Project 4

CSCI-341: Software Engineering

CSIT at UDC

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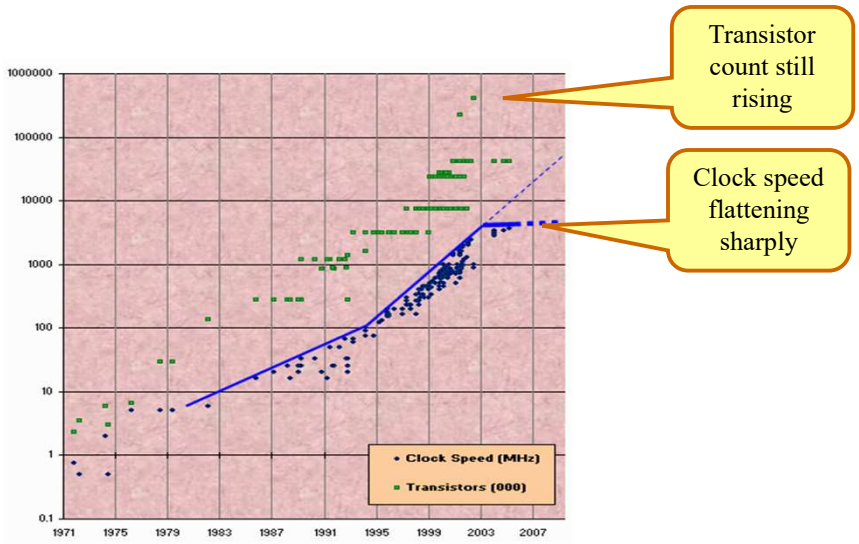
Moore's Law



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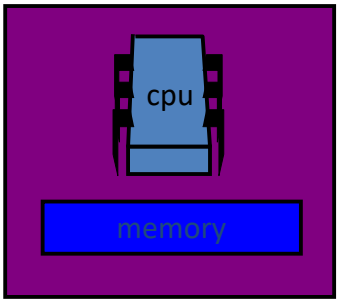
Still on some of your desktops: The Uniprocessor



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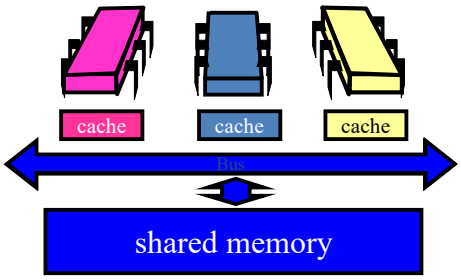
In the Enterprise: The Shared Memory Multiprocessor (SMP)



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Multicores Are Here

- Intel Core i9 (10 Cores) [Cnet]
- AMD Ryzen has 32 cores and Symmetrical Multi-Threading [Tech News]
- Meet KiloCore, a 1,000-core processor so efficient it could run on an AA battery [PC World]

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Why do we care?

- Time no longer cures software bloat
  - The “free ride” is over
- When you double your program’s path length
  - You can’t just wait 6 months
  - Your software must somehow exploit twice as much concurrency

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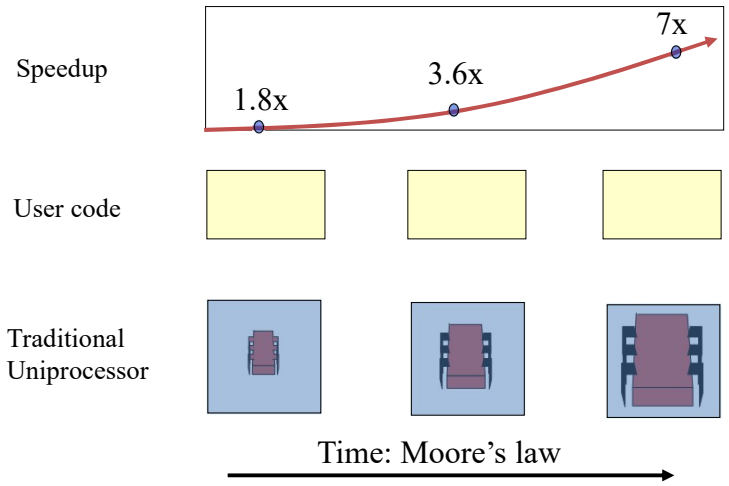
Traditional Scaling Process



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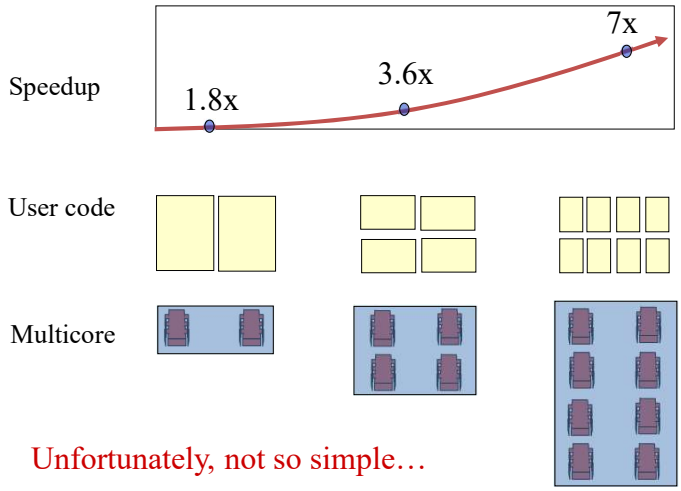
Multicore Scaling Process



Unfortunately, not so simple…

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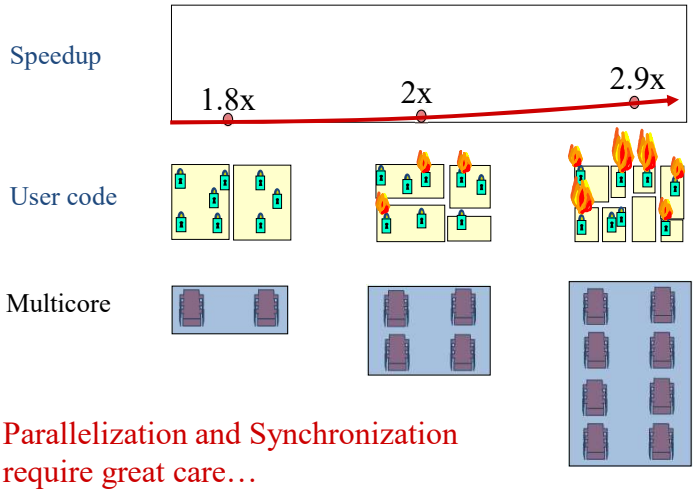
Real-World Scaling Process



Parallelization and Synchronization require great care…

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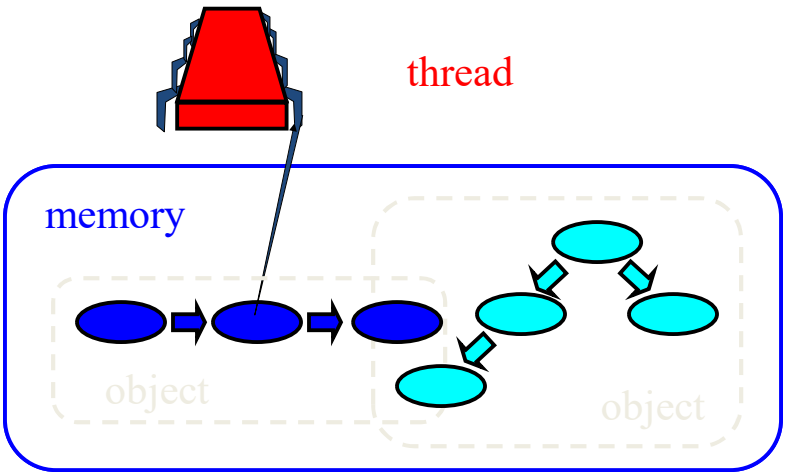
Sequential Computation



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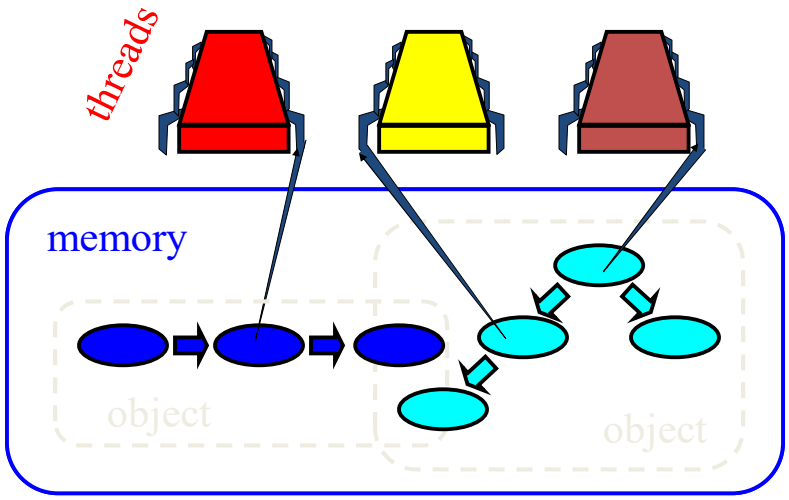
Concurrent Computation



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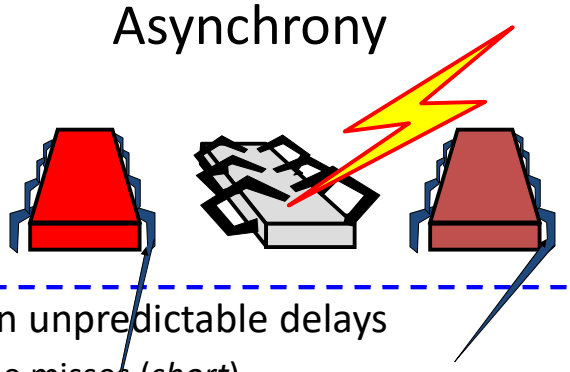
Asynchrony



- Sudden unpredictable delays
  - Cache misses (*short*)
  - Page faults (*long*)
  - Scheduling quantum used up (*really long*)

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Distributed Systems

- **Advantages:**
  - **No bottlenecks from sharing processors**
  - **No central point of failure**
  - **Processing can be localized for efficiency**
- **Disadvantages:**
  - **Complexity**
  - **Communication overhead**
  - **Distributed control**

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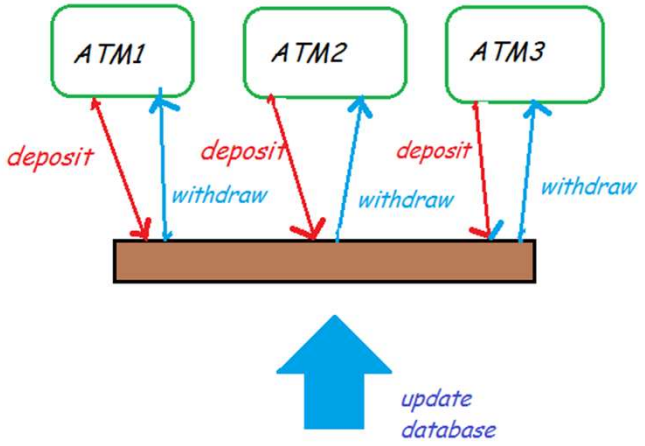
An Example of Distributed Concurrent Program



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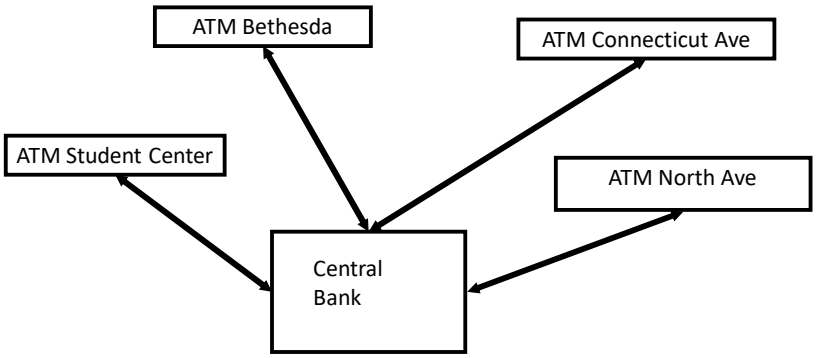
Distributed Systems

Multiple computers working together with no central program "in charge."



