

# HPSC - FINAL ASSIGNMENT

---

NGUYEN T. Hoang - SID: 15M54097

Spring 2016, W831 Mon-Thu. Period 1-2

Due date: 2016/06/06

## Problem

Solve the Laplace equation using multigrid.

$$\frac{\partial^2 p}{\partial x^2} + \frac{\partial^2 p}{\partial y^2} = 0,$$

in a  $x = [0, 2]$ ,  $y = [0, 1]$  domains with boundary conditions:

$$p = 0 \text{ at } x = 0,$$

$$p = y \text{ at } x = 2,$$

$$\partial p / \partial y = 0 \text{ at } y = 0, 1.$$

Modify the code in `demo.py` so that it runs with the sparse matrix from `step1.py`.

*The source code and jupyter notebook for this assignment can be found at:*

<https://github.com/gear/HPSC/tree/master/hw> File name: `assign2.worksheet.ipynb`

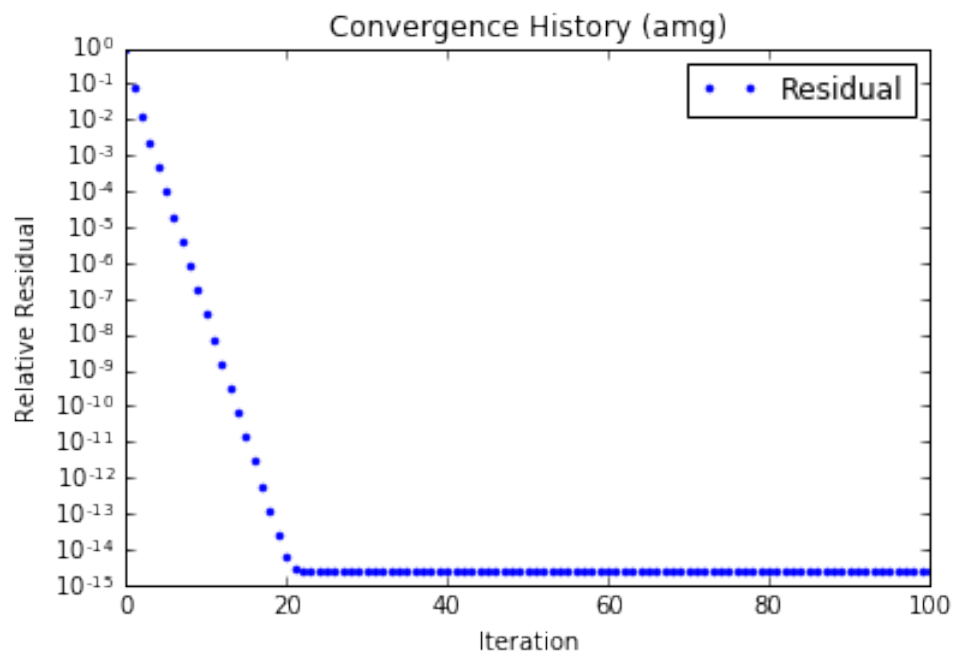
# Answer

Using the given code in `step1.py`, I have the matrix  $A$ , vector  $b$ . This procedure is rewritten in `assign2_worksheet.ipynb` as `laplace_eq`.

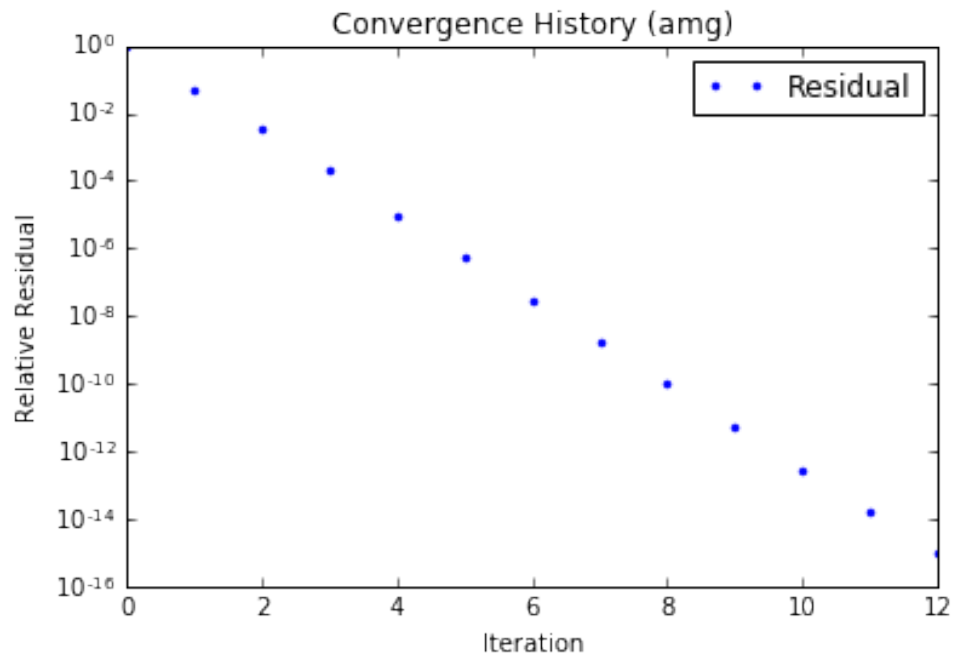
Listing 1: Solving Laplace equation using pyamg

```
1      # Extracted from assign2\_worksheet.ipynb
2      def amg_solver(A, b, cg=False, name='amg', tol=1e-10):
3          mls = rootnode_solver(A)
4          print mls
5          # Solve  $Ax = b$ 
6          residuals = []
7          if cg:
8              x = mls.solve(b, tol=tol, accel='cg', residuals=
                  residuals)
9          else :
10             x = mls.solve(b, tol=tol, accel=None, residuals=
                  residuals)
11             # Compute relative residuals
12             residuals = numpy.array(residuals)/residuals[0]
13             # Plot convergence history
14             import pylab
15             pylab.figure()
16             pylab.title('Convergence_History_(%s)' % name)
17             pylab.xlabel('Iteration')
18             pylab.ylabel('Relative_Residual')
19             pylab.semilogy(residuals, label='Residual', linestyle='
                  None', marker='.')
20             pylab.legend()
21             pylab.show()
```

The result plots:



(a) Convergence of AMG without CG method.



(b) Convergence of AMG with CG method.

Figure 1: Convergence of AMG.