MATLAB Environment Example for 16:711:550 Nonlinear Optimization: Unconstrained Optimization

We declare some symbolic variables to use in the objective function

```
>> syms x1 x2
```

Collect these variables into a row vector (hence "," not ";" inside the vector)

```
>> vars = [x1,x2];
```

Define a symbolic function of these variables

```
>> f40 = 0.5*(x1^2 + 40*x2^2)

f40 =

1/2*x1^2+20*x2^2
```

Now execute steepest descent with Armijo stepsize:

- `f40,vars` indicate the function to optimize and its symbolic variables
- `[40;1]` is the starting point as a column vector (hence the ";")
- `1e-7` is the stopping tolerance – if norm of the gradient gets this small, we stop
- `20` is the maximum number of iterations – we will stop at this point even if the gradient is larger than the tolerance
- `1,.25,.5` are the Armijo-rule parameters s, σ, and β, respectively

```
>> steepestArmijo(f40,vars,[40;1],1e-7,20,1,.25,.5)
 1: m=4 f=748.125000000 ||grad f||=70.754858490
x =  37.500000000 -1.500000000
 2: m=5 f=662.678833008 ||grad f||=39.303087233
x =  36.328125000  0.375000000
 3: m=3 f=550.210161209 ||grad f||=67.900076012
x =  31.787109375 -1.500000000
 4: m=5 f=476.940395432 ||grad f||=34.252821648
x =  30.793762207  0.375000000
 5: m=3 f=408.004169940 ||grad f||=65.772398009
x =  26.944541931 -1.500000000
 6: m=5 f=343.483405578 ||grad f||=30.105511309
x =  26.102524996  0.375000000
 7: m=3 f=305.826162083 ||grad f||=64.200095983
x =  22.839709371 -1.500000000
 8: m=5 f=247.591740002 ||grad f||=26.731226683
x =  22.125968453  0.375000000
```

```
 9: m=4 f=221.466128908 ||grad f||=30.602712426
x =  20.743095425 -0.562500000
10: m=4 f=203.324417497 ||grad f||=38.951697941
x =  19.446651961  0.843750000
11: m=5 f=178.342799740 ||grad f||=20.642122482
x =  18.838944087 -0.210937500
12: m=3 f=150.100663296 ||grad f||=37.560448135
x =  16.484076076  0.843750000
13: m=5 f=128.393553853 ||grad f||=18.060972532
x =  15.968948699 -0.210937500
14: m=3 f=111.858271914 ||grad f||=36.528105362
x =  13.972830112  0.843750000
15: m=5 f=92.503965848 ||grad f||=15.950534561
x =  13.536179171 -0.210937500
16: m=3 f=84.380306097 ||grad f||=35.767954229
x =  11.844156774  0.843750000
17: m=5 f=66.716538943 ||grad f||=14.242355809
x =  11.474026875 -0.210937500
18: m=4 f=59.857709208 ||grad f||=16.609983922
x =  10.756900195  0.316406250
19: m=4 f=55.354598575 ||grad f||=21.496639945
x =  10.084593933 -0.474609375
20: m=5 f=48.002647867 ||grad f||=10.861287514
x =  9.769450373  0.118652344
```

The function returns the entire history of points it generated (which is helpful for plotting). To suppress this output, we'd put a ";" at the end of the command above.

```
ans =

  Columns 1 through 7

   40.0000   37.5000   36.3281   31.7871   30.7938   26.9445   26.1025
    1.0000   -1.5000    0.3750   -1.5000    0.3750   -1.5000    0.3750

  Columns 8 through 14

   22.8397   22.1260   20.7431   19.4467   18.8389   16.4841   15.9689
   -1.5000    0.3750   -0.5625    0.8438   -0.2109    0.8438   -0.2109

  Columns 15 through 21

   13.9728   13.5362   11.8442   11.4740   10.7569   10.0846    9.7695
    0.8438   -0.2109    0.8438   -0.2109    0.3164   -0.4746    0.1187
```