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Unit Commitment and Methods for Solving; a Review

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ABSTRACT

Nowadays important problem in economic is optimum generation and consumption of energy. Unit commitment and economic dispatch is one of the most important issues in power systems. So knowing method solve in unit commitment is necessity. In this paper we survey and compare a number of methods for solving UC included tabu search, simulated annealing, genetic algorithm, abc algorithm. In this paper we review several methods used in the unit commitment in addition to advantages and disadvantages of these methods.
KEYWORDS: Unit Commitment, tabu Search, Simulated Annealing, Genetic Algorithm, ABC.

1. INTRODUCTION

The goal of solving UC is optimum using of generation to cover limitations such as generation of each power plant, losses, fuels, cost, employee, etc. There is no complete solution for UC with pragmatism yet. Each method have constrained in solving UC. Methods that using for UC division three section: classical, intelligent, and compound. First section is Exhaustive Enumeration, Priority List, Dynamic Programming, Lagrangian Relaxation. These methods have not enough accuracy in convergence and quality in nonlinear system. Current intelligent method for solving UC is tabu search, Simulated Annealing, Genetic Algorithm, ABC Algorithm. These methods have better accuracy and quality in nonlinear systems. But in larger systems and time calculation have problem will appear. By using compound methods such as Neural networks with Simulated Annealing and, we try to decrease the problems (faster and application in large system) of classical and intelligent methods [1]. In next section in this paper we explain important methods in UC and paper presentation yet.

2. UC METHODS

2.1. Priority List

The simplest solving method include is Priority List of units. With consideration average cost use the full load in unit. Cost is multiplication thermal net rate in full load and fuel cost. Mostly priority list method compound with other algorithm. The advantage is simple and less calculation, faster and disadvantages is less accuracy [2]. Priority list method consisted of the following considerations:

1. When load decrease in hours, we should know that unit out of network. We have generation for load or not and have spinning reserve in circuit or not .If we have, we can out of service the unit.
2. We know that when needing unit at all out unit of network. If no problem for out unit of network otherwise at all out unit of the circuit.
3. Calculation cost in 2 states. Next unit of the circuit otherwise shouldn't change the state.

In recent years many different problems about unit commitment using priority list method investigated such as: priority list method [3]. compound modified priority list with hopfied lagrange [4].

2.2. Dynamic programming

In dynamic programming suppose that

1. Each state includes arrangement of units that some of them are active and another inactive
2. Cost active for each unit is independent of time (constant).
3. Cost for inactive unit is zero
4. There is priority list for units and minimum capacity should be active in a period

2.2.1. Back Dynamic programming method

Solve start of least step. Otherwise considering time step M. Dynamic programming equations for calculating minimum total cost fuel in K step below presented as the following:

$$F_{COST}\ [K, I] = Minj\ [P_{COST}\ [K, I] + S_{COST}\ [I, K : J, K + 1] + F_{COST}\ [K + 1, J]] \quad (1)$$

$$F_{COST}[M, I] = P_{COST}[M, I] \quad (2)$$

$F_{COST}[K, I]$ is minimum total cost of state I in step K until M step.

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$P_{COST}[K,I]$ is minimum generation cost for load in K step and with I state.

$S_{COST}[I,K:J,K+1]$ is additive to start up of I state in K step to J.

In J is state in K+1 step.

J sets of possible state in K+1 step.

Generation cost $P_{COST}[K,I]$ is economic dispatch for inactive unit in I state.

One path [$path$] is K a state start from send in step M. Optimization path, path is minimum total fuel cost. Considering optimization path exist of each state started, Optimization path started from each state can get in K step. This algorithm description in *fig 1* [2].

