

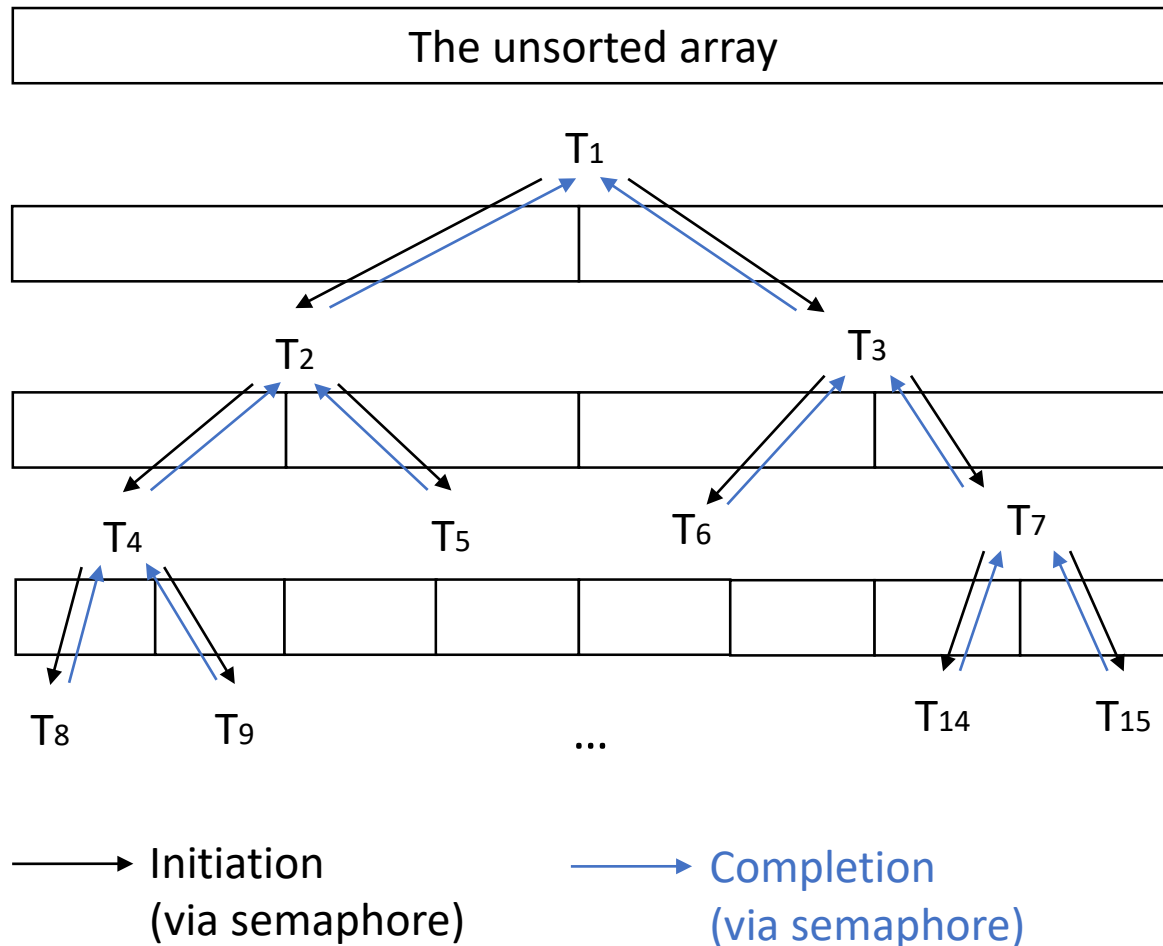
Operating Systems Programming Assignment #3

Parallel Merge Sort using Pthread

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Parallel Merge Sort



- T_1 : the master thread
1. Divides the array into two equal sub-arrays
 2. Signals T_2 and T_3 (via **semaphores**) to sort the two sub-arrays
 3. Waits on T_2 and T_3 (via **semaphores**)
 4. Merges the two sorted sub-arrays
 5. Generate an output file

- $T_8 \sim T_{15}$:
1. Do bubble sort on their own sub-arrays
 2. Signal their upper-level threads (via **semaphores**)

APIs

- `<pthread.h>`

Thread management

- `Pthread_create`, `pthread_exit`
- Do not use `pthread_join`, use semaphore instead.

- `<semaphore.h>`

Semaphore operations

- `sem_init`, `sem_wait`, `sem_post`, `sem_getvalue`, `sem_destroy`

Requirements

1. Prompt for the name of the input file
2. Read integers from the file
3. Do the sorting
4. Print the execution time of multi-thread sorting and single-thread sorting
 - MT sorting should be much faster than ST sorting
 - Their results must be exactly the same
5. Write the sorted array to a file
 - output1.txt → MT sorting
 - output2.txt → ST sorting

Requirements

- The cooperation among threads must be **exactly the same** as shown in the figure
- Create all threads **in the beginning** of your program
 - Each of T1~T15 waits on its own semaphore
 - The main program signals the master thread T1 to start
 - T1 signals the 2nd-level threads T2 and T3 to start
 - ... and so on
- Use **Bubble sort** at the bottom level (T8~T15)
 - For observation of speed-up

Requirements

- Single-thread sorting
 - Use one single thread to do the same sorting, but no thread parallelism
 - 3 levels of array partitioning, bubble sort at the bottom level, and merge sub-arrays on return
 - Should be noticeably slower than the multithreaded version
- Fail to comply with the requirements will incur a score penalty
- You get 0 point if you call `qsort()` at any place in your program

Input/output format

- Input file format:

<total # of integers><space>\n

<all integers separated by space>

- Largest input: 1,000,000 integers
- Generate your own file for testing

- Output file format:

<sorted integers separated by space>

Testing OS Environment

- Ubuntu 16.04, Ubuntu 14.04 or CS Linux work station
 - Your code should compile successfully in one of the above environments