lamar" by a searching user who has read access permission for the internal event listing **154** may match the Opening-Act item **155***b* and return the internal event listing **154**. The non-hidden information items (Name="Kanye Concert," Date="21 Jan. 2017," and Location="Levi's Stadium") may be presented to the searching user as part of the internal event listing **154** matching the search, though the hidden information item **155***b* ("Kendrick Lamar") may not be presented to the searching user unless the searching user's identity satisfies a condition. The condition may be that the searching user is the administrator **230** of the internal event listing **154** or is the user who created the hidden information item **155***b* (e.g., "Dave Jones" in this example). Thus, the information item **155***b* (Opening-Act="Kendrick Lamar) may be presented to the user "Adam Smith" or to the user "Dave Jones" as part of the internal event listing **154** when the internal event listing **154** is presented to either of those users, e.g., as a search result or in other situations in which event listings are presented to users.

[0064] FIG. **4** illustrates an example **400** of updating an internal event listing by changing an existing information item to have a new value from an external event listing **156**. In the example of FIG. **4**, an external event listing **156** includes an updated value ("28 Jan. 2017") for the Date information item **157***d*. Since the existing value for the Date information item **155***c* in the internal event listing **154** is different ("21 Jan. 2017"), the Date information item **155***c* in the internal event listing **154** is changed to have the value from the external event listing **156**. The updated value is shown as an updated Date information item **155***d* having the value "28 Jan. 2017" and a deleted information item **155***c*. In this example, the external event listing **156** has a Created-By item having the same value as the administrator **234** ("Ticketmerchant"), so the internal event listing is updated with the new Date value **157***d* instead of creating a hidden item for the new Date value.

[0065] FIG. **5** illustrates an example **500** of creating a new internal event listing from an external event listing. The external event listing **156** includes information items **157**, including a Name item ("49ers Football Game"), a Date item ("12 Nov. 2017"), a Location item ("Levi's Stadium"), and a Created-By item ("Ticketmerchant"), indicating that the external event listing **156** was created by a partner named "Ticketmerchant"). Upon receiving the external event listing **156**, the social-networking system **160** may determine whether there is an existing internal event listing corresponding to the external event listing **156**. In this example, there is no existing internal event listing **154** sufficiently similar to the external event listing **156**. A new internal event listing **154** is therefore created based on the information items **157** in the external event listing **156**. In this example, the new internal event listing **154** includes information items **155** that are the same as (e.g., copies of or references to) the information items **157** in the external event listing **156**. The user "Ticketmerchant" who created the existing information item **156** is the administrator of the new internal event listing **154**, as shown by the administrator association **232** between the internal event listing **154** and the "Ticketmerchant"" user **230**. As an example and not by way of limitation, the administrator association **232** may be an edge between an event node representing the internal event listing **154** and a user node representing the "Ticketmerchant" user.

[0066] In particular embodiments, an existing internal event listing **154** to be updated may be identified explicitly by the user, e.g., by being selected in a user interface or of a web browser **132** or referenced in the user interface by an event identifier that uniquely identifies the existing internal event listing **154** (e.g., "Event-2196"). If the user identifies the internal event listing **154** using a system external to the social-networking system **160**, e.g., the client system **130** or the server system **180**, then information identifying the user-identified internal event listing **154** may be sent from the external system to the server **162** of the social-networking system **160**. The identifying information may be sent as a parameter in an invocation of the events API **168** via the network **110**, for example. In particular embodiments, the existing event listing **154** may be identified by the social-networking system **160** using at least one item of event information provided by the user as search criteria (e.g., name="Kanye Concert"). The identified internal event listing **154** may then be updated to include the new information items **155**. Optionally, the updated information items **155** may be included in the internal event listing **154** as replacements or additional values for information items **155** having the same name in the internal event listing **154**. As an example, the information items **155** that correspond to and are used to identify the existing internal event listing **154** may include, but are not limited to, the event name (e.g., ""Kanye Concert" in the above example), venue ("Levi's Stadium"), and/or location ("Santa Clara"), date ("21 Jan. 2017").

[0067] In particular embodiments, the event system **161** may determine whether particular information items **155** correspond to an existing internal event listing **154** by calculating a probability based on the information items **155** and the existing internal event listing **154** as described below. If the probability satisfies a threshold condition, such as being greater than a threshold value, a corresponding internal event listing **154** already exists and may be updated to subsequently include the information items.

[0068] In particular embodiments, if no existing internal event listing **154** corresponds to the specified information items **155**, a new internal event listing **154** that includes the specified information items **155** may be created. For example, the new event listing **154** may include the name of the opening act and any other specified information items **155**. Examples of information items **155** that may be associated with existing internal events **154** include ticket URL, artist, ticket provider, and ticket price tags.

[0069] In particular embodiments, internal event listings **154** that are automatically-created may be referred to herein as "ingested events" and may be unowned, e.g., not associated with a user **101** or other type of entity, at the time they are created, or may be owned by the online social network. Ingested events may be presented to users by the social-networking system **160** and may be discoverable through discovery interfaces or surfaces, such as an events search results page that lists events identified in response to a search query. Performers who are detected as performing on an event may confirm that they are on (e.g., associated with) the event. In particular embodiments, any page on the social-networking system **160** may add an ingested event to a page. A notification or news feed update referencing or including the event may be sent to users associated with the page, e.g., to fans associated with the page or fans of the performer. Alternatively, unowned internal event listings **154** or internal event listings owned by the online social network may not ordinarily distributed (e.g., presented) to users until an action, such as an intentional action by a user **101** referencing the unowned internal event listings **154**, causes them to be distributed to one or more users. As an example, unowned internal event listings **154** may be distributed to users when a user action related to a page associated with the unowned internal event listing **154** occurs. Particular internal unowned event listings **154** may be distributed to users by, e.g., adding the events to the users' feeds.

[0070] In particular embodiments, internal event listings **154** may not be presented to users **101** unless an action occurs in the social-networking system **160** that causes a particular internal event listing **154** to be presented to users. In particular embodiments, an internal event listing **154** may be presented to users when one of the following actions occurs: a user adds the internal event listing **154** to a page, such as one of the user's pages, thereby implicitly claiming ownership of the internal event listing **154** and becoming its administrator, or a user **101** specifically searches for the event, e.g., using a search query that matches an information item of the internal event listing **154**. A user **101** who claims ownership of an internal event listing **154** may then maintain, promote, and encourage people to engage with the internal event listing **154**. That is, the user **101** may become an administrator of the claimed internal event listing **154**. Performers who confirm that they are performing on an event may maintain and edit the event on the confirmed event. In particular embodiments, any user may promote an event. Notifications referencing a claimed internal event listing **154** may be generated, e.g., notifications may be sent to the venue and artist associated with the internal event listing **154** requesting that they claim the event.

[0071] In particular embodiments, when a user **101** adds an internal event listing **154** to a page, such as one of the user's pages, notifications that refer to or include the internal event listing **154** can then be sent to users **101** who like the page. As another example, if a user performs an action on the internal event listing **154**, then a story or notification can be generated. Users who indicate that they "like" the page may see the event in a story. For example, when a venue lists an event on their page, the internal event listing **154** may be distributed via the venue's page to users who view the page. As another example, an "Add to Calendar" action may be displayed on an event page, and the internal event listing **154** may be distributed to users once it is on the user's calendar and visible to other users. In another example, a page owner may access an internal event listing and request that the event show up on their page. Notifications about the internal event listing **154** may then be sent to followers of the owner's page.

[0072] In particular embodiments, internal event listings **154** may contain incorrect information. For example, crawling web sites for external event listings **156** may identify an event type and venue, but may identify incorrect values for those information items. Further, when event listings are ingested from a partner, the information from the partner does not ordinarily reference social-networking system pages for entities such as artists and venues. The information from the partner merely includes the names of such entities. The names are matched to the social-networking system page IDs, and there is a possibility that the matching is incorrect. In particular embodiments, information associated with an internal event listing **154** may be corrected by a user **121**, the administrator of the internal event listing **154**, or another user associated with the internal event listing **154**, such as an artist associated with the event listing. If the information is incorrect, the administrator of the page, e.g., the artist, can report the error. The information can be reviewed and corrected manually on the social-networking system **160**. If a user has claimed to be the owner of the event, that user may be permitted to edit the information. For events that nobody has claimed, users who view the event may be asked if the information is correct, and if not, to correct the error, e.g., by suggesting corrections. The suggested corrections may be sent to other users through crowdsourcing. Users may then vote on whether the corrections are accurate and should be applied to the internal event listing.

[0073] In particular embodiments, one or more items of event information **155** included in the internal event listing **154** associated with the external event listing **156** are may be inaccessible by users of the online social network **160**. Such items of event information **155** included in the internal event listing **154** associated with the external event listing **156** may be accessible by one or more search-engine systems and may be referred to herein as hidden information items **155**. As an example and not by way of limitation, the items of event information **155** may be accessible as metadata on the web page for the internal event listing **154**, e.g., located on the web server **182**. As another example, the metadata may be extracted by an external search engine (not shown). Alternatively, the metadata may be metadata associated with the internal event listing **154** that is not on the web page, but instead internally associated with the internal event listing **154** and therefore only accessible to searches of the data store **164** performed by an internal search engine in the social-networking system **160**, e.g., by the server **162**.

[0074] In particular embodiments, the social-networking system **160** may send, to one or more client systems **130**, one or more notifications to the one or more identified entities **161** associated with the internal event listings. Each notification may indicate the associated event listing has been updated or created. A client system **130** associated with one of the entities **161** may receive the notifications and present the notifications on an output device. For example, when the location information item **155** of an internal event listing **154** is updated to a new value (e.g., changed from "London" to "San Francisco"), then a notification of the update may be sent to one or more client systems **130** associated with one or more entities **161** that are in turn associated with the

internal event listing. A user **101** associated with a client system **130** may be, e.g., a user who is logged into the client system **130**, a user who is or has recently been using or carrying the client system **130**, or a user **101** who most recently used the device **130**. A user **101** associated with an internal event listing **154** may be, e.g., a user **101** who is registered to attend the corresponding event, a user **101** who is an administrator of the corresponding event, or a user **101** who is an artist associated with the event (e.g., "Kanye West").

[0075] As an example and not by way of limitation, when at least one of the notifications is sent to an administrator of the internal event listing **154**, the notifications may include a request for the administrator to approve the update to the internal event listing **154**. As another example, the notification may indicate that the associated internal event listing **154** has been created, and that the entity **161** can claim the associated internal event listing **154** as administrator. That is, the entity **161** may perform administrative operations on the associated internal event listing **154**, such as updating the event listing **154**, deleting the event listing **154**, or sending the event listing **154** to other users **101** of the social-networking system **160**.

[0076] FIG. **6** illustrates an example method **600** for aggregating events on a social-networking system **160**. The method may begin at step **610**, where the social-networking system **160** may receive, from an external event system, one or more external event listings. At step **620**, the social-networking system **160** may identify one or more entities of the online social network associated with each external event listing. At step **630**, the social-networking system **160** may determine whether the external event listing corresponds to an internal event listing on the online social network based on an analysis of the event information associated with the respective external event listing. At step **640**, the social-networking system **160** may determine whether the external event listing corresponds to an internal event listing. At step **650**, if the external event listing corresponds to an internal event listing, then the social-networking system **160** may update the internal event listing to include one or more items of event information associated with the external event listing. At step **650**, if the external event listing does not correspond to an internal event listing, then the social-networking system **160** may create a new internal event listing based on the one or more items of event information associated with the external event listing. At step **670**, the social-networking system **160** may send, to one or more client systems, one or more notifications to one or more identified entities associated with the internal event listings indicating the associated internal event listing has been updated or created.

[0077] Particular embodiments may repeat one or more steps of the method of FIG. **6**, where appropriate. Although this disclosure describes and illustrates particular steps of the method of FIG. **6** as occurring in a particular order, this disclosure contemplates any suitable steps of the method of FIG. **6** occurring in any suitable order. Moreover, although this disclosure describes and illustrates an example method for aggregating events on a social-networking system including the particular steps of the method of FIG. **6**, this disclosure contemplates any suitable method for aggregating events on a social-networking system including any suitable steps, which may include all, some, or none of the steps of the method of FIG. **6**, where appropriate. Furthermore, although this disclosure describes and illustrates particular components, devices, or systems carrying out particular steps of the method of FIG. **6**, this disclosure contemplates any suitable combination of any suitable components, devices, or systems carrying out any suitable steps of the method of FIG. **6**.

De-Duping the Event System

[0078] In particular embodiments, duplicate event listings **154** representing a single real-world event may be identified and linked together, combined, or otherwise associated with each other to avoid unnecessary duplication and inconsistency. Two event listings **154** may be duplicates if both event listings **154** include one or more of the same information items **155**, though duplicate event listings **154** need not be identical. Duplicate event listings **154** may be created separately, e.g., by different users **101** or at different times. A user **101** who creates a duplicate event listing **154** may be unaware of the existence of an existing event listing **154**, or a user **101** may purposefully create a duplicate event listing **154** having one or more additional information items **155** that are not included in the existing event listing **154** or are to be kept separate from those in the existing event listing **154**. A selected duplicate event listing **154** may be designated as a canonical event listing **154**, and access to each of the other duplicate event listings **154**, such as registering to attend an event or reading/writing event information items **155**, may be directed to the canonical event listing **154** unless the access is specifically directed to one of the other (non-canonical) event listings **154**. For example, a user **101** may create a duplicate event listing **154** intentionally to share with friends. Access to that event listing **154** by the user and the user's friends may be directed to the duplicate event listing **154** instead of the canonical event listing **154**.

[0079] In particular embodiments, an event bucketization technique may be used to identify event listings **154** that are likely to correspond to a particular event. The identified event listings **154** may be processed further by a classifier, e.g., to determine their similarity scores. Event listings **154** that are not identified as being likely to correspond to a particular event may be ruled out, and thus need not be evaluated by the classifier. For example, two event listings **154***a*, **154***f* having locations separated by a substantial distance and times separated by a substantial amount of time are unlikely to correspond to the same event. The event bucketization technique may assign event listings **154** to buckets based on event listing information items **155** that have ranges of values such that different values imply different events. Examples of such information items **155** include event listing time and event location. When two event listings **154** are to be evaluated to determine whether they refer to the same real-world event, the buckets that correspond to the event listings **154** may be compared. If the event listings **154** correspond to different buckets, then the event listings are unlikely to correspond to the same events, and the classifier need not be used for those two event listings **154**.

[0080] In particular embodiments, each bucket may be associated with a range of values of one or more items of event information **155**, such as start time and location. A particular event listing **154** may correspond to the bucket(s) associated with the range(s) that include the event listing's particular information item values. As an example, for start time, time may be discretized into 1-hour time slots, and

each time slot associated with one of 24 time buckets. Each event listing **154** may be placed into (e.g., associated with) multiple buckets that cover a range of values near the values of the event's corresponding information items **155**. For example, an event listing **154** may be placed into three time buckets: a bucket for the event listing's start hour (which is the hour that includes the event's start time), a bucket for the hour immediately preceding the event listing's start hour, and a bucket for the hour immediately after the event listing's start hour.

[0081] As another example, for event location, geographic locations may be discretized into tiles, and each tile may be associated with a portion of a geographic map. A given latitude and longitude may be mapped to a tile on the geographic map. The sizes of the tiles may be configured according to a desired level of sensitivity (i.e., granularity) of event matching. Each event listing **154** may be placed into nine location buckets: a bucket for the event's location (which is the tile that includes the event listing's latitude and longitude coordinates), and buckets for the eight tiles surrounding the event listing's location. Thus each event listing **154** may be associated with 27 different buckets: 3 different hours and 9 different tiles. The buckets may be thought of as a hash table for which the key is a combination of the time bucket and the space bucket for particular event listing **154**. When a new event listing **154** is created or an existing event listing **154** is moved in time or location, the classifier may be run for only the event listings in the 27 buckets associated with the new or changed event listing **154**. The length of the time window used for event listing comparison may be changed by changing the lengths of the time buckets.

[0082] In particular embodiments, two event listings **154** having sufficiently similar information items, e.g., having a sufficiently close similarity score, may be classified as duplicates. To determine whether two event listings **154** are duplicates, a first step may be performed in which candidate event listings **154** that are close in time and space are identified, and a second step may be performed in which the classifier algorithm is run to determine similarity scores for event listings that are identified as being close in time and space, e.g., probabilities that two event listings **154** correspond to the same real-world event. Two event listings **154** having a similarity score of at least a threshold value may be considered duplicates.

[0083] In particular embodiments, even if there is a large number of event listings **154**, e.g., 100 million, when a new event listing **154** is created, each bucket for the event listing **154** ordinarily contains a small number of events, e.g., 2, 3, 10, etc., which may be the existing event listings **154** in the relatively small temporal and geographic area around the new event listing. The classifier may be run on event listing pairs formed from those 2-10 other event listings **154** (and other affected pairs, e.g., in adjacent hours and adjacent map tiles) to re-calculate their similarity scores. After the calculation, the similarity score may be cached. Subsequently, a canonical event listing **154** may be identified using a cache lookup. Each cached similarity score may be stored on or otherwise associated with the canonical event listing **154** for which it was calculated. Event listings **154** may be stored in a database, and there may be a database entry for each event listing **154**. The entry may include information items **155** such as the venue, start time, author, which other event listings are duplicates of this one, and their similarity scores (e.g., with respect to the canonical event listing **154** and/or with respect to other event listings **154**). An indication of which event listing **154** is the canonical one may also be stored. Thus, a previously-identified canonical event listing **154** may be identified from cached information, without looking up the buckets or running the classifier again. The buckets and classifier may be used when an event listing **154** is created or moved in time or space, in which case the similarity scores for buckets associated with the moved event listing **154** may be recomputed, and the recomputed similarity scores and/or the identity of the canonical event listing **154** may be cached. In the example of 27 buckets, the event listings **154** in the 27 buckets may be recomputed and the similarity scores cached by storing them in the database.

[0084] FIG. **7** illustrates an example **700** in which duplicate event listings **154** have been identified and linked together to form event listing clusters **702**. One of the duplicate event listings **154***a-d* in a cluster **702***a* may be designated as a canonical event listing **154***a*. In particular embodiments, a social-networking system **160** may identify two or more event listings **154***a-d* that are likely to correspond to the same real-world event, and generate associations identifying the event listings **154***b-d* as duplicates of a canonical event listing **154***a*. Subsequently, requests to accesses the other duplicate event listings **154***b-d* in the cluster **702***a*, such as to retrieve or update information items **155**, may be redirected to the associated canonical event listing **154***a*. Such requests may be redirected by default, unless the requests specifically indicate that the requested duplicate event listing itself, e.g., event listing **154***b*, is to be accessed. If such requests are not redirected or otherwise processed to control access to duplicate event listings **154***a-d*, inconsistencies and unnecessary duplication of event listing information may occur. Requests to access separate ones of the duplicate event listings **154***a-d* that correspond to the same event may be generated by users **101** who obtain one or more of the duplicate event listings **154***a-d* from searches, e.g., using two different queries that match the respective duplicate event listings **154***a-d*, by receiving links to the duplicate event listings **154** from other users via messages, or the like. In particular embodiments, duplicate event listings **154***a-d* may be identified when they are created, or subsequently to being created, e.g., when they are identified by a search query, referenced in a notification or message, presented to a user, or sent to an external system **170**.

[0085] In particular embodiments, duplicate event listings **154** are not necessarily identical. Two or more event listings **154** that have one or more information items in common, e.g., the same name, location, and date, may be duplicates even if they also have different information items, e.g., different start times. Thus two or more event listings that identify and correspond to the same real-world event may be duplicates even if there are differences between the two event listings.

[0086] In particular embodiments, duplicate event listings **154** may be created inadvertently, e.g., as a result of actions by one or more users or entities. A user who creates a duplicate event listing **154***b* may be unaware of an existing event listing **154***a* that could have been used instead of creating a new event listing. A selected one of the duplicate event listings, which may be the existing event listing **154***a* or one of the subsequent duplicate event listings **154***b*, may be designated as a canonical event listing, and an access request for each of the other duplicate event listings **154***b*,

c,d, such as a request to retrieve or modify an event listing, may be directed to the canonical event listing **154***a* unless the access request satisfies particular criteria for accessing the non-canonical event listing. Such criteria may be, e.g., that the user **101** requesting access is the creator of the non-canonical event listing **154***a* or a friend of the creator, as described below.

[0087] In particular embodiments, duplicate event listings **154** may be created intentionally by a user or entity, e.g., to maintain a separate copy of an event listing. For example, a user may intentionally create a private event listing for use by the user and his or her friends, in which case the user may request that accesses to the private event listing not be redirected to a canonical event listing. As another example, a user **101** may create a duplicate event listing intentionally **154***b* to share with friend, and access to that event by the user **101** and the friends may be directed to the duplicate event listing **154***b* instead of the canonical event listing **154***a*, while other users who are not friends of the user may be directed to the canonical event listing **154** if they attempt to access the duplicate event listing **154***b*. As another example, a duplicate event listing **154***b* may have one or more additional information items **155** that are not included in the existing event **154***a* or are to be kept separate from those in the existing event **154***a*, e.g., in case of subsequent changes to the duplicate event **154***b* that the user wishes to keep separate from or does not have permission to make to the existing event. For example, information items **155** of a duplicate event **154***b* that differ from information items in another otherwise similar event **154***a* may be of use to users, so the duplicate event **154***b* may be identified, linked to an event **154***a* of which it is a duplicate, stored in the data store **164**, and made accessible by users (though access may be provided conditionally).

[0088] Note that the term "event listing" **154** used without an "internal" or "external" qualifier may refer to either an internal event listing **154** or an external event listing **154**. The techniques described herein with reference to event listings **154** may be applied to either internal event listings **154** or external event listings **156**.

[0089] The example **700** illustrates three event clusters **702***a,b,c*. Each event cluster **702***a,b,c* includes two or more event listings **154**, one of which is a respective canonical event listing **154***a,e,i*, and the other(s) of which are duplicates of the canonical event listing **154***a,e,i* and contain redirection information **704** to the canonical event listing in their cluster **702***a,b,c*. As introduced above, in particular embodiments, different event listings **155** for the same real-world event may be created in a social-networking system **160** by, for example, different users **101**, or by a single user at different times. Duplicate events may also be created by different external sources **130**, **170**, **180**. As an example, a third-party system **170**, a server system **180**, and one or more client systems **130** operated by users **101** may create different event listings **154** for a Beyonce concert event. Each event listing **154** may include one or more items of event information **155**, such as an event name, date, location, and so on.

[0090] In particular embodiments, the quality of an event listing **154** may be determined based on the information items **155** included in the event listing **154**. For example, in a news feed, a user may join, e.g., register to attend, a Beyonce event listing **154** of low quality, e.g., an event listing **154** that has few details, but there may be another event listing **154** of higher quality, e.g., having more details, for the same real-world Beyonce event. The higher-quality event listing **154** may be considered more desirable, and should be presented to users instead of the lower-quality event listing **154**, particularly when the higher-quality event listing **154** contains a superset of the information in the lower-quality event listing **154**.

[0091] In particular embodiments, a canonical event listing **154***a* may be, for example, the most accurate, complete, or reliable of the duplicate event listings **154***a-d*. Users should see and be able to join the canonical event listing **154***a* for a particular real-world event, even if other duplicate event listings **154***c-d* have been created for the real-world event. Further, search results should ordinarily show the same canonical event listing **154***a* for a particular real-world event, regardless of how many duplicate events **154***b-d* representing the real-world event exist. When a user **101** requests to create a new online event, but a canonical event listing **154***a* already exists for the same real-world event, the canonical event **154***a* may be presented to the user, and the user informed that the new event listing may be a duplicate **154***b*, and asked to confirm that the new event listing is still to be created.

[0092] In particular embodiments, the social-networking system **160** may present one or more event listings **154** to a user **101** in response to a search query. For example, the user **101** may search for event listings **154** that contain a particular query term, such as the name of an artist (e.g., Kanye West), venue (e.g., Levi's Stadium), location (e.g., Santa Clara), or other information item of an event listing **155**. If there are duplicate event listings **154***a-d* in the event system (e.g., stored in an event database), the search query may match one or more of the duplicate event listings. For a particular real-world event, the search results may include the canonical event listing **154***a* but not the other duplicate event listings **154***b,c,d*. Alternatively, the search results may include the canonical event listing **154***a* and one or more of the duplicate event listings **154***b-d*, in which case the canonical event listing **154***a* may be the highest-ranked search result, and the other duplicate event listings **154***b-d* may be ranked below the canonical event listing **154***a*.

[0093] FIG. **8**A illustrates an example geographic map **800** divided into geographic map tiles. The map **800** is divided into nine large tiles **802-818**, eight of which are adjacent to a large center tile **810**. The large tiles are divided by solid lines. The map is also divided into 36 small tiles, which are divided by dashed and solid lines. Each large tile is identified by a numeric reference number and divided into four small tiles, which are identified by the numeric reference number of the large tile followed by a letter A, B, C, or D. For example, the large tile **802** is divided into small tiles **802**A-D by dashed lines. The large tiles correspond to a first resolution in which the large tiles are increments, and the small tiles correspond to a second resolution in which the small tiles are increments that are smaller but more densely arranged than those of the first resolution. Note that although FIG. **8**A illustrates map tiles of particular sizes, this disclosure contemplates map tiles of any suitable sizes. For example, the map tiles could be of differing sizes based on object density, as described in U.S. Patent No. U.S. Pat. No. 8914393, issued on 16 Dec. 2014, which is incorporated by reference herein.

[0094] In particular embodiments, the locations of event listings **154** on the map **800** may be used to place the event

listings **154** in buckets that correspond to the map tiles, and the resulting bucketization may be used to identify event listings **154** that are likely to correspond to the same events because of the geographic proximity between the event listings **154**. Two event listings may be more likely to correspond to the same event if the two event listings are in the same tile or adjacent tiles, and less likely (e.g., unlikely) to correspond to the same event if the two event listings **154** are in non-adjacent tiles (e.g., tiles whose edges do not touch and whose corners do not touch). Thus, a first event listing **154***a* is more likely to correspond to the same real-world event as a second event listing **154***b* if the second event listing **154***b* is located in the same tile as the first event listing **154***a* or in one of the eight tiles surrounding the first event listing's tile, and less likely to correspond to the second event **154***b* if the second event listing **154***b* is not located in one of those nine tiles according to this bucketization criteria. In this example, in the first resolution, eight large tiles are adjacent to any particular large tile, while in the second resolution, eight small tiles are adjacent to any particular small tile.