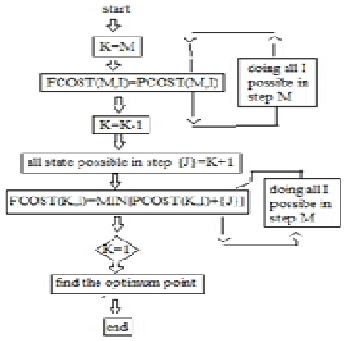

Figure .1. Backward dynamic programming method

2.2.2. Forward Dynamic programming method

Back dynamic programming method can't solve most problem for example if cost start up unit function of time that unit inactive (thermal degree), and Forward dynamic programming method is suitable for problem because we can calculation back state in each step. The Algorithm for calculation minimum cost, in step K with I is follows:

$$F_{COST}\ [K,I] = MinL\ [P_{COST}\ [K,I] + S_{COST}\ [K-1, L:K,I] + F_{COST}\ [K-1,L]] \quad (3)$$

$F_{COST}\ [K,I]$ Is minimum total cost for state (K, I).

$P_{COST}\ [K,I]$ Is generation cost for state (K, I).

$S_{COST}\ [K-1, L:K,I]$ Is transmission cost from state (K-1,L) to state (K, I).

That is state $[K,I]$ is step I in K step. In this method purpose is path that from a state in particular time to other state in next time. Considering defines two new variable X and N. X is number of states that search in each period. And N is number of states or target that save in each step. This variable make until control possible in this method. This algorithm description in *fig 2* [2].

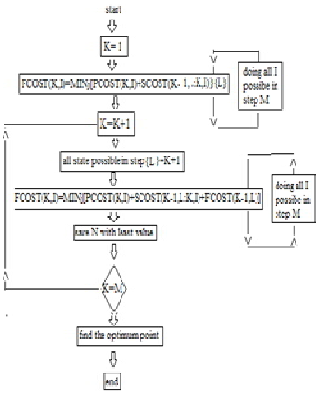

Figure .2. forward dynamic programming method

In recent years many different problems about unit commitment using dynamic programming investigated such as: compare between dynamic programming and fuzzy system and genetic algorithm[5]. Dynamic programming based fast calculation for artificial neural Network. [6]. fuzzy system and Simulated Annealing based dynamic programming [7].

2.3. Particle Swarm Optimization

Kennedy was the first work on the Particle Swarm Optimization J.Burand Eberhart, Rin 1995 [8]. This method based animal society behavior such as behavior bird and fish. So PSO start to a Primary random population matrix, PSO like to other evolution Algorithm such as Genetic Algorithm, ABC Algorithm. Unlike to Genetic Algorithm, don't have vault (jump) and twin. PSO very similar to colonialism evolution Algorithm than GA. In fact PSO is made from many

define ingredients that primaliy value is random. Each ingredient description two value situation and speed that modeling to a location vector and speed vector. Ingredients repeat in N space problem moving until receive the target value (optimum value). Then receive several conditions until one ingredient save for result. With this result, ingredient decision move to next step. In each repetition, ingredient moving in N space, until receiving to optimum point (optimum value). Ingredient update with better result i.e.:

$$p_{m.n}^{new} = p_{m,n}^{old} + p_{m,n}^{new} \quad (3)$$

1. $V_{m,n}^{new}$ is speed Ingredient.
2. $P_{m,n}^{new}$ is variable Ingredient.
3. T_1, T_2 is random with uniform distribution and learning.
4. $P_{m,n}^{localbest}$ is best local result.
5. $P_{m,n}^{globalbest}$ is best global result.

PSO, speed vector each ingredient is update the speed value added to location or value ingredient. Speed update under effect of both of them. F_1, F_2 called understanding factor and society factor. PSO advantage than other method performance is simple and have low parameter. PSO able to optimization with complex function and high local minimum [9]. In recent years many different problems about unit commitment using Particle Swarm Optimize investigated such as: Particle Swarm Optimize[12]. PSO for UC problem with constrained emission [13]. binary Algorithm PSO for UC problem [11]. modified Particle Swarm Optimize for UC problem [10].

2.4. Simulated Annealing

Algorithm Annealing or thermal Simulated is Mehtahyorisic that application in an intelligent algorithm. This Algorithm was introduced in 1983 by Scott Kirkpatrick, Daniel Gelatt [14]. Orginally most Algorithm in this field is established by rules in environment. Annealing method is based on metal in this process. First increase temperature high degree than slow coulding processes accrue. When temperature is high, Ingredient speed is very high. In next step Ingredient cool slowly that make new situation that Ingredients will be stronger than before. The algorithm is as follows

S1= choose an initial solution
T= choose an initial temperature
REPEAT
S2=Generate a neighbor of the solution C
ΔF= objectives(S1) – objective(S2)
IF (ΔF<0) THEN
S1=S2
ELSE IF EXP (ΔF/T)>Random(0=1)THEN
S1=S2
END IF
T-T-D_t
UNTIL T<Temperature Of Stop Condition

Advantage of this method is using low memory (unlike GA Algorithm) and like PSO performance isn't bad (rather than DP,…). This method have good result because have local search. And can pass from local optimum because have random method, in PSP and TSP problem have better result than GA Algorithm. And stationary structure and less costis like to Steady-State Genetic Algorithm. And disadvantage ofthis method is dependent to primaliy value and if choose primaliy temperature put in trap (local optimum) and forecasting result is difficult. Forecasting primarily value without Bench Mark is impossible. In recent years many different problems about unit commitment using simulated annealing investigated such as: simulated annealing [15]**.** simulated annealing for unit commitment problem compound with artificial neural network [16]**.** simulated annealing for unit commitment problem compound with fuzzy system [17-18] **.**modified simulated annealing for unit commitment problem [19]**.**

2.5. Genetic Algorihm

Genetic algorithm discusses about 30 year ago and revelation of environment structure [20]. Advantage is we can popularization is good, convergence speed and accuracy is reverse together [21]. Vault or jump is words that application very much in GA algorithm. Without vault is convergence speed very good than other method but accuracy is low and unsuitable. When use it receive accuracy very good but repetition (cycle) is very high [22]. This method is good for complex system because don't need to linear for system and searching is global (in searching global point don't put in local optimum). We can two way receive to optimum point. Choose initial population and random [24]. In recent years many different problems about unit commitment using genetic algorithm investigated such as: genetic algorithm [25, 26] . genetic algorithm for unit commitment problem with constrained [27, 28]. genetic algorithm for unit commitment problem in large units [29, 30]. compound genetic algorithm and Lagrangian method for unit commitment problem [31] .genetic algorithm based on searching tabu for unit commitment problem [32]. genetic algorithm for unit commitment problem with constrained energy [33, 34]. searching random genetic algorithm for unit commitment problem [35]

.genetic algorithm for new modeling fuzzy unit commitment problem [36]. simple matrix genetic algorithm for unit commitment problem [38]. Genetic algorithm for safe unit commitment problem [39].

2.6. Bee Colony Algorithm

Study in some of natural systems such as insect Colony show us that can use it in external simple organism (dynamic and flexible).we can simulate in once complex system perform. Bees distributed and organic, one of the best Colony for solving complex problem. This Algorithm is Simulation of searching for food[40] . Basic step in this Algorithm is:

Step1: give initial value for situation of food.
Step2: worker Bees define new situation in food location until recsive better food.
Step3: supervisor Bees choose better path considering situation of food and quality of food.
Step 4: worker Bees lookout for searching new situation of food.
Step5: save best situation of food in memory.
Step6: until receives the target step 2 to 5 repeat.

The first step of Algorithm we choose random result in limit parameter $X_i[i = 1,2,3,..... S_n]$. Sn is number of situation of food. In second step, each situation of food equal to two worker Bees $V_{i,j} = X_{i,j} + \varphi[X_{i,j} - X_{k,j}]$. Ψ random numbers is uniform in limit [-1, 1]. And K result Index that choose random of colony, J = 1…D. and D is problem space. Than make V_i this new result compared with X_i .and worker Bees use best situation. In third step, supervisor Bees make situation of food with possibility $P_i = \frac{fit}{\sum_{i=1}^{Sn} fit}$. That fit is gracefully for X_i. after all supervisor Bees distributed in situation of food. This is step Bees should decide situation of food transmit or not. $X_{i,j} = X_i^{\min} + [X_i^{\max} + X_i^{\min}] \times ran_i$ [40].

In recent years many different problems about unit commitment using Bee Colony Algorithm investigated such as: matrix coded Bee Colony Algorithm for thermal Unit Commitment problem [41].

