Contents

Homework 4 #1 Introduction

```
% Geneva Porter, 2019.11.07
% Homework 4, Problem 1, Math 693A
% Professor Uduak George, SDSU

% This assignment applies the standard conjugate gradient method to solve
% the linear systems describing the Helical Coordinate Preconditioner for
% the Laplacian in one, two, and three dimensions. The variable "n" on line
% 20 can be changed to represent the size of the n x n matrix A. The
% function I created for using the CG method is cg_standard.m.



clear
clc
```

Establishing Parameters

```
n = 3;
```

One-dimensional solution

```
d1 = ones(n,1);
x1 = zeros(size(d1));
b1 = ones(size(d1));
A1 = spdiags([d1, -2*d1, d1], [-1 0 1], n, n);
r_norm_1 = cg_standard(A1,b1,x1,"yes");
```

Two-dimensional solution

```
d2 = ones(n^2, 1);
x2 = zeros(size(d2));
b2 = ones(size(d2));
A2 = spdiags([d2 d2 -4*d2 d2 d2], [-n -1 0 1 n], n^2, n^2);
r_norm_2 = cg_standard(A2,b2,x2,"yes");
```

Three-dimensional solution

```
d3 = ones(n^3, 1);
x3 = zeros(size(d3));
b3 = ones(size(d3));
A3 = spdiags([d3 d3 d3 -6*d3 d3 d3 d3], [-n^2 -n -1 0 1 n n^2], n^3, n^3);
r_norm_3 = cg_standard(A3,b3,x3,"yes");
```

Solving Ax=b for 3 x 3 matrix A, which has 9 elements and 7 nonzero elements. There were 3 iterations needed to reach zero residual. A total time of 0.040467 seconds elapsed. The 1D solution vector for x is:
    -1.5000
    -2.0000
    -1.5000

Solving Ax=b for 9 x 9 matrix A, which has 81 elements and 37 nonzero elements. There were 6 iterations needed to reach zero residual. A total time of 0.0060562 seconds elapsed. The 1D solution vector for x is:
    -0.9548
    -1.2410
    -1.3494
    -1.5783
    -1.6596
    -1.5783
    -1.3494
    -1.2410
    -0.9548

Solving Ax=b for 27 x 27 matrix A, which has 729 elements and 163 nonzero elements. There were 12 iterations needed to reach zero residual. A total time of 0.0058651 seconds elapsed. The 1D solution vector for x is:
    -0.7517
    -0.9074
    -0.9696
    -1.1316
    -1.1974
    -1.2295
    -1.2821
    -1.3116
    -1.3387
    -1.4710
    -1.5258
    -1.5491
    -1.5891
    -1.6041
    -1.5891
    -1.5491
    -1.5258
    -1.4710
    -1.3387
    -1.3116
    -1.2821
    -1.2295
    -1.1974
    -1.1316
    -0.9696
    -0.9074
```

```
-0.7517
```