[0095] In particular embodiments, the choice of which resolution to use may be made based on factors such as the density of event locations on the map or the number of candidate event listings **154** identified for processing by the classifier. If the density of event locations is low, then a "lower" resolution with larger tiles may be used, since each the average number of events in each tile may be relatively low, and vice-versa. Smaller tile sizes are more likely, on the average, to exclude nearby event listings from being passed on to the classifier, and thus may generate fewer candidates for processing by the classifier than larger tile sizes. Thus, smaller tile sizes may be used to reduce the amount of computational resources used by the classifier to score and cluster event listings **154**. The tile size may also be selected based on the geographical area of interest to the user. For example, if the user has selected a map resolution at the neighborhood level or frequently attends events in a particular neighborhood, then small map tiles that divide up a neighborhood may be selected. Alternatively, if the user selects or searches a map resolution at the city level, or frequently attends events located throughout a city, then larger map tiles that divide up a city but may include entire neighborhoods may be selected. The tile size may be based on any other suitable factors. For example, if a large percentage of the event listings **154** are often placed in a single tile, then the tile size may be decreased. If few event listings **154** (e.g., 0 or 1) are placed in each tile, then the tile size may be increased.

[0096] In the example of FIG. **8**A, the locations and times of several example event listings are shown on the map **800**. A "Cadet Concert" event **822** starting on 8 Oct. 2017 is located at "Roundhouse" **820** in map tile **802**A. A "Lunch" event **826** starting on 8 Oct. 2017 is located at "Pret a Manger" **824** in tile **804**D. A "DJ Shadow" event **830** starting on 8 Oct. 2017 is located at "Electric Ballroom" **828** in tile **810**B. An "Oktoberfest" event **834** starting on 8 Oct. 2017 located at "Proud Camden" **832** is in tile **810**D. Another "Lunch" event **838**, this one starting on 10 Oct. 2017, is located at "Pret a Manger" **836** in tile **818**. The events may be placed into location buckets according to their geographical locations.

[0097] In the large-tile resolution, the "Cadet Concert" event **822** is placed in tile **802**, the "Lunch" event **826** is placed in tile **804**, the "DJ Shadow" event **830** and the "Oktoberfest" **834** event are placed in tile **810**, and the "Lunch" event **838** is placed in tile **818**. Thus, if only the location dimension is used to identify event listings **154** that are unlikely to correspond to the same event, then, evaluating each event, the "Cadet Concert" event **822** in tile **802** may correspond to the same event as any of (1) the "Lunch" event **826** in tile **804**, (2) the "DJ Shadow" event **830** in tile **810**, or (3) the "Oktoberfest" event **834** in tile **810**. The "Lunch" event in tile **818** is in a non-adjacent tile and is therefore unlikely to correspond to the same event as the "Cadet Concert" event **822**. Thus, when identifying event listings that may correspond to the same event as the "Cadet Concert" event **822**, the three events **826**, **830**, and **834** may be evaluated further, e.g., by computing their similarity scores relative to event **822** using the classifier. The "Lunch" event **826** in tile **804** may be evaluated similarly to obtain the same result. The two event listings **830**, **834** in the large center tile **810** are located adjacent to all of the other large tiles on the map **800**, so all of the other events on the map **800** may be evaluated further when identifying event listings that are potentially for the same event as each of the two event listings **830**, **834**. The "Lunch" event **838** in tile **818** is located adjacent to tile **810**, but not to tiles **802** and **804**. Thus, the events **830**, **834** in tile **810** may be evaluated further when identifying event listings that are potentially for the same event as the "Lunch" event listing **838**, but the event **822** in tile **802** and the event **826** in tile **804** need not be evaluated further for event listing **838**.

[0098] In the small-tile resolution, the "Cadet Concert" event **822** is placed in tile **802**A, the "Lunch" event **826** is placed in tile **804**D, the "DJ Shadow" event **830** is placed in tile **810**B, the "Oktoberfest" **834** event is placed in tile **810**D, and the "Lunch" event **838** is placed in tile **818**D. Thus, if only the location dimension is used to identify event listings **154** that are unlikely to correspond to the same event, then, evaluating each event, for the "Cadet Concert" event **822** in tile **802**A, every other event listing on the map **800** may be excluded from further evaluation because tile **802**A is not adjacent to the tiles of any other events on the map. For the "Lunch" event **826** in tile **804**D, the "DJ Shadow" event listing **830** is in an adjacent tile (**810**B) and may thus be evaluated further (e.g., by the classifier) to determine whether it may correspond to the same event as the "Lunch" event listing **826**. No other event listings on the map are adjacent to tile **804**D, so there are no other event listings to be evaluated further for the "Lunch" event **826**. Similarly, for the "DJ Shadow" event listing **830** in tile **810**B, the "Lunch" event listing **826** in tile **804**D and the "Oktoberfest" event listing **834** in tile **810**D are adjacent to tile **810**B and may be evaluated further. For the "Oktoberfest" event listing **834** in tile **810**D, the "DJ Shadow" event **830** in tile **810**B is adjacent and may be evaluated further. For the "Lunch" event listing **838** in tile **818**D, there are no adjacent events, so every other event on the map **800** may be excluded from further evaluation. In this example, using small tiles has excluded more events from further evaluation by the classifier than were excluded when using large tiles on the same map **800**, because event listings at locations more distant than one tile are excluded.

[0099] FIG. **8**B illustrates an example timeline **850** divided into time increments **852**-**862**. Event listings may be placed in, e.g., associated with, particular time increments. For example, event listings may be placed in time incre-

ments that correspond to the start times (or dates) associated with the event listings. On the example timeline **850**, event listings **820**, **826**, **830**, and **834** are placed in time increment **856** ("8 Oct. 2017") and event listing **838** is placed in time increment **860** ("10 Oct. 2017"). In particular embodiments, for each event listing, another event listing that is in the same time increment or an adjacent time increment is more likely to correspond to the same event, while another event listing that is not in the same or an adjacent time increment is less likely to correspond to the same event. Thus, the time increments in which two event listings are placed may be used to determine whether to evaluate the two event listings in more detail to determine if they represent the same event, or to rule out the possibility that they represent the same event without performing more detailed evaluation. The time increments bucketization may be used as the only factor in this determination, or may be combined with other factors such as map tile location bucketization.

[0100] Two of the time increments, "7 Oct. 2017" **854** and "9 Oct. 2017" **858**, are adjacent to the time increment "8 Oct. 2017" **856**, into which four of the events (**822**, **826**, **830**, and **834**) are placed. One event (**838**) is placed in the time increment "10 Oct. 2017" (**860**), which is not adjacent to the time increment "8 Oct. 2017." The remaining event, event **838**, occurs on 10 Oct. 2017 and is placed in time increment **860**. Each of the example event listings may be evaluated with respect to another one of the event listings to determine whether the two event listings are likely or unlikely to correspond to the same event.

[0101] In the example of FIG. **8**B, for event listing **822**, event listings **826**, **830**, and **834** are in the same time increment and may thus be placed in the same bucket as event listing **822**. Each of the event listings **826**, **830**, **834** is thus more likely to correspond to the same event as event listing **822**, and may be processed further (e.g., by the classifier). Similarly, for each of the event listings **836**, **830**, and **834**, the other three events in the 8 Oct. 2017 time increment may be processed further. Further, for each event listing **822**, **826**, **830**, and **834**, the event listing **838** is unlikely to correspond to the same event, and need not be processed further.

[0102] Each time increment on the timeline **850** corresponds to one day. In particular embodiments, the time increment size may be changed to larger increments such as months, or smaller increments such as hours. The time increment size may be based on how closely selected event listings occur in time, for example. The selected event listings may be the event listings having locations within nine adjacent tile squares on the map **800**. The time increment size may be determined based on the average time difference between the selected events, or on any other suitable factors. For example, if a large percentage of the event listings are often placed in a single time increment, then the time increment size may be decreased. If few event listings are placed in each time increment (e.g., 0 or 1 listings), then the time increment size may be increased.

[0103] In particular embodiments, with reference to FIGS. **8**A-**8**C, the social-networking system **160** may receive a first event listing **834** ("Oktoberfest") corresponding to a first event. The first event listing **834** may be understood as an event listing that has been received or otherwise identified, e.g., identified as a canonical event listing. Other event listings may then be evaluated to determine whether they are duplicates of the first event listing **834**. The other event listings being evaluated relative to the first event listing **834** may be referred to as "candidate" event listings. Event listing **834** is used as the first event listing in this example for explanatory purposes. Any of the other event listings shown in FIGS. **7** and **8**A may alternatively be used as the first event listing.

[0104] The first event listing **834** is shown in further detail as event listing **154**i ("Oktoberfest") in FIG. **7**. The first event listing **834** may include one or more items of event information **155** associated with the first event, and the items of event information **155** may include at least a time ("8 Oct. 2017") and a geographic location ("Proud Camden" and "London").

[0105] FIG. **8**C illustrates an example two-dimensional array **880** of map tiles and time increments. In particular embodiments, a condition based on the values of two or more event listing information items, e.g., geographic location and time, may be evaluated to determine whether to perform further, e.g., more detailed processing, such as invoking a classifier. When comparing two event listings, if, for each pair of event listings evaluated, the values of the information items for the two event listings are sufficiently close, e.g., in the same or adjacent tiles, the same or adjacent time increments, or the like, then the two event listings may be likely to correspond to the same event. In particular embodiments, a range of values for an event listing information item may be represented as an array of values. If a condition having multiple information items is to be evaluated, then the range of values of each information item may be represented as a dimension of a K-dimensional array, where K is the number of information items to be evaluated. As an example, when the location and time information items are to be evaluated, the range of location values may be represented as a first array dimension, and the range of time values may be represented as a second array dimension, as shown by the array **880** of FIG. **8**C. The array **880** has a location dimension **864** corresponding to a location information item of event listings and a time dimension **866** corresponding to a time information item of event listings. The location dimension **864** is shown as nine rows that correspond to map tiles **802**-**818**, and the location dimension **866** is shown as six columns that correspond to time increments **852**-**862**.

[0106] In particular embodiments, for a given set of candidate event listings, a subset of the candidate event listings for which a similarity score relative to a first event listing is to be computed may be identified using the two-dimensional array **880**. The subset may be determined by identifying a first bucket of the array **880** in which the first event listing is placed and, for each candidate event listing, determining whether the value of each of the two information items of the candidate event listing places the candidate event listing in the first bucket of the array or in one of the buckets of the array adjacent to the first bucket. For example, to determine which of the example event listings **822**, **826**, **834**, **838** are be passed to the classifier for similarity score calculation relative to a first event listing **830**, the event listings may be placed in buckets of the array **880**. Although the event listing **830** is selected as the first event listing relative to which the other event listings are evaluated in this example, any desired event listing may be selected as the first event listing. The first event listing **830** in this example is placed in bucket **882***c* of the array **880** because the location of the event listing **830** is map tile **810** (the large tiles are used in this

example), and the time of the event listing **830** is time increment **856** ("8 Oct. 2017"), so the first event listing **830** is placed in bucket **882***c*, which is referred to as a first bucket. The buckets in which the candidate event listings are placed in this example are as follows, as shown in FIG. **8**C: event listing **822** is in map tile **802** and time increment **856**, so is placed in bucket **882***a*; event listing **826** is in map tile **804** and time increment **856**, so is placed in bucket **882***b*; event listing **834** is in map tile **810** and time increment **856**, so is placed in bucket **882***c*; and event listing **838** is in map tile **818** and time increment **860**, so is placed in bucket **882***d*.

[0107] In particular embodiments, the social-networking system **160** may bucketize the first event listing **834** based on the time and location of the event by placing the first event listing **834** in a first bucket **882***c* of an array **880** (shown in FIG. **8**C). A first dimension **864** of the array **880** may correspond to time increments **852-862**, and a second dimension **866** of the array may correspond to geographic map tiles **802-818**. The bucketization may place the first element in the corresponding bucket **882***c* based on the first event listing's map tile **810** and time increment **856**. The first bucket **882***c* may thus correspond to the time increment **856** including the time of the first event and the geographic map tile **810** including the geographic location of the first event. A map may be divided into map tiles (hereinafter simply "tiles"), where each tile represents a particular geographic area of the map. Thus, particular locations may be within particular tiles of a map. As an example and not by way of limitation, a location X may be within a first tile, and locations Y and Z may be within a second tile. More information on geographic map tiles may be found in U.S. Pat. No. 8,914,393, issued on 16 Dec. 2014, which is incorporated by reference herein.

[0108] In particular embodiments, the social-networking system **160** may identify one or more second event listings **822**, **826**, **834**, and **838** corresponding to one or more second events, respectively. Each second event listing may include one or more items of event information **155** associated with the respective second event. The items of event information **155** may include at least a time of the respective second event and a geographic location of the respective second event. Each second event listing may have a time and geographic location placing it in the first bucket **882***c* of the array or one of the buckets of the array adjacent to the first bucket **882***c*. As an example and not by way of limitation, the adjacency is between map tiles or between time increments, and is not necessarily between elements of the array **800**.

[0109] To determine which of a set of candidate event listings **822**, **826**, **834**, **838** are to be passed to the classifier for similarity score calculation, for each candidate event listing, the bucket in which the candidate event listing is placed may be compared to the first bucket (in which the first event listing is placed). If the buckets are the same, or are adjacent to each other, then a similarity score may be calculated for the candidate event listing. In this example, candidate event listing **834** is in the same bucket **882***c* as the first event listing **830**, so a similarity score may be calculated between event listing **834** and the first event listing **830**. No other candidate event listings are in the same bucket as the first event listing **830** in this example. However, map tiles **802** and **804** are both adjacent to map tile **810**, so candidate event listings **822** in map tile **802** and candidate event listing **826** in map tile **804** are in map tiles adjacent to the map tile of the first event listing **830**, and are in the same time increment **856** as the first event listing **830**. Thus, similarity scores may also be calculated for candidate event listings **822** and **826**. Candidate event listing **838** is in an adjacent tile (tile **818** is adjacent to tile **810**), but is not in an adjacent time interval (interval **862** is not adjacent to interval **856**). Thus, a similarity score need not be calculated for event listing **838**.

