**CS2030 Parallelism and Asynchronous Programming**

**Parallel Progamming**

What is Parallel Programming?

Parallel programming is to use multiple threads to speed up the computation of a program, to more efficiently utilize computational resources.

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Description automatically generated

What kind of tasks are best suited for parallelism?

In terms of parallel streams, stateless operations without side effects are best for usage, especially commutative operations!

* This is because as tasks are completed, other threads may still be processing the previous operation, hence there is no inherent order to the completion of each sub-operation in the program.

The task should also be relatively computationally expensive.

* This is because there are associated overhead costs with the implementation of parallelism that only make it worthwhile to compute in parallel when dealing with a large problem and outweigh the overheads involved.

**Under the hood of Parallelism:**

How parallelism works is that, under the hood when parallelism is enabled, work is first processed by the main thread in a double ended queue, with other threads also having one of their own.

Then the main thread forks a task, lets say Matrix Multiplication of a matrix.

The more related task is kept by the main thread to continue working on it, while the partitioned out part is added to a work deque for the thread.

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This subtask is forked and thrown to the work deque.

Then a worker thread that is free steals the work from the **back of the queue** from main.

A similar approach happens with each thread.

When the main is done with the subtask, it takes work from the front of its queue.

**Hence Work Stealing from other threads is from the back of the queue while taking from your own queue is from the front (LIFO).**

Asynchronous Programming using Completable Future

In Asynchronous Programming, it uses the same backend logic as that of Parallelism,

However, the value of asynchronous programming is that we **can do a totally unrelated task** as that of a task thrown to the worker pool while waiting for that task, (likely computationally expensive) to complete.

This requires an understanding of how Java Multi-threading occurs.

Note that CompletableFuture is a Functor and a Monad, and hence can be chained together like a stream or an optional.