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DEVELOPMENT OF OPTIMIZATION STRATEGIES COMBINING RANDOM AND DETERMINISTIC METHODS

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Abstract: *The optimal allocation of powers is one of main functions of the manufacturing operation and control of electrical energy. The overall objective is to determine optimal production units in order to minimize production cost while the system operates in its safe limit. This article proposes a hybridization between deterministic and stochastic approaches (Method of Davidon-Fletcher-Powell and genetics) to improve the optimization of the cost function nodes.*

Keywords – Optimization, DFP, GA, Power Flow

I. INTRODUCTION

The optimal allocation of powers [1] is a problem of nonlinear programming and is used to determine the optimal output of the generator, in the power system with an objective to minimize the total production cost while the system operates in its safe limit [2,3]. Several conventional methods (deterministic) [4] have been used to solve this problem; unfortunately, these methods suffer from three main problems. First, they may not be able to provide the optimum solution and usually get stuck at a local optimum, all these methods are based on accepting the continuity of the objective function that is not always feasible in practice. These methods cannot be implemented with discrete variables.

The genetic algorithm (GA) is an appropriate method to resolve this problem eliminates the above disadvantages, but this method sulphur problem of exploitation of the research area, cons by the deterministic method is efficient in this area but it is weak-side exploration , so it was a compromise between the two techniques to improve the final solution.

II. MATHEMATICAL MODEL

The function occurs most often in the form of a polynomial of second degree:

$$F_i(P_{Gi}) = a_i + b_i P_{Gi} + c_i P_{Gi}^2 \quad (1)$$

The coefficients $\{a_i, b_i, c_i\}$ are unique to each production, they are determined using interpolation methods such as those of Lagrange, de Newton or Least Squares. To minimize the total production cost of an interconnected system, we must minimize the sum of cost functions of production units and raised the global formula as follows:

$$Min\left\{F_t(P_G) = \sum_{i=1}^{NG} F_i(P_G)\right\} \quad (2)$$

Taking into consideration the following constraints**:**

1) Equality constraints

$$\sum_{i=1}^{NG} P_{Gi} = \sum_{j=1}^{ND} P_{Dj} + P_L \quad (3)$$

2) Inequality constraints

$$P_{Gi}^{\min} \le P_{Gi} \le P_{Gi}^{\max} \quad (4)$$

where
F_t : Total production cost ($/h)
F_i : Production cost of ith plant ($/h)
a_i, b_i, c_i fuel cost coefficients
P_{Gi} : Real power output of generator i (MW)
P_D : Total demand (MW)
$P_{Gi}^{\min}, P_{Gi}^{\max}$ Upper and lower limit of active power generation at bus i
NG : Number of generator
P_L : Real losses.

III. PRINCIPLE OF GENETIC ALGORITHMS

A genetic algorithm is an iterative algorithm is [5], he manipulates a population of given size. This population consists of chromosomes. Each chromosome represents the coding of a potential solution to the problem to solve; it consists of a set of genes [6].

By applying genetic operators (selection, crossing and mutation) (table and II)to initial population is reached to create a new population containing the same number of chromosomes as the previous but have better quality than before and so on repeating the same process is repeated each time the population at each generation to improve the quality of chromosomes that are better adapted to their environment which is represented by the objective function and thus the chromosomes will tend towards the optimum function [7]. The selection of the best chromosomes is the first step in a genetic algorithm. During this operation the algorithm selects the best. The crossover is used to generate two new chromosomes "children" from two chromosomes selected "parent" fig 1 while the transfer makes the inversion of one or more genes from one chromosome set (3).

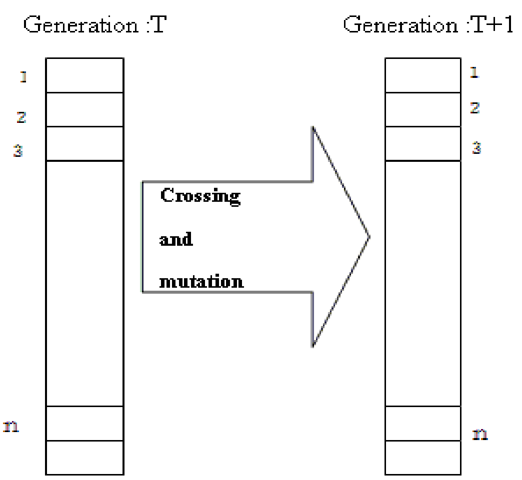

Fig. 1 Evolution of generations

TABLE I
T SCHEMATIC REPRESENTATION OF THE JUNCTION POINT

Parent1	**1001010110**	Child 1	1110100**110**
Parent2	1110101110	Child 2	**100101**1110

