OPTIMISED MODEL OF INFORMATION TRANSFER IN VIRTUAL ENTERPRISES IN CLOUD COMPUTING ENVIRONMENT

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Keywords: Cloud computing, Virtual enterprises, Communication mechanism.

Abstract: The information transfer in a virtual enterprise is a crux of achieving effective integral management of virtual enterprises. We implement cloud computing in information transfer of virtual enterprises, the model of which is simulated by JSP language.

1 INTRODUCTION

With the development of economic globalization and the deepening of enterprise management practices, virtual enterprise management (VEM) has gradually become one of the most important ways to enhance each company's competitiveness. The achievement of virtual enterprise management is greatly due to the mechanism of communication and information processing. Also data transfer, data collection, data storage and data processing are very important. In the current Internet environment, however, due to the limitations of information infrastructure platform itself, it is difficult to truly solve the problems of virtual enterprise problems. The main characteristics of cloud computing is that the computing resources can be dynamically and efficiently allocated, and buyers can maximize their use of computing resources without managing the underlying complexity of this technology, which can serve to solve the existing problems of virtual enterprise management（Brian Hayes, 2008）. In order to meet the requirements of future development of virtual enterprise management, this paper will propose a novel communication mechanism of virtual enterprises in cloud computing environment, and then implement JSP to achieve the model.

2 LITERATURE REVIEW

Cloud computing is a network carrier which provides the infrastructure, platform, software and other services to form a large-scale integration of scalable computation, storage, data, applications and other distributed computing resources to conduct a dynamic and easily extended super-computing model（Lizhe Wang et al,2008）. In the cloud computing model, users just need to pay the fee to cloud computing service providers, and then easily obtain the required computing, storage and other resources through the network. With future software installed and data stored in the "cloud" side, users are able to accomplish remote computing, data processing through a browser with results displayed in the client side.（Sahinoglu, M. and Cueva-Parra, L., 2011）

The commercial value of cloud computing may be reflected as follows: on the one hand, resources provided by cloud computing is cheaper than companies themselves can provide. The most important reason for companies to willingly give up the control of their own resources and allow them to exist in a virtual cloud is cost saving, including the management costs and application costs. (Michael Miller, 2008) On the other hand, with greater flexibility and scalability, cloud computing can be

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virtualized between different applications in order to increase the utility of Servers (Vouk, M.A., 2008).

With considerable advantages stated above, this paper indicates a new method for communication mechanism of virtual enterprises using cloud computing.

3 MODEL DESIGN

3.1 Organization Structure

In order to adapt to the dynamic variability of the external environment, the organization structure of virtual enterprise is an "a myriad of stars surround the moon" type distributed topology. According to the needs of a task, the organization structure can be divided into several virtual work teams (the smallest organization unit), which consist of working groups from each business partner. The agility of partners must be considered when designing virtual enterprise organization structure, which means the partners should be agile enterprises themselves. The upper management agency is Virtual Enterprise Operation Management Center (referred to as VEOMC), which manages the operation of virtual enterprises. (Assimakopoulos, 2006)Based on the above principles of organization design, Figure 1 shows a typical organization structure of virtual enterprise.

It is known from Figure 1 that the VEOMC is composed of core enterprise and compact partners. Virtual work team, consisting of working groups, is a unit of sub-task, and each virtual work team is led and managed by a core working group. Core working group generally comes from the core enterprise or compact partners, such as compact partner 1 of working group 1 from virtual work team 1 shown in Figure 1; other working groups come from the compact or semi-compact partners. Once a sub-task is completed, the virtual work team will be disintegrated, and the working groups will be return-type partners. When new tasks arise, the working groups form a new virtual work team. All of the above processes are accompanied by data transfer, data collection, data storage and data processing, making the management of virtual enterprises looks very complicated. In order to establish the model, we set aside some of details and simplify the process of virtual enterprise management.

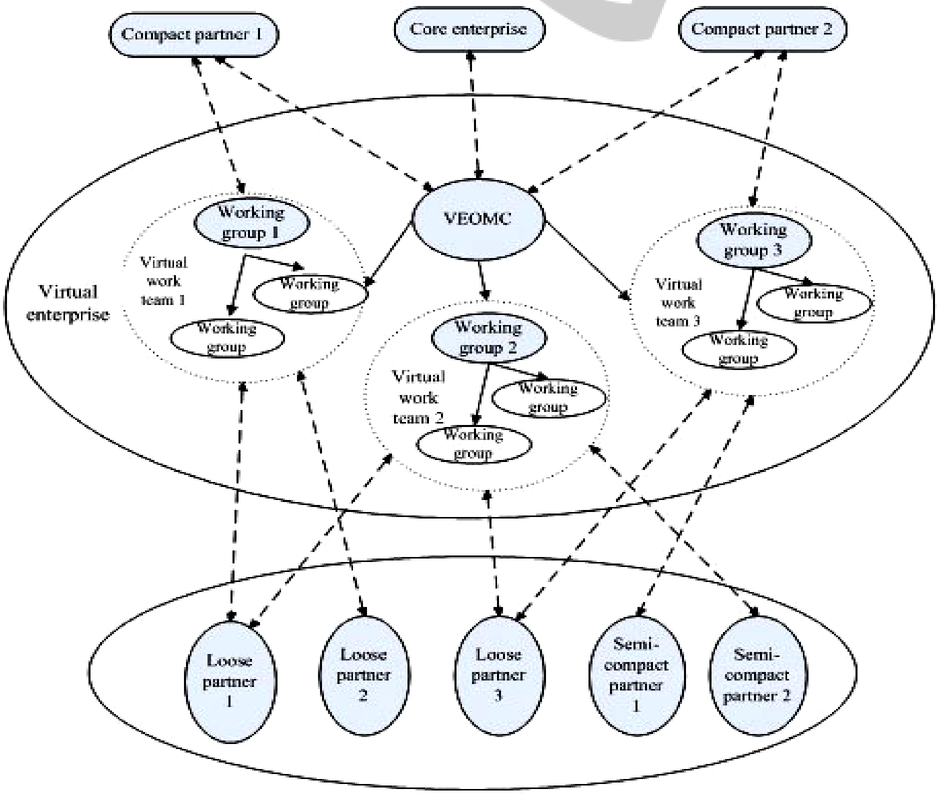

Figure 1: Organization structure of virtual enterprise.

3.2 Model Design

3.2.1 Idea Review

In a virtual enterprise, each company that participates in a sub-task, whether it is core enterprise, compact partner, semi-compact partner, or loose partner, needs to share information which includes the performance of a partner completing a sub-task, the constraint information that VEOMC manages each virtual work team. (Dragoi George et al, 2006) Obviously, it is of great importance to share this information as soon as possible. Suppose that there is a communication network being used in the virtual enterprise, which allows data set (or file) to be transferred from one company computer to another. This example is illustrated in Figure 2:

In Figure 2, vertex V1, V2... Vm refers to computers that process information in each virtual

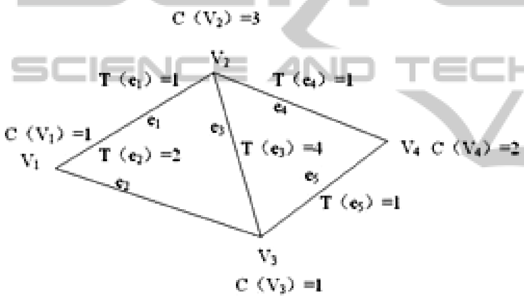

Figure 2: Sample graph.

enterprise entity; edge e1, e2... en, means file information to be transferred; T(ex) means time needed to transfer Files ex; C(Vy) means the processing capacity of computer Vy, i.e. the number of files that can be transferred at a time. File transfer must occupy all the time required of two relevant computers transferring files. C(Vy) = 1 means that the computer Vy can only transfer one file once.

What needs to be solved here is to arrange the transfer so as to cost as little time as possible to complete the transfer of all documents. The total time is called "completion time" in the Operations Research. (Hua Chen et al, 2006)

To facilitate the establishment of the model, the problem is described as follows: there are 13 entities in the virtual enterprise model, including one VEOMC, four core working groups and eight other working groups. Assume that each entity has only one computer, and each computer is represented as a vertex in Figure 3. There are 12 files to be transferred between entities within a day. Edges in Figure 10 represent file transfer. In this network, for all x, y, T(ex) = 1, C(Vy) = 1, we are to find out the schedule of the transfer and the corresponding completion time. The graphical model is shown in Figure 3:

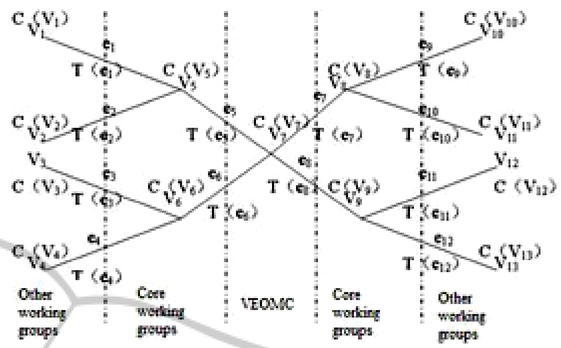

Figure 3: Model Design.

It is concluded from Figure 3 that we should figure out the shortest time of file transfer with constrains of limited computer processing capacity and transfer time.

To simplify the calculation, here are some basic assumptions:

(1) Communication network graph is a simple undirected graph. There are no overlapping edges between any two vertices, which means all the information transferred between two computers can be included in one file.
(2) Preparation time of files to be transferred is negligible, namely, zero. So the process of communication network file transfer can be continuous.
(3) The transfer time of each file is a fixed number.
(4) All files are independent of each other, and there is no order or priority among them.
(5) There allows no interruption during the process of transfer. Once a file is being transferred, it has to be finished continuously.
(6) Communications network won't break down during the transfer process.
(7) Suppose the time required is identical, T(ex) = 1.
(8) Each computer can only process one file once, i.e. C(Vy) = 1.

3.2.2 Model and Solution in the Local Cluster Environment

The assumption that the transfer time of each file T(ex) = 1, and each computer's processing capacity C(Vy) = 1, makes the problem-solving relatively simple. If all the files are to be transferred in the shortest possible time, files have to be processed in

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batches, and the batch number is the minimum completion time. There are different files being transferred in each unit of time, which correspond to the edge set without the same endpoint in the graph, namely, one match in Figure 3. Different matches have different edges, and the union set constitute Figure 3. Thus, the optimal transfer schedule is to divide Figure 3 into as few non-overlapping matches as possible, the number of which is the optimal completion time.

Based on the maximum cardinality bipartite graph matching algorithm, method is designed as follows:

Step 1: Let E (u) be the set of all edges of G, set STAGE = 1.
Step 2: Calculate a maximum cardinality match of E(u); the edges in the match are noted as "labelled".
Step 3: Remove the labelled edges from E(u).
Step 4: If E(u) is not empty, go to step 5; otherwise terminate the calculation, STAGE is the optimal completion time.
Step 5: STAGE = STAGE +1, return to Step 2.

Reflected in the form of bipartite graph of Figure 3, we get Figure 4. Find out the maximum cardinality match in Figure 4 (dashed-line edges in Figure 5), the corresponding file of whose edge is to be transferred in the first batch. Remove these edges to get Figure 6. Repeat the above steps in Figure 6 to get Figure 7 and again Figure 8.

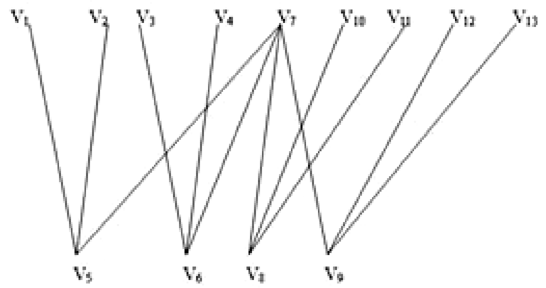

Figure 4: Step 1.

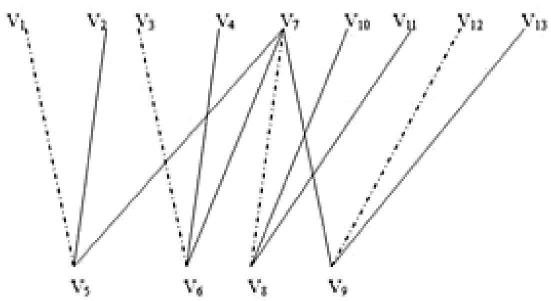

Figure 5: Step 2.

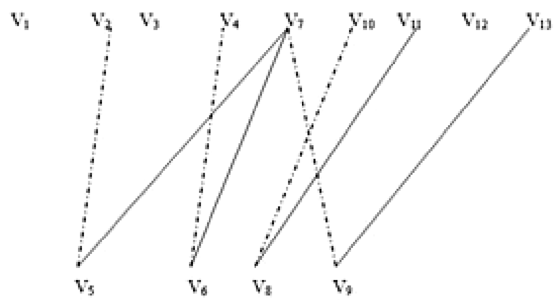

Figure 6: Step 3.

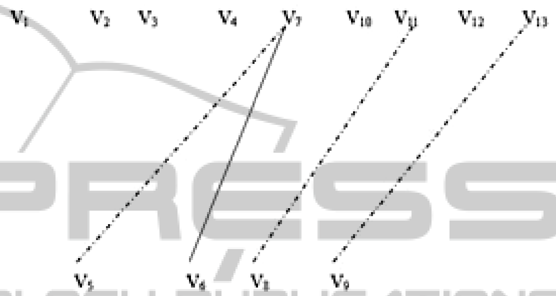

Figure 7: Step 4.

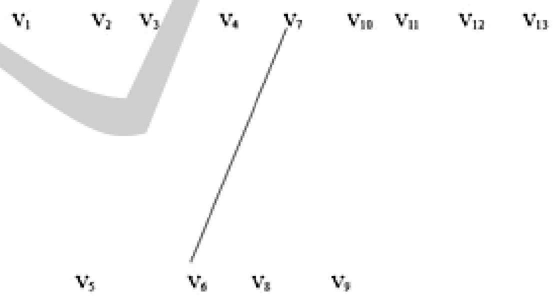

Figure 8: Step 5.

By the above analysis of the solution, 4 files are transferred in the first unit of time, then 4 files in the second unit of time, 3 files in the third and 1 file in the fourth. The completion time is 4 units of time, which is also the optimal completion time.

3.2.3 Model in Cloud Computing Environment

In the cloud computing environment, the participating entities share data processing capability from the "cloud" through browsers. Virtual enterprises can provide information infrastructures and integrate all the virtual enterprise data into one global database without considering the data location and the type of systems used in various entities. Currently, the various entities in the virtual enterprise use the heterogeneous IT environment,

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which means the data source systems are different. (Cheng, G et al, 2010) According to the agreement on data source systems that provide item data, several virtualized levels need to be set to the virtual enterprise:

(1) If all the participating entities are in favour of a uniform flat file format of providing item data, then the virtual enterprise can use a distributed file system. If so, the virtual enterprise can access to data on the basis of flat file.

(2) If the agreement only includes item data file format itself, but with a different file type, then the virtual enterprise requires a virtual data layer, which is used to shield different file types and provide a unified access to source of data.

(3) If the agreement merely includes the format of the item data, rather the types of data source, then the virtual enterprise need to be able to integrate data provided by different data systems transparently in a virtual layer, such as relational or non-relational DBMS, and a variety of different types of flat files.

To simplify the modeling, this article assumes that global virtual database is within VEOMC, and then Figure 3 can be transformed into Figure 9. In Figure 9, the C(V7) is set to ∞, because the processing capacity of the entire communication system can be utilized based on the purchased capability according to characteristics of cloud computing, the power of which is much larger than a single computer's data processing capacity.

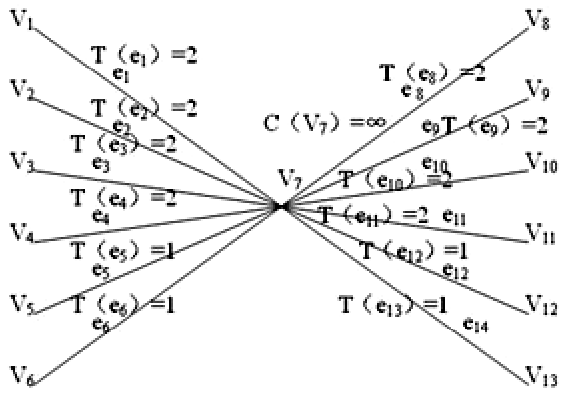

Figure 9: Brief graph of the model in cloud computing environment.

In Figure 9, since both the processing capacity and the transfer time is not all 1, the maximum cardinality matching algorithm cannot be directly used to calculate the completion time. A method to solve this problem is to introduce the "pseudo-vertex" concept, that is, if the capacity of a vertex is 3, then introduce two pseudo-vertexes in the original image, and set 1 to the capacity of original vertex and “pseudo-vertexes”. If so, maximum cardinality matching and maximum weight matching algorithm can be used in the changed graph. Meanwhile, the edge formed between “pseudo-vertexes” is “equivalent edge”.

