Solution to Optimal Power flow by Differential Evolution

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1. Introduction

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Optimal Power flow (OPF) is allocating loads to plants for minimum cost while meeting the network constraints. It is formulated as an optimization problem of minimizing the total fuel cost of all committed plant while meeting the network(power flow) constraints. The variants of the problems are numerous which model the objective and the constraints in different ways.

The basic OPF problem can described mathematically as a minimization of problem of Minimizing the total fuel cost of all committed plants subject to the constraints.

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

$F(P_i)$ 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.

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

The total generation should meet the total demand and transmission loss. The transmission loss can be determined from power flow.

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

$$P_l = real(\sum_{j}^{n} V_i Y_{ij}{}^{*} V_j), i = 1,2,..n \tag{A4}$$

$$Q_l = imag(\sum_{j}^{n} V_i Y_{ij}{}^{*} V_j), i = 1,2,..n \tag{A5}$$

2. Solution to Optimal Power flow by Differential Evolution

1. Collect the busdata,line data and cost coefficients and their limits.

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

$$Minimize$$

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

3. This software contain two case studies. The first one is the ieee 30 bus system This can be simulated by running the file deopf30.m. The other case study is the ieee 26 bus system.It is the example from Hadi sadaat example 7.11.This can be solved by running the file deopf26.m

4.The file .opf2.m is a function file which returns the fuel cost, voltage ,Generation, and transmission loss. Pflow.m is the power flow routine

5. I am using the differential evolution toolbox developed by Mr. Dipl.-Ing. Markus Buehren Stuttgart, Germany(mb_matlab@gmx.de, http://www.markusbuehren.de)My sincere thanks to him for this efficient toolbox.

6. Change your default folder as deopf. Just run deopf26 or deopf30 to simulate the opf. The results will be displayed on the command window. This is the simulation result of ieee 30 bu system.

Iteration: 180, Best: 801.843596, F: 0.800000, CR: 0.800000, NP: 20

best(1) = 48.830058

best(2) = 21.473815

best(3) = 21.648141

best(4) = -12.093687

best(5) = 2.783315

Iteration: 190, Best: 801.843596, F: 0.800000, CR: 0.800000, NP: 20

best(1) = 48.830058

best(2) = 21.473815

best(3) = 21.648141

best(4) = -12.093687

best(5) = 2.783315

Elapsed time is 52.556025 seconds.

F1 = 801.8436

PP = 176.7303   48.8301   21.4738   21.6481   12.0937   12.0000

vv = Columns 1 through 12

1.0600   1.0430   1.0254   1.0171   1.0100   1.0148   1.0050   1.0100   1.0530

1.0467   1.0820   1.0599

 Columns 13 through 24

 1.0710   1.0450   1.0402   1.0471   1.0415   1.0304   1.0277   1.0317   1.0345

1.0350   1.0296   1.0237

 Columns 25 through 30

  1.0203   1.0027   1.0269   1.0128   1.0071   0.9957

ALL THE BEST