Management Resources Allocation and Scheduling based on Particle Swarm Optimization (PSO)

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***Abstract* — Resources allocation and scheduling can be accomplished in various ways, and there are different criteria for resources allocation and scheduling. In this regard it is generally subject to the values of a particular time and space, but also subject to accounting under certain conditions of time and space dominance interests and values-oriented social groups, but also subject to a specific time and space research under way to study the subject of economic interests orientation and values. Therefore, any kind of theory of optimal allocation of resources, in fact, are based on certain values and interests on the basis of the guide. This paper presents management resources allocation and scheduling (MRAAS) optimization based on Particle Swarm Optimization (PSO), which has been modified and applied to solve it effectively. Case studies have been conducted to verify the performance and efficiency of the modified PSO algorithm, providing scientific reference channels.**

Keywords - Particle Swarm Optimization; Management resources allocation and scheduling; Resource scheduling; Optimization

I. INTRODUCTION

Management resources allocation and scheduling (MRAAS) research question is the optimal allocation of production or supply of a variety of useful goods and services, and is in fact the exchange, distribution or consumption of the sense of social research produced or provided useful optimization of goods and services configuration. Resource understood or defined as various forms of factors of production, and therefore the study is to optimize the configuration of the various factors of production, and in fact, is to study the optimal allocation of factors of production in the production of meaning [1-2]. We can in the production, exchange, distribution and consumption of the unity of significance, optimize the allocation of economic resources, including the use of a variety of value optimization configuration and optimization of factors of production configuration.

A basic principle of market allocation of resources in the way, is the marginal cost equals marginal revenue, which could apply to optimize the allocation of use value, may also apply to optimize the allocation of factors of production have personified representatives, but not necessarily applicable to non-personified representative of factors of production optimal allocation, because we cannot determine natural resources, ecological environment, time of marginal costs and benefits cannot be determined without the personification of natural resources on behalf of the effectiveness of the implementation of marginal cost equals marginal revenue of the basic principles of what. In our view, the marginal cost and marginal revenue in orthodox economics, the economy is still based on a person assumes rational behavior based on the concept of socialization is not fully applicable without personification representatives optimal allocation of production factors.

Particle Swarm Optimization (PSO) combines evolutionary computation and swarm intelligence features. Initially conceived just simulate birds foraging process, but later found PSO is a good optimization tool. Similar to other evolutionary algorithms, PSO algorithm is through collaboration and competition between individuals to achieve complex search space optimal solution. PSO first step to generate the initial population, feasible solution space random initialization group of particles, each particle is a feasible solution of the optimization problem, the objective function by determining whom a fitness value. Each particle motion in the solution space, a rate determined by its direction and distance [3-5]. Typically the particles will follow the current best particle, and by the last generation of search-by-optimal solution. In each generation, the particles will follow the extremes, one is the optimal solution found so far pbest the particle itself, and the other is the optimal solution found so far gbest the entire population. This management resources allocation and scheduling (MRAAS) in multi-objective problem, effective resource scheduling provides a good solution.

II. MANAGEMENT RESOURCES ALLOCATION AND SCHEDULING OPTIMIZATION (MRAAS) ANALYSIS

Although the target optimal allocation of resources can be attributed in a general sense for the optimal allocation of resources to improve efficiency, but optimal allocation of resources itself but it can make a different understanding from different angles. One of the resources allocation and scheduling optimization actors may have different levels of understanding or behavioral aspects [6]. The main goal is to improve the allocation of resources should be the entire resources allocation and scheduling effective management objective optimal allocation of resources can be attributed to the optimal allocation of resources to improve the efficiency in a general sense, but the resources allocation and scheduling optimization itself can be made different from different angles understanding. Optimal allocation of resources can actually be accomplished in various ways. Clearly, based on the different allocation of resources, a different resource allocation theory. We have stressed that the competition is to improve coordination and efficiency of the possible ways, which can be an effective allocation of resources. Figure 1 illustrates an example of an MRAAS instance with a corresponding feasible schedule.