[0110] Although the example array **880** has a location dimension having nine map tile entries and a time dimension having six time increment entries, other sizes and element types are possible. For example, the location dimension may alternatively have five entries corresponding to four map tiles to the north, south, east, and west of a specified tile **810**C and the specified tile **810**C itself, or 25 entries corresponding to a 5×5 square of map tiles centered on the specified tile **810**C. The time dimension may alternatively have three entries corresponding to a specified increment **856** and the two increments **854**, **848** adjacent to the specified increment **856**, or eleven entries corresponding to the specified increment **856** and five consecutive increments on each size of the specified increment **856**. Increasing the number of entries in the array in either or both dimensions to include more values may be understood as increasing the bucket size, and may cause more candidate event listings to be placed in a bucket and processed further, e.g., by the classifier.

[0111] In particular embodiments, the social-networking system **160** may compute, for each of the second event listings, a similarity score between the first event listing and the second event listing. The similarity score may be based on a comparison of the event information of the first event listing and the event information of the second event listing.

[0112] In particular embodiments, a trained machine-learning model referred to herein as an event classifier may identify event listings **154** that are similar to each other by comparing pairs of event listings **154** and generating a similarity score based on a probability that the two event listings **154** correspond to the same real-world event. Canonical event listings **154***a* may then be identified by selecting one of the event listings **154***a-d* that has the greatest similarity score of the event listings **154***a-d*. Alternatively, or additionally, a set of the highest-ranking event listings **154** may be selected, and a rule-based system may be used to identify the canonical event **154***a*. The rule-based selection is described in further detail below. In particular embodiments, the classifier may receive features of two event listings **154***a*,b as input and generate a similarity score, which may be based on a probability that the two event listings **154***a,b* correspond to the same real-world event. Given two event listings **154***a,b*, a list of features may be generated and provided as input to the classifier, and the similarity between the two event listings **154***a,b* may be determined by the classifier based on the similarities between their features such as their information items **155**. The event listing features may include: event title, start time, location, distance between the two events, number of attendees, event host, how many words or tokens of the titles of the two events match, what percent of the descriptions are similar, how many people who joined (e.g., registered to attend) the first event listing **154***a* also joined the second event listing **154***b*, and so on. Note that an exact match is not needed between the values of certain information items **155**, because different values may represent the same actual item.

For example, for the event location, different addresses or latitude/longitude coordinates may represent the same place. Similar titles are also likely to refer to the same event.

[0113] Although event listings **154** are described above as being compared to generate a similarity score, the classifier as implemented does not necessarily operate directly on two different event listings **154**. Instead, the classifier's input may be a single "combined" vector for each pair of event listings **154**. The vector may be generated based on pairwise comparisons or combinations of information items **155** of the two event listings **154**, and the classifier may convert the vector into a similarity score. The vector may include feature scores generated from the two event listings **154** being compared. One feature score may be a count of how many (or what percentage) of the tokens in the descriptions of the event listings **154** are exactly the same. Other feature scores may include the difference in seconds between the start times of the two event listings **154**, the difference in miles between the locations of the two event listings **154**, how many administrators each of the two event listings have, and how many users have joined both event listings (before they were known to be the same). The output of the classifier may be a similarity score representing a probability that the two event listings **154** correspond to the same real-world event. The similarity score may be in the range 0 to 1, for example. A threshold similarity score may be used to determine whether each event listing **154** is one of a set of best-matching event listings. For example, each event listing **154** that has a similarity score of 0.9 or greater may be included in the set of best-matching event listings. The best-matching event listings may then be ranked in an order, and the top-ranked one selected as the canonical event **154***a*.

[0114] In particular embodiments, the classifier may be a machine-learning model trained using human-labeled event data. A list of candidate event listings **154** may be generated, which may include event listings **154** that have similar starting times and are geographically located near each other. Pairs of the candidate event listings may be presented to a human editor, who indicates whether the two event listings in each pair are the same, i.e., correspond to the same real-world event. The human editor labels the pair "yes" if he or she thinks the event candidate listings are the same, or "no" if not. From the labeled candidate event listings, the classifier may learn which of the features are important for deciding whether two event listings **154** are the same, e.g., correspond to the same real-world event. For example, if the titles of two event listings **154** are very similar, or the same host is an administrator for both event listings, the two event listings **154** are likely to be the same. The classifier may be implemented using a gradient boosted decision tree, for example, or other suitable machine-learning technique.

[0115] Referring to FIG. **7**, to identify the canonical event listings **154***a,e,i*, the set of event listings **154***a*-**1** may be divided into clusters **702** by calculating the similarity scores between the event listings **154***a*-**1** and using the similarity scores as input to a clustering algorithm. The clustering algorithm may be k-means clustering or other appropriate algorithm. The similarity scores between each pair of event listings **154***a*-**1** may be computed to form a similarity matrix M, in which entry M(i, j) is the similarity score between the i^{th} and j^{th} event listings **154***a*-**1**. For each cluster, the similarity scores in each cluster **702***a,b,c* may be ranked, and the event listing **154** having the top-ranking similarity score may be designated the canonical event listing **154***a,e,i* of the respective cluster.

[0116] In the example shown in FIG. **7**, the identified clusters include a first cluster **702***a* containing four duplicate event listings: **154***a* (name="DJ Shadow Concert"), **154***b* (name="DJ Shadow Show"), **154***c* (name="DJ SHADOW"), and **154***d* (no name item, but having other items **155** similar to listings **154***a-c*). The event listing **154***a* ("DJ Shadow Concert") includes the following information items: a name ("DJ Shadow Concert"), a date ("7 Oct. 2017"), a venue ("The Electric Ballroom"), a location ("London"), an event type or genre ("Rap Concert"), and the name of a user who created the event listing ("Chad"). The canonical event listing in each cluster **702** may be the highest-ranking event listing **154** in the cluster **702**. The highest-ranking event listings are "DJ Shadow Concert" **154***a*, "Cadet Concert" **154**e, and "Oktoberfest" **154***i* in clusters **702***a,b,c*, respectively. The other event listings **154***b-d* in the cluster **702***a*, although different from the canonical event listing **154***a*, are sufficiently similar to be placed in the same cluster as event listing **154***a* (e.g., by a clustering algorithm based on the similarity scores of the event listings **154***a-d*). The event listing **154***b* ("DJ Shadow Show") includes the following information items: a name ("DJ Shadow Show"), a date ("5 Oct. 2017"), a time ("9:00 PM"), a venue ("Electric Ballroom"), a genre ("Rap"), and a creator name ("Cheryl"). The event listings **154***a*, **154***b* have similar names ("DJ Shadow Concert" and "DJ Shadow Show"), similar dates ("**7** Oct **2017**" and "**5** Oct **2017**"), a similar venue ("The Electric Ballroom", "Electric Ballroom"), and similar genres ("Rap", "Rap Concert"). Thus, although there are differences in the values of information items of the event listings **154***a*, **154***b*, the similarities are sufficient for these event listings to be classified as duplicates and placed in the same cluster **702***a*. Similarly, the event listings **154***c* ("DJ SHADOW") and **154***d* (no name) are sufficiently similar to the canonical event listing **154***a* to be classified as duplicates and placed in the same cluster.

[0117] A second cluster **702***b* contains event listings **154***e* ("Cadet Concert"), **154***f* ("Cadet"), **154***g* ("Cadet Concert"), and **154***h* ("Kadet Show"). As in the first cluster **702***a*, although there are differences in the values of information items of the event listings **154***e-h*, the similarities are sufficient for the two event listings to be classified as duplicates and placed in the same cluster **702***b*. The non-canonical duplicate event listings **154***f-h* are configured to be hidden event listings in this example, and so are not displayed to users except in particular conditions. The information items of the hidden event listings **154***f-h* are searchable, however, so a search for "Kadet" matches the name of event listing **154***h* ("Kadet Show"). Since event listing **154***h* is a hidden event listing, the corresponding canonical event listing **154***e* may be displayed as a search result instead of the non-canonical event listing **154***h*. As an example of conditions in which the hidden duplicate event listings **154***f-h* may be displayed to users, the user "Amy" who created the non-canonical event listings **154***f* and **154***g* may access the event listings **154***f* and **154***g*, e.g., as search results and make them available to other users, such as friends or other connections of user "Amy."

[0118] A third cluster **702***c* contains event listings **154***i* ("Oktoberfest"), **154***j* ("Oktoberfest"), **154***k* ("Octoberfest"), and **154***l* (no name item, but having other items **155**

similar to listings **154***i-k*). As in the first cluster **702***a*, although there are differences in the values of information items of the event listings **154***i*-**1**, the similarities are sufficient for these event listings to be classified as duplicates and placed in the same cluster **702***c*.

[0119] In particular embodiments, event listings **154** may be discarded from each cluster based on a comparison of the similarity score of each event listing **154** to a threshold. For example, the top K event listings **154** in each cluster may be retained, and listings ranked lower than K may be discarded, for a threshold value K (e.g., 3, 5, 8, 10, or another suitable value). In FIG. **7**, for example, the value of K may be 4, resulting in the canonical event listing and three other event listings being retained in each cluster **702**. As another example, each event listing **154** having a similarity score greater than or equal to a value N may be retained, and each event listing having a similarity score less than N may be discarded. The value N may be, e.g., 0.9, 0.8, 0.75, 0.5, 0.333, or other suitable value (where similarity scores range from 0 (least similar) to 1.0 (most similar)).

[0120] In particular embodiments, the social-networking system **160** may update a set of second event listings **154***b-d* so that each second event listing having a similarity score greater than a threshold includes redirection information **704** to a first event listing **154***a*. The redirection information **704** may identify the second event listings as being in an event cluster **702***a* with the first event listing **154***a*. The redirection information may further identify a canonical event listing in the event cluster to which the other event listings in the cluster are redirected. In particular embodiments, to update each second event listing having a similarity score greater than a threshold score to include redirection information to the first event listing, the social-networking system **160** may store a reference to the first event listing in the canonical event listing. In particular embodiments, the social-networking system **160** may receive, from a client system, a request to retrieve an event listing having specified event information. The social-networking system **160** may identify the event listing based on the event information, and the event listing may include the redirection information. The social-networking system **160** may identify, using the redirection information, the canonical event listing, and send, to the client system, instructions for presenting the canonical event listing in response to the request.

[0121] In particular embodiments, each non-canonical event listing **154** in each cluster **702** may be updated to include redirection information **704** to the canonical event listing **154** in the cluster. The redirection information **704** may include a link or reference to the canonical event listing **154**, which may create the association **706** from the non-canonical event listings **154** to the canonical event listing **154**. Further, the redirection information **704** may identify the cluster of which the event listing **154** is a member.

[0122] For example, the redirection information **704** in each non-canonical event listing **154** includes a canonical link item having a value that references the cluster's canonical event listing **154**. In the example **700**, the canonical link value in each non-canonical event listing **154***b-d* in the first cluster **702***a* is set to "**154***a* " to indicate that event listing **154***a* is the canonical event listing linked to the non-canonical event listing. The canonical link value in the canonical event listing **154***a* may be set to a value such as "this" or null to indicate that the event listing **154***a* itself is the canonical event listing **154***a*. Alternatively, the canonical link value in the canonical event listing **154***a* may be set to a value that references the canonical event listing **154** itself (e.g., **154***a*). An implementation-appropriate type of value, such as an event listing identifier, may be used for the canonical link value in place of the reference number, which is used for illustrative purposes in this example. The redirection information **704** may also include a cluster item that identifies the cluster of which the event listing **154** is a member. In the example **700**, the cluster value of each event listing **154***a-d* is set to "**702***a*" to indicate that each event listing is a member of cluster **702***a*. Although the cluster value is set to a reference number in this example, the cluster value may be set to a different type of value that identifies the cluster **702***a*, or the event listings in the cluster may be identified by a different type of association.

[0123] In the example **700**, for the second cluster **702***b*, the canonical link's value in each non-canonical event listing **154***f-h* in the second cluster **702***a* is **154***e* to indicate that event listing **154***e* is the canonical event listing linked to the non-canonical event listing. Further, the cluster value in each event listing **154***e-h* is **702***b* to indicate that each event listing **154***e-h* is in the cluster **702***b*. For the third cluster **702***c*, the canonical link's value in each non-canonical event listing **154***j*-**1** in the second cluster **702***a* is **154***i* to indicate that event listing **154***i* is the canonical event listing linked to the non-canonical event listing. Further, the cluster value in each event listing **154***i*-**1** is **702***c* to indicate that each event listing **154***i*-**1** is in the cluster **702***c*.

[0124] The canonical and cluster items in the example redirection information **704** may be stored as information items **155**, and may be hidden information items **206** so they are not presented to users. Alternatively, the canonical and cluster values may be represented as values other than information items **155**, e.g., as variables or other types of attributes of the event listings **154**. Alternative implementations of the redirection information **704** are possible. For example, a data structure separate from the information items may be used instead, e.g., a table of clusters that identifies the event listings **154** in each cluster **702** and identifies which of the event listings **154** is the canonical event listing **154** in each cluster **702**.

