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DESCRIPTION

Field of the Invention

[0001] This invention relates to data clustering.

Background to the Invention

[0002] In a fraud investigation an analyst may have to make decisions regarding selection of electronic data entities within an electronic collection of data. Such a collection of data may include a large number of data items (also referred to as "data entities") that may or may not be related to one another, and which may be stored in an electronic data store or memory. For example, such a collection of data may include hundreds of thousands, millions, tens of millions, hundreds of millions, or even billions of data entities, and may consume significant storage and/or memory. Determination and selection of relevant data entities within such a collection of data may be extremely difficult for the analyst. Further, processing of such a large collection of data (for example, as an analyst uses a computer to sift and/or search through huge numbers of data entities) may be extremely inefficient and consume significant processing and/or memory resources.

[0003] Reference is directed to WO 2008/011728A1, US 6 567 936 B1 and Wiggerts T. A. - Baxter et al ("Using clustering algorithms in legacy systems remodularization" REVERSE ENGINEERING, 1997. PROCEEDINGS OF THE FOURTH WORKING CONFERENCE ON AMSTERDAM, NETHERLANDS 6-8 OCT. 1997, LOS ALAMITOS, CA, USA, IEEE COMPUT. SOC, US, 6 October 1997 (1997-10-06), pages 33-43).

Summary Of The Invention

[0004] The invention is set forth in appended claims 1, 6 and 7, with optional features being defined in the dependent claims appended thereto.

[0005] Embodiments of the present disclosure relate to automatic generation of memory-efficient clustered data structures and, more specifically, to automatic selection of an initial data entity of interest, adding of the initial data entity to the memory-efficient clustered data structure (which may be referred to herein as a "cluster"), and determining and adding one or more related data entities to the cluster. In various embodiments, a generated cluster may include far fewer data entities than the collection of data described above, and the data entities included in the cluster may only include those data entities that are relevant to a particular investigation (for example, a fraud investigation). Accordingly, in an embodiment, processing of the generated cluster may be highly efficient as compared to the collection of data described above. This may be because, for example, a given fraud investigation by an analyst (for example, as the analyst sifts and/or searches through data entities of a cluster) may only require storage in memory of a single cluster data structure. Further, a number of data entities in a cluster may be several orders of magnitude smaller than in the entire electronic collection of data described above because only data entities related to each other are included in the cluster.

[0006] According to various embodiments, the present disclosure describes methods and systems by which memory-efficient clustered data structures of related data entities (or "clusters") may be generated. Generation of clusters may begin by automatic generation, determination, and/or selection of an initial data entity of interest, called a "seed." A data entity may include any data, information or things, such as a person, a place, an organization, an account, a computer, an activity, and event, and/or the like. Seeds may be automatically selected/generated according to various seed determination strategies, and clusters of related data entities may be generated based on those seeds and according to cluster generation strategies (or cluster strategies). The system may further generate a score, multiple scores, and/or metascores for each generated cluster, and may optionally rank or prioritize the generated clusters based on the generated metascores. High priority clusters may be of greater interest to an analyst as they may contain related data entities that meet particular criteria related to the analyst's investigation. In an embodiment, the system may enable an analyst to advantageously start an investigation with a prioritized cluster including many related data entities rather than a single randomly selected data entity. Further, as described above, processing requirements of the analyst's investigation may thereafter be highly efficient as compared to processing of the huge collection of data described above. As mentioned above, this is because, for example, a given investigation by an analyst may only require storage in memory of a single cluster, and further, a number of data entities in a cluster may be several orders of magnitude smaller than in the entire electronic collection of data described above because only data entities related to each other are included in the cluster.

[0007] Advantageously, according to various embodiments, the disclosed techniques provide a more effective starting point for an investigation of data entities of various types. An analyst may be able to start an investigation from a cluster of related data entities instead of an individual data entity, which may reduce the amount of time and effort required to perform the investigation. The disclosed techniques may also, according to various embodiments, provide a prioritization of multiple clusters. For example, the analyst may also able to start the investigation from a high priority cluster, which may allow the analyst to focus on the most important investigations. In each case, the processing and memory requirements of such an investigation may be significantly reduced due to the creation and use of highly efficient cluster data structures of related data entities.

Brief Description Of The Drawings

[0008] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

Figure 1 is a block diagram illustrating an example data analysis system, according to one embodiment.

Figure 2 illustrates the generation of clusters by the data analysis system, according to one embodiment.

Figures 3A-3C illustrate the growth of a cluster of related data entities, according to one embodiment.

Figure 4 illustrates the ranking of clusters by the data analysis system, according to one embodiment of the present invention.

Figure 5 illustrates an example cluster analysis user interface (UI), according to one embodiment.

Figure 6 is a flow diagram of method steps for generating clusters, according to one embodiment.

Figure 7 is a flow diagram of method steps for scoring clusters, according to one embodiment.

Figure 8 illustrates components of a server computing system, according to one embodiment.

Detailed Description

[0009] According to various embodiments, the present disclosure describes methods and systems by which memory-efficient clustered data structures of related data entities (or "clusters") may be generated. Generation of clusters may begin by automatic generation, determination, and/or selection of an initial data entity of interest, called a "seed." As mentioned above, a data entity may include any data, information or things, such as a person, a place, an organization, an account, a computer, an activity, and event, and/or the like. Seeds may be automatically selected/generated according to various seed determination strategies, and clusters of related data entities may be generated based on those seeds and according to cluster generation strategies (or cluster strategies). Seeds and related data entities may be accessed from various databases and data sources including, for example, databases maintained by financial institutions, government entities, private entities, public entities, and/or publicly available data sources. Such databases and data sources may include a variety of information and data, such as, for example, personal information, financial information, tax-related information, computer network-related data, and/or computer-related activity data, among others. Further, the databases and data sources may include various relationships that link and/or associate data entities with one another. Various data entities and relationships may be stored across different systems controlled by different entities and/or institutions. According to various embodiments, the data analysis system may bring together data from multiple data sources in order to build clusters.

[0010] In various embodiments, the methods and systems of the present disclosure may enable a user to efficiently perform analysis and investigations of various data entities and clusters of data entities. For example, the system may enable a user (also referred to herein as an "analyst") to perform various financial and security investigations related to a seed (for example, an initial data entity or data object). As described above, the processing and memory requirements of such an investigation may be significantly reduced due to the creation and use of highly efficient cluster data structures of related data entities.To perform financial and security investigations related to the seed, an analyst may have to search several layers of related data entities. For example, the analyst could investigate data entities related to a seed credit card account, by discovering the customer identifiers associated with the credit card account, the phone numbers associated with those customer identifiers, the additional customer identifiers associated with those phone numbers, and finally the additional credit card accounts associated with those additional customer identifiers. If the seed credit card account were fraudulent, then the analyst could determine that the additional credit card accounts could also be fraudulent. In such an investigation, the analyst would discover the relationship between the additional credit card accounts and the seed credit card accounts through several layers of related data entities. This technique is particularly valuable for investigations where the relationship between data entities could include several layers and would be difficult to identify.

[0011] In one embodiment, the data analysis system automatically discovers data entities related to a seed and stores the resulting relationships and related data entities together in a "cluster." A cluster generation strategy specifies what searches to perform at each step of the investigation process. The searches produce layers of related data entities to add to the cluster. Thus, the analyst starts an investigation with the resulting cluster, instead of the seed alone. Starting with the cluster, the analyst may form opinions regarding the related data entities, conduct further analysis of the related data entities, or may query for additional related data entities. Further, for numerous such seeds and associated investigations, the data analysis system may prioritize the clusters based upon an aggregation of characteristics of the related data entities within the clusters. The data analysis system then displays summaries of the clusters. The summaries may be displayed according to the prioritization. The prioritization may assist the analyst in selecting what clusters to investigate.

[0012] In the following description, numerous specific details are set forth to provide a more thorough understanding of the present invention. However, it will be apparent to one of skill in the art that the present invention may be practiced without one or more of these specific details.

[0013] Figure 1 is a block diagram illustrating an example data analysis system 100, according to one embodiment of the present invention. As shown, the data analysis system 100 includes an application server 115 running on a server computing system 110, a client 135 running on a client computer system 130, and at least one database 140. Further, the client 135, application server 115, and database 140 may communicate over a network 150, e.g., to access cluster data sources 160.

[0014] The application server 115 includes a cluster engine 120 and a workflow engine 125. The cluster engine 120 is configured to build one or more clusters of related data entities, according to a defined analysis strategy. The cluster engine 120 may read data from a variety cluster data sources 160 to generate clusters from seed data. Once created, the resulting clusters may be stored on the server computer 110 or on the database 140. The operations of the cluster engine 120 are discussed in detail below in conjunction with Figures 2 and 3.

[0015] The cluster engine 120 is configured to score the clusters, according to a defined scoring strategy. The score may indicate the importance of analyzing the cluster. For instance, the cluster engine 120 could execute a scoring strategy that aggregates the account balances of credit card accounts within the cluster. If the cluster included a larger total balance than other clusters, then the cluster could be a greater liability for the financial institution. Thus, the cluster would be more important to analyze and would receive a higher score. In one embodiment, the cluster engine 120 organizes and presents the clusters according to the assigned scores. The cluster engine 120 may present summaries of the clusters and/or interactive representations of the clusters within the cluster analysis UI. For example, the representations may provide visual graphs of the related data entities within the clusters. The cluster engine 120 may generate the cluster analysis UI as a web application or a dynamic web page displayed within the client 135. The cluster engine 120 also allows an analyst to create tasks associated with the clusters. The operations of the cluster engine 120 are discussed in detail below in conjunction with Figures 4 and 5. In one embodiment, the cluster engine 120 generates clusters automatically, for subsequent review by analysts. Analysts may also assign tasks to themselves via a workflow UI. The workflow engine 125 consumes scores generated by the cluster engine 120. For example, the workflow engine 125 may present an analyst with clusters generated, scored, and ordered by the cluster engine 120.

[0016] The client 135 represents one or more software applications configured to present data and translate input, from the analyst, into requests for data analyses by the application server 115. In one embodiment, the client 135 and the application server 115 are coupled together. However, several clients 135 may execute on the client computer 130 or several clients 135 on several client computers 130 may interact with the application server 115. In one embodiment, the client 135 may be a browser accessing a web service.

[0017] While the client 135 and application server 115 are shown running on distinct computing systems, the client 135 and application server 115 may run on the same computing system. Further, the cluster engine 120 and the workflow engine 125 may run on separate applications servers 115, on separate server computing systems, or some combination thereof. Additionally, a history service may store the results generated by an analyst relative to a given cluster

[0018] In one embodiment, the cluster data sources 160 provide data available to the cluster engine to create clusters from a set of seeds. Such data sources may include relational data sources, web services data, XML data, etc. For example, the data sources may be related to customer account records stored by a financial institution. In such a case, the data sources may include a credit card account data, bank account data, customer data, and transaction data. The data may include data attributes such as account numbers, account balances, phone numbers, addresses, and transaction amounts, etc. Of course, cluster data sources 160 is included to be representative of a variety of data available to the server computer system 110 over network 150, as well as locally available data sources.

[0019] The database 140 may be a Relational Database Management System (RDBMS) that stores the data as rows in relational tables. While the database 140 is shown as a distinct computing system, the database 140 may operate on the same server computing system 110 as the application server 115.

