Concurrency: Threads and Processes

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Programming Concepts using Java

Week 10

Concurrent programming

- Multiprocessing
  - Single processor executes several computations “in parallel”
  - Time-slicing to share access

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  - Communicate via "shared memory"
  - Context switches are easier
- Henceforth, we use process and thread interchangeably

Shared variables

- Browser example: download thread and user-interface thread run in parallel
  - Shared boolean variable `terminate` indicates whether download should be interrupted
  - `terminate` is initially false
  - Clicking `Stop` sets it to true
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  - `terminate` is initially false
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  - Download thread checks the value of this variable periodically and aborts if it is set to true
- Watch out for race conditions
  - Shared variables must be updated consistently

Creating threads in Java

- Have a class extend `Thread`

```
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  private int id;

  public Parallel(int i){ id = i; }
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Creating threads in Java

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public class Parallel extends Thread{
  private int id;
  public Parallel(int i){ id = i; }
  public void run(){
    for (int j = 0; j < 100; j++){
      System.out.println("My id is "+id);
      try{
        sleep(1000);        // Sleep for 1000 ms
      }
      catch(InterruptedException e){}
    }
  }
}
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public class TestParallel {
  public static void main(String[] args){
    Parallel p[] = new Parallel[5];
    for (int i = 0; i < 5; i++){
       p[i] = new Parallel(i);
       p[i].start();  // Start p[i].run()
    }                 // in concurrent thread
  }
}
```

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  - Directly calling `p[i].run()` does not execute in separate thread!

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- `sleep(t)` suspends thread for `t` milliseconds
  - Static function — use `Thread.sleep()` if current class does not extend `Thread`
  - Throws `InterruptedException` — later

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  private int id;
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- `sleep(t)` suspends thread for `t` milliseconds
  - Static function — use `Thread.sleep()` if current class does not extend `Thread`
  - Throws `InterruptedException` — later

Typical output

```
My id is 0
My id is 3
My id is 2
My id is 1
My id is 4
My id is 0
My id is 2
My id is 3
My id is 4
My id is 1
My id is 0
My id is 3
My id is 1
My id is 2
My id is 4
My id is 0
...
```

Java threads . . .

- Cannot always extend `Thread`
  - Single inheritance

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- Cannot always extend `Thread`
  - Single inheritance
- Instead, implement `Runnable`

```
public class Parallel implements Runnable{
  // only the line above has changed
  private int id;
  public Parallel(int i){ ... } // Constructor
  public void run(){ ... }

}
```

Java threads . . .

- Cannot always extend `Thread`
  - Single inheritance
- Instead, implement `Runnable`
- To use `Runnable` class, explicitly create a `Thread` and `start()` it

```
public class Parallel implements Runnable{
  // only the line above has changed
  private int id;
  public Parallel(int i){ ... } // Constructor
  public void run(){ ... }

}

public class TestParallel {
  public static void main(String[] args){
    Parallel p[] = new Parallel[5];
    Thread t[]   = new Thread[5];

    for (int i = 0; i < 5; i++){
       p[i] = new Parallel(i);
       t[i] = new Thread(p[i]);
            // Make a thread t[i] from p[i]
       t[i].start();  // Start off p[i].run()
                      // Note: t[i].start(),
    }                 //   not p[i].start()
  }
}
```

Summary

- Common to have logically parallel actions with a single application
  - Download from one webpage while browsing another
- Threads are lightweight processes with shared variables that can run in parallel
- Use `Thread` class or `Runnable` interface to create parallel threads in Java