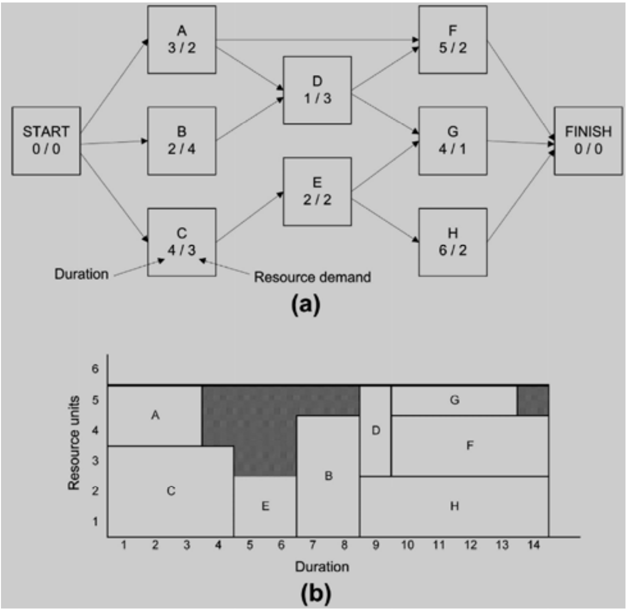

Figure 1. (a) An example project instance for the MRAAS and (b) a feasible solution.

In this definition of the classic problems are expected due to the limited resources of the unit, it can be allocated to activities that enable resource-constrained project scheduling produce cross after CPM will most likely be greater than the initial calculation of time, without taking into account resource usage limits. MRAAS is the starting point to face a variety of real-world decision-making problems. Therefore, many people proposed extension of the basic model, for example by introducing generalized precedence relations activities (MRAAS-GPR), allow active preemption (MRAAS), consider other types of objective function. Detailed reports and an extensive literature review and basic MRAAS extension can be found.

For optimal allocation of resources in fact there are different criteria. In this regard it is generally subject to the values of a particular time and space, but also subject to accounting under certain conditions of time and space dominance interests and values-oriented social groups, but also subject to a specific time and space research under way to study the subject of economic interests orientation and values. Therefore, any kind of theory of optimal allocation of resources, in fact, are based on certain values and interests on the basis of the guide.

III. The proposed PSO principle

Since the theory of biological evolution is accepted, research on Evolutionary Computation (EC) has been a great development. Evolutionary Algorithms (EAs) that is based on this idea developed for a class of stochastic search techniques they are learning modeled by a collective group of individuals in the process, in which each individual represents a given problem in a point in the search space. Evolutionary algorithm from any initial groups starting by random selection, mutation and recombination process, the population will evolve into more and better search space area. The selection process so that the population is worse than the individual good adaptability adaptable individuals have more opportunities for replication, recombination operator information to fathers and combines them spread offspring, variation introduced a new variant in the population. Currently there are three main areas of evolutionary computation typical algorithms: genetic algorithms (GA), evolutionary programming (EP) and evolutionary strategies (ES). These three algorithms are developed independently of each other [7-9].

Particle Swarm Optimization (PSO) were Kennedy and Eberhart proposed an evolutionary approach. Multi-agent algorithm, which is inspired by a collective behavior of decentralized systems, and has applied to solve complex optimization problems. PSO concept that the population of randomly positioned particles, called the group to find the best location of the best fitness. By a group called the personal agent particles by the vector where each particle corresponds to the optimization problem of a potential solution. A particle is considered a multi-dimensional space a point, a characteristic of the state of the particle is its location and speed [10]. The position of each particle provides a candidate to solve the problem at hand. In each iteration, each particle is moved to a new location within the search space consists of a variable is a velocity vector. Corresponding new position and calculate the fitness of the best position of each particle discovery memory. As a result, speed is a key parameter to find a good solution. There are two different positions for the update rate. The first location is the best experience of all the particles, and remember all the world to get the best solutions proxy. The second location is the best individual particles encountered personal experience this memory particles. A group of particles moving locus update using the following formula:

$$V_i(t) = w(t) \times V_i(t-1) + c_1 \times r_1 \times (X_i^L - X_i(t-1)) + c_2 \times r_2 \times (X^G - X_i(t-1)) \tag{1}$$

$$X_i(t) = V_i(t) + X_i(t-1) \tag{2}$$

where the particles are represented by i = 1,..., M with M meaning the total number of the particles in a swarm, and the iterations by t = 1, . . . , T with T meaning the maximum number of iterations.