[0125] In particular embodiments, the social-networking system **160** may send, responsive to a request to access one of the event listings in the cluster, instructions for presenting an event-listing interface comprising a reference to the canonical event listing. The event-listing interface may be part of a search-results interface, a newsfeed interface, or other user interface of the social-networking system **160**. The event-listing interface may include references to the other event listings in the cluster, and the canonical event listing may be presented at a higher rank than the other event listings in the cluster in the event-listing interface. The other event listings in the cluster may be ranked according to their similarity scores with respect to the canonical event listing.

[0126] In particular embodiments, the similarity score for each of the second event listings may be determined using a machine-learning model. The machine-learning model may receive one or more feature vectors having one or more feature values including a first feature value based on the first event listing and a second feature value based on the second event listing, and compute the similarity score based on the first and second feature values. The feature values may include a count of how many strings in the first event listing are the same as strings in the second event listing, a

difference in time between the start times of the first and second event listings, a difference in distance between the locations of the first and second event listings, or other values based on information items of the event listings.

[0127] In particular embodiments, the second event listings may be received from an external event system, a user of the online social network, a notification on the online social network, a message on the online social network, and/or a list of search results.

[0128] In particular embodiments, a rule-based system may be used to identify the canonical (e.g., best-matching) event listing by evaluating rules. The rules may be used instead of or in addition to other techniques for identifying the canonical event listing, such as selecting the highest-ranking duplicate event listing as the canonical event listing as described elsewhere herein. The rules may be based on one or more information items of each event listing in the event cluster, and may be evaluated in an order. A first rule may check whether one of the event listings is an official event listing that was received from a trusted event provider, such as TICKETMASTER or a highly-trusted partner. If so, the event listing may be the canonical event listing.

[0129] In particular embodiments, a second rule may determine whether the creator of the event listing is a verified user. If so, then the event listing may be the canonical event listing. As an example, if the venue of the event listing is the same as the venue that created the ticket, then the event may be the canonical event listing. Thus, for example, if the venue Levi's Stadium created a Beyonce event listing, and the event's location information item indicates that the event takes place in Levi's Stadium, then that event listing is the canonical event, and may be assigned a higher preference than other Beyoncé events that take place in Levi's stadium created by users other than the Levi's Stadium user account.

[0130] In particular embodiments, a third rule, which may be used as a fallback, may determine how many people are registered to attend (e.g., are going to) the event. The event that has the most attendees may be the canonical event. The first rule may have more weight than the second rule, and the second rule may have more weight than the third rule. For example, if a famous artist such as "50 Cent" has a user account with a verified badge and creates an event listing, then the event listing created by "50 Cent" may be ranked higher than another event listing that has more registered attendees.

[0131] FIG. **9** illustrates an example method **900** for de-duplicating events on a social-networking system **160**. The method may begin at step **910**, where the social-networking system **160** may receive a first event listing corresponding to a first event, wherein the first event listing comprises one or more items of event information that include at least a time of the first event and a geographic location of the first event. At step **920**, the social-networking system **160** may identify one or more second event listings including one or more items of event information that include at least a time and a geographic location placing the second event listing in the first bucket of the array or one of the buckets of the array adjacent to the first bucket. At step **930**, the social-networking system **160** may compute, for each of the second event listings, a similarity score between the first event listing and the second event listing, wherein the similarity score is based on a comparison of the event information of the first event listing and the event information of the second event listing. At step **940**, the social-networking system **160** may update each second event listing having a similarity score greater than a threshold score to include redirection information referencing the first event listing and identifying the second event listings as being in an event cluster with the first event listing.

[0132] Particular embodiments may repeat one or more steps of the method of FIG. **9**, where appropriate. Although this disclosure describes and illustrates particular steps of the method of FIG. **9** as occurring in a particular order, this disclosure contemplates any suitable steps of the method of FIG. **9** occurring in any suitable order. Moreover, although this disclosure describes and illustrates an example method for de-duplicating events on a social-networking system including the particular steps of the method of FIG. **9**, this disclosure contemplates any suitable method for de-duplicating events on a social-networking system including any suitable steps, which may include all, some, or none of the steps of the method of FIG. **9**, where appropriate. Furthermore, although this disclosure describes and illustrates particular components, devices, or systems carrying out particular steps of the method of FIG. **9**, this disclosure contemplates any suitable combination of any suitable components, devices, or systems carrying out any suitable steps of the method of FIG. **9**.

[0133] FIG. **10** illustrates an example method **1000** for retrieving canonical event listings on a social-networking system **160**. The method may begin at step **1010**, where the social-networking system **160** may receive, from a client system, a request to retrieve an event listing having specified event information. At step **1020**, the social-networking system **160** may identify the event listing based on the event information, wherein the event listing includes the redirection information. At step **1030**, the social-networking system **160** may identify, using the redirection information, the canonical event listing. At step **1040**, the social-networking system **160** may send, to the client system, instructions for presenting the canonical event listing in response to the request.

[0134] Particular embodiments may repeat one or more steps of the method of FIG. **10**, where appropriate. Although this disclosure describes and illustrates particular steps of the method of FIG. **10** as occurring in a particular order, this disclosure contemplates any suitable steps of the method of FIG. **10** occurring in any suitable order. Moreover, although this disclosure describes and illustrates an example method for retrieving canonical event listings on a social-networking system including the particular steps of the method of FIG. **10**, this disclosure contemplates any suitable method for retrieving canonical event listings on a social-networking system including any suitable steps, which may include all, some, or none of the steps of the method of FIG. **10**, where appropriate. Furthermore, although this disclosure describes and illustrates particular components, devices, or systems carrying out particular steps of the method of FIG. **10**, this disclosure contemplates any suitable combination of any suitable components, devices, or systems carrying out any suitable steps of the method of FIG. **10**.

Automatic Detection of Events

[0135] In particular embodiments, a machine-learning model may be used to automatically categorize event listings **154** on a social-networking system **160**. Event listings **154** may be associated with categories such as music (jazz, rap),

comedy, sports (kickball, ultimate Frisbee), e-sports (League of Legends, HearthStone), and so on. Such event categories may be useful for search and discovery features on online social networks or other user applications, such as specific event-management applications. For example, a user may click or tap on a category name in an events application to view event listings **154** in that category. Event categories may be related to other event categories, so that related event listings **154** may be found by searching related categories. The event categories may be arranged in a hierarchy, with the broadest categories at the top of the hierarchy and the narrowest at the bottom. For example, "entertainment" may be a top-level category, "music" may be below entertainment, and "jazz" and "rap" may be below "music." Thus, by automatically categorizing event listings **154**, the social-networking system **160** may allow users to more easily search for and browse event listings **156**, and to find event listings **156** in related categories in the hierarchy.

[0136] FIG. **11**A illustrates an event recommendation example **1101** in which a category **1110** of an event listing **1154** may be used to identify a related category **1110** and event listings **1154** in the related category. In particular embodiments, event listings **1154** may correspond to the internal events **1154** or external events **1156** of FIG. **1**, and may be associated with categories **1110** such as music **1102** (e.g., jazz, rap), comedy, sports (e.g., kickball, ultimate Frisbee), e-sports (e.g., League of Legends, HearthStone), and so on. Such event categories **1110** are useful for search and discovery features of user applications. For example, a user **101** may click or tap on a category name in an events application presented on a client system **130** to view event listings **1154** in that category **1110**. Event categories **1110** may be related to other event categories **1110**, so that related events may be found by searching related categories **1110**. The event categories **1110** may be arranged in a hierarchy **1100**, with the broadest categories **1110** at the top of the hierarchy and the narrowest categories **1110** at the bottom. As an example, "entertainment" (not shown) may be a top-level category, "music" **1102** may be below "entertainment," and "hip-hop" **1104** may be below "music" **1102**. Thus, by automatically categorizing event listings **1154**, the social-networking system **160** may allow users **101** to more easily search for and browse event listings **1154**, and to find event listings **1154** in related or adjacent categories. Although users **101** may manually provide categories for events, for example, by typing in a description in a category-field when creating an event, or selecting a predetermined category from a drop-down menu, doing so can be inconvenient or, for large quantities of event listings **1154** such as those imported from a third-party system **170**, impractical. In particular embodiments, a category **1110** may be associated with one or more event listings **1154** in a social-networking system **160** by a machine-learning model that has been trained to identify appropriate categories **1110** for event listings **1154**. The machine-learning model may be, e.g., a deep neural network or other suitable type of model.

[0137] In particular embodiments, the social-networking system **160** may receive one or more event listings **154** corresponding to one or more real-world events. The event listings **154** may be received from, for example, an external event system such as a third-party system **170**, a user **101** of the online social network, e.g., via a user interface of a client system **130**, a notification on the social networking system **160**, a message on the social networking system **160**, or a list of search results generated by, e.g., the social-networking system **160**, the third-party system **170**, or the server system **180**. For each of the received event listings **154**, the social-networking system **160** may identify, using a machine-learning model, one or more categories **1110** for the event listing **154** based on one or more items of information **155** included in the event listing **154**, and associate the identified categories **1110** with the event listing **154**. The identified categories may be selected from the plurality of categories in the hierarchy **1100**. The hierarchy **1100** may also be referred to herein as a hierarchical category index **1100**.

[0138] In particular embodiments, the machine-learning model may map one or more items of event information **155** in an event listing **1154** to each category **1110** associated with the event listing **1154**. The items of event information **155** may include text content, which may be provided to the machine-learning model as input. As described with reference to FIG. **1**, the event listing **1154** may represent a real-world event, and the text content may include a title **210** of the event, a time **210** of the event, a geographic location **210** of the event, an entity **230** associated with the event, a description of the event, or other value **210** of an item **155** of event information. The items of event information **155** may include a graphical image and/or a hash or embedding computed based on the graphical image. The hash or embedding may be provided to the machine-learning model as input.

[0139] In particular embodiments, a social-networking system **160** may receive, from a first client system **130** of a first user **101** of the social-networking system **160**, a search query for event listings **1154** that are to be identified. The search query may specify one or more criteria for identifying event listings **1154**. For example, the criteria may include an event category **1110**, a value of an information item **155** associated with an event listing **1154**, such as the name of an artist or location, a type of event, or other appropriate values of information items **155**. In particular embodiments, one or more categories **1110** may be associated with an event listing **1154**. As an example and not by way of limitation, the categories **1110** associated with an event listing **1154** may be stored in the event listing **1154** as items of event information **155** having a name "Category" **208** and a value **1110** that specifies the name of the category. Although this disclosure describes associating categories **1110** with an event listing **1154** in a particular manner, this disclosure contemplates associating categories **1110** with an event listing **1154** in any suitable manner.

[0140] In particular embodiments, the categories **1110** associated with an event listing **1154** may be selected from a set of categories **1110** in a hierarchical category index **1100** that includes one or more top-level categories, e.g., "music" **1102**, and one or more lower-level categories below the top-level categories. The lower-level categories in the example of FIG. **11**A include "hip-hop" **1104**, "rap" **1106**, "trap" **1108**, and "west coast" **1112**. Each category **1110** associated with a first event listing **1154** may be determined using a machine-learning model that analyzes one or more of the items of event information **155** provided by a creator of the first event listing **1155**. The machine-learning model may categorize an event listing **1154** by analyzing content associated with the event listing **1154**, such as the items **155** of information, e.g., the title and description of the event listing **154**, and applying one or more category labels to the event. The category labels may be, e.g., names or identifiers

of categories **1110**, and may be applied by, e.g., associating them with the event listing **154**. The category labels may be selected from a set of category labels associated with Wikipedia topics, which have been manually mapped into a category hierarchy. There may be numerous labels in the set, e.g., thousands of labels. The machine-learning model may also use computer-vision features from the cover photo image associated with the event. A hash or an embedding may be computed for an image and compared to hashes/embeddings for other images, such that if two hashes/embeddings are similar, then the corresponding two images are similar. The hash or embedding may be used as an input feature for the machine-learning model. In one example, this image feature showed a 10% average improvement in precision across all categories in a hierarchy. More information on hashes and embedding may be found in U.S. patent application Ser. No. 15/289532, filed 10 Oct. 2016, and U.S. patent application Ser. No. 15/847451, filed 19 Dec. 2017, each of which is incorporated by reference herein.

[0141] The machine-learning model used for event categorization may be a deep-text model, which may perform convolutions over word embeddings. The model may implement a sequence-modeling system that takes an input as a series of symbols and maps the input to a class. Words may be mapped to data, for example. The machine-learning model may be trained using events for which human users have provided categories.

[0142] In particular embodiments, similarity scores may be calculated for graphical images, such as event cover photos or other images associated with event listings **154**, using transfer learning. An image segmentation system may extract features from images and produce a hash value based on the extracted features. The hash value may have, e.g., 255 Boolean values. When comparing hash values, if most of the Boolean values are the same, then the images tend to be similar. If most of the values are different, the images tend to be quite different semantically and content-wise. The hash from an event's image may be used as an input to the model, which may learn and generalize based on similarity between labeled data (e.g., labeled cover photos) and unlabeled data. For example, music concerts often have artists that are shown in event cover photos. A cover photo showing music artists may be more likely to be a music event according to the model. The image model need not be trained specifically for this purpose. Instead, the image model may trained for another purpose, and then the output of that trained image model may be used as input to this model. That ensemble may be trained specifically on manually-labeled events data. The model may be trained on images of events, where the events have been trained by human trainers. For example, an event may have an associated category of soccer, and a photo associated with the event is known to be associated with soccer for training purposes.