TABLE II
Schematic of a mutation in a chromosome

Chromosome	11100101011101
Chromosome muté	11100111011101

IV. PRINCIPLES SIMULATION GENETICS

Genetic algorithms are a recent approach in the field of Technical Operations Research [8]. Their effectiveness has been demonstrated for several cases of solving complex optimization problems; we will cite just a basic algorithm. The execution cycle of the iterative genetic algorithm base encloses the following steps (Fig 2):

1) Produce a random initial population of N Individuals (or candidates).

2) Until the stopping criterion is not completed Assign the adequacy of individual's population. Assign each individual a probability objective function giving an estimate of its performance against targets.

3) Produce using the selection algorithm a new population of identical size favoring members greater fitness

4) Making crosses between some individuals and insert the results of this recombination in the new population, promoting good exploration of the often large space of potential solutions[10].

5) Making changes on a few individuals and insert the results of this recombination in the new population, to introduce some diversity in the population

*7)*Present the best individual of the population.

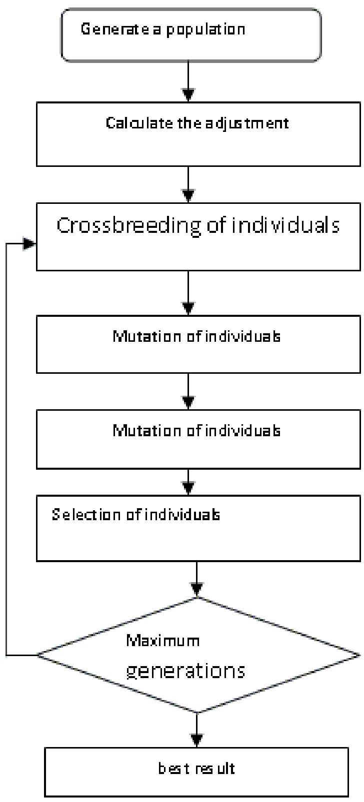

Fig. 2 Standard Genetic Algorithm

V. METHOD OF DAVIDON-FLETCHERPOWEL

This method is among those that have been used in economic dispatch, was developed by Davidon-Fletcher-Powell, we will call thereafter DFP based on the principle of Newton's method. Indeed, this method is a generalization of Newton's iterative formula:

$$x^{k+1} = x^k - \lambda_k \, [\nabla^2 f(x^k)]^{-1} \nabla f(x^k) \qquad (5)$$

We can replace the quantity $[\nabla^2 f(x^k)]^{-1}$ a positive definite matrix Hk giving the direction of travel from the gradient $\nabla f(x^k)$, or a form of iterative type:

$$x^{k+1} = x^k - \lambda_k \, H_k \nabla f(x^k) \qquad (6)$$

λ_k is chosen to minimize $g(\lambda) = f(x^k + \lambda d_k)$ in the direction $d_k = - H_k \nabla f(x^k)$ The matrix Hk is modified at each iteration. When applying the method to any function, Hk can now be seen at every moment, as an approximation (positive definite) of the inverse of the Hessian of f. There are obviously many possible variations in the choice of the update matrix. Usually we impose the relation:

$$H_k \nabla f(x^k) - \nabla f(x^{k-1}) = x^k - x^{k-1} \qquad (7)$$

This algorithm uses the correction formula of rank 2 as follows:

$$H_{k+1} = H_k + \frac{\delta_k . \delta_k^{\tau}}{\delta_k^{\tau} . \delta_k} - \frac{H_k . \delta_k . \delta_k^{\tau} . H_k}{\delta_k^{\tau} . H_k . \delta_k} \qquad (8)$$

Where X^{k+1} is obtained from X^k shift in direction: $d_k = - H_k \nabla f(x^k)$

And where

$$\delta_k = x^{k+1} - x^k$$
$$\gamma_k = \nabla f(x^{k+1}) - \nabla f(x^k) \qquad (9)$$

1) X^0 starting point. H_0 Choose any positive definite (eg the unit matrix): k = 0.