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The:

$$X_i(t) = \left(X_{i1}(t), ..., X_{iN}(t) \right)$$

is the position of the ith particle in the tth iteration consisted of N components, and:

$$V_i(t) = \left(v_{i1}(t), ..., v_{iN}(t) \right)$$

is the velocity (N-dimensional) of the particle i in iteration t. The:

$$X_i^L = (x_{i1}^L, ..., x_{iN}^L)$$

represents the individual-local best (L best) position that the particle i found so far, while:

$$X^G = (x_{i1}^G, ..., x_{iN}^G)$$

denotes the global best (gbest) position found by the swarm. The C_1 and C_2 are positive constants used as learning factors indicating how the i th particle approaches either the individual or the global experience position, while r_1 and r_2 are random numbers uniformly distributed between 0 and 1 influencing the tradeoff between the global exploitation and local exploration abilities during search. In addition, w(t)is the inertia weight for controlling the impact of the previous velocities on the new velocity.

Efficiency of the algorithm depends on its ability to perform global search and local search space search. Particle world's best high-impact positions will result in faster convergence algorithm for a particular point, so the algorithm emphasizes the development of the search space. On the other hand, the promotion of local search settings to prevent the bees trapped in local optimum conditions, and PSO emphasized explore the search space. PSO recently used in the treatment project scheduling problem.

IV. PARTICLE-REPRESENTED PRIORITIES OF ACTIVITIES

In order to apply the algorithm, we need to find the right MRAAS mapping between the particles and the PSO. Combining parallel conversion priority-based scheduling program for bridge PSO and MRAAS particles.

In general, the goal to make scheduling decisions based on heuristics priority rule to reduce the duration of the project. Conflict schedule multiple activities compete for limited resources can be solved according to the priority; the former can be scheduled activities are completed, no more than the number of available resources, have the resources and programs higher priority activities should be allocated before lower priority. A priority activity is usually based on one or more factors, such as key indicators of operating system activity, duration, required a lot of resources and direct continuous activity, and so on. Different calculation models for the priority of these factors will be described corresponding priority rules and may result in different performances. Because there is no measurement system selection heuristic rules or decisions better than others, a multi-pass heuristic method, consider a different priority for each rule by proposing to choose the best solutions in multiple. In addition, the search for ways to improve local solution by adjusting some activities start time according to the current multi-process multiple solutions heuristic recommendations [11-12].

The above multi-ride or a local search heuristic method actually reflect the concept of determining the priority of a better result in a better plan or by adjusting the original focus of their work. Such a concept is the basis of the priority activities represented by PSO particles, so the optimal schedule can search priorities based update mechanism from population particle-represented. Rather than from different heuristic rules to obtain an initial priority algorithm particles represents initial priority is randomly generated.

N-dimensional space of a point to study particle algorithm N elements can stand activities in a project. Therefore, the parameter N particle system may represent the location priority activities N and N-dimensional particle position parameters correspond to the index reflecting activity, as shown in Figure 2.

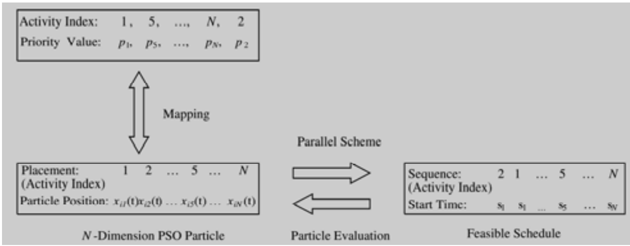

Figure 2. Mapping to PSO particle and transformation to schedule.

Similar to the above-described priority-based gas particles represent a random key encoding solutions MRAAS chromosome represents a random number. As random key chromosome representation showing possible to avoid infeasible sequence from the current position of the particles, which may be resulted from sequence-permutation representation that is often used for GA in solving the MRAAS priority-based particles.