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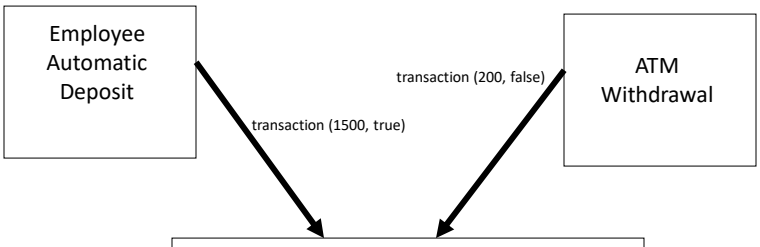
A Concurrent World on ATM




```
double balance;  // a global variable

void transaction (double amount, boolean deposit)
{
   if (deposit)
            balance = balance + amount;
   else
            balance = balance - amount;
}
```

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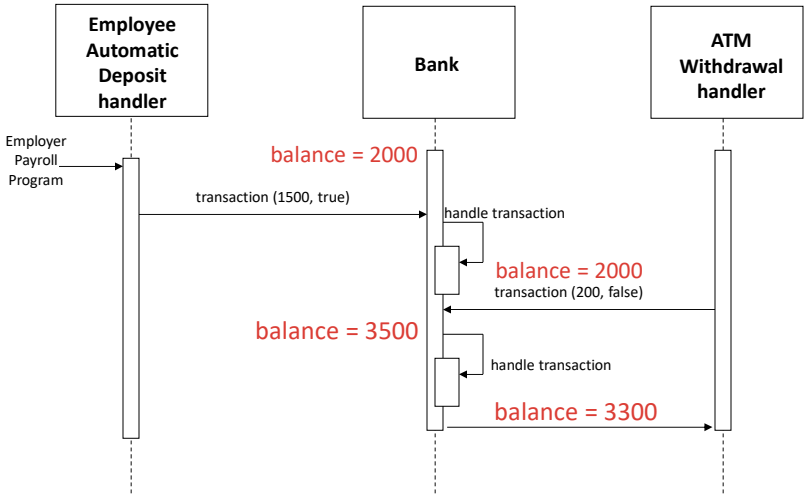
A Wrong Diagram



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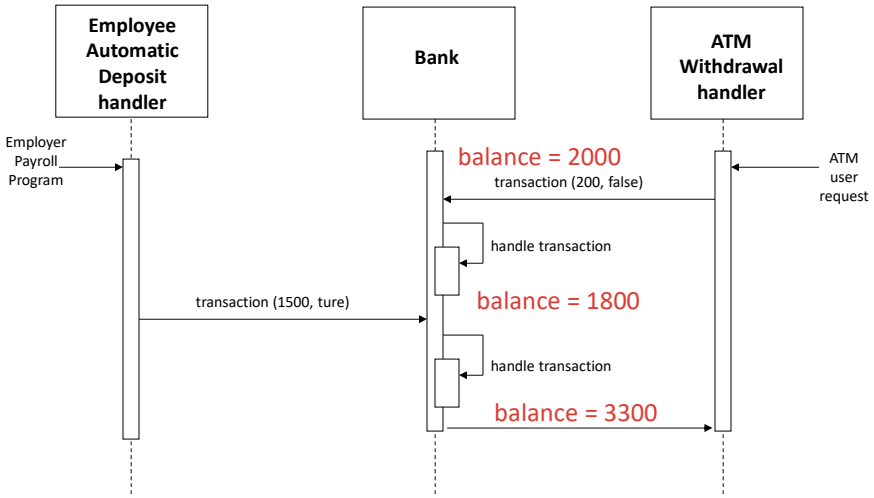
A Wrong Diagram



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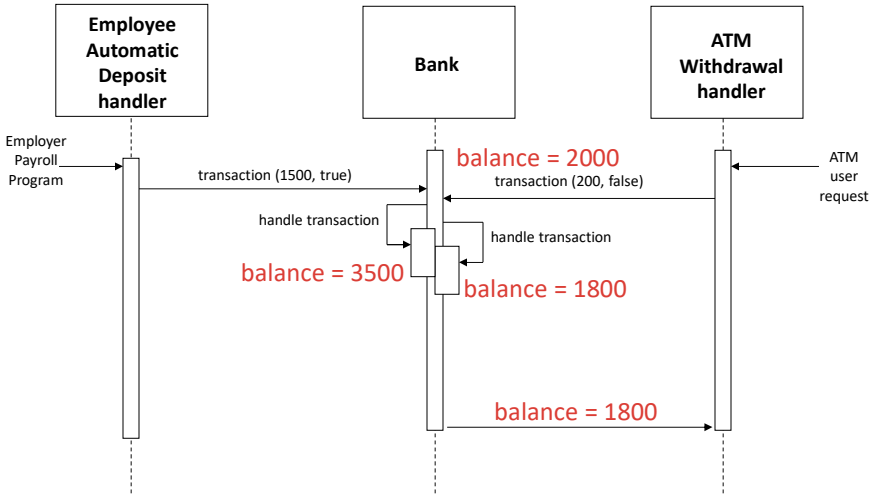
A Wrong Diagram



