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(54) **DATA PROCESSING APPARATUSES, METHODS, AND NON-TRANSITORY TANGIBLE MACHINE-READABLE MEDIUM THEREOF**

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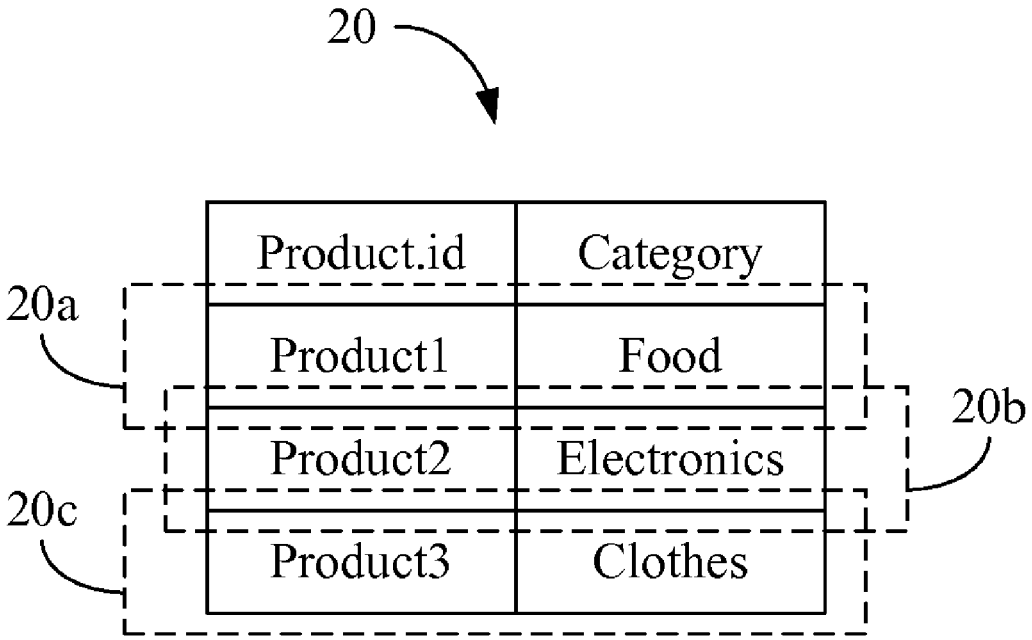
(57) **ABSTRACT**

Data processing apparatuses, methods, and non-transitory tangible machine-readable medium thereof are provided. The data processing method accesses a dimension table. The dimension table is defined with a plurality of attributes and includes at least one member. Each of the at least one member includes a plurality of attribute values corresponding to the attributes. The data processing method generates a smart index for each of the distinct attribute values. Each of the smart indexes includes a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value, the first values are distinct. The data processing method integrates the smart indexes into a smart index record, wherein each of the smart indexes has an index within the smart index record.



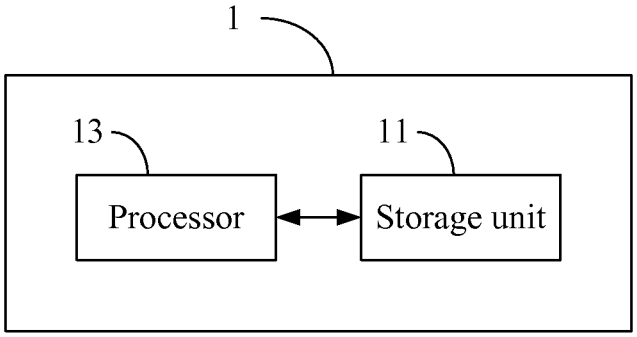

1
13
11
Processor
Storage unit

FIG. 1

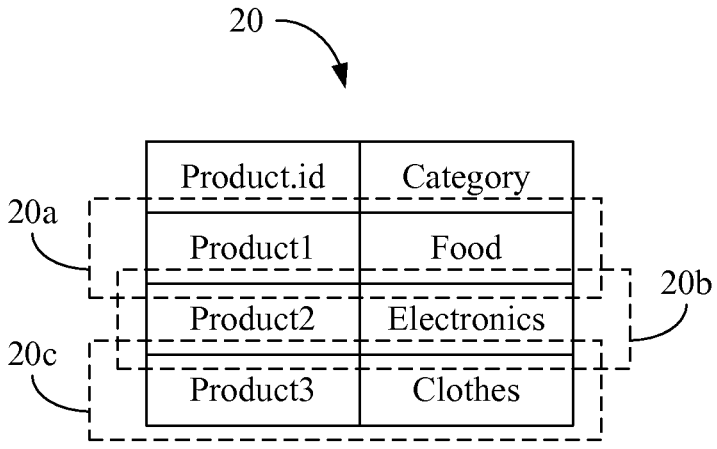

20
Product.id
Category
20a
Product1
Food
20b
Product2
Electronics
20c
Product3
Clothes

FIG. 2A

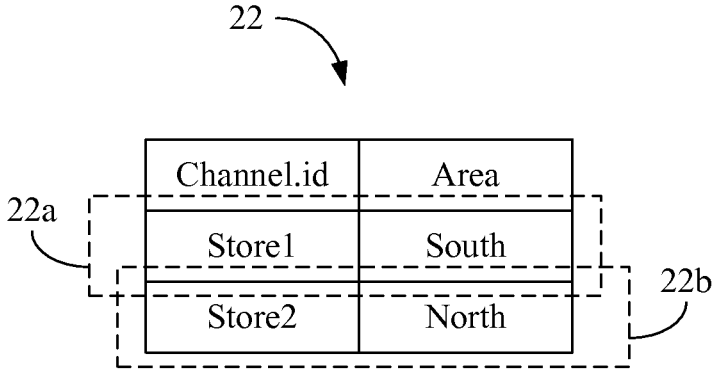

22
Channel.id
Area
22a
Store1
South
22b
Store2
North

FIG. 2B

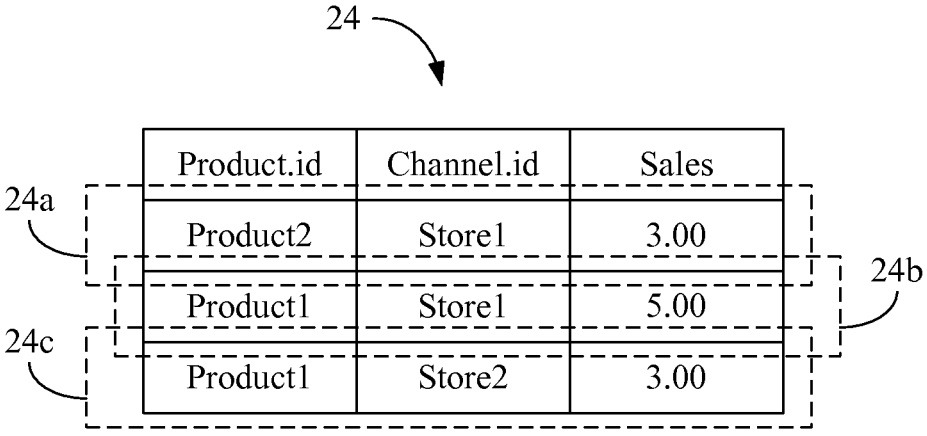
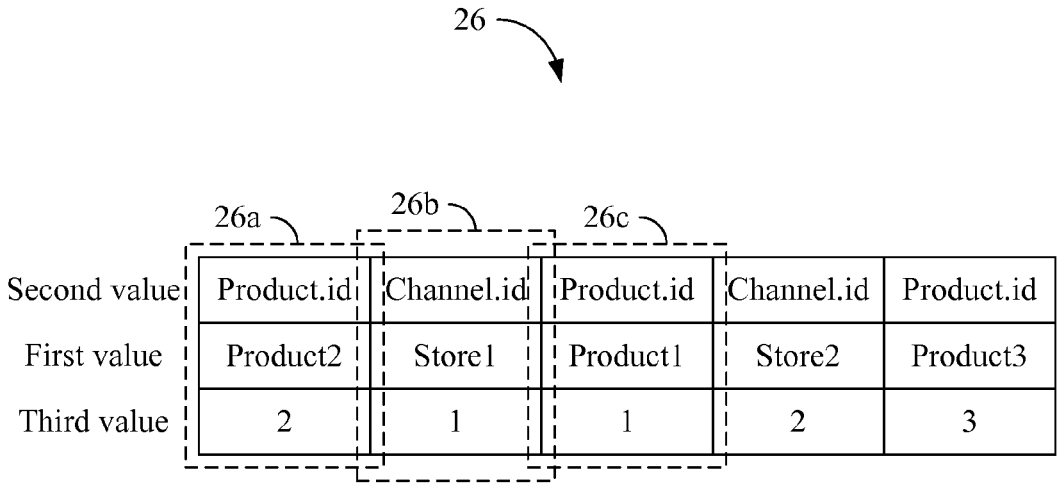

24
Product.id
Channel.id
Sales
24a
Product2
Store1
3.00
24b
Product1
Store1
5.00
24c
Product1
Store2
3.00

FIG. 2C



Second value	Category	Category	Category	Area	Area
First value	Food	Electronics	Clothes	South	North
Third value	1	2	3	1	2
Index	6	7	8	9	10

FIG. 2D

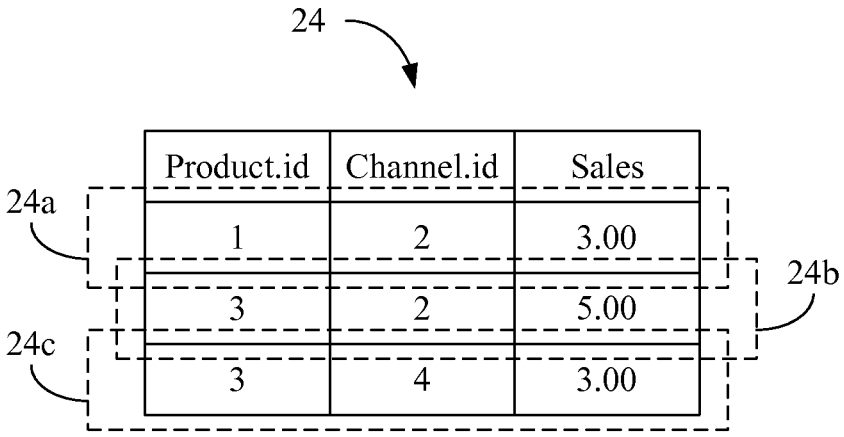

24
Product.id
Channel.id
Sales
24a
1
2
3.00
24b
3
2
5.00
24c
3
4
3.00

FIG. 2E

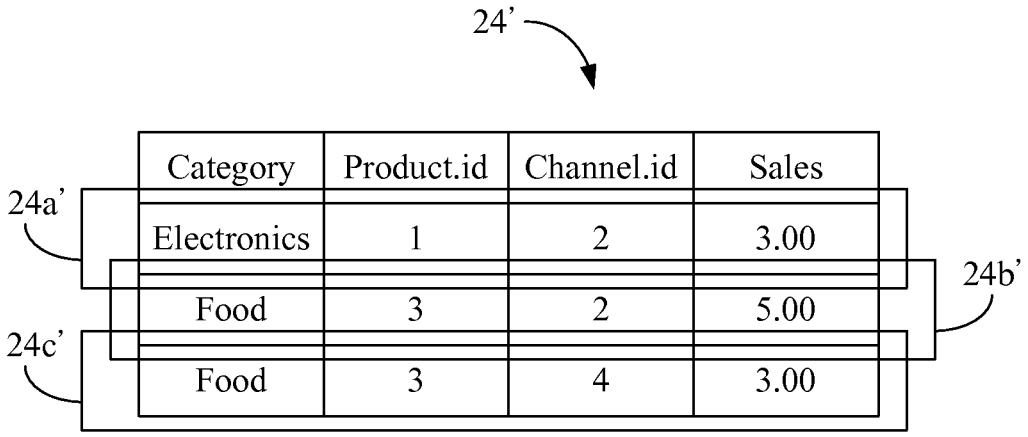

24'
Category
Product.id
Channel.id
Sales
24a'
Electronics
1
2
3.00
24b'
Food
3
2
5.00
24c'
Food
3
4
3.00

FIG. 2F

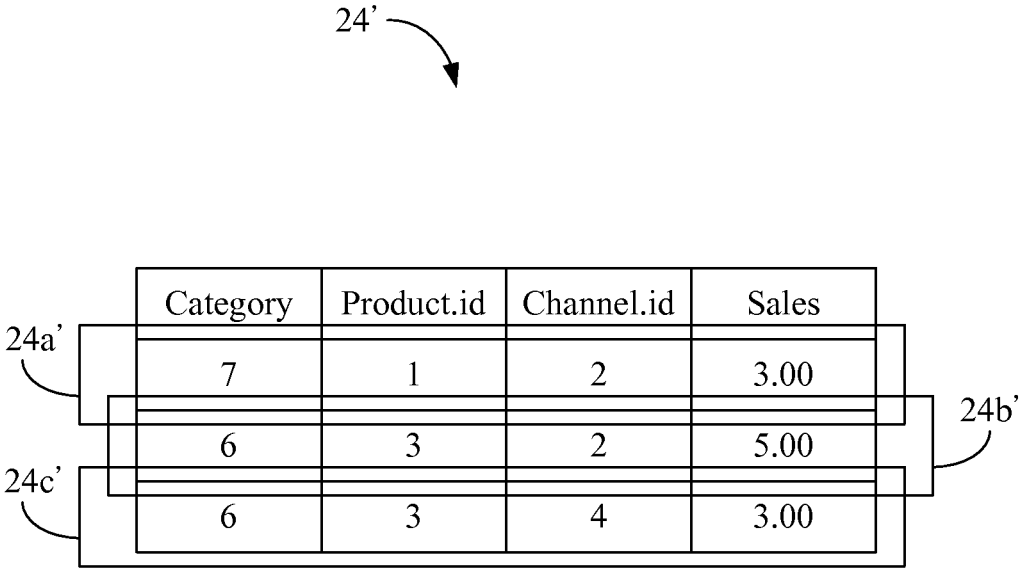
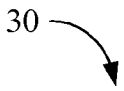
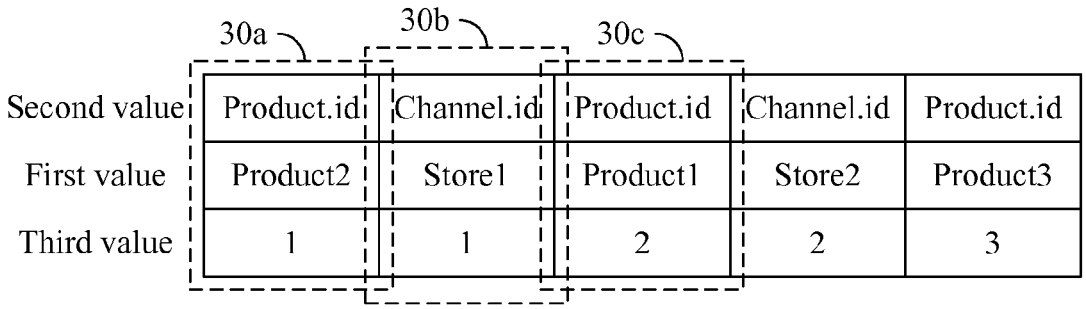

24'
Category
Product.id
Channel.id
Sales
24a'
7
1
2
3.00
24b'
6
3
2
5.00
24c'
6
3
4
3.00

FIG. 2G

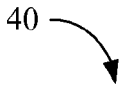




Second value	Product.id	Channel.id	Product.id	Channel.id	Product.id
First value	Product2	Store1	Product1	Store2	Product3
Third value	1	1	2	2	3
Index	1	2	3	4	5

Second value	Category	Category	Category	Area	Area
First value	Food	Electronics	Clothes	South	North
Third value	1	2	3	1	2
Index	6	7	8	9	10

FIG. 3



Second value	Product.id	Channel.id	Product.id	Channel.id	Product.id
First value	Product2	Store1	Product1	Store2	Product3
Third value	2	1	1	2	3
Fourth value	1	1	2	2	3
Index	1	2	3	4	5

Second value	Category	Category	Category	Area	Area
First value	Food	Electronics	Clothes	South	North
Third value	1	2	3	1	2
Fourth value	1	2	3	1	2
Index	6	7	8	9	10

FIG. 4

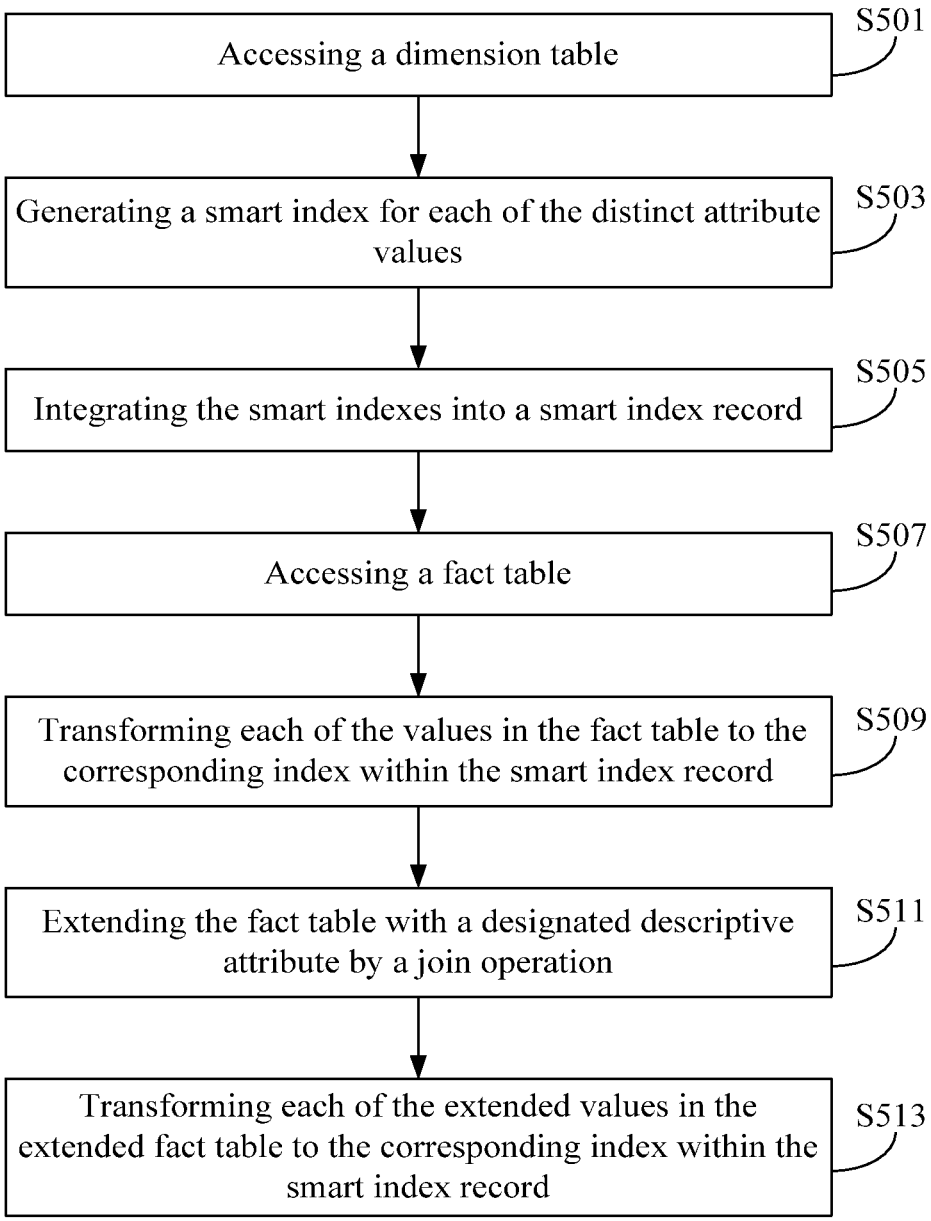

Accessing a dimension table
S501
Generating a smart index for each of the distinct attribute values
S503
Integrating the smart indexes into a smart index record
S505
Accessing a fact table
S507
Transforming each of the values in the fact table to the corresponding index within the smart index record
S509
Extending the fact table with a designated descriptive attribute by a join operation
S511
Transforming each of the extended values in the extended fact table to the corresponding index within the smart index record
S513

FIG. 5A

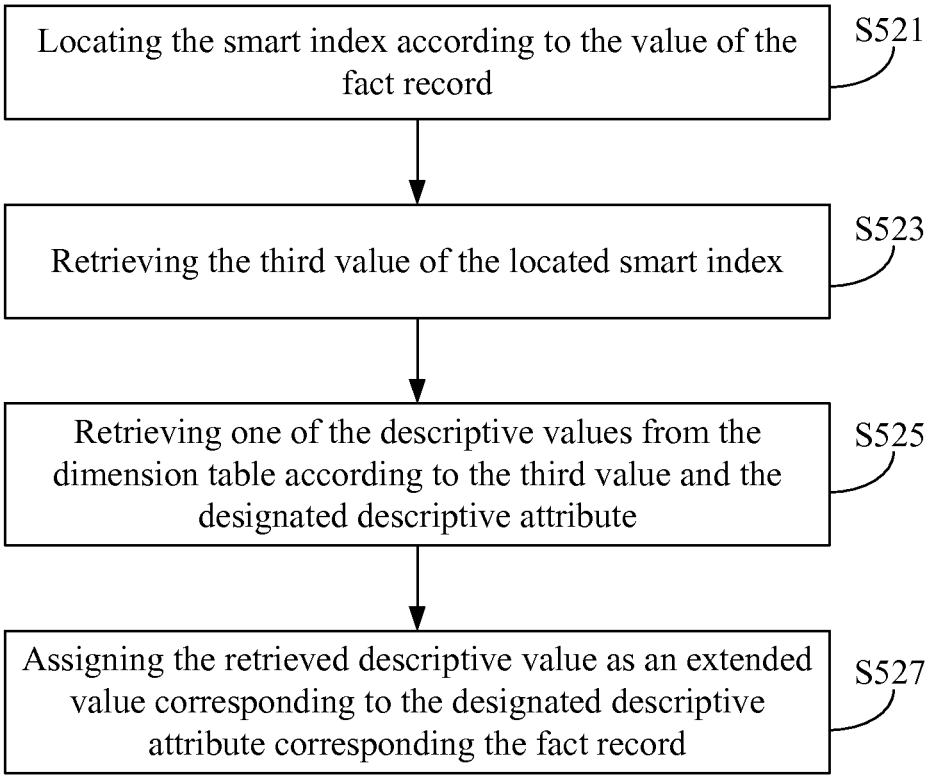

Locating the smart index according to the value of the fact record
S521
Retrieving the third value of the located smart index
S523
Retrieving one of the descriptive values from the dimension table according to the third value and the designated descriptive attribute
S525
Assigning the retrieved descriptive value as an extended value corresponding to the designated descriptive attribute corresponding the fact record
S527

FIG. 5B

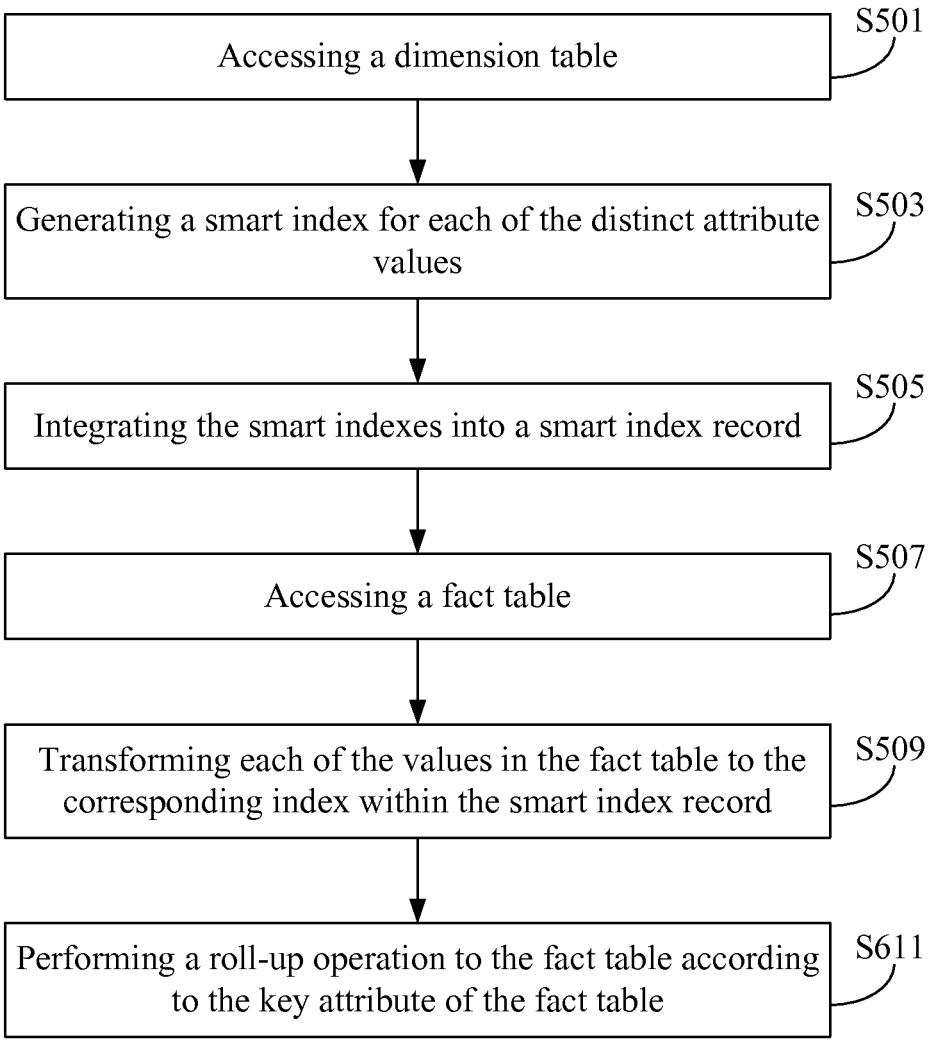

Accessing a dimension table
S501
Generating a smart index for each of the distinct attribute values
S503
Integrating the smart indexes into a smart index record
S505
Accessing a fact table
S507
Transforming each of the values in the fact table to the corresponding index within the smart index record
S509
Performing a roll-up operation to the fact table according to the key attribute of the fact table
S611

FIG. 6A

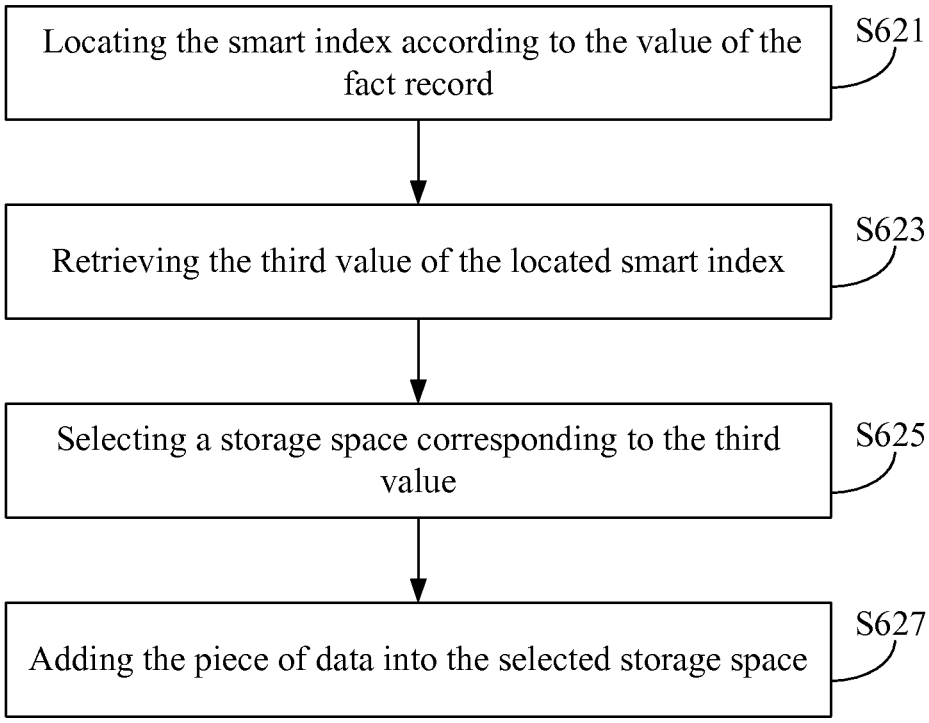

Locating the smart index according to the value of the fact record
S621
Retrieving the third value of the located smart index
S623
Selecting a storage space corresponding to the third value
S625
Adding the piece of data into the selected storage space
S627

FIG. 6B

DATA PROCESSING APPARATUSES, METHODS, AND NON-TRANSITORY TANGIBLE MACHINE-READABLE MEDIUM THEREOF

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] Not applicable.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to data processing apparatuses, methods, and non-transitory tangible machine-readable medium thereof. More particularly, the present invention relates to data processing apparatuses, methods, and non-transitory tangible machine-readable medium thereof with smart index.

[0004] 2. Descriptions of the Related Art

[0005] With the rapid development in computer technologies, most enterprises collect, store, manipulate, and organize business information/data in computers in a systematic way. Relational databases and on-line analytical processing (OLAP) are examples of commonly adopted technologies.

[0006] Although various commercial products of relational databases and OLAP have been developed, they have shortcomings when the amount of business data being stored becomes huge. There are occasions that a business manager would like to analyze the huge amount of data stored in a database, such as by applying a join operation or a roll-up operation to these data. However, databases on the market today cannot provide a quick response when the amount of data being processed is huge. Accessing and analyzing millions or billions records usually take significant amount of time. For business managers that have to perform analysis and make quick decisions based on big data, the long-processing time of the databases on the market today is intolerable.

[0007] According to the above description, data processing apparatuses, methods, and non-transitory tangible machine-readable medium thereof that can rapidly process big/huge/large data is in an urgent need.

SUMMARY OF THE INVENTION

[0008] An objective of the present invention is to provide a data processing apparatus, which comprises a storage unit and a processor electrically connected to the storage unit. The storage unit is stored with a dimension table. The dimension table is defined with a plurality of attributes and comprises at least one member, wherein each of the at least one member comprises a plurality of attribute values corresponding to the attributes one-on-one. The processor is configured to generate a smart index for each of the distinct attribute values and integrate the smart indexes into a smart index record. Each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value. The first values are distinct. Each of the smart indexes has an index within the smart index record.

[0009] Another objective of the present invention is to provide a data processing method for use in an electronic apparatus. The method comprises the following steps of: (a) accessing a dimension table, wherein the dimension table is defined with a plurality of attributes and comprises at least one member, wherein each of the at least one member comprises a plurality of attribute values corresponding to the attributes one-on-one, (b) generating a smart index for each of the distinct attribute values, wherein each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value, the first values are distinct, and (c) integrating the smart indexes into a smart index record, wherein each of the smart indexes has an index within the smart index record.

[0010] A further objective of the present invention is to provide a non-transitory tangible machine-readable medium, which is stored with a computer program. The computer program comprises a plurality of codes, wherein the codes are able to execute a data processing method when the computer program is loaded into an electronic apparatus. The data processing method comprising the steps of: (a) accessing a dimension table, wherein the dimension table is defined with a plurality of attributes and comprises at least one member, wherein each of the at least one member comprises a plurality of attribute values corresponding to the attributes one-on-one, (b) generating a smart index for each of the distinct attribute values, wherein each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value, the first values are distinct, and (c) integrating the smart indexes into a smart index record, wherein each of the smart indexes has an index within the smart index record.

[0011] According to the above descriptions, the present invention generates a smart index for each of the distinct attribute values in the dimension table(s) and integrates these smart indexes in a smart index record. Each of the smart indexes comprises a first value equivalent to one of the distinct attribute values, a second value equivalent to the attribute that the first value corresponds to, and at least a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value.

[0012] Depending on different scenarios, the third value of a smart index may be of different values. In some embodiments, the third value of a smart index may be a row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table. For these embodiments, a join operation can be performed efficiently. Yet in some other embodiments, the third value of a smart index may be a process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table.

[0013] The detailed technology and preferred embodiments implemented for the subject invention are described in the following paragraphs accompanying the appended drawings for people skilled in this field to well appreciate the features of the claimed invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** illustrates a schematic view of a data processing apparatus **1** of the present invention;

[0015] FIG. **2**A illustrates the content of the dimension table **20**;

[0016] FIG. **2**B illustrates the content of the dimension table **22**;
[0017] FIG. **2**C illustrates the content of the fact table **24**;
[0018] FIG. **2**D illustrates the smart index record **26** of the first embodiment;
[0019] FIG. **2**E illustrates the transformed fact table **24**;
[0020] FIG. **2**F illustrates the extended fact table **24'** generated by a join operation;
[0021] FIG. **2**G illustrates the transformed extended fact table **24'**;
[0022] FIG. **3** illustrates the smart index record **30** of the second embodiment;
[0023] FIG. **4** illustrates the smart index record **40** of the third embodiment;
[0024] FIG. **5**A and FIG. **5**B illustrates the flowchart of the fourth embodiment; and
[0025] FIG. **6**A and FIG. **6**B illustrates the flowchart of the fifth embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0026] In the following descriptions, data processing apparatuses, methods, and non-transitory tangible machine-readable medium thereof of the present invention will be explained with reference to embodiments thereof. However, these embodiments are not intended to limit the present invention to any specific environment, applications, or particular implementations described in these embodiments. Therefore, description of these embodiments is only for purpose of illustration rather than to limit the present invention. It should be appreciated that elements unrelated to the present invention are omitted from depiction in the following embodiments and the attached drawings.

[0027] FIG. **1** illustrates a schematic view of a data processing apparatus **1** of the present invention. The data processing apparatus **1** comprises a storage unit **11** and a processor **13**, wherein the processor **13** is electrically connected to the storage unit **11**. The storage unit **11** may be a memory, a floppy disk, a hard disk, a compact disk (CD), a mobile disk, a magnetic tape, a database accessible to networks, or any other storage media with the same function and well-known to persons having ordinary skill in the art. The processor **13** may be any of various processors, central processing units (CPUs), microprocessors, or other computing devices well known to persons having ordinary skill in the art. The following embodiments will be described with reference to the data processing apparatus **1**.

[0028] Please refer to FIGS. **1**, **2**A, **2**B, **2**C, **2**D, **2**E, **2**F, and **2**G for a first embodiment of the present invention. The storage unit **11** is stored with two dimension tables **20**, **22** and a fact table **24**. Please be noted that the present invention does not limit the number of the dimension tables and the number of the fact tables stored in the storage unit **11**.

[0029] The content of the dimension table **20** is illustrated in FIG. **2**A. The dimension table **20** is defined with a plurality of attributes (i.e. "Product.id" and "Category" as shown in FIG. **2**A). The dimension table **20** comprises a plurality of members **20***a*, **20***b*, **20***c*, wherein each of the members **20***a*, **20***b*, **20***c* comprises a plurality of attribute values corresponding to the attributes of the dimension table **20** one-on-one. To be more specific, the member **20***a* has a first attribute value (i.e. "Product1") corresponding to the first attribute (i.e. "Product.id") and a second attribute value (i.e. "Food") corresponding to the second attribute (i.e. "Category"), the member **20***b* has a first attribute value (i.e. "Product2") corresponding to the first attribute (i.e. "Product.id") and a second attribute value (i.e. "Electronics") corresponding to the second attribute (i.e. "Category"), and the member **20***c* has a first attribute value (i.e. "Product3") corresponding to the first attribute (i.e. "Product.id") and a second attribute value (i.e. "Clothes") corresponding to the second attribute (i.e. "Category").