[0143] In particular embodiments, the social-networking system **160** may identify one or more first event listings **1154** that match the query. Each first event listing **1154** may include one or more items of event information **155** associated with a respective first event **1154**. A first event listing **1154** may match the query if, e.g., one or more items of event information **155** associated with the first event listing **1154** are the same as one or more of the query criteria. As an example, the query "Kanye" has the value "Kanye" as query criteria. The "Kanye" query may match the first event listing **1154** because the "Name" information item **155** has the value "Kanye Concert" **210**, which contains the query criteria "Kanye." The "Kanye" query may also match the first event listing **1154** because the "Artist" information item **155** has the value "Kanye West" **210**, which matches the criteria "Kanye." The second event listing **1154** does not have any information items **155** containing the query criteria "Kanye" and so does not match the query "Kanye." Queries may also include criteria specifying a value for a particular information item. For example, the query "Artist=Kanye" may match the first event listing **1154** because the first event listing **1154** includes the information item **155** "Artist=Kanye West." A query may match multiple event listings **1154**. For example, the query "Concert" may match both the first event listing **1154** an the second event listing **1154** because both event listings **1154** include information items **155** having values that include the string "Concert" and both the first and second event listings **1154** may be included in search results for the query "Concert."

[0144] In particular embodiments, the social-networking system **160** may identify one or more second event listings **1154** based on the first event listing **1154**. In particular embodiments, the first event listing **1154** may be identified or received from a source such as an external event system **170**, a user **101** of the social-networking system **160**, a notification on the social-networking system **160**, a message on the social-networking system, a list of search results, or the like. In the example of FIG. **4**, the first event listing **1154** includes four information items **155**: a name ("Kanye Concert"), an artist ("Kanye West"), a category ("Rap" **1110**), and a cover photo (an image **210**, e.g., an image of the artist). The second event listing **1154** includes three information items **155**: a name ("Kendrick Lamar Concert"), an artist ("Kendrick Lamar"), and a category ("West Coast" **1110**). The hierarchical category index **1100** has a "Music" category **1102**, which has a more-specific child category "Hip-Hop" **1104**, which in turn has three more-specific child categories: "Rap" **1106**, "Trap" **1108**, and "West Coast" **1112**.

[0145] In particular embodiments, each second event listing **1154** may be associated with a predetermined category from an adjacent category of the one or more predetermined categories in the hierarchical category index **1100**. For example, a first category **1110** associated with a first event listing **1154** may be used to identify a second event listing **1154** having a second category **1110**. The second category **1110** may related to the first category **1110** by a category index **1100**, and the second event listing **1154** may be identified by using the category index **1100** to map the first category **1110** to the second category **1110**. Event listings **1154** having the second category may be identified and used as the second event listings **1154**. In particular embodiments, to identify the second event listings **1154** related to the first event listing **1154**, the social-networking system **160** may select a category **1110** of the first event listing **1154**, then, using the hierarchical category index **1100**, identify one or more second event listings **1154** having either (a) the same category **1110** as the first event listing **1154** or (b) a "second" category **1112** related to the category **1110** of the first event listing **1154**. In particular embodiments, the same category **1110** may be selected when there are one or more second event listings **1154** having the same category **1110** as the first event listing. If there are no such second event listings **1154**, or each such second event listing **1154** has already been identified in response to a previous request, then the second

category **1112** related to the category of the first event listing **1154** may be selected, and a second event listing **1154** having the second category **1112** may be identified.

[0146] As an example and not by way of limitation, upon receiving a first event listing **1154** ("Kanye Concert") having a category **1110** ("Rap"), to identify a second event listing **1154** for use in a recommendation, the social-networking system **160** may search the event listings (e.g., in the data store **164**) for another event **1154** listing having the same category **1110** ("Rap"). To identify an additional second event listing **1154** in a different category to recommend, or if there are no second event listings having the same category **1110**, the social-networking system **160** may select a category node **1106** ("Rap") in the category index **1100** having the same category **1110** as the first event listing **1154**, then select an adjacent category node, e.g., node **1108** ("Trap") or **1112** ("West Coast"), and search the event listings (e.g., in the data store **164**) for a second event listing **1154** having the adjacent category. If the adjacent category node **1112** ("West Coast") is selected, then the search may identify a second event listing **1154** ("Kendrick Lamar Concert") having the same category **1110** ("West Coast") as the adjacent category node **1112**. The second event listing **1154** may then be identified as a result, e.g., for recommendation to a user **101**.

[0147] In particular embodiments, to select one or more second categories **1110** that are related to a given category (such as those of the first event listing **1154**), the social-networking system **160** may find a category node in the hierarchical category index **1100** reachable via a path from the node that corresponds to the given category. Thus, a second category related to a given category may be a category adjacent to the given category (e.g., a sibling of the given category) in the category index **100**. That is, an adjacent category may be a sub-category of a parent category of a given predetermined category. The second category related to a given category may alternatively be a parent or child of the given category, or a sibling of a parent or child of the given category, or a parent or child of a sibling of the given category. The terms "parent" and "child" as used herein ordinarily refer to a first-degree parent or child, though greater degrees are possible (e.g., the second category may be a grandparent (a second-degree parent) or a grandchild (a second-degree child)).

[0148] Referring to FIG. **11**A, as introduced above, to identify the related category **1112**, the social-networking system **160** may search the category index **1100** for a node corresponding to the first category **1110**. Upon finding a first node **1106** corresponding to the first category **1110** in the category index **1100**, the social-networking system **160** may traverse the category index **1100** from the first node **1106** to identify a node corresponding to the related category **1112**. The traversal may identify a node having a predetermined relationship to the first node **1106** of the first category **1110**, such as being adjacent to the first node **11106**. For example, the traversal may identify an adjacent category node **1112** ("West Coast") or **1108** ("Trap"). The choice between multiple adjacent nodes may be made randomly or based on criteria such as selecting the closest node. Further, when there are multiple possible choices, e.g., multiple adjacent nodes, each subsequent request may be provided with a different node as a response, until all of the possible choices have been selected in different subsequent responses, at which point the cycle may begin again, possibly in a different order. For example, if there are multiple adjacent nodes from which to choose, the closest node not previously returned may be selected for each response, in which case, when selecting nodes adjacent to node **1106** ("Rap"), the closest adjacent node **1108** ("Trap") may be selected in response to a first request, the next-closest node **1112** ("West Coast") may be selected in response to a second request, and so on.

[0149] FIG. **11**B illustrates an example hierarchical category index **1100**, in which nodes correspond to categories. The hierarchical category index **1100** includes a "Music" category **1102**, which is the top-level category illustrated in FIG. **11**B. There may be one or more parent categories of "Music" **1102**, e.g., an "Entertainment" category (not shown) or the like. The "Music" category **1102** has three children: a "Hip-Hop" category **1104**, a "Rock" category **1114**, and a "Classical" category **1118**. In particular embodiments, categories that are direct (e.g., first-degree) children of the same node may be referred to herein as adjacent categories. Thus, "Hip-Hop" **1104**, "Rock" **1114**, and "Classical" **1118** may be considered adjacent categories. The "Hip-Hop" category **1104** has three children: A "Rap" category **1106**, a "Trap" category **1108**, and a "West Coast" category **1112**, which may be considered adjacent categories. The "Rock" category **1114** has one child, which is an "Arena Rock" category **1116**. In particular embodiments, "Arena Rock" **1116** is not considered adjacent to "West Coast" **1112** because the two categories do not have a common first-degree parent category. The "Classical" category **1118** has two children: an "Orchestra" category **1120** and a Piano category **1122**. The "Orchestra" category **1120** has one child, a "Symphony" category **1124**. In particular embodiments, the hierarchical category index **1100** may be constructed manually, e.g., by initially analyzing labeled data and category co-occurrence. A clustering analysis may then be performed based on category assignment by determining which two categories are together more often (i.e., co-occurring event labels), and using the resulting tree to build the hierarchy. For example, users **101** may label the leaves, and a natural order may be derived from the labeled leaves.

[0150] In particular embodiments, as introduced above, the hierarchical category index **1100** may be used to identify event listings **1154** that are related to a given event listing **1154**. Given an event listing, related event listings may be identified by identifying a category **1112** related to the category **1110** of the event listing, then identifying second event listings **1154** having the related category **1112**. As an example, for "a Kanye Concert" event listing **1154**, the category of the event listing **154** may be identified by an information item **155** of the event listing **154**, e.g., by an information item **155** having the value "Rap" **1110**. Alternatively, the category of the event listing **154** may be identified based on information items **155** such as the artist name **210** or the event listing name **210**, instead of or in addition to the category information item **155**. As an example, if an event listing **154** includes an information item Artist="Kanye West," then a category **1110** associated with "Kanye West" may be identified, e.g., from a database or in-memory table that associates artists with music genres, or by performing a web search for the artist name and extracting a category from the search results. The determined category may be "Rap," for example, if the search results mention "Rap". The hierarchical category index **1100** may

then be used to identify a category related to "Rap," e.g., by identifying the "Rap" node **1104** in the index **1100** and selecting one of the child nodes of the "Rap" node **1104**, such as "West Coast" **1112**, as a related category **1112**.

[0151] In particular embodiments, on an events user interface page, if a user selects, e.g., taps on, a category, such as Rap **1106**, then a search and discovery user interface may present events from one or more genres of music that are related to the selected category (e.g., West Coast **1112** and Hip-Hop **1104**). If there are not enough event listings in the selected category, then related categories such as adjacent categories may be identified. The related categories may be selected as described above, and/or based on relevance to the user, e.g., based on relevance of the categories to the user's past interactions with the events user interface, or whether one or more of the user's friends are going to (e.g., registered to attend) an event associated with the category.

[0152] In particular embodiments, related categories **1110** may be identified by traversing up the hierarchical category index **1100** and assigning weights proportionally to the levels. For example, lower levels may be assigned higher weights, and the weight of each successively higher level may be lower than the level below. The operation of retrieving the related categories may be performed by a distributed system, in which the retrieval may be biased so that the retrieval is more likely to retrieve elements from a first category, slightly less likely, to retrieve from a second category, and even less likely to retrieve from a third category. The first category may be the highest-weighted, the second category may have lower weight than the first, and the third category may have lower weight than the second. As an example and not by way of limitation, a query for Rap artists may be configured to retrieve an event listing with 100% probability if the listing's event category is Rap **1106**, to retrieve an event listing with 50% probability if the listing's category is Hip-Hop **1104**, and to retrieve the listing with 20% probability if the listing's category is Music **1102**. In particular embodiments, the siblings of the queried category ("Rap" **1106**), e.g., "Trap" **1108** and "West Coast" **1112**, may be assigned the same retrieval probability as the level above the queried category ("Hip-hop" **1104**). For example, a different child category of Hip-Hop **1104**, e.g., Trap or West Coast, may be retrieved with 50% probability.

[0153] In particular embodiments, the social-networking system **130** may send, to the first client system **130** responsive to a search query, instructions for presenting a search-results interface comprising references to one or more of the first event listings **1154** and one or more of the second event listings **1154**. Search query results may be sent to the client system **130**, and the search query results may include an event listing **154** or a reference to an event listing **154**. The reference to the event listing **154** may include a link with a snippet (e.g., the title of the event and a thumbnail cover photo), which may be selectable in a user interface on the client system **130** to cause presentation (e.g., display) on the client system **130** of an event-interface that contains the event listing **154**. As an example and not by way of limitation, each of the references may include an event identifier for the referenced event listing **1154**, a link to the referenced event listing **1154**, and/or a photo associated with the referenced event listing **1154**.

[0154] FIG. **12** illustrates an example method **1200** for identifying event listings based on a search query and one or more event categories. The method may begin at step **1210**, where the social-networking system **160** may receive, from a first client system of a first user of the social-networking system **160**, a search query for event listings, wherein the search query specifies one or more criteria. At step **1220**, the social-networking system **160** may identify one or more first event listings that match the query, wherein each first event listing includes one or more items of event information associated with a respective first event, and the items of event information include at least one or more predetermined categories selected from a hierarchical category index. At step **1230**, the social-networking system **160** may identify one or more second event listings based on the first event listings, wherein each second event listing is associated with a predetermined category from an adjacent category of the one or more predetermined categories in the hierarchical category index. At step **1240**, the social-networking system **160** may send, to the first client system responsive to the search query, instructions for presenting a search-results interface comprising references to one or more of the first event listings and one or more of the second event listings.

[0155] Particular embodiments may repeat one or more steps of the method of FIG. **12**, where appropriate. Although this disclosure describes and illustrates particular steps of the method of FIG. **12** as occurring in a particular order, this disclosure contemplates any suitable steps of the method of FIG. **12** occurring in any suitable order. Moreover, although this disclosure describes and illustrates an example method for identifying event listings based on a search query and one or more event categories including the particular steps of the method of FIG. **12**, this disclosure contemplates any suitable method for identifying event listings based on a search query and one or more event categories including any suitable steps, which may include all, some, or none of the steps of the method of FIG. **12**, where appropriate. Furthermore, although this disclosure describes and illustrates particular components, devices, or systems carrying out particular steps of the method of FIG. **12**, this disclosure contemplates any suitable combination of any suitable components, devices, or systems carrying out any suitable steps of the method of FIG. **12**.

Social Graphs

[0156] FIG. **13** illustrates example social graph **1300**. In particular embodiments, social-networking system **160** may store one or more social graphs **1300** in one or more data stores. In particular embodiments, social graph **1300** may include multiple nodes—which may include multiple user nodes **1302** or multiple concept nodes **1304**—and multiple edges **1306** connecting the nodes. Example social graph **1300** illustrated in FIG. **13** is shown, for didactic purposes, in a two-dimensional visual map representation. In particular embodiments, a social-networking system **160**, client system **130**, or third-party system **170** may access social graph **1300** and related social-graph information for suitable applications. The nodes and edges of social graph **1300** may be stored as data objects, for example, in a data store (such as a social-graph database). Such a data store may include one or more searchable or queryable indexes of nodes or edges of social graph **1300**.

