# 1 GENOMINO–Genetic Algorithms Software

GENOMINO is a small program (approximately 300 Fortran–77 statements) intended to illustrate the Genetic Algorithms (GA) in practice. It is not a production code, rather it is a simple implementation and hence invites the user to experiment with it. No elaborate termination rules are implemented; the program stops when a maximum number of iterations (corresponding to succeeding generations) is completed. Upon completion of the GA iterations, a call to a local procedure is made in order to "polish" the minimum point to be returned as the (hopefully) global minimizer.

## 1.1 Genomino's parameters

In the very first lines of the main program (`PROGRAM GENOMINO`), there are three `PARAMETER` statements, as shown below.

```
C =======================================================================
      PROGRAM GENOMINO
C =======================================================================
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      DOUBLE PRECISION MUTPC
      PARAMETER (N= 2, M= 100, NG =   10)
      PARAMETER (DELPC =   2.D-2, SELPC=  5.D-2,MUTPC=  8.D-2)
      PARAMETER (PMUTE=  5.D0)
```

1. `N` is the dimension of the problem at hand.
2. `M` is the size of the population, i.e. the number of its members.
3. `NG` is the maximum allowed number of iterations (generations).
4. `DELPC` is the deterministic elitism fraction, i.e. the $\max\{1, M*DELPC\}$ fittest individuals will be maintained to the next generation.
5. `SELPC` is the stochastic elitism fraction, i.e. $\max\{1, M * SELPC\}$ individuals will be selected to survive with a probability proportional to their fitness.
6. `MUTPC` is the mutation fraction, i.e. $\max\{1, M*MUTPC\}$ individuals will be selected to undergo the mutation operation.

7. PMUTE is the mutation parameter ($\beta$ in the text of paragraph **??**).

The following statements calculate the actual numbers, NCRO is the number to be selected for the crossover operation.

```
NDEL = MAX(1.D0,DELPC*M)
NSEL = MAX(1.D0,SELPC*M)
NMUT = MAX(1.D0,MUTPC*M)
NCRO = M-NDEL-NSEL-NMUT
```

The interface to Merlin, which is the software employed for the local optimization, is implemented via the following statements that are located nearly at the end of the program.

```
C ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C  PREPARE THE INTERFACE TO MERLIN (LOCAL MINIMIZER).
C
            NOF = 0
            ND  = N
C
C  INSTRUCT MERLIN TO OPTIMIZE FROM THE GLOBALY BEST POINT FOUND
C
            CALL OPTIMA(ND,NOF,WA,VAL,XL,XR,IXAT,ICODE,
     >          'in.dat','/dev/null',GRMSO,NF,NOG,NHO,NJO)
C ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

Note that /dev/null is the "sink" device for UNIX–systems. In other systems it may be replaced with any valid filename. The random number generator used (FUNCTION RANM()), does not appear explicitly in the code, since it is included in Merlin. More information regarding SUBROUTINE OPTIMA may be found in the documentation of the Merlin optimization environment. If one wants to avoid installing Merlin, the above statements may be commented as well as the following statements till the end of the program. In this case however one must include the random number generator code (FUNCTION RANM()), or substitute it with another.

## 1.2 Sample I/O of GENOMINO

The following output is from a run with the Shubert test function.

```
 GENOMINO RUNS WITH THE FOLLOWING DATA:
 D-ELITISM NUMBER:  3
 P-ELITISM NUMBER:  7
 CROSSOVER NUMBER:  128
 MUTATION  NUMBER:  12
 MUTATION    RATE:   5.
 POPULATION  SIZE:  150
 MAX. GENERATIONS:  20
=========================================================
      GA:   CALLS       MINIMUM            POINT
            3000   -0.2396732E+02      -0.4667646E+00
                                       -0.4951348E+00
---------------------------------------------------------
  MERLIN:
              43   -0.2406250E+02      -0.4913908E+00
                                       -0.4913908E+00
=========================================================
 TOTAL FUNCTION CALLS:  3043
 TOTAL GRADIENT CALLS:  38
```

Notice that the extra 43 calls spent by Merlin slightly modified the already very good result obtained by GA. The function values are very close and in the variables a rather small change may be observed. However, this is not always the case, as can be verified by inspecting the output of a run with different parameters, listed below.

```
 GENOMINO RUNS WITH THE FOLLOWING DATA:
 D-ELITISM NUMBER:  2
 P-ELITISM NUMBER:  6
 CROSSOVER NUMBER:  102
 MUTATION  NUMBER:  10
 MUTATION    RATE:   5.
 POPULATION  SIZE:  120
```

```
 MAX. GENERATIONS:  5
==========================================================
     GA:   CALLS       MINIMUM            POINT
            600   -0.2259271E+02      -0.4572395E+00
                                      -0.5821454E+00
----------------------------------------------------------
  MERLIN:
             41   -0.2406250E+02      -0.4913908E+00
                                      -0.4913908E+00
==========================================================
 TOTAL FUNCTION CALLS:  641
 TOTAL GRADIENT CALLS:  36
```