The PSO algorithm was inspired by the social behavior of bird flocking and fish schooling. Three aspects will be considered simultaneously when an individual fish or bird (particle) makes a decision about where to move: (1) its current moving direction (velocity) according to the inertia of the movement, (2) the best position that it has achieved so far, and (3) the best position that its neighbor particles have achieved so far. In the algorithm, the particles form a swarm and each particle can be used to represent a potential solution of a problem. In each iteration, the position and velocity of a particle can be adjusted by the algorithm that takes the above three considerations into account. After a number of iterations, the whole swarm will converge at an optimized position in the search space.

V. PSO PARTICLE REPRESENTATION FOR THE MRAAS

The sequence-permutation representation directly stands for a schedule because the number of an element in the permutation represents an activity Õs index and the placement of the element corresponds to the order or sequence of the activity. On the other hand, particle-represented priority must into realistic timetable based on precedence constraints and time available resources, so that the particles can be updated assessment of the objective of minimizing project time. Known priority activities, there are two options, namely. Serial and parallel programs programs, taking into account of implementation constraints and resource constraints among scheduling priorities, including determining the sequence of activities and the start time. In addition to plans to gas random key chain chromosome represents a schedule, a parallel program to generate a schedule from the representative of priority algorithm particles. Program consists of multiple series of parallel activities should be satisfied with the conversion phase of prioritization and resource constraints. Time schedule of each phase is equal earliest finish time scheduling of activities at an earlier stage.

Taking into account the known priority activities, every stage is composed of the following four steps: (1) determine the new scheduled time is equal to the earliest completion time but did not complete the planned activities; (2) to collect a set of viable activities priority satisfactory feasibility and dispatch if new allocation of resources currently available to determine the scheduled time; (3) to select a desired activity in descending order of priority and allocation of available resources from a set of possible events one by one; (4) program start new activities identified resource allocation scheduling time, and then continue with (1) So far no events scheduled. Priority can be a number between 0 and 1. Because of the random number and a random initialization (real number from 0 to 1) calculation equations (4) and (5) updating particles, there is little probability of two or more than two identical priority activity (real number), the processing need not be measured tie-priority cases. Any absolute priority of a group corresponding to a workable plan, although some different priorities may lead to other people's schedule, because of the small change they cannot change the priority order from highest to lowest.

Figure 3 (a) is an example of an activity-on-node network project has six active and two virtual activities, activities on behalf of the circle with the index nodes, numbers above and below, respectively, and requires a lot of activity duration various types of resources. Through the parallel scheme, a six-dimensional particle-represented priorities, ie, {0.58, 0.65, 0.33, 0.77, 0.09, 0.39}, can be transformed to the schedule (Figure 3 (b)) which includes allocation pro fi le of the resources.

The procedure is described in a flowchart through Figure 4. According to the procedure, the proposed PSO for the MRAAS has been implemented using VISUAL C ++ programming language. In order not to lengthen the paper, the details for the developed system are not provided here .

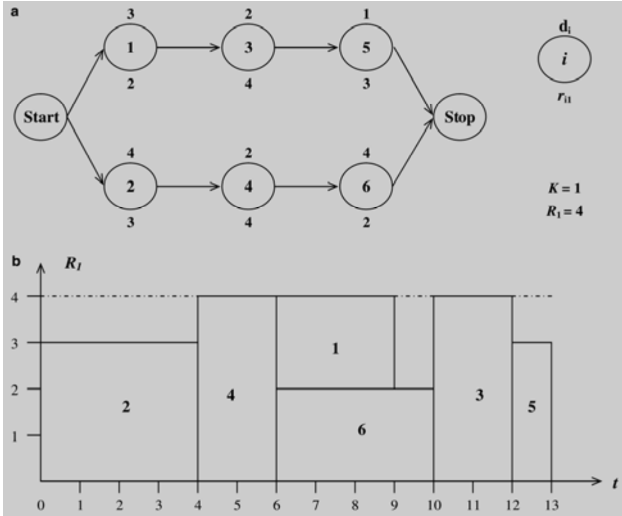

Figure 3. An illustrative example of MRAAS.

