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Economic Laod dispatch with genetic algorithm based solution

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Abstract
This paper presents an approach based on genetic algorithm to solve the economic load dispatch (ELD) problem this approach was successfully tested for a reference plant systems data. The performance of Genetic Algorithm has been analyzed and results have been shown for the problem solving.

Keywords: ELD, GA, OPF, Fitness, Mutation.

1. Introduction

In a practical power system, power plants are not at the same distance from the centre of load and their fuel costs are different. Also, under normal operating condition the generation capacity is more than the total load demand and losses. Thus there are many options for scheduling generation
In an interconnected power system, the objective is to find the real & reactive power scheduling of each power plant in such a way as to minimizing the operating cost this means that the real &reactive power are allowed to vary within certain limits, so as to meet a particular load demand within minimum fuel cost. This is referred as optimal power flow (OPF) problem.
The OPF is to optimize the power flow solution of a large scale power system.
This is done by minimizing selected objective functions while maintaining an acceptable system performance in terms of generator capability limits.

Operating Cost of a Thermal Plant

The factors influencing power generation at minimum cost are

- Operating efficiencies of generators
- Fuel cost
- Transmission losses

The most efficient generator does not guarantee minimum cost as it may be located in an area where fuel cost is high.
Again if the plant is located far from the load center, Transmission losses may be considerably higher and hence the plant may be overly uneconomical.
Hence the problem is to determine the generation of different plants such that the total operating cost is minimum

Proposed Method

Economic load dispatch problem is allocating loads to plants for minimum cost while meeting the constraints. It is formulated as an optimization problem of minimizing the total fuel cost of all committed plant while meeting the demand and losses. The variants of the problems are numerous which model the objective and the constraints in different ways.
The basic economic dispatch problem can described mathematically as a minimization of problem of minimizing the total fuel cost of all committed plants subject to the constraints.

$$Minimize \sum_{i=1}^{n} \mathrm{F_i}(P_i) \tag{A1}$$

$F_i(P_i)$ is the fuel cost equation of the 'i'th plant. It is the variation of fuel cost ($ or Rs) with generated power (MW).Normally it is expressed as continuous quadratic equation.

$$F_{ij}(P_i) = a_i P_i^2 + b_i P_i + c_i, \quad P_i^{\min} \le P_i \le P_i^{\max} \tag{A2}$$

The total generation should meet the total demand and transmission loss. The transmission loss can be determined form either B_{mn} coefficients or power flow.

$$\sum_{i=1}^{n} P_i = D + P_l \tag{A3}$$

$$P_l = \sum_{i}^{n} \sum_{j}^{n} B_{ij} P_i P_j \tag{A4}$$

Preliminary and background of Genetic Algorithm

Genetic algorithm (GA) uses the principles of evolution, natural selection and genetics from natural biological systems in a computer algorithm to simulate evolution. Essentially, the genetic algorithm is an optomization technique that performs a parallel, stochastic, but directed search to evolve the fittest population. The idea, in all the system based on Genetic algorithm, was to evolve a population of candidate solutions to a given problem, using operators inspired by natural genetic variation and natural selection.
Biological evolution is an appealing source of inspiration for addressing optimization problems. Evolution is, in effect, a method of searching among an enormous number of possibilities for "solutions." In biology the enormous set of possibilities is the set of possible genetic sequences, and the desired "solutions" are highly favourable organisms—organisms, which are able to survive and reproduce in their

environments. Evolution can also be seen as a method for designing innovative solutions to complex problems. The fitness criteria continually change as creatures evolve, so evolution is searching a constantly changing set of possibilities. Searching for solutions in the face of changing conditions is precisely what is required for adaptive computer programs. Furthermore, evolution is a massively parallel search method rather than a work on one species at a time. Evolution tests and changes millions of species in parallel.
Finally, viewed from a high level, the "rules" of evolution are remarkably simple: species evolve by means of random variation (via mutation, recombination, and other operators), followed by natural selection in which the fittest tend to survive over others.

Approach for Solving Eld Problem with Ga

1. Select a reference plant. For better convergence chose a plant which has maximum capacity and range. In this program it is considered as plant 1. The reference plant allocation is fixed by the equations (A3&A4).
2. Convert the constrained optimization problem as an unconstrained problem by penalty function method.

Minimize

$$\sum_{i=1}^{n} F_i(P_i) + 1000 * abs\left(\sum_{i=1}^{n} P_i - D - \sum_{i=1}^{n}\sum_{j=1}^{n} B_{ij} P_i P_j\right)$$

3. The allocation minimum fuel cost and transmission losses can be determined.

Outline of the Algorithm

- 0. START: Create random population of n chromosomes
- FITNESS: Evaluate fitness f(x) of each chromosome in the population
- NEW POPULATION

0 SELECTION: Based on f(x)

1. RECOMBINATION: Cross-over chromosomes
2. MUTATION: Mutate chromosomes
3. ACCEPTATION: Reject or accept new one

- REPLACE: Replace old with new population: the new generation
- TEST: Test problem criterium
- LOOP: Continue step 1 – 4 until criterium is satisfied

Simulation Result

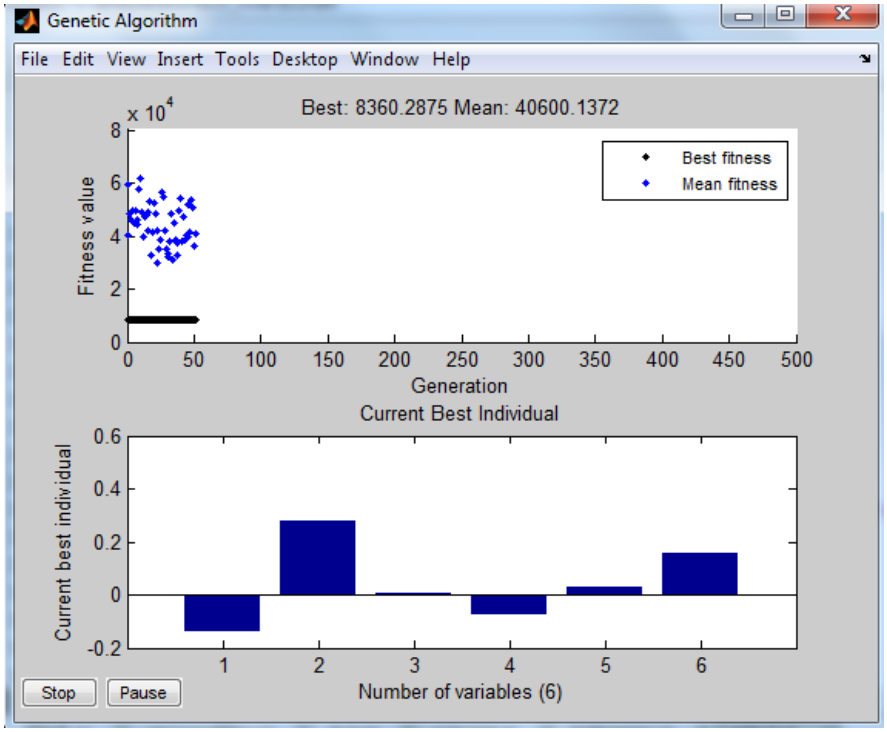

Fig 1: Results

F is the total fuel cost
F = 8.3603e+003
P1 is the allocation vector
P1 = 334.2802 71.1276 141.4308 50.3256 61.4439 52.0454
Pl is the transmission losss
Pl = 10.6535

Conclusion

This paper has attempted to solve economic load dispatch problem of the power system networks using genetic algorithm. The simulated results are obtained for Fuel Cost, allocation vector and transmission losses considering a specified plant systems data. Further this work may be extended to one plant as combined cycle cogeneration plant in multi thermal plant system.

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