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Counter Implementation

```
public class Counter {
  private long value;

  public long getAndIncrement() {
    return value++;
  }
}
```

Source: Art of Multiprocessor Programming

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Counter Implementation

```
public class Counter {
  private long value;

  public long getAndIncrement() {
    return value++;
  }
}
```

OK for single thread,
not for concurrent threads

Source: Art of Multiprocessor Programming

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What It Means

```
public class Counter {
  private long value;

  public long getAndIncrement() {
    return value++;
  }
}
```

```
temp  = value;
value = temp + 1;
return temp;
```

Source: Art of Multiprocessor Programming

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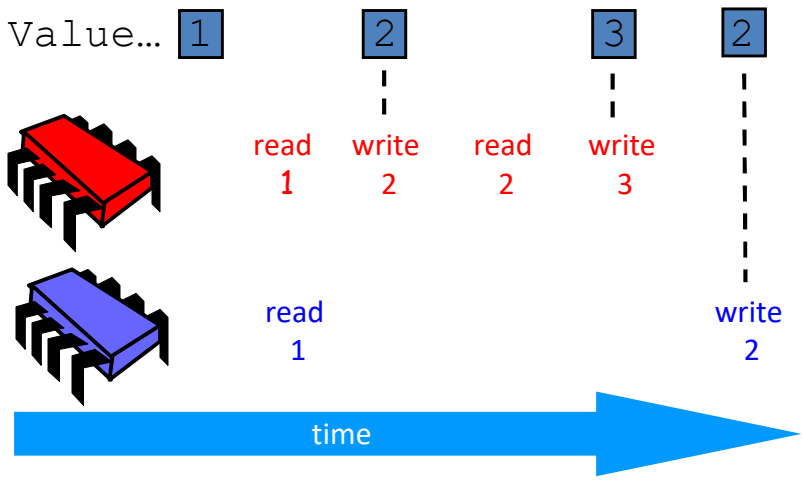
Not so good…



Source: Art of Multiprocessor Programming

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Challenge

```
public class Counter {
  private long value;

  public long getAndIncrement() {
    temp  = value;
    value = temp + 1;
    return temp;
  }
}
```

Make these steps *atomic* (indivisible)

Source: Art of Multiprocessor Programming

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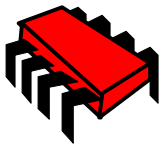
Hardware Solution

```
public class Counter {
  private long value;

  public long getAndIncrement() {
    temp  = value;
    value = temp + 1;
    return temp;
  }
}
```



ReadModifyWrite() instruction

Source: Art of Multiprocessor Programming

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An Aside: Java™

```
public class Counter {
  private long value;

  public long getAndIncrement() {
    synchronized {
      temp  = value;
      value = temp + 1;
      }
    return temp;
  }
}
```

Source: Art of Multiprocessor Programming

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Concurrency Control in Sequence Diagram

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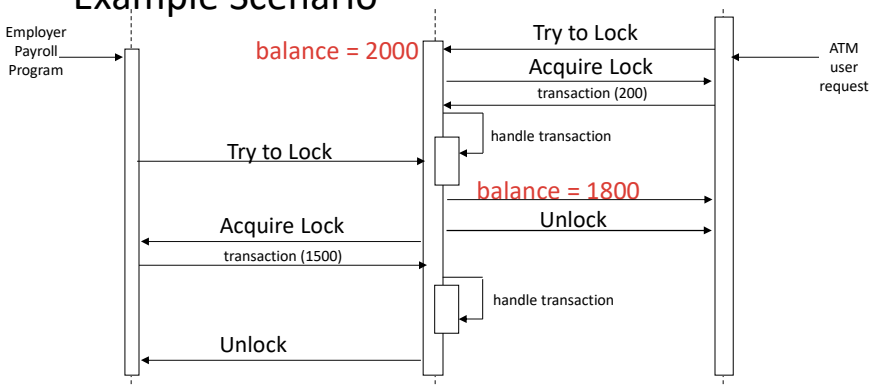
Pessimistic Concurrency Control

