Pitfalls

What can go wrong

Joseph Kehoe[1]

[1]Department of Computing and Networking
Institute of Technology Carlow

CDD101, 2017

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!**

```
TaskA:
    X=1
    a=Y

TaskB:
    Y=1
    b=X
```

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Mutual Exclusion and Locks

- Locks are a last resort
- Use Locks 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

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Lack of Locality

Two types 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

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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