2.7. Ant Colony Algorithm

The idea is based on the following observation. A colony of ants is able to succeed in a task to find the shortest path between the nest and the food source. It was found that ants deposit a chemical substance trail, called pheromone on the ground when they move. This pheromone can be observed by other ants and motivates them to follow the path with a high probability. The following example shows how over tome,the shortest pathe arefound through this self-reinforcing process. Like neural networks, ACO is based on biological research-in this case is the research into the foraging behavior of ant colonies. While individual ants essentially move at random, ant colonies can be seen as a system of collaborating agents pursuing a common goal: finding the quickest path to a food source. Ants communicate with the aid of a chemical called pheromone in a process referred to a “stigmergy”. Pheromones are produced by ants and ACO is based on the indirect communication of a colony of simple agents, called (artificial) ants, mediated by (artificial) pheromone trails. The pheromone trails in ACO serve as distributed, numerical information, which the ants use to probabilistically construct solutions to the problem being solved, and which the ants adapt during the algorithm’s execution to reflect their search experience.deposit them on trails when walking in search of food[42]. In recent years many different problems about unit commitment using Ant Colony Algorithm investigated such as: Ant Colony Algorithm [43, 44, 46]. Ant Colony Algorithm for unit commitment problem with local searching [45].

3. Comperation Methods of UC

Comparison of total production costs are shown in *Table 1* [47].

Table 1. Comparison of total production costs

	Cost		
	No of units		
METHO	10	80	100
LR	565.825	4.526.022	5.657.277
GA	565.825	4.504.933	5.627.437
EP	564.551	4.498.479	5.623.885
LRGA	564.800	4.501.844	5.613.127
DPLR	564.049	4.512.391	5.640.488
GAUC	563.977	4.505.614	5.640.488
Propose LR	563.937.69	4.484.915	5.604.470

CPU time comparison are shown in *Table 2* [47].

Table 2. Comparison of CPU time

	CPU time			
	No of units			
METHO	10	40	80	100
GA	221	2697	10036	15733
EP	100	1176	3584	6120
LRGA	518	2165	3383	4045
DPLR	108	1200	8447	12437
GAUC	85	614	1975	3547
Propose LR	10	25	64	80

Comparison performance among AG an LR are shown in *Table 3* [48].

Table .3. Comparison performance among AG an LR

	Cost by DP	Cost by LR	Cost by AG
10 unit	565.825	565.825	564.005
20 unit	-	1.130.660	1.124.651
40 unit	-	2.258.503	2.249.072

Number of papers published in each year are shown in *Fig 1* [49].

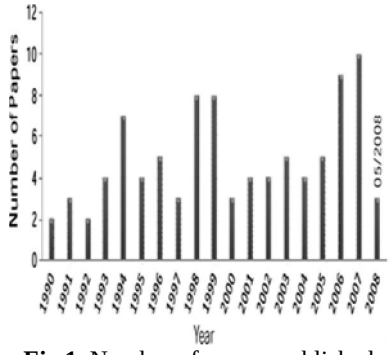

Fig 1. Number of papers published

Number of papers published on different optimization method used are shown in *Fig 2* [49].

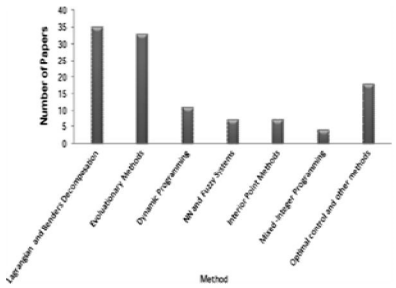

Fig 2. Number of papers published

Conclusions

Unit Commitment with classical method such as integral numbering and Exhaustive Enumeration, Priority List, Dynamic Programming, Lagrangian Relaxation mostof method don't have accuracy in convergence speed and solving nonlinear system in quality. And the advantage is calculation time is short. Against other method such as tabu search, Simulated Annealing, Genetic Algorithm, ABC Algorithm with accuracy and convergence speed is better than classical methods but calculation time is higher than them. With improvement of methods considering of more constrained such as spinning reserve and forecasting load increase. observation show us that each more calculation,have cost higher than before. We offer to use new methods for optimization such as Dynamic programming and Priority List.

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