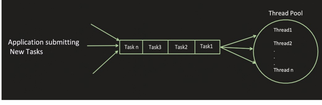
Thread Pools and ThreadPoolExecutor

"Concept && Coding" YT Video Notes

What is ThreadPool:

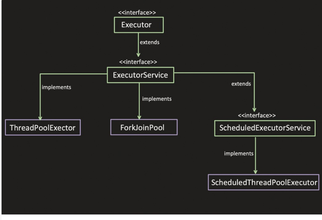
- It's a collection of threads (aka workers), which are available to perform the submitted tasks.
- Once task completed, worker thread get back to Thread Pool and wait for new task to assigned.
- Means threads can be reused.



What's the Advantage of Thread Pool?

- **Thread Creation time can be saved:**
  - When each thread created, space is allocated to it (stack, heap, program counter etc..) and this takes time.
  - With thread, this can be avoided by reusing the thread.
- **Overhead of managing the Thread lifecycle can be removed:**
  - Thread has different state like Running, Waiting, terminate etc. And managing thread state includes complexity.
  - Thread pool abstract away this management.
- **Increased the performance:**
  - More threads means, more **Context Switching** time, using control over thread creation, excess context switching can be avoided.

package java.util.concurrent;



ThreadPoolExector:

It's helps to create a customizable ThreadPool.

```
public ThreadPoolExecutor
                    ( int corePoolSize
                      int maximumPoolSize,
                      long keepAliveTime,
                      TimeUnit unit,
                      BlockingQueue<Runnable> workQueue,
                      ThreadFactory threadFactory,
                     RejectedExecutionHandler handler)
```

- ***corePoolSize***:
  Number of threads are initially created and keep in the pool, even if they are idle.

- **allowCoreThreadTimeOut**:
  If this property is set to TRUE (by default its FLASE), idle thread kept Alive till time specified by 'KeepAliveTime'.

- **KeepAliveTime**:
  Thread, which are idle get terminated after this time.

- **maxPoolSize**:
  Maximum number of thread allowed in a pool.
  If no. of thread are == *corePoolSize* and queue is also full, then new threads are created (till its less than 'maxPoolSize').

Excess thread, will remain in pool, this pool is not shutdown or if *allowCoreThreadTimeOut* is set to true, then excess thread get terminated after remain idle for *KeepAliveTime*.

- **TimeUnit**:
  TimeUnit for the keepAliveTime, whether ***Millisecond*** or ***Second*** or ***Hours*** etc.

- **BlockingQueue**:
  Queue used to hold task, before they got picked by the worker thread.
  - **Bounded Queue:** Queue with FIXED capacity.
    - Like: *ArrayBlockingQueue*
  - **Unbounded Queue:** Queue with NO FIXED capacity.
    - Like: *LinkedBlockingQueue*

- **ThreadFactory**:
  Factory for creating new thread. ThreadPoolExecutor use this to create new thread, this Factory provide us an interface to:

  - To give custom Thread name
  - To give custom Thread priority
  - To set Thread Daemon flag etc.

- **RejectedExecutionHandler**:
  Handler for tasks that can not be accepted by thread pool.
  Generally logging logic can be put here. For debugging purpose.
  - **new ThreadPoolExecutor.AbortPolicy**
    - Throws *RejectedExecutionException*
  - **new ThreadPoolExecutor.CallerRunsPolicy**
    - Executed the rejected task in the caller thread (thread that attempted to submit the task)
  - **new ThreadPoolExecutor.DiscardPolicy**
    - Silently discard the Rejected task, without throwing any exception.
  - **new ThreadPoolExecutor.DiscardOldestPolicy**
    - Discard the oldest task in the queue, to accommodate new task.

Example:

```
public class Main {

    public static void main(String args[]) {


        ThreadPoolExecutor poolExecutor = new ThreadPoolExecutor( corePoolSize: 2, maximumPoolSize: 5, keepAliveTime: 1,
                TimeUnit.HOURS, new ArrayBlockingQueue<>( capacity: 10), new CustomThreadFactor(),
                new CustomRejectedHandler());

        poolExecutor.allowCoreThreadTimeOut( value: true);

        //submit task
        for(int i=1; i< 25 ; i++){
            poolExecutor.submit(() -> {
                try {
                    Thread.sleep( millis: 1000);
                    System.out.println("Thread name:" + Thread.currentThread().getName());
                }catch (Exception e) {
                }
            });
        }

        poolExecutor.shutdown();

    }
}

class CustomRejectedHandler implements RejectedExecutionHandler{

    @Override
    public void rejectedExecution(Runnable r, ThreadPoolExecutor executor) {
        //logging
        System.out.println("Task denied:" + r.toString());
    }
}

class CustomThreadFactor implements ThreadFactory{

    @Override
    public Thread newThread(Runnable r) {

        Thread th = new Thread(r);
        return th;
    }
}
```

Interview question:

Why you have taken corePoolSize as 2, why not 10 or 15 or another number, what's the logic?

My Answer:

Generally, the ThreadPool min and max size are depend on various factors like:
- CPU Cores
- JVM Memory
- Task Nature (CPU Intensive or I/O Intensive)
- Concurrency Requirement (Want high or medium or low concurrency)
- Memory Required to process a request
- Throughput etc.

And its an iterative process to update the min and max values based on monitoring.

Formula to find the no. of thread:

Max No of thread = No. of CUP Core * (1 + Request waiting time/processing time)

No. of CUP Core = 4
Request waiting time = 10ms
Processing time = 100ms

But this formula, do not consider Memory yet, which need to be consider...