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(54) **SYSTEM AND METHOD FOR INDEXING SPATIAL DATA IN A COMPUTER NETWORK USING THE LEAST DIFFERENTIAL SUM AND BINARY DECISION TREE**

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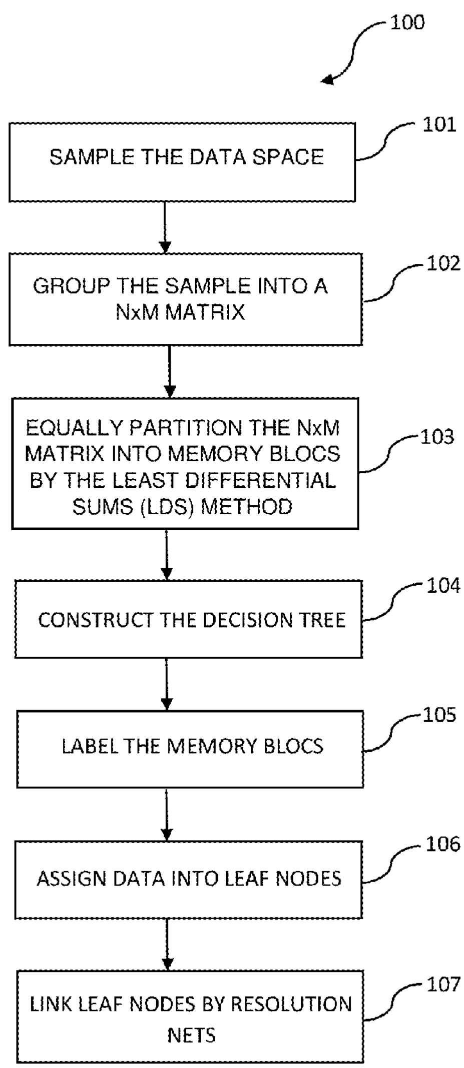
(57) **ABSTRACT**

A method and a computer software for managing a database of a computer network are disclosed which comprises: selecting a data sample, dividing the data sample into an N×M matrix having equal cells, grouping adjacent cells into a plurality of memory blocs by a least differential sum method, constructing a decision tree based on the partitions of the memory blocs, labeling each of the memory blocs based on the decision tree; storing and retrieving data points into the memory blocs; and linking the memory blocs together by a set of resolution nets.



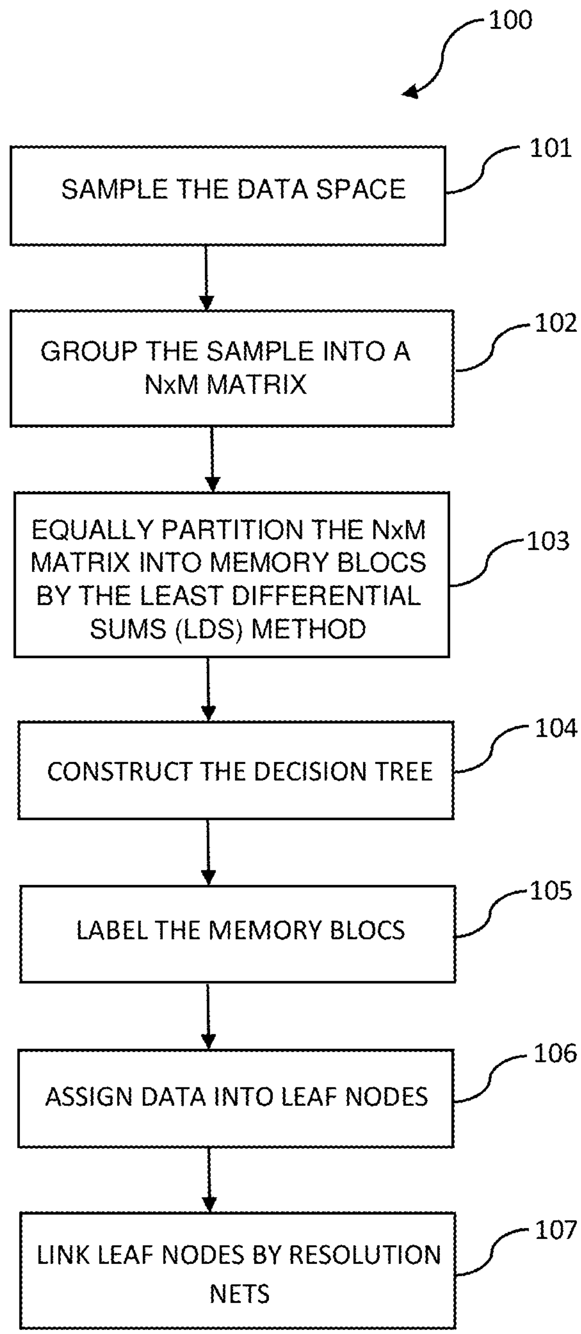

100
SAMPLE THE DATA SPACE
101
GROUP THE SAMPLE INTO A NxM MATRIX
102
EQUALLY PARTITION THE NxM MATRIX INTO MEMORY BLOCS BY THE LEAST DIFFERENTIAL SUMS (LDS) METHOD
103
CONSTRUCT THE DECISION TREE
104
LABEL THE MEMORY BLOCS
105
ASSIGN DATA INTO LEAF NODES
106
LINK LEAF NODES BY RESOLUTION NETS
107

FIG. 1

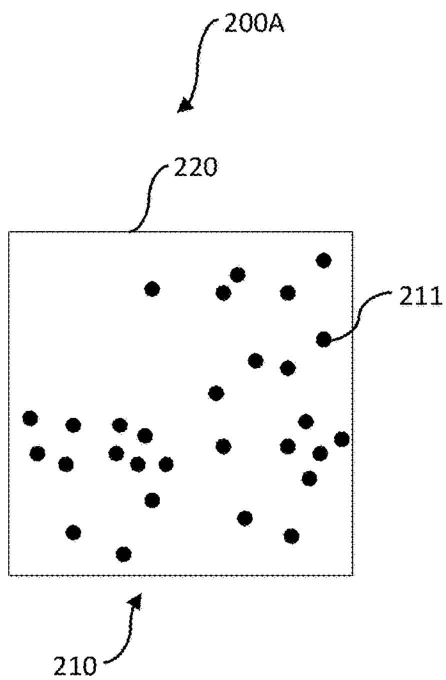


FIG. 2(A)

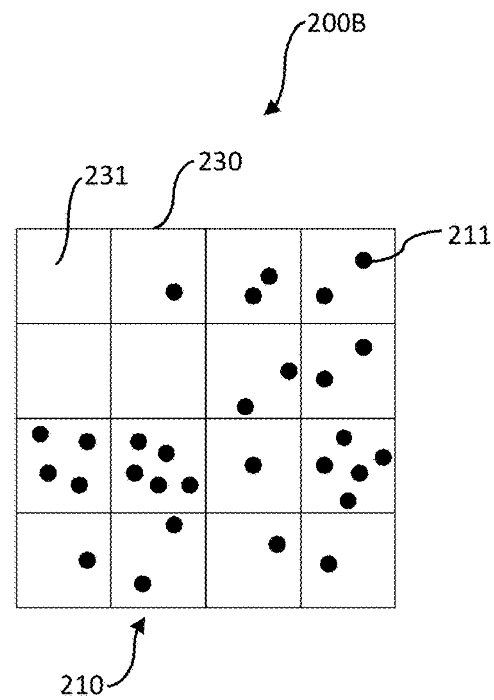
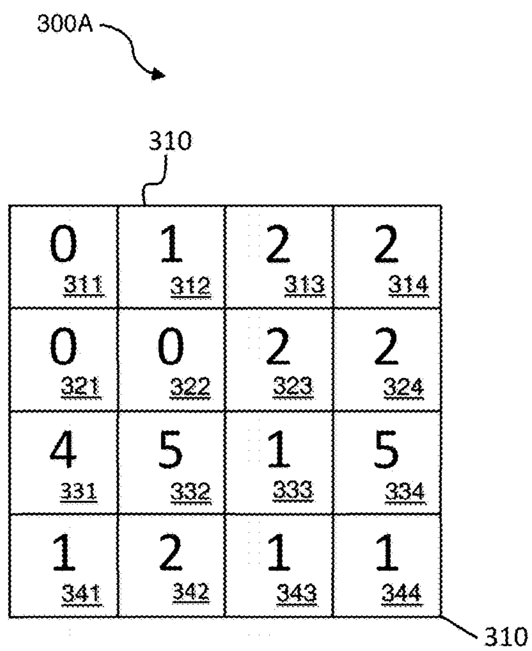
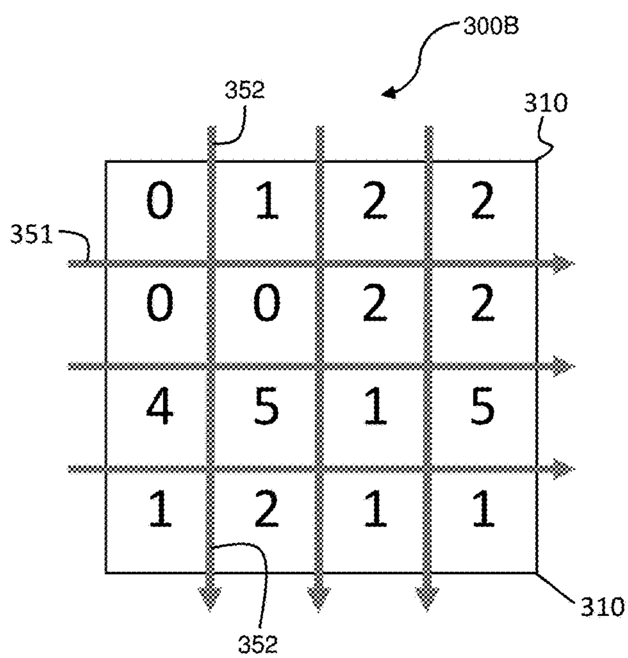


FIG. 2(B)



300A
310
0
311
1
312
2
313
2
314
0
321
0
322
2
323
2
324
4
331
5
332
1
333
5
334
1
341
2
342
1
343
1
344
310

FIG. 3(A)



300B
352
310
351
0
1
2
2
0
0
2
2
4
5
1
5
1
2
1
1
310
352

FIG. 3(B)

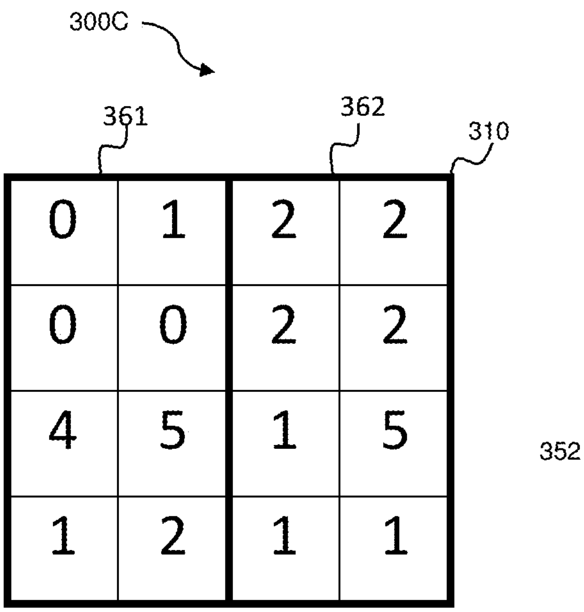

300C
361
362
310
0 1 2 2
0 0 2 2
4 5 1 5
1 2 1 1
352

FIG. 3(C)

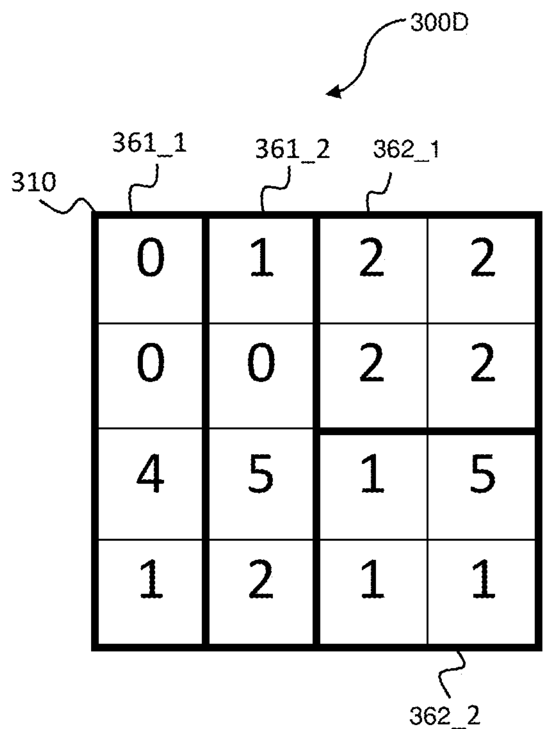

300D
361_1
361_2
362_1
310
0 1 2 2
0 0 2 2
4 5 1 5
1 2 1 1
362_2

FIG. 3(D)

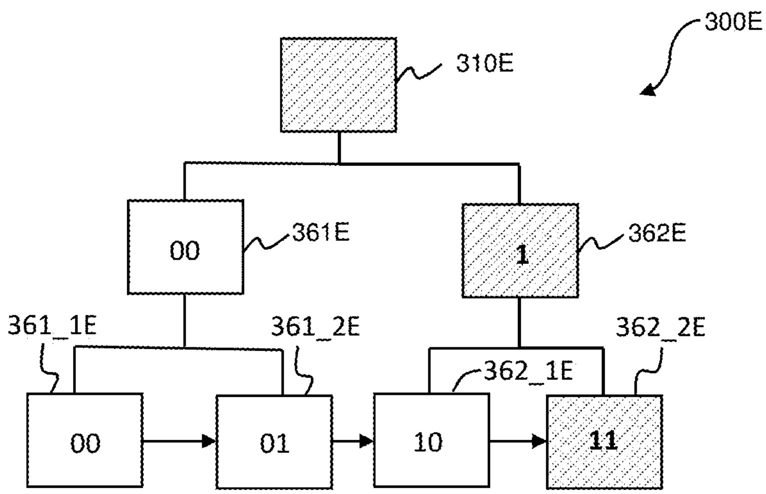

300E
310E
00
361E
1
362E
361_1E
361_2E
362_2E
362_1E
00
01
10
11

FIG. 3(E)

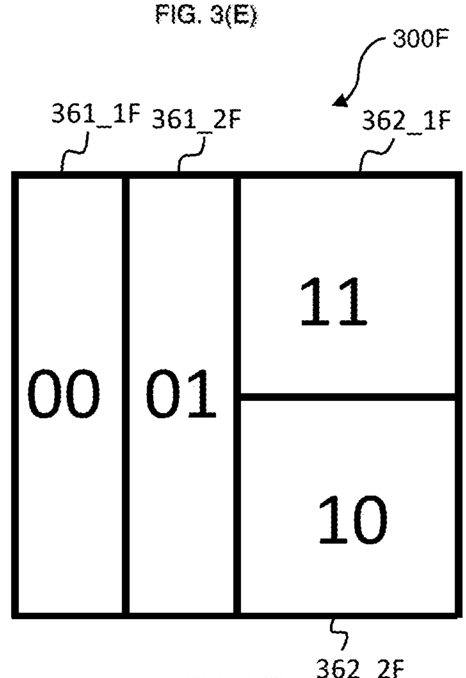

300F
361_1F
361_2F
362_1F
00
01
11
10
362_2F

FIG. 3(F)

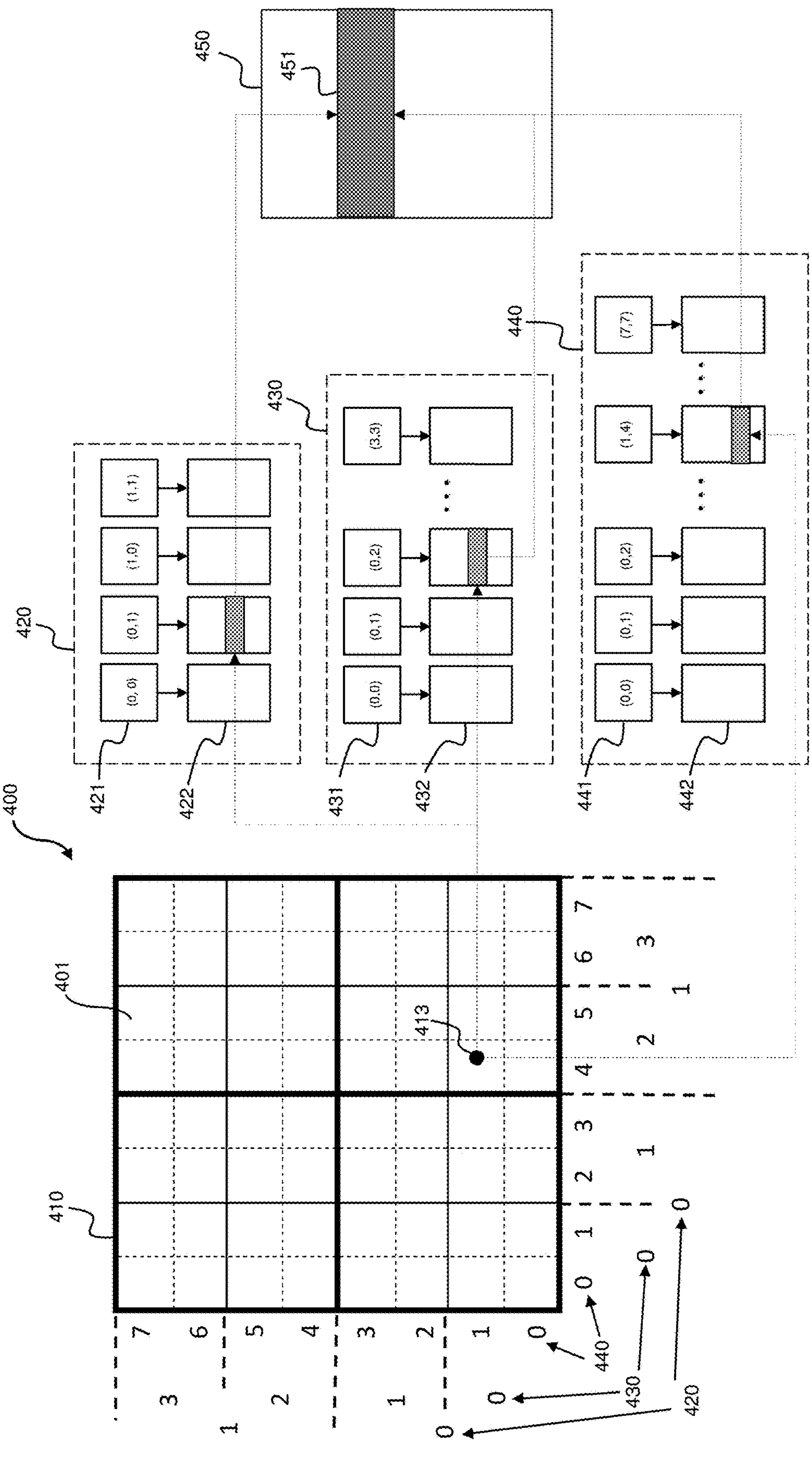

400
401
410
413
420
421
422
430
431
432
440
441
442
450
451
(0,0)
(0,1)
(1,0)
(1,1)
(0,2)
(3,3)
(1,4)
(7,7)

