Administrivia

• HW1 peer-review assignments out later this week.
• HW2 out next week.
• Get Cython installed & working for HW1.
• No class Monday.
• Reading for Wednesday on Piazza.
Locks
Why Locks

- Control access to shared resources.
- Ensure valid state in shared structures.
Shared Resources

- Network, display, memory, etc.

- “Some people, when confronted with a problem, think, ‘I know, I'll use threads,’ and then two they hav erpoblesms.”
Coarse-grained Locks

- Lock large pieces of state.
  - e.g., Database, library of functions, GIL.
  - Linux 2.0 - first multiprocessor, one large lock. (remnants until v2.6.39)
Fine-grained Locks

• Lock individual items / substructures

  • Overhead is higher:
    • More locks (more memory)
    • More locking (more computation)
Tradeoffs

• Coarse-grained:
  - high contention
  - low concurrency
  + simple code

• Fine-grained:
  + high concurrency
  - high overhead
  - complex (and buggy) code
Lock problems

- Overhead & Contention
- Deadlock
- Starvation
- Priority Inversion
Deadlock

- Thread 1 needs resource A and resource B.
- Thread 2 needs resource B and resource A.
  - So they use locks to acquire them…
    - In that order…
Starvation

- Thread 1 repeatedly calls `long_running_function()`
- Thread 2 calls `fast_function()`
  - `long_running_function()` shares a lock with `fast_function()`
Preemption

• Unimportant thread has a lock.

• Important thread needs a lock.

• Add code to make unimportant thread give up the lock when Important thread asks.
Priority Inversion

- Unimportant thread has a lock.
- Important thread needs a lock.
- Add code to make unimportant thread give up the lock when Important thread asks.
- Medium-important thread preempts Unimportant thread, for a long time…
  - Unimportant can never run, holds lock…
Mars Pathfinder

- Priority inversion:
  - Unimportant: Meteorological data collection
  - Important: Data movement
  - Medium: Communication

- Saved by a debugging interpreter being available on the rover (even though it was written in C)
Next Time

- Poll:
  - OpenMP in Cython?
  - Discuss Problem 5?