Due to the “pseudo-vertex” and “equivalent edge”, even though the maximum cardinality matching and the maximum weight matching algorithm (transfer time is inconsistent) can be used in the transformed graph G’= (V’, E’) (the capacity of each vertex is 1), the match can only contain one edge of all the “equivalent edges”. So once an edge is selected into the match, other equivalent edges have to be removed immediately from the graph.

Based on the above analysis, due to the use of maximum cardinality matching and maximum weight matching algorithms, we get Figure 10.

Figure 10: The maximum weight matching algorithm.

According to Figure 10, it is obvious that it takes only two units of time to transfer 12 files, which is the optimal completion time.

3.2.4 Model Comparison and Extension

As is elaborated above, the optimal completion time in cloud computing environment is two units less than that in non-cloud environment, which is the advantage of the cloud in data processing. It is because the hierarchical progression is reduced in cloud computing environment where the transferred time decreases.

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To facilitate the modeling, this paper utilizes the simplest fact-based chain structure of virtual enterprise modeling. But in reality, the structure of virtual enterprise network is much more complex than the model, and the mode of composition is multi-layered. With the increase of virtual enterprise structure complexity, extended analysis indicates a continuous decrease of completion time. Imagine if all the resources in the world are run in the cloud computing platform, the savings of completion time will be amazing.

Meanwhile, since all the virtual enterprise information platforms share the cloud computing environment, it is reasonable to view all the processing power in a virtual global database, making the information transfer even simpler. The whole virtual enterprise can be viewed as a "tree", the global database is the "root" of the "tree". Therefore maximum weight of the path of the "tree" can be used to obtain the "optimal completion time".

4 JSP SIMULATION

This section aims to find out a solution of the maximum weight of the tree by JSP language, with the results shown directly in the form of web page,.

4.1 Model Algorithm

The maximum weight recursive backtracking algorithm is used in the accomplishment of the model, which is as follows:

Step 1: Look for leaves from all nodes, and assign an array to all the leaves.

Step 2: Calculate the length of the array.

Step 3: Look for the parent node of each leaf, and then the parent node which is the child node of the previous parent node until you find the root up. Calculate the weight of each path.

Step 4: Calculate all the weights of each full-path, and compare to get the maximum value.

The logic flow chart of the algorithm is shown in Figure 11.

The algorithm code is referred to Appendix.

4.2 Database Interface Design

4.2.1 Datasheet Design

ACCESS is used as the database to achieve the model. The specific design shown in Table 1:

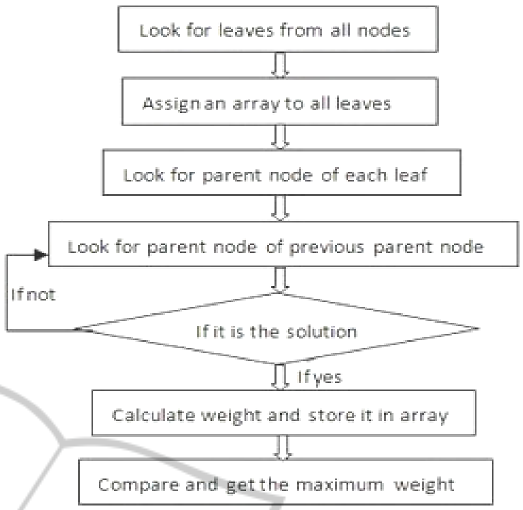

Figure 11: Logic flow chart of algorithm.

Table1: Datasheet Design.

Data item	Code	Type	Length
Identifier	id	long integer	
Parent node	parent_id	text	8
Child node	son_id	text	8
Weight	total_weight	float	

4.2.2 Database Interface Code

The interface code is as follows:

```
   <%
   Class.forName("sun.jdbc.odbc.JdbcOdb
cDriver") ;
   Connection conn =
DriverManager.getConnection("jdbc:odbc:
parent_son");
   Statement、
stmt=conn.createStatement(ResultSet.TYP
E_SCROLL_SENSITIVE,ResultSet.CONCUR_UPD
ATABLE) ;
   %>
```

4.3 Model Demonstration

Figure 12 shows a web page which runs the program of the optimized model.

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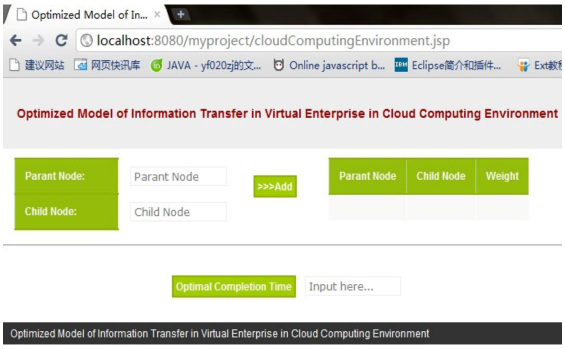

Figure 12: Webpage of model program.

Here, integer is input in text boxes of the parent and child nodes, such as 0 for the parent node, 1 for the child node; float is input in the text box of weights, such as 3.0 for the weight. After clicking the "Add" button to submit, you can continue to input, such as 0 for the parent node, 2 for the child node, 4.0 for the weight. Thus, the input model is shown in Figure 13.

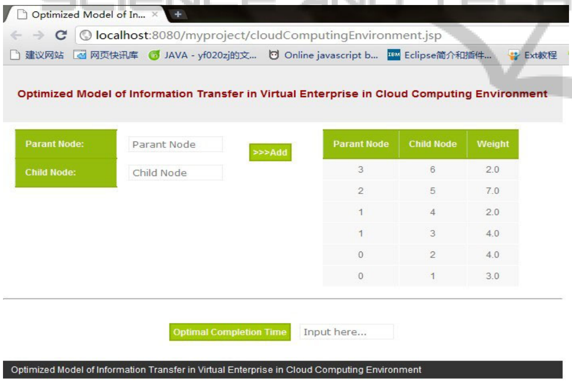

Figure 13: Webpage of data input.

Click on the "Optimal Time Calculation" button, the results are shown in Figure 14. (Code referred to Appendix).

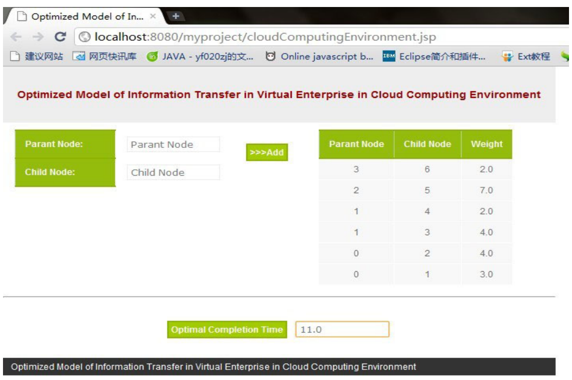

Figure 14: Webpage of result output.

5 CONCLUSIONS

After the establishment of an optimized model of virtual enterprise in cloud computing environment, the great advantages of cloud computing are demonstrated in the virtual enterprise environment. And the simulation of the model by JSP language further illustrates the advantage and trend of the use of cloud computing in supply chain management. Although this paper focuses on the processing of information flow in the supply chain, cloud computing environment for virtual enterprise management model can also be from other aspects, such as the model of actual management process of virtual enterprise, which is the future direction for further research.

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APPENDIX

```
   <%
   String strSQL;
   strSQL = "select  son_id from
parent_son where son_id not in(select
parent_id from parent_son) ";
   ResultSet
rs=stmt.executeQuery(strSQL);
   ArrayList leaf=new ArrayList();
   String leaf_id="";
   while (rs.next())
     {
        leaf_id=rs.getString("son_id");
     leaf.add(leaf_id);
   }
   rs.close();
   Object oleaf[]=leaf.toArray();
   float ototal[]=new
float[oleaf.length];
   PreparedStatement ps=null;
   String cquery="select parent_id
,total_weight from parent_son where
son_id=?";
   String t_son_id="";
   float Max=0;
   outer1:for(int i=oleaf.length-
1;i>=0;i--)
        {
            float ftotal=0;
            float total_weight;

    t_son_id=oleaf[i].toString();
            int insert_sequence=0; //

    ps=conn.prepareStatement(cquery);
    outer2: for(int j=0;j<2;j++)
            {

    ps.setString(1,t_son_id);
                rs=ps.executeQuery();
                if(rs.next()){

    t_son_id=rs.getString("parent_id");

    //scm_line=scm_line+"---"+t_son_id;

    ftotal=ftotal+rs.getFloat("total_we
ight");
                j=0;
                continue outer2;
                }else{
                    ototal[i]=ftotal;
                    continue outer1;
                }
            }
        }
   for( int m=0;m<oleaf.length;m++)
   {
      if(ototal[m]>Max)
      Max=ototal[m];
   }
```

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