International Journal of Hybrid Information Technology
Vol. 9, No.6 (2016), pp. 245-252
http://dx.doi.org/10.14257/ijhit.2016.9.6.21

Numerical Analysis of Optimization of Scheduling Based on Fisher Fishing Algorithm

Liu Ying-fen

Gannan Teachers' College
liuyingfen1964@163.com

Abstract

In order to obtain the minimum supply and demand scheduling under Cloud manufacturing platform, the fisher fishing algorithm is applied in it. Firstly, the optimization algorithm of fisher fishing is studied. Secondly, the supply and demand scheduling mode under Cloud manufacturing platform is constructed, and the corresponding optimization mathematical model is established. Finally, the simulation results of supply and demand scheduling time is carried out, results show that the fisher fishing algorithm is an effective tool.

Keywords*: supply and demand scheduling; Cloud manufacturing platform; optimization*

1. Introduction

With development of High and new technology, manufacturing industry information has become a necessary trend. At present, a new manufacturing module with information interaction online and materialization processing off-line is proposed, which is named as cloud manufacturing. The cloud manufacturing breaks the limitation of space geographical position, and can get manufacturing resources distributed in different position together through server, and can offer more convenient and timely service for customers distributed in different position than traditional network manufacturing. The cloud manufacturing accepts the advanced achievements provided by agile manufacturing, grid manufacturing and supplier of application service, it also develops based on ideas of cloud computing, the cloud manufacturing achieves the interaction of advanced information technology, manufacturing technology and Internet of things, and manages and operates the all kinds of manufacturing resources intelligently, and it can response to the scheduling tasks proposed by every node in supplying chain, and it can offer available all the time, safe and reliable, and high quality cheap service. The cloud designates the developing direction for the manufacturing informatization.

In recent years, some achievements relating to the cloud manufacturing are obtained. Xiao-ying Yang focused on the requirement of the large equipment manufacturing industry to adapt collaborative operation to transform the industry to cloud manufacturing services and to solve the new problem of federal resources coordination in complete service operation, and studied federal resources cooperation under cloud manufacturing mode to complete a large complex project [1].

Shi-long Wang *et al*. studied the strategies needed of cloud manufacturing application mode from four aspects of business concept, platform, technology and security, and put forward the new ideas of cloud manufacturing, such as regional cloud manufacturing platform, refactoring technology areas and cloud security strategy [2]. X.V. Wang *et al.* presented an interoperable manufacturing perspective based on Cloud manufacturing. Service methodologies were developed to support two types of Cloud users, *i.e.*, customer user and enterprise user, along with standardized data models describing Cloud service and relevant features. Two case studies were undertaken to evaluate the proposed system [3]. Xu, X. discussed some of the essential features of cloud computing. Cloud computing was also

ISSN: 1738-9968 IJHIT

emerging as one of the major enablers for the manufacturing industry: it could transform the traditional manufacturing business model, helped it align product innovation with business strategy, and created intelligent factory networks that encouraged effective collaboration [4].

The Cloud manufacturing breaks the limitation of space geographical position, supplying resources and services are not limited to the nearby enterprises, and can search corresponding supply chain resources from the whole country and world, and relate the activities in whole life cycle of products, which concludes design, purchase, manufacturing, sales, transportation and other parts. With development of globalization and informatization, the data of Cloud manufacturing supplying chain resources shows increasing trends. At a moment, hundreds of downstream enterprises in supply chain may put forward service requirement, how the supply upstream chain resource that can be competent for these tasks registered in the Cloud manufacturing platform is limited, if the Cloud manufacturing platform cannot manage the resources, then the requirement offered by customers cannot be satisfied, the advantages of supply chain under Cloud manufacturing platform cannot be reflected. How to find out proper suppliers of resources for many demanders of resources and achieve docking of supply and demand of resources, then the total processing time of these tasks can be shortest, the quick response of resources can be achieved. In order to carry out effective scheduling for supply chain resources under Cloud manufacturing platform, an advanced algorithm should be applied in optimization of Supply and demand scheduling. Fisher fishing algorithm is put forward based on the activity of fisher fishing, a searching method is established based on this activity. The core part of this algorithm is listed as follows: the block is constructed at the center of selected individual, and the individual can move and contract according to the near environment, then the global optimization solution can be found out. The fisher fishing algorithm has been applied in many fields according to certain searching mechanism and strategy. The fisher fishing algorithm can be applied in optimization of supply and demand scheduling under Cloud manufacturing platform, then the global optimization ability can be improved.

