Genetic algorithm using to the solution of unit commitment

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Abstract-This paper presents for the solution of unit commitment and constrained problem by genetic algorithm. The unit commitment word in power system using for deciding and planning for using generating unit according to load demand at particular hour and any time. Genetic algorithm is an evolutionary algorithm which works on the principle of natural selection like "survival of fittest". In the case study 5power generating units system for 24 hour period of cycle. The aim of this paper is detract the total production cost including all constraints, and generate a system for economically use of power generating unit.

Key words: unit commitment problem, genetic algorithm, power system, constrained problem.

1 Introduction

Unit commitment is a combination of mixed integer and non-liner optimization problem. A unit commitment plays a vital role for the economically use of power generating unit in the power system. [1].As we know that for many electric power system works in cycle. The demand of power during the day time is higher and late evening and early morning is lower .This 24 hours cyclical demand used to utility companies plan for generation of power an hourly basis. [2]. Unit commitment which schedule the power power generating units in according to the load demand with economic operation in which include all constrained of units. Unit commitment including scheduling to which determine ON and OFF state of units in order to the load demand and save large amount of fuel cost.A genetic algorithm generates a sequence of parameter to be tested using the system under consideration, objective function (to be maximized or minimized) and constraints [3]. Genetic algorithms are adaptive heuristic search algorithms based on the evolutionary thought of natural selection and genetics. They give an ideas for a random search used to solve optimization problem. They make use of historical information to direct the search into the scope of the better Performance whit in the search space. The basic principle of the genetic algorithms are designed to simulate processes in natural system necessary for evolution especially Principle first lay down by Charles Darwin "survival of fittest" because in nature. Genetic algorithms are the maintenance of a population of encoded solutions to the problem (genotypes) that developed in time. They are based on solution of reproduction, solution of evaluation and selection of the best genotypes. Genetic reproduction is performed by Crossover and Mutation [4]. In the present days GAs are applied to resolve complicated optimization problems, such as organizing the time table , scheduling job shop[3][5]. Many papers have given complete solution methods for unit commitment problem. The famous traditional techniques such as Integer Programming (Michaelwich, 1990), Dynamic Programming (Tong et. al., 1991), Branch and Bound (wood and Wollenberg, 1984), Linear Programming (Tong et. al., 1991), Network flow programming (Tong et. al.,

1991),Lagrangian relaxation (cheng et. at. 2000), and simulated annealing (Mantawy at. al. 1999). All these methods only provide near optimal solution. The Tabu search is power full optimization process that has been successfully applied to anumber of combinational optimization problems.(Mantawy et. at.1999). Swarup (2002) have employed a new solution methodology to solve the Unit commitment problem using Genetic algorithm. Gaing (2003) has built an integrated approach of discrete binary particle swarm optimization (BPSO) with the lambda- iteration methods for solving the Unit commitment problem. Zhao (2006) have proposed an improved particle swarm optimization (IPSO) algorithm for power system Unit commitment problem. Ting et al. (2006) have integrated a new approach of hybrid particle swarm optimization (HPSO) scheme, which is a combination of HPSO, BPSO and real-coded particle swarm optimization (RCPSO) to solve the UN problem. Funabashi et al (2007) have formulated a twofold simulated annealing method for the optimization of fuzzy-based UN model.[1].

2 Problem Formulation

The unit commitment problem can be determined the start up and shut down times and power output of power generating units at each hour in scheduling time T. So that the total start up, shut down and production costs are minimized to system and unit constraints

The FC_i is the cost function of the generator power output at any time interval.

$$FC_i = A_i + BiPi + CiPi^2 \qquad (1)$$

Where Ai, Bi, Ci represent unit cost coefficient, while P_i is the i unit power output.

Start up cost at any time interval can be represented by an exponential cost curve.

$$SC_i = \sigma_{i+} \delta i \{1-\exp(-T_{off,i} / \tau_i)\} \qquad (2)$$

Where σ_i is the hot start up cost, δi is the cold start up cost, τ_i is the cooling time constant, $T_{off,I}$ is the time a unit has been off. The shut down cost is a constant value for each unit.

The overall production cost for i units and t hours is the sum of all three cost .

$$F_{T,i} = FC_{i,t} + SC_{i,t} + SD_{i,t} \qquad (3)$$

Following constraints in unit commitment problem

(i) Power valance constraint, where the total power generated must be equal to power demand P_D and system losses P_L .

$$\sum_{i=0}^{N} P_i u_I - (P_D+P_L) = 0 \quad t= 1,2,..T \qquad (4)$$

(ii) Hourly spinning reserve R

$$\sum_{i=0}^{N} P_i^{max} u_i - (P_D+P_L) = R \qquad t=1,2,..T \qquad (5)$$

(iii) Generation limit constraint

$$P_{i,t}^{min} \le P_{i,t} \le P_{i,t}^{max} \qquad (6)$$

(iv)Start up cost

$$(T^{on}_{t-1,i} - MUT_i)(u_{t-1,i} - u_{t,i}) \ge 0 \qquad (7)$$

$$(T^{off}_{t-1,i} - MDT_i)(u_{t,i} - u_{t-1,i}) \ge 0 \qquad (8)$$

T^{on} and T^{off} is the unit on and off time , while $u_{t,i}$ is the unit on/ off [1,0] state.

3Genetic algorithm using in unit commitment

The idea of evolutionary computing was introduced in 1960 by I. Rechenberg in his work Evolutionary strategies. Genetic algorithms are computerized search and optimization algorithms based on mechanics of natural genetics and natural selection. The important imposed operators of Genetic algorithm are-

(i)Coding of solution

Genetic algorithms need design space to be converted into genetic search space. So, genetic algorithms work with a code of variables. The avail of working with a code of variable space is that coding discreteness the search space even through the function may be continuous. The solution in the unit commitment problem is represented by a binary matrix (*U*) of dimension *H* X *N*. The proposed method for coding is a mixer of binary and decimal numbers, an H-bit string is needed to describe the operation schedule of single unit .in such string a '1' at certain location indicates that the unit is ON and 0 represent unit is OFF. In this paper 5generating unit and 24 hour scheduling period the strings are 5*24=120 bits long resulting in search space.