FIG.4

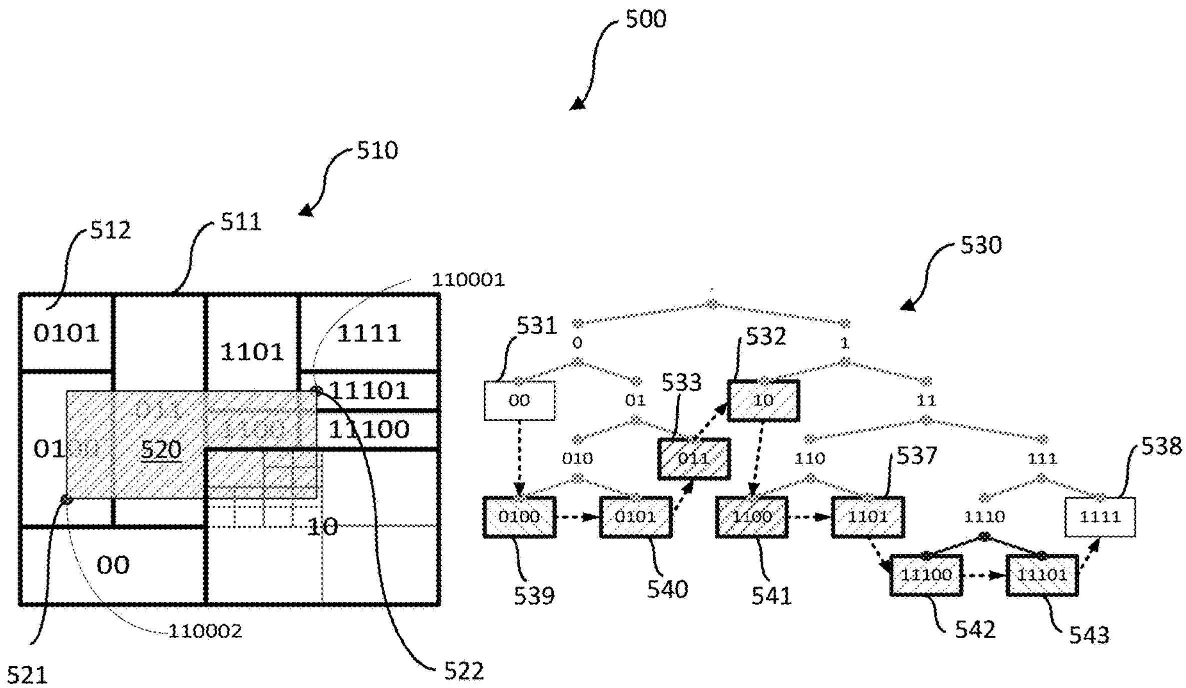

500
510
512
511
0101
1101
1111
110001
11101
11100
01
520
10
00
110002
521
522
530
531
0
1
532
533
00
01
10
11
010
011
110
111
537
538
0100
0101
1100
1101
1110
1111
11100
11101
539
540
541
542
543

FIG.5

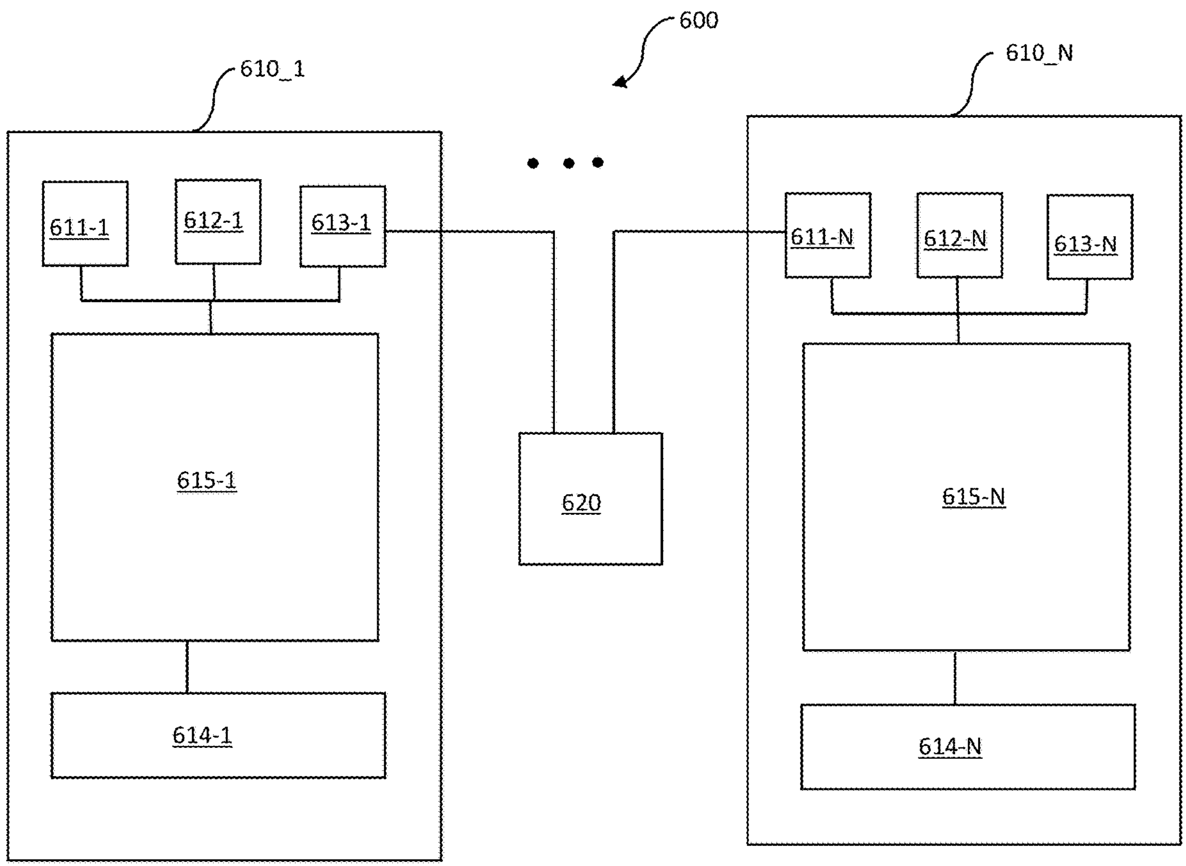

600
610_1
610_N
611-1
612-1
613-1
611-N
612-N
613-N
615-1
620
615-N
614-1
614-N

FIG.6

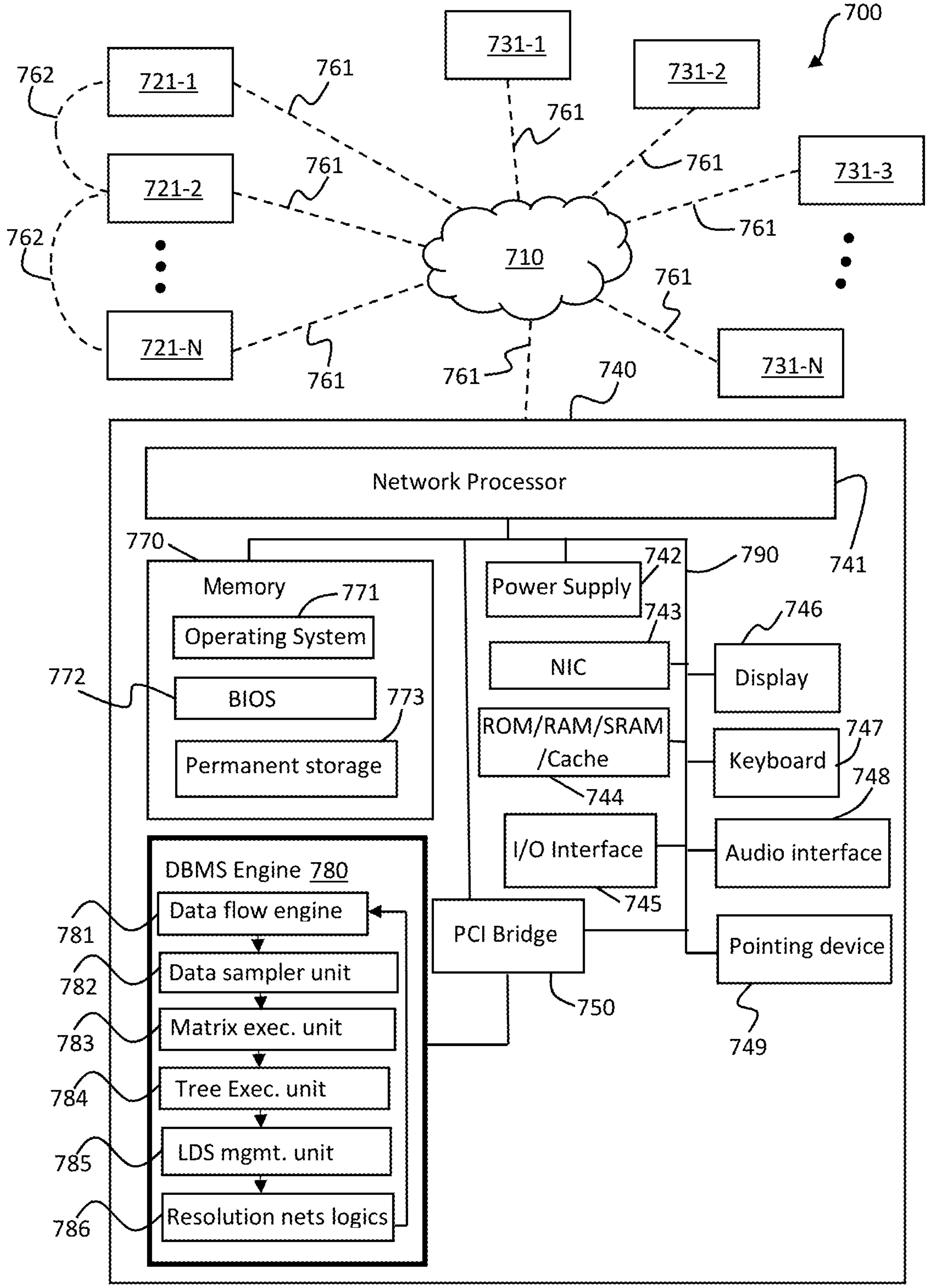

700
721-1
721-2
721-N
731-1
731-2
731-3
731-N
710
761
762
740
Network Processor
741
770
Memory
771
Operating System
772
BIOS
773
Permanent storage
742
Power Supply
790
743
NIC
Display
746
ROM/RAM/SRAM /Cache
744
Keyboard
747
748
Audio interface
I/O Interface
745
PCI Bridge
750
Pointing device
749
DBMS Engine 780
781
Data flow engine
782
Data sampler unit
783
Matrix exec. unit
784
Tree Exec. unit
785
LDS mgmt. unit
786
Resolution nets logics

FIG. 7

SYSTEM AND METHOD FOR INDEXING SPATIAL DATA IN A COMPUTER NETWORK USING THE LEAST DIFFERENTIAL SUM AND BINARY DECISION TREE

FIELD OF THE INVENTION

[0001] The present invention relates generally to the field of data processing. More specifically, the present invention relates to indexing methods in database management system (DBMS).

BACKGROUND ART

[0002] Indexing for spatial or geographical data plays an important role in database management systems (DBMS). Indexing is a structure that exists independent of the main data. It is similar to an index table in the back of a text book. The purpose of indexing is to optimize the ability of searching, retrieving, and entering data. Thus, indexing helps improving the database performance. With the support of index structures, in response to a data request, database administrators only need to look into a small portion of the relevant data instead of scanning the entire database. It is analogous to searching for a word in its alphabetical group, find the word and all relevant pages where that word occurs. Thus, indexing saves time and costs for searching, reading data, and entering data. In addition, a good indexing structure optimizes memory spaces and achieves low latency and scalability in data manipulation such as addition, deletion, and modification.

[0003] In computer networking, often the data set is too large, it cannot be stored on a single computer. The large data set needs to be stored in a data center comprising many databases. In this distributed environment, the indexing methods usually used are R-Tree, Quad-Tree, k-d Tree, and even dividing net. R-Tree and its variants including R*-Tree, R+-Tree split the data space into possibly overlapping small rectangles called minimum bounding region (MBR). These rectangles are grouped into larger rectangles which contain all smaller rectangles or children rectangles. Large rectangles continue to be grouped until they form the largest rectangle, covering all the children rectangles. The relationship between the rectangles is transformed into the R-Tree. When retrieving data, the database management system (DBMS) will browse each node in the tree, starting with the root node representing the largest rectangle that spans the entire space. After each browsing step, the search space will be narrowed down until the rectangle containing the relevant data at the leaf node of the tree is located. In situation where the relevant rectangle is not found, the DBMS returns a "not found" message. The advantage of the R-Tree is that it is a balanced tree so the search process is fast and not affected by the distribution of data. However, in the process of adding data, the R-Tree needs to do a lot of extra work. This makes R-Tree inefficient in network databases that frequently update the data set.

[0004] Quad-Tree manages data in a given rectangular space represented by a root node. Each node in the Quad-Tree has a certain capacity and is equal. When the number of data entered into the node exceeds this threshold, the node will automatically split into four other children nodes: four rectangles formed by separating the old nodes in both horizontal and vertical directions. The data is then redistributed to the children nodes. The Quad-Tree has relatively short data duration as it does not have to rebalance its structure. However, because of this, Quad-Tree retrieves data slowly, especially with deviated data sets which are distributed almost randomly.

[0005] K-d Tree manages data on a given rectangular space. Each node on the k-d tree has the same capacity and this capacity is the same for all nodes. When the amount of data in the node exceeds this threshold, the node is split into two nodes. Two children nodes are measured by the pitch or center of gravity of the point in the median along either vertical or horizontal direction, depending on which node divides the node. Similar to quad-tree, k-d tree does not take much time to add data, but data access is very slow in deviated data sets.

[0006] Mesh is a method of dividing the rectangular shape of the storage space into equal squares or rectangles. This method allows new data to be added very fast but slower data retrieval in case of deviated data sets.

[0007] Therefore, what is needed is an indexing method and system in a computer network that is easy to design and efficient in data management.

[0008] Furthermore, what is needed is an indexing method and DBMS system that can access deviated distribution of data set in a minimal time.

[0009] Yet, what is needed is an indexing method and a DBMS that has a variety of resolution nets so that data can be efficiently stored in either dense or sparse data centers.

[0010] The present invention provides solutions to the above needs.

SUMMARY OF THE INVENTION

[0011] Accordingly, an objective of the present invention is to provide a method for managing a database of a computer network which comprises: selecting a data sample, dividing the data sample into an N×M matrix having equal cells, grouping adjacent cells of the N×M matrix into a plurality of memory blocs by a least differential sum (LDS) method, constructing a decision tree based on the partitions of the memory blocs, labeling each of the memory blocs based on the decision tree, storing and retrieving data points into the memory blocs, and linking the memory blocs together by a set of resolution nets.

[0012] Another objective of the present invention is to provide an indexing method on the distribution of data to split the memory space into separate partitions with similar data volumes to easily distribute data on multiple computers. In each data area, data points are managed by multiple layers to shorten the process of adding and reading data.

[0013] Yet another objective of the present invention is to provide a computer software program for managing a database of a computer network which comprises: selecting a data sample, dividing the data sample into an N×M matrix having equal cells, grouping adjacent cells into a plurality of memory blocs by a least differential sum method, constructing a decision tree based on the partitions of the memory blocs, labeling each of the memory blocs based on the decision tree,_storing and retrieving data points into the memory blocs, and linking the memory blocs together by a set of resolution nets.

[0014] Yet another objective of the present invention is to provide a computer network which comprises: a plurality of computing devices each comprising a non-transitory data storage, a microprocessor, an input/output system, and a display unit; a network operable to facilitate the communication between the plurality of computing devices, and the network is operable to link the non-transitory data storages together into an aggregate spatial data space; a data management system for managing the aggregate spatial data space. The computer network further includes a microprocessor operable to execute computer program instructions, and a memory operable to store the computer program instructions executable by the microprocessor for performing the steps of: sampling an aggregate data space into a data sample including a plurality of data points, covering the plurality of data points with an N×M matrix so that each cell of the N×M matrix has an equal area, grouping the cells into a plurality of memory blocs using a least differential sum method, constructing a binary decision tree based on the memory blocs, labeling each memory bloc by means of the binary decision tree, managing the plurality of data points from the memory blocs, and linking the memory blocs together by a set of resolution nets.

[0015] These and other advantages of the present invention will no doubt become obvious to those of ordinary skill in the art after having read the following detailed description of the preferred embodiments, which are illustrated in the various drawing Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0017] FIG. **1** is a flowchart of a least differential sum (LDS) indexing method for managing a data space in accordance with an exemplary embodiment of the present invention;

[0018] FIG. **2**(A) is a diagram illustrating the first step of the least differential sum indexing (LDS) method in accordance with an exemplary embodiment of the present invention;

[0019] FIG. **2**(B) is a diagram illustrating the second step of the least differential sum indexing (LDS) method in accordance with an exemplary embodiment of the present invention;

[0020] FIG. **3**(A)-FIG. **3**(F) are diagrams illustrating the remaining steps and the binary decision tree of the least differential sum indexing (LDS) method in accordance with an embodiment of the present invention;

[0021] FIG. **4** is a diagram illustrating the resolution nets linking memory spaces at the leaf nodes level in accordance with an exemplary embodiment of the present invention;

[0022] FIG. **5** is a diagram illustrating a process of finding and updating data points using the resolution net of the least differential sum (LDS) indexing method in accordance with an exemplary embodiment of the present invention;

[0023] FIG. **6** is a schematic diagram of a computer network that has a distributed data space that method of FIG. **1** can be used as a database management system (DBMS) in accordance with an exemplary embodiment of the present invention; and

[0024] FIG. **7** is a schematic diagram of a network computer that includes a database management engine implementing the method of FIG. **1** in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0025] Reference will now be made in detail to the preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the preferred embodiments, it will be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be obvious to one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

[0026] Many aspects of the present invention are now described with reference to FIG. **1**-FIG. **6**. FIG. **1** illustrates a flowchart of the least differential sum (LDS) indexing method **100** for managing a data space in accordance with an embodiment of the present invention.

[0027] Method **100** begins at step **101** where data space is first sampled. In many aspects of the present invention, data space is defined as the collection of data points in the memories of a single computer or many different computers connected together via a network such as cloud, internet, wide area network (WAN), or local area network (LAN), or personal area network (PAN), etc. In one exemplary embodiment, data space can be optical memory such as CD, DVD, HD-DVD, Blue-Ray Discs, etc.; semiconductor memory such as RAM, EPROM, EEPROM, etc.; and/or magnetic memory such as hard-disk drive, floppy-disk drive, tape drive, MRAM, etc. In another exemplary embodiment, data space can be a network attached storage (NAS) which is a mass storage attached to a computer in a network from which other computers can access at file level. Within the scope of the present invention, the term "sampling" means grouping and/or taking samples of data points from a data space defined above.

[0028] Next at step **102**, the data sample is grouped or enclosed by an N×M matrix, wherein N, M are non-zero positive integers (I^+). In one exemplary embodiment, the N×M matrix has N×M cells of equal area. It is noted that the denser the distribution of the data space (or smaller the standard deviation), the narrower the cell of the N×M matrix. On the contrary, the more the data space is widely distributed or deviated (the larger the standard deviation), the wider the area of the cells.

