SparseMatrixSolutor v1.2 Test Report

Anqi Lv*
PHYS 2200011316

2025.10.6

I Sparse Matrix

i Construction and Print

Try Matrix Construction:
SparseMatrix A(3, 3);
A.setValue(0, 0, 1.0);
A.setValue(0, 2, 2.0);
A.setValue(1, 1, 3.0);
A.setValue(2, 2, 5.0);
A.setValue(2, 0, 4.0);
Print A both in Dense and Sparse form. Output is correct.

```
Matrix A(Concentrate):
1       0       2
0       3       0
4       0       5

Matrix A(Sparse):
row: 3, col: 3, elements: 5
values: 1 2 3 4 5
col_indices: 0 2 1 0 2
row_ptr: 0 2 3 5
```

Figure 1: Print

ii Transpose

Try transposing the Matrix A(defined above):

*email:2200011316@stu.pku.edu.cn tel:18315391730

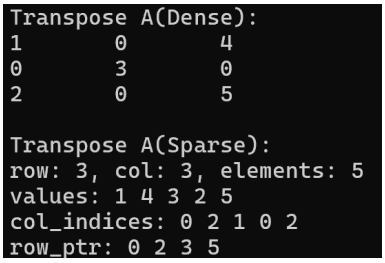

Figure 2: Transpose

Output is correct.

iii Cut

Try cutting Matrix into diagonal part, upper triangle part and lower triangle part.

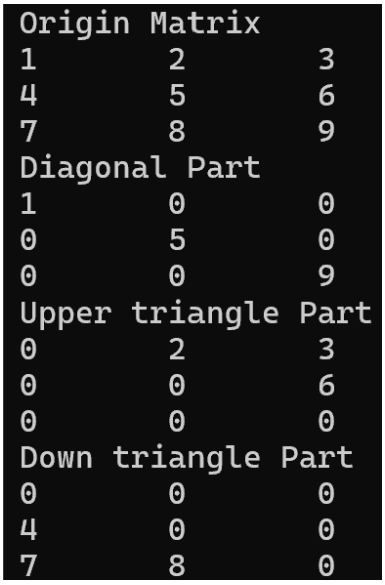

Figure 3: Cut

Operation is correct.

iv Add and Multyply

Try defining Matrix B, and testing + operator and * operator.

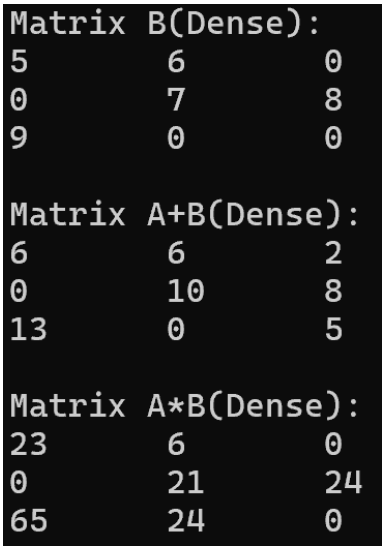

Figure 4: Add and Multiply

Operation is correct.

II Matrix Solver

I have write two method for solving matrix:

Gauss-Sider Iteration is suitable for most cases,especially when the diagonal element is dominant.

Conjuction Gradient is based on Krylov subspace. It can only be used when the matrix is positive defined and symmetric.

i Correction Test

I test a 6*6 Matrix when the RHS is 12.0, 20.0, 30.0, 60.0, 20.0, 30.0, for each equation respectively:

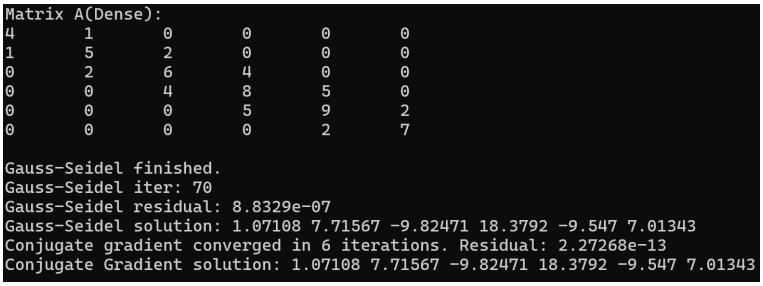

Figure 5: Correction Test

And the result is correct for each method.

Noticing that Conjuction Gradient's Iteration is obviously less than Gauss-Sider,and it's residual is much less than the other one. Conjuction Gradient is recommanded for positive symmetric case.

ii Time Test

I test a 100000*100000 Matrix when the RHS is periodic. There are three elements in each row:

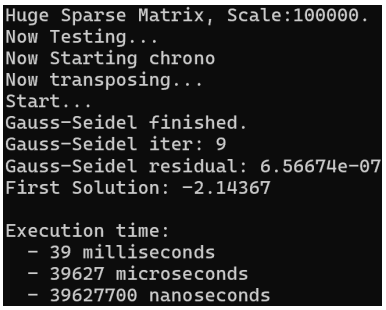

Figure 6: Time Test

Only takes 39ms for both transposing and Gauss-Sider Iteration.

III PDE Solver

i Dirichlet BC in Rectangle area

I solve Poisson equation as:

$$\nabla^2 u = 0$$

with Boundary Condition:

$$u(x, y) = x^2 - y^2 (x = 0||x = 1||y = 0||y = 1)$$

I make grid with interval x,y is both 0.01,meaning that there are 100*100 nodes.

The problem is solved rapidly:

```
Gauss-Seidel finished.
Gauss-Seidel iter: 2884
Gauss-Seidel residual: 9.9891e-05
Successfully wrote 10000 doubles to vector_data.bin
Press ENTER to finish
```

Figure 7: Solve Poisson EQ

ii Visualize

In this part I choose Python language to Plot the result. Mention that the solution of the equation is obvious $u(x, y) = x^2 - y^2$, the computing result is obviously right.

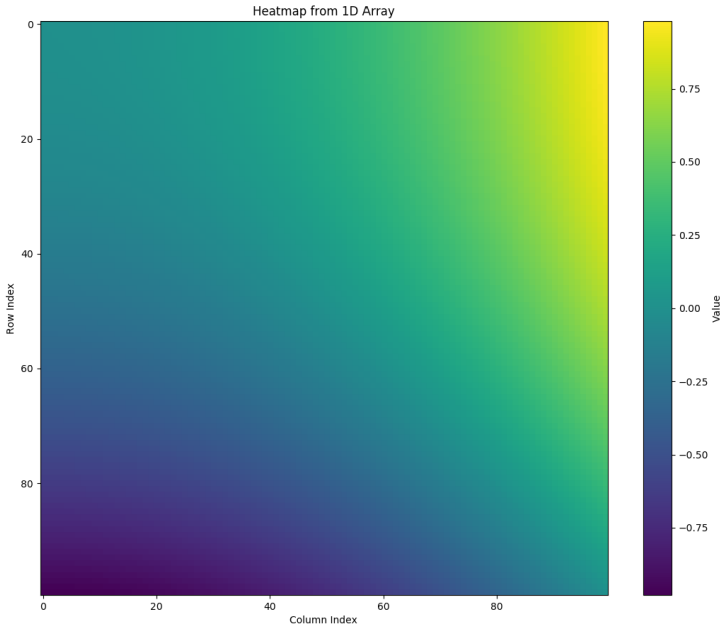

Figure 8: Visualize the Solution