1. Heat Diffusion Process

By using iterative methods to solve the linear system from Crank-Nicolson, the runtime performance has become much better. So I am able to increase the problem size to give a better looking heat diffusion plot. The following figures are drawn using Matlab.

Method used: Crank-Nicolson, Jacobi (no source term, cubic domain, same partitioning, and zero boundary condition)

Problem size: 100

Precision: output every 1000 time steps.

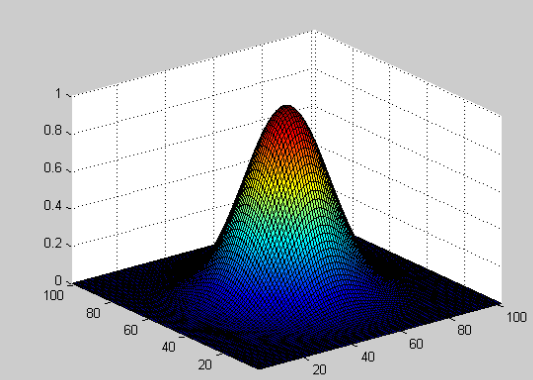

Figure 1

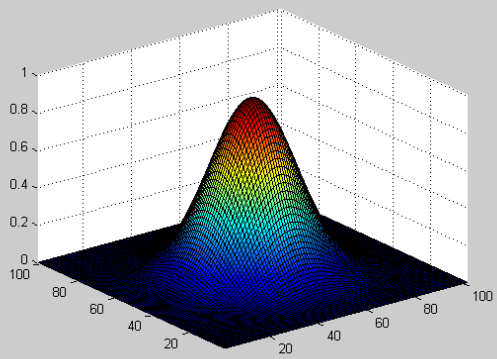

Figure 2

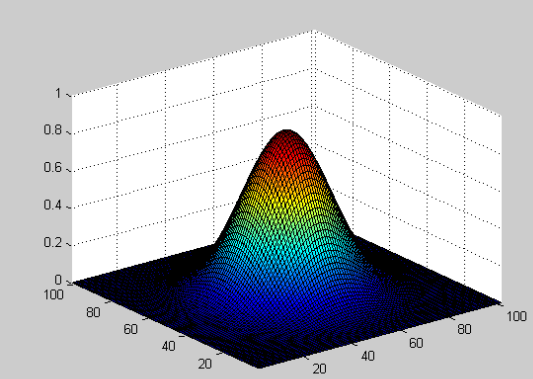

Figure 3

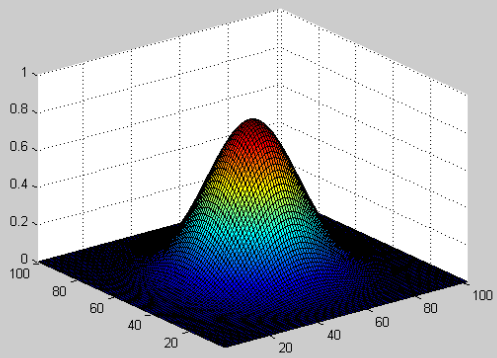

Figure 4

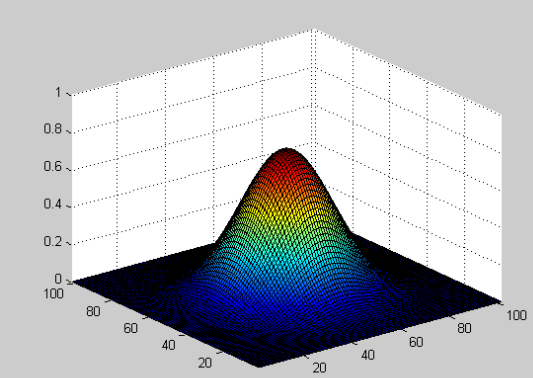

Figure 5

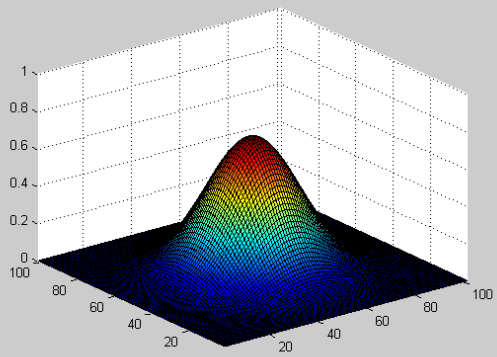

Figure 6

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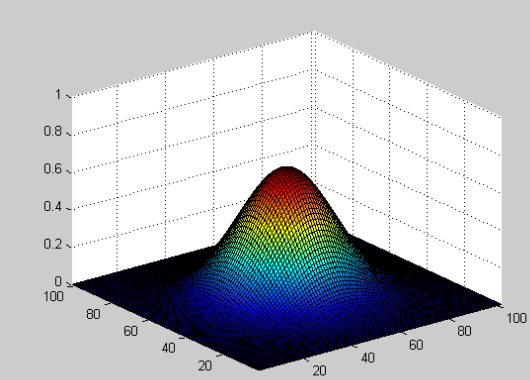

Figure 7

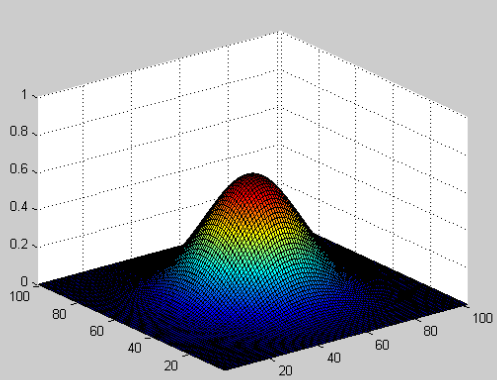

Figure 8

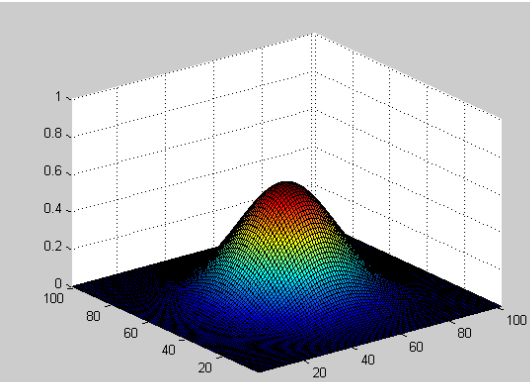

Figure 9

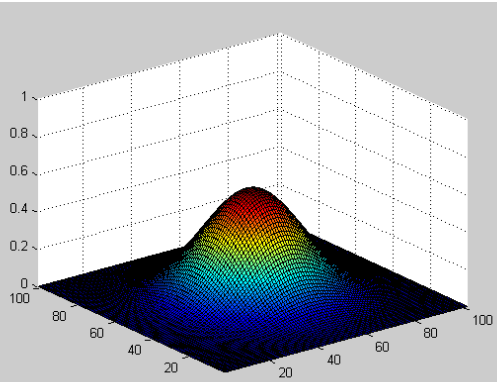

Figure 10

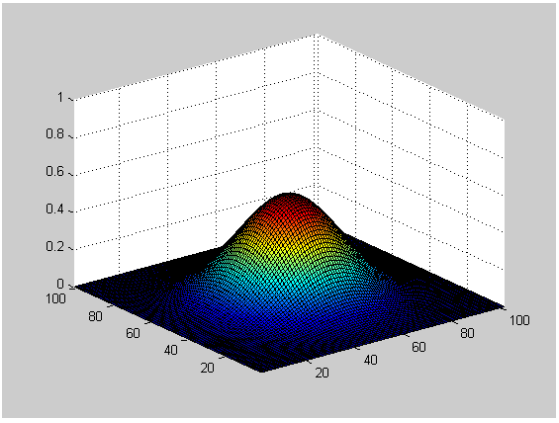

Figure 11

2. Runtime performance analysis

As I was saying, iterative methods are so much faster than Gaussian elimination when the problem grows large enough.

When I ran the program, since I printed out the amount of iterations are used each time step, I found that the amount of iterations SOR uses is about 1⁄4 of that of Gauss-Seidel, and the amount of iterations Gauss-Seidel uses is about half of that of Jacobi. So is the runtime performance.

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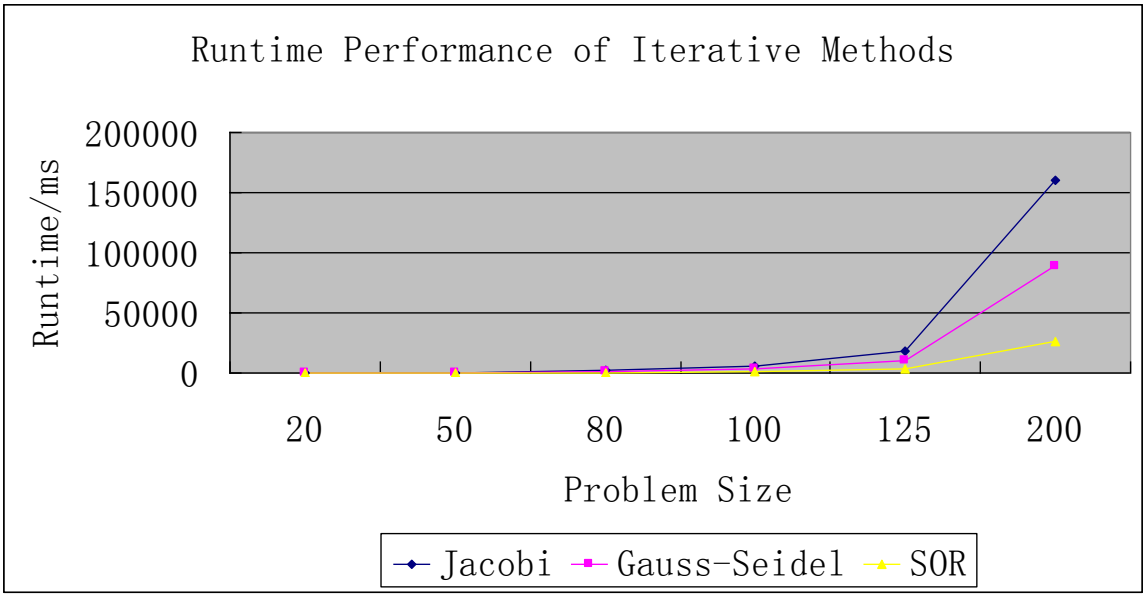
I integrate three plots into one to compare the runtime performance. Different color means different method used.



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