ME527 – Introduction to Engineering Optimisation
2020-21 – Coursework
Bi-Objective Optimisation of Expensive Functions

Dr Edmondo Minisci
Department of Mechanical and Aerospace Engineering
University of Strathclyde, Glasgow, Scotland, UK

The problem

As attachment you have two functions:

- the **problem** function in the routine *ExpModel.p (expensive)*, and
- the **auxiliary** function in the routine *AuxModel.p (**not** expensive)*
-

Both functions take as input a design vector bounded as

- Lower bounds LB = [0, 0, 0, 0, 0, 0]
- Upper bounds UB = [10, 1000, 20, 2000, 30, 3000]

and gives as output a vector, **F**, of two elements: [F(1), F(2)]

The final aim of the work is minimising both F(1) and F(2) given by the expensive routine D_C.p

The steps to perform are:

a) Implement a strategy (NO surrogate based) to find a good approximation of the ENTIRE Pareto front with at most 50000 function evaluations using the auxiliary function in the file AuxModel.p; the strategy should be reliable and should be tested on **10 independent runs**.

b) Implement a SURROGATE based strategy to find a good approximation of the ENTIRE Pareto front with at most 300 function evaluations of the true auxiliary function in AuxModel.p; the strategy should be reliable and should be tested on **10 independent runs**.

c) Use the SURROGATE based strategy developed at point b) to find the best approximation of the true Pareto front for the problem function implemented in ExpModel.p (the expensive routine) with at most **300 function evaluations** of the expensive function.

REPORT

You are required to write a very short report not exceeding **1500 words** (excluding appendix).

Your report should include the following features:

- *description of the NON-surrogate based global search strategy* (just the name of the algorithm is not enough - you should mention and describe the main steps of the algorithm - algorithmic form would be appreciated);
- *description of the SURROGATE based global search strategy* (just the name of the algorithm is not enough - you should mention and describe the main steps of the algorithm - algorithmic form would be appreciated);

...

REPORT

…

- *results* of all the optimisation processes, reporting:
  - for point a) the achieved 10 approximations of the Pareto front (clear figure), and the computational cost of the optimisation.
  - for point b) the achieved 10 approximations of the Pareto front (clear figure), and the computational cost of the optimisation.
  - for point c) the achieved approximation of the Pareto front (clear figure and table of results), and the computational cost of the optimisation. Make sue that you report/show the Pareto front of the true function and not that of the surrogate (**i.e., verify the final results of the surrogate, with the true function, this will not be counted as part of the 300 budget)**
- *discussion* on the obtained results, including the analysis of the performance of both strategies (NON-surrogate based and SURROGATE based), and the use of the surrogate based approach to solve the expensive problem;

SUBMISSION: 1) one Word/PDF file containing the report, and 2) one compressed file containing all the routines.

Marking criteria

Assessment criteria (total marks: 100)

- Description of the global search strategies (clarity, **effort**, and logic; for both cases there should be the explicit description of the global exploratory and local exploitative parts) - report i) & ii) – **50 Marks**
- Results (correctness/goodness and clarity) – report iii) – **30 Marks**
- Final discussion (correctness and clarity) – report iv) – **20 Marks**
- Appendix – **NOTE:** all the routines and instructions to use them should be "run ready", i.e., the lecturer should be able to run the main script(s) and replicate your results; if that cannot be done, marks will be penalised.

Due date

Thu, 01 April 2021, 4:00 PM

University of
Strathclyde
Glasgow