[0157] In particular embodiments, a user node **1302** may correspond to a user of social-networking system **160**. As an example and not by way of limitation, a user may be an individual (human user), an entity (e.g., an enterprise, busi-

ness, or third-party application), or a group (e.g., of individuals or entities) that interacts or communicates with or over social-networking system **160**. In particular embodiments, when a user registers for an account with social-networking system **160**, social-networking system **160** may create a user node **1302** corresponding to the user, and store the user node **1302** in one or more data stores. Users and user nodes **1302** described herein may, where appropriate, refer to registered users and user nodes **1302** associated with registered users. In addition or as an alternative, users and user nodes **1302** described herein may, where appropriate, refer to users that have not registered with social-networking system **160**. In particular embodiments, a user node **1302** may be associated with information provided by a user or information gathered by various systems, including social-networking system **160**. As an example and not by way of limitation, a user may provide his or her name, profile picture, contact information, birth date, sex, marital status, family status, employment, education background, preferences, interests, or other demographic information. In particular embodiments, a user node **1302** may be associated with one or more data objects corresponding to information associated with a user. In particular embodiments, a user node **1302** may correspond to one or more webpages.

[0158] In particular embodiments, a concept node **1304** may correspond to a concept. As an example and not by way of limitation, a concept may correspond to a place (such as, for example, a movie theater, restaurant, landmark, or city); a website (such as, for example, a website associated with social-networking system **160** or a third-party website associated with a web-application server); an entity (such as, for example, a person, business, group, sports team, or celebrity); a resource (such as, for example, an audio file, video file, digital photo, text file, structured document, or application) which may be located within social-networking system **160** or on an external server, such as a web-application server; real or intellectual property (such as, for example, a sculpture, painting, movie, game, song, idea, photograph, or written work); a game; an activity; an idea or theory; an object in a augmented/virtual reality environment; another suitable concept; or two or more such concepts. A concept node **1304** may be associated with information of a concept provided by a user or information gathered by various systems, including social-networking system **160**. As an example and not by way of limitation, information of a concept may include a name or a title; one or more images (e.g., an image of the cover page of a book); a location (e.g., an address or a geographical location); a website (which may be associated with a URL); contact information (e.g., a phone number or an email address); other suitable concept information; or any suitable combination of such information. In particular embodiments, a concept node **1304** may be associated with one or more data objects corresponding to information associated with concept node **1304**. In particular embodiments, a concept node **1304** may correspond to one or more webpages.

[0159] In particular embodiments, a node in social graph **1300** may represent or be represented by a webpage (which may be referred to as a "profile page"). Profile pages may be hosted by or accessible to social-networking system **160**. Profile pages may also be hosted on third-party websites associated with a third-party system **170**. As an example and not by way of limitation, a profile page corresponding to a particular external webpage may be the particular external webpage and the profile page may correspond to a particular concept node **1304**. Profile pages may be viewable by all or a selected subset of other users. As an example and not by way of limitation, a user node **1302** may have a corresponding user-profile page in which the corresponding user may add content, make declarations, or otherwise express himself or herself. As another example and not by way of limitation, a concept node **1304** may have a corresponding concept-profile page in which one or more users may add content, make declarations, or express themselves, particularly in relation to the concept corresponding to concept node **1304**.

[0160] In particular embodiments, a concept node **1304** may represent a third-party webpage or resource hosted by a third-party system **170**. The third-party webpage or resource may include, among other elements, content, a selectable or other icon, or other inter-actable object (which may be implemented, for example, in JavaScript, AJAX, or PHP codes) representing an action or activity. As an example and not by way of limitation, a third-party webpage may include a selectable icon such as "like," "check-in," "eat," "recommend," or another suitable action or activity. A user viewing the third-party webpage may perform an action by selecting one of the icons (e.g., "check-in"), causing a client system **130** to send to social-networking system **160** a message indicating the user's action. In response to the message, social-networking system **160** may create an edge (e.g., a check-in-type edge) between a user node **1302** corresponding to the user and a concept node **1304** corresponding to the third-party webpage or resource and store edge **1306** in one or more data stores.

[0161] In particular embodiments, a pair of nodes in social graph **1300** may be connected to each other by one or more edges **1306**. An edge **1306** connecting a pair of nodes may represent a relationship between the pair of nodes. In particular embodiments, an edge **1306** may include or represent one or more data objects or attributes corresponding to the relationship between a pair of nodes. As an example and not by way of limitation, a first user may indicate that a second user is a "friend" of the first user. In response to this indication, social-networking system **160** may send a "friend request" to the second user. If the second user confirms the "friend request," social-networking system **160** may create an edge **1306** connecting the first user's user node **1302** to the second user's user node **1302** in social graph **1300** and store edge **1306** as social-graph information in one or more of data stores **164**. In the example of FIG. **13**, social graph **1300** includes an edge **1306** indicating a friend relation between user nodes **1302** of user "A" and user "B" and an edge indicating a friend relation between user nodes **1302** of user "C" and user "B." Although this disclosure describes or illustrates particular edges **1306** with particular attributes connecting particular user nodes **1302**, this disclosure contemplates any suitable edges **1306** with any suitable attributes connecting user nodes **1302**. As an example and not by way of limitation, an edge **1306** may represent a friendship, family relationship, business or employment relationship, fan relationship (including, e.g., liking, etc.), follower relationship, visitor relationship (including, e.g., accessing, viewing, checking-in, sharing, etc.), subscriber relationship, superior/subordinate relationship, reciprocal relationship, non-reciprocal relationship, another suitable type of relationship, or two or more such relationships. Moreover, although this disclosure generally describes nodes as being connected, this disclosure also describes users or concepts as

being connected. Herein, references to users or concepts being connected may, where appropriate, refer to the nodes corresponding to those users or concepts being connected in social graph **1300** by one or more edges **1306**.

[0162] In particular embodiments, an edge **1306** between a user node **1302** and a concept node **1304** may represent a particular action or activity performed by a user associated with user node **1302** toward a concept associated with a concept node **1304**. As an example and not by way of limitation, as illustrated in FIG. **13**, a user may "like," "attended," "played," "listened," "cooked," "worked at," or "watched" a concept, each of which may correspond to an edge type or subtype. A concept-profile page corresponding to a concept node **1304** may include, for example, a selectable "check in" icon (such as, for example, a clickable "check in" icon) or a selectable "add to favorites" icon. Similarly, after a user clicks these icons, social-networking system **160** may create a "favorite" edge or a "check in" edge in response to a user's action corresponding to a respective action. As another example and not by way of limitation, a user (user "C") may listen to a particular song ("Imagine") using a particular application (SPOTIFY, which is an online music application). In this case, social-networking system **160** may create a "listened" edge **1306** and a "used" edge (as illustrated in FIG. **13**) between user nodes **1302** corresponding to the user and concept nodes **1304** corresponding to the song and application to indicate that the user listened to the song and used the application. Moreover, social-networking system **160** may create a "played" edge **1306** (as illustrated in FIG. **13**) between concept nodes **1304** corresponding to the song and the application to indicate that the particular song was played by the particular application. In this case, "played" edge **1306** corresponds to an action performed by an external application (SPOTIFY) on an external audio file (the song "Imagine"). Although this disclosure describes particular edges **1306** with particular attributes connecting user nodes **1302** and concept nodes **1304**, this disclosure contemplates any suitable edges **1306** with any suitable attributes connecting user nodes **1302** and concept nodes **1304**. Moreover, although this disclosure describes edges between a user node **1302** and a concept node **1304** representing a single relationship, this disclosure contemplates edges between a user node **1302** and a concept node **1304** representing one or more relationships. As an example and not by way of limitation, an edge **1306** may represent both that a user likes and has used at a particular concept. Alternatively, another edge **1306** may represent each type of relationship (or multiples of a single relationship) between a user node **1302** and a concept node **1304** (as illustrated in FIG. **13** between user node **1302** for user "E" and concept node **1304** for "SPOTIFY").

[0163] In particular embodiments, social-networking system **160** may create an edge **1306** between a user node **1302** and a concept node **1304** in social graph **1300**. As an example and not by way of limitation, a user viewing a concept-profile page (such as, for example, by using a web browser or a special-purpose application hosted by the user's client system **130**) may indicate that he or she likes the concept represented by the concept node **1304** by clicking or selecting a "Like" icon, which may cause the user's client system **130** to send to social-networking system **160** a message indicating the user's liking of the concept associated with the concept-profile page. In response to the message, social-networking system **160** may create an edge **1306** between user node **1302** associated with the user and concept node **1304**, as illustrated by "like" edge **1306** between the user and concept node **1304**. In particular embodiments, social-networking system **160** may store an edge **1306** in one or more data stores. In particular embodiments, an edge **1306** may be automatically formed by social-networking system **160** in response to a particular user action. As an example and not by way of limitation, if a first user uploads a picture, watches a movie, or listens to a song, an edge **1306** may be formed between user node **1302** corresponding to the first user and concept nodes **1304** corresponding to those concepts. Although this disclosure describes forming particular edges **1306** in particular manners, this disclosure contemplates forming any suitable edges **1306** in any suitable manner.

Systems and Methods

[0164] FIG. **14** illustrates an example computer system **1400**. In particular embodiments, one or more computer systems **1400** perform one or more steps of one or more methods described or illustrated herein. In particular embodiments, one or more computer systems **1400** provide functionality described or illustrated herein. In particular embodiments, software running on one or more computer systems **1400** performs one or more steps of one or more methods described or illustrated herein or provides functionality described or illustrated herein. Particular embodiments include one or more portions of one or more computer systems **1400**. Herein, reference to a computer system may encompass a computing device, and vice versa, where appropriate. Moreover, reference to a computer system may encompass one or more computer systems, where appropriate.

[0165] This disclosure contemplates any suitable number of computer systems **1400**. This disclosure contemplates computer system **1400** taking any suitable physical form. As example and not by way of limitation, computer system **1400** may be an embedded computer system, a system-on-chip (SOC), a single-board computer system (SBC) (such as, for example, a computer-on-module (COM) or system-on-module (SOM)), a desktop computer system, a laptop or notebook computer system, an interactive kiosk, a mainframe, a mesh of computer systems, a mobile telephone, a personal digital assistant (PDA), a server, a tablet computer system, an augmented/virtual reality device, or a combination of two or more of these. Where appropriate, computer system **1400** may include one or more computer systems **1400**; be unitary or distributed; span multiple locations; span multiple machines; span multiple data centers; or reside in a cloud, which may include one or more cloud components in one or more networks. Where appropriate, one or more computer systems **1400** may perform without substantial spatial or temporal limitation one or more steps of one or more methods described or illustrated herein. As an example and not by way of limitation, one or more computer systems **1400** may perform in real time or in batch mode one or more steps of one or more methods described or illustrated herein. One or more computer systems **1400** may perform at different times or at different locations one or more steps of one or more methods described or illustrated herein, where appropriate.

[0166] In particular embodiments, computer system **1400** includes a processor **1402**, memory **1404**, storage **1406**, an input/output (I/O) interface **1408**, a communication interface

1410, and a bus **1412**. Although this disclosure describes and illustrates a particular computer system having a particular number of particular components in a particular arrangement, this disclosure contemplates any suitable computer system having any suitable number of any suitable components in any suitable arrangement.

[0167] In particular embodiments, processor **1402** includes hardware for executing instructions, such as those making up a computer program. As an example and not by way of limitation, to execute instructions, processor **1402** may retrieve (or fetch) the instructions from an internal register, an internal cache, memory **1404**, or storage **1406**; decode and execute them; and then write one or more results to an internal register, an internal cache, memory **1404**, or storage **1406**. In particular embodiments, processor **1402** may include one or more internal caches for data, instructions, or addresses. This disclosure contemplates processor **1402** including any suitable number of any suitable internal caches, where appropriate. As an example and not by way of limitation, processor **1402** may include one or more instruction caches, one or more data caches, and one or more translation lookaside buffers (TLBs). Instructions in the instruction caches may be copies of instructions in memory **1404** or storage **1406**, and the instruction caches may speed up retrieval of those instructions by processor **1402**. Data in the data caches may be copies of data in memory **1404** or storage **1406** for instructions executing at processor **1402** to operate on; the results of previous instructions executed at processor **1402** for access by subsequent instructions executing at processor **1402** or for writing to memory **1404** or storage **1406**; or other suitable data. The data caches may speed up read or write operations by processor **1402**. The TLBs may speed up virtual-address translation for processor **1402**. In particular embodiments, processor **1402** may include one or more internal registers for data, instructions, or addresses. This disclosure contemplates processor **1402** including any suitable number of any suitable internal registers, where appropriate. Where appropriate, processor **1402** may include one or more arithmetic logic units (ALUs); be a multi-core processor; or include one or more processors **1402**. Although this disclosure describes and illustrates a particular processor, this disclosure contemplates any suitable processor.

