Homework 5 Solution and Discussion

Example MATLAB code written by Max Yi Ren and Emrah Bayrak were modified in solving the following nonlinear constrained optimization problem:

A picture containing text

Description automatically generated

The optimization settings were first defined by creating function handles for the objective function (f), the gradient of the objective function (df), constraints (g), and gradient of constraints (dg). The gradients are defined as row vectors.

Text

Description automatically generated

Two different algorithms can be specified to solve the optimization problem (“myqp” and “matlabqp”). ‘myqp’ solves the QP problem by implementing an Active-Set strategy whereas “matlabqp” uses one of three algorithms which can be user-specified:

Graphical user interface, text

Description automatically generated with medium confidence

For this problem, the active set algorithm will be utilized.

Optimization Process and Results:

The optimization begins at the initial point [x1, x2] = [1, 1]. This is confirmed to be in the feasible region before proceeding with the optimization. Sequential quadratic programming works by solving multiple optimization subproblems. The subproblems will be solved until the termination criteria is met; the norm of the Lagrangian gradient must be smaller than a user-defined tolerance ε. In this case, ε is 1\*10-3. The gradient of the Lagrangian function is defined as

Each QP subproblem is solved using the active set strategy which ensures that all the Lagrange multipliers are positive. The solutions for each iteration are tabulated below:

**Solution Points for Each Iteration**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | P1 | P2 | P3 | P4 |  | P5 |
| x1 | 1 | 1.750000 | 0.938524 | 1.0705432 |  | 1.0604169 |
| x2 | 1 | 2.250000 | 1.542121 | 1.4652623 |  | 1.4563356 |

Chart

Description automatically generated

The solution trajectory in the variable space is shown with the shaded green area representing the feasible region. The final solution lands on a the constraint as expected.

Chart

Description automatically generated

Chart, line chart

Description automatically generated