

# Programming Assignment #4: Merge Sort with A Pool of Threads

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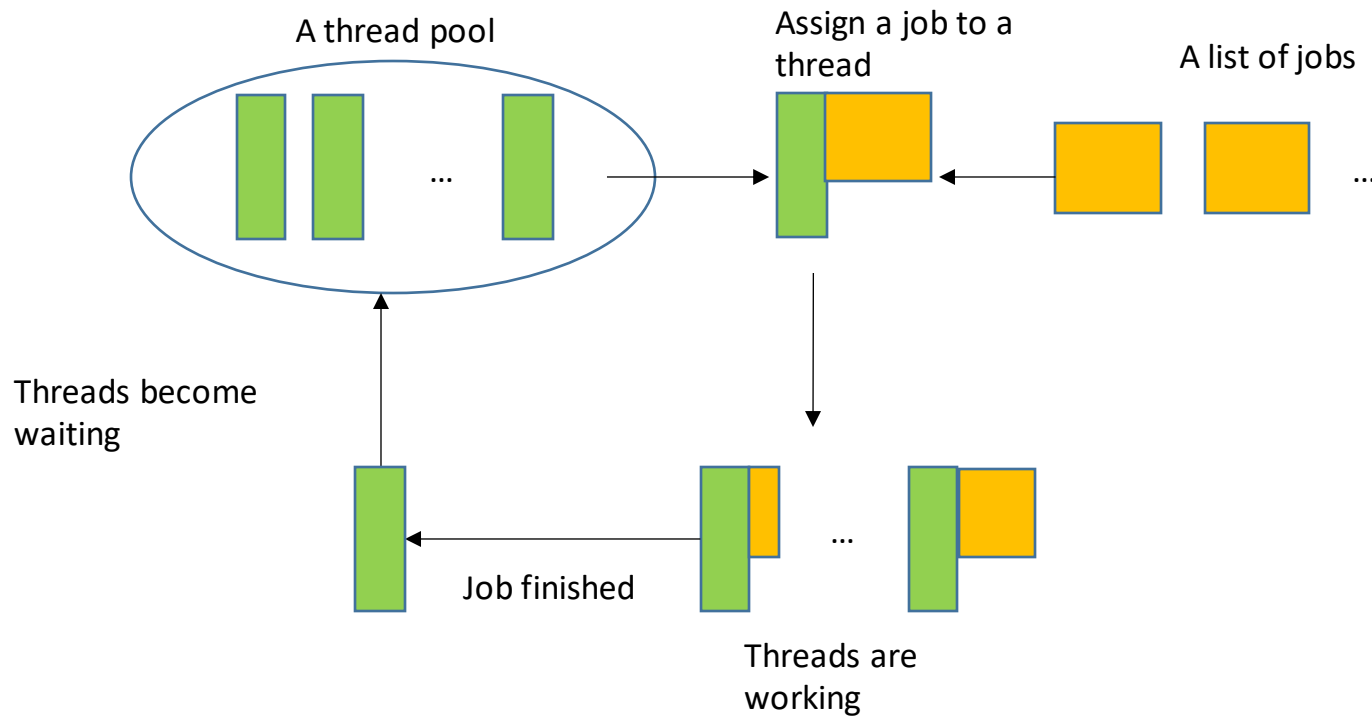
# Objective

- Multithreaded sorting using a pool of threads
  - # of threads in the pool determines the max. degree of parallelism
- The problem definition is the same as that in the previous assignment, except that the binding of jobs to threads is dynamic