[0030] One of the attributes "Product.id" and "Category" of the dimension table **20** is a key attribute and the rest of the attributes is at least one descriptive attribute. To be more specific, the attribute "Product.id" is the key attribute and the attribute "Category" is the descriptive attribute. The attribute values (i.e. "Product1," "Product2," and "Product3") that correspond to the key attribute are the key values, while the attribute values (i.e. "Food," "Electronics," and "Clothes") that corresponds to the descriptive attribute are the descriptive values.

[0031] The content of the dimension table **22** is illustrated in FIG. **2**B. The dimension table **22** is defined with a plurality of attributes (i.e. "Channel.id" and "Area" as shown in FIG. **2**B). The dimension table **22** comprises a plurality of members **22***a*, **22***b*, wherein each of the members **22***a*, **22***b* comprises a plurality of attribute values corresponding to the attributes of the dimension table **22** one-on-one. To be more specific, the member **22***a* has a first attribute value (i.e. "Store1") corresponding to the first attribute (i.e. "Channel.id") and a second attribute value (i.e. "South") corresponding to the second attribute (i.e. "Area") and the member **22***b* has a first attribute value (i.e. "Store2") corresponding to the first attribute (i.e. "Channel.id") and a second attribute value (i.e. "North") corresponding to the second attribute (i.e. "Area").

[0032] One of the attributes "Channel.id" and "Area" is a key attribute and the rest of the attributes is at least one descriptive attribute. Particularly, the attribute "Channel.id" is the key attribute and the attribute "Area" is the descriptive attribute. The attribute values (i.e. "Store1" and "Store2") that correspond to the key attribute are the key values, while the attribute values (i.e. "South" and "North") that corresponds to the descriptive attribute are the descriptive values.

[0033] It should be noted that the present invention does not limit the number of the attributes and the number of the members in each dimension table. That is, the aforesaid dimension tables **20**, **22** are simply two exemplary dimension tables of the present invention.

[0034] In some other embodiments, the processor **13** may further transform each of the attributes and the distinct attribute values of the dimension tables **20**, **22** into a unique integer.

[0035] A encoding mechanism is adopted for such transformations. For the embodiments that each of the attributes and the distinct attribute values is transformed into a unique integer, dimension tables **20**, **22** and the fact table **24** may be stored more compactly.

[0036] The content of the fact table **24** is illustrated in FIG. **2**C. The fact table **24** is defined with two key attributes (i.e. "Product.id" and "Channel.id") and a data field (i.e. "Sales"), wherein each of the key attributes of the fact table **24** is a key attribute of one of the dimension tables **20**, **22**. The fact table **24** comprises three fact records **24***a*, **24***b*, **24***c*. Each of the fact records **24***a*, **24***b*, **24***c* comprises a first value corresponding to one of the key attribute, a second value corresponding to another key attribute, and a piece of data corresponding to the

data field, wherein each of the first value and the second value is equivalent to one of the key values of one of the dimension tables **20**, **22**.

[0037] To be more specific, the fact record **24***a* comprises a first value (i.e. "Product2") equivalent to one of the key values of the dimension table **20**, a second value (i.e. "Store1") equivalent to one of the key values of the dimension table **22**, and the piece of data (i.e. 3.00). The fact record **24***b* comprises a first value (i.e. "Product1") equivalent to one of the key values of the dimension table **20**, a second value (i.e. "Store1") equivalent to one of the key values of the dimension table **22**, and the piece of data (i.e. 5.00). The fact record **24***c* comprises a first value (i.e. "Product1") equivalent to one of the key values of the dimension table **20**, a second value (i.e. "Store2") equivalent to one of the key values of the dimension table **22**, and the piece of data (i.e. 3.00). The first values of the fact records **24***a*, **24***b*, **24***c* correspond to the key attribute (i.e. "Product.id"), while the second values of the fact records **24***a*, **24***b*, **24***c* correspond to the key attribute (i.e. "Channel.id").

[0038] It should be noted that the present invention does not limit the number of key attributes and the number of fact records in a fact table. That is, the aforesaid fact table **24** is simply an exemplary fact table of the present invention.

[0039] In this embodiment, the processor **13** generates a smart index for each of the distinct attribute values (i.e. "Product2," "Store1," "Product1," "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North") in the dimension tables **20**, **22** and integrates the smart indexes into a smart index record **26** as shown in FIG. **2**D. Each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value. Particularly, the rank in this embodiment is a row number of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table. It is noted that the first values of the smart indexes are distinct because these first values correspond to distinct attribute values. In addition, each of the smart indexes has an index within the smart index record **26**.

[0040] The content of the smart indexes and the smart index record **26** are elaborated with several examples shown in FIG. **2**D. The processor **13** generates a smart index **26***a* for the attribute value "Product2." Particularly, the smart index **26***a* comprises a first value (i.e. "Product2"), a second value (i.e. "Product.id") equivalent to the attribute corresponding to the first value, and a third value (i.e. 2) indicating the rank of the first value (i.e. "Product2") comparing to the rest attribute values (i.e. "Product1" and "Product3") corresponding to the second value (i.e. "Product.id"). As mentioned, the rank in this embodiment is the row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table **20**. Since the first value (i.e. "Product2") is stored in the second row of the dimension table **20**, the third value of the smart index **26***a* is 2.

[0041] The processor **13** generates a smart index **26***b* for the attribute value "Store1." Particularly, the smart index **26***b* comprises a first value (i.e. "Store1"), a second value (i.e. "Channel.id") equivalent to the attribute corresponding to the first value, and a third value (i.e. 1) indicating the rank of the first value (i.e. "Store1") comparing to the rest attribute values (i.e. "Store2") corresponding to the second value (i.e. "Channel.id"). As mentioned, the rank in this embodiment is the row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table **22**. Since the first value (i.e. "Store1") is stored in the first row of the dimension table **22**, the third value of the smart index **26***b* is 1.

[0042] The processor **13** generates a smart index **26***c* for the attribute value "Product1." Particularly, the smart index **26***c* comprises a first value (i.e. "Product1"), a second value (i.e. "Product.id") equivalent to the attribute corresponding to the first value, and a third value (i.e. 1) indicating the rank of the first value (i.e. "Product1") comparing to the rest attribute values (i.e. "Product2" and "Product 3") corresponding to the second value (i.e. "Product.id"). As mentioned, the rank in this embodiment is the row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table **20**. Since the first value (i.e. "Product1") is stored in the first row of the dimension table **22**, the third value of the smart index **26***c* is 1.

[0043] The processor **13** also generates a smart index for each of the rest attribute values (i.e. "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North") as shown in FIG. **2**D. Please be noted that the present invention does not limit the order of the attribute values when generating the smart indexes. Afterwards, the processor **13** integrates these smart indexes into a smart index record **26** and assigns an index to each of the smart indexes within the smart index record **26**. For example, the index of the smart index **26***a* with in the smart index record **26** is 1, the index of the smart index **26***b* with in the smart index record **26** is 2, and etc.

[0044] Next, the processor **13** transforms each of the first values and second values in the fact table **24** to the corresponding index within the smart index record **26** as illustrated in FIG. **2**E. In FIG. **2**E, the first value (i.e. "Product2") and the second value (i.e. "Store1") of the fact record **24***a* are transformed into 1 (i.e. the index of "Product2" in the smart index record **26**) and 2 (i.e. the index of "Store1" in the smart index record **26**) respectively. The first value (i.e. "Product1") and the second value (i.e. "Store1") of the fact record **24***b* are transformed into 3 (i.e. the index of "Product1" in the smart index record **26**) and 2 (i.e. the index of "Store1" in the smart index record **26**) respectively. The first value (i.e. "Product1") and the second value (i.e. "Store2") of the fact record **24***c* are transformed into 3 (i.e. the index of "Product1" in the smart index record **26**) and 4 (i.e. the index of "Store2" in the smart index record **26**) respectively.

[0045] When a user intends to dig more information about the fact table **24**, a join operation may be applied to the fact table **24** with reference to a designated descriptive attribute. The designated descriptive attribute is one of the descriptive attributes of the dimension tables **20**, **22**. The attribute values corresponding to the designated descriptive attribute are the information that the user intends to learn. The user may input a command including a name (or identity) of the fact table **24**, the designated descriptive attribute, and the join operation through an interface (not shown) of the data processing apparatus **1**. After receiving the command, the processor **13** extends the fact table **24** with the designated descriptive attribute by the join operation. It is emphasized that the transformed fact table **24** shown in FIG. **2**E is used in the join operation.

[0046] For convenience, it is assumed that the designated descriptive attribute is "Category." Nevertheless, please be noted that the designated descriptive attribute may be other ones. The extension of the fact table **24** with the designated

descriptive attribute by the join operation is elaborated herein. The join operation executed by the processor **13** is applied to each of the fact records **24***a*, **24***b*, **24***c*. For each of the fact records **24***a*, **24***b*, **24***c*, the join operation locates the smart index according to the value of the fact record, retrieves the third value of the located smart index, retrieves one of the descriptive values from the dimension table according to the third value and the designated descriptive attribute, and assigns the retrieved descriptive value as an extended value corresponding to the designated descriptive attribute within the fact record. The details of applying the join operation to each of the fact records **24***a*, **24***b*, **24***c* is described below.

[0047] For the fact record **24***a*, the join operation locates a smart index according to the first value (i.e. 1) of the fact record **24***a*. The first value of the fact record **24***a* is used for locating the smart index because the first value and the designated descriptive attribute (i.e. "Category") corresponds to the same dimension table **20**. If the designated descriptive attribute corresponds to the dimension table **22**, the second value (i.e. 2) will be used for locating the smart index because the second value corresponds to the dimension table **22**. In this example, the smart index **26***a* is located because its index within the smart index record **26** is 1, which is equivalent to the first value of the fact record **24***a*. Then, the join operation retrieves the third value of the located smart index **26***a*, which is 2. As mentioned, the third value of the located smart index **26***a* is the row number in essential. Next, the join operation retrieves the descriptive value "Electronics" from the dimension table **20** according to the third value (i.e. 2) of the located smart index **26***a* and the designated descriptive attribute (i.e. "Category"). The descriptive value "Electronics" is retrieved because it is stored in the second row (indicated by the third value of the located smart index **26***a*) corresponding to the designated descriptive attribute (i.e. "Category"). Next, the join operation assigns the retrieved descriptive value (i.e. "Electronics") as an extended value corresponding to the designated descriptive attribute corresponding to the fact record **24***a*. Please see the extended fact record **24***a*' in the extended fact table **24**' in FIG. **2**F.

[0048] For the fact record **24***b*, the join operation locates a smart index according to the first value (i.e. 3) of the fact record **24***b*. In this example, the smart index **26***c* is located because its index within the smart index record **26** is 3, which is equivalent to the first value of the fact record **24***b*. Then, the join operation retrieves the third value of the located smart index **26***c*, which is 1. As mentioned, the third value of the located smart index **26***c* is the row number in essential. Next, the join operation retrieves the descriptive value "Food" from the dimension table **20** according to the third value (i.e. 1) of the located smart index **26***c* and the designated descriptive attribute (i.e. "Category"). The descriptive value "Food" is retrieved because it is stored in the first row (indicated by the third value of the located smart index **26***c*) corresponding to the designated descriptive attribute (i.e. "Category"). Next, the join operation assigns the retrieved descriptive value (i.e. "Food") as an extended value corresponding to the designated descriptive attribute corresponding to the fact record **24***b*. Please see the extended fact record **24***b*' in the extended fact table **24**' in FIG. **2**F.

[0049] As to the fact record **24***c*, the join operation performs similar operations as described above and results in the extended fact record **24***c*' in the extended fact table **24**'. The details are not repeated herein. After the derivation of the extended fact table **24**', the user is able to know the categories of each of the extended fact records **24***a*', **24***b*', **24***c*' in the extended fact table **24**'.

[0050] For better performance in the future, the processor **13** may further transforms each of the extended values in the extended fact table **24**' to the corresponding index within the smart index record **26** by similar fashion as shown in FIG. **2**G. In FIG. **2**G, the extended value (i.e. "Electronics") of the extended fact record **24***a*' is transformed into 7 (i.e. the index of "Electronics" in the smart index record **26**). The extended value (i.e. "Food") of the extended fact record **24***b*' is transformed into 6 (i.e. the index of "Food" in the smart index record **26**). Likewise, the extended value (i.e. "Food") of the extended fact record **24***c*' is transformed into 6 (i.e. the index of "Food" in the smart index record **26**).

[0051] According to the above descriptions, each of the distinct attribute values (i.e. "Product2," "Store1," "Product1," "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North") in the dimension tables **20**, **22** has a corresponding smart index in the smart index record **26**. Furthermore, each of the smart indexes comprises a first value equivalent to one of the distinct attribute values, a second value equivalent to the attribute that the first value corresponds to, and a third value indicating a rank of the first value (i.e. a row number of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table). With these special smart indexes, a fact table can be rapidly extended by a join operation and a designated descriptive attribute (which is one of the distinct attribute values) because attribute values corresponding to the designated descriptive attribute can be quickly located through the smart indexes. Even when a fact table comprises millions or billions fact records, a join operation still can be processed efficiently.

[0052] Please refer to FIGS. **1**, **2**A, **2**B, **2**C, **2**E and **3** for a second embodiment of the present invention. In this embodiment, the storage unit **11** is also stored with two dimension tables **20**, **22** and the fact table **24**. The content of the dimension tables **20**, **22** and the fact table **24** has been described in the first embodiment; hence, the details are not repeated herein. There are two main differences between the first and second embodiments. First, the smart indexes and the smart index record are different. Second, the operation that a user intends to execute is different. Please be noted that the following descriptions will only focused on these differences.

[0053] In this embodiment, the processor **13** generates a smart index for each of the distinct attribute values (i.e. "Product2," "Store1," "Product1," "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North") in the dimension tables **20**, **22** and integrates the smart indexes into a smart index record **30** as shown in FIG. **3**. Each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value. Particularly, the rank in this embodiment is a process order of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table. It is noted that the first values of the smart indexes are distinct because these first values correspond to distinct attribute values. In addition, each of the smart indexes has an index within the smart index record **30**.

[0054] The content of the smart indexes and the smart index record **30** are elaborated with several examples shown in FIG.

3. In this embodiment, the order for generating the smart indexes among these distinct attribute values is: "Product2," "Store1," "Product1," "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North." However, please be noted that the present invention does not limit the order of the attribute values when generating the smart indexes.

[0055] First, the processor **13** generates a smart index **30***a* for the attribute value "Product2" according to the aforementioned order. The smart index **30***a* comprises a first value (i.e. "Product2"), a second value (i.e. "Product.id") equivalent to the attribute corresponding to the first value, and a third value (i.e. 1) indicating the rank of the first value (i.e. "Product2") comparing to the rest attribute values (i.e. "Product1" and "Product3") corresponding to the second value (i.e. "Product.id"). As mentioned, the rank in this embodiment is the process order of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table. Since the first value (i.e. "Product2") is the first processed attribute value among the attribute values "Product1," "Product2," and "Product3," the third value of the smart index **30***a* is 1.

[0056] Second, the processor **13** generates a smart index **30***b* for the attribute value "Channel1" according to the aforementioned order. The smart index **30***b* comprises a first value (i.e. "Channel1"), a second value (i.e. "Channel.id") equivalent to the attribute corresponding to the first value, and a third value (i.e. 1) indicating the rank of the first value (i.e. "Channel1") comparing to the rest attribute values (i.e. "Channel2") corresponding to the second value (i.e. "Channel.id"). As mentioned, the rank in this embodiment is the process order of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table. Since the first value (i.e. "Channel1") is the first processed attribute value among the attribute values "Channel1" and "Channel2," the third value of the smart index **30***b* is 2.

[0057] Third, the processor **13** generates a smart index **30***c* for the attribute value "Product1" according to the aforementioned order. The smart index **30***c* comprises a first value (i.e. "Product1"), a second value (i.e. "Product.id") equivalent to the attribute corresponding to the first value, and a third value (i.e. 2) indicating the rank of the first value (i.e. "Product1") comparing to the rest attribute values (i.e. "Product2" and "Product3") corresponding to the second value (i.e. "Product.id"). As mentioned, the rank in this embodiment is the process order of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table. Since the first value (i.e. "Product1") is the second processed attribute value among the attribute values "Product1," "Product2," and "Product3," the third value of the smart index **30***c* is 2.

[0058] The processor **13** also generates a smart index for each of the rest attribute values (i.e. "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North") according to the aforementioned order as shown in FIG. **3**. Afterwards, the processor **13** integrates these smart indexes into a smart index record **30** and assigns an index to each of the smart indexes within the smart index record **30**. For example, the index of the smart index **30***a* with in the smart index record **30** is 1, the index of the smart index **30***b* with in the smart index record **30** is 2, and etc.

[0059] After the generation of the smart index record **30**, the processor **13** transforms each of the first values and second values in the fact table **24** to the corresponding index within the smart index record **30** as illustrated in FIG. **2**E. The details are the same as those described in the first embodiment; hence, they are not repeated herein.

[0060] When a user intends to dig more information about the fact table **24**, a roll-up operation may be applied to the fact table **24** shown in FIG. **2**E according to a designated key attribute of the fact table **24**. It is noted that the designated key attribute is one of the key attributes of the fact table **24**. It is assumed that the designated key attribute of the fact table **24** is "Product.id" for convenience; nevertheless, please be noted that the designated key attribute may be other ones. For each of the fact records **24***a*, **24***b*, **24***c*, the roll-up operation locates the smart index according to the value of the fact record **24**, retrieves the third value of the located smart index, selects a storage space corresponding to the third value, and adds the piece of data into the selected storage space. The details of applying the roll-up operation to each of the fact records **24***a*, **24***b*, **24***c* is described below.

[0061] For the fact record **24***a*, the roll-up operation locates the smart index according to the first value (i.e. 1) of the fact record **24***a*. The first value of the fact record **24***a* is used for locating the smart index because the first value corresponds to the designated key attribute "Product.id." In this example, the smart index **30***a* is located because its index within the smart index record **30** is 1, which is equivalent to the first value of the fact record **24***a*. Then, the roll-up operation retrieves the third value of the located smart index **30***a*, which is 1. Following that, the roll-up operation selects a storage space (not shown) corresponding to the third value of the smart index **30***a* and adds the piece of data (i.e. 3) of the fact record **24***a* into the selected storage space. For convenience, it is assumed that the storage space selected for the fact record **24***a* is denoted as S[1]. Hence, the roll-up operation adds 3 to S[1]. If the storage space is initialized to zero, S[1] will be equivalent to 3 after the process of the fact record **24***a*.

[0062] For the fact record **24***b*, the roll-up operation locates the smart index according to the first value (i.e. 3) of the fact record **24***b*. The first value of the fact record **24***b* is used for locating the smart index because the first value corresponds to the designated key attribute "Product.id." In this example, the smart index **30***c* is located because its index within the smart index record **30** is 3, which is equivalent to the first value of the fact record **24***b*. Then, the roll-up operation retrieves the third value of the located smart index **30***a*, which is 2. Following that, the roll-up operation selects a storage space (not shown) corresponding to the third value of the smart index **30***c* and adds the piece of data (i.e. 5) of the fact record **24***b* into the selected storage space. For convenience, it is assumed that the storage space selected for the fact record **24***b* is denoted as S[2]. Hence, the roll-up operation adds 5 to S[2]. If the storage space is initialized to zero, S[2] will be equivalent to 5 after the process of the fact record **24***b*. As to the fact record **24***c*, the roll-up operation performs similar operations as described above and results in S[2] being updated to 8 (i.e. 5+3=8).

[0063] According to the above descriptions, each of the distinct attribute values (i.e. "Product2," "Store1," "Product1," "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North") in the dimension tables **20**, **22** has a corresponding smart index in the smart index record **30**. Each of the smart indexes comprises a first value equivalent to one of the distinct attribute values, a second value equivalent to the attribute that the first value corresponds to, and a third value indicating a rank of the first value (i.e. a

process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table). With these special smart indexes, a fact table can be rapidly roll-up according to a designated key attribute because the storage spaces for summing up the data of the fact records can be quickly located. Even when a fact table comprises millions or billions fact records, a roll-up operation still can be processed efficiently.

[0064] Please refer to FIGS. **1**, **2**A, **2**B, **2**C, **2**E and **4** for a third embodiment of the present invention. In this embodiment, the storage unit **11** is also stored with two dimension tables **20**, **22** and the fact table **24**. The content of the dimension tables **20**, **22** and the fact table **24** has been described in the first embodiment; hence, the details are not repeated herein. The difference between the third embodiments and the aforesaid two embodiments is the third embodiment integrates the smart indexes generated in the aforesaid two embodiments as shown in FIG. **4**. The following descriptions will only focused on the difference.

[0065] In this embodiment, the processor **13** generates a smart index for each of the distinct attribute values (i.e. "Product2," "Store1," "Product1," "Store2," "Product3," "Food," "Electronics," "Clothes," "South," and "North") in the dimension tables **20**, **22** and integrates the smart indexes into a smart index record **40** as shown in FIG. **4**. Each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, a third value indicating a row number of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table, and a fourth value indicating the process order of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table.

[0066] The details for generating the third value for each smart index are the same as those described in the first embodiment, while the details for generating the fourth value for each smart index are the same as those described in the second embodiment. Hence, the details are not repeated herein. Since each of the smart indexes has a third value and a fourth value, both join operation and roll-up operation can be performed efficiently in this embodiment.

[0067] In addition to the aforesaid operations, the third embodiment can also execute all the operations and functions set forth in the first and second embodiments. How the third embodiment executes these operations and functions will be readily appreciated by those of ordinary skill in the art based on the explanation of the first and second embodiments, and thus will not be further described herein.

[0068] A fourth embodiment of the present invention is a data processing method for use in an electronic apparatus (e.g. the data processing apparatus **1**) and a flowchart of the data processing method is illustrated in FIG. **5**A and FIG. **5**B.

[0069] First, step S**501** is executed by the electronic apparatus for accessing a dimension table. The dimensional table may be stored in the electronic apparatus or a storage external to the electronic apparatus. The dimension table is defined with a plurality of attributes and comprises at least one member, wherein each of the at least one member comprises a plurality of attribute values corresponding to the attributes one-on-one. One of the attributes is a key attribute and the rest of the attributes is at least one descriptive attribute. The attribute values that correspond to the key attribute are the key values, while the attribute values that corresponds to the at least one descriptive attribute are the descriptive values.

[0070] In some embodiments, another step (not shown) may be executed by the electronic apparatus after the execution of the step S**501** for transforming each of the attributes and the distinct attribute values into a unique integer.

[0071] Next, step S**503** is executed by the electronic apparatus for generating a smart index for each of the distinct attribute values. Each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value, the first values are distinct. In this embodiment, the rank is a row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table. Following that, step S**505** is executed by the electronic apparatus for integrating the smart indexes into a smart index record, wherein each of the smart indexes has an index within the smart index record.

[0072] After that, step S**507** is executed by the electronic apparatus for accessing a fact table. The fact table may be stored in the electronic apparatus or a storage external to the electronic apparatus. The fact table is defined with the key attribute and a data field and comprises at least one fact record. Each of the at least one fact record comprises a value equivalent to one of the key values and a piece of data corresponding to the data field. Following that, step S**509** is executed by the electronic apparatus for transforming each of the values in the fact table to the corresponding index within the smart index record.

[0073] Next, step S**511** is executed by the electronic apparatus for extending the fact table with a designated descriptive attribute by a join operation, wherein the designated descriptive attribute is one of the at least one descriptive attribute. To be more specific, for each of the fact records, the join operation executes the steps illustrated in FIG. **5**B. As shown in FIG. **5**B, step S**521** is executed by the electronic apparatus for locating the smart index according to the value of the fact record. Next, step S**523** is executed by the electronic apparatus for retrieving the third value of the located smart index. Following that, step S**525** is executed by the electronic apparatus for retrieving one of the descriptive values from the dimension table according to the third value and the designated descriptive attribute. After that, step S**527** is executed the electronic apparatus for assigning the retrieved descriptive value as an extended value corresponding to the designated descriptive attribute corresponding the fact record. After the steps S**521**, S**523**, S**525**, and S**527** have been applied to every fact record of the fact table, the join operation has been completed.

[0074] After the step S**511**, step S**513** is executed by the electronic apparatus for transforming each of the extended values in the extended fact table to the corresponding index within the smart index record.

[0075] In addition to the aforesaid steps, the fourth embodiment can also execute all the operations and functions set forth in the first embodiment. How the fourth embodiment executes these operations and functions will be readily appreciated by those of ordinary skill in the art based on the explanation of the first embodiment, and thus will not be further described herein.

[0076] A fifth embodiment of the present invention is a data processing method for use in an electronic apparatus (e.g. the

data processing apparatus **1**) and a flowchart of the data processing method is illustrated in FIG. **6**A and FIG. **6**B.

[0077] In this embodiment, the aforementioned steps S**501**, S**503**, S**505**, S**507**, and S**509** are also executed by the electronic apparatus. In this embodiment, the smart indexes generated in the step S**503** are a little bit different from those generated in the fourth embodiment. The step S**503** generates a smart index for each of the distinct attribute values, wherein each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value. Particularly, the rank is a process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table. For the rest steps S**501**, S**505**, S**507**, and S**509**, they are the same as those described in the fourth embodiment; hence, the details are not repeated herein.

[0078] In this embodiment, step S**611** is executed by the electronic apparatus after the execution of the step S**509**. To be more specific, step S**611** is executed for performing a roll-up operation to the fact table according to the key attribute of the fact table. To be more specific, for each of the fact records, the roll-up operation executes the steps illustrated in FIG. **6**B. As shown in FIG. **6**B, step S**621** is executed by the electronic apparatus for locating the smart index according to the value of the fact record. Next, step S**623** is executed by the electronic apparatus for retrieving the third value of the located smart index. Following that, step S**625** is executed by the electronic apparatus for selecting a storage space corresponding to the third value. Afterwards, step S**627** is executed by the electronic apparatus for adding the piece of data into the selected storage space. After the steps S**621**, S**623**, S**625**, and S**627** have been applied to every fact record of the fact table, the roll-up operation has been completed.

[0079] In addition to the aforesaid steps, the fifth embodiment can also execute all the operations and functions set forth in the second embodiment. How the fifth embodiment executes these operations and functions will be readily appreciated by those of ordinary skill in the art based on the explanation of the second embodiment, and thus will not be further described herein.

[0080] Based on the descriptions in the fourth and fifth embodiments, persons having ordinary skill in the art are able to conceive the idea of having a sixth embodiment that combines the steps addressed in both the fourth and fifth embodiments. For the sixth embodiment, the smart indexes generated in the step S**503** are a little bit different from those generated in the fourth and fifth embodiments.

[0081] To be more specific, the step S**503** generating a smart index for each of the distinct attribute values. Particularly, each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, a third value indicating a row number of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table, and a fourth value indicating the process order of the first value comparing to the rest attribute values corresponding to the second value within the corresponding dimension table.

[0082] Since each of the smart indexes has a third value and a fourth value, both join operation (by the steps S**511**, S**513**, S**521**, S**523**, S**525**, and S**527**) and roll-up operation (by the steps S**611**, S**621**, S**623**, S**625**, and S**627**) can be performed efficiently in this embodiment as well. Since these steps have been described in the fourth and fifth embodiments, the details are not repeated herein.

[0083] The data processing methods in the fourth, fifth, and sixth embodiments may be implemented as a computer program. When the computer program is loaded into an electronic apparatus, a plurality of codes comprised in the computer program are able to perform the data processing methods of the fourth, fifth, and sixth embodiments. This computer program may be stored in a tangible machine-readable medium, such as a read only memory (ROM), a flash memory, a floppy disk, a hard disk, a compact disk (CD), a mobile disk, a magnetic tape, a database accessible to networks, or any other storage media with the same function and well known to those skilled in the art.

[0084] According to the above descriptions, the present invention generates a smart index for each of the distinct attribute values in the dimension table(s) and integrates these smart indexes in a smart index record. Each of the smart indexes comprises a first value equivalent to one of the distinct attribute values, a second value equivalent to the attribute that the first value corresponds to, and at least a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value.

[0085] Depending on different scenarios, the third value of a smart index may be of different values. In some embodiments, the third value of a smart index may be a row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table. For these embodiments, a join operation can be performed efficiently. Yet in some other embodiments, the third value of a smart index may be a process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table.

[0086] The above disclosure is related to the detailed technical contents and inventive features thereof. People skilled in this field may proceed with a variety of modifications and replacements based on the disclosures and suggestions of the invention as described without departing from the characteristics thereof. Nevertheless, although such modifications and replacements are not fully disclosed in the above descriptions, they have substantially been covered in the following claims as appended.

What is claimed is:

1. A data processing apparatus, comprising:

a storage unit, being stored with a dimension table, wherein the dimension table is defined with a plurality of attributes and comprises at least one member, each of the at least one member comprises a plurality of attribute values corresponding to the attributes one-on-one; and

a processor, being electrically connected to the storage unit and configured to generate a smart index for each of the distinct attribute values and integrate the smart indexes into a smart index record;

wherein each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value, the first values are distinct, and each of the smart indexes has an index within the smart index record.

2. The data processing apparatus of claim **1**, wherein one of the attributes is a key attribute and the rest of the attributes is

at least one descriptive attribute, the attribute values that correspond to the key attribute are the key values, the attribute values that corresponds to the at least one descriptive attribute are the descriptive values, the storage unit is further stored with a fact table, the fact table is defined with the key attribute and a data field, the fact table comprises at least one fact record, each of the at least one fact record comprises a value equivalent to one of the key values and a piece of data corresponding to the data field, and the processor further transforms each of the values in the fact table to the corresponding index within the smart index record.

3. The data processing apparatus of claim **2**, wherein the rank is a row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table.

4. The data processing apparatus of claim **3**, wherein the processor further extends the fact table with a designated descriptive attribute by a join operation, the designated descriptive attribute is one of the at least one descriptive attribute, wherein for each of the fact records, the join operation locates the smart index according to the value of the fact record, retrieves the third value of the located smart index, retrieves one of the descriptive values from the dimension table according to the third value and the designated descriptive attribute, and assigns the retrieved descriptive value as an extended value corresponding to the designated descriptive attribute corresponding to the fact record.

5. The data processing apparatus of claim **4**, wherein the processor further transforms each of the extended values in the extended fact table to the corresponding index within the smart index record.

6. The data processing apparatus of claim **2**, wherein the rank is a process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table.

7. The data processing apparatus of claim **6**, wherein the processor further performs a roll-up operation to the fact table according to the key attribute of the fact table, wherein for each of the fact records, the roll-up operation locates the smart index according to the value of the fact record, retrieves the third value of the located smart index, selects a storage space corresponding to the third value, and adds the piece of data into the selected storage space.

8. The data processing apparatus of claim **5**, wherein each of the smart indexes further comprises a fourth value, the fourth is a process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table, the processor further performs a roll-up operation to the extended fact table according to the designated descriptive attribute of the extended fact table, wherein for each of the fact records in the extended fact table, the roll-up operation locates the smart index according to the extended value of the fact record, retrieves the fourth value of the located smart index, selects a storage space corresponding to the retrieved fourth value, and adds the piece of data of the fact record into the selected storage space.

9. The data processing apparatus of claim **1**, wherein the processor further transforms each of the attributes and the distinct attribute values into a unique integer.

10. A data processing method for use in an electronic apparatus, comprising the following steps of:

accessing a dimension table, wherein the dimension table is defined with a plurality of attributes and comprises at least one member, wherein each of the at least one member comprises a plurality of attribute values corresponding to the attributes one-on-one;

generating a smart index for each of the distinct attribute values, wherein each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value, the first values are distinct; and

integrating the smart indexes into a smart index record, wherein each of the smart indexes has an index within the smart index record.

11. The data processing method of claim **10**, wherein one of the attributes is a key attribute and the rest of the attributes is at least one descriptive attribute, the attribute values that correspond to the key attribute are the key values, the attribute values that corresponds to the at least one descriptive attribute are the descriptive values, and the data processing method further comprises the steps of:

accessing a fact table, wherein the fact table is defined with the key attribute and a data field, the fact table comprises at least one fact record, each of the at least one fact record comprises a value equivalent to one of the key values and a piece of data corresponding to the data field; and

transforming each of the values in the fact table to the corresponding index within the smart index record.

12. The data processing method of claim **11**, wherein the rank is a row number of the first value comparing to the rest attribute values corresponding to the second value within the dimension table.

13. The data processing method of claim **12**, further comprising the step of:

extending the fact table with a designated descriptive attribute by a join operation, the designated descriptive attribute being one of the at least one descriptive attribute, wherein for each of the fact records the join operation comprises the following steps of:

locating the smart index according to the value of the fact record;

retrieving the third value of the located smart index;

retrieving one of the descriptive values from the dimension table according to the third value and the designated descriptive attribute; and

assigning the retrieved descriptive value as an extended value corresponding to the designated descriptive attribute corresponding the fact record.

14. The data processing method of claim **13**, further comprising the step of:

transforming each of the extended values in the extended fact table to the corresponding index within the smart index record.

15. The data processing method of claim **11**, wherein the rank is a process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table.

16. The data processing method of claim **15**, further comprising the step of:

performing a roll-up operation to the fact table according to the key attribute of the fact table, wherein for each of the fact records, the roll-up operation comprises the following steps of:

locating the smart index according to the value of the fact record;

retrieving the third value of the located smart index;

selecting a storage space corresponding to the third value; and

adding the piece of data into the selected storage space.

17. The data processing method of claim **14**, wherein each of the smart indexes further comprises a fourth value, the fourth is a process order of the first value comparing to the rest attribute values corresponding to the second value within the dimension table, and the data processing method further comprises the step of:

performing a roll-up operation to the extended fact table according to the designated descriptive attribute of the extended fact table, wherein for each of the fact records in the extended fact table, the roll-up operation comprising the steps of:

locating the smart index according to the extended value of the fact record;

retrieving the fourth value of the located smart index;

selecting a storage space corresponding to the retrieved fourth value; and

adding the piece of data of the fact record into the selected storage space.

18. The data processing method of claim **10**, further comprising the step of:

transforming each of the attributes and the distinct attribute values into a unique integer.

19. A non-transitory tangible machine-readable medium, being stored with a computer program, the computer program comprising a plurality of codes, the codes being able to execute a data processing method when the computer program is loaded into an electronic apparatus, the data processing method comprising the steps of:

accessing a dimension table, wherein the dimension table is defined with a plurality of attributes and comprises at least one member, wherein each of the at least one member comprises a plurality of attribute values corresponding to the attributes one-on-one;

generating a smart index for each of the distinct attribute values, wherein each of the smart indexes comprises a first value equivalent to one of the attribute values, a second value equivalent to the attribute corresponding to the first value, and a third value indicating a rank of the first value comparing to the rest attribute values corresponding to the second value, the first values are distinct; and

integrating the smart indexes into a smart index record, wherein each of the smart indexes has an index within the smart index record.

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