Numerical Optimization in Robotics Homework1

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1. Workflow

   (a) The function cal_grad() calculate gradient of Rosenbrock, which is

   $$400X_{2i-1}(X_{2i-1}^2 - X_{2i} + 2(X_{2i-1} - 1)$$

   for odd term,

   $$200(-X_{2i-1}^2 + X_{2i})$$

   for even term.

   (b) The line_search function calculate the step, if step=1 do not meet the Armijo condition, step=step/2, until step meet the Armijo condition.

   (c) The get_f function just gets the value of the Rosenbrock function.

   (d) The armjo function first check if the iteration time is bigger than the threshold, then it calls function line_search to get the step, then it uses step and gradient to update the x. The original x is set to a zero vector.

2. Result
   Result is shown as below. After 12524 times of iteration, the result is pretty close to [1,1,1,1]

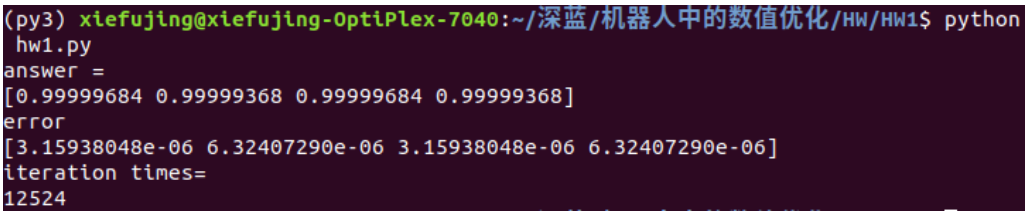

Figure 1:

3. Analysis
   This is a optimization problem that can be solved by gradient descent, as requested by the instruction, using Armijo condition to chose step for each iteration. By giving a termination condition for example iteration times, the algorithm should return optimized x.
   And the Rosenbrock function needs lots of iteration since when the function value is small, x_{2i-1}^2 is close to x_{2i}, the gradient is very close to 0, therefore hard to minimize.

4. Visualizaiton
   The optimization process can be visualization as the image below, the y starts at 1, since the initial value of x is [0,0], then after optimization, y is very close to 0.

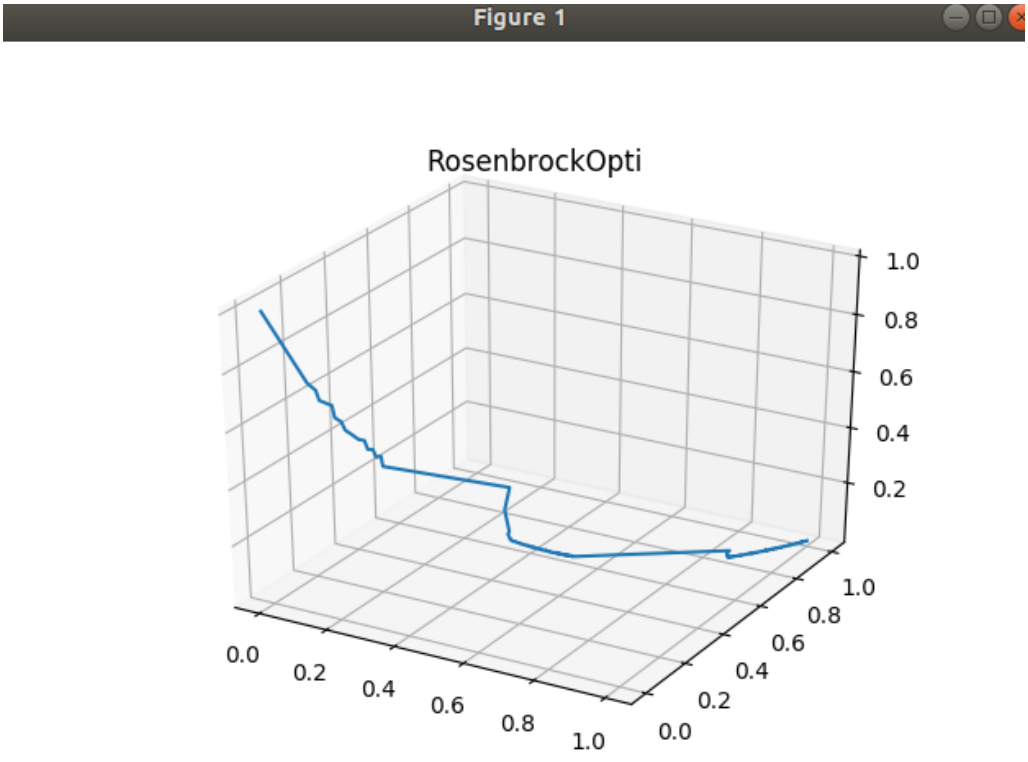
Figure 1
RosenbrockOpti
1.0
0.8
0.6
0.4
0.2
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0

Figure 2: