# Distributed Systems

COMP90015 2023 Semester 1
Tutorial 03

## Today’s Agenda

- Quickly go through the thread slides
- Concept/question discussion
  1. What is a thread and life cycle of a thread
  2. Synchronous access to shared resources
  3. Comparison of worker pool multi-threading architecture with the thread-per-request architecture
- Code demonstration of thread Sleep, Join and Synchronization and Multithreaded Server and Client

## Q1. What is Thread?

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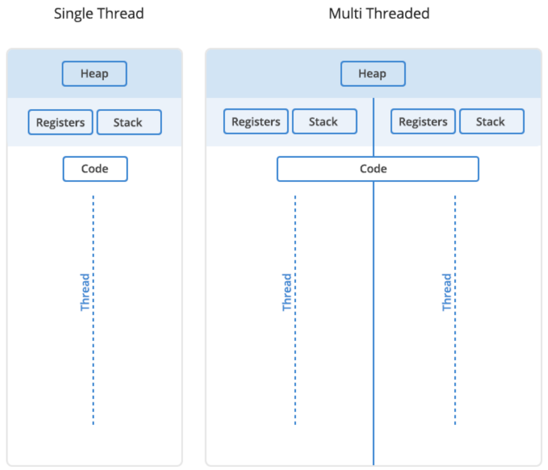
- A Thread is a piece of code that runs in concurrent with other threads.
- Each thread is a statically ordered sequence of instructions.
- Threads are used to express concurrency on both single and multiprocessors machines.

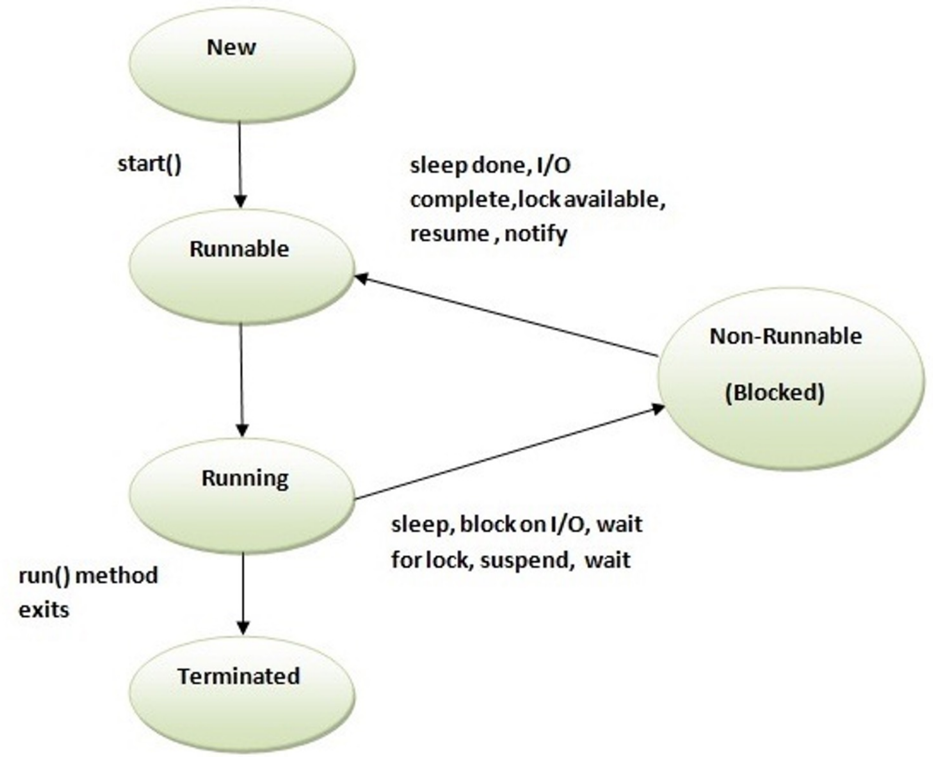


## Thread vs Process

- Advantages of thread based parallelism
  - Threads share the same address space.
  - Context-switching between threads is normally inexpensive.
  - Communication between threads is normally inexpensive.

## Q3. What is life cycle of a thread?

## Thread Lifecycle


New
start()
Runnable
sleep done, I/O complete,lock available, resume , notify
Non-Runnable (Blocked)
Running
sleep, block on I/O, wait for lock, suspend, wait
run() method exits
Terminated

