More threads!

10/7/15
Last time: Threads

- Program can use multiple threads to run faster
- Speedup is ratio of serial running time to parallel (multi-threaded) running time
- Would like linear speedup (= #cores used)
- One reason we might not get it:
  Amdahl’s law: running time = \( T_1 \frac{(1-B)}{p} + T_1 B \)
  \( T1 \) = Serial time
  \( B \) = fraction of program that must run serially
  \( p \) = #processing elements
Why not linear speedup? (2)

- Poor load balance:
Why not linear speedup? (3)

• Overhead
  – Extra instructions needed for running in parallel
  – Examples:
    • creating and destroying threads
    • calls needed to coordinate threads or communicate between them
    • changes to algorithm needed to expose parallelism or improve load balance
Race conditions

• Logic errors caused by interactions through shared variables
• Example: processing ATM withdrawal

<table>
<thead>
<tr>
<th>Operation</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read current value (100)</td>
<td>$100</td>
</tr>
<tr>
<td>Perform calculation (80)</td>
<td>$100</td>
</tr>
<tr>
<td>Store new value</td>
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Race conditions

• Logic errors caused by interactions through shared variables
• Example: processing ATM withdrawal

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Solving race conditions

• One solution: locks
  – acquire: block if lock is held, mark lock as held
  – release: mark lock as not held, unblock one waiting thread (if any)
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• Usage:
  acquire lock
  do critical section
  release lock
Construction blocks one lane of a two-lane highway so that all traffic must use one lane.

What parallelism/concurrency concept does this illustrate?

A. Threads  
B. Race condition  
C. Critical section  
D. Parallel overhead  
E. I hate construction
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What parallelism/concurrency concept does this illustrate?

A. Threads  
B. Race condition  
C. Critical section  
D. Parallel overhead  
E. I hate construction
Multi-threading concepts

• Threads
• Parallelism and concurrency
• Fork-join
• Speedup
  – Amdahl’s law
  – load balance
  – overhead
• Race conditions
  – critical sections and locks
Discussion of lab

(including a bit of cheating)