[0020] Figure 2 illustrates the generation of clusters by data analysis system 200, according to one embodiment. As shown, the data analysis system 200 interacts with a seed list 210, a cluster list 250, and a cluster strategy store 230. The seed list 210 includes seeds 212-1, 212-2 ... 212-S and the cluster list 250 includes clusters 252-1, 252-2... 252-C. The cluster engine 120 is configured as a software application or thread that generates the clusters 252-1, 252-2... 252-C from the seeds 212-1, 212-2 ... 212-S.

[0021] Seeds 212 are the starting point for generating a cluster 252. To generate a cluster, the cluster engine 120 retrieves a given seed 212 from the seed list 210. The seed 212 may be an arbitrary data entity within the database 140, such as a customer name, a customer social security number, an account number, or a customer telephone number.

[0022] The cluster engine 120 generates the cluster 252 from the seed 212. In one embodiment, the cluster engine 120 generates the cluster 252 as a collection of data entities and the relationships between the various data entities. As noted above, the cluster strategy executes data bindings in order to add each additional layer of objects to the cluster. For example, the cluster engine 120 could generate the cluster 252 from a seed credit card account. The cluster engine 120 first adds the credit card account to the cluster 252. The cluster engine 120 could then add customers related to the credit card account to the cluster 252. The cluster engine 120 could complete the cluster 252 by adding additional credit card accounts related to those customers. As the cluster engine 120 generates the cluster 252, the cluster engine 120 stores the cluster 252 within the cluster list 250. The cluster 252 may be stored as a graph data structure. The cluster list 250 may be a collection of tables in the database 140. In such a case, there may be a table for the data entities of the cluster 252, a table for the relationships between the various data entities, a table for the attributes of the data entities, and a table for a score of the cluster 252. The cluster list 250 may include clusters 252 from multiple investigations. Note that the cluster engine 120 may store portions of the cluster 252 in the cluster list 250 as the cluster engine 120 generates the cluster 252.

[0023] Persons skilled in the art will recognize that many technically feasible techniques exist for creating and storing graph data structures.

[0024] The cluster strategy store 230 includes cluster strategies 232-1, 232-2... 232-N. Each cluster strategy may include references 235 to one or more data bindings 237. As noted, each data binding may be used to identify data that may grow a cluster (as determined by the given search strategy 232). The cluster engine 120 executes a cluster strategy 232 to generate the cluster 252. Specifically, the cluster engine 120 executes the cluster strategy 232 selected by an analyst. The analyst may submit a selection of the cluster strategy 232 to the cluster engine 120 through the client 135.

[0025] Each cluster strategy 232 is configured as to perform an investigation processes for generating the cluster 252. Again, e.g., the cluster strategy 232 may include references 235 to a collection of data bindings executed to add layer after layer of data to a cluster. The investigation process includes searches to retrieve data entities related to the seed 212. For example, the cluster strategy 232 could start with a possibly fraudulent credit card account as the seed 212. The cluster strategy 232 would search for customers related to the credit card account, and then additional credit card accounts related to those customers. A different cluster strategy 232 could search for customers related to the credit card account, phone numbers related to the customers, additional customers related to the phone numbers, and additional credit card accounts related to the additional customers.

[0026] In one embodiment, the cluster strategy 232 includes a reference to at least one data binding 237. The cluster engine 120 executes the search protocol of specified by the data binding 237 to retrieve data, and the data returned by a given data binding forms a layer within the cluster 252. For instance, the data binding 237 could retrieve sets of customers related to an account by an account owner attribute. The data binding 237 retrieves the set of related data entities from a data source. For instance, the data binding 237-1 could define specify a database query to perform against a database. Likewise, the data binding 237-2 could define a connection to a remote relational database system and the data binding 237-3 could define a connection and query against a third-party web service. Once retrieved, the cluster strategy 232 may evaluate whether the returned data should be added to a cluster being grown from a given seed 212. Multiple cluster strategies 232 may reference a given data binding 237. The analyst can update the data binding 237, but typically updates the data binding 237 only if the associated data source changes. A cluster strategy 232 may also include a given data binding 237 multiple times. For example, executing a data binding 237 using one seed 212 may generate additional seeds for that data binding 237 (or generate seeds for another data binding 237). More generally, different cluster strategies 232-1, 232-2 ... 232-N may include different arrangements of various data bindings 237 to generate different types of clusters 252.

[0027] The cluster strategy 232 may specify that the cluster engine 120 use an attribute from the related data entities retrieved with one data binding 237, as input to a subsequent data binding 237. The cluster engine 120 uses the subsequent data binding 237 to retrieve a subsequent layer of related date entities for the cluster 252. For instance, the cluster strategy 232 could specify that the cluster engine 120 retrieve a set of credit card account data entities with a first data binding 237-1. The cluster strategy 232 could also specify that the cluster engine 120 then use the account number attribute from credit card account data entities as input to a subsequent data binding 237-2. The cluster strategy 232 may also specify filters for the cluster engine 120 to apply to the attributes before performing the subsequent data binding 237. For instance, if the first data binding 237-1 were to retrieve a set of credit card account data entities that included both personal and business credit card accounts, then the cluster engine 120 could filter out the business credit card accounts before performing the subsequent data binding 237-2.

[0028] In operation, the cluster engine 120 generates a cluster 252-1 from a seed 212-1 by first retrieving a cluster strategy 232. Assuming that the analyst selected a cluster strategy 232-2, then the cluster engine 120 would retrieve the cluster strategy 232-2 from the cluster strategy store 230. The cluster engine 120 could then retrieve the seed 212-1 as input to the cluster strategy 232-2. The cluster engine 120 would execute the cluster strategy 232-2 by retrieving sets of data by executing data bindings 237 referenced by the cluster strategy 232-2. For example, the cluster strategy could execute data bindings 237-1, 237-2, and 237-3. The cluster engine 120 evaluates data returned by each data binding 237 to determine whether to use that data to grow the cluster 252-1. The cluster engine 120 may then use elements of the returned data as input to the next data binding 237. Of course, a variety of execution paths are possible for the data bindings 237. For example, assume one data binding 237 returned a set of phone numbers. In such a case, another data binding 237 could evaluate each phone number individually. As another example, one data binding 237 might use input parameters obtained by executing multiple, other data bindings 237. More generally, the cluster engine 120 may retrieves data for each data binding referenced by the cluster strategy 232-2. The cluster engine 120 then stores the complete cluster 252-1 in the cluster list 250.

[0029] As the cluster engine 120 generates the clusters 252-1, 252-2... 252-C from seeds 212-1, 212-2... 212-S, the cluster list 250 may include overlapping clusters 252. Two clusters 252-1 and 252-C overlap if both clusters 252-1 and 252-C include a common data entity. Oftentimes, a larger cluster 252 formed by merging two smaller clusters 252-1 and 252-C may be a better investigation starting point than the smaller clusters 252-1 and 252-C individually. The larger cluster 252 may provide additional insight or relationships, which may not be available if the two clusters 252-1 and 252-C remain separate.

[0030] In one embodiment, the cluster engine 120 includes a resolver 226 that is configured to detect and merge two overlapping clusters 252 together. The resolver 226 compares the data entities within a cluster 252-1 to the data entities within each one of the other clusters 252-2 through 252-C. If the resolver 226 finds the same data entity within the cluster 252-1 and a second cluster 252-C, then the resolver 226 may merge the two clusters 252-1 and 252-C into a single larger cluster 252. For example, the cluster 252-1 and cluster 252-C could both include the same customer. The resolver 226 would compare the data entities of cluster 252-1 to the data entities of cluster 252-C and detect the same customer in both clusters 252. Upon detecting the same customer in both clusters 252, the resolver 226 could merge the cluster 252-1 with cluster 252-C. The resolver 226 may test each pair of clusters 252 to identify overlapping clusters 252. Although the larger clusters 252 may be better investigation starting points, an analyst may want to understand how the resolver 226 formed the larger clusters 252. The resolver 226, stores a history of each merge.

[0031] After the cluster engine generates a group of clusters from a given collection of seeds (and after merging or resolving the cluster), the cluster engine 120 may score, rank, or otherwise order the clusters relative to a scoring strategy 442.

[0032] In one embodiment, the analysis system 100, and more specifically, the cluster engine 120 receives a list of seeds to generate a group of clusters, subsequently ranked, ordered, and presented to analysts. That is, the cluster engine 120 consumes seeds generated by other systems. Alternatively, in other embodiments, cluster engine 120 may generate the seeds 212-1, 212-2... 212-S. For instance, the cluster engine 120 may include a lead generation strategy that identifies data entities as potential seeds 212. The lead generation strategy may apply to a particular business type, such as credit cards, stock trading, or insurance claims and may be run against a cluster data source 160 or an external source of information.

[0033] Figures 3A - 3C illustrate the growth of a cluster 252 of related data entities, according to one embodiment. As shown in Figure 3A, a cluster 252 includes a seed data entity 302, links 303-1 and 303-2, and related data entities 305-1 and 305-2. The cluster 252 is based upon a seed 212. The cluster engine 120 builds the cluster 252 by executing a cluster strategy 232 with the following searches:

- Find seed owner
- Find all phone numbers related to the seed owner
- Find all customers related to the phone numbers
- Find all accounts related to the customers
- Find all new customers related to the new accounts

[0034] Assuming that the seed 212 were a fraudulent credit card account, then the cluster engine 120 would add the credit card account to the cluster 252 as the seed data entity 302. The cluster engine 120 would then use the account owner attribute of the credit card account as input to a data binding 237. The cluster engine 120 would execute the search protocol of data binding 237 to retrieve the customer data identifying the owner of the fraudulent credit card account. The cluster engine 120 would then add the customer data to the cluster 252 as the related data entity 305-1. The cluster engine 120 would also add the account owner attribute as the link 303-1 that relates the account number to the customer data of the owner. The cluster engine 120 would execute the next search of the cluster strategy 232 by inputting the customer identifier attribute of the customer data into a data binding 237 to retrieve a phone data. The cluster engine 120 would then add the phone data as the related data entity

305-2 and the customer identifier attribute as the link 303-2 between the customer data and the phone data. At this point in the investigation process, the cluster 252 would include the seed data entity 302, two links 303-1 and 303-2, and two related data entities 305-1 and 305-2. That is, the cluster 252 includes the fraudulent credit card account, the customer data of the owner of the credit card, and the phone number of the owner. By carrying the investigation process further, the cluster engine 120 could reveal further related information - e.g., additional customers or potentially fraudulent credit card accounts.

[0035] Turning to Figure 3B, the cluster engine 120 would continue executing the cluster strategy 232 by searching for additional account data entities related to the phone number of the owner of the fraudulent credit card account. As discussed, the phone number would be stored as related data entity 305-2. The cluster engine 120 would input the phone owner attribute of the phone number to a data binding 237. The cluster engine 120 would execute the search protocol of data binding 237 to retrieve the data of two additional customers, which the cluster engine 120 would store as related data entities 305-3 and 305-4. The cluster engine 120 would add the phone owner attribute as the links 303-3 and 304-4 between the additional customers and the phone number.

