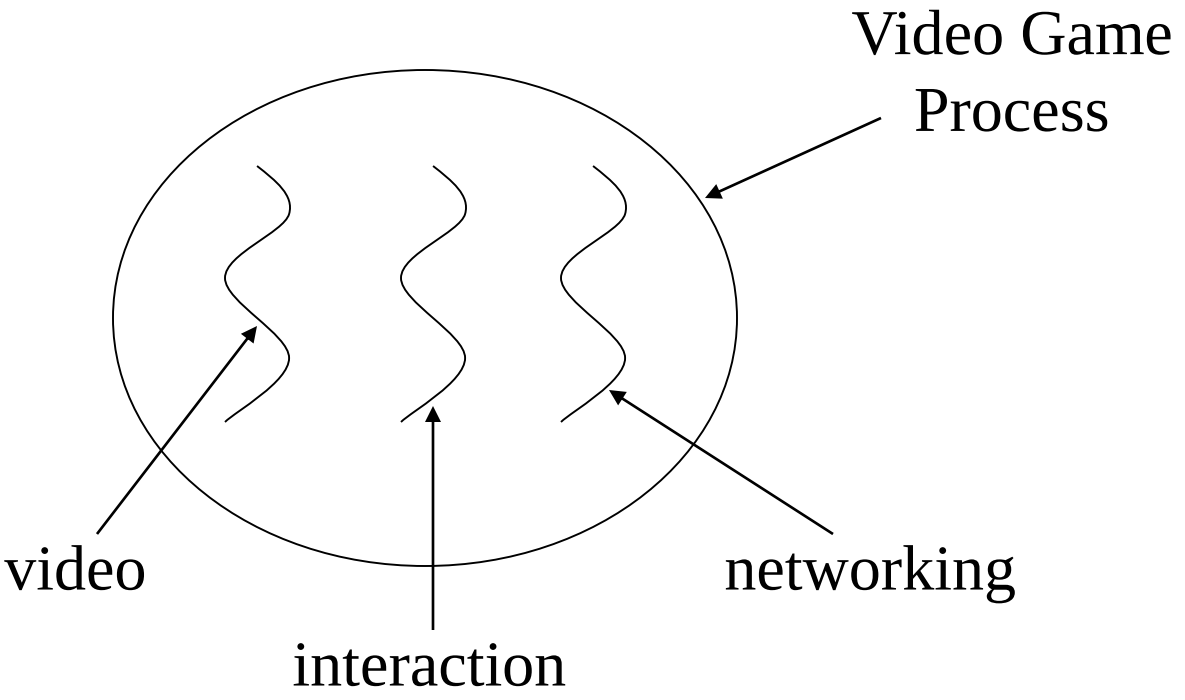
Java Threads

Introduction to multithreading in Java

What is a Thread?

- Individual and separate unit of execution that is part of a process
  - multiple threads can work together to accomplish a common goal
- Video Game example
  - one thread for graphics
  - one thread for user interaction
  - one thread for networking

What is a Thread?



Advantages

- easier to program
  - 1 thread per task
- can provide better performance
  - thread only runs when needed
  - no polling to decide what to do
- multiple threads can share resources
- utilize multiple processors if available

Disadvantage

- multiple threads can lead to deadlock
  - much more on this later
- overhead of switching between threads

Creating Threads (method 1)

- extending the Thread class
  - must implement the ***run()*** method
  - thread ends when *run()* method finishes
  - call .***start()*** to get the thread ready to run

Creating Threads Example 1

```
class Output extends Thread {
    private String toSay;
    public Output(String st) {
        toSay = st;
    }
    public void run() {
        try {    for(;;) {
                        System.out.println(toSay);
                        sleep(1000);
                }
        } catch(InterruptedException e) {
                System.out.println(e);
        }        }}
```

Example 1 (continued)

```
class Program {
    public static void main(String [] args) {
        Output thr1 = new Output("Hello");
        Output thr2 = new Output("There");
        thr1.start();
        thr2.start();
    }
}
```

- main thread is just another thread (happens to start first)
- main thread can end before the others do
- any thread can spawn more threads

Creating Threads (method 2)

- implementing Runnable interface
  - virtually identical to extending Thread class
  - must still define the *run()* method
  - setting up the threads is slightly different

Creating Threads Example 2

```
class Output implements Runnable {
    private String toSay;
    public Output(String st) {
        toSay = st;
    }
    public void run() {
        try {                   for(;;) {
                                System.out.println(toSay);
                                Thread.sleep(1000);
                    }
        } catch(InterruptedException e) {
                    System.out.println(e);
        }}}
```

Example 2 (continued)

```
class Program {
    public static void main(String [] args) {
        Output out1 = new Output("Hello");
        Output out2 = new Output("There");
        Thread thr1 = new Thread(out1);
        Thread thr2 = new Thread(out2);
        thr1.start();
        thr2.start();
    }
}
```