- Try to Lock (or Lock) and Unlock
- Example Scenario



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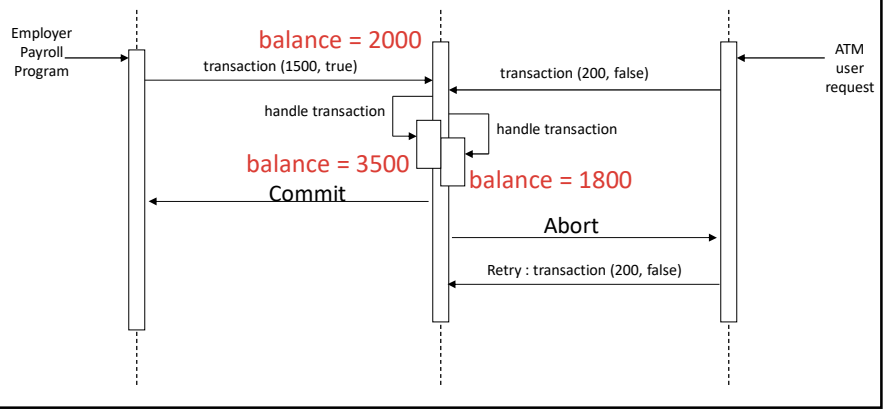
Optimistic Concurrency Control

- Commit and Abort
- Example Scenario



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Sample of Specification

- If the ATM is running out of money or no card should be accepted, An error message is displayed
- The ATM has to check if the entered card is a valid cash card
- If the cash card is valid the ATM should read the serial number and bank code
- If password and serial number are ok, the authorization process is finished.
- Select an action
- Perform a transaction

etc

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ATM in PlantUML

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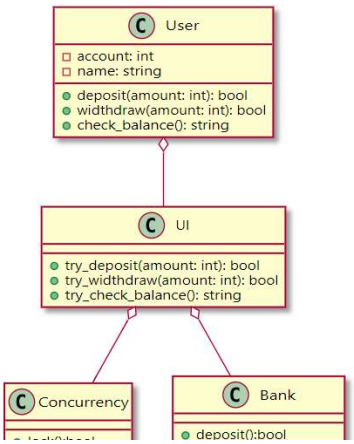
Class Diagram

- Main Classes:
  - User, UI, Concurrency, Bank
- Optional Classes:
  - Authentication, Account, Banker



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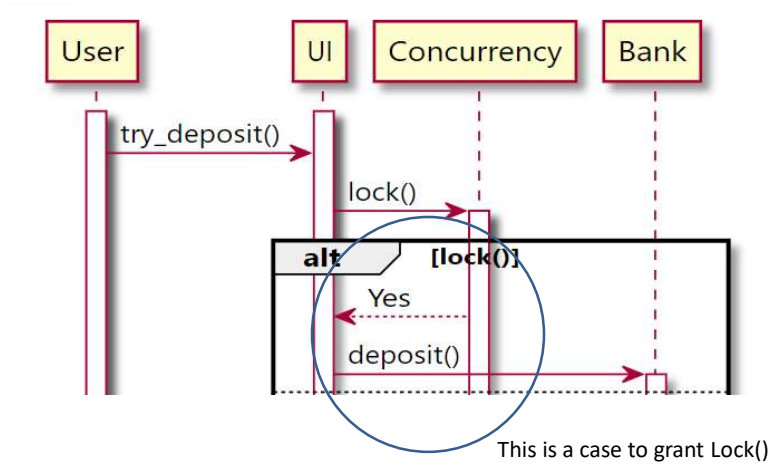
Sequence Diagram



This is a part of project 4

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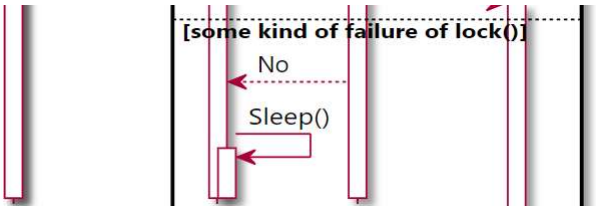
Lock vs Unlock



Once you deposit successfully, you must unlock.

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Design three cases – deposit(), withdraw() and check_balance()

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Design Guideline in PlantUML

- All operations for each class must participate in a sequence diagram.
- At least two operations must be defined in each class.
- Class and sequence diagrams must be feasible.

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Group Project Option

- Up to two students
- A student
  - More than 4 classes
- Two students
  - More than 7 classes
  - Put you and your partner's names to a DOC/PDF and both students must submit the same DOC/PDF.

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