EE 457 HW 3

Yagiz Savas

Question 1)

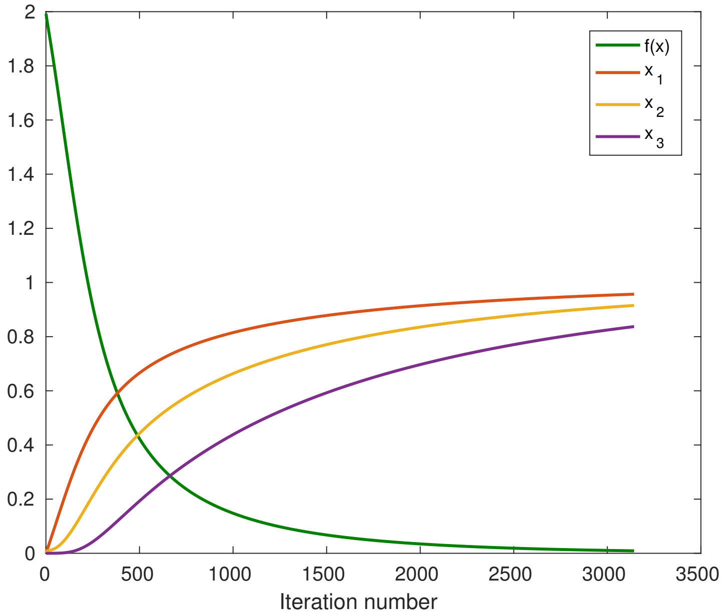

Figure 1: Minimization results for Rosenbrock equation with the use of gradient descent algorithm with $\alpha = 0.001$ as fixed step size and $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ as stopping criteria.

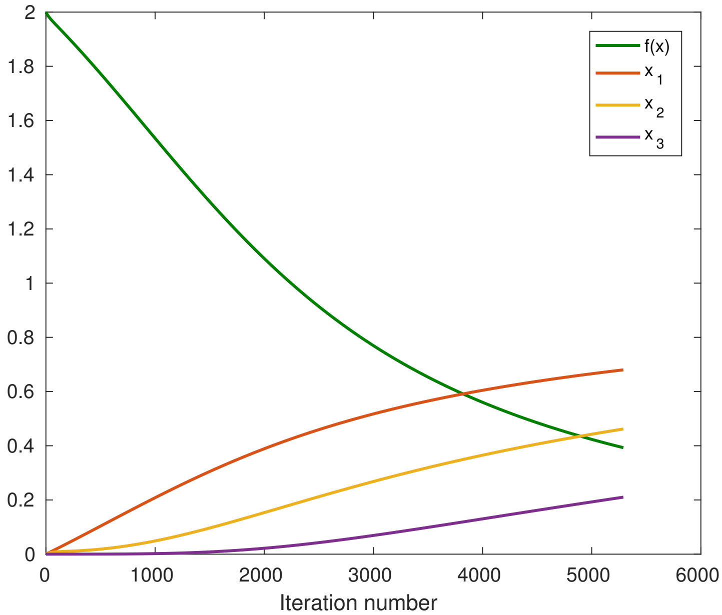

Figure 2: Minimization results for Rosenbrock equation with the use of gradient descent algorithm with $\alpha = 0.0001$ as fixed step size and $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ as stopping criteria.

Question 2)

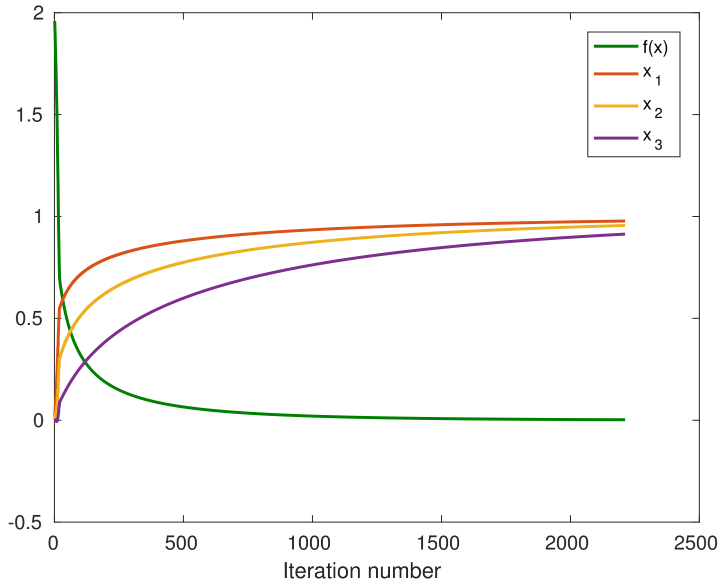

Figure 3: Minimization results for Rosenbrock equation with the use of steepest descent algorithm. Secant method is used for exact line search and $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ is used as stopping criteria.

Question 3)

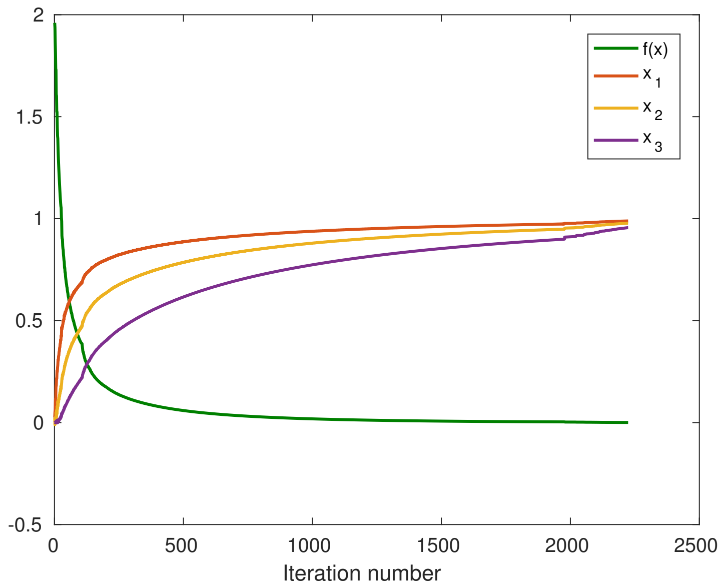

Figure 4: Minimization results for Rosenbrock equation with the use of gradient descent algorithm. First Armijo condition is used for inexact line search and $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ is used as stopping criteria. Parameters used for Armijo condition are $\epsilon = 0.001$, $\tau = 0.5$.

Question 4)

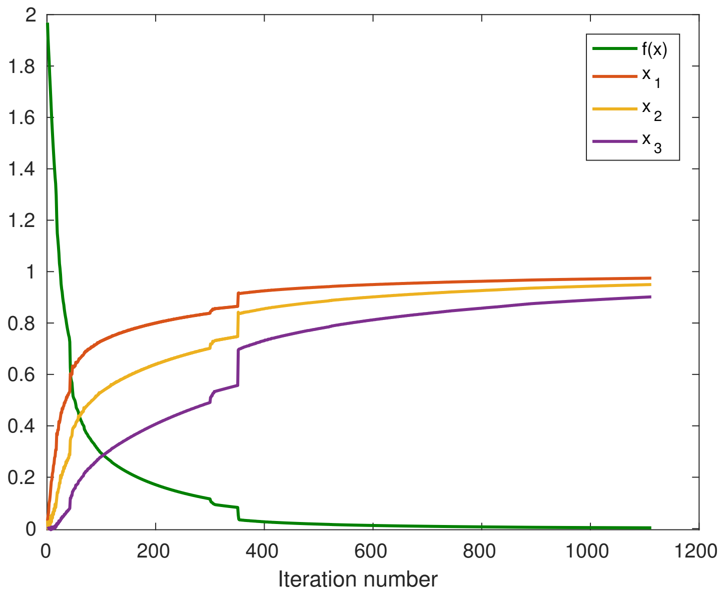

Figure 5: Minimization results for Rosenbrock equation with the use of gradient descent algorithm. Armijo-Goldstein conditions are used for inexact line search and $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ is used as stopping criteria. Parameters used for Armijo-Goldstein condition are $\epsilon = 0.2$, $\tau_1 = 0.5$, $\tau_2 = 1.5$, $\eta = 0.8$.

