have a user-friendly interface for finding out interested data at any level of data granularity quickly and easily is needed.

SUMMARY

Provided is an interoperable data exploration apparatus. The interoperable data exploration apparatus comprises a transceiving interface, a processor, and a storage device, wherein the processor is electrically connected to the transceiving interface and the storage device. The processor is configured to install a data object package including a data process engine, a database, and a visualization user interface and execute the data process engine, wherein the data process engine continuously inputs a stream of data into the database to derive a first data object. The storage device is configured to retain the first data object.

The data process engine enables a display screen to display the visualization user interface comprising a first display area for the first data object and a second display area for a second data object belonging to another interoperable data exploration apparatus by establishing a connection to the another interoperable data exploration apparatus via the transceiving interface. The another interoperable data exploration apparatus performs a first task of data exploration on the second data object by issuing a first sequence of queries in response to a first sequence of operations on the second display area to narrow down a target of interest, wherein each query is applied on a resulted dataset of the previous query, and the first query is applied on the second data object. The data process engine receives, via the connection, a first set of identifiers corresponding to the target of interest from the second data object and performs a second task of data exploration on the first data object by issuing a second sequence of queries in response

to a second sequence of operations on the first display area according to the first set of identifiers to produce a target dataset.

Provided is an interoperable data exploration apparatus. The interoperable data exploration apparatus comprises a transceiving interface, a processor, and a storage device, wherein the processor is electrically connected to the transceiving interface and the storage device. The processor is configured to install a data object package including a data process engine, a database, and a visualization user interface and execute the data process engine, wherein the data process engine continuously inputs a stream of data into the database to derive a first data object. The storage device is configured to retain the first data object.

The data process engine enables a display screen to display the visualization user interface comprising a first display area for the first data object and a second display area for a second data object belonging to another interoperable data exploration apparatus by establishing a connection to the another interoperable data exploration apparatus via the transceiving interface. The data process engine performs a first task of data exploration on the first data object by issuing a first sequence of queries in response to a first sequence of operations on the first display area to narrow down a target of interest, wherein each query is applied on a resulted dataset of the previous query, and the first query is applied on the first data object. The data process engine receives a first set of identifiers corresponding to the target of interest from the first data object and transmits the first set of identifiers to the another interoperable data exploration apparatus via the connection. The another interoperable data exploration apparatus performs a second task of data exploration on the second data object by issuing a

and a second display area for the second data object by establishing a connection to the second interoperable data exploration apparatus. The second interoperable data exploration apparatus performs a first task of data exploration on the second data object by issuing a first sequence of queries in response to a first sequence of operations on the second display area to narrow down a target of interest, wherein each query is applied on a resulted dataset of the previous query, and the first query is applied on the second data object. The second interoperable data exploration apparatus transmits a first set of identifiers corresponding to the target of interest to the central management apparatus, the central management apparatus transmits a second set of identifiers corresponding to the first set of identifiers to the first interoperable data exploration apparatus, and the first interoperable data exploration apparatus performs a second task of data exploration on the first data object by issuing a second sequence of queries in response to a second sequence of operations on the first display area according to the second set of identifiers to produce a target dataset.

Provided is a federated data exploration system. The federated data exploration system comprises a central management apparatus, a first interoperable data exploration apparatus, and a second interoperable data exploration apparatus. Each of the first and second interoperable data exploration apparatuses installs a data object package including a data process engine, a database, and a visualization user interface. The first interoperable data exploration continuously inputs a first stream of data into the corresponding database to derive a first data object by the corresponding data process engine, retains the first data object, and transmits a first piece of meta information to the central management apparatus to register the first data

object. The first piece of meta information describes a plurality of first identifiers and a plurality of first attributes. The second interoperable data exploration continuously inputs a second stream of data into the corresponding database to derive a second data object, retains the second data object, and transmits a second piece of meta information to the central management apparatus to register the second data object. The second piece of meta information describes a plurality of second identifiers and a plurality of second attributes. The first interoperable data exploration apparatus transmits a message to the central management apparatus for subscribing the second data object.

The first interoperable data exploration apparatus enables a display screen to display the corresponding visualization user interface comprising a first display area for the first data object and a second display area for the second data object by establishing a connection to the second interoperable data exploration apparatus. The first interoperable data exploration apparatus performs a first task of data exploration on the first data object by issuing a first sequence of queries in response to a first sequence of operations on the first display area to narrow down a target of interest, wherein each query is applied on a resulted dataset of the previous query, and the first query is applied on the first data object. The first interoperable data exploration apparatus transmits a first set of identifiers corresponding to the target of interest to the central management apparatus. The central management apparatus transmits a second set of identifiers corresponding to the first set of identifiers to the second interoperable data exploration apparatus. The second data exploration apparatus performs a second task of data exploration on the second data object by issuing a second sequence of queries in response to a

between the interoperable data exploration apparatuses **11**, **12** will be achieved in a way that separates data ownership from the use of data. In other words, the data object retained in the interoperable data exploration apparatus **11** (i.e., data owned by the data owner **O1**) can be explored by a user **U2** of the interoperable data exploration apparatus **12** without sacrificing the data ownership of the data owner **O1**. Likewise, the data object retained in the interoperable data exploration apparatus **12** (i.e., data owned by the data owner **O2**) can be explored by a user **U1** of the interoperable data exploration apparatus **11** without sacrificing the data ownership of the data owner **O2**. The details to achieve the separation of data ownership and the use of data will be described later.

Each of the interoperable data exploration apparatuses **11**, **12** is an electronic computing apparatus such as a desktop computer, a notebook, and a tablet. **FIG. 1B** illustrates a schematic view of the interoperable data exploration apparatuses **11**, **12**. The interoperable data exploration apparatus **11** comprises a processor **111**, a transceiving interface **113**, and a storage device **115**, wherein the processor **111** is electrically connected to the transceiving interface **113** and the storage device **115**. Similarly, the interoperable data exploration apparatus **12** comprises a processor **121**, a transceiving interface **123**, and a storage device **125**, wherein the processor **121** is electrically connected to the transceiving interface **123** and the storage device **125**.

Each of the processors **111**, **121** may be any kind of processing unit, central processing unit (CPU), microprocessor, digital signal processor (DSP), or any kind of computing device with similar functions and well-known to those skilled in the art. Each of the transceiving interface **113**, **123** maybe a wired interface or a wireless interface, which is configured to

apparatus. The aforesaid connection is a connection over network. In this embodiment, the display area **D1** is for the data object **112** while the display area **D2** is for the data object **122** belonging to the interoperable data exploration apparatus **12**. In order to enable the display area **D2** to display data object **112**, the data process engine **EN** executed by the interoperable data exploration apparatus **11** establishes a connection between the interoperable data exploration apparatus **11** and the interoperable data exploration apparatus **12**.

The user **U1** may perform a first sequence of operations (not shown) on the display area **D2** to dig into the data object **122** for useful information. In some embodiments, if the data object **122** is a dataset (not shown) having a plurality of dimensions (not shown), the first sequence of operations that the user **U1** performed on the display area **D2** is related to a subset of key dimensions. The first sequence of operations on the display area **D2** is related to selecting an ordered combination of the dimensions with values, and each operation is based on the selected dimensions of the previous operation followed by an arbitrary dimension among the dimensions, and each query generates a temporary set of identifiers for every key dimension. In response to the first sequence of operations that the user **U1** performed on the display area **D2**, the data process engine **EN** executed on the interoperable data exploration apparatus **12** performs a first task of data exploration on the data object **122** by issuing a first sequence of queries (not shown) to narrow down a target of interest (not shown), such as users who had bought a specific product in a certain city, cars having a driving speed in the range of 60 to 80 Km/h in Taipei City last month. Please note that each query is applied on a resulted dataset (not shown) of the previous query, and the first query is applied on the data object **122**.

In some embodiments, the data object **112** and the data object **122** may adopt different coding schemes regarding the same item (e.g., attribute, dimension). For those embodiments, after receiving the first set **S1** of identifiers, the data process engine **EN** executed by the interoperable data exploration apparatus **11** transforms the first set **S1** of identifiers into a second set of identifiers one-to-one. Then, the data process engine **EN** executed by the interoperable data exploration apparatus **11** performs data exploration on the data object **112** by issuing the second sequence of queries in response to the second sequence of operations on the display area **D1** according to the second set of identifiers.

In some embodiments, the aforementioned data exploration can be performed in an opposite way. The user **U1** may perform a first sequence of operations (not shown) on the display area **D1** to dig into the data object **112** for useful information. In response to the first sequence of operations that the user **U1** performed on the display area **D1**, the data process engine **EN** executed by the interoperable data exploration apparatus **11** performs a first task of data exploration on the data object **112** by issuing a first sequence of queries (not shown) to narrow down a target of interest (not shown). Then, the data process engine **EN** executed by the interoperable data exploration apparatus **11** receives the set **S1** of identifiers corresponding to the target of interest from the data object **112**. Then, the data process engine **EN** executed by the interoperable data exploration apparatus **11** transmits the first set of identifiers to the interoperable data exploration apparatus **12** via the connection. The data process engine **EN** executed by the interoperable data exploration apparatus **12** performs a second task of data exploration on the data object **122** by issuing a second sequence of queries in response to a

has to transmit, via the transceiving interface **113**, a message **M1** to the central management apparatus **15** for subscribing the data object **122**. After the subscription, the interoperable data exploration apparatus **11** has the right to explore the data object **122**. In some embodiments, the message **M1** for subscribing the data object **122** comprises the access control for controlling the accessibility of a subset of the data object **122**. If the data object **122** is a dataset having a plurality of dimensions, the access control controls which dimensions can be accessed by the interoperable data exploration apparatus **11**.

In some embodiments, the visualization user interface **VI** displayed on the display screen comprises a display area **D3** in addition to the display areas **D1** and **D2** as shown in **FIG. 2**. Specifically, the display area **D3** is configured to display a plurality registered data objects **116**, **126** of the central management apparatus **15**. Each of the registered data objects **116**, **126** has a registered piece of meta information in the central management apparatus **15**, wherein the registered pieces of meta information and the first piece of meta information **114** has at least one common identifier description. In this way, a user of the interoperable data exploration apparatuses **11** may browse the registered data objects **116**, **126** and find out the data object that he or she is interested in.

In this embodiment, after the data process engine **EN** of the interoperable data exploration apparatus **11** narrows down a target of interest from the data object **122**, the central management apparatus **15** will handle the exchange of the identifiers corresponding to the target of interest. Specifically, the interoperable data exploration apparatus **12** transmits the set **S1** of identifiers corresponding to the target of interest to the central management apparatus **15**. The central

CLAIMS

What is claimed is:

1. An interoperable data exploration apparatus, comprising:

a storage device;

a transceiving interface; and

a processor, being electrically connected to the storage device and the transceiving interface and configured to install a data object package including a data process engine, a database and a visualization user interface, and execute the data process engine,

wherein the data process engine continuously inputs a stream of data into the database to derive a first data object, and the storage device retains the first data object,

wherein the data process engine enables a display screen to display the visualization user interface comprising a first display area for the first data object and a second display area for a second data object belonging to another interoperable data exploration apparatus by establishing a connection to the another interoperable data exploration apparatus via the transceiving interface,

wherein the another interoperable data exploration apparatus performs a first task of data exploration on the second data object by issuing a first sequence of queries in response to a first sequence of operations on the second display area to narrow down a target of interest, wherein each query of the first sequence of queries is applied on a resulted dataset of the previous

query, and a first query of the first sequences of queries is applied on the second data object,

wherein the data process engine receives, via the connection, a first set of identifiers corresponding to the target of interest from the second data object and performs a second task of data exploration on the first data object by issuing a second sequence of queries in response to a second sequence of operations on the first display area according to the first set of identifiers to produce a target dataset.

2. The interoperable data exploration apparatus of Claim 1, wherein the data process engine further transforms the first set of identifiers into a second set of identifiers one-to-one, wherein the target dataset is produced according to the second set of identifiers.

3. The interoperable data exploration apparatus of Claim 1, wherein the second data object is a dataset of a plurality of dimensions including a subset of key dimensions, the first sequence of operations on the second display area is related to selecting an ordered subset of the dimensions with a plurality of values, and each operation of the first sequence of operations is based on the ordered subset of the dimensions of a previous operation followed by an arbitrary dimension among the dimensions, and each query of the first sequence of queries generates a temporary set of identifiers for every key dimension.