[0036] Figure 3C shows the cluster 252 after the cluster engine 120 performs the last step of the cluster strategy 232. For example, the cluster engine 120 would use the customer identifier attribute of the related data entity 305-3 and 305-4 to retrieve and add additional account data entities as the related data entities 305-5 and 305-6. The cluster engine 120 would couple the related data entities 305-5 and 305-6 to the related data entities 305-3 and 305-4 with the customer identifier attributes stored as links 303-5 and 303-6. Thus, the cluster 252 would include six related data entities 305 related by six links 303, in addition to the seed data entity 302. The analyst could identify and determine whether the additional data account entities, stored as related data entities 305-3 and 305-4, represent fraudulent credit card accounts more efficiently, than if the analyst started an investigation with only the seed 212. As the foregoing illustrates, with the cluster engine 120 and cluster strategy 232, the analyst is advantageously able to start an investigation from a cluster 252 that already includes several related data entities 305.

[0037] Figure 4 illustrates the ranking of clusters 252 by the data analysis system 100 shown in Figure 1, according to one embodiment of the present invention. As shown, Figure 4 illustrates some of the same elements as shown in Figure 1 and Figure 2. In addition, Figure 4 illustrates a scoring strategy store 440, coupled to the workflow engine 125.

[0038] The cluster engine 120 coupled to the cluster list 250. The scoring strategy store 440 includes scoring strategies 442-1, 442-2... 442-R.

[0039] The cluster engine 120 executes a scoring strategy 442 to score a cluster 252. For example, the cluster engine 120 may generate a cluster, via a cluster strategy/data bindings, and attempt to resolve it with existing clusters. Thereafter, the cluster engine 120 may score the resulting cluster with any scoring strategies associated with a given cluster generation strategy. In one embodiment, the score for a cluster may be a meta score generated as an aggregation of scores generated for different aspects, metrics, or data of a cluster. Ordering for a group of clusters, (according to a given scoring strategy) may be performed done on demand when requested by a client. Alternatively, the analyst may select of a scoring strategy 442 to the cluster engine 120 through the clienti35 or the analyst may include the selection within a script or configuration file. In other embodiments, the cluster engine 120 may execute several scoring strategies 442 to determine a combined score for the cluster 252.

[0040] The scoring strategy 442 specifying an approach for scoring a cluster 252. The score may indicate the relative importance or significance of a given cluster 252. For instance, the cluster engine 120 could execute a scoring strategy 442-1 to determine a score by counting the number of a particular data entity type within the cluster 252. Assume, e.g., a data entity corresponds to a credit account. In such a case, a cluster with a large number of accounts opened by a single individual (possibly within a short time) might correlate with a higher fraud risk. Of course, a cluster score may be related to a high risk of fraud based on the other data in the cluster, as approaite for a given case. More generally, each scoring strategy 442 may be tailored based on the data in clusters created by a given cluster strategy 230 and the particular type of risk or fraud (or amounts at risk).

[0041] In operation, the cluster engine 120 scores a cluster 252-1 by first retrieving a scoring strategy 442. For example, assume a analyst selects scoring strategy 442-1. In response, the cluster engine 120 retrieves the scoring strategy 442-1. The cluster engine 120 also retrieves the cluster 252-1 from the cluster list 250. After determining the score of the cluster 252-1, the cluster engine 120 may store the score with the cluster 252-1 in the cluster list 250.

[0042] The cluster engine 120 may score multiple clusters 252-1, 252-2... 252-C in the cluster list 250. The cluster engine 120 may also rank the clusters 252-1, 252-2... 252-C based upon the scores. For instance, the cluster engine 120 could rank the cluster 252-1, 252-2... 252-C from highest score to lowest score.

[0043] Figure 5 illustrates an example cluster analysis UI 500, according to one embodiment. As discussed, the workflow engine 125 is configured to present the cluster analysis UI 500. As shown, the cluster analysis UI 500 includes a lead box 510, a cluster strategy box 530, a cluster summary list 525, a cluster search box 520, and a cluster review window 515. The workflow engine 125 may generate the cluster analysis UI 500 as a web application or a dynamic web page displayed within the client 135.

[0044] The lead box 510 allows the analyst to select a seed list 210 or a suitable lead generation strategy. The lead generation strategy generates a seed list 210. The lead generation strategy may generate a seed list 210 from the database 140 or an external source of information (e.g., a cluster data source 160).

[0045] The cluster strategy box 530 displays the cluster strategies 232 that the cluster engine 120 ran against the seed list 210. The cluster engine 120 may execute multiple cluster strategies 232 against the seed list 210, so there may be multiple cluster strategies 232 listed in the cluster strategy box 530. The analyst may click on the name of a given cluster strategy 232 in the cluster strategy box 530 to review the clusters 252 that the cluster strategy 232 generated.

[0046] The workflow engine 125 displays summaries of the clusters 252 in the cluster summary list 525. For example, the summaries ,may include characteristics of the clusters 252, such as identifiers, the scores, or analysts assigned to analyze the clusters 252. The workflow engine 125 can select the clusters 252 for the display in the cluster summary list 525 according to those or other characteristics. For instance, the workflow engine 125 could display the summaries in the order of the scores of the clusters 252, where a summary of the highest scoring cluster 252 is displayed first.

[0047] The workflow engine 125 controls the order and selection of the summaries within the cluster summary list 525 based upon the input from the analyst. The cluster search box 520 includes a search text box coupled to a search button and a pull-down control. The analyst may enter a characteristic of a cluster 252 in the search text box and then instruct the workflow engine 125 to search for and display clusters 252 that include the characteristic by pressing the search button. For example, the analyst could search for clusters with a particular score. The pull-down control includes a list of different characteristics of the clusters 252, such as score, size, assigned analyst, or date created. The analyst may select one of the characteristics to instruct the workflow engine 125 to present the summaries of the clusters 252 arranged by that characteristic.

[0048] The workflow engine 125 is also configured to present details of a given cluster 252 within the cluster review window 515. The workflow engine 125 displays the details of the cluster 252, e.g., the score, or average account balances within a cluster, when the analyst clicks a mouse pointer on the associated summary within the cluster summary list 525. The workflow engine 125 may present details of the cluster 252, such as the name of the analyst assigned to analyze the cluster 252, the score of the cluster 252, and statistics or graphs generated from the cluster 252. These details allow the analyst to determine whether to investigate the cluster 252 further. The cluster review window 515 also includes a button which may be clicked to investigate a cluster 252 within a graph and an assign button for assigning a cluster to an analyst.

[0049] The analyst can click a mouse pointer on the button to investigate the cluster 252 within an interactive graph. The interactive representation is a visual graph of the cluster 252, where icons represent the entities of the cluster 252 and lines between the icons represent the links between entities of the cluster 252. For example, the workflow engine 125 could display the interactive graph of the cluster 252 similar to the representation of the cluster 252 in Figure 3C. The interactive representation allows the analyst to review the attributes of the related data entities or perform queries for additional related data entities.

[0050] An administrative user can click a mouse pointer on the assign button to assign the associated cluster 252 to an analyst. The workflow engine 125 also allows the administrative user to create tasks associated with the clusters 252, while the administrative user assigns the cluster 252. For example, the administrative user could create a task for searching within the three highest scoring clusters 252 for fraudulent credit card accounts. The workflow engine 125 may display the summaries in the cluster summary list 525 according to the names of the analysts assigned to the clusters 252. Likewise, the workflow engine 125 may only display summaries for the subset of the clusters 252 assigned to an analyst.

[0051] The interface shown in Figure 5 is included to illustrate one exemplary interface useful for navigating and reviewing clusters generated using the cluster engine 120 and the workflow engine 125. Of course, one of skill in the art will recognize that a broad variety of user interface constructs could be used to allow the analyst to select cluster strategies 232, scoring strategies 242, or seed generation strategies, initiate an investigation, or review and analyze the clusters 252. For example, the workflow engine 125 may display additional controls within the cluster analysis UI 500 for controlling the cluster generation process and selecting cluster strategies 232 or scoring strategies 242. Also, the workflow engine 125 may not display the lead box 510 or the options to select a lead generation strategy. In addition, although the workflow engine 125 generates the cluster analysis UI 500, in different embodiments, the cluster analysis UI 500 is generated by a software application distinct from the workflow engine 125. Further, in different embodiments, the cluster review window 515 is configured to display a preview of the cluster 252 or additional statistics generated from the cluster 252. As such, an interactive representation of the cluster 252 may be presented in an additional UI or the cluster 252 may be exported to another software application for review by the analyst.

[0052] Figure 6 is a flow diagram of method steps for generating clusters, according to one embodiment. Although the method steps are described in conjunction with the systems of Figures 1 and 2, persons skilled in the art will understand that any system configured to perform the method steps, in any order, is within the scope of the present invention. Further, the method 600 may be performed in conjunction with method 700 for scoring a cluster, described below.

[0053] As shown, method 600 begins at step 605, where the cluster engine 120 retrieves a cluster strategy 232 and a seed 212. Once a cluster strategy is selected The cluster engine 120 identifies a list of seeds to build clusters using the selected cluster strategy. At step 610, the cluster engine 120 initializes a cluster 252 with one of the seeds in the list. The cluster 252 is stored as a graph data structure. The cluster engine 120 initializes the graph data structure, and then adds the seed 212-1 to the graph data structure as the first data entity.

[0054] At step 615, the cluster engine 120 grows the cluster 252 by executing the search protocol of a data binding 237 from the cluster strategy 232-2. The cluster strategy 232-2 includes a series of data bindings 237 that the cluster engine 120 executes to retrieve related data entities. A given data binding 237 may include queries to execute against a cluster data source 160 using the seed as an input parameters. For example, if the seed 212-1 were an account number, then the data binding 237 might retrieve the data identifying the owner of the account with the account number. After retrieving this information, the cluster engine 120 would add the customer data entity to the cluster as a related data entity and the account owner attribute as the link between the seed 212-1 and the related data entity. After retrieving the related data entities, the cluster engine 120 adds them to the cluster 252.

[0055] At step 620, the cluster engine 120 determines if the cluster strategy 232-2 is fully executed. If so the method 600 returns to step 615 to execute additional data bindings for a given seed. Once the cluster strategy is executed for that seed, the cluster engine 120 may determine and assign a score to that cluster (relative to a specified scoring strategy). After generating clusters for a group of seeds, such clusters may be ordered or ranked based on the relative scores. Doing so allows an analyst to rapidly identify and evaluate clusters determined to represent a high risk of fraud (or having high amounts at risk).

[0056] At step 625, the cluster engine 120 stores the cluster 252 in cluster list 250. The cluster list 250 is a collection of tables within a relational database, where a table may include the seed and related data entities of the cluster 252 and another table may include links between the related data entities of the cluster 252. At step 630, the cluster engine 120 determines if there are more seeds 212 to analyze in the seed list 210. If so, the method 600 returns to step 605 to generate another cluster from the next seed. Otherwise, the method 600 ends. Note, while method 600 describes a single cluster being generated, one of skill in the art will recognize that the cluster generation process illustrated by method 600 may be performed in parallel.

[0057] Figure 7 is a flow diagram of method steps for scoring clusters, according to one embodiment. Although the method steps are described in conjunction with the systems of Figures 1 and 4, persons skilled in the art will understand that any system configured to perform the method steps, in any order, is within the scope of the present invention.

