MA3236 NONLINEAR PROGRAMMING

Semester 1, 2018/2019

Assignment 1

Jakkarin Sae-Tiew A0157285W

1. Minimizing the Rosenbrock function using Backtracking Line Search

Function:

```
function [x, iter] = backtracking(impMethod,x0,rho,c,printyes)

… (see attached backtracking.m file)

end
```

is defined

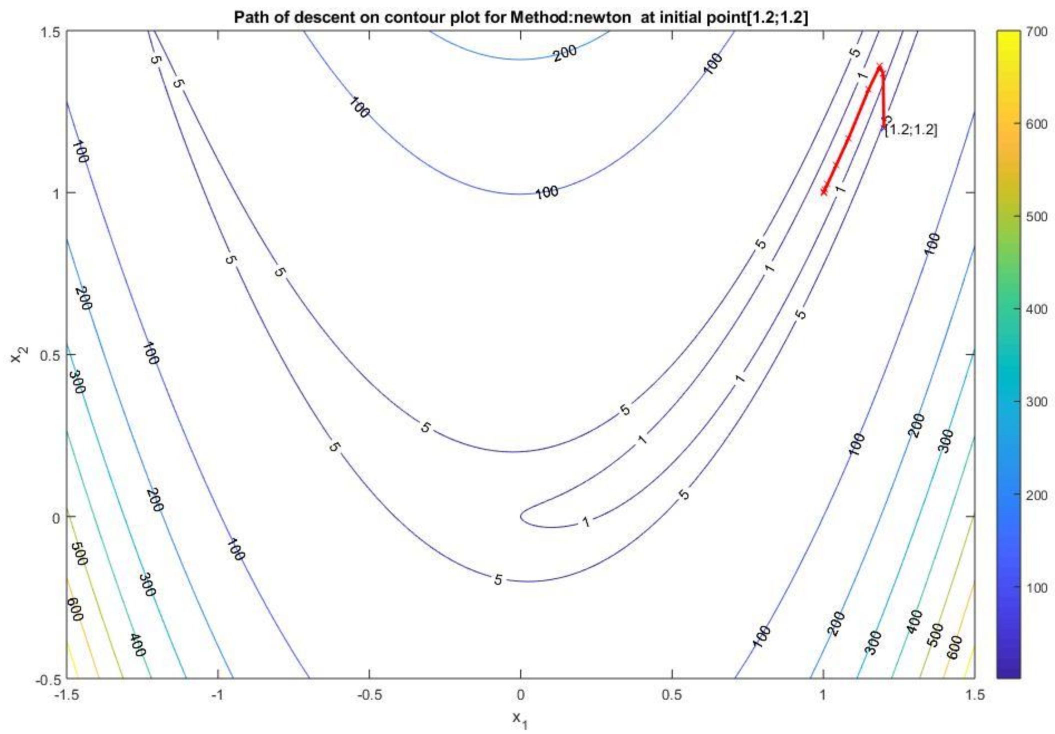
For initial point x_2 [1.2; 1.2]:

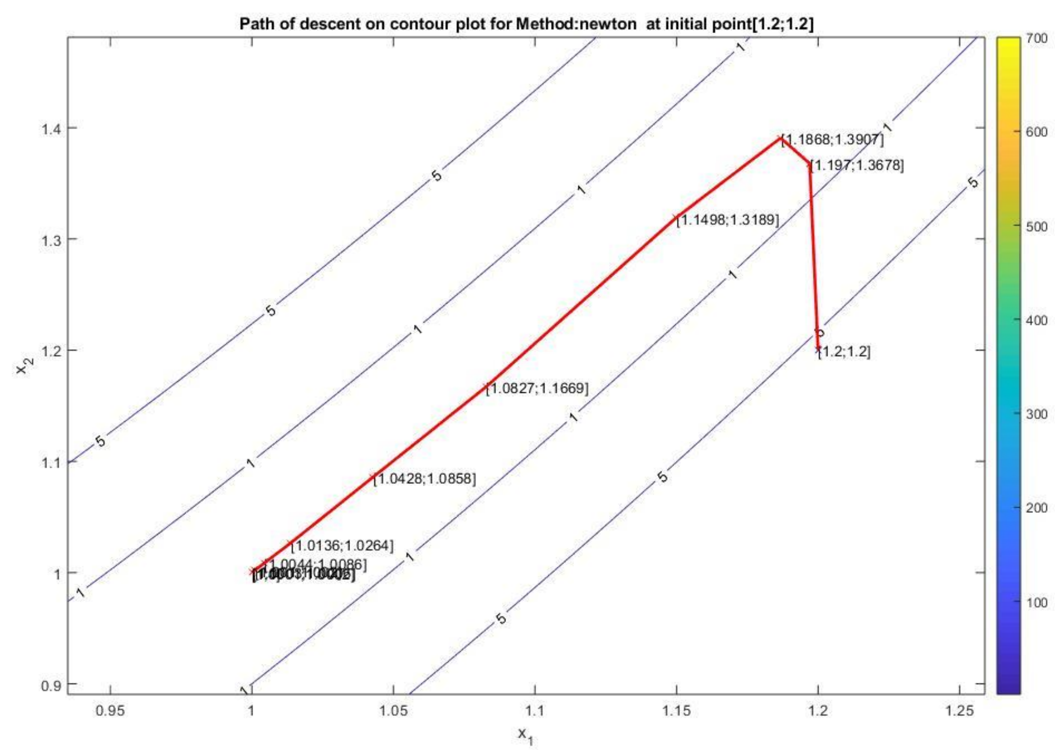
Newton Method:

```
>> [x, iter] = backtracking('newton',[1.2;1.2], 0.9, 0.6, 1);
```

iter	x1	x2	f(x)	step-len
0	1.200	1.200	5.800	0.729
1	1.197	1.368	0.462	0.729
2	1.187	1.391	0.066	0.900
3	1.150	1.319	0.023	0.729
4	1.083	1.167	0.010	1.000
5	1.043	1.086	0.002	0.900
6	1.014	1.026	0.000	0.810
7	1.004	1.009	0.000	0.810
8	1.001	1.002	0.000	0.729
9	1.000	1.001	0.000	0.729
10	1.000	1.000	0.000	0.729