[0029] At step **103**, the N×M matrix is partitioned into memory blocs by the least differential sum (LDS) scheme of the present invention. That is, the N×M matrix is partitioned along either the horizontal lines or vertical lines in the following manner: (1) The sums of the number of data points within either a column or a row are taken; (2) the difference between the sums of two adjacent rows or columns is taken; (3) along which direction the N×M matrix is partitioned depends on which direction the difference is smaller. That is, the partition obeys the following formula:

$$\text{Min.}\left(\min_{i=1}^{N-2}\left|\sum_{j=0}^{M-1}\left(\sum_{k=0}^{i} C_{k,j} - \sum_{k=i+1}^{N-1} C_{k,j}\right)\right|,\ \min_{j=1}^{M=2}\left|\sum_{i=0}^{N-1}\left(\sum_{k=0}^{j} C_{i,k} - \sum_{k=j+1}^{M-1} C_{i,k}\right)\right|\right), \quad \text{(Equation 1)}$$

wherein $C_{k,j}$ is contents of either columns and rows of the N×M matrix; according to Equation 1, every adjacent rows and columns are summed up, their differentials are taken, and the minimum among those differentials are selected. The least among those minima is finally selected as the final partitioning line. If the N×M matrix is a 4×4 matrix, there are 3 different ways to divide the rows and 3 different ways to divide the columns. If each row and column address starts at 0, there are N−2 and M−2 different ways of dividing the N×M matrix.

[0030] In one exemplary embodiment, in case of equipartition, when N=M=even positive integer number ($N=M \in 2I^{+}$), N×M matrix is equipartitioned (always divided into two equal halves), the formula is much simpler and Equation 1 becomes:

$$\text{Min.}\left\{\left|\sum_{j=1}^{M} C_{i,j} - \sum_{j=1}^{M} C_{i+1,j}\right|, \left|\sum_{l=1}^{N} R_{k,l} - \sum_{l=1}^{N} R_{k+1,l}\right|\right\}, \quad \text{(Equation 2)}$$

where $C_{i,j}$ is the content of the $C_{i,j}$ column of the N×M matrix and $C_{i+1,j}$ is the content of the adjacent column; similarly, $R_{k,l}$ is the content of the $R_{k,l}$ row and $R_{k+1,l}$ is the content of the adjacent row. With equipartitioning embodiment, the number of dividing steps reduced significantly. The partitioning process continues in accordance with the least differential sum (LDS) until the N×M matrix cannot be partitioned further. Please refer to FIG. **3** for more illustrations of the least differential sum method.

[0031] At step **104**, a decision tree is constructed based on the partitioning results of step **103**. More particularly, the root node represents the entire sample data (or the entire data points enclosed inside the N×M matrix). The first-generation children nodes represent the first partition results. The grand-children nodes represent the subsequent partition results. The leaf nodes represent the final partition results. In one exemplary embodiment of the present invention, the decision tree is a binary decision tree. That is, the left-hand side children nodes always get a **0** and the right-hand side children nodes always get a "1". Finally, leaf nodes are linked together to form a single linked list, starting from the leftmost leaf node and ending at the rightmost leaf node.

[0032] Next is step **105**, after the partition is completed and the decision tree is constructed, memory blocs are labeled using the decision tree. In the binary embodiment, every generation on the left-hand side gets a "0" and that on the right-hand side gets a "1" until leaf nodes are reached.

[0033] At step **106**, data points are assigned to leaf nodes. In corollary, from the memory blocs, the computer system knows the binary address based on the binary tree.

[0034] Finally, at step **107**, leaf nodes and memory blocs are linked together by resolution nets. Resolution nets are a set of matrices of different resolutions (or sizes): the smaller the matrix size the higher the resolution. This way, all the cousin leaf nodes are linked by these resolution trees. Each resolution net contain a different address of a data point. For example, when data points are dispersed (deviated) in a memory bloc corresponding to a leaf node, the low-resolution net can be used. On the other hand, when data points are dense, the high-resolution net is used.

[0035] In reference to FIG. **2**(A)-FIG. **2**(F), various illustrating examples of a database management algorithm using least differential sum indexing (LDS) method **100** above are presented and discussed in details as follows.

[0036] Now referring to FIG. **2**(A)-FIG. **2**(B), diagrams **200**A and **200**B illustrating the first two steps **101** and **102** of least differential sum (LDS) indexing method **100** in accordance with an exemplary embodiment of the present invention are presented. In FIG. **2**(A), a data space **210** including many data points **211** is sampled, collected, or grouped in a boundary **220**. As alluded in step **101** above, data space **210** can be sampled from a single hard drive or from a network attached storage (NAS) or distributed databases. FIG. **2**(B) illustrates the implementation of step **103**. The data sample is partitioned into an N×M matrix **230** with equal-area cells **231**, where N and M are non-zero positive integers (I^{+}). As alluded above, the more data points **211** are geographically disperse (or deviated), the larger the area of cell **231**.

[0037] Next referring to FIG. **3**(A)-FIG. **3**(F), diagrams **300**A-**300**F illustrating respective steps **104**-**107** of method **100** are shown. In FIG. **3**(A), a diagram **300**A illustrates the summing process of the present disclosure: data points **211** in each cell **231** are added up. Please refer back to FIG. **2**, as an example, first cell **231** having a matrix address **311** (from heretofore cell having matrix address **311** is identified as "cell **311**") has zero data point. Thus, the total number of data points **211** in cell **311** is zero. A cell **312**, in the first row of the second column has one data. The total number of data points **211** in cell **312** is therefore 1. Similarly, the total number of data points **211** of a cell **313** in the first row of the third column is 2. The total number of data points **211** of a cell **314** in the first row of the fourth column is also 2. The total number of data points **211** of a cell **321** in a second row of a first column is also 0. The total number of data points **211** of a cell **322** in the second row of the-second column is also 0. The total number of data points **211** of a cell **323** in the second row of the third column is 2. The total number of data points **211** of a cell **324** in the second row of the fourth column is also 2. Next, pointing to the third row of N×M matrix **310**, the total number of data points **211** of a cell **331** in the third row of the first column is 4. The total number of data points **211** of a cell **332** in the third row of the second column is 5. The total number of data points **211** of a cell **333** in the third row of a third column is 1. The total number of data points **211** of a cell **334** in the third row of the fourth column is 5. Next, moving to the fourth row, the total number of data points **211** of a cell **334** in the fourth row of the first column is 1. The total number of data points **211** of a cell **342** in the fourth row of the second column is 2. The total number of data points **211** of a cell **343** in the fourth row of the third column is 1. Finally, the total number of data points **211** of a cell **344** in the fourth row of the fourth column cell **344** is 1. Thus, from the total number of data points **211** in each cell **231** of N×M matrix **310**, the spatial distribution of data points **211** can be determined. The third row has a very low standard deviation of data distribution:

from the first column to the fourth column of the third row, the distribution of data points can be observed as follows: 4, 5, 1, and 5 respectively.

[0038] Referring again to FIG. **3**(B), a diagram **300**B illustrates the division method of the present disclosure as follows: in the regular partitioning embodiment, there are 3 (4-1) different ways to divide N×M matrix **310** in the row direction and 3 different ways to divide them in the column direction (N, M=4). In accordance to Equation 1, the first sums in the row direction from top to bottom are 5, 4, 15, and 5 respectively. If row 1 line (bottom line) is used as a partitioning line, the differential is: 24−5=19. If row 2 line is used as the partitioning line, the differential is: 20−9=11. If row 3 line is used as the partitioning line, the differential is: 24−5=19. Therefore, the least differential in the row direction is 11. Accordingly, the middle row is selected as the partitioning line in the row directions. Now, in the column direction, the sums in the column direction from left to right are 5, 8, 6, and 10 respectively. Therefore, if column 1 line (rightmost line) is used as the partitioning line, the differential is: 24−5=19. If column 2 line is used as the partitioning line, the differential is: 16−13=3. And if column 3 line is used as the partitioning line, the differential is: 19−10=9. Thus, the least differential sum (LDS) in the column direction is 3. The column line 2 should be selected as the partitioning line in the column direction. Finally, since 3 is the least differential sum (LDS) in both row and column directions, the column 2 line is selected as the partitioning line as shown in FIG. **3**(B).

[0039] Next, referring to FIG. **3**(C), a diagram **300**C shows two possible ways of partitioning N×M matrix **310** in accordance with the equipartition embodiment of the present invention. The first partition uses horizontal lines **351** going across the rows of N×M matrix **310**. The second partition uses vertical lines **352** going across the columns. Whether the first partition or the second partition is chosen to partition N×M matrix **310** depending on the least differential sums (LDS), please see Equation 2 between two adjacent rows or columns. At first, N×M matrix **310** is divided in half (equipartitioning). If horizontal line **351** is used, the sum of the first horizontal half is 9 and that of second horizontal half is 25. Their differential sum between these two adjacent rows is: 25−5=20. Now if vertical line **352** is used, the sum of first columnar half is 13 and that of the second columnar half is 16. The differential sums between the first columnar half and the second columnar half is 3. Because the differential sum by horizontal lines **351** is highest (20), and that of vertical line **352** is lowest (3), the first partitioning of N×M matrix **310** is performed along vertical line **352** into first columnar (vertical) half **361** and second columnar (vertical) half **362** as shown in diagram **300**C of FIG. **3**(C).

[0040] Next, referring to FIG. **3**(D), a diagram **300**D illustrates the next partitioning step **103**. Again, in the regular or unequal area partitioning embodiment of Equation 1, in first columnar (vertical) half **361**, there is one vertical partitioning and 3 horizontal partitioning. The vertical partitioning results in the differential: 8−5=3. The sums of three horizontal partitioning from top to bottom are: 1, 0, 9, and 3 respectively. If row 1 line is selected, then the differential is: 12−1=10. If row 2 line is selected, then the differential is: 12−1=10. If row 3 line is selected, then the differential is: 10−3=7. Thus, for first columnar (vertical) half **361**, the vertical division is the minimal. As such, first columnar half is divided into first half **361_1** and **361_2**. Next, in second columnar (vertical) half **362**, there is one vertical partitioning and 3 horizontal partitioning. If the third column line is selected, the differential is: 10−6=4. The sums of three horizontal partitioning from top to bottom are: 4, 4, 6, and 2 respectively. If row 1 line is selected, then the differential is: 12−4=8. If row 2 line is selected, then the differential is: 8−8=0. If row 3 line is selected, then the differential is: 14−2=12. Thus, for second columnar (vertical) half **362**, the horizontal partition using row 2 line is the least differential. As such, second columnar half **362** is divided into first half **362_1** and **362_2**.

[0041] Referring again to FIG. **3**(D), in the equipartitioning of Equation 2, first vertical half **361** is again divided into two equal halves. The horizontal lines **351** and vertical lines **352** partitions as discussed above in FIG. **3**(B) are used again. Again, the differential sums between first half along horizontal line **531** is12−1=11. While that of vertical line **532** is 8−5=3. So, the differential sum along vertical line **532** is the least differential sum (LDS). Thus, first vertical half **362** is divided along a vertical line into a first half **361_1** and a second half **361_2**. Next, in second half **362**, the differential sum between vertical line **352** is 10−6=4; while that horizontal line **351** is 8−8=0, which is the least differential sum. Thus, second half **362** is divided along horizontal line **351** into **362_1** and **362_2**.

[0042] FIG. **3**(E) illustrates step **104** of constructing a decision tree **300**E. A root node **310**E represents the entire data points of N×M matrix **310**. First generation children nodes **361**E and **362**E represent first partitioned halves **361** and **362** respectively. Grand-children nodes **361-1**E and **361-2**E represent two halves **361_1** and **361_2** respectively. Similarly, grand-children nodes **362-1**E and **362-2**E represent two halves **362_1** and **362_2**. Please note that grand-children nodes **361-1**E to **362-2**E are leaf nodes. In one exemplary embodiment of the present invention, decision tree **300**E is a binary decision tree: in which every left-hand side node is assigned a zero (0) and every right-hand side node is assigned a one (1). As such, node **361** is a left-hand side node which gets a 0. Node **362** is a right-hand side node which gets a 1.

[0043] Continuing with FIG. **3**(E), next generation children nodes **361-1**E and **361-2**E get 00 and 01 binary address respectively. Similarly, next generation children nodes **362-1**E and **362-2**E get 10 and 11 binary addresses respectively. As alluded above, leaf nodes **361-1**E to **362-2**E are linked together to form a single linked list having the binary addresses ranging from 00 to 11 respectively.

[0044] Referring to FIG. **3**(F), a diagram **300**F illustrates the operation of step **105**: a matrix **310**F is labeled using decision tree **310**E. More particularly, halves **361_1**, **361_2**, **362_1**, and **362_2** are labeled in accordance with binary decision tree **310**E. Memory bloc **361_1**F having a binary address 00 is assigned to leaf node **361-1**E. Memory block **361_2**F having a binary address 01 is assigned to leaf node **361-2**E. Memory block **362_1**F having a binary address 11 is assigned to leaf node **362-1**E. Memory block **362_2**F having a binary address 10 is assigned to leaf node **362-2**E.

[0045] Now referring to FIG. **4**, a diagram **400** illustrating the resolution nets linking memory spaces at the leaf nodes level in accordance with an exemplary embodiment of the present invention is illustrated. An actual data storage area **450** is at the leaf node of decision tree. Therefore, when a new data point **413** to be added, modified, or removed, the location information of data point **413** will be used to browse the resolution tree to find the leaf node of the limited space surrounding data point **413**. Data content of data point **413** will then be updated into this space. For each resolution net: a lowest resolution net **420**, a medium resolution net **430**, and a highest resolution net **440** can be employed inside a storage space. As such, a pointer to data point **413** is created and stored in storage area **450**. More particularly, in one exemplary embodiment of the present invention, lowest resolution net **420** is a largest 2×2 matrix having the addresses ranging from 0-1 in both directions. Thus, within lowest resolution net **420**, data point **413** has the address of (0), which is indicated in leaf node **421** of binary decision tree **420**. The content of data point **413** is indicated by a shaded area in a storage space **422** under the address (0, 1). Next, medium resolution net **430** is a 4×4 matrix having the addresses ranging from 0-3 in both directions. Thus, within medium resolution net **430**, data point **413** has the address of (0, 2), which is indicated in leaf node **431** of binary decision tree **430**. The content of data point **413** is represented by the shaded area in a storage space **432** under the address (0, 2). Similarly, highest resolution net **440** is a finest 8×8 matrix having the addresses ranging from 0-7 in both directions. Thus, within highest resolution net **440**, data point **413** has the address of (1, 4), which is indicated in leaf node **441** of binary decision tree **440**. The content of data point **413** is the shaded area in a storage space **442** under the address (1, 4). It will be appreciated that any numbers K of resolution nets of I by J matrices, where J, K are non-zero positive integers (I^+), are within the scope of the present invention.

[0046] Referring again to FIG. **4**, from the above non-limiting example, any data point **451** of a data storage **450** can have K different resolution nets and K addresses corresponding to various sizes of I×J resolution matrices. Depending on the distribution of data points **451** in the data set, a suitable resolution net is used to quickly locate and modify that data point, thus saving time, improving latency, and reducing errors. In many aspects of the present invention described in FIG. **4**, resolution nets are similar to adding pages, lines, and columns addresses to a word in a book. If words in a page are thinly distributed (i.e., summary of a chapter), then line and column addresses of a word are not needed. Only page address of that word is necessary. On the other hand, if words are located in different pages and on a densely distributed page, then pages, lines, and column addresses are helpful in locating, adding, modifying, and deleting those words. For example, the words, "data" has page addresses as 5, 15, and 100; lines addresses 2, 29 on page 5; 3, 18, 27 on page 15; and 4, 5, 6, 7 on page 100. Column addresses include 2, 20 on line 2, page 5, etc. Then this word can be rather quickly located on page 5, line 2 starting from the top, and columns 2 and 20 starting from beginning of the sentence. Thus, various aspects of the present invention as described in FIG. **4** achieve the objectives of saving time, improving latency, and reducing errors.

[0047] Now, referring to FIG. **5**, a data retrieval process **500** applying method **100** is shown. In one exemplary embodiment, matrix **510** labeled with binary addresses using binary decision tree **530** is presented. Memory blocks **512** are formed by the least differential sum (LDS) method **100** described above in FIG. **1**-FIG. **3** sampled into an area **511**. A query is entered by a user and translated into the database management language SQL or XML by a data flow engine. The query is defined by a first point **521** and a second point **522**, which creates a rectangle area **520** on matrix **510**. The upper right vertex of rectangular area **520** is point **522** which contains 110001. The lower left vertex **521** is 110002. Using resolution nets described above, points **521** and **522** have respective addresses of 11101 and 0100. Using binary decision tree **530** achieved by least differential method (LDS) method **100** described above, by traveling along the linked list starting from 0100 and ending at 11101, checking nodes by nodes, the memory blocs covered by queried rectangular area **520** are identified as: 00, 011, 0100, 0101, 10, 11100, 1101, 11100, 111101, and 1111. Those memory blocs that are completely covered such as 1100, all data points are necessarily retrieved. Those memory blocs that are completely outside rectangular area **520**, no data points are retrieved. Next, using resolution nets to pinpoint data points in memory blocs that are partially intersected by rectangular area **520**. Assuming memory block **10** is checked, the scan will be performed on the data grid from lowest resolution net **420** to highest resolution net **440**. Therefore, the lowest or 2×2 resolution net **420** will be checked first. Of the cells, only cells (1, 0) assigned to the query should only check the data in this cell. Next, medium or 4×4 resolution net **430** is be scanned, since the cell (3,0) is in the query, so all data in this cell is retrieved. Meanwhile, cells (3, 1), (2, 0), and (2, 1) are only partially allocated, so the cells in the lowest or 8×8 resolution net **440** are checked. When examining the grid 8×8, because the cells (7, 0), (7, 1), (6, 0), and (6, 1) are in the grid (3, 0) of middle solution net **430**, no further examination is necessary. The cells (7, 2) and (6,2) lie in span of the query, all data points in these cells are retrieved. As this is the final resolution net, all data points in the remaining cells are examined to find out which data points in the query will be included in the result set.

[0048] Next referring to FIG. **6**, a schematic diagram of a computer network **600** that has a distributed data space that method **100** described above can be used as a database management engine in accordance with an exemplary embodiment of the present invention is illustrated. Computer network **600** includes a plurality of computing devices **610-1** to **610**-N, where N is a non-zero positive integer (I^+). Computing device **610-1** includes an input/output port **611-1**, a central processing unit (CPU) **612-2**, a network card **613-1**, a storage device **615-1**, and a display unit **614-1**. Similarly, computing device **610**-N includes an input/output port **611**-N, a central processing unit (CPU) **612**-N, a network card **613**-N, a storage device **615**-N, and a display unit **614**-N. Computing devices **610-1** to **610**N are connected together through a network **620**. Method **100** described above and illustrating examples in FIG. **2** to FIG. **3**(F) are used to manage the distributed data space in storage devices **615-1** to **615**-N.

[0049] Thus, the present invention proposes a method and system for indexing spatial data used in computer network **600** which enables access, read, and update of aggregate spatial data space **615-1** to **615**-N at high a speed and within the fastest time.