[0058] As shown, method 700 begins at step 705, where the cluster engine 120 retrieves a scoring strategy 442 and a cluster 252 (e.g., a cluster just created using the method 600 of Figure 6). In other cases, he cluster engine 120 may retrieve the scoring strategy 442 associated with a stored cluster. Other alternatives include an analyst selecting a scoring strategy 442 through the client 135, the cluster engine 120 via the cluster analysis UI 500, a script, or a configuration file. The cluster engine 120 retrieves the selected scoring strategy 442 from the scoring strategy store 440. The cluster engine 120 retrieves the cluster 252 from the cluster list 250.

[0059] At step 710, the cluster engine 120 executes the scoring strategy 442 against the cluster 252. The scoring strategy 442 specifies characteristics of the related data entities within the cluster 252 to aggregate. The cluster engine 120 executes the scoring strategy 442 by aggregated the specified characteristics together to determine a score. For instance, the cluster engine 120 could aggregate the account balances of related data entities that are account data entities. In such a case, the total amount of dollars included within the balances of the account data entities of the cluster 252 could be the score of the cluster 252.

[0060] At step 715, the cluster engine 120 stores the score with the cluster 252 in the cluster list 250. At step 720, the cluster engine 120 determines if there are more clusters 252 to score. For example, in one embodiment, a set of clusters may be re-scored using an updated scoring strategy. In other cases, the cluster engine may score each cluster when it is created from a seed (based on a given cluster generation and corresponding scoring strategy). If more clusters remain to be scored (or re-scored), the method 700 returns to step 705.

[0061] At step 725, the cluster engine 125 ranks the clusters 252 according to the scores of the clusters 252. For example, after re-scoring a set of clusters (or after scoring a group of clusters generated from a set of seeds), the cluster engine 125 may rank the clusters 252 from highest score to lowest score. The ranking may be used to order a display of summaries of the clusters 252 presented to the analyst. The analyst may rely upon the ranking and scores to determine which clusters 252 to analyze first. The ranking and sorting may generally be performed on-demand when an analyst is looking for a cluster to investigate. Thus, the ranking need not happen at the same time as scoring. And further, the clusters may be scored (and later ranked) using different raking strategies.

[0062] Figure 8 illustrates components of a server computing system 110, according to one embodiment. As shown, the server computing system 110 includes, a central processing unit (CPU) 860, a network interface 850, a memory 820, and a storage 830, each connected to an interconnect (bus) 840. The server computing system 110 may also include an I/O device interface 870 connecting I/O devices 875 (e.g., keyboard, display and mouse devices) to the computing system 110. Further, in context of this disclosure, the computing elements shown in server computing system 110 may correspond to a physical computing system (e.g., a system in a data center) or may be a virtual computing instance executing within a computing cloud.

[0063] The CPU 860 retrieves and executes programming instructions stored in memory 820 as well as stores and retrieves application data residing in memory 820. The bus 840 is used to transmit programming instructions and application data between the CPU 860, I/O device interface 870, storage 830, network interface 850, and memory 820. Note that the CPU 860 is included to be representative of a single CPU, multiple CPUs, a single CPU having multiple processing cores, a CPU with an associate memory management unit, and the like. The memory 820 is generally included to be representative of a random access memory. The storage 830 may be a disk drive storage device. Although shown as a single unit, the storage 830 may be a combination of fixed and/or removable storage devices, such as fixed disc drives, removable memory cards, or optical storage, network attached storage (NAS), or a storage area-network (SAN).

[0064] Illustratively, the memory 820 includes a seed list 210, a cluster engine 120, a cluster list 250, and a workflow engine 125. The cluster engine 120 includes a cluster strategy 232-2. The particular cluster strategy 232-2 includes data bindings 237-1, 237-2, and 237-3, with which the cluster engine 120 accesses the cluster data source 160. The workflow engine 125 includes a scoring strategy 442-1.

[0065] Illustratively, the storage 830 includes a cluster strategy store 230, data bindings store 835, and a scoring strategy store 440. As discussed the cluster strategy store 230 may include a collection of different cluster strategies 232, such as cluster strategy 232-2. The cluster strategy store 230 may be a directory that includes the cluster strategies 232-1, 232-2... 232-N as distinct modules. The scoring strategy store 440 may include a collection of different scoring strategies 442, such as scoring strategy 442-2 and may also be a directory of distinct modules. The data binding store 835 includes data bindings 237-1, 237-2 ... 237-M, which may also be stored as distinct modules within a directory.

[0066] Although shown in memory 820, the seed list 210, cluster engine 120, cluster list 250, and workflow engine 125, may be stored in memory 820, storage 830, or split between memory 820 and storage 830. Likewise, copies of the cluster strategy 232-2, data binding 237-1, 237-2, and 237-3, and scoring strategy 442-2 may be stored in memory 820, storage 830, or split between memory 820 and storage 830.

[0067] Note, while financial fraud using credit card accounts is used as a primary reference example in the discussion above, one of ordinary skill in the art will recognize that the techniques described herein may be adapted for use with a variety of data sets. For example, information from data logs of online systems could be evaluated as seeds to improve cyber security. In such a case, a seed could be a suspicious IP address, a compromised user account, etc. From the seeds, log data, DHCP logs, IP blacklists packet captures, webapp logs, and other server and database logs could be used to create clusters of activity related to the suspicions seeds. Other examples include data quality analysis used to cluster transactions processed through a computer system (whether financial or otherwise).

[0068] Embodiments of the present disclosure have been described that relate to automatic generation of memory-efficient clustered data structures and, more specifically, to automatic selection of an initial data entity of interest, adding of the initial data entity to the memory-efficient clustered data structure, and determining and adding one or more related data entities to the cluster. As described above, in various embodiments, a generated cluster may include far fewer data entities as compared to a huge collection of data items that may or may not be related to one another. This may be because, for example, data entities included in a cluster may only include those data entities that are related to one another and which may be relevant to a particular investigation. Accordingly, in various embodiments, processing of generated clusters may be highly efficient because, for example, a given fraud investigation by an analyst may only require storage in memory of a single cluster data structure. Further, a number of data entities in a cluster may be several orders of magnitude smaller than in the huge collection of data items that may or may not be related to one another because only data entities related to each other are included in the cluster.

[0069] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof. For example, aspects of the present invention may be implemented in hardware or software or in a combination of hardware and software. One embodiment of the invention may be implemented as a program product for use with a computer system. The program(s) of the program product define functions of the embodiments (including the methods described herein) and can be contained on a variety of computer-readable storage media. Illustrative computer-readable storage media include, but are not limited to: (i) non-writable storage media (e.g., read-only memory devices within a computer such as CD-ROM disks readable by a CD-ROM drive, flash memory, ROM chips or any type of solid-state non-volatile semiconductor memory) on which information is permanently stored; and (ii) writable storage media (e.g., hard-disk drive or any type of solid-state random-access semiconductor memory) on which alterable information is stored.

[0070] It is particularly advantageous if the seed is automatically selected, although in other embodiments the seed may be selected by an analyst or other user and the seed then used in the same way,

[0071] The invention has been described above with reference to specific embodiments. Persons of ordinary skill in the art, however, will understand that various modifications and changes may be made thereto without departing from the broader scope of the invention as set forth in the appended claims. The foregoing description and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. Therefore, the scope of the present invention is determined by the claims that follow.

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO2008011728A1 [0003]
- US6567936B1 [0003]

Non-patent literature cited in the description

- Using clustering algorithms in legacy systems remodularization**WIGGERTS T.**

A.BAXTER et al.REVERSE ENGINEERING, 1997. PROCEEDINGS OF THE FOURTH WORKING CONFERENCE ON AMSTERDAMIEEE COMPUT. SOC1997100633-43 [0003]

PATENTKRAV

1. Computer-implementeret fremgangsmåde til generering af en klynge af relaterede dataenheder, hvilken fremgangsmåde omfatter:

kommunikation med ét eller flere elektroniske datalagre (820, 830), hvori der er lagret en flerhed af dataenheder og tilsvarende dataenhedsattributter, hvor det ene eller flere elektroniske datalagre er i forbindelse med én eller flere hardwarecomputerprocessorer (860), hvor den ene eller flere hardwarecomputerprocessorer er konfigureret med specifikke instruktioner, der kan udføres af en computer;

generering, for hver af én eller flere oprindelsesdataenheder udvalgt fra flerheden af dataenheder, og ved hjælp af den ene eller flere hardwarecomputerprocessorer, af en dataenhedsklynge ved mindst:

automatisk at udpege oprindelsesdataenheden (302) som en initial dataenhed af dataenhedsklyngen (252, 252-1);

tilgang, baseret på en klyngestrategi (232), til to eller flere søgeprotokoller (237-1, 237-2, ... , 237-M);

udførelse af en første af de to eller flere søgeprotokoller på det ene eller flere elektroniske datalagre for at identificere én eller flere dataenheder relateret til oprindelsesdataenheden, hvor udførelse af den første af de to eller flere søgeprotokoller omfatter:

identificering, ved hjælp af den ene eller flere hardwarecomputerprocessorer, af mindst ét dataenhedsattribut (303-1), der er forbundet med oprindelsesdataenheden;

evaluering, ved hjælp af den ene eller flere hardwarecomputerprocessorer, af flerheden af dataenheder for at bestemme den ene eller flere dataenheder (305-1), der deler det mindst ene dataenhedsattribut med oprindelsesdataenheden;

og tilføjelse af den ene eller flere dataenheder til dataenhedsklyngen;

og udførelse gentagne gange af de andre søgeprotokoller af de to eller flere søgeprotokoller på det ene eller flere elektroniske datalagre for at identificere én eller flere supplerende dataenheder (305-2, ... , 305-6) relateret til den ene eller flere dataenheder, der tidligere er tilføjet dataenhedsklyngen, hvor udførelse af hver af de andre søgeprotokoller af de to eller flere søgeprotokoller omfatter:

identificering, ved hjælp af den ene eller flere hardwarecomputerprocessorer, af mindst ét dataenhedsattribut (303-2, ... , 303-6), der er forbundet med mindst én af den ene eller flere dataenheder, der tidligere er tilføjet dataenhedsklyngen, hvor søgeprotokollen anvender det mindst ene identificerede dataenhedsattribut som et dataparameterinput til søgeprotokollen;

evaluering, ved hjælp af den ene eller flere hardwarecomputerprocessorer og baseret på udførelse af søgeprotokollen, af flerheden af dataenheder for at bestemme den ene eller flere supplerende dataenheder, der deler det mindst ene dataenhedsattribut med den mindst ene af den ene eller flere dataenheder, der tidligere er tilføjet dataenhedsklyngen; og

tilføjelse af den ene eller flere supplerende dataenheder til dataenhedsklyngen (252-1); og lagring af dataenhedsklyngen.

2. Fremgangsmåde ifølge krav 1, der endvidere omfatter:

sammenligning, ved hjælp af den ene eller flere hardwarecomputerprocessorer, af dataenheder, der er forbundet med dataenhedsklyngen (252-1), med dataenheder, der er forbundet med en anden dataenhedsklynge (252-C);

og som reaktion på bestemmelse af, at mindst én dataenhed, der er forbundet med dataenhedsklyngen, deler et attribut med og/eller er relateret til mindst én dataenhed, der er forbundet med den anden dataenhedsklynge, sammenføring af dataenhedsklyngen (252-1) og den anden dataenhedsklynge (252-C).

