

## Program NMO: User Instructions

### a) Preparation and calling the program

Setup function fu() in the program. Parameters are in list lxw.

Example: You want to minimize the function

$y = (x_1 - 2)^2 + (x_2 - 1)^2 + (x_3 - 1.5)^2 + x_4^2 + (x_5 + 1)^2 + 2 \cdot ((x_1 - 2) \cdot (x_2 - 1))^2 + 0.5 \cdot ((x_2 - 1) \cdot (x_5 + 1))^2$ . Then it looks like this (in the third line the following part is hidden: " $)^2 \rightarrow xy$ "):

```

1.1 1.2 *nmo RAD
nmo 14/12
Define fu()=Func
Local xy
(lxw[1]-2.)^2+(lxw[2]-1.)^2 →xy
xy+(lxw[3]-1.5)^2+lxw[4]^2 →xy
xy+(lxw[5]+1.)^2+2.·((lxw[1]-2.)·(lxw[2]-1.))^2
xy+0.5·((lxw[2]-1)·(lxw[5]+1))^2 →xy
Return xy
EndFunc

```

Put in an estimate for parameters in the list lxw and start the program with the following parameters:

- initial step length (here: 1.)
- termination criterion for step length (here: 0.0001)
- maximum number of iterations.

### b) Program running and results:

The process starts. The following information is displayed:

- iter: Number of iteration
- fmin: Minimum value of function reached so far
- zak: Termination criterion

```

1.1 1.2 *nmo RAD
{ 0,0,0,0,0 } →lxw { 0,0,0,0,0 }
nmo(1.,1.E-4,250)
iter-fmin-zak: 1 3.09829 1.16619
iter-fmin-zak: 2 1.2408 1.69044
iter-fmin-zak: 3 1.2408 1.73683
iter-fmin-zak: 4 1.2408 1.62118
iter-fmin-zak: 5 1.2408 1.51973

```

After 161 Iterations, the minimum reached is 5.4E-9, parameters can be found in list lxw. If you put in lxw you get:

```

lxw
{ 2.00004,0.999956,1.5,-0.000033,-0.99997 }

```

During the iteration process, the following information is given: iter: # of iteration, fmin: minimum

reached so far, zak: termination criterion.

```
1.1 1.2 *nmo RAD
iter-fmin-zak: 159 5.37672E-9 0.000118
iter-fmin-zak: 160 5.37672E-9 0.000107
iter-fmin-zak: 161 5.37672E-9 0.000092
--- Done -----
fmin= 5.37672E-9
Parameter: lxw
Fertig
```

If the process terminates because the maximum number of iterations is reached, but the termination criterion is not reached you can add additional iterations. Just let the list lxw unchanged and put in a somewhat smaller step length and as many iterations as you like.

Real Minimum is at {2.,1.,1.5,0.,-1.} and fmin = 0.