## Q4. What do you mean by synchronous access to shared resources and how can we achieve it?

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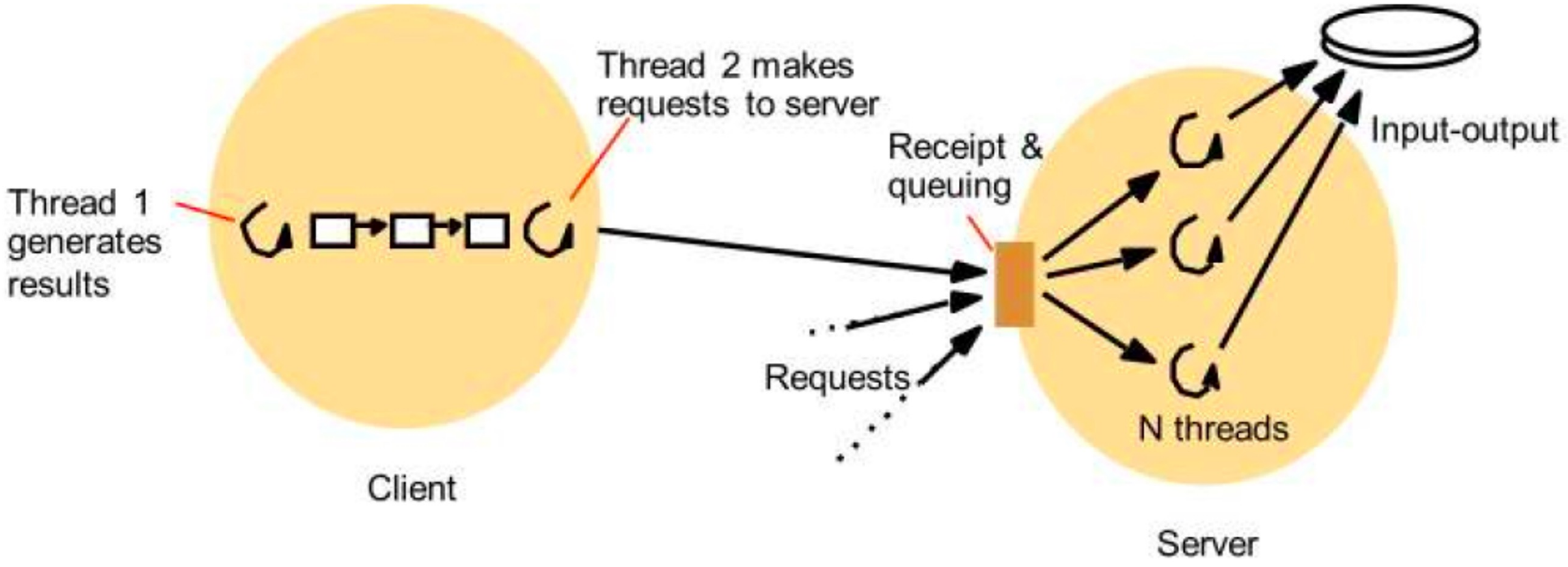
- If one thread tries to read the data and other thread tries to update the same data, it leads to inconsistent state.
- This can be prevented by synchronising access to the data.
- Use “synchronized” to methods or objects:

```
public synchronized void update()
{
                    …
}
```

## Q5. Compare the worker pool multi-threading architecture with the thread-per-request architecture.

## Worker pool architecture



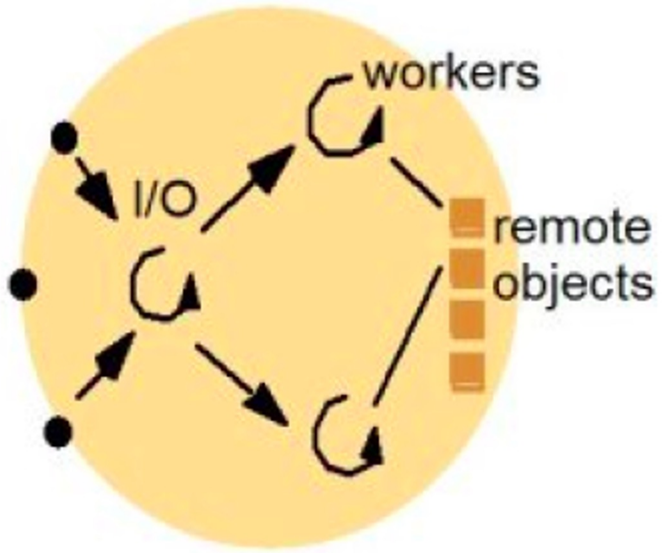
## Worker pool architecture

The server creates a fixed number of threads called a worker pool. As requests arrive at the server, they are put into a queue by the I/O thread and from there assigned to the next available worker thread.

Server creates worker pool ➜ request comes in, put into a queue ➜ assigned to an available worker thread.

Useful in highly concurrent system

## Thread-per-request



a. Thread-per-request

## Thread-per-request architecture

Thread created for each request, when the request is finished, the thread is deallocated.

## Code Demonstration

- Multi-threading in Java – Synchronization
    - In java, multithreading can be implemented in two ways
        - Extending Thread class
        - Implementing Runnable interface
- Multithreaded Server and client with Sockets
- Helper Link (Concept): https://www.youtube.com/watch?v=mTGdtC9f4EU&list=PLL8woMHwr36EDxjUoCzboZjedsnhLP1j4
- Helper Link (Coding): https://www.youtube.com/watch?v=J09TLPgwd0Y

## End of Tutorial