3. Fremgangsmåde ifølge krav 1, hvor den første søgeprotokol anvender dataenhedsoprindelsen som et dataparameterinput til den første søgeprotokol.

4. Fremgangsmåde ifølge krav 3, hvor den første søgeprotokol søger efter særlige dataenheder i et første elektronisk datalager og de andre søgeprotokoller af de to eller flere søgeprotokoller søger efter særlige dataenheder i et andet elektronisk datalager.

5. Fremgangsmåde ifølge et hvilket som helst af krav 3 til 4, der endvidere omfatter: tildeling af en rangscore til dataenhedsklyngen, hvor rangscoren anvendes til at ordne dataenhedsklyngen i forhold til en flerhed af andre dataenhedsklynger genereret fra tilsvarende dataenhedsoprindelser i henhold til klyngestrategien.

6. Computerprogram, der omfatter maskinlæsbare instruktioner, der, når de udføres af en computeranordning, styrer den til at udføre fremgangsmåden ifølge et hvilket som helst foregående krav.

7. Anordning, der omfatter:

ét eller flere elektroniske datalagre (820, 830), hvori der er lagret en flerhed af dataenheder og tilsvarende dataenhedsattributter;

og én eller flere hardwarecomputerprocessorer (860) i forbindelse med det ene eller flere elektroniske datalagre og konfigureret med specifikke instruktioner, der kan udføres af en computer, hvor instruktionerne er konfigureret til at foranledige den ene eller flere hardwarecomputerprocessorer til at:

generere, for hver af én eller flere oprindelsesdataenheder udvalgt fra flerheden af dataenheder, en dataenhedsklynge ved mindst:

automatisk at udpege oprindelsesdataenheden (302) som en initial dataenhed af dataenhedsklyngen (252, 252-1);

tilgå, baseret på en klyngestrategi (232), to eller flere søgeprotokoller (237-1, 237-2, ... , 237-M);

udføre en første af de to eller flere søgeprotokoller på det ene eller flere elektroniske datalagre for at identificere én eller flere dataenheder relateret til oprindelsesdataenheden, hvor udførelse af den første af de to eller flere søgeprotokoller omfatter:

identificering af mindst ét dataenhedsattribut (303-1), der er forbundet med oprindelsesdataenheden;

evaluering af flerheden af dataenheder for at bestemme den ene eller flere dataenheder (305-1), der deler det mindst ene dataenhedsattribut med oprindelsesdataenheden;

og tilføjelse af den ene eller flere dataenheder til dataenhedsklyngen;

og udførelse gentagne gange af hver af de andre søgeprotokoller af de to eller flere søgeprotokoller på det ene eller flere elektroniske datalagre for at identificere én eller flere supplerende dataenheder (305-2, ... , 305-6) relateret til den ene eller flere dataenheder, der tidligere er tilføjet dataenhedsklyngen, hvor udførelse af hver af de andre søgeprotokoller af de to eller flere søgeprotokoller omfatter:

identificering af mindst ét dataenhedsattribut (303-2, ... , 303-6), der er forbundet med mindst én af den ene eller flere dataenheder, der tidligere er tilføjet dataenhedsklyngen, hvor søgeprotokollen anvender den identificerede mindst ene dataenhed, der er tillagt, som et dataparameterinput til søgeprotokollen;

evaluering, baseret på udførelse af søgeprotokollen, af flerheden af dataenheder for at bestemme den ene eller flere supplerende dataenheder, der deler det mindst ene dataenhedsattribut med den mindst ene af den ene eller flere dataenheder, der tidligere er tilføjet dataenhedsklyngen;

og tilføjelse af den ene eller flere supplerende dataenheder til dataenhedsklyngen (252-1);

og lagring af dataenhedsklyngen i det ene eller flere elektroniske datalagre.

8. Anordning ifølge krav 7, hvor instruktionerne endvidere er konfigureret til at foranledige den ene eller flere hardwarecomputerprocessorer til at:

sammenligne dataenheder, der er forbundet med dataenhedsklyngen (252-1), med dataenheder, der er forbundet med en anden dataenhedsklynge (252-C);

og som reaktion på bestemmelse af, at mindst én dataenhed, der er forbundet med dataenhedsklyngen, deler et attribut med og/eller er relateret til mindst én dataenhed, der er forbundet med den anden dataenhedsklynge, at sammenføre dataenhedsklyngen (252-1) og den anden dataenhedsklynge (252-C).

9. Anordning ifølge krav 7, hvor den første søgeprotokol anvender dataenhedsoprindelsen som et dataparameterinput til den første søgeprotokol.

10. Anordning ifølge krav 9, hvor den første søgeprotokol søger efter særlige dataenheder i et første elektronisk datalager og de andre søgeprotokoller af de to eller flere søgeprotokoller søger efter særlige dataenheder i et andet elektronisk datalager.

11. Anordning ifølge et hvilket som helst af krav 9 til 10, hvor instruktionerne endvidere er konfigureret til at foranledige den ene eller flere hardwarecomputerprocessorer til at:

tildele en rangscore til dataenhedsklyngen, hvor rangscoren anvendes til at ordne dataenhedsklyngen i forhold til en flerhed af andre dataenhedsklynger genereret fra tilsvarende dataenhedsoprindelser i henhold til klyngestrategien.

DRAWINGS

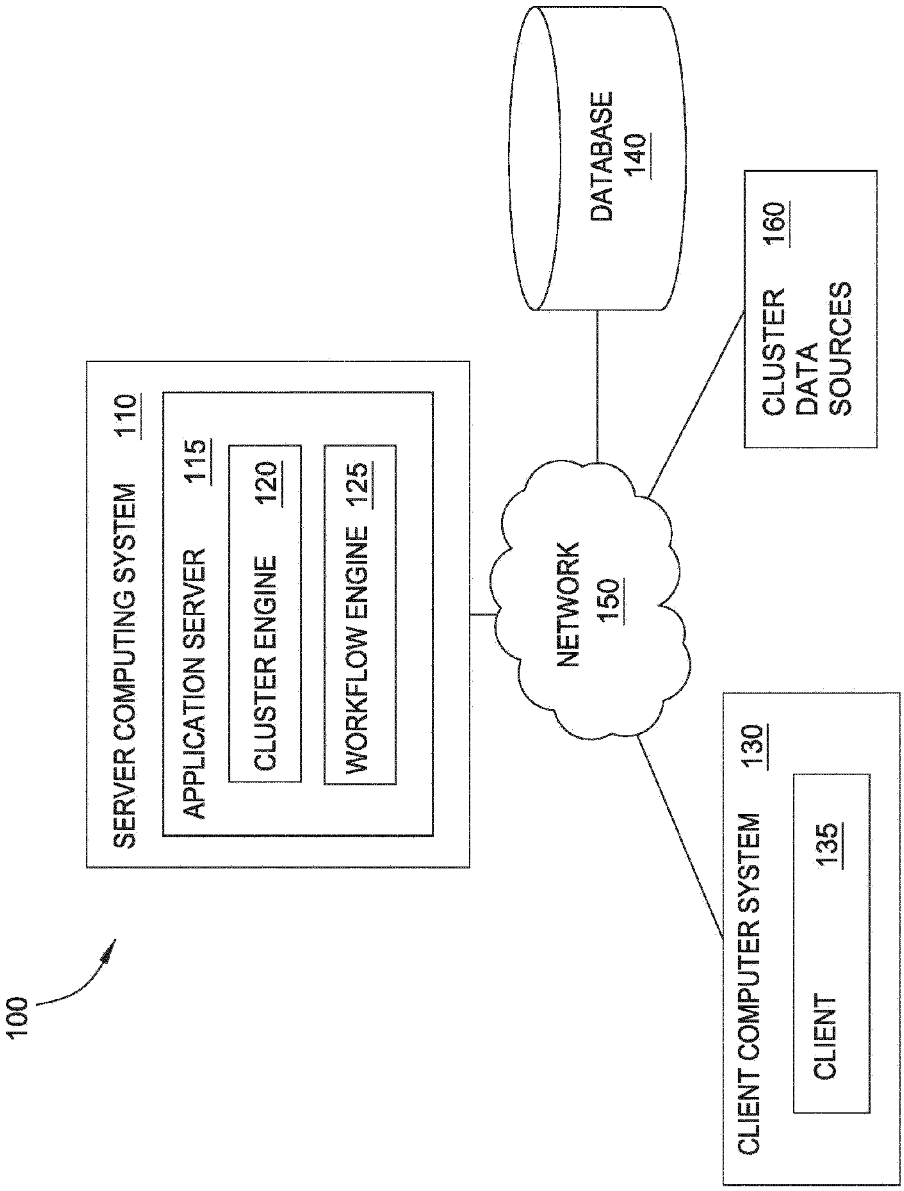


FIG. 1

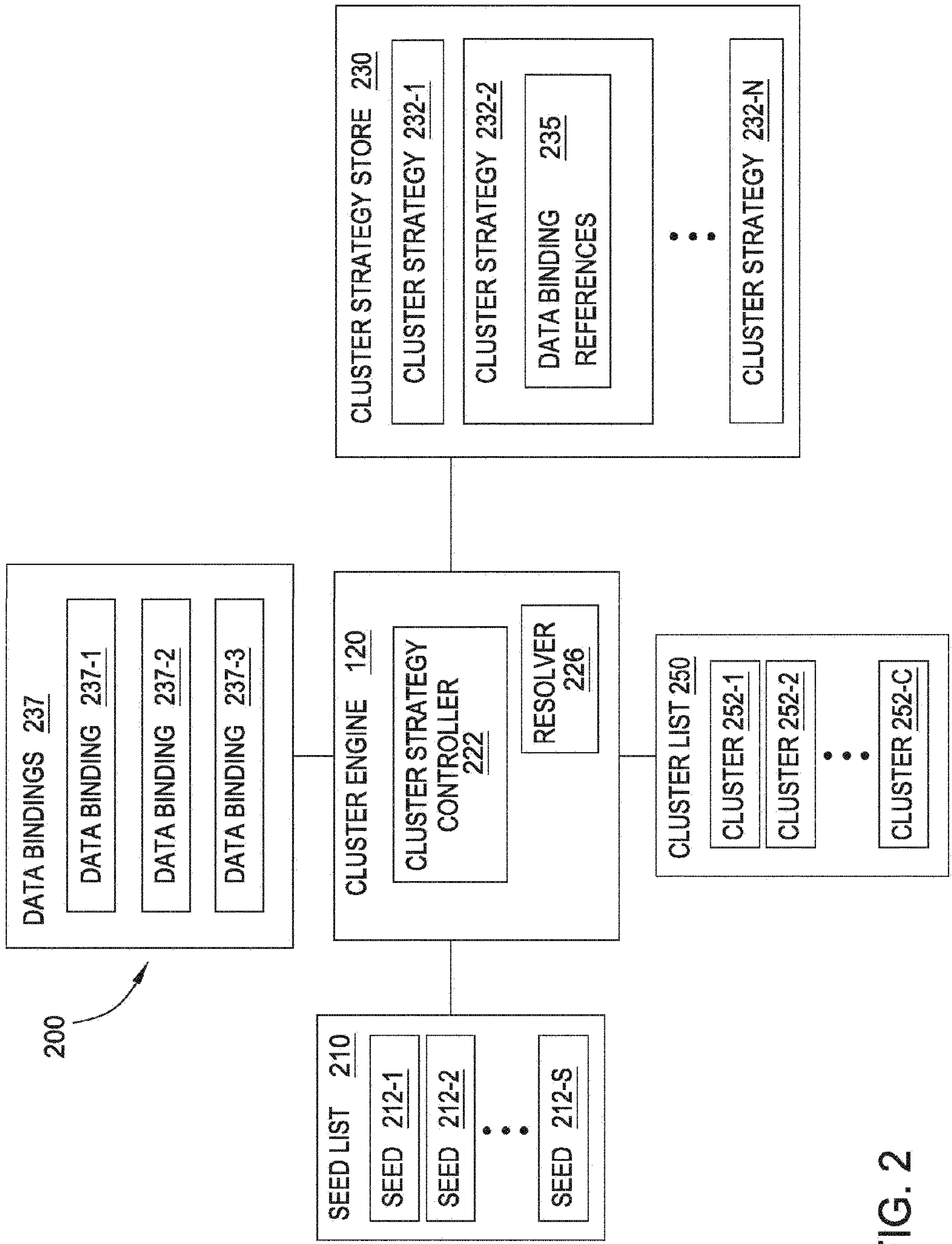

200
CLUSTER STRATEGY STORE 230
CLUSTER STRATEGY 232-1
CLUSTER STRATEGY 232-2
DATA BINDING REFERENCES 235
CLUSTER STRATEGY 232-N
DATA BINDINGS 237
DATA BINDING 237-1
DATA BINDING 237-2
DATA BINDING 237-3
CLUSTER ENGINE 120
CLUSTER STRATEGY CONTROLLER 222
RESOLVER 226
CLUSTER LIST 250
CLUSTER 252-1
CLUSTER 252-2
CLUSTER 252-C
SEED LIST 210
SEED 212-1
SEED 212-2
SEED 212-S

FIG. 2

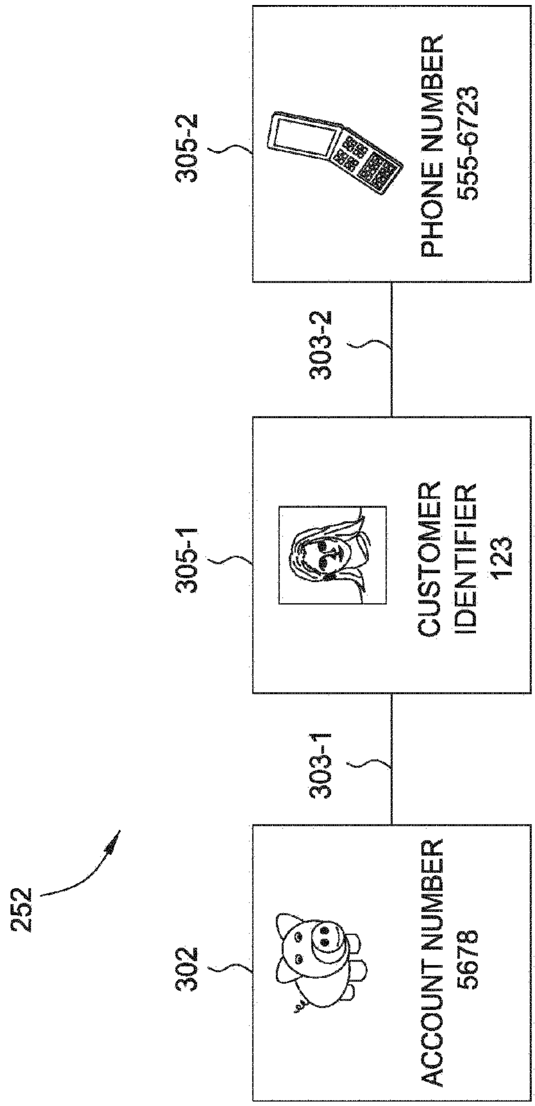

252
302
ACCOUNT NUMBER
5678
303-1
305-1
CUSTOMER
IDENTIFIER
123
303-2
305-2
PHONE NUMBER
555-6723

FIG. 3A

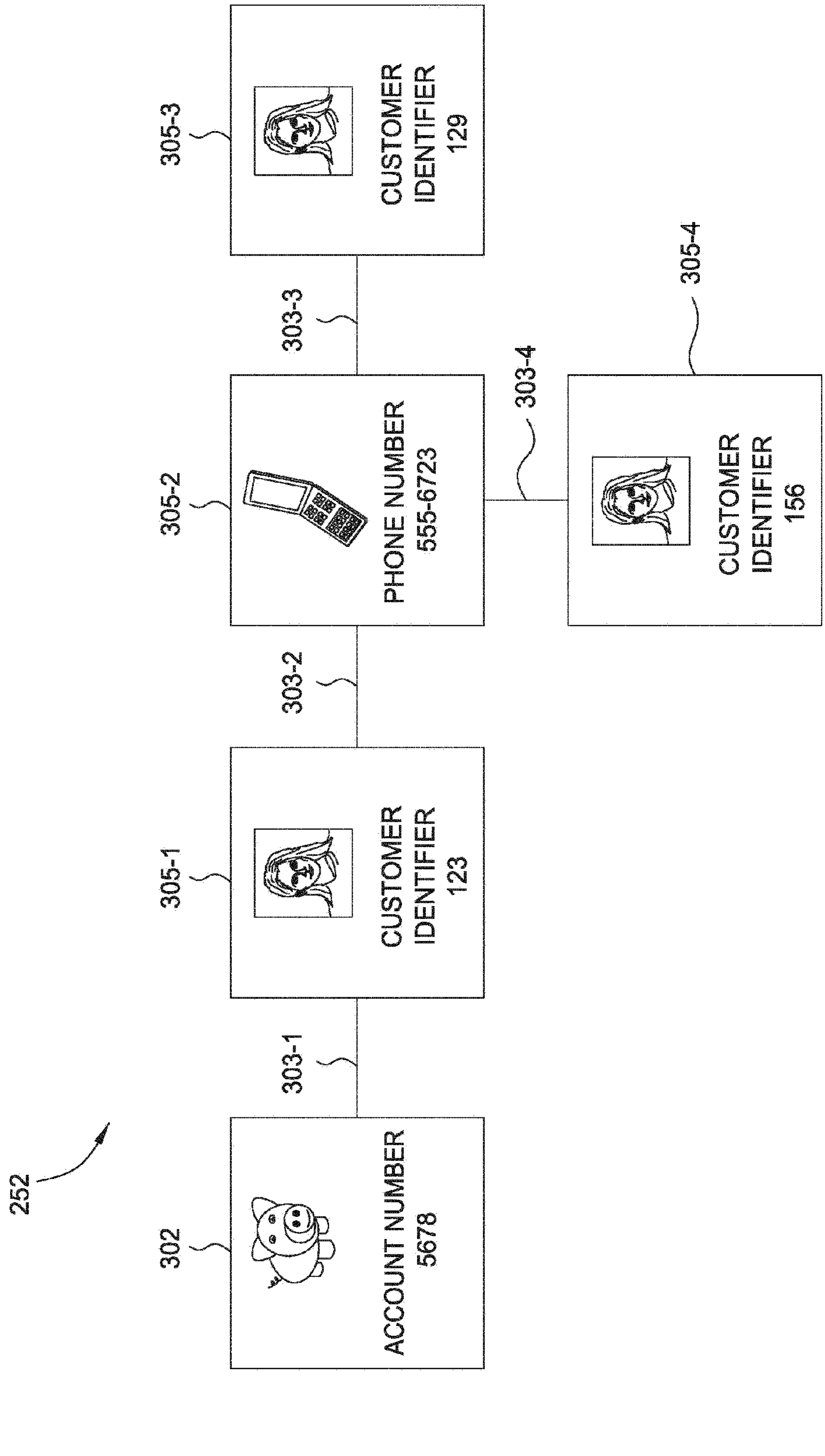

252
302
ACCOUNT NUMBER
5678
303-1
305-1
CUSTOMER
IDENTIFIER
123
303-2
305-2
PHONE NUMBER
555-6723
303-3
305-3
CUSTOMER
IDENTIFIER
129
303-4
305-4
CUSTOMER
IDENTIFIER
156

FIG. 3B

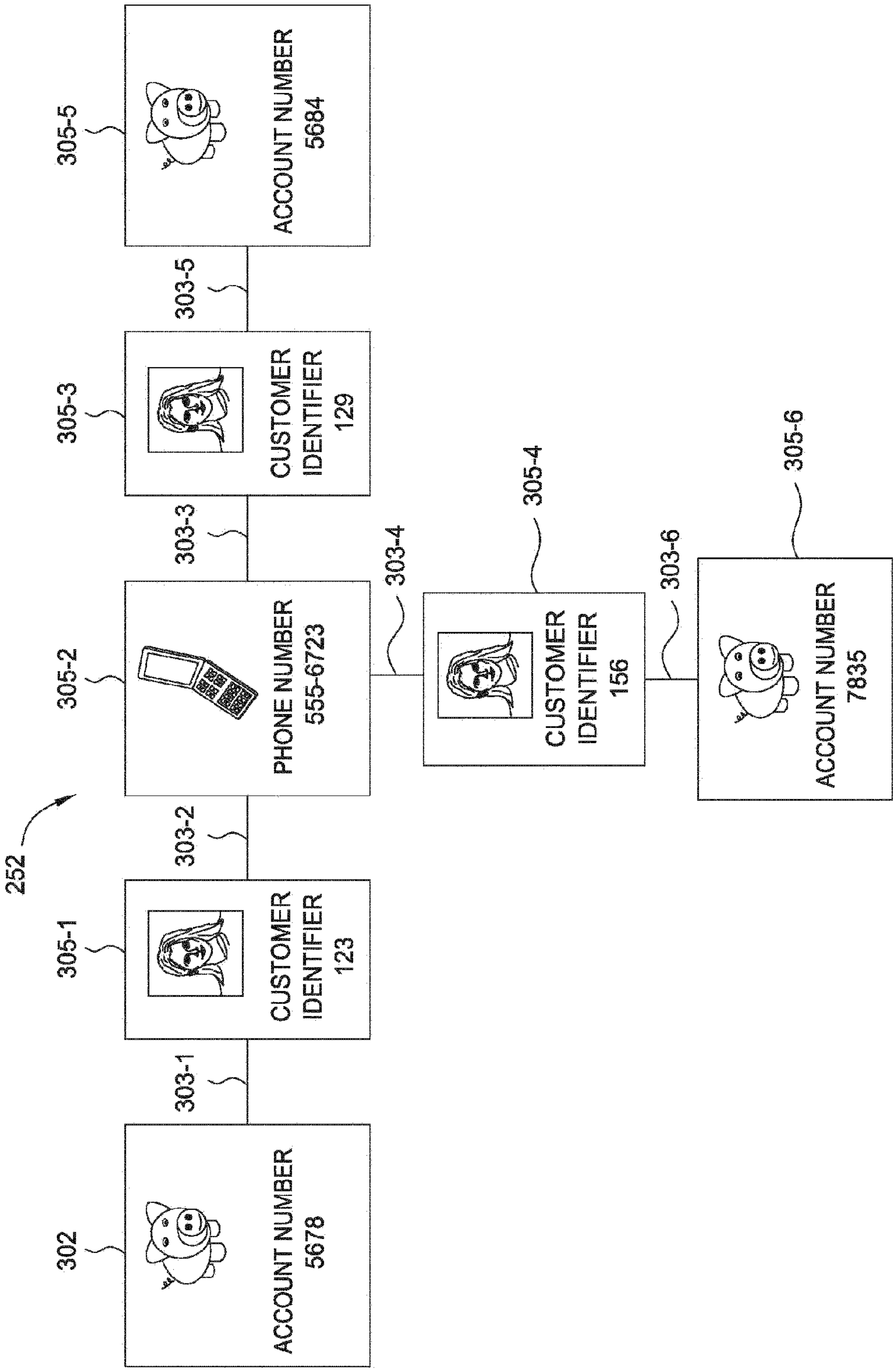

252
302
ACCOUNT NUMBER 5678
303-1
305-1
CUSTOMER IDENTIFIER 123
303-2
305-2
PHONE NUMBER 555-6723
303-3
305-3
CUSTOMER IDENTIFIER 129
303-5
305-5
ACCOUNT NUMBER 5684
303-4
305-4
CUSTOMER IDENTIFIER 156
303-6
305-6
ACCOUNT NUMBER 7835

