

Lab 07: Debugging & Good Coding Practices

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1 CODE

1.1 SCRIPT FILE

```
1 % Math 3341, Fall 2021
2 % Lab 07: Debugging & Good Coding Practices
3 % Author: Melissa Butler
4 % Date: 10/04/2021
5
6 clc; clear; close all;
7
8 % Change default text interpreter to LaTeX
9 set(groot, 'defaultTextInterpreter','latex');
10 set(groot, 'defaultAxesTickLabelInterpreter','latex');
11 set(groot, 'defaultLegendInterpreter','latex')
12
13 A = [4 3 0; 3 4 -1; 0 -1 4];
14 b = [24; 30; -24];
15 tol = 1e-8;
16 maxIter = 100;
17 x0 = [0; 0; 0];
18 w = 1.25;
19
20 [X, iter, res] = lab_07_function(A, b, x0, w, tol, maxIter);
21
22 X_size = size(X);
23
24 % Formatting the output
25 file_handle = fopen('sor_gauss_seidel.tex', 'w');
26 fprintf(file_handle, '\\begin{table}[!hbt]\n');
27 fprintf(file_handle, '\\caption{Solving the linear system using SOR}\n');
28 fprintf(file_handle, '\\centering\n');
29 fprintf(file_handle, '\\begin{tabular}{lrrrr}\n');
30 fprintf(file_handle, '\\toprule\n');
31 fprintf(file_handle, '%6s & %15s & %15s & %15s & %15s \\\n', 'iter', '$x$', '$y$', '$z$', '
    residual');
32 fprintf(file_handle, '\\midrule\n');
33 for i = 1:X_size(1)
34     fprintf(file_handle, '%4d$ & %13.10f$ & %13.10f$ & %13.10f$ & %13.7e$ \\\n', i - 1, X(i,
        1), X(i, 2), X(i, 3), res(i));
35 end
36 fprintf(file_handle, '\\bottomrule\n');
```

```
37 fprintf(file_handle, '\\end{tabular}\\n');
38 fprintf(file_handle, '\\end{table}\\n');
39 type('sor_gauss_seidel.tex');
40
41 fprintf('\\nSolution of System: \\n')
42 fprintf('x1 = %13.10f \\n', X(end, 1))
43 fprintf('x2 = %13.10f \\n', X(end, 2))
44 fprintf('x3 = %13.10f \\n', X(end, 3))
45 fprintf('Found in %d iterations\\n', iter)
46
47 % Plot the solution
48 figure(1);
49 hold on;
50 styles = {'o-', '*:', 'v-.'};
51 iters = [1:X_size(1)] - 1;
52 for i = 1:3
53     plot(iters, X(:, i), styles{i});
54 end
55 legend({'$x$', '$y$', '$z$', 'Location', 'best'});
56 grid minor;
57 xlabel('iteration');
58 ylabel('solution');
59 title('solution vs. iteration');
60
61 figure(2);
62 semilogy(iters, res);
63 grid minor;
64 xlabel('iteration');
65 ylabel('residual');
66 title('residual vs. iteration');
67
68 % Save Plots
69 prefix = 'lab_07_plot_';
70 for i = 1:2
71     name = strcat(prefix, num2str(i)); % Set filename for figure i
72     fig = figure(i); % Set figure i as current figure window
73     set(fig, 'PaperPositionMode', 'auto'); % Set paper position mode to 'auto'
74     pos = get(fig, 'PaperPosition'); % Get figure window paper position
75     set(fig, 'PaperSize', [pos(3) pos(4)]); % Set figure paper size
76     print(fig, '-dpdf', name); % Save figure
77 end
```

1.2 FUNCTION FILE

```
1 function [X, iter, res] = lab_07_function(A, b, x0, w, tol, maxIter)
2
3 [row, col] = size(A);
4 n = length(b);
5 x = x0;
6
7 % Check the size of inputs
8 if (row ~= n) || (col ~= n)
9     disp('Error');
10    return;
11 end
12
13 iter = 0;
14 X(1, :) = x;
15 r = A * x - b;
16 res(1) = norm(r);
17
18 % Successive over-relaxation method
19 while res(iter + 1) >= tol && iter <= maxIter
20     iter = iter + 1;
21     for i = 1:n
22         s = 0;
23         for j = 1:n
24             if j < i
25                 s = s + A(i,j) * x(j);
26             elseif j > i
27                 s = s + A(i,j) * x0(j);
28             end
29         end
30         x(i) = (1 - w) * x0(i) + w / A(i,i) * (b(i) - s);
31     end
32     % Check the norm of the residual
33     res(iter + 1) = norm(A * x - b);
34     X(iter + 1, :) = x;
35     x0 = x;
36 end
37
38 end
```

2 RESULTS

```
\subsection{Output}
```

```
\lstinputlisting[style=Plain]{../src/lab_07_output.txt}
```

```
\subsection{Formatted output}
```

```
\input{../src/sor_gauss_seidel.tex}
```

```
\newpage
```

```
\subsection{Plots}
```

```
\begin{figure}[!htbp]
```

```
    \centering
```

```
    \includegraphics[width=0.80\textwidth]{../src/lab_07_plot_1.pdf}
```

```
    \includegraphics[width=0.80\textwidth]{../src/lab_07_plot_2.pdf}
```

```
    \caption{Solution and residual}
```

```
    \label{fig:sol}
```

```
\end{figure}
```