

Homework 3: Conjugate Gradient

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3.1

This part of the report is written in a separate pdf file named "hw3.pdf" found within the same directory as this file.

3.2

The following is a table showing time in seconds, num iter represents the number of iterations it took for the norm of the residual to reach 10^{-8} and N is the size of the problem.

| N | time | num iter |
|-----|------------|----------|
| 4 | 0.012270 | 79 |
| 8 | 0.076803 | 215 |
| 16 | 0.737514 | 578 |
| 32 | 7.197663 | 1433 |
| 64 | 248.338108 | 2622 |
| 128 | 297.793319 | 1526 |

Below is a plot for the highest resolution resulting function $u(x)$ for $N = 128$. This plot matches what I would expect for the solution of this problem as the analytical solution to this problem is $u(x_1, x_2) = \sin(\pi x_1) \sin(\pi x_2)$, as shown in "hw3.pdf". There is discrepancy as the analytical solution should have its maximum value at 1 in the middle of the plot, this discrepancy is likely due to the limited convergence set by us.

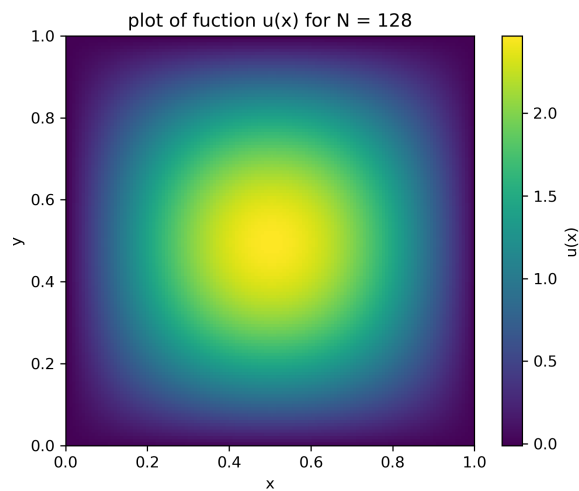


Figure 1:

3.3

In figure 2 chose to plot a semilogx plot. I plotted the error bound given in the question in dotted line and the actual error I computed, assuming the true solution to the problem is the final step in the iteration. In my plot you can see that my error is not exactly bound by the error bound in later iterations. The curves do however look like a bit like a scaled version of the bounding functions, following a vaguely similar scaled trajectory. What is good is that the error decreases as the number of iterations increases.

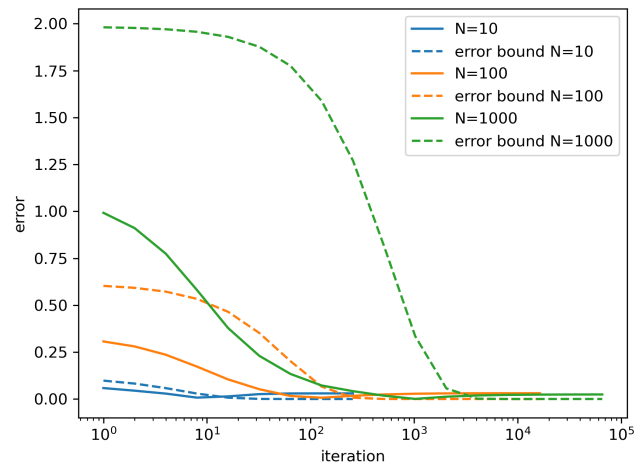


Figure 2: