Case Studies HW4 — Subgrid Methods

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Question 4.1

This is almost a copy of my submittion for homework 3 with some minor changes and is found in "q1.pdf" in the "writeup" directory.

Question 4.2

The code for the implemention of my Vcycle() function sits in the file "v_cycle.c" in the top most directory.

My implementaion of this function involves a few extra parameters. "l" for keeping track of how deep the recursion is, "eps" as a convergens criterion and returns an int for allowing keeping track of wether the function executed with errors or not. I chose to construct the marices "A" part of the problem statement with a "make_matrix()" function on each level in hopes of not having the user to keep track of aspects like constructing approprate "A"s for the given problem. In a more general verison of this function I would have the "make_matrix()" function as another parameter of "Vcycle()". Apart from that, keeping track of possible errors is done at the very top of the function and in the main if statement of the pseudo code algorithm which I have starting in line 375. I keep track of whether the problem size reaches "nl_next == 2" which essentially makes sure we dont try to be solving a 1×1 matrix and premtively starts solving the coarsest system for the user.

The restriction and prolongation functions are inspried from lecture notes, and aim to pick out relevant values for the simplicity and follow a linear interpolation respectively as these were the easiest not to mess up. I chose not to implement these as matrices as this would increase the overhead of the functions creating matrix objects and performing matrix muttiplications as oppose to some for loops with appropriate indexing.

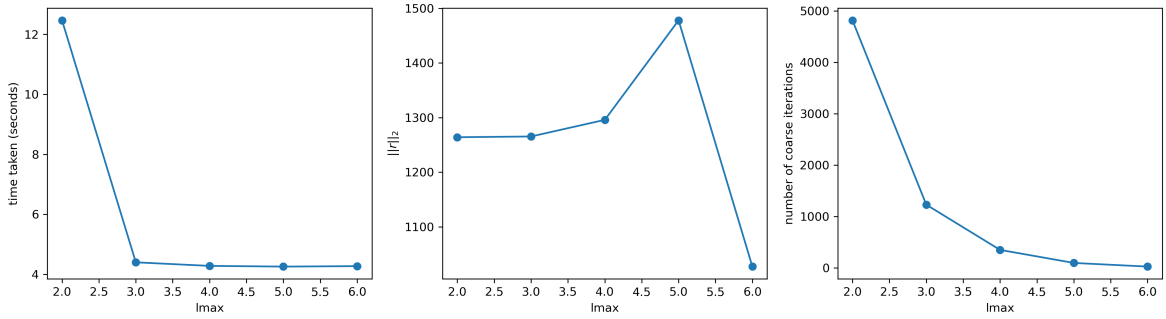
Question 4.3

The code to produce all of the below sits in a bash file "runme.sh" in the top directory. This file makes ".out" files which hold the outputs of the relevant files for plotting later on.

Part 1

Code run from the file "q3_part1.c"

Bits to note in the plots below. The number of iterations in the right most plot and the time it takes appear directly related and makes sense since the these iterations take most of the copmute time. Having a look at the norm of the residual in the middle plot from which we can note that the value of the residual stays roughly in the same range of values. This tells us that is we change $lmax$, our residual stays roughy the same untill interpolation and extrapolation errors take over.



Part 2

Code run from the file "q3_part2.c"

The plots below are only showing $N = 16, 32, 64, 128$. For the value of $N = 256$ I didnt have a machine to use with a sufficent amount of RAM. In the middle plot below you can see that comparing both $lmax$ values the norm of the residual doesnt change significanlty and grows linearly. Keeping this in mind and analysing the left and right most plots we can see that $lmax = 8$ outpreforms $lmax = 2$ in runtime and and $lmax = 8$ requires a significanly smaller number of iterations to be soled at the lowest level.