2) à l'itération k ; déterminer la direction de déplacement

$$d_k = - H_k \nabla f(x^k) \qquad (10)$$

Determine X^{k+1} as the minimum of $f(x^k + \sigma dk)$ for $\sigma \geq 0$

Ask:

$$\delta_k = x^{k+1} - x^k$$

Calculate:

$$\gamma_k = \nabla f(x^{k+1}) - \nabla f(x^k)$$

Then:

$$H_{k+1} = H_k + \frac{\delta_k . \delta_k^{\tau}}{\delta_k^{\tau} . \delta_k} - \frac{H_k . \gamma_k . \gamma_k^{\tau} . H_k}{\gamma_k^{\tau} . H_k . \gamma_k} \qquad (11)$$

Test arrest or return b).

VI. METHODOLOGY

Traditionally, GA [11] is a stochastic optimization method that starts from multiple points for a solution, but it only provides a solution around. On the other hand, DFP looks from one point to get a solution [9].

However, the solution obtained from DFP is normally an optimum solution. Therefore, to obtain a quality solution, and to take advantages of each method were made hybridization [12] of the two methods the genetic method and the method of Davidon-Fletcher-Powel (GADFP).

VII. APPLICATION AND COMPARISON OF RESULTS

In this last stage of our work, we conducted a comparison of results obtained in the three approaches optimization after its application on a network IEEE 57 knots [1]. The values characterizing the IEEE 57 bus system are given in Table 1:

TABLE III
The coefficients of cost functions and limits of generators

Bus	Pmin	Pmax	A	B	c
1	0.00	575.88	0.01	0.30	0.20
2	0.00	100.0	0.01	0.30	0.20
3	0.00	140.0	0.01	0.30	0.20
6	0.00	100.0	0.01	0.30	0.20
8	0.00	550.0	0.01	0.30	0.20
9	0.00	100.0	0.01	0.30	0.20
12	0.00	410.0	0.01	0.30	0.20

With the total consumption P_D = 1250 MW
The power base S_b = 100 MVA
It was the study in two variants:

1) *Variant 1*: Here we have neglected the losses (P_L) and it was considered that the power requested by subscribers P_D = 1250 MW.

2) *Variant 2*: We took into account losses as a constant whose value is determined by the method of Gauss Seidel: P_L =19.9 [MW]

3) *Selection of parameters of the GA*

Parameters of the third test network are as follows:
The population size = 110
Probability of mutation = 0.01
Maximum iteration = 500.

4) *Table of results :*

Table IV presents the parameters PG1, P_{G2}, P_{G3}, P_{G4}, P_{G5}, P_{G6} and P_{G7} obtained from the three approaches, and the value of the objective function Variant 1.

P_{G1}, P_{G2}, P_{G3}, P_{G4}, P_{G5}, P_{G6} and P_{G7} obtained from the three approaches, and the value of the objective function according to variant 2(Table V) .

TABLE IV
Results obtained by DFP, GA, GADFP, With PL =0.00 [MW]

Methods	DFP	GA	GADFP
P_{G1}	292.46	296.21	292.14
P_{G2}	99.99	99.86	99.59
P_{G3}	138.99	139.63	139.89
P_{G4}	99.38	99.58	99.96
P_{G5}	254.54	268.48	272.30
P_{G6}	98.80	99.75	99.99
P_{G7}	256.39	235.45	233.18
Cost ($/h)	3369.19	3349.67	3318.28

TABLE V
Results obtained by DFP, GA, GADFP, with PL =19.9 [MW]

Methods	DFP	GA	GADFP
P_{G1}	272.62	295.70	304.56
P_{G2}	99.70	99.74	99.94
P_{G3}	139.65	139.76	139.67
P_{G4}	98.72	99.99	99.81
P_{G5}	322.89	310.60	292.20
P_{G6}	99.76	99.63	99.78
P_{G7}	225.11	213.00	221.68
Cost ($/h)	3512.22	3474.10	3441.07

VIII. CONCLUSION

This paper presents a methodology to solve the problem of optimizing the production and the optimal allocation of electrical energy. The method exploits the advantage of GA that can provide a solution close early Then DFP which takes over to find the optimal solution with high accuracy. Results of the study show that the proposed method gives better solutions than GA or DFP alone.

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