

ME5470: Introduction to Parallel Scientific Computing

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Homework 1

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Question 1:

Code file name: code.c

(a) Sizes of Generated Files:

The code was run with $n = 4000$, and the following sizes were observed for the generated files:

Format	File Name	Size (MB)
ASCII (format 0)	array_004000_asc.out	320 MB
Binary (format 1)	array_004000_bin.out	123 MB

```
Files have been written successfully.
co22btech11003@edison18:~/iithme5470-classroom-hw1-ME5470_HW1$du -sh array_004000_asc.out
320M   array_004000_asc.out
co22btech11003@edison18:~/iithme5470-classroom-hw1-ME5470_HW1$du -sh array_004000_bin.out
123M   array_004000_bin.out
```

(b) Array Size in Memory:

The array size in memory can be calculated as follows:

$$\begin{aligned}\text{Estimated size of array} &= \text{size of one double} \times \text{no. of doubles} \\ &= 8 \text{ bytes} \times 4000 \times 4000 \text{ (here } n \text{ is } 4000) \\ &= 122.0703125 \text{ MB}\end{aligned}$$

Comments:

1. Size in Memory vs. Disk:

- The ASCII file (320 MB) is significantly larger than the binary file (123 MB) due to the overhead of storing numbers as text with high precision.
- The binary file size (123 MB) is very close to the array size in memory (122.07 MB), as it directly stores the raw binary representation of doubles.

2. Best Format for Large Data:

- **Binary format** is better suited for saving large datasets as it is more compact and faster to read/write than ASCII.

Question 2:

Code file name: code2.c

Overview of Functions:

The following functions were used to ensure modularity and code reuse:

1. **read_matrix:** Reads an $n \times n$ matrix from a file.

2. **read_vector**: Reads a vector of size n from a file.
3. **append_eigenvalue**: Appends the eigenvalue to the vector file if the vector is an eigenvector.
4. **is_eigenvector**: Checks whether a vector is an eigenvector of a matrix and calculates the corresponding eigenvalue if true.

These functions are reused across different program parts, minimizing redundant code and improving readability.

Results:

The code verifies whether each vector is an eigenvector of the matrix. For valid eigenvectors, the eigenvalue is:

1. Printed to the screen.
2. Appended to the corresponding vector file.

Workflow of the Code:

1. The matrix size (n) is read from the file input.in.
2. The matrix is read from mat_{nnnnnn}.in.
3. Each vector file vec_{nnnnnn}_{vecnum}.in is read iteratively:
 - If the vector is an eigenvector, its eigenvalue is calculated, printed, and appended to the file.
 - If not, a message indicating it is not an eigenvector is printed.

Testing Results:

The code was tested with the following inputs:

```
co22btech11003@edison18:~/iithme5470-classroom-hw1-ME5470_HW1$ ./a.out
inputfiles/vec_000003_000001.in : Yes : -6.0000000000000000
inputfiles/vec_000003_000002.in : Yes : -6.0000000000000000
inputfiles/vec_000003_000003.in : Yes : -1.0000000000000000
inputfiles/vec_000003_000004.in : Not an eigenvector
co22btech11003@edison18:~/iithme5470-classroom-hw1-ME5470_HW1$ ./a.out
inputfiles/vec_000005_000001.in : Yes : 0.268098080462330
inputfiles/vec_000005_000002.in : Not an eigenvector
inputfiles/vec_000005_000003.in : Yes : 0.986875024534868
inputfiles/vec_000005_000004.in : Yes : 1.399038515259468
co22btech11003@edison18:~/iithme5470-classroom-hw1-ME5470_HW1$ ./a.out
inputfiles/vec_000050_000001.in : Not an eigenvector
inputfiles/vec_000050_000002.in : Yes : 0.479628234701048
inputfiles/vec_000050_000003.in : Yes : 1.337887289556923
inputfiles/vec_000050_000004.in : Not an eigenvector
co22btech11003@edison18:~/iithme5470-classroom-hw1-ME5470_HW1$ ./a.out
inputfiles/vec_000080_000001.in : Yes : 0.333017754867211
inputfiles/vec_000080_000002.in : Yes : 0.493141980754358
inputfiles/vec_000080_000003.in : Yes : 0.939274515847899
inputfiles/vec_000080_000004.in : Not an eigenvector
co22btech11003@edison18:~/iithme5470-classroom-hw1-ME5470_HW1$
```

Comments:

- Eigenvalues for valid eigenvectors were appended to their respective files.
- The results were printed to the screen as specified.

Input.in: It is an input file for both question 1 and question 2. So, edit the input file according to the question.

Ensure that the input.in is in the same directory as the code files and input files of the vector and matrix files for question 2 are inside the folder named inputfiles.