FIG. 3C

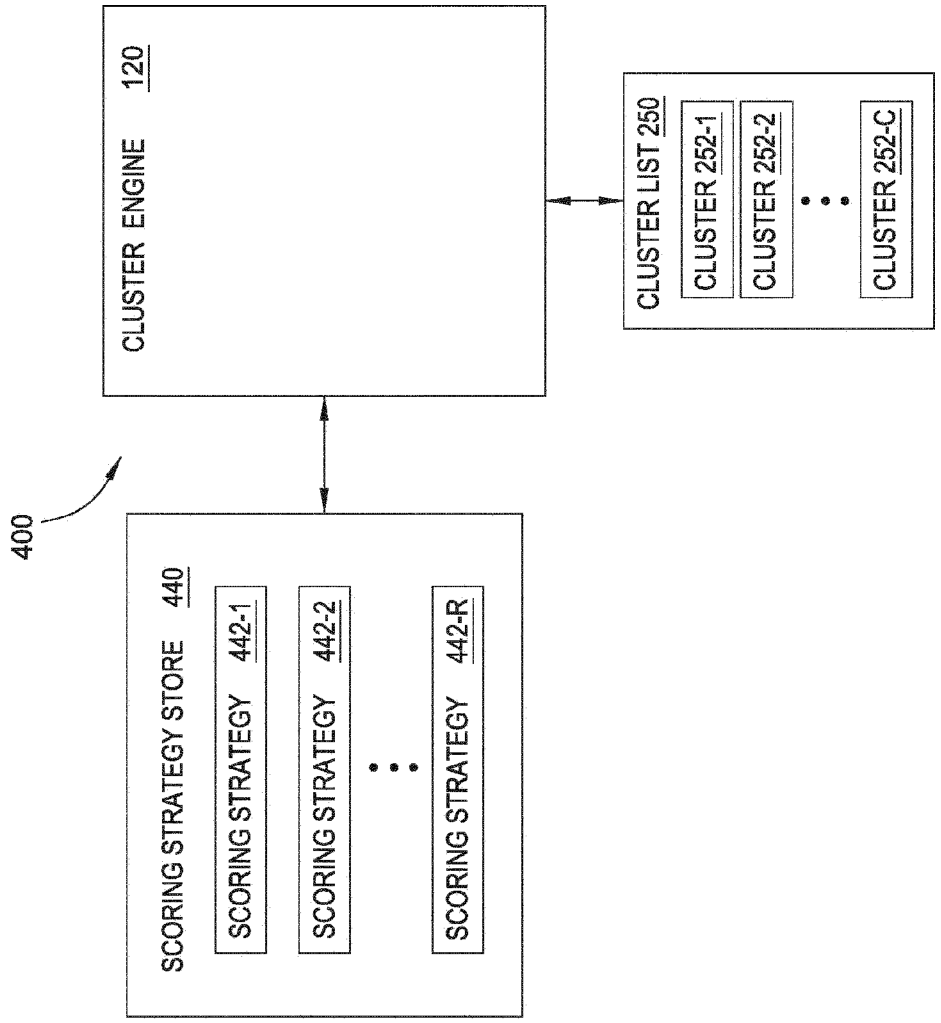
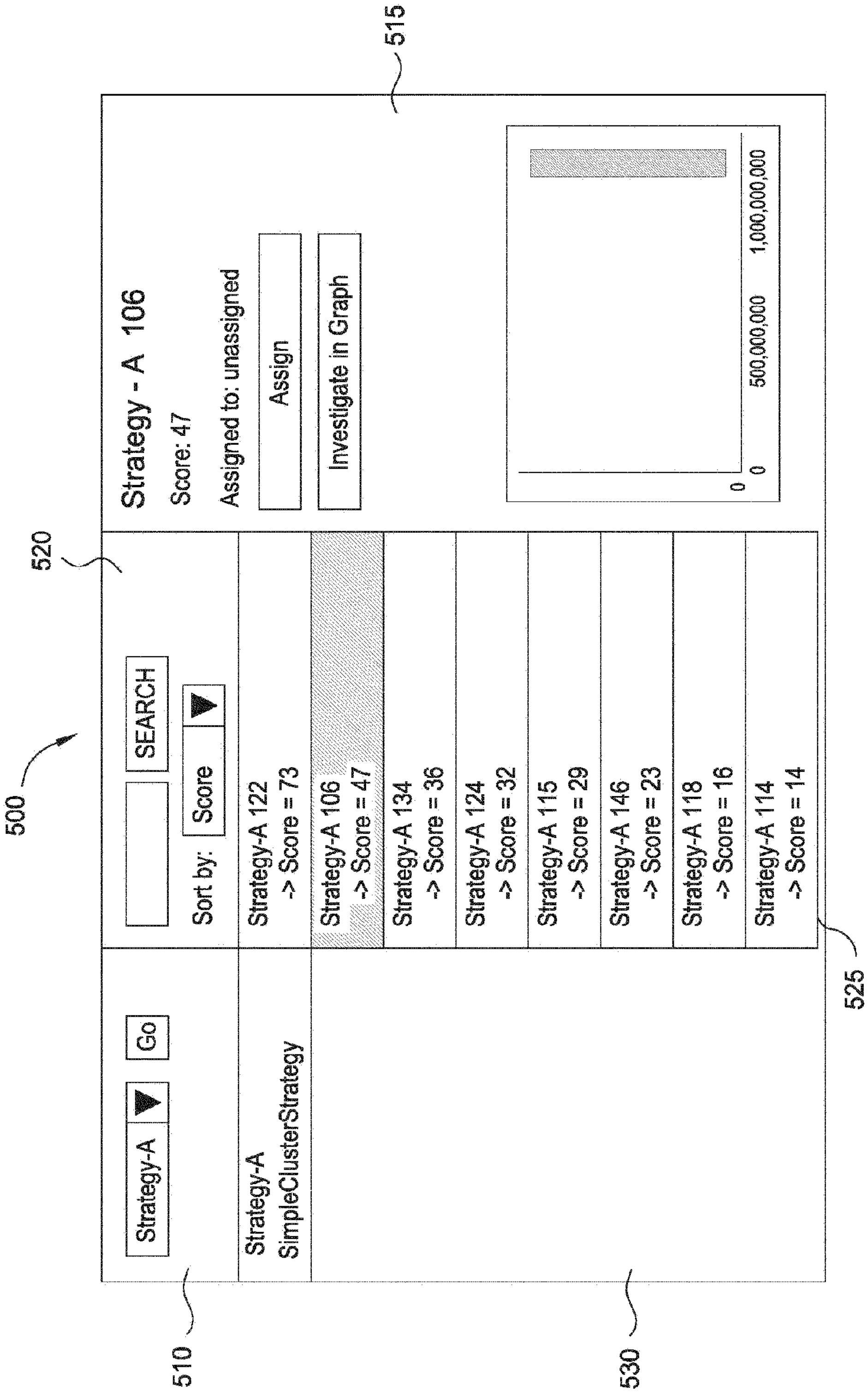

400
CLUSTER ENGINE 120
CLUSTER LIST 250
CLUSTER 252-1
CLUSTER 252-2
CLUSTER 252-C
SCORING STRATEGY STORE 440
SCORING STRATEGY 442-1
SCORING STRATEGY 442-2
SCORING STRATEGY 442-R

FIG. 4



500
515
520
510
530
525
Strategy-A
Go
Strategy-A
SimpleClusterStrategy
SEARCH
Sort by:
Score
Strategy-A 122
-> Score = 73
Strategy-A 106
-> Score = 47
Strategy-A 134
-> Score = 36
Strategy-A 124
-> Score = 32
Strategy-A 115
-> Score = 29
Strategy-A 146
-> Score = 23
Strategy-A 118
-> Score = 16
Strategy-A 114
-> Score = 14
Strategy - A 106
Score: 47
Assigned to: unassigned
Assign
Investigate in Graph
0
0
500,000,000
1,000,000,000

