IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 7, February 2013)

Performance Analysis of GA and PSO over Economic Load Dispatch Problem

Sakshi Rajpoot
sakshirajpoot1988@gmail.com

Dr. Sandeep Bhongade
sandeepbhongade@rediffmail.com

Abstract – **Economic Load dispatch problem is one of the most popular concern in power system engineering. Many method have been proposed in past to solve this. Genetic algorithm and particle swarm optimization are the most popular algorithms in term of optimization. This paper is implementation of GA and PSO over the Economic Load Dispatch problem. Comparison of both algorithm is shown here with a standard example when considering Loss and No Loss Conditions.**

Keywords – **Genetic algorithm, PSO, Economic Load Dispatch.**

I. INTRODUCTION

In Economic Load Dispatch (ELD) are designed and operated to meet the continuous variation of power demand. The power demand is shared among the generating units and economic of operation is the main consideration in assigning the power to be generated by each generating units. Therefore, Economic load Dispatch (ELD) is implemented in order to ensure for economic operation of a power system. Economic Dispatch problem is an optimization problem that determines the optimal output of online generating units so as to meet the load demand with an objective to minimize the total generation cost. Economic load dispatch (ELD) pertains to optimum generation scheduling of available generators in an interconnected power system to minimize the cost of generation subject to relevant system constraints. Cost equations are obtained from the heat rate characteristics of the generating machine. Smooth costs functions are linear, differentiable and convex functions. The most simplified cost function of each generator can be represented as a quadratic function as given in whose solution can be obtained by the conventional mathematical methods:

$$C = \sum F_j P_j$$

$$F_j P_j = a_j + b_j P_j + c_j P_j^2$$

Where
C = Total generation cost
F_j = Cost function of generator j
a_j, b_j, c_j = Cost coefficients of generator j

While minimizing the total generation cost, the total generation should be equal to the total system demand plus the transmission network loss. The transmission loss is given by the equation,

$$PL = \sum Bo_j P_j$$

Where

Bo_j = The loss co-efficient matrix.

The equality constraint for the ED problem can be given by,

$$\sum P_j = D + \sum PL$$

Where D is the total demand needed by the load or consumer. The generation output of each unit should be between its minimum and maximum limits. That is, the following inequality constraint for each generator should be satisfied:

$$P_{j\min} < P_j < P_{j\max}$$

Where $P_{j\min}$, $P_{j\max}$ are the minimum and maximum output of individual generators respectively.

II. PROPOSED METHODOLOGY

Various mathematical methods and optimization techniques have been employed to solve ELD

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 7, February 2013)

problems. We here analysing performance of two most popular algorithms from optimization family.

A. Genetic Algorithm

Genetic Algorithms are a family of computational models inspired by evolution. These algorithms encode a potential solution to a special problem on a simple chromosome-like data structure and apply recombination operators to these structures as to preserve critical information. Genetic algorithms are often viewed as function optimizer, although the range of problems to which genetic algorithms have been applied are quite broad. Genetic Algorithms are search algorithms that are based on concepts of natural selection and natural genetics. Genetic algorithm was developed to simulate some of the processes observed in natural evolution, a process that operates on chromosomes (organic devices for encoding the structure of living being).

The genetic algorithm differs from other search methods in that it searches among a population of points, and works with a coding of parameter set, rather than the parameter values themselves. It also uses objective function information without any gradient information. The transition scheme of the genetic algorithm is probabilistic, whereas traditional methods use gradient information. Because of these features of genetic algorithm, they are used as general purpose optimization algorithm. They also provide means to search irregular space and hence are applied to a variety of function optimization, parameter estimation and machine learning applications. GAs start with selecting an initial population, iteratively apply operators to reproduce new populations, evaluate these populations, and decide whether or not the algorithms should continue to execute.

GAs differ from classical optimization algorithms mainly in that Gas operate on a population of individuals instead of parameters in classical algorithms. Compared to the optimization algorithms, each individual in a population is encoded into a chromosome that represents a candidate solution. A chromosome is composed of genes that are usually of binary form. The evaluation of an individual is determined by the fitness function value corresponding to the objective function value.

Typical GAs include the following steps:

1. Generate an initial random population of chromosomes.
2. Evaluate the population of chromosomes using an appropriate fitness function.
3. Select the subset of chromosomes with better fitness value as parents.
4. Crossover the pairs of parents with given probability (P_c) to produce offspring.
5. Mutate the chromosomes of offspring with probability (Pm) to avoid early trap into local solutions.
6. Re-evaluate the fitness values of offspring.
7. Terminate algorithms if the stopping criteria are satisfied.

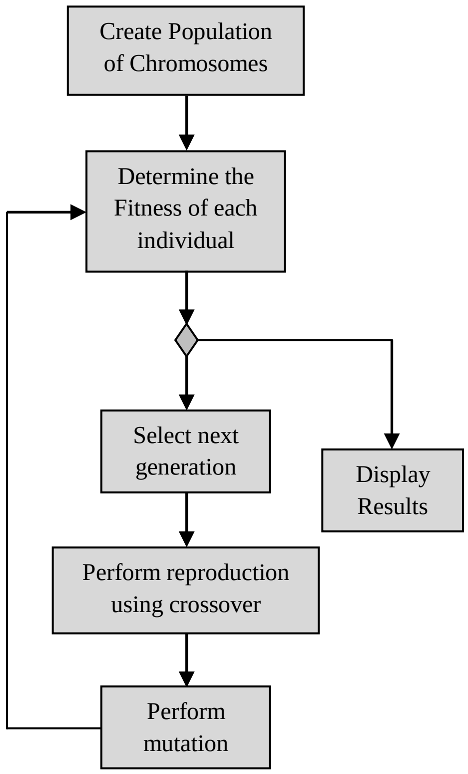

Figure 1: Flow chart of Genetic Algorithm

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 7, February 2013)

B. Particle Swam Optimization

Particle Swarm Optimization (PSO) is a technique used to explore the search space of a given problem to find the settings or parameters required to maximize or minimize a particular objective.

This technique, first described by James Kennedy and Russell C. Eberhart in 1995, originates from two separate concepts: the idea of swarm intelligence based off the observation of swarming habits by certain kinds of animals (such as birds and fish); and the field of evolutionary computation. The PSO algorithm works by simultaneously maintaining several candidate solutions in the search space. During each iteration of the algorithm, each candidate solution is evaluated by the objective function being optimized, determining the fitness of that solution. Each candidate solution can be thought of as a particle “flying” through the fitness landscape finding the maximum or minimum of the objective function. Initially, the PSO algorithm chooses candidate solutions randomly within the search space. It should be noted that the PSO algorithm has no knowledge of the underlying objective function, and thus has no way of knowing if any of the candidate solutions are near to or far away from a local or global maximum or minimum.

The PSO algorithm simply uses the objective function to evaluate its candidate solutions, and operates upon the resultant fitness values. Each particle maintains its position, composed of the candidate solution and its evaluated fitness, and its velocity. Additionally, it remembers the best fitness value it has achieved thus far during the operation of the algorithm, referred to as the individual best fitness, and the candidate solution that achieved this fitness, referred to as the individual best position or individual best candidate solution.

Finally, the PSO algorithm maintains the best fitness value achieved among all particles in the swarm, called the global best fitness, and the candidate solution that achieved this fitness, called the global best position or global best candidate solution. The PSO algorithm consists of just three steps, which are repeated until some stopping condition is met:

1. Evaluate the fitness of each particle.
2. Update individual and global best fitness’s and positions.
3. Update velocity and position of each particle.

The first two steps are fairly trivial. Fitness evaluation is conducted by supplying the candidate solution to the objective function. Individual and global best fitness and positions are updated by comparing the newly evaluated fitness against the previous individual and global best fitness, and replacing the best fitness and positions as necessary. The velocity and position update step is responsible for the optimization ability of the PSO algorithm. The velocity of each particle in the swarm is updated using the following equation:

$$v_i(t+1) = wv_i(t) + c_1r_1[\hat{x}_i(t) - x_i(t)] + c_2r_2[g(t) - x_i(t)]$$

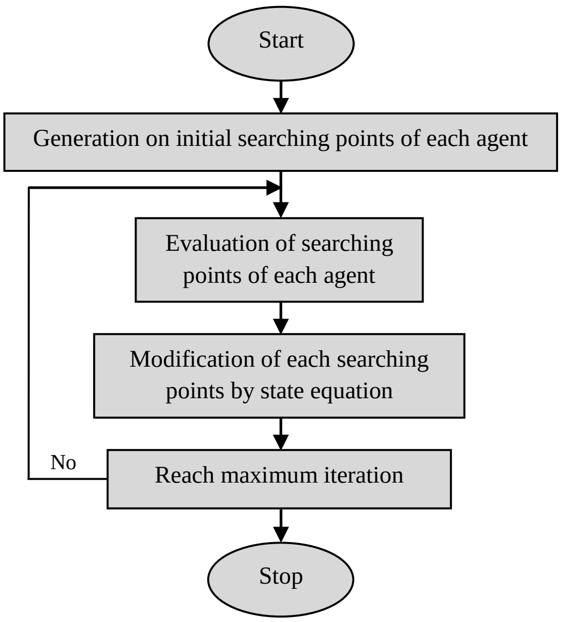

Figure 1.2: Flow chart of PSO

Each of the three terms of the velocity update equation have different roles in the PSO algorithm. This process is repeated until some stopping

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 7, February 2013)

condition is met. Some common stopping conditions include: a pre-set number of iterations of the PSO algorithm, a number of iterations since the last update of the global best candidate solution, or a predefined target fitness value.

III. Simulation and Results

We developed model for solving the Economic Load Dispatch problem using the statements mentioned in section I in MATLAB R2009b. We used Genetic algorithm and particle swarm optimization toolboxes with the objective functions developed for ELD. We simulated many problems one which is as follows:

We considered a standard problem for three generator system. The cost characteristic equation for all three units are as given below:

UNIT 1: $F_1 = 0.00156 * P_1^2 + 7.92 * P_1 + 561\ \mathrm{Rs/Hr} \qquad 100 \leq P_1 \leq 600\ \mathrm{MW}$

UNIT 2: $F_2 = 0.00194 * P_2^2 + 7.85 * P_2 + 310\ \mathrm{Rs/Hr} \qquad 100 \leq P_2 \leq 400\ \mathrm{MW}$

UNIT 2: $F_3 = 0.00482 * P_3^2 + 7.97 * P_3 + 78\ \mathrm{Rs/Hr} \qquad 50 \leq P_2 \leq 200\ \mathrm{MW}$

Transmission Loss B_{mn} matrix for the above equations is as follows:

B = [0.0000750 0.0000050 0.0000075;

0.0000050 0.0000150 0.0000100;

0.0000075 0.0000100 0.0000450];

And the system load is 585 MW.

Scenario 1: Neglecting System Loss

In this case we making B = 0.

On simulating our program the results we get are as follows:

Method	P_1 (MW)	P_2 (MW)	P_3 (MW)	Cost (RS/Hr)
GA	391.2481	142.4395	51.3125	5865.6435
PSO	268.8938	234.2651	81.8411	5821.439

Scenario 2: Considering System Loss

On simulating our program the results we get are as follows:

Method	P_1 (MW)	P_2 (MW)	P_3 (MW)	Cost (RS/Hr)
GA	301.4843	238.7099	55.4343	5919.5899
PSO	233.2524	267.8646	90.8404	5886.9409

IV. Conclusion

In this paper both conventional GA and PSO based economic dispatch of load for generation cost reduction were comparatively investigated on two sample networks (3 generator system with loss and without loss). The results obtained were satisfactory for both approaches but it was shown that the PSO performed better than GA from the economic viewpoints. This is because of the better convergence criteria and efficient population generation of PSO. A future recommendation can be made for GA and PSO to solve ELD problems as the use of new efficient operators to control and enhance the efficiency of instantaneous population for better and fast convergence.

Reference

[1] A Eberhart RC and Kennedy J, "A new optimizer using particle swarm theory", In Proceedings of 6th Internationl Symposium on Micro Machine and Human Science, Nagoya,Japan, IEEE Service Center, Piscataway, NJ, pp. 39–43, 1995.

[2] R. Chakrabarti, P. K. Chattopadhyay, M. Basu, and C. K. Panigrahi, "Particle swarm optimization technique for dynamic economic dispatch", IE(I) Journal-EL, vol. 87, pp. 48-54, 2006.

[3] B. N. S. Rahimullah, E.I. Ramlan and T.K.A. Rahman, "Evolutionary Approach for Solving Economic Dispatch in Power System", In Proceedings of the IEEE/PES National Power Engineering Conference, vol.1, pp. 32 – 36, Dec 2003.

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary research
Website: www.ijdacr.com (Volume 1, Issue 7, February 2013)

[4] Younes.M, hadjeri.S, Zidi.S, Houari.S and Laarioua. M, ‘‘Economic Power Dispatch using an Ant Colony Optimization Method”, 10th International conference on Sciences and Techniques of Automatic control & computer engineering, Hammamet, Tunisia, 785-794, December 20-22, 2009.

[5] K.A. De Jong, W.M. Spears and D.F. Gordon, “Using Markov chains to analyze GAFOs”. In D. Whitley and M. Vose (eds.), Foundations of Genetic Algorithms 3, Morgan Kaufmann, San Mateo, CA, 115–137, 1995.

[6] J. Rees and G.J. Koehler, “An investigation of GA performance results for different cardinality alphabets”. In L.D. Davis, K. DeJong, M.D. Vose and L.D. Whitley (eds.), Evolutionary Algorithms: IMA Volumes in Mathematics and its Applications, Vol. 111. Springer-Verlag, New York, 191–206, 1999.

[7] J.L. Shapiro, A. Prügel-Bennett and M. Rattray, “A statistical mechanics formulation of the dynamics of genetic algorithms. Lecture Notes in Computer Science, Vol. 865. Springer-Verlag, Berlin, pp. 17–27, 1994.

[8] James Kennedy and Russell Eberhart, “Particle swarm optimization”, In Proceedings of the IEEE International Conference on Neural Networks, volume IV, pages 1942–1948, Piscataway, NJ, 1995.

[9] James Kennedy, Russell Eberhart, and Yuhui Shi. Swarm Intelligence. Morgan Kaufmann, 2001.

[10] Yuhui Shi and Russell Eberhart, “A modified particle swarm optimizer”, Proceedings of the IEEE International Conference on Evolutionary Computation, pages 69–73, 1998.