[0168] In particular embodiments, memory **1404** includes main memory for storing instructions for processor **1402** to execute or data for processor **1402** to operate on. As an example and not by way of limitation, computer system **1400** may load instructions from storage **1406** or another source (such as, for example, another computer system **1400**) to memory **1404**. Processor **1402** may then load the instructions from memory **1404** to an internal register or internal cache. To execute the instructions, processor **1402** may retrieve the instructions from the internal register or internal cache and decode them. During or after execution of the instructions, processor **1402** may write one or more results (which may be intermediate or final results) to the internal register or internal cache. Processor **1402** may then write one or more of those results to memory **1404**. In particular embodiments, processor **1402** executes only instructions in one or more internal registers or internal caches or in memory **1404** (as opposed to storage **1406** or elsewhere) and operates only on data in one or more internal registers or internal caches or in memory **1404** (as opposed to storage **1406** or elsewhere). One or more memory buses (which may each include an address bus and a data bus) may couple processor **1402** to memory **1404**. Bus **1412** may include one or more memory buses, as described below. In particular embodiments, one or more memory management units (MMUs) reside between processor **1402** and memory **1404** and facilitate accesses to memory **1404** requested by processor **1402**. In particular embodiments, memory **1404** includes random access memory (RAM). This RAM may be volatile memory, where appropriate. Where appropriate, this RAM may be dynamic RAM (DRAM) or static RAM (SRAM). Moreover, where appropriate, this RAM may be single-ported or multi-ported RAM. This disclosure contemplates any suitable RAM. Memory **1404** may include one or more memories **1404**, where appropriate. Although this disclosure describes and illustrates particular memory, this disclosure contemplates any suitable memory.

[0169] In particular embodiments, storage **1406** includes mass storage for data or instructions. As an example and not by way of limitation, storage **1406** may include a hard disk drive (HDD), a floppy disk drive, flash memory, an optical disc, a magneto-optical disc, magnetic tape, or a Universal Serial Bus (USB) drive or a combination of two or more of these. Storage **1406** may include removable or non-removable (or fixed) media, where appropriate. Storage **1406** may be internal or external to computer system **1400**, where appropriate. In particular embodiments, storage **1406** is non-volatile, solid-state memory. In particular embodiments, storage **1406** includes read-only memory (ROM). Where appropriate, this ROM may be mask-programmed ROM, programmable ROM (PROM), erasable PROM (EPROM), electrically erasable PROM (EEPROM), electrically alterable ROM (EAROM), or flash memory or a combination of two or more of these. This disclosure contemplates mass storage **1406** taking any suitable physical form. Storage **1406** may include one or more storage control units facilitating communication between processor **1402** and storage **1406**, where appropriate. Where appropriate, storage **1406** may include one or more storages **1406**. Although this disclosure describes and illustrates particular storage, this disclosure contemplates any suitable storage.

[0170] In particular embodiments, I/O interface **1408** includes hardware, software, or both, providing one or more interfaces for communication between computer system **1400** and one or more I/O devices. Computer system **1400** may include one or more of these I/O devices, where appropriate. One or more of these I/O devices may enable communication between a person and computer system **1400**. As an example and not by way of limitation, an I/O device may include a keyboard, keypad, microphone, monitor, mouse, printer, scanner, speaker, still camera, stylus, tablet, touch screen, trackball, video camera, another suitable I/O device or a combination of two or more of these. An I/O device may include one or more sensors. This disclosure contemplates any suitable I/O devices and any suitable I/O interfaces **1408** for them. Where appropriate, I/O interface **1408** may include one or more device or software drivers enabling processor **1402** to drive one or more of these I/O devices. I/O interface **1408** may include one or more I/O interfaces **1408**, where appropriate. Although this disclosure describes and illustrates a particular I/O interface, this disclosure contemplates any suitable I/O interface.

[0171] In particular embodiments, communication interface **1410** includes hardware, software, or both providing one or more interfaces for communication (such as, for

example, packet-based communication) between computer system **1400** and one or more other computer systems **1400** or one or more networks. As an example and not by way of limitation, communication interface **1410** may include a network interface controller (NIC) or network adapter for communicating with an Ethernet or other wire-based network or a wireless NIC (WNIC) or wireless adapter for communicating with a wireless network, such as a WI-FI network. This disclosure contemplates any suitable network and any suitable communication interface **1410** for it. As an example and not by way of limitation, computer system **1400** may communicate with an ad hoc network, a personal area network (PAN), a local area network (LAN), a wide area network (WAN), a metropolitan area network (MAN), or one or more portions of the Internet or a combination of two or more of these. One or more portions of one or more of these networks may be wired or wireless. As an example, computer system **1400** may communicate with a wireless PAN (WPAN) (such as, for example, a BLUETOOTH WPAN), a WI-FI network, a WI-MAX network, a cellular telephone network (such as, for example, a Global System for Mobile Communications (GSM) network), or other suitable wireless network or a combination of two or more of these. Computer system **1400** may include any suitable communication interface **1410** for any of these networks, where appropriate. Communication interface **1410** may include one or more communication interfaces **1410**, where appropriate. Although this disclosure describes and illustrates a particular communication interface, this disclosure contemplates any suitable communication interface.

[0172] In particular embodiments, bus **1412** includes hardware, software, or both coupling components of computer system **1400** to each other. As an example and not by way of limitation, bus **1412** may include an Accelerated Graphics Port (AGP) or other graphics bus, an Enhanced Industry Standard Architecture (EISA) bus, a front-side bus (FSB), a HYPERTRANSPORT (HT) interconnect, an Industry Standard Architecture (ISA) bus, an INFINIBAND interconnect, a low-pin-count (LPC) bus, a memory bus, a Micro Channel Architecture (MCA) bus, a Peripheral Component Interconnect (PCI) bus, a PCI-Express (PCIe) bus, a serial advanced technology attachment (SATA) bus, a Video Electronics Standards Association local (VLB) bus, or another suitable bus or a combination of two or more of these. Bus **1412** may include one or more buses **1412**, where appropriate. Although this disclosure describes and illustrates a particular bus, this disclosure contemplates any suitable bus or interconnect.

[0173] Herein, a computer-readable non-transitory storage medium or media may include one or more semiconductor-based or other integrated circuits (ICs) (such, as for example, field-programmable gate arrays (FPGAs) or application-specific ICs (ASICs)), hard disk drives (HDDs), hybrid hard drives (HHDs), optical discs, optical disc drives (ODDs), magneto-optical discs, magneto-optical drives, floppy diskettes, floppy disk drives (FDDs), magnetic tapes, solid-state drives (SSDs), RAM-drives, SECURE DIGITAL cards or drives, any other suitable computer-readable non-transitory storage media, or any suitable combination of two or more of these, where appropriate. A computer-readable non-transitory storage medium may be volatile, non-volatile, or a combination of volatile and non-volatile, where appropriate.

[0174] Herein, "or" is inclusive and not exclusive, unless expressly indicated otherwise or indicated otherwise by context. Therefore, herein, "A or B" means "A, B, or both," unless expressly indicated otherwise or indicated otherwise by context. Moreover, "and" is both joint and several, unless expressly indicated otherwise or indicated otherwise by context. Therefore, herein, "A and B" means "A and B, jointly or severally," unless expressly indicated otherwise or indicated otherwise by context.

[0175] The scope of this disclosure encompasses all changes, substitutions, variations, alterations, and modifications to the example embodiments described or illustrated herein that a person having ordinary skill in the art would comprehend. The scope of this disclosure is not limited to the example embodiments described or illustrated herein. Moreover, although this disclosure describes and illustrates respective embodiments herein as including particular components, elements, feature, functions, operations, or steps, any of these embodiments may include any combination or permutation of any of the components, elements, features, functions, operations, or steps described or illustrated anywhere herein that a person having ordinary skill in the art would comprehend. Furthermore, reference in the appended claims to an apparatus or system or a component of an apparatus or system being adapted to, arranged to, capable of, configured to, enabled to, operable to, or operative to perform a particular function encompasses that apparatus, system, component, whether or not it or that particular function is activated, turned on, or unlocked, as long as that apparatus, system, or component is so adapted, arranged, capable, configured, enabled, operable, or operative. Additionally, although this disclosure describes or illustrates particular embodiments as providing particular advantages, particular embodiments may provide none, some, or all of these advantages.

What is claimed is:

1. A method comprising, by one or more computing systems of an online social network:

receiving, at the one or more computing systems from an external event system, one or more external event listings corresponding to one or more events, respectively, wherein each external event listing comprises one or more items of event information associated with the respective event;

identifying, by the one or more computing systems, for each of the external event listings received from the external event system, one or more entities of the online social network associated with the external event listing;

determining, by the one or more computing systems, for each of the external event listings, whether the external event listing corresponds to an internal event listing on the online social network based on an analysis of the event information associated with the respective external event listing;

based on the determining, for each of the external event listings:

if the external event listing corresponds to an internal event listing, then updating the internal event listing to include one or more items of event information associated with the external event listing, wherein the internal event listing is associated with one or more entities of the online social network; else

if the external event listing does not correspond to an internal event listing, then creating a new internal event listing based on the one or more items of event information associated with the external event listing, wherein the new internal event listing is associated with the one or more identified entities associated with the external event listing; and

sending, by the one or more computing systems to one or more client systems, one or more notifications to the one or more identified entities associated with the internal event listings, wherein each notification indicates the associated internal event listing has been updated or created.

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

receiving, at the one or more computing systems from a client system, content posted to the online social network by a first user of the online social network, wherein the content references one of the internal event listings; and

sending, by the one or more computing systems to one or more client systems, one or more notifications based on the referenced internal event listing to one or more second users.

3. The method of claim **2**, wherein the one or more second users are listed as attendees of the event associated with the referenced internal event listing.

4. The method of claim **2**, wherein the one or more second users are friends of the first user on the online social network.

5. The method of claim **2**, wherein the one or more notifications to the one or more second users comprise recommendations for the event associated with the referenced internal event listing.

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

sending, by the one or more computing systems, a plurality of notifications to a plurality of client systems, wherein each notification references one of the internal event listings;

receiving, by the one or more computing systems from a plurality of client systems, a plurality of user-submitted corrections to the one of the event listings, wherein each user-submitted correction comprises an updated item of event information; and

updating, by the one or more computing systems, the one of the event listings to include a particular updated item of event information when at least a threshold number of corrections comprising the particular updated item of event information are received.

7. The method of claim **1**, wherein the one or more external event listings are received from an external event system via an application programming interface (API).

8. The method of claim **7**, wherein the API comprises a set of instructions defined at the online social network, the set of instructions being executable to enable the external event system to share the one or more external event listings on the online social network.

9. The method of claim **7**, wherein the API comprises a set of instructions defined at the external event system, the set of instructions being executable to enable the online social network to retrieve the one or more external event listings from the external event system.

10. The method of claim **9**, further comprising:

sending, by the one or more computing systems to the external event system, a request for the external event listings via the API, wherein the one or more external event listings are received from the external event system in response to sending the request.

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

crawling, by the one or more computing systems, one or more event pages of the external event system to identify the one or more external event listings, wherein the one or more external event listings are received from the external event system in response to crawling the one or more event pages.

12. The method of claim **1**, wherein identifying the one or more entities of the online social network associated with the external event listing comprises, for each of the external event listings:

parsing the one or more items of event information of the external event listing to identify one or more name strings; and

identifying the one or more entities of the online social network that correspond to the name strings.

13. The method of claim **1**, wherein for the updated internal event listing the one or more items of event information included in the internal event listing associated with the external event listing are not accessible by users of the online social network.

14. The method of claim **1**, wherein for the updated internal event listing the one or more items of event information included in the internal event listing associated with the external event listing are accessible by one or more search-engine systems.

15. The method of claim **1**, wherein one of the notifications is sent to an administrator of the internal event listing, and wherein the one of the notifications comprises a request for the administrator to approve the update to the internal event listing.

16. The method of claim **1**, wherein the notification indicates that the associated internal event listing has been created and that the entity can claim the associated event listing as administrator.

17. One or more computer-readable non-transitory storage media embodying software that is operable when executed to:

receive, from an external event system, one or more external event listings corresponding to one or more events, respectively, wherein each external event listing comprises one or more items of event information associated with the respective event;

identify, for each of the external event listings received from the external event system, one or more entities of the online social network associated with the external event listing;

determine, for each of the external event listings, whether the external event listing corresponds to an internal event listing on the online social network based on an analysis of the event information associated with the respective external event listing;

based on the determining, for each of the external event listings:

if the external event listing corresponds to an internal event listing, then update the internal event listing to include one or more items of event information associated with the external event listing, wherein the internal event listing is associated with one or more entities of the online social network; else

if the external event listing does not correspond to an internal event listing, then create a new internal event listing based on the one or more items of event information associated with the external event listing, wherein the new internal event listing is associated with the one or more identified entities associated with the external event listing; and

send, to one or more client systems, one or more notifications to the one or more identified entities associated with the internal event listings, wherein each notification indicates the associated internal event listing has been updated or created.

18. A system comprising: one or more processors; and a non-transitory memory coupled to the processors comprising instructions executable by the processors, the processors operable when executing the instructions to:

receive, from an external event system, one or more external event listings corresponding to one or more events, respectively, wherein each external event listing comprises one or more items of event information associated with the respective event;

identify, for each of the external event listings received from the external event system, one or more entities of the online social network associated with the external event listing;

determine, for each of the external event listings, whether the external event listing corresponds to an internal event listing on the online social network based on an analysis of the event information associated with the respective external event listing;

based on the determining, for each of the external event listings:

if the external event listing corresponds to an internal event listing, then update the internal event listing to include one or more items of event information associated with the external event listing, wherein the internal event listing is associated with one or more entities of the online social network; else

if the external event listing does not correspond to an internal event listing, then create a new internal event listing based on the one or more items of event information associated with the external event listing, wherein the new internal event listing is associated with the one or more identified entities associated with the external event listing; and

send, to one or more client systems, one or more notifications to the one or more identified entities associated with the internal event listings, wherein each notification indicates the associated internal event listing has been updated or created.

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