1 SMEENOS–Particle Swarm Software

Smeenos (from the Greek $\Sigma\mu\acute{\eta}\nu o\varsigma$, meaning Swarm) is a small program (approximately 200 Fortran–77 statements) intended to illustrate the PSO ideas 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 swarm moves) is completed. Upon completion of the swarm 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 Smeenos parameters

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

```
C ===========================================================================
      PROGRAM SMEENOS
C ===========================================================================
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      PARAMETER (N = 2, M = 150, NITER =  20)
      PARAMETER (CFL = 2.D0, CFG = 5.D0)
```

1. `N` is the dimension of the problem at hand.
2. `M` is the size of the swarm, i.e. the number of birds in the swarm.
3. `NITER` is the maximum allowed number of iterations (swarm moves).
4. `CFL` is the local bias, i.e. the coefficient that adjusts the velocity gain toward the bird's best position (c_1 in eq. (**??**)).
5. `CFG` is the global bias, i.e. the coefficient that adjusts the velocity gain toward the swarm's best position (c_2 in eq. (**??**)).

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,XB,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 SMEENOS

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

```
 SMEENOS . . . 'FLIES' WITH THE FOLLOWING DATA !!! :
 NUMBER OF VARIABLES:  2
 SWARM SIZE:  150
 MAX.# OF MOVES:  20
 LOCAL FACTOR:   2.
 GLOBAL FACTOR:   5.
=========================================================
     PSO:  CALLS       MINIMUM            POINT
           3000   -0.2406250E+02      -0.4913907E+00
                                      -0.4913909E+00
---------------------------------------------------------
  MERLIN:
             27   -0.2406250E+02      -0.4913908E+00
                                      -0.4913908E+00
```

```
==========================================================
 TOTAL FUNCTION CALLS:  3027
 TOTAL GRADIENT CALLS:  4
```

Notice that the extra 27 calls spent by Merlin slightly modified the already excellent result obtained by the swarm moves. The function values have identical the first 7 significant digits. In the variables a change in the last (7^{th}) digit 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.

```
 SMEENOS . . . 'FLIES' WITH THE FOLLOWING DATA !!! :
 NUMBER OF VARIABLES:  2
 SWARM SIZE:  120
 MAX.# OF MOVES:  5
 LOCAL FACTOR:   2.
 GLOBAL FACTOR:   5.
==========================================================
    PSO:   CALLS       MINIMUM           POINT
            600   -0.2403710E+02     -0.4944146E+00
                                     -0.4789202E+00
----------------------------------------------------------
  MERLIN:
             25   -0.2406250E+02     -0.4913908E+00
                                     -0.4913908E+00
==========================================================
 TOTAL FUNCTION CALLS:  625
 TOTAL GRADIENT CALLS:  6
```