FIG. 5

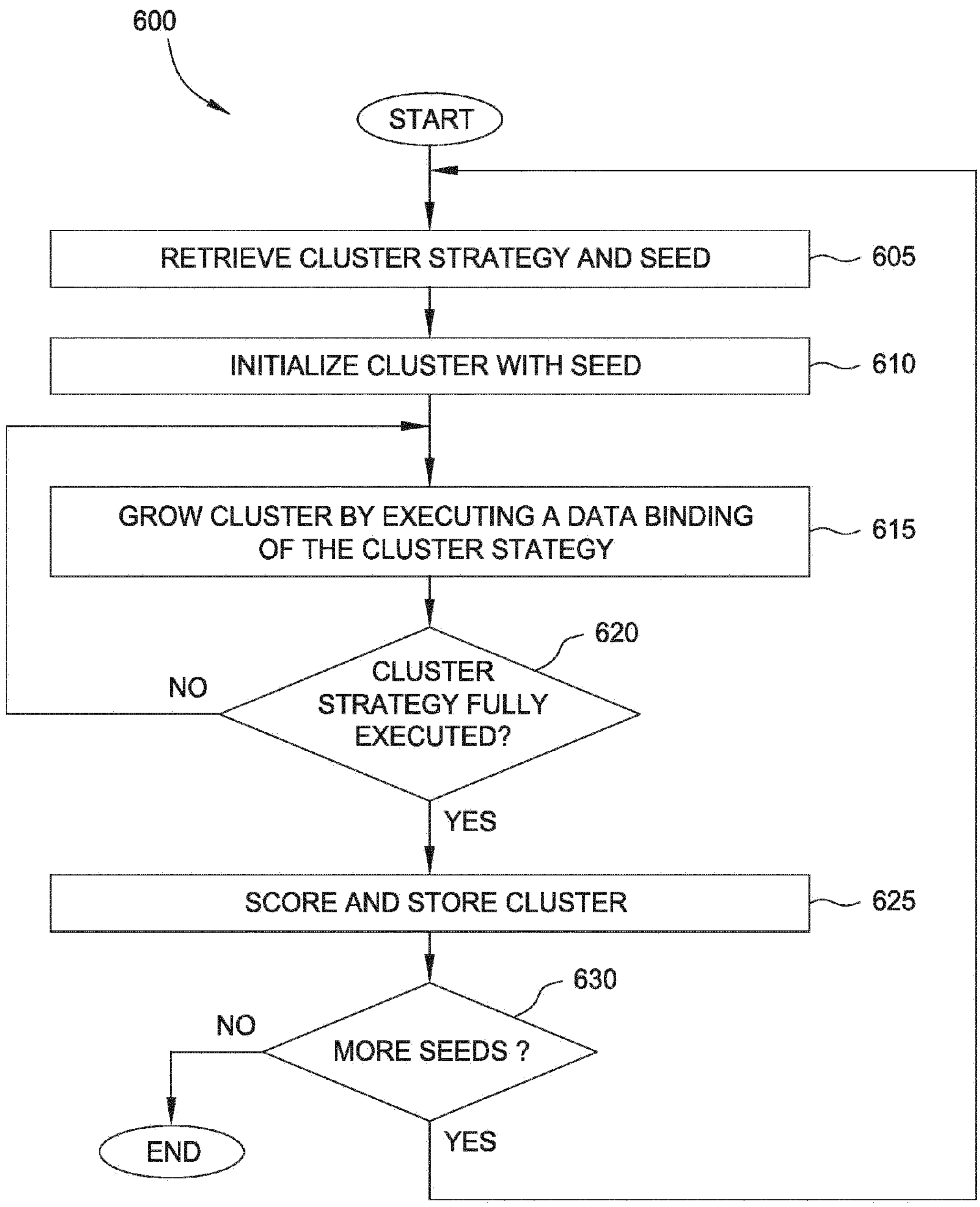

600
START
RETRIEVE CLUSTER STRATEGY AND SEED
605
INITIALIZE CLUSTER WITH SEED
610
GROW CLUSTER BY EXECUTING A DATA BINDING OF THE CLUSTER STATEGY
615
620
CLUSTER STRATEGY FULLY EXECUTED?
NO
YES
SCORE AND STORE CLUSTER
625
630
MORE SEEDS ?
NO
YES
END

FIG. 6

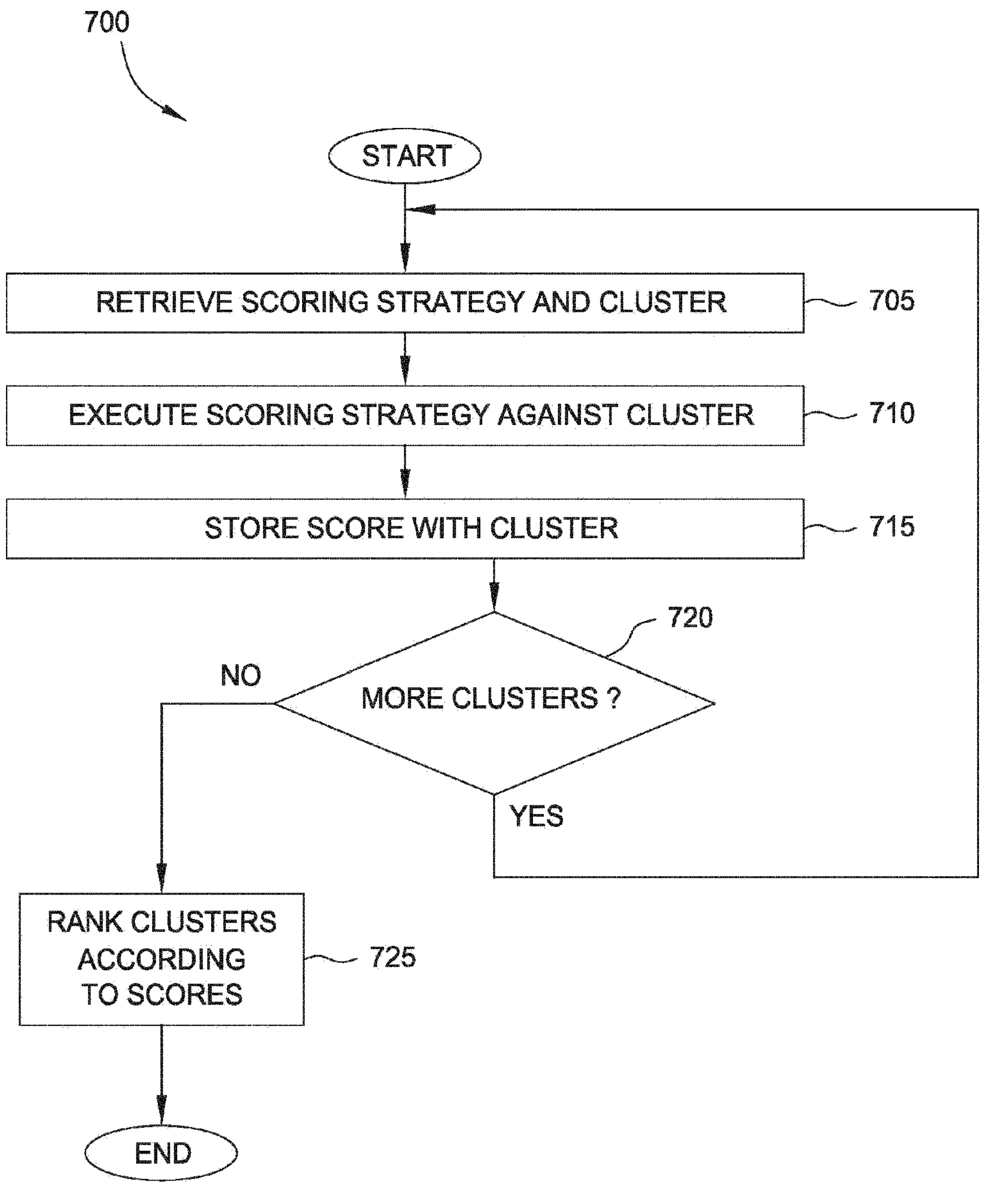

700
START
RETRIEVE SCORING STRATEGY AND CLUSTER
705
EXECUTE SCORING STRATEGY AGAINST CLUSTER
710
STORE SCORE WITH CLUSTER
715
720
NO
MORE CLUSTERS ?
YES
RANK CLUSTERS ACCORDING TO SCORES
725
END

FIG. 7

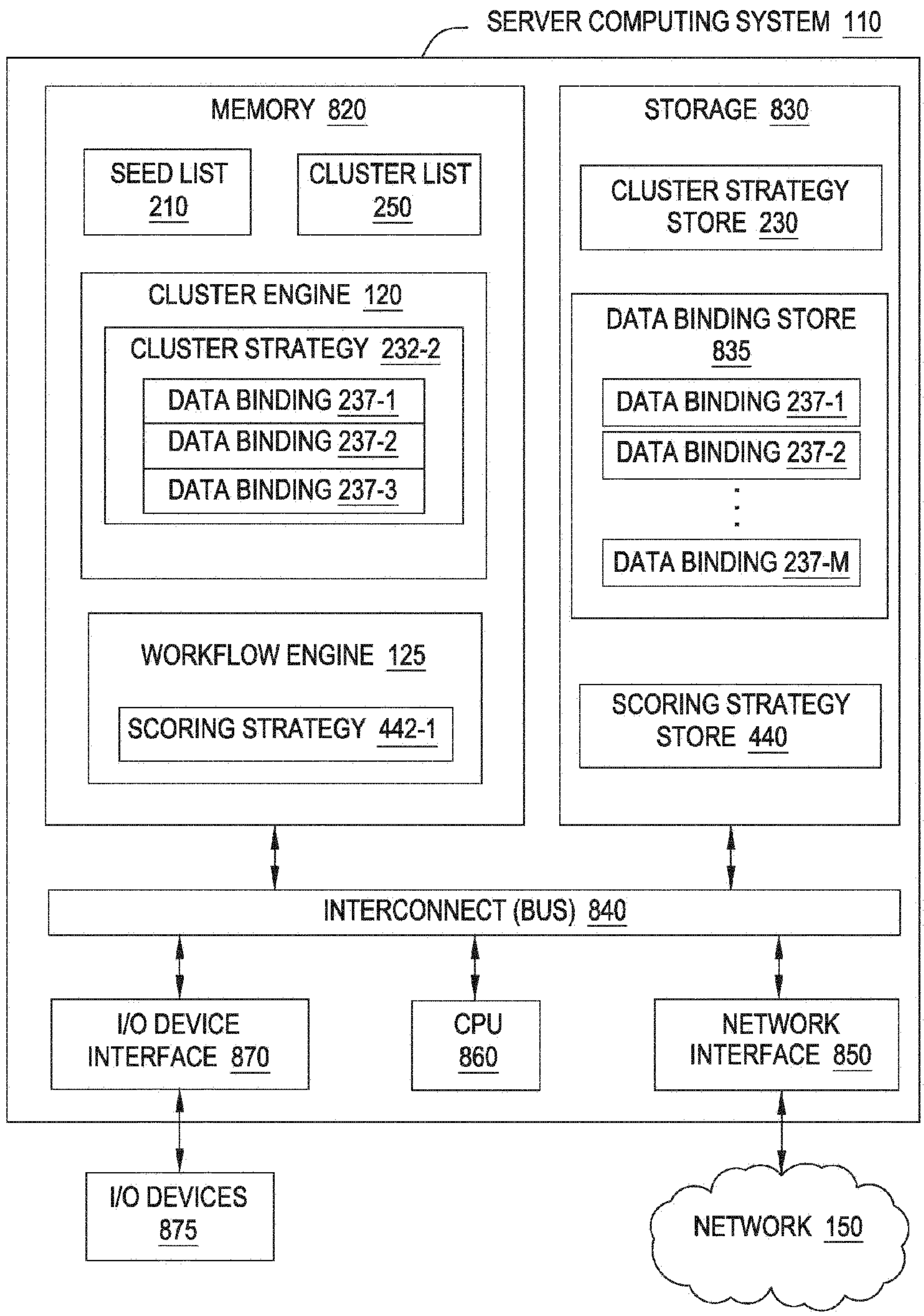

SERVER COMPUTING SYSTEM 110
MEMORY 820
SEED LIST 210
CLUSTER LIST 250
CLUSTER ENGINE 120
CLUSTER STRATEGY 232-2
DATA BINDING 237-1
DATA BINDING 237-2
DATA BINDING 237-3
WORKFLOW ENGINE 125
SCORING STRATEGY 442-1
STORAGE 830
CLUSTER STRATEGY STORE 230
DATA BINDING STORE 835
DATA BINDING 237-1
DATA BINDING 237-2
DATA BINDING 237-M
SCORING STRATEGY STORE 440
INTERCONNECT (BUS) 840
I/O DEVICE INTERFACE 870
CPU 860
NETWORK INTERFACE 850
I/O DEVICES 875
NETWORK 150

FIG. 8