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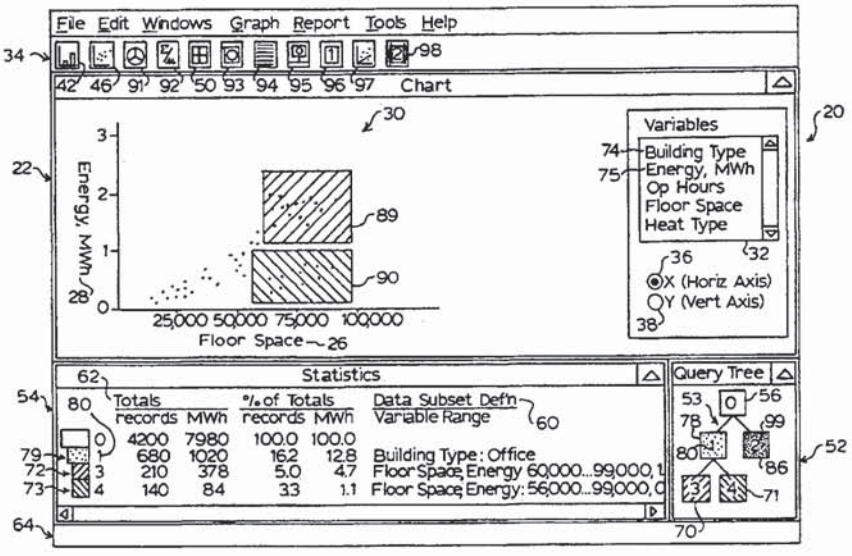

(57) Abstract

A method and system for computer-based visual data evaluation which allows on-the-fly viewing, evaluation, and querying of complex databases (20, 34) with simple user operations. A visual chart representation of a data set (30) is used to select display data subsets through interaction between the user within the chart of the data set (60). The results of the user's data subset selections are displayed in the chart (30). The visual symbols may be used as software buttons (42, 46, 91, 92, 50, 93, 94, 95, 96, 97, 98) for selecting for display the associated data subset and other operations. Visual data evaluation includes browsing, querying and manipulation of data and other information (22, 54, 52, 20) within a database by providing chart representations of database data and operating only on the attributes (74, 75) of the chart (30) and within the data area of the chart (30).

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Computer-Based Visual Data Evaluation

Background

This invention generally relates to a process for database querying, and more particularly concerns an interactive interface for chart-based graphical data browsing, querying and manipulation.

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Visual data evaluation is an important part of information processing. For many objectives such as pattern recognition, outlier analysis and general data exploration, human visual data evaluations are far superior to other options such as automated statistical procedures.

Visual data evaluation embodies two related activities: browsing and querying. Browsing is an information-seeking process which utilizes chart displays of data including bar charts, scatter plots and the like to detect patterns, to develop an intuitive understanding of relationships exhibited by the data and to determine the next desired chart presentation of the data. "Querying," which is a mechanism for accessing information stored in a database, specifies and selects data subsets which can then be used for additional browsing, querying or other information processing. Browsing can be considered the primary visual information gathering step while querying allows the user to "navigate" through the data.

Visual data evaluation, however, is necessarily constrained by the limits of human cognitive abilities which permit only relatively small quantities of data to be evaluated at one time. For example, a data series with one hundred observations can easily be inspected visually while one with ten thousand observations cannot. Consequently, large data series must be divided into subsets to conduct visual data evaluations. Furthermore, graphical

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representations quickly become confusing when a third or fourth dimension is added. Therefore, most visual data evaluation is conducted on pairs of data items or variables. Finally, the limits of human memory make it difficult to remember and process important information from more than a dozen or so data subsets or pair-wise visual evaluations.

Commercially available software can provide data manipulation, querying and charting functions required to conduct visual data evaluation. While the general class of software referred to as spreadsheet software is most suited and most frequently used to conduct these evaluations, its application is cumbersome and tedious.

Spreadsheet software represents data in a column and row tabular format. Spreadsheet data is selected for use in a chart by specifying desired columns and rows either through a series of keyboard entries or with mouse operations on the tabular data display. Chart specifications are determined with a series of choices presented in menus, dialogue boxes, or other user-interactive devices. Finally, the chart is presented in a separate display area. Changing one of the variable series presented in the chart is initiated by returning to the spreadsheet display and then repeating the data selection process and updating the chart display.

Examining a noncontiguous subset of spreadsheet data requires a separate data query to extract the desired data and place it in another area of the worksheet. Queries are performed after users specify the data to be queried, query parameters and the area in the spreadsheet that will hold the query results. The columns and rows containing the new data subset are then referenced and incorporated in new chart displays. Spreadsheet data manipulation is also often applied to compute statistics for query results at intermediate points in the evaluation. Additional charting, querying and data manipulation continue through as many additional repetitions as desired.

While the results of spreadsheet-based visual data evaluations are recognized to have substantial value, only limited evaluations can be undertaken before the detailed, cumbersome, and error-prone nature of identifying and developing new charts and keeping track of the relationships between the new queries and charts and the query and chart histories overtakes the ability of the user to interpret the information.

Commercially available database management software (DBMS) also represents data in a tabular format; however, instead of the row and column terminology, database data is

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generally referenced as records and fields. DBMS typically provides greater flexibility in query operations including the computation of a limited number of statistics. Although queries of great complexity may be formulated using DBMS, this software is much more difficult to use than is spreadsheet software. The standard Structured Query Language (SQL) is entered in English-like commands; however, complicated and rigorously structured syntax makes SQL querying a difficult process for users to master. Table or form-based procedures such as Query-by-Example (QBE) have been developed to convert form and table input into query results, and while these developments have decreased the burden of SQL query formulation somewhat, they certainly have not eliminated it.

More recent DBMS and spreadsheet software systems apply graphical user interface (GUI) techniques which allow users to select icons, symbols or other representations presented on the display to specify query details. While software in this later category is often said to provide "graphical" queries (applying the word "graphical" as it is used in the term GUI), a more appropriate characterization is "symbolic query". That is, the user selects symbols from the display to specify a query. Symbols include icons, tables, text, pictures and other representations which connotate data or query operations.

While symbolic systems provide a more intuitive query process than SQL thereby reducing the number of errors inexperienced SQL users might otherwise make, they still require the user to conceptually comprehend complicated database or spreadsheet processes and structures in order to master a series of detailed procedures to define query criteria and relationships.

One of the most important DBMS operations is the "join" operation which is applied to relational databases to combine data from two separate database tables into a single table for further processing. Users must specify commands in SQL text or use mouse selections in symbolic systems to select the tables to be joined and to identify the variables to be included in the resulting table. The problem with this process is that each time the user wants to combine a new set of variables from different tables or wants to include another variable in the current table, a new join operation must be completed. While the relational database approach of storing data in separate tables provides an efficient and flexible model for maintaining the physical database system, it also adds the additional burdens on the user who

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