4. The interoperable data exploration apparatus of Claim 1, wherein when narrowing down to the target of interest, the another interoperable data exploration apparatus creates an identifiable label corresponding to the target of interest on the second data object in response to a confirmation operation on the second display area, the identifiable label corresponds to the

first set of identifiers, and the data process engine further performs the following operations:

receiving, via the connection, a notification message regarding the creation of the identifiable label,

transmitting, via the connection, a request for the first set of identifiers to the another interoperable data exploration apparatus, and

receiving, via the connection, the first set of identifiers from the another interoperable data exploration apparatus.

5. The interoperable data exploration apparatus of Claim 1, wherein the data process engine further receives, via the connection, at least one attribute of each identifier in the first set of identifiers from the second data object and the data process engine performs the second task of data exploration on the first data object by issuing the second sequence of queries in response to the second sequence of operations on the first display area according to the first set of identifiers and the at least one attribute of each identifier in the first set of identifiers to produce the target dataset.

6. An interoperable data exploration apparatus, comprising:

a storage device;

a transceiving interface; and

a processor, being electrically connected to the storage device and the transceiving interface and configured to install a data object package including a data process engine, a database, and a visualization user interface, and execute the data process

engine,

wherein the data process engine continuously inputs a stream of data into the database to derive a first data object, and the storage device retains the first data object,

wherein the data process engine enables a display screen to display the visualization user interface comprising a first display area for the first data object and a second display area for a second data object belonging to another interoperable data exploration apparatus by establishing a connection to the another interoperable data exploration apparatus via the transceiving interface,

wherein the data process engine performs a first task of data exploration on the first data object by issuing a first sequence of queries in response to a first sequence of operations on the first display area to narrow down a target of interest, wherein each query of the first sequence of queries is applied on a resulted dataset of the previous query of the first sequence of queries, and a first query of the first sequence of queries is applied on the first data object,

wherein the data process engine receives a first set of identifiers corresponding to the target of interest from the first data object, transmits the first set of identifiers to the another interoperable data exploration apparatus via the connection, and the another interoperable data exploration apparatus performs a second task of data exploration on the second data object by issuing a second sequence of queries in response to a second sequence of operations on the second display area according to the first set of identifiers to produce a target dataset.

7. The interoperable data exploration apparatus of Claim 6, wherein the data process engine further transforms the first set of identifiers into a second set of identifiers one-to-one, wherein the target dataset is produced according to the second set of identifiers.

8. The interoperable data exploration apparatus of Claim 6, wherein the first data object is a dataset of a plurality of dimensions including a subset of key dimensions, the first sequence of operations on the first display area is related to selecting an ordered subset of dimensions with a plurality of values, each operation of the first sequence of operations is based on the ordered subset of dimensions of a previous operation of the first sequence of operations followed by an arbitrary dimension among the dimensions, and each query of the first sequence of queries generates a temporary set of identifiers for every key dimension of the subset of key dimensions.

9. The data exploration apparatus of Claim 6, wherein when narrowing down to the target of interest, the data process engine further creates an identifiable label corresponding to the target of interest on the first data object in response to a confirmation operation on the first display area, the identifiable label corresponds to the first set of identifiers, and the data process engine further performs the following operations:

transmitting, via the connection, a notification message regarding the creation of the identifiable label to the another interoperable data exploration apparatus,

receiving, via the connection, a request for the first set of identifiers from the another interoperable data exploration apparatus, and

transmitting, via the connection, the first set of identifiers to the another interoperable data

exploration apparatus.

10. The interoperable data exploration apparatus of Claim 6, wherein the data process engine further transmits, via the connection, at least one attribute of each identifier in the first set of identifiers from the first data object to the another interoperable data exploration apparatus, and the another interoperable data exploration apparatus performs the second task of data exploration on the second data object by issuing the second sequence of queries in response to the second sequence of operations on the second display area according to the first set of identifiers and the at least one attribute of each identifier in the first set of identifiers to produce the target dataset.

