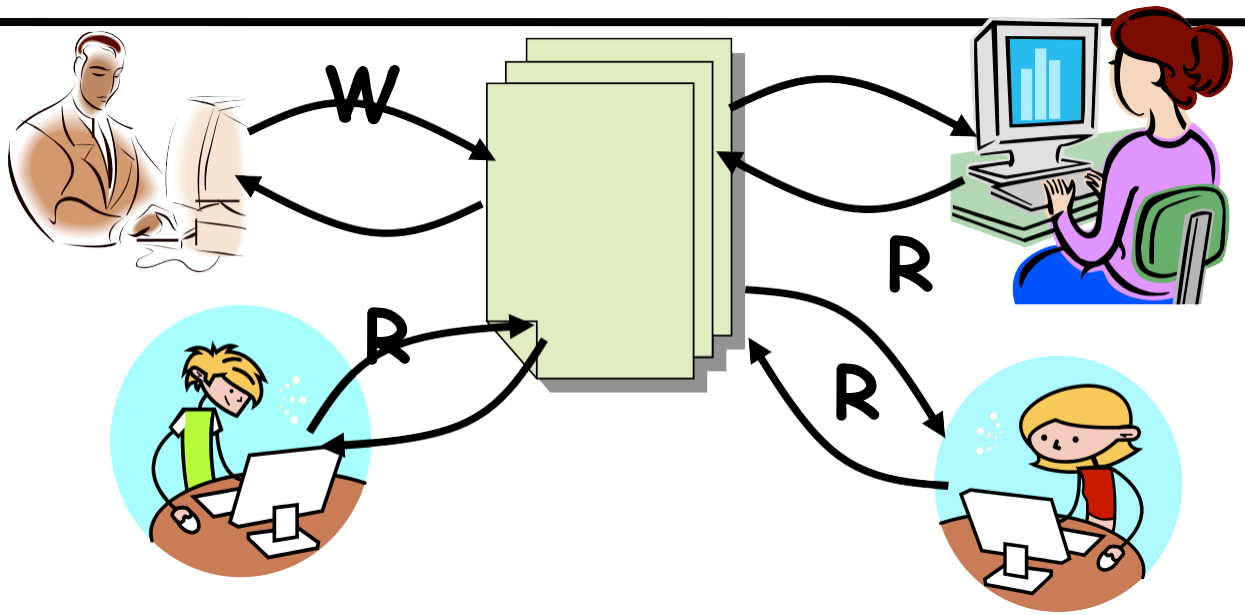
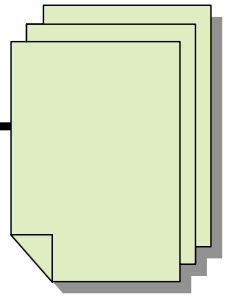
Reader/Writer Synchronization

Readers/Writers Problem



- Motivation: Consider a shared database
  - Two classes of users:
    - » Readers – never modify database
    - » Writers – read and modify database
  - Is using a single lock on the whole database sufficient?
    - » Like to have many readers at the same time
    - » Only one writer at a time

Basic Readers/Writers Solution



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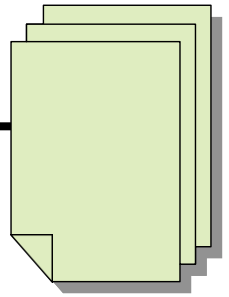

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  - Readers can access database when no writers
  - Writers can access database when no readers
  - Only one thread manipulates state variables at a time

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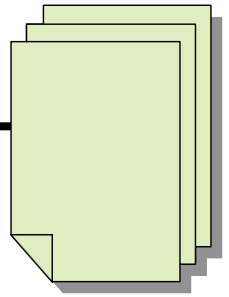

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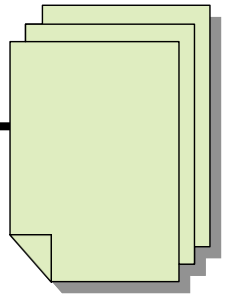

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Access data base
Check out - wake up a waiting writer
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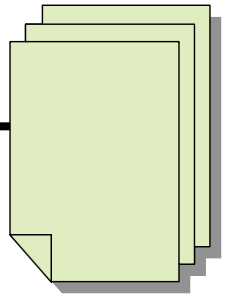

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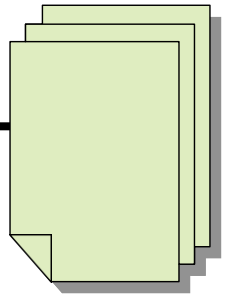

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  - State variables (Protected by a lock called "lock):
    - » int AR: Number of active readers; initially = 0
    - » int WR: Number of waiting readers; initially = 0
    - » int AW: Number of active writers; initially = 0
    - » int WW: Number of waiting writers; initially = 0
    - » Condition okToRead = NIL

Code for a Reader

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Reader() {
  // First check self into system
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Reader() {
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  while ((AW + WW) > 0) {  // Is it safe to read?
    WR++;                  // No. Writers exist
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  AR++;                    // Now we are active!
  lock.release();
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  // Perform actual read-only access
  AccessDatabase(ReadOnly);
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  lock.release();             active!

  // Perform actual read-only access
  AccessDatabase(ReadOnly);

  // Now, check out of system
  lock.Acquire();
  AR--;                    // No longer active
  if (AR == 0 && WW > 0)   // No other active readers
    okToWrite.signal();    // Wake up one writer
  lock.Release();
}
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Why is lock realeased here ?

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Writer() {
  // First check self into system
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  while ((AW + AR) > 0) { // Is it safe to write?
    WW++;                 // No. Active users exist
    okToWrite.wait(&lock); // Sleep on cond var
    WW--;                 // No longer waiting
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Writer() {
  // First check self into system
  lock.Acquire();
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  }

  AW++;                    // Now we are active!
  lock.release();

  // Perform actual read/write access
  AccessDatabase(ReadWrite);

  // Now, check out of system
  lock.Acquire();
  AW--;                    // No longer active
  if (WW > 0){             // Give priority to writers
    okToWrite.signal();    // Wake up one writer
  } else if (WR > 0) {     // Otherwise, wake reader
    okToRead.broadcast(); // Wake all readers
  }
  lock.Release();
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- Consider the following sequence of operators:
  - R1, R2, W1, R3

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- First, R1 comes along:

  AR = 1, WR = 0, AW = 0, WW = 0

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- First, R1 comes along:

  AR = 1, WR = 0, AW = 0, WW = 0

- Next, R2 comes along:

  AR = 2, WR = 0, AW = 0, WW = 0

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- Can't start because of readers, so go to sleep:

  AR = 2, WR = 0, AW = 0, WW = 1

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- Finally, R3 comes along:

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- When writer completes, we are finished