1. Exact line search steepest descent method
2. Fixed step length steepest descent method with $\alpha = 10{-}3$.
3. Newton's method with fixed step length as 1.
4. Backtracking steepest descent method with $c1 = 10{-}4$, $\rho = 0.1$.
5. Backtracking Newton's method with $c1 = 10{-}4$, $\rho = 0.9$.
6. Heavyball method with $\alpha = 10{-}3$ and $\beta = 0.95$.
7. Trust region method with Cauchy point, parameters are set as in project 3.
8. Trust region method with dogleg method, parameters are set as in project 3.
9. BFGS method with exact line search.
10. BFGS method with backtracking line search. 11. SR1 method with exact line search.
12. SR1 method with backtracking line search.

The stopping criteria is set as gradient norm less than $10{-}9$.
Perform the experiments on the following problems:
P1. Quadratic function as in Project 1. Starting at (5,5).

| Methods | Problems | # of Iteration |
|---------|----------|----------------|
| 1 | P1 | 12 |
| 2 | P1 | 10872 |
| 3 | P1 | 1 |
| 4 | P1 | 113 |
| 5 | P1 | 1 |
| 6 | P1 | 826 |
| 7 | P1 | 77 |
| 8 | P1 | 3 |
| 9 | P1 | 2 |
| 10 | P1 | 6 |
| 11 | P1 | 2 |
| 12 | P1 | 3 |

P2. Rosenbrock function as in Project 1. Starting at $(-1.2,1)$.

| Methods | Problems | # of Iteration |
|---|---|---|
| 1 | P2 | 24500 |
| 2 | P2 | 49371 |
| 3 | P2 | 7 |
| 4 | P2 | 946 |
| 5 | P2 | 20 |
| 6 | P2 | 4682 |
| 7 | P2 | 23176 |
| 8 | P2 | 38 |
| 9 | P2 | 22 |
| 10 | P2 | 21 |
| 11 | P2 | 22 |
| 12 | P2 | N/A<br>(fail assertion in backtracking) |

P3. Powell's quartic function in this project. Starting at $(3, -1, 0, 1)$

| Methods | Problems | # of Iteration |
|---|---|---|
| 1 | P3 | N/A<br>(time consuming) |
| 2 | P3 | N/A<br>(time consuming) |
| 3 | P3 | 23 |
| 4 | P3 | 1000001 |
| 5 | P3 | 23 |
| 6 | P3 | 1000001 |
| 7 | P3 | N/A |

| 8 | P3 | N/A |
| --- | --- | --- |
| 9 | P3 | 32 |
| 10 | P3 | 58 |
| 11 | P3 | 32 |
| 12 | P3 | N/A<br>(fail assertion in backtracking) |