11. A federated data exploration system, comprising:

a central management apparatus; and

a first interoperable data exploration apparatus and a second interoperable data exploration apparatus, wherein each of the first interoperable data exploration apparatus and the second interoperable data exploration apparatuses installs a data object package including a data process engine, a database, and a visualization user interface,

wherein the first interoperable data exploration apparatus continuously inputs a first stream of data into the corresponding database to derive a first data object, retains the first data object, and transmits a first piece of meta information to the central management apparatus to register the first data object, and the first piece of meta information describes a plurality of first identifiers and a plurality of first attributes,

wherein the second interoperable data exploration apparatus continuously inputs a second stream of data into the corresponding database to derive a second data object, retains the second data object, and transmits a second piece of meta information to the central management apparatus to register the second data object, and the second piece of meta information describes a plurality of second identifiers and a plurality of second attributes,

wherein the first interoperable data exploration apparatus transmits a message to the central management apparatus for subscribing the second data object,

wherein the first interoperable data exploration apparatus enables a display screen to display the corresponding visualization user interface comprising a first display area for the first data object and a second display area for the second data object by establishing a connection to the second interoperable data exploration apparatus,

wherein the second interoperable data exploration apparatus performs a first task of data exploration on the second data object by issuing a first sequence of queries in response to a first sequence of operations on the second display area to narrow down a target of interest, each query of the first sequence of queries is applied on a resulted dataset of a previous query of the first sequence of queries, and a first query of the first sequence of queries is applied on the second data object,

wherein the second interoperable data exploration apparatus transmits a first set of identifiers corresponding to the target of interest to the central management apparatus, the central management apparatus transmits a second set of identifiers corresponding to the first set of identifiers to the first interoperable data exploration apparatus, and

the first interoperable data exploration apparatus performs a second task of data exploration on the first data object by issuing a second sequence of queries in response to a second sequence of operations on the first display area according to the second set of identifiers to produce a target dataset.

12. The federated data exploration system of Claim 11, wherein the corresponding visualization user interface displayed on the display screen further comprises a third display area, the third display area is configured to display a plurality of registered data objects, each of the registered data objects has a registered piece of meta information in the central management apparatus, the registered pieces of meta information and the first piece of meta information have at least one common identifier description.

13. The federated data exploration system of Claim 11, wherein the central management apparatus transforms the first set of identifiers into the second set of identifiers one-to-one.

14. A federated data exploration system, comprising:

a central management apparatus; and

a first interoperable data exploration apparatus and a second interoperable data exploration apparatus, wherein each of the first interoperable data exploration apparatus and the second interoperable data exploration apparatus installs a data object package including a data process engine, a database, and a visualization user interface,

wherein the first interoperable data exploration apparatus continuously inputs a first stream of data

into the corresponding database to derive a first data object, retains the first data object, and transmits a first piece of meta information to the central management apparatus to register the first data object, and the first piece of meta information describes a plurality of first identifiers and a plurality of first attributes,

wherein the second interoperable data exploration apparatus continuously inputs a second stream of data into the corresponding database to derive a second data object, retains the second data object, and transmits a second piece of meta information to the central management apparatus to register the second data object, and the second piece of meta information describes a plurality of second identifiers and a plurality of second attributes,

wherein the first interoperable data exploration apparatus transmits a message to the central management apparatus for subscribing the second data object,

wherein the first interoperable data exploration apparatus enables a display screen to display the corresponding visualization user interface comprising a first display area for the first data object and a second display area for the second data object by establishing a connection to the second interoperable data exploration apparatus,

wherein the first interoperable data exploration apparatus performs a first task of data exploration on the first data object by issuing a first sequence of queries in response to a first sequence of operations on the first display area to narrow down a target of interest, each query of the first sequence of queries is applied on a resulted dataset of a previous query of the first sequence of queries, and a first query of the first sequence of queries is applied on the first data object,

wherein the first interoperable data exploration apparatus transmits a first set of identifiers corresponding to the target of interest to the central management apparatus, the central management apparatus transmits a second set of identifiers corresponding to the first set of identifiers to the second interoperable data exploration apparatus, and the second interoperable data exploration apparatus performs a second task of data exploration on the second data object by issuing a second sequence of queries in response to a second sequence of operations on the second display area according to the second set of identifiers to produce a target dataset.

15. The federated data exploration system of Claim 14, wherein the correspondiong visualization user interface displayed on the display screen further comprises a third display area, the third display area is configured to display a plurality of registered data objects, each of the registered data objects has a registered piece of meta information in the central management apparatus, the registered pieces of meta information and the first piece of meta information have at least one common identifier description.

16. The federated data exploration system of Claim 14, wherein the central management apparatus transforms the first set of identifiers into the second set of identifiers one-to-one.