Unit / Hour	1	2	-	H
Unit 1	1	1	1	1
Unit 2	0	0	1	1
-	0	1	1	1
Unit N	0	1	0	1

(ii) Objective function

As we are generating always feasible solutions in the proposed Genetic algorithm, the fitness function is taken as the reciprocal of the total production cost. Linear scaling is used in our algorithm, which requires linear relationship between the original fitness function and the scaled on.

(iii) Population

A population is a collection of individuals. A population consists of a number of chromosomes being tested, the phenotype parameters defining the individual and some information about the search space. For each and every problem, the population size will depend on the complexity of the problem. The initial population chooses randomly.

(iv)Selection

Selection is a method that randomly chooses chromosome out of the population according to their evaluation function. The higher the fitness function, the better individual will be selected. The selection pressure is defined as the degree to which the better individuals are favored. The higher the selection pressured the more the better individuals are favored. The convergence rate of GA is determined by the magnitude of the selection pressure, with higher selection pressure resulting in higher convergence rates.

(v)Crossover

Crossover is a random technique of mating of string .Based on the probability of crossover, partial exchange of characters between two strings is performed. The crossover technique is include, the select two mating parents, select a crossover point and swap the chromosome between two strings. [7].Crossover has many types as single point ,two point and multipoint its depends on the number of cut I n bit string.

Single point crossover

Parent 1	1	0	1	1
Parent 2	1	1	0	0

Two point crossover

Parent 1	1	0	1	1
Parent 2	1	1	0	0

Multi point crossover

Parent 1	1	1	1	0	1
Parent 2	1	0	0	1	0

(vi) Mutation

Mutation operation is performed by randomly selecting chromosome with a prespecified probability. The selected chromosome is decoded to its binary digit 0 or1. Then the unit number and time period are randomly selected and the rule of mutation is applied to reverse the status of units keeping the feasibility of the constraints.

4Test result.

In the case study we use 5 units' system data. In table1 shows 5 generators data and table 2shows load at different hours**.**

parameter	Unit1	Unit2	Unit3	Unit4	Unit5
P_{max}(MW)	455	130	130	80	55
P_{min}(MW)	150	20	20	20	10
a($/h)	1000	700	680	370	660
b($/MWh)	16.19	16.6	16.5	22.26	25.92
c($/$MW^2$/h)	0.00048	0.002	0.00211	0.00712	0.00413
Min uptime (h)	8	6	6	4	1
Min down time(h)	8	6	6	4	1
Hot start up cost ($)	4500	550	560	170	30
Cold start up cost($)	9000	1100	1120	340	60
Cold start hours(h)	5	4	4	2	0
Initial status(h)	8	-6	-6	-4	-1

The load demand of the power is vary according to load ,in the table2 where some hours load is high and some hours load is minimum then these requirement of load is fulfill using by different combination of power generating unit.

Table 2: load demand

hour	load	hour	load
1	330	13	810
2	450	14	820
3	480	15	750
4	360	16	800
5	520	17	650
6	590	18	670
7	730	19	790
8	780	20	750
9	620	21	770
10	650	22	610
11	680	23	520
12	630	24	360

24 hours load demand graph

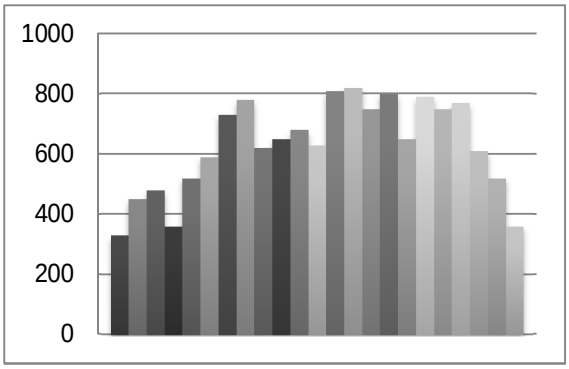

Table3: Schedule of units

unit	hour	1	2	3	4	5	6	7	8	9	10	11	12
Unit 1		1	1	1	1	1	1	1	1	1	1	1	1
Unit 2		0	0	0	0	0	1	1	1	1	1	1	1
Unit3		0	0	0	0	1	1	1	1	1	1	1	0
Unit4		0	0	1	0	0	0	0	1	0	0	0	1
Unit5		0	0	0	0	0	0	1	0	0	0	0	0

unit	hour	13	14	15	16	17	18	19	20	21	22	23	24
Unit 1		1	1	1	1	1	1	1	1	1	1	1	1
Unit 2		1	1	1	1	1	1	1	1	1	1	0	0
Unit3		1	1	1	1	1	1	1	1	1	1	1	0
Unit4		1	1	1	1	0	0	1	1	1	0	0	0
Unit5		1	1	0	1	0	0	0	0	0	0	0	0

table 4 Overall production cost comparison

units	DP Method Prateek kumar (2011)	GA Method
5 unit system	312880.00	312579.55

5 Conclusion

The unit commitment problem can be solved by many method to get optimal solution .the study of the load graph can understand the load demand continuously change according to load demand change. The unit commitment problem is nothing, it is the simple study of load required at different time schedule. In this paper genetic algorithm can study and generated a better result to the dynamic programming method . The technique for handling constraints in genetic algorithm for optimization problem, we proposed a method for handling constraints

6 References

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