Contour and plot of each iterate for Newton Method



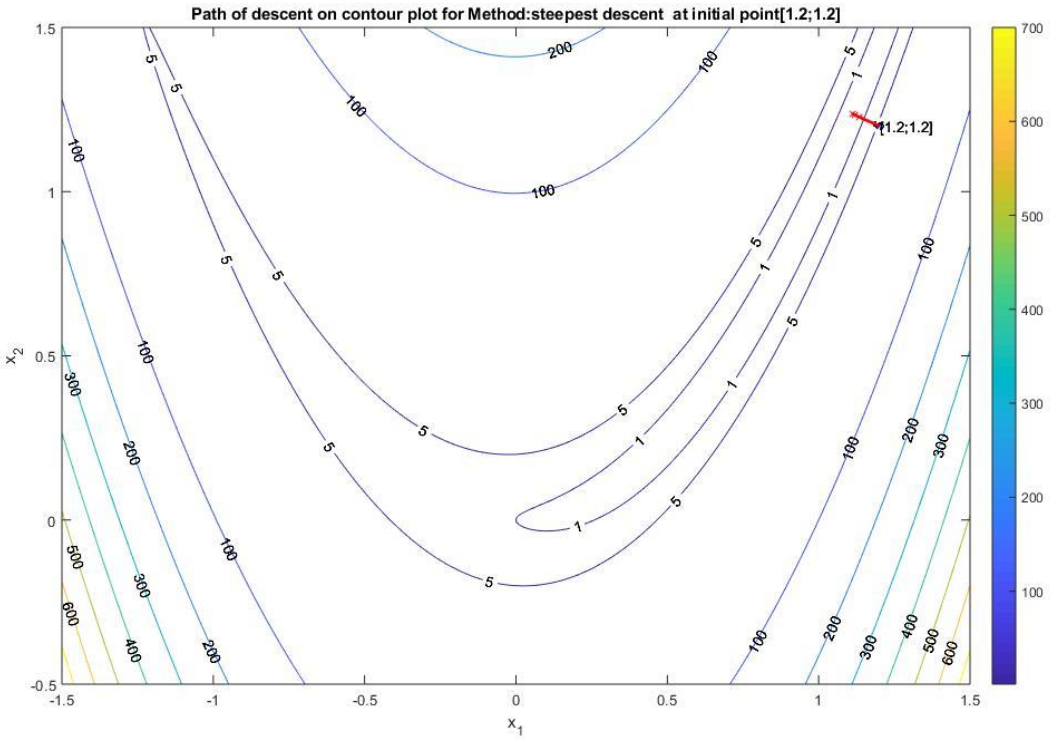


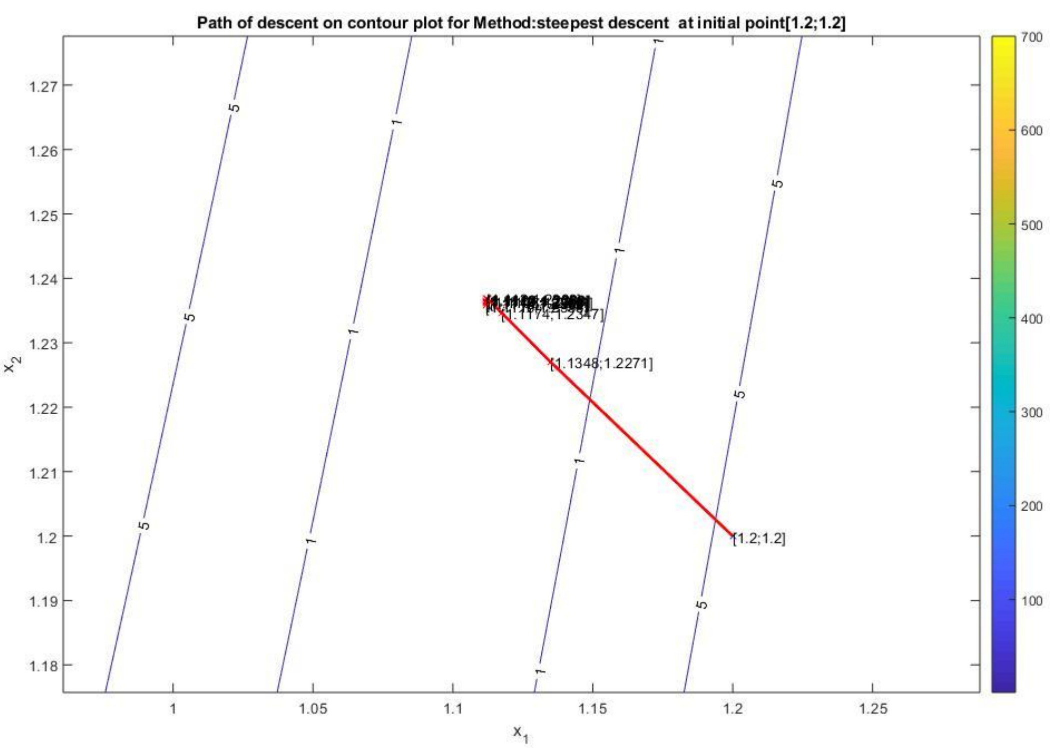
Steepest Descent Method:

```
>> [x, iter] = backtracking('steepest descent',[1.2;1.2], 0.9,
0.6, 1);

 iter    x1    x2    f(x)     step-len
--------------------------------------
 0     1.200  1.200  5.800     0.001
 1     1.135  1.227  0.387     0.001
 2     1.117  1.235  0.033     0.001
 3     1.113  1.236  0.014     0.001
 4     1.112  1.237  0.013     0.001
 5     1.112  1.237  0.013     0.002
 6     1.112  1.237  0.013     0.002
 7     1.112  1.237  0.013     0.001
 8     1.112  1.237  0.013     0.002
 9     1.112  1.236  0.012     0.001
10     1.112  1.236  0.012     0.004
--------------------------------------
```

Contour and plot of each iterate for Steepest Descent Method:





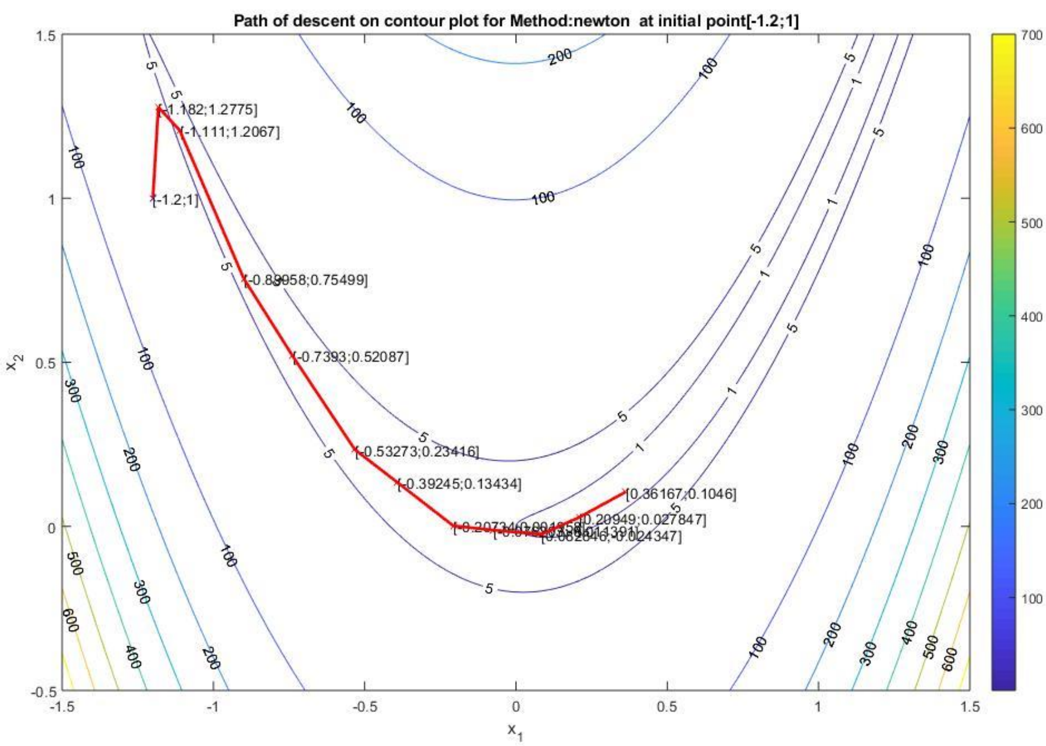
For initial point [-1.2; 1]:

Newton Method:

```
>> [x, iter] = backtracking('newton',[-1.2;1], 0.9, 0.6, 1);
```

iter	x1	x2	f(x)	step-len
0	-1.200	1.000	24.200	0.729
1	-1.182	1.278	6.191	0.810
2	-1.111	1.207	4.533	0.656
3	-0.900	0.755	3.903	1.000
4	-0.739	0.521	3.091	0.729
5	-0.533	0.234	2.596	1.000
6	-0.392	0.134	1.978	0.656
7	-0.207	0.002	1.626	1.000
8	-0.076	-0.011	1.188	0.656
9	0.083	-0.024	0.939	1.000
10	0.209	0.028	0.651	0.810

Contour and plot of each iterate for Newton Method:

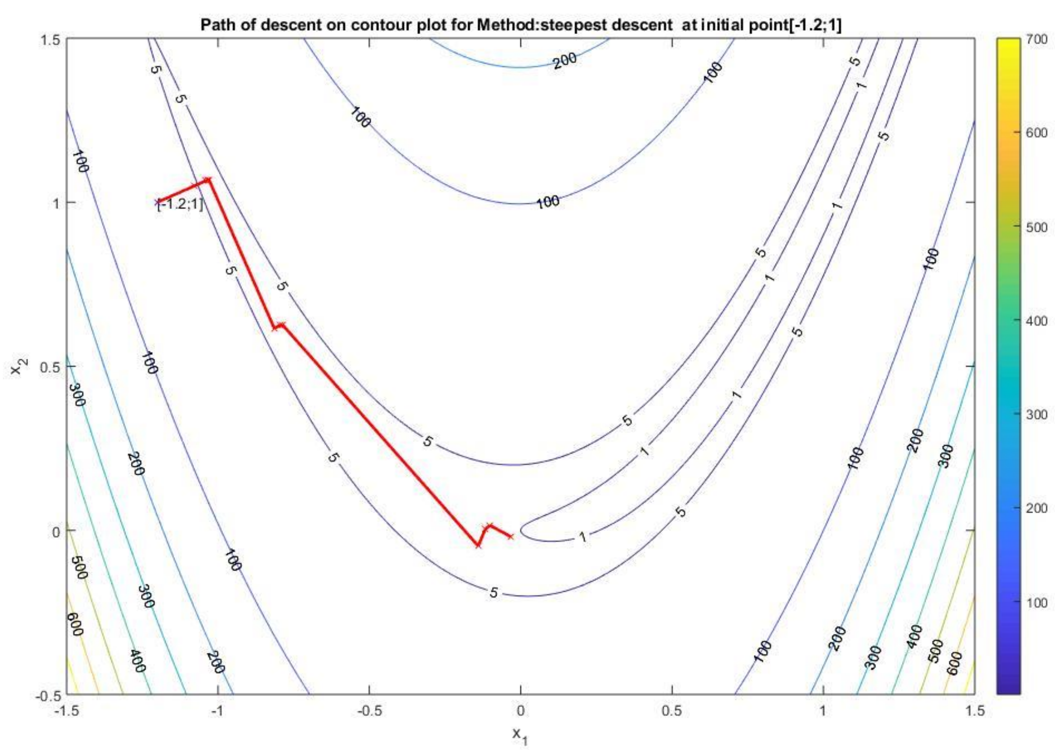


Steepest Descent Method:

```
>> [x, iter] = backtracking('steepest descent',[-1.2;1], 0.9,
0.6, 1);

 iter     x1      x2     f(x)       step-len
---------------------------------------
 0     -1.200  1.000 24.200      0.001
 1     -1.078  1.050  5.605      0.001
 2     -1.041  1.065  4.205      0.001
 3     -1.033  1.068  4.133      0.001
 4     -1.030  1.068  4.125      0.282
 5     -0.814  0.616  3.513      0.001
 6     -0.794  0.626  3.221      0.001
 7     -0.787  0.627  3.200      0.478
 8     -0.140 -0.048  1.756      0.004
 9     -0.117  0.003  1.261      0.006
10     -0.102  0.015  1.216      0.034
---------------------------------------
```

Contour and plot of each iterate for Steepest Descent Method:



2. Run ten iterations of the steepest descent and conjugate gradient algorithms to find approximate minimizers of the quadratic function:

$$\boldsymbol{f}(\mathbf{x}) = \frac{\mathbf{1}}{\mathbf{2}}\mathbf{x}^{\mathrm{T}}\mathbf{A}\mathbf{x} - \mathbf{b}^{\mathrm{T}}\mathbf{x}$$

Steepest Descent Method

Functions:

```
function [x,p,iter] = steepestDesc(fun)
…
end

function [fx,grad] = quadFn(x, A, b)
fx = 0.5*x'*A*x-b'*x;
grad = A*x-b;
end
```

are defined

Results:

```
>> [x,p,iter] = steepestDesc('quadFn');

 iter   ||x - x*||
 ------------------
  0       20.551
  1       20.491
  2       20.445
  3       20.396
  4       20.352
  5       20.304
  6       20.261
  7       20.214
  8       20.172
  9       20.126
 10       20.085
```

Therefore, $\left||x_{10} - x^*|\right| = 20.085$

Conjugate Gradient Method

Functions:

```
function [x,p,iter] = conjugateGrad(fun)

… (see attached conjugateGrad.m file)

end

function [fx,grad] = quadFn(x, A, b)
fx = 0.5*x'*A*x-b'*x;
grad = A*x-b;
end
```

are defined

Results:

```
>> [x,p,iter] = conjugateGrad('quadFn');

 iter   ||x - x*||
-------------------
  0       20.551
  1       20.491
  2       20.331
  3       20.068
  4       19.727
  5       19.383
  6       18.622
  7       17.375
  8       15.797
  9       14.264
 10       13.411
```

Therefore, $||x_{10} - x^*|| = 13.411$