PHY 480 - Computational Physics
Project 1: Linear Algebra Methods

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Github Repository at https://github.com/ThomasBolden/PHY-480-Spring-2016

Abstract

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Contents

Introduction

An important part of physics is being able to efficiently solve systems of linear equations. . .

Methods

Given a differential equation of the form

$$-\frac{\mathrm{d}^2}{\mathrm{d}x^2}u(x) = f(x) \tag{1}$$

where $f(x)$ is continuous on the domain $x \in (0,1)$. We also assume the boundary conditions $u(0) = u(1) = 0$. The second derivative can be approximated as

$$u'' = \frac{u_{i+1} + u_{i-1} - 2u_i}{u^2} \tag{2}$$

$$\mathbf{A} = \begin{pmatrix} 2 & -1 & 0 & \cdots & \cdots & \cdots & 0 \\ -1 & 2 & -1 & 0 & \cdots & \cdots & 0 \\ 0 & -1 & 2 & -1 & \ddots & & 0 \\ \vdots & 0 & -1 & 2 & \ddots & \ddots & \vdots \\ \vdots & \vdots & \ddots & \ddots & \ddots & \ddots & 0 \\ \vdots & \vdots & & \ddots & \ddots & \ddots & -1 \\ 0 & 0 & \cdots & \cdots & 0 & -1 & 2 \end{pmatrix}, \quad \mathbf{v} = \begin{pmatrix} v_0 \\ v_1 \\ \vdots \\ v_{n-1} \\ v_n \end{pmatrix}$$

Results

.

Conclusions

.

Code

../Code/Project1.cpp

```cpp
// Project 1 — Vector and Matrix Operations

#include <iostream>
#include <fstream>
#include <cmath>
#include <iomanip>
#include <string>
//#include "armadillo"
```

```
 9
10 using namespace std;
11 //using namespace arma;
12 ofstream myfile;
13
14
15 int main(){
16
17     // -~- Declaration of Variables -~- \\
18     double n;
19     string outfilename;
20
21     cout << "Enter a number: "; // user enters a number
22     cin >> n;
23     cout << "Enter a name for the output file: ";
24     // user enters a name for the output file
25     cin >> outfilename;
26
27     // body of the program
28
29
30
31     // writing value to file, to be read and graphed in python later
32     myfile.open(outfilename);
33     //myfile << setiosflags(ios::showpoint | ios::uppercase);
34     // setting scientific notation of numbers
35     myfile << n << endl;
36
37     myfile.close();
38
39     return 0;
40
41 }
```

References

[1] M. Hjorth-Jensen, *Computational Physics*, University of Oslo (2013).

[2] W. McLean, *Poisson Solvers*, Northwestern University (2004).