2. Optimization Algorithm of Fisher Fishing

The fisher fishing operating region is defined as limited closed region, which is expressed as follows: $D = D_1 \times D_2 \times \cdots \times D_n$, it denotes sampling rate of controlling variable groups. K fishers denote K controlling variable groups; the position status variable of fisher is defined by $X = (x_1, x_2, \cdots, x_n)$, the density function of fish in D is defined by $f(X)$, $t_{\min}$ denotes the minimum completion time of production task. The problem of finding maximum density of fish and its position can be transformed to the optimization problem of solving minimum completion of task and status variables [5].

(1) Mobile searching: the original position is selected randomly by K fishers in fishing operating region, and the position of ith fisher can be expressed as follows:

$$P_0^{(i)} = (x_{01}^{(i)}, x_{02}^{(i)}, \cdots, x_{0n}^{(i)}),\ i = 1, 2, \cdots, k \tag{1}$$

The fisher i constructs the block at the centre of original position $P_0^{(i)}$, and casts a net all around the b

$$\text{and } f(P_m^{(i)}) \geq \max_{X(i) \in \Omega_m^{(i)}} f(X^{(i)}) \tag{8}$$

Then the position of fisher i is the global optim lock, the corresponding net point set is defined by $\Omega_0^{(i)}$, which is expressed as follows:

$$\Omega_0^{(i)} = \{X^{'(t)} = (t_1^{(i)}, t_2^{(i)}, \cdots, t_n^{(i)}) \mid t_j^{(i)} \in \{x_{0j}^{(i)} - l_j^{'(-)}, x_{0j}^{(i)}, x_{0j}^{(i)} - l_j^{'(+)}\}, j = 1, 2, \cdots, n\} \tag{2}$$

where, $l_j^{'(-)} = \beta l_j^{(-)}$, $l_j^{'(+)} = \beta l_j^{(+)}$, β denotes contracting factor, $0 < \beta < 1$. $\Omega_0^{'(i)} \subset \Omega_0^{(i)}$. After the contacting searching is over, i th fisher can carried out the procession mentioned above repeatedly, then the optimization objective can be achieved. K fishers can find out extreme point of $f(X)$ according to the same method.

In order to make K fishers not cast the net to the same position during the procession of searching optimization stage, the corresponding note board is set, and then every fisher can grasp the current fishing position and different optimization path.

(2) Contacting searching:

After m times mobile searching is over, fisher i can construct the block at the center of current position, the net point set can be obtained as follows [6]:

$$\Omega_m^{(i)} = \{X_m^{(i)} = (t_1^{(i)}, t_2^{(i)}, \cdots, t_n^{(i)}) \mid t_j^{(i)} \in \{x_{mj}^{(i)} - l_j^{(-)}, x_{mj}^{(i)}, x_{mj}^{(i)} - l_j^{(+)}\}, j = 1, 2, \cdots, n\} \quad (3)$$

If $f(X_m^{(i)}) = \max_{X(i) \in \Omega_m^{(i)}} f(X^{(i)}) < f(P_m^{(i)})$, the block may exist the point with bigger density of fish, then the fisher moves from mth position $P_m^{(i)}$ to m+1th position $P_{m+1}^{(i)}$, and construct the block again to fishing, then fisher i begins to carry out contacting searching strategy, the m+1th net point set is expressed as follows:

$$\Omega_{m+1}^{(i)} = \{X_{m+1}^{(i)} = (t_1^{(i)}, t_2^{(i)}, \cdots, t_n^{(i)}) \mid t_j^{(i)} \in \{x_{mj}^{(i)} - l_j^{(-)}, x_{mj}^{(i)}, x_{mj}^{(i)} - l_j^{(+)}\}, j = 1, 2, \cdots, n\} \quad (4)$$

where, $l_j^{(-)} = \alpha l_j^{(-)}$, $l_j^{(+)} = \alpha l_j^{(+)}$, $0 < \alpha < 1$, α denotes the contacting factor of block.

