CS162
Operating Systems and Systems Programming
Lecture 6
(extra)

Readers/Writers Problem, Working in Teams

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Examples of Read-Modify-Write Processor Instructions

- ```
  test&set (&address) {     /* most architectures */
      result = M[address];
      M[address] = 1;
      return result;
  }
  ```

- ```
  swap (&address, register) { /* x86 */
      temp = M[address];
      M[address] = register;
      register = temp;
  }
  ```

- ```
  compare&swap (&address, reg1, reg2) { /* 68000 */
      if (reg1 == M[address]) {
          M[address] = reg2;
          return success;
      } else {
          return failure;
      }
  }
  ```
  ```

Synchronized (Infinite) Queue Example

```
AddToQueue(item) {
  lock.Acquire();
  queue.enqueue(item);
  dataready.signal();
  lock.Release();
}
```

```
RemoveFromQueue() {
  lock.Acquire();
  if (queue.isEmpty()) {
    dataready.wait(&lock);
  }
  item = queue.dequeue();
  lock.Release();
  return(item);
}
```

Basic Readers/Writers Solution

- Correctness Constraints:
  - Readers can access database when no writers
  - Writers can access database when no readers or writers
  - Only one thread manipulates state variables at a time
- Basic structure of a solution:
  - **`Reader()`**
    ```
    Wait until no writers
    Access database
    Check out - wake up a waiting writer
    ```
  - **`Writer()`**
    ```
    Wait until no active readers or writers
    Access database
    Check out - wake up waiting readers or writer
    ```
  - State variables (Protected by a lock called "lock"):
    - » int AR: Number of active readers; initially = 0
    - » int WR: Number of waiting readers; initially = 0
    - » int AW: Number of active writers; initially = 0
    - » int WW: Number of waiting writers; initially = 0
    - » Condition okToRead = NIL
    - » Condition okToWrite = NIL

Read/Writer Questions

```
Reader() {
    // check into system
    lock.Acquire();
    while ((AW + WW) > 0) {
      WR++;
      okToRead.wait(&lock);
      WR--;
    }
    AR++;
    lock.release();

    // read-only access
    AccessDbase(ReadOnly);

    // check out of system
    lock.Acquire();
    AR--;
    if (AR == 0 && WW > 0)
      okToWrite.signal();
    lock.release();
  }
```

```
Writer() {
    // check into system
    lock.Acquire();
    while ((AW + AR) > 0) {
      WW++;
      okToWrite.wait(&lock);
      WW--;
    }
    AW++;
    lock.release();

    // read/write access
    AccessDbase(ReadWrite);

    // check out of system
    lock.Acquire();
    AW--;
    if (WW > 0){
      okToWrite.signal();
    } else if (WR > 0) {
      okToRead.broadcast();
    }
    lock.release();
  }
```

5min Break

Tips for Programming in a Project Team

"You just have to get your synchronization right!"

- Big projects require more than one person (or long, long, long time)
  - Big OS: thousands of person-years!
- It's very hard to make software project teams work correctly
  - Doesn't seem to be as true of big construction projects
    - » Empire state building finished in one year: staging iron production thousands of miles away
    - » Or the Hoover dam: built towns to hold workers