Concurrency

Some Basics

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Issues

- There are a number of issues that we need to be aware of
- We will briefly look at some of them here

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Race Conditions

- Two or more threads perform operations on the same location at the same time
- Sequential Consistency may not be guaranteed!
  - System may reorder operations!
- Task A
  - X=1
  - a=Y
- For Example:
- Task B
  - Y=1
  - b=X

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Mutual Exclusion and Locks

- Only one process/thread can hold a lock at any one time
- Locks are a last resort
- Use to protect logical invariants not memory locations

Deadlock

- Avoid Mutexes where possible
- Hold at most one lock at a time
  - Never call someone elses code while holding a lock unless you are sure they never acquire a lock
- Always acquire multiple locks in the same order
  - Stratify the mutexes
  - Sort mutexes
  - Backoff

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Strangled Scaling

- Each Mutex is a potential bottleneck
- More threads means more contention
- Fine grained locking helps
- Atomic Operations can also be helpful

Lack of Locality

Temporal Locality The core is likely to access the same location again in the near future

Spatial Locality The core is likely to access nearby locations in the near future

- One the cache is full use everything in it before using anything else!
- Try use Cache Oblivious algorithms

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Load Imbalance

- Uneven distribution of work accross workers
- Over-decomposition
- Divide the work into more tasks than there are workers

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Overhead

- If tasks are too small then overhead per task is too large
- Watch arithmetic intensity!
  - Ratio of arithmetic operations per memory access

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