In order to improving the optimization ability of algorithm, the improved fisher fishing algorithm is put forward, then the problem of falling into the local optimal can be avoided.

Fisher i begins to carry out contacting strategy in m th time for fishing. When the contacting times of fisher reaches the predefined threshold and does not reach the new position with bigger density of fish, then fisher i may fall into local optimal region. According to this problem, the accelerating jumping mechanism of fisher is set. When searching times of fisher i in position $P_m^{(i)}$ reaches threshold, and the following conditions are satisfied:

$$f(P_m^{(i)}) \geq \max_{X(i) \in \Omega_m^{(i)}} f(X^{(i)}) \quad (5)$$

$$f(P_m^{(i)}) < \max\{f(P_m^{(i)}, 1, 2, \cdots, k\} \quad (6)$$

Then fisher i does not find out the point with bigger density of fish in the block constructed by themselves, however positions of other fishers may exist the point with bigger density of fish, then fisher i jumps the current position quickly. A point is originated randomly in fishing region again, the mobile and contacting strategies are carried out repeatedly, if the following conditions are satisfied:

$$f(P_m^{(i)}) \geq \max_{X(i) \in \Omega_m^{(i)}} f(X^{(i)}) \quad (7)$$

$$f(P_m^{(i)}) \geq f(P_m^{(i)}) \text{ and } f(P_m^{(i)}) \geq \max_{X(i) \in \Omega_m^{(i)}} f(X^{(i)}) \quad (8)$$

Then the position of fisher i is the global optimal.

3. Supply and Demand Scheduling Mode under Cloud Manufacturing Platform

Under Cloud model the manufacturing enterprise focuses on the real time sharing of production information, every processing node in production workshop under Cloud manufacturing environment should construct the relationship model. Production information under Cloud environment changes in real time according to actual production status, therefore supply and demand scheduling of production resources may exist many feasible plans. In order to achieve the production task with shortest time and highest efficiency, according to the real time information of production resources and real time load status of physical devices, the optimal technology route of production task is decided, and every processing procedure is arranged on the physical device. Then the optimal technical route of every processing task can be obtained, at same time the results are fed back to execution layer, then the optimal supply and demand scheduling results under Cloud manufacturing model are obtained. The supply and demand scheduling model under Cloud manufacturing is shown in Figure 1.

The supply and demand scheduling system concludes three layers, which are listed as follows:

(1) Cloud information exchanger layer: this layer is made up of Cloud interface information exchanger and process knowledge base. Cloud interface information exchanger mainly is responsible for processing production task from order and track real time data changes from Cloud, and the processing process is fed back. Process knowledge base can construct the connection with enterprise public Cloud through connecting with Cloud interface exchanger, and update the instance database and rule library regularly, and uploads the resources.

(2) Critical controlling layer: this layer is made up of management center for manufacturing task and matching assignment model of processing node data flow. The main function of it preprocesses task request issued by Cloud information exchanging layer, and carries out feature quantitative description for order information, and divides them into several sub tasks, according to the established matching rule transfers the information of process knowledge base, and carries out istantiation for divided sub task, finally execution route and scheduling results are obtained.

(3) Allocating layer of resources: this layer is the end of the whole system, which is made up of communicating protocol, physical processing equipment and resource recovery module. Through established communication protocol, the resource nodes madding up of a series of processing devices find out the needed physical equipment for every processing node according to execution route and scheduling results.

The optimal objective function is expressed as follows [7]:

$$J = \min\{t(x)\} \tag{9}$$

where x denotes a feasible solution of scheduling plans; $t(x)$ denotes a feasible solution of completion time.

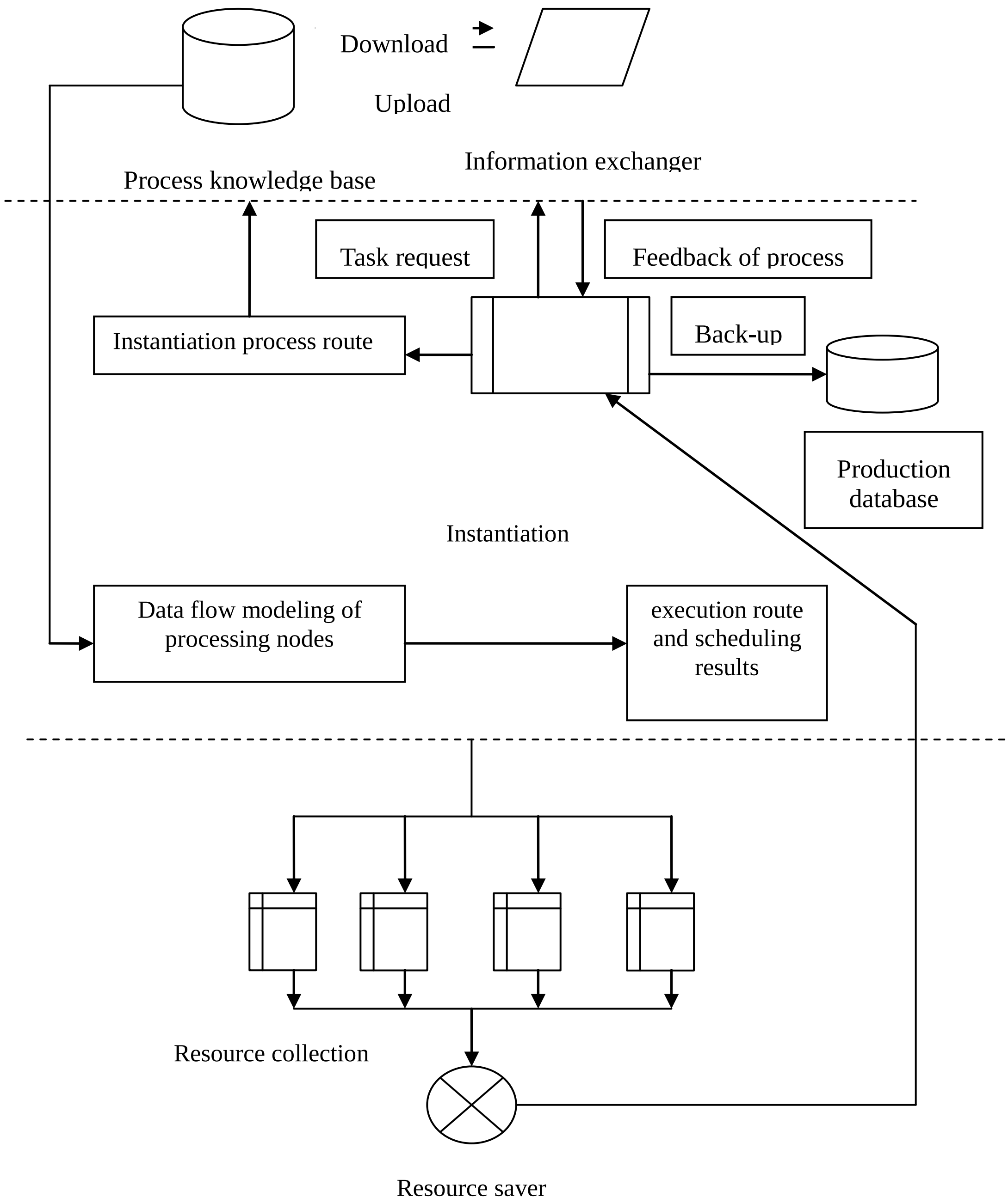

Figure 1. Diagram of Supply and Demand Scheduling Model under Cloud Manufacturing

The boundary conditions are expressed as follows:

$$T_i \le DT_i \tag{10}$$

$$t_s(i,m) + M(1-\eta_{imn}) \ge t_e(i,n) \tag{11}$$

$$t_s(i,k) + M(1-\eta_{ijk}) \ge t_e(j,k) \tag{12}$$

$$pri(T_i) < pri(T_j) \tag{13}$$

where T_i denotes completion time of processing task MT_i; DT_i denotes the delivery period; $t_s(i,m)$ denotes the beginning time of m th activity in production task MT_i; $t_e(i,n)$

denotes the processing time of n th activity in production task MT_i; η_{imn} and η_{ijk} denote the indicating coefficients; $pri(T_i)$ and $pri(T_i)$ denote processing series.

4. Simulation Results of Supply and Demand Scheduling Time

The optimization of supply and demand scheduling time is carried out based on fisher fishing algorithm, and the corresponding simulation programmer is compiled by MATLAB software, the parameters of algorithm are chosen as follows: scale of fishers K is equal to 100, continuous parameters l_1^+ and l_1^- are equal to 0.04, the discrete parameters l_2^+ and l_2^- are equal to 2.5. The continuous parameter of contacting procession $\alpha = rank(\ )*l_1*$; the discrete parameter is taken as $[rank(\ )*l_1*]$, where $rank(\ )$ denotes random number from 0 to 1, $[\ ]$ denotes rounding.

The task number under Cloud manufacturing platform is taken as 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600 respectively, and the simulation results are shown in Table 1.

Table 1. Simulation Results for Different Task Number under Cloud Manufacturing Platform

Task number	Running time/s	Iteration times of founding optimization solution	Optimal scheduling time/d
100	8.12	66	20
150	12.68	62	24
200	18.95	55	27
250	24.31	48	32
300	30.44	45	39
350	36.82	43	45
400	42.65	41	52
450	48.06	39	56
500	54.25	38	60

As seen from Table 1, with increasing of tasks under Cloud manufacturing platform, the running time of fisher fishing algorithm increases slowly, and the iteration time of fisher fishing algorithm decreases accordingly, with increasing of production task under Cloud manufacturing platform, the algorithm shows good convergence characteristics, then the optimization supply and demand scheduling time can be obtained finally.

5. Conclusions

Under Cloud manufacturing platform, many enterprises of supply chain nodes registered at any moment, and the service requests can be put forward. The Cloud manufacturing platform can classify, store and manage the resources, the quantity of data are big, and updates frequently, then the core competition of supply chain enterprise can be improved. The fisher fishing algorithm is applied in the optimization of supply and demand scheduling, simulation results show that the fisher fishing algorithm is an effective tool. The minimum scheduling time can be obtained finally.

References

[1] X.Y. Yang, G.H. Shi and Z.W. Zhang, “Collaboration of large equipment complete service under cloud manufacturing mode”, International Journal of Production Research, vol. 2, no. 52, **(2014)**.
[2] S.L. Wang, L. Guo and L. Kang, “Cloud manufacturing application mode and program analysis”, Computer Integrated Manufacturing Systems, vol.7, no.18, **(2012)**.
[3] X.V. Wang and X.W. Xu, “An interoperable solution for Cloud manufacturing, Robotics and Computer-Integrated Manufacturing, vol.4, no.29, **(2013)**.
[4] X. Xu, “Cloud manufacturing: A new paradigm for manufacturing businesses”, Australian Journal of Multi-Disciplinary Engineering, vol.2, no.9, **(2013)**.
[5] Y. Wang, J.R. Chen and X. Pang, “An optimization approach combining artificial fish swarm and fishing strategy”, Computer Applications and Software, vol.2, no.8, **(2009)**.
[6] R.T. Wang, Y.L. Yang and B. Wang, « Application of optimization algorithm on simulating the fisher fishing in multi-objective optimal reactive power”, Power System Protection and Control, vol.21, no.39, **(2011)**.
[7] T.D. Braun, H.J. Siegel and N. Beck, “A comparison of eleven static heuristics for mapping a class of independent tasks onto heterogeneous distribution computing systems”,Journal of Parallel and Distributed Computing, vol.6, no.16, **(2001)**.

Author

Liu Ying-fen is a professor in Gannan Teachers’ College. Her research direction is Computational Mathematics.