Computer System Organization Recitation [Fall 2018]

CSCI-UA 201-006

R09: Multi-thread programming

Recap

- Generating Fibonacci numbers is not parallelizable (unless you use some formulate that does not depend on the previous items).
- A general framework to use threads.
  - Using pthread_create() to create threads.
  - The argument that passed to pthread_create() may be different for different threads to represent different data.
  - Using pthread_join() to wait for all threads to finish.

Multi-thread programming

- If threads have to share data, what should we do?
  - Use lock to protect the data.
  - Use lock-free technique to design the program.
    - This is an advanced technique, we will only introduce the basic.
- race.c demonstrate race condition.

Lock

- In computer science, a lock or mutex (from mutual exclusion) is a synchronization mechanism for enforcing limits on access to a resource in an environment where there are many threads of execution. A lock is designed to enforce a mutual exclusion concurrency control policy.
  — Wikipedia

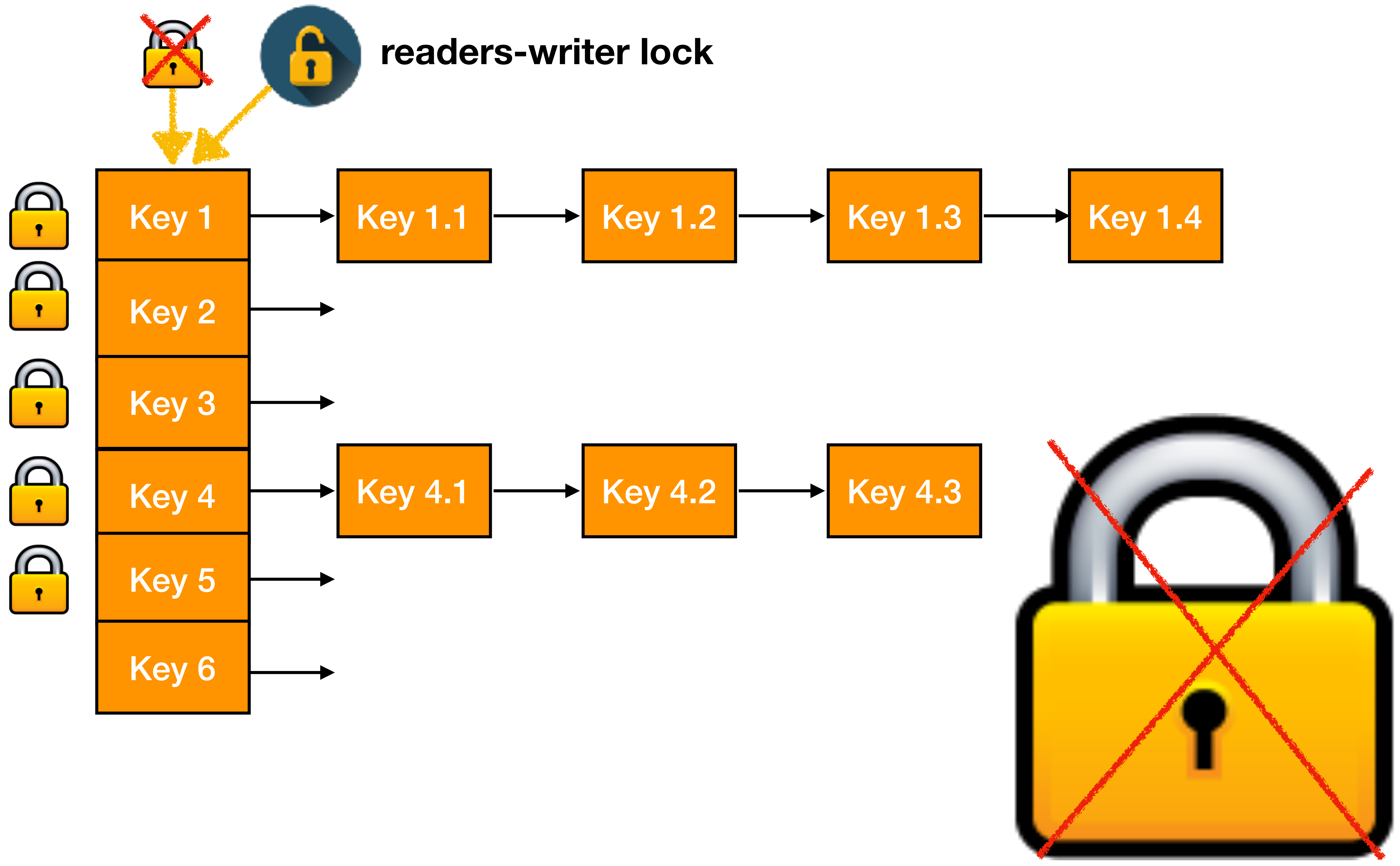
- In short, we use locks to make sure only one thread access the data per time.

Lock

- Coarse-grained lock and fine-grained lock:
  - Coarse-grained lock means that using only one (big) lock to protect the entire data.
  - Fine-grained lock means that using several (small) locks to protect the data. Each lock protect a portion of data.

- Coarse-grained lock is easy to use but has slow performance. On the other hand, fine-grained lock is difficult to use but has much higher performance.

Lock


readers-writer lock
Key 1
Key 1.1
Key 1.2
Key 1.3
Key 1.4
Key 2
Key 3
Key 4
Key 4.1
Key 4.2
Key 4.3
Key 5
Key 6

Lock-free programming

- Problem with locking:
  - Deadlock
  - Fairness
  - Overall performance
  - A lot of problems…
- Lock-free programming
  - Thread-safe access to shared data without the use of synchronization primitives such as mutexes.
  - Possible but not practical in the absence of hardware support.

How I debug multi-threading programs

- Use logging…
- Only use GDB when there is a segmentation fault.

r06 Questions