Solution to Economic Dispatch by Equal Incremental Cost Criterion

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1. Introduction

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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.

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

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

2. Solution by Particle Optimization

1. . Convert the constrained optimization problem as an unconstrained problem by penalty function method.

Minimize

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

2. This software contains two examples psotest.m and psotest.1.By running the programs (psotest.m or psotest1.m) as they are in the default pso1 folder the economic dispatch problem can be solved. The allocation minimum fuel cost and transmission losses are determined.
3. I am using the PSOt, particle swarm optimization toolbox for matlab developed by Prof Brian Birge(Reference).My sincere thanks to him for the efficient toolbox.

```
% the data matrix should have 5 columns of fuel cost coefficients and plant  limits.
% 1.a ($/MW^2) 2. b $/MW 3. c ($) 4.lower lomit(MW) 5.Upper limit(MW)
% This Example system is taken from the book Power System Analysis  by Prof Haadi Sadaat Example 7.8
%no of rows denote the no of plants(n)
clear
clc;
format long;
global data B B0 B00
data=[0.008    7    200    10    85
0.009    6.3    180    10    80
0.007    6.8    140 10 70];
B=.01*[.0218 .0093 .0028;.0093 .0228 .0017;.0028 .0017 .0179];
 B0=0*[.0003 .0031 .0015];
 Pd=150;
l=data(:,4)';
u=data(:,5)';
```

```
ran=[l' u'];
n=length(data(:,1));
Pdef = [100 100000 100 2 2 0.9 0.4 1500 1e-6 5000 NaN 0 0];
 [OUT]=pso_Trelea_vectorized('f6',n,1,ran,0,Pdef);
 out=abs(OUT)
 P=out(1:n)
  [F Pl]=f6(P')
```

The results

```
P =
  32.88968876120133
  64.59837992682773
  54.85448624558800


F =    1.597481635286200e+003


Pl =   2.34255491258807
```

This solution is better than the solution given in the book
P=[33.4701 64.0974 55.1011];
F=1599.98

Reference:

Birge, B., 2003, *PSOt, A Particle Swarm Optimization Toolbox for Matlab*, **IEEE Swarm Intelligence Symposium Proceedings**, April 24-26

ALL THE BEST