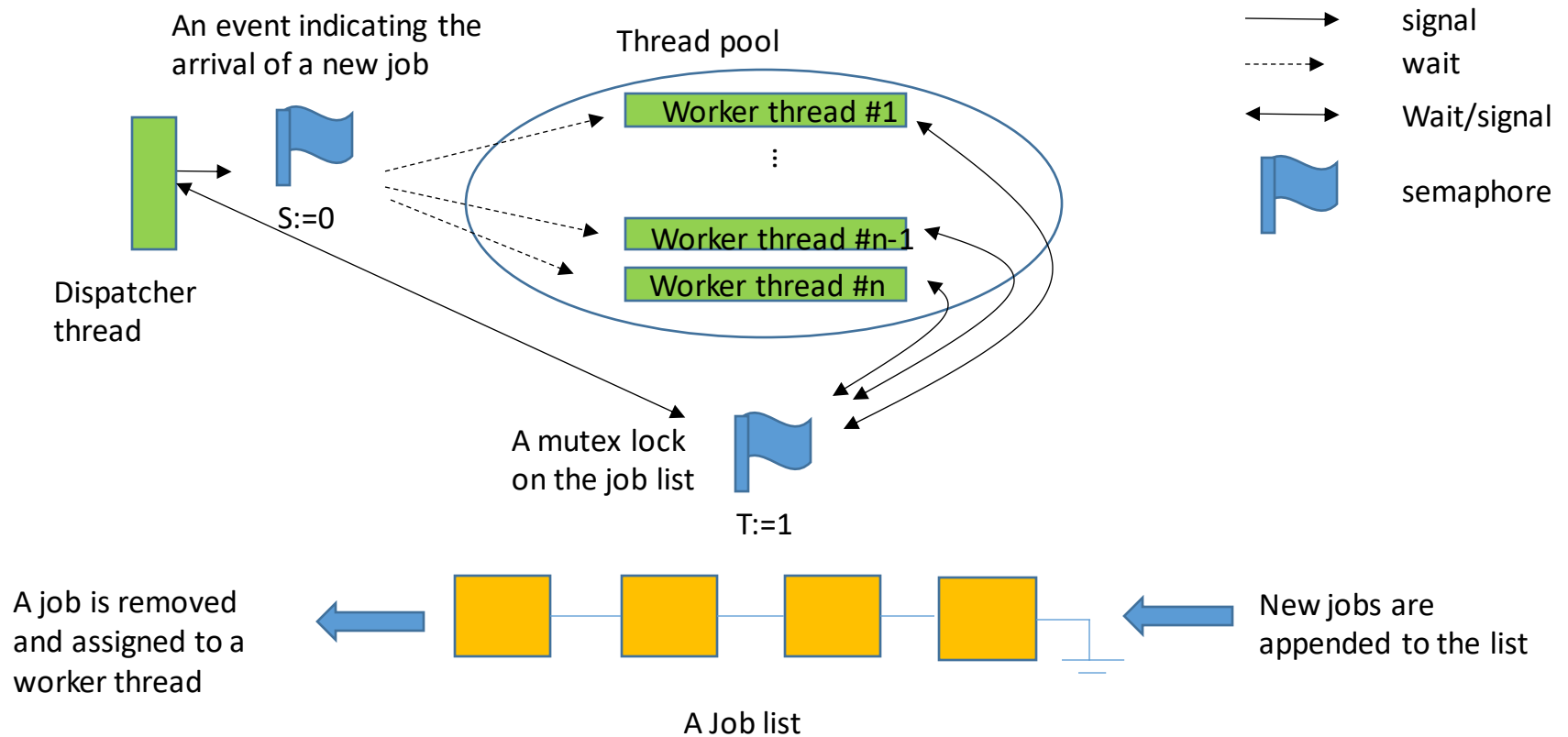
# Job Binding

- A job is
  - Sorting a last-level array using bubble sort, or
  - Merging two sorted sub-arrays into a large, sorted array
- All threads in the thread pool must have been created before the first job starts

# The Concept of a Thread Pool



# A Reference Design



# A Reference Design

- Initially, the dispatcher thread inserts eight sort jobs for the eight bottom-level arrays and wakes up worker threads
- The dispatcher checks if any two pairing (buddy) sub-arrays have been sorted. If so, it inserts a new job to merge the two sub-arrays

# Procedure

1. Read data from the input file “input.txt”
2.  $n=1$
3. Do the sorting with a thread pool of  $n$  threads
4. Print the execution time
5. Write the sorted array to a file
  - Filename: output\_ $n$ .txt (e.g., **output\_3.txt** if  $n=3$ )
6.  $n++$ ; if  $n \leq 8$  then goto 3

# Remarks

- Reuse your assignment 3
- The binding of jobs to threads must be **dynamic**
- All the 8 output files must be **identical**
- Execution time **decreases** as  $n$  increases
- Performance improv. **saturates** when  $n$  is large
- **Do not** pre-generate all jobs in the job list
- Numbers should be sorted in ascending order
- **You got 0 mark if you use quicksort**



# Input/Output Format

- Format of “input.txt”:

<# of elements of array><space>\n

<all elements separated by space>

- Largest input: the same as in assignment #3

- Output file format “output\_?.txt”:

<sorted array elements separated by space>

# Header of your .c or .cpp

```
/*
```

```
Student No.: <your student id>
```

```
Student Name: <your name>
```

```
Email: <your email>
```

```
SE tag: xnxctxuxoxsx
```

```
Statement: I am fully aware that this program is not  
supposed to be posted to a public server, such as a  
public GitHub repository or a public web page.
```

```
*/
```

# Testing OS Environment

- Ubuntu 18.04
- Install as a VM or on a physical machine