[0050] Finally, referring to FIG. **7**, a schematic diagram of a network computer **700** that includes a hardware database management engine implementing the method **100** in accordance with an exemplary embodiment of the present invention is illustrated. Computer network **700** includes a first group of master-slave computers **721-1** to **721**-N, a second group of computers **731-1** to **731**-N, and a network computer **740**, all are connected together and to a network **710** via communication channels **761**. It will be appreciated that communication channel **761** may include, but not limited to, short range wireless communication channels, medium range wireless communication channels, and long range wireless communication channels. Wireless short range communication channels include ZigBee™/IEEE 802.15.4, Bluetooth™, Z-wave, NFC, Wi-Fi/802.11, cellular (e.g., GSM, GPRS, WCDMA, HSPA, and LTE, etc.), IEEE 802.15.4, IEEE 802.22, ISA100a, wireless USB, and Infrared (IR), etc. Medium range wireless communication channels in this embodiment of communication link **161** include Wi-Fi and Hotspot. Long range wireless communication channels include UHF/VHF radio frequencies.

[0051] First group of master-slave computers **721-1** to **721**-N are connected together via a second communication channel **762** and set up so that computers **721-1** to **721**-N are master-slave to one another. In an exemplary implementation of the present invention, second group of master-slave computers **721-1-721**-N are connected together in different master-slave configurations via communication channel **761**. It is noted that, non-limiting examples of communication channel **761** include short range wireless communication channels, medium range wireless communication channels, and long range wireless communication channels. Wireless short range communication channels include ZigBee™/IEEE 802.15.4, Bluetooth™ Z-wave, NFC, Wi-Fi/802.11, cellular (e.g., GSM, GPRS, WCDMA, HSPA, and LTE, etc.), IEEE 802.15.4, IEEE 802.22, ISA100a, wireless USB, and Infrared (IR), etc. Medium range wireless communication channels in this embodiment of communication link **161** include Wi-Fi and Hotspot. Long range wireless communication channels include UHF/VHF radio frequencies.

[0052] However they are connected together, all computers **721-1** to **721**-N and **731-1** to **731**-N have databases (not shown) connected via network **710**. Together these databases form a distributed database, or database space. As shown in FIG. **7**, server computer **740** includes a microprocessor **741** in communication with a memory **770** via a bus **790**. Server computer **740** also includes a power supply **742**, a network interface card (NIC) **743**, a temporary memory such as ROM/RAM/Cache/SRAM **444**, I/O interface **745**. Server computer **740** also includes a display **746**, a keyboard **747**, an audio interface **748**, pointing devices **749**, and PCI (peripheral communication interface) **750**. In one exemplary embodiment, power supply **742** provides power to the entire server computer **740**. In another exemplary embodiment server computer **740** is a super computer. Yet in another embodiment, server computer **740** is a rack of blade servers.

[0053] Memory **770** may include Random Access Memory (RAM), Read-Only Memory (ROM), and/or other types of memory. Memory **770** illustrates an example of computer-readable storage media for storage of information such as computer-readable instructions, data structures, program modules or other data. Memory7 stores a basic input/output system (BIOS) **772** for controlling low-level operation of server computer **740**. Memory **770** also stores an operating system (OS) **771** for controlling the operation of server computer **740**. It will be appreciated that operating system **771** may include a general-purpose operating system such as a version of UNIX, or LINUX™, or a specialized operating system such as Microsoft Corporation's Windows® operating system, or the Apple Corporation's IOS® operating system. Operating system **771** may include, or interface with a Java virtual machine module that enables control of hardware components and/or operating system operations via Java application programs.

[0054] Data storage **773** may further include different types of data sets, which can be utilized by server computer **740** to store, among other things, log events and data/patterns. In many embodiments of the present invention, data/patterns storage **773** include, but not limited to, permanent storage such as optical memory (CD, DVD, HD-DVD, Blue-Ray Discs), semiconductor memory (e.g., RAM, EPROM, EEPROM), and/or magnetic memory (hard-disk drive, floppy-disk drive, tape drive, MRAM) among others.

[0055] Database management engine **780** may be hardware or software module. In one exemplary embodiment of the present invention, database management engine **780** is a hardware system which includes a data flow engine **781**, a data sampler unit **782**, a matrix execution unit **783**, a tree execution unit **784**, a least differential sum (LDS) management unit **785**, and a resolution net logic unit **786**. In various aspects of the present invention, data flow engine **781**, data sampler unit **782**, matrix execution circuitry **783**, tree execution unit **784**, least differential sum (LDS) management unit **785**, and resolution net logic unit **786** are either combinatorial logic circuitry, or FPGA, or ASIC, or the combinations thereof. Data flow engine **781** uses either extensible mark-up language (XML) or structured query language (SQL) to manipulate, store, retrieve, and/or modify databases in **721-1** to **731**-N and **731-1** to **731**-N including permanent data storage **773** and cache/SRAM/ROM/RAM **744**. Data sampler unit **782** samples all data points in the data space. In other words, data sampler unit **782** implements step **101** in FIG. **1** above. Matrix execution unit **783** creates a matrix for the data space, implementing step **102** above. Least differential sum (LDS) management unit **785** performs the equipartition and summing up the data points in each cells as described in FIG. **1**, which implements step **103**. Tree execution unit **784**, constructs the binary decision tree and assign binary address to each memory bloc as described in FIG. **3**(E) and FIG. **3**(F) which implements steps **104-107**. Resolution net logic unit **786** performs the reading, writing, modifying of data points as described in FIG. **4** and FIG. **5**. Then, the results will be transferred to data flow engine **781** to display to users.

[0056] The foregoing description details certain embodiments of the invention. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention can be practiced in many ways. As is also stated above, it should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the invention with which that terminology is associated. The scope of the invention should therefore be construed in accordance with the appended claims and any equivalents thereof.

DESCRIPTION OF NUMERALS

[0057] **210** spatial data space or geographical data space

[0058] **211** a single data point

[0059] **220** a data sample or a collection of data to be managed

[0060] **230** N×M matrix covering the spatial data space

[0061] **231** a cell of the N×M matrix

[0062] **310** the sum N×M matrix where the number of data points are added in each cell
[0063] **311-344** address of each cell in the N×M matrix
[0064] **351** the vertical (columnar) partitioning line
[0065] **352** the horizontal partitioning line
[0066] **361** a first half after the first partition by the least differential sum (LDS)
[0067] **362** a second half after the first partition by the LDS
[0068] **361_1** first memory bloc after the second partition
[0069] **361_2** second memory bloc after the second partition
[0070] **362_1** third memory bloc after the second partition
[0071] **362_2** fourth memory bloc after the second partition
[0072] **361-1**E a first leaf node in the binary resolution tree
[0073] **361-2**E a second leaf node in the binary resolution tree
[0074] **362-1**E a third leaf node in the binary resolution tree
[0075] **362-2**E a fourth leaf node in the binary resolution tree
[0076] **361_1**F first memory bloc with binary address from decision tree
[0077] **361_2**F second memory bloc with binary address from decision tree
[0078] **362_1**F third memory bloc with binary address from decision tree
[0079] **362_2**F fourth memory bloc with binary address from decision tree
[0080] **401** a single cell in the resolution nets
[0081] **410** data space
[0082] **420** lowest resolution net or 2×2 resolution net
[0083] **421** leaf nodes of the lowest resolution net
[0084] **422** corresponding memory blocs of the lowest resolution net
[0085] **430** medium resolution net or 4×4 resolution net
[0086] **431** leaf node of the medium resolution net
[0087] **432** corresponding memory blocs of the medium resolution net
[0088] **440** highest resolution net or 8×8 resolution net
[0089] **441** leaf node of the highest resolution net
[0090] **442** corresponding memory blocs of the highest resolution net
[0091] **413** a data point being stored in a leaf node
[0092] **420** the highest density net
[0093] **421** binary addresses of each memory space in the highest density net
[0094] **422** memory space of the highest density net
[0095] **430** the medium density net
[0096] **431** binary addresses of each memory space in the medium density net
[0097] **432** memory space of the medium density net
[0098] **440** the lowest density net
[0099] **441** binary addresses of the lowest density space
[0100] **442** memory space of the lowest density space
[0101] **450** the physical memory space
[0102] **451** data point stored in the physical memory space
[0103] **510** binary addressed matrix and the search query
[0104] **511** binary addressed matrix
[0105] **512** memory bloc
[0106] **520** the rectangular area defining the scope of the search query
[0107] **521** lowest left boundary of the search query
[0108] **522** upper right boundary of the search query
[0109] **530** The corresponding binary decision tree
[0110] **531** Node 00 of the binary decision tree
[0111] **532** Node 10 of the binary decision tree
[0112] **533** Node 011 of the binary decision tree
[0113] **538** Node 1111 of the binary decision tree
[0114] **539** Node 0100 of the binary decision tree
[0115] **540** Node 0101 of the binary decision tree
[0116] **541** Node 1000 of the binary decision tree
[0117] **542** Node 11100 of the binary decision tree
[0118] **543** Node 11101 of the binary decision tree
[0119] **600** a computer network that forms a distributed database
[0120] **610_1** First computer
[0121] **610**_N N^{th} computer
[0122] **620** network
[0123] **611_1** input/output port of the first computer
[0124] **612_1** CPU of the first computer
[0125] **613_1** NIC of the first computer
[0126] **614-1** display unit of the first computer
[0127] **611**_N input/output port of the N^{th} computer
[0128] **612**_N CPU of the N^{th} computer
[0129] **613**_N NIC of the N^{th} computer
[0130] **614**_N display unit of the N^{th} computer
[0131] **700** A computer network with distributed data space and DBMS of the present invention
[0132] **710** network
[0133] **721_1** First master-slave computer
[0134] **721**_N Nth master-slave computer
[0135] **731_1** First independent computer
[0136] **731**_N Nth independent computer
[0137] **740** Network computer having a DBMS of the present invention
[0138] **741** Network processor
[0139] **742** power supply
[0140] **743** NIC
[0141] **744** ROM/RAM/SRAM/Cache memory
[0142] **745** Input/Output interface
[0143] **746** display screen
[0144] **747** keyboard
[0145] **748** audio interface
[0146] **749** pointing device
[0147] **750** PCI bridge
[0148] **461** communication link
[0149] **770** memory
[0150] **771** Operating System
[0151] **772** BIOS
[0152] **773** Permanent storage
[0153] **780** DBMS engine
[0154] **781** data flow engine
[0155] **782** data sampler unit
[0156] **783** matrix execution unit
[0157] **784** tree execution unit
[0158] **785** LDS management unit
[0159] **786** resolution net logics unit
[0160] **790** bus

What is claimed is:

1. A method for indexing a spatial data set in a database of a computer network, the method comprising:

selecting a data sample of said spatial data set;

dividing said data sample into an N×M matrix comprising cells, wherein N and M are non-zero positive integer numbers;

grouping said N×M matrix into a plurality of memory blocs by a least differential sum method;
constructing a decision tree based on said plurality of memory blocs;
labeling each of said plurality of memory blocs based on said decision tree;
storing and retrieving data points into said plurality of memory blocs; and
linking said memory blocs together by a set of resolution nets.

2. The method according to claim **1** wherein said cell is a square cell of equal area wherein the size of each cell depends on a distribution of said spatial data set and wherein the area of said square cell depends on a standard deviation of said distribution so that each cell contains only one data point.

3. The method according to claim **1** wherein said grouping said N×M matrix into a plurality of memory blocs by a least differential sum method further comprises:
providing a cell sum by adding up said data points in each cell of said N×M matrix; and
recording said cell sum for each cell.

4. The method according to claim **3** wherein grouping said N×M matrix into a plurality of memory blocs by a least differential sum method further comprises:
partitioning said N×M matrix into either a horizontal half or a vertical half by either a horizontal line or a vertical line that yields a least differential sum between a minimal row differential sum and a minimal column differential sum, wherein said horizontal half comprises a first horizontal half and a second horizontal half and wherein said vertical half comprises a first vertical half and a second vertical half; and
continuing partitioning each of said first horizontal half, said second horizontal half, said first vertical half, and said second vertical half until said N×M matrix cannot be further divided into said horizontal half and said vertical half.

5. The method according to claim **4** wherein said least differential sum further comprises:
selecting a row in said N×M matrix and adding up said cell sums in said selected row and all rows either above or below said selected row into a first sum;
adding up said cell sums in remaining rows into a second sum;
subtracting said first sum from said second sum to find a row differential sum; and
moving to a next row and repeating the above steps until said minimal row differential is achieved;
selecting a column in said N×M matrix and adding up said cell sums in said selected column and all columns either to the left or to the right of said selected column into a third sum;
adding up said cell sums in remaining columns into a fourth sum;
subtracting said second sum from said third sum to find a column differential sum;
moving to a next column and repeating the above steps until said minimal column differential is achieved; and
comparing said row minimal differential and said column minimal differential to find said least differential sum.

6. The method according to claim **4**, when N equals to M and both are positive even integer numbers, said grouping said N×M matrix into a plurality of memory blocs by said least differential sum method (LDS) further comprises equipartitioning said N×M matrix into two equal areas which further comprises:
selecting a first horizontal half in said N×M matrix and adding up said cell sums in said first horizontal half into a first sum;
adding up said cell sums in remaining rows into a second sum; and
subtracting said first sum from said second sum to find a row differential sum;
selecting a first vertical half in said N×M matrix and adding up said cell sums in said first vertical half into a third sum;
adding up said cell sums in remaining columns into a fourth sum;
subtracting said second sum from said third sum to find a column differential sum; and
comparing said minimal differential and said column differential to find said least differential sum.

7. The method according to claim **1** wherein said decision tree comprises a binary tree and wherein the number of leaf nodes equals to the number of final horizontal halves and final vertical halves which equal to the number of said memory blocs.

8. The method according to claim **7**, wherein said labeling each of said plurality of memory blocs based on said decision tree further comprises:
assigning a root node to the entirety of said N×M matrix;
assigning a “0” to a left child node and “1” to a right child node;
adding a “0” to a next generation left node until said leaf node is achieved; and
adding a “1” a next generation right node until said leaf node is achieved.

9. The method according to claim **8**, further comprising assigning each of said plurality of memory blocs to each of said leaf nodes.

10. The method according to claim **9**, wherein said set of resolution nets are located at said leaf nodes and further comprises a I×J resolution net, a K×L resolution net, and a resolution R×S net, each comprising a plurality of cells having a row address and a column address, where I, J, K, L, R, S are non-zero positive integers, wherein R=S which is greater than K=L which is greater than I=J and wherein R×S net covers said K×L net which covers said I×J net.

11. A computer software program stored in a non-transitory computer readable medium for indexing and managing a database in a computer network, comprising:
selecting a data sample of said database;
dividing said data sample into an N×M matrix comprising square cells, wherein N and M are non-zero positive integer numbers;
grouping said N×M matrix into a plurality of memory blocs by a least differential sum method;
constructing a decision tree based on said memory blocs;
labeling each of said plurality of memory blocs based on said decision tree;
storing and retrieving data points into said plurality of memory blocs; and
linking said plurality of memory blocs together by a set of resolution nets.

12. The computer software program according to claim **11** wherein said cell is a square cell of equal area wherein the size of each cell depends on a distribution of said spatial data set and wherein the area of said square cell depends on a standard deviation of said distribution so that each cell contains only one data point.

13. The computer software program according to claim **11** wherein said grouping said N×M matrix into a plurality of memory blocs by a least differential sum method further comprises:

providing a cell sum by adding up said data points in each cell of said N×M matrix; and

recording said cell sum for each cell.

14. The computer software program according to claim **13** wherein grouping said N×M matrix into a plurality of memory blocs by a least differential sum method further comprises:

partitioning said N×M matrix into either a horizontal half or a vertical half by either a horizontal line or a vertical line that yields a least differential sum between a minimal row differential sum and a minimal column differential sum, wherein said horizontal half comprises a first horizontal half and a second horizontal half and wherein said vertical half comprises a first vertical half and a second vertical half; and

continuing partitioning each of said first horizontal half, said second horizontal half, said first vertical half, and said second vertical half until said N×M matrix cannot be further divided into said horizontal half and said vertical half.

15. The computer software program according to claim **14** wherein said least differential sum further comprises:

selecting a row in said N×M matrix and adding up said cell sums in said selected row and all rows either above or below said selected row into a first sum;

adding up said cell sums in remaining rows into a second sum;

subtracting said first sum from said second sum to find a row differential sum; and

moving to a next row and repeating the above steps until said minimal row differential is achieved;

selecting a column in said N×M matrix and adding up said cell sums in said selected column and all columns either to the left or to the right of said selected column into a third sum;

adding up said cell sums in remaining columns into a fourth sum;

subtracting said second sum from said third sum to find a column differential sum;

moving to a next column and repeating the above steps until said minimal column differential is achieved; and

comparing said row minimal differential and said column minimal differential to find said least differential sum.

16. The computer software program according to claim **15** when N equals to M and both are positive even integer numbers, said grouping said N×M matrix into a plurality of memory blocs by said least differential sum method (LDS) further comprises equipartitioning said N×M matrix into two equal areas which further comprises:

selecting a first horizontal half in said N×M matrix and adding up said cell sums in said first horizontal half into a first sum;

adding up said cell sums in remaining rows into a second sum; and

subtracting said first sum from said second sum to find a row differential sum;

selecting a first vertical half in said N×M matrix and adding up said cell sums in said first vertical half into a third sum;

adding up said cell sums in remaining columns into a fourth sum;

subtracting said second sum from said third sum to find a column differential sum; and

comparing said minimal differential and said column differential to find said least differential sim

17. The computer software program according to claim **17**, wherein said labeling each of said plurality of rectangular memory blocs based on said decision tree further comprises:

assigning a root node to the entirety of said N×M matrix;

assigning a "0" to a left child node and "1" to a right child node;

adding a "0" to a next generation left node until said leaf node is achieved; and

adding a "1" a next generation right node until said leaf node is achieved.

18. The computer software program according to claim **8**, further comprising assigning each of said plurality of memory blocs to each of said leaf nodes.

19. The method according to claim **9**, wherein said set of resolution nets are located at said leaf nodes and further comprises a I×J resolution net, a K×L resolution net, and a resolution R×S net, each comprising a plurality of cells having a row address and a column address, where I, J, K, L, R, S are non-zero positive integers, wherein R=S which is greater than K=L which is greater than I=J and wherein R×S net covers said K×L net which covers said I×J net.

20. A computer network, comprising:

a plurality of computing devices each comprising a non-transitory data storage, a microprocessor, an input/output system, and a display unit;

a network operable to facilitate the communication between said plurality of computing devices, wherein said network is operable to link said non-transitory data storages together into an aggregate spatial data space;

a database management system for managing said aggregate spatial data space, comprising:

a microprocessor operable to execute computer program instructions; and

a memory operable to store said computer program instructions executable by said microprocessor, said computer program instructions comprising the steps of:

sampling said aggregate data space into a data sample including a plurality of data points;

covering said plurality of data points with an N×M matrix so that each cell of said N×M matrix has an equal area, wherein N and M are non-zero positive integer numbers;

grouping said cells into a plurality of memory blocs using a least differential sum method;

constructing a binary decision tree based on said plurality of memory blocs;

labeling each of said plurality of memory blocs based on said binary decision tree;

storing and retrieving said plurality of data points into said plurality of memory blocs; and

linking said memory blocs together by a set of resolution nets.

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