

## Report

1. 程序已实现任意维度的 Rosenbrock 函数最小值的求解
2. 程序主要包含两个部分：
  - 2.1 Rosenbrock 函数的构建，定义一个 Rosenbrock 类，包括三个 function，分别用来计算函数在  $x$  点的值，梯度，以及梯度的模长。

```
using VectorDouble = std::vector<double>;

class RosenbrockCost
{
public:
    RosenbrockCost() = default;
    ~RosenbrockCost() = default;
    double ComputeValue(const VectorDouble &x);
    VectorDouble ComputeGradient(const VectorDouble &x);
    double ComputeGradientNorm(const VectorDouble &x);
};
```

- 2.2 定义一个带 Amijo Condition 的非精确线搜索的随机梯度下降法求解器类 GradientDescentSolver，主要包含三个 function, Solve 函数为主函数，用来求解，LineSearch 用来计算步长，GetNextXWithStepAndDirection 函数根据步长和方向计算新的  $x$ 。

```
class GradientDescentSolver
{
public:
    GradientDescentSolver(const VectorDouble& init_guess);
    GradientDescentSolver(const VectorDouble& init_guess, const int& maxIters, const double& c);
    ~GradientDescentSolver() = default;
    VectorDouble Solve();
    double LineSearch(const VectorDouble &x);
    VectorDouble GetNextXWithStepAndDirection(const VectorDouble &x,
                                              const VectorDouble &direction, const double alpha);
private:
    RosenbrockCost cost_;
    VectorDouble init_guess_;
    Logger logger_;
    int max_iters_ = 1000;
    double c_ = 1e-4;
    double discount_ = 0.5;
    double alpha_ = 1.0;
};
```

3. 运行结果，以三维问题为例，经过 11451 次迭代，结果收敛于[0.999996, 0.99992, 0.999985]，精度为  $10^{-5}$

```
[In 11428th Iteration] : x = [0.999996,0.999992,0.999984], delta = 1.00141e-05
[In 11429th Iteration] : x = [0.999996,0.999992,0.999984], delta = 2.53368e-05
[In 11430th Iteration] : x = [0.999996,0.999992,0.999984], delta = 1.22123e-05
[In 11431th Iteration] : x = [0.999996,0.999992,0.999984], delta = 1.74909e-05
[In 11432th Iteration] : x = [0.999996,0.999992,0.999984], delta = 1.01596e-05
[In 11433th Iteration] : x = [0.999996,0.999992,0.999985], delta = 2.66627e-05
[In 11434th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.25726e-05
[In 11435th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.8275e-05
[In 11436th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.03238e-05
[In 11437th Iteration] : x = [0.999996,0.999992,0.999985], delta = 2.80769e-05
[In 11438th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.29675e-05
[In 11439th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.91181e-05
[In 11440th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.05081e-05
[In 11441th Iteration] : x = [0.999996,0.999992,0.999985], delta = 2.95841e-05
[In 11442th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.33992e-05
[In 11443th Iteration] : x = [0.999996,0.999992,0.999985], delta = 2.00235e-05
[In 11444th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.07143e-05
[In 11445th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.43448e-05
[In 11446th Iteration] : x = [0.999996,0.999992,0.999985], delta = 2.19281e-05
[In 11447th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.1198e-05
[In 11448th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.54416e-05
[In 11449th Iteration] : x = [0.999996,0.999992,0.999985], delta = 2.40868e-05
[In 11450th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.17747e-05
[In 11451th Iteration] : x = [0.999996,0.999992,0.999985], delta = 1.67065e-05
result: 0.999996 0.999992 0.999985
```