Question 5)

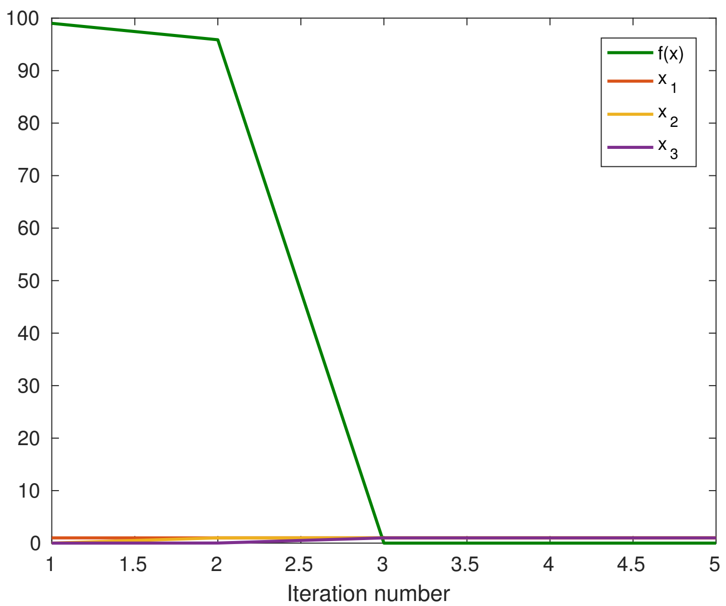

Figure 6: Minimization results for Rosenbrock equation with the use of Newton's algorithm. Stopping criteria is taken as $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$.

Question 6)

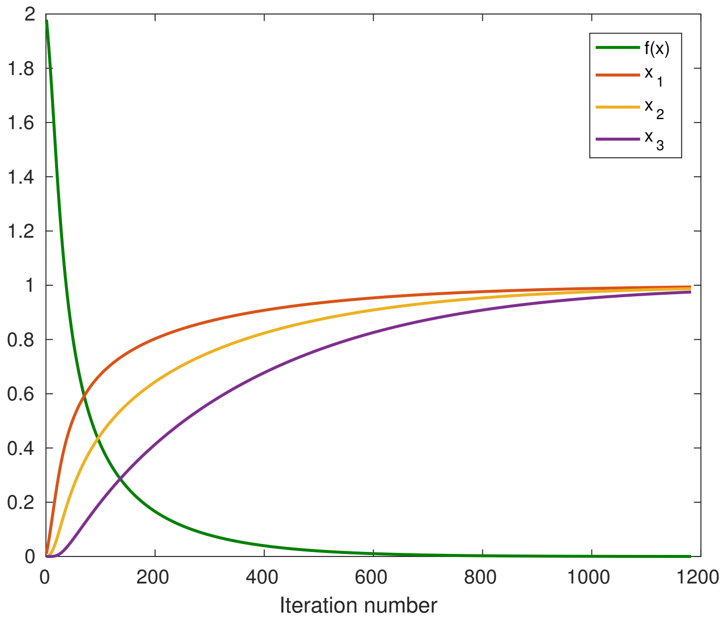

Figure 7: Minimization results for Rosenbrock equation with the use of modified Newton's algorithm. Stopping criteria is taken as $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ and secant method is used for exact line search.

Question 7)

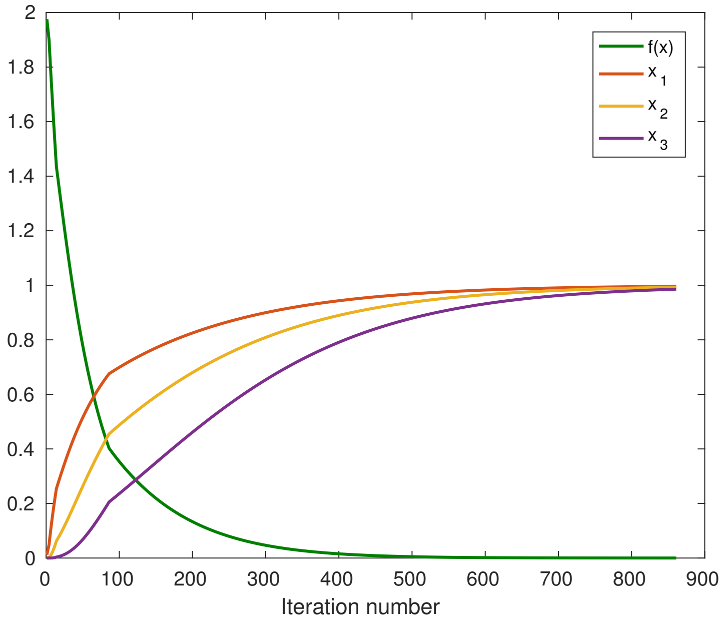

Figure 8: Minimization results for Rosenbrock equation with the use of modified Newton's algorithm. Stopping criteria is taken as $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ and first Armijo condition is used for inexact line search. Parameters used for Armijo condition are $\epsilon = 0.001$, $\tau = 0.5$.

Question 8)

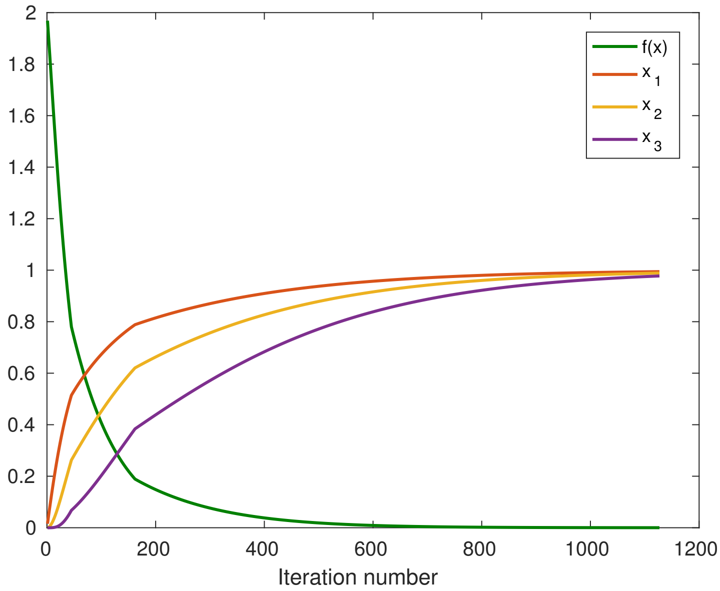

Figure 9: Minimization results for Rosenbrock equation with the use of modified Newton's algorithm. Stopping criteria is taken as $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ and Armijo-Goldstein conditions are used for inexact line search. Parameters used for Armijo-Goldstein conditions are $\epsilon = 0.2$, $\tau_1 = 0.5$, $\tau_2 = 1.5$, $\eta = 0.8$.

Question 9)

Table 1: Results for all algorithms employed to find minimum of Rosenbrock equation. Stopping criteria of $\|x^{(k)} - x^{(k-1)}\|_2 < 10^{-4}$ is used for all algorithms.

Problem number:	**Iterations for vector calculation:**	**Iterations for line search:**	**Function Value:**
1 a)	3143	-	0.0091
1 b)	5290	-	0.3929
2)	2212	11044	0.0024
3)	2224	34891	6.1526e-04
4)	1112	9793	0.0032
5)	5	-	2.4866e-23
6)	1182	5171	1.9689e-04
7)	861	11958	6.3757e-05
8)	1127	8809	1.5957e-04

As can be seen from Table 1, by far the best results are provided by Newton's method. However, its results are strongly dependent on initial conditions. Modified Newton methods with exact and inexact line search provide almost the same results for this problem. However, the use of inexact line search conditions may provide better results with less iteration numbers for other problems. This can be observed by comparing the results of 2) and 3). Rather than using steepest descent method, the use of inexact line search with first Armijo condition yields a smaller function value. Although 3) necessitates a large number of iterations for line search, this number is strongly dependent on Armijo parameters. Therefore, the selection of more appropriate parameters may lead to better results. Additionally, it can be concluded from the table that 1 b) provides the worst results. However, that result is caused by the stopping criteria. When the norm of the gradient is used as stopping criteria rather than the norm difference of state variables, it can be seen that it provides results better than most algorithms with less iterations.