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## Problem Statement

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**Objectives**

- Introducing threads concepts and POSIX threads library.

- Implementing popular algorithms as multi-threaded ones.

It is required to implement two popular algorithms as multi-threaded ones

- Matrix Multiplication - It is required to implement two variations of this algorithm:.

- Merge Sort - An O (n log n) comparison-based sorting algorithm. It is a divide and conquer algorithm.

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## Features
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**Some of the features present**

- Command-line arguments.

- I/O from text files.

- Descriptive error and warning messages.

- Bash files for easy execution.

- Time elapsed display after the termination of each algorithm.

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## Overall Description
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**How pthread is used**

We can crate a thread **t** that executes a method **m** given list of arguments **a** using the call

```
pthread_create(&t, &attr, m, (void*) a)
```

and to finish the execution of a thread use

```
pthread_exit(&s)
```

and **s** is the returned value. If we want to wait till the execution of **t** finishes we use

```
pthread_join(t, &s)
```

## Multipliction

The algorithm for the first method

```
for (int y = 0; y < h; ++y)
    for (int x = 0; x < w; ++x)
        create a thread for calculating cell x,y
for (int y = 0; y < h; ++y)
    for (int x = 0; x < w; ++x)
        join thread x,y
```

The algorithm for the second method

```
for (int y = 0; y < h; ++y)
    create a thread for calculating row y
for (int y = 0; y < h; ++y)
    join thread y
```

## Sort

The algorithm for the merge sort

```
SORT(A)
    if A.size() < 2
        exit current thread
    pthread_t thread[2];
    a0 = A[0, A.size() / 2]
    create a thread for sorting a0
    a1 = A[A.size() / 2, A.size()]
    create a thread for sorting a1
    join both threads
    merge a0,a1 to A
    size_t i = 0, j = 0;
    exit current thread
```

# Sample Runs

Help

```
mghareeb@Aspire5738Z:~/eclipse-workspaces/eclipse-workspace/threads/lab2$ ./thre
ads_help
"-help"
wrong input
usage: ./threads <options> <input_file> <output_file>
        <options>:
                -mulCell        : a thread for each cell
                -mulRow         : a thread for each row
                -sort           : merge sort
mghareeb@Aspire5738Z:~/eclipse-workspaces/eclipse-workspace/threads/lab2$
```

Multiplication

```
mghareeb@Aspire5738Z:~/eclipse-workspaces/eclipse-workspace/threads/lab2$ ./thre
ads_mul
"-mulCell"
reading...
multiplying...
writing...
0.000 ms
"-mulRow"
reading...
multiplying...
writing...
0.000 ms
```

Sorting

```
0.000 ms
mghareeb@Aspire5738Z:~/eclipse-workspaces/eclipse-workspace/threads/lab2$ ./thre
ads_sort
"-sort"
reading...
sorting...
writing...
0.000 ms
```