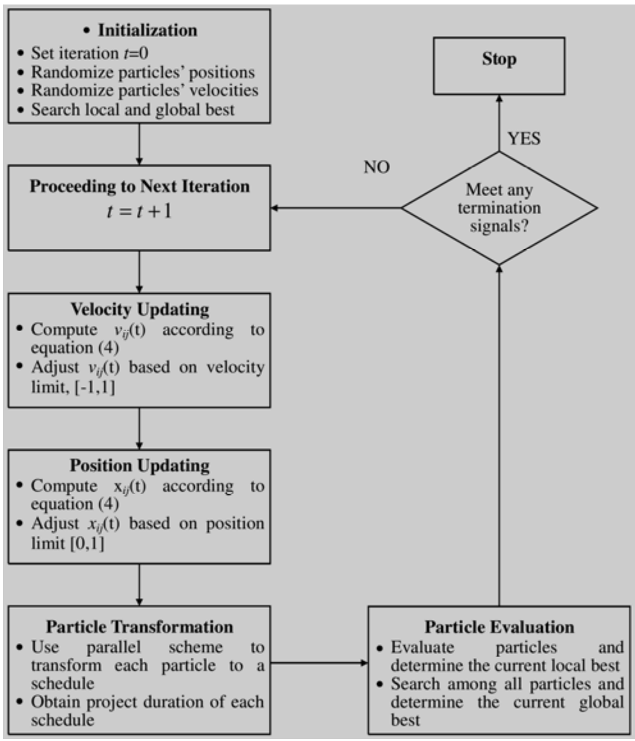

Figure. 4. Procedure to implement PSO for the MRAAS.

VI. COMPUTATIONAL ANALYSES

To investigate PSO-based MRAAS method, the typical project example analysis shown in Figure 5. The project consider three types of resources and activities and 25 by two virtual activities. Each activity has a specific time which is above the corresponding node. Two activities require two types of resources, while others require three types, the number of each type of resource, respectively, round the

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following node. Precedence Constraints Description and arrow line activities.

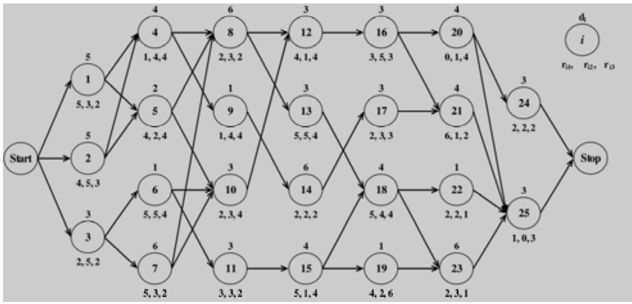

Figure 5. An example of MRAAS.

Figure 6 shows the corresponding optimal schedule obtained using the PSO-based approach. In addition to sequences and start times or finish times of the 25 activities in which dummy activities are not included, the allocation pro fi les of the three types of resources are reflectively described in the schedule.

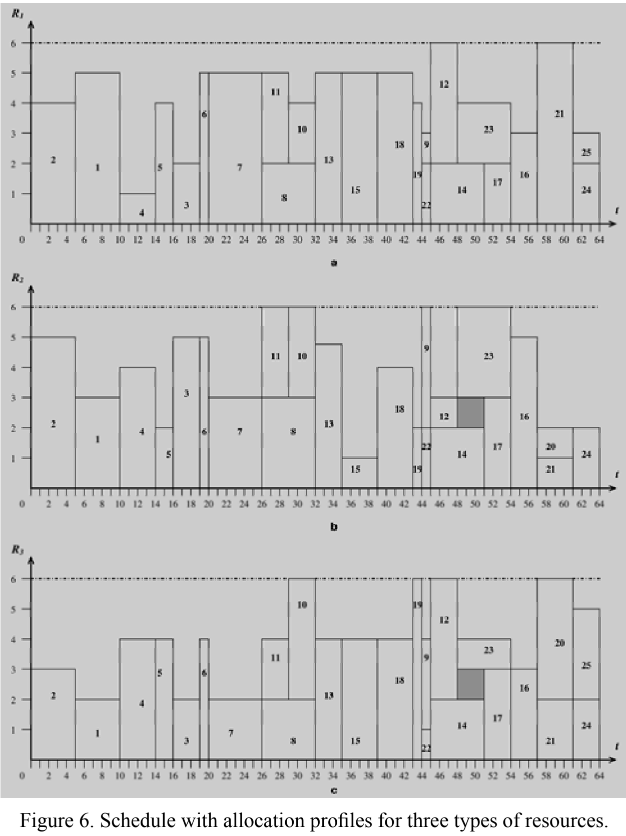

Figure 6. Schedule with allocation profiles for three types of resources.

VII. Conclusions

PSO-based methods include the corresponding framework proposed duration solve MRAAS minimize project. Particle represents an absolute priority activities according to a realistic timetable PSO-based method can produce, without using sequence-permutation said it could lead to unworkable plans. In order to evaluate each potential solution, namely. particle-represented priority activity, a parallel program is the use of particle is converted into a workable arrangement according to priorities and resource constraints. Calculation shows that, PSO-based method MRAAS ability to find global optimal, the genetic algorithm is more efficient than the method because of its features, such as one-way sharing of experiences in the algorithm of search mechanism. PSO-based method provides an efficient, easy to implement and realize the analysis of alternatives MRAAS.

Further work should address these issues, including performance reasonable choice of algorithm parameters, and better application of PSO algorithm for solving complex MRAAS consider resource level or more goals. In addition, the algorithm method will be developed into a user-friendly system, in addressing MRAAS practitioners can use it.

References

[1] Song Y, Wang H, Li Y, et al. Multi-tiered on-demand resource scheduling for VM-based data center[C]//Proceedings of the 2009 9th IEEE/ACM International Symposium on Cluster Computing and the Grid. IEEE Computer Society, 2009: 148-155.

[2] Zhong H, Tao K, Zhang X. An approach to optimized resource scheduling algorithm for open-source cloud systems[C]//ChinaGrid Conference (ChinaGrid), 2010 Fifth Annual. IEEE, 2010: 124-129.

[3] Zhang H, Li H, Tam C M. Particle swarm optimization for resource-constrained project scheduling[J]. International Journal of Project Management, 2006, 24(1): 83-92.

[4] Pandey S, Wu L, Guru S M, et al. A particle swarm optimization-based heuristic for scheduling workflow applications in cloud computing environments[C]//Advanced Information Networking and Applications (AINA), 2010 24th IEEE International Conference on. IEEE, 2010: 400-407.

[5] Liu H, Abraham A, Hassanien A E. Scheduling jobs on computational grids using a fuzzy particle swarm optimization algorithm[J]. Future Generation Computer Systems, 2010, 26(8): 1336-1343.

[6] Chen R M, Wu C L, Wang C M, et al. Using novel particle swarm optimization scheme to solve resource-constrained scheduling problem in PSPLIB[J]. Expert systems with applications, 2010, 37(3): 1899-1910.

[7] Guo Y W, Li W D, Mileham A R, et al. Applications of particle swarm optimisation in integrated process planning and scheduling[J]. Robotics and Computer-Integrated Manufacturing, 2009, 25(2): 280-288.

[8] Faria P, Soares J, Vale Z, et al. Modified particle swarm optimization applied to integrated demand response and DG resources scheduling[J]. Smart Grid, IEEE Transactions on, 2013, 4(1): 606-616.

[9] Izakian H, Ladani B T, Zamanifar K, et al. A novel particle swarm optimization approach for grid job scheduling[M]//Information Systems, Technology and Management. Springer Berlin Heidelberg, 2009: 100-109.

[10] Wu Z, Ni Z, Gu L, et al. A revised discrete particle swarm optimization for cloud workflow scheduling[C]//Computational Intelligence and Security (CIS), 2010 International Conference on. IEEE, 2010: 184-188.

[11] Bala A, Chana I. A survey of various workflow scheduling algorithms in cloud environment[C]//2nd National Conference on Information and Communication Technology (NCICT). 2011: 26-30.

[12] Xhafa F, Abraham A. Computational models and heuristic methods for Grid scheduling problems[J]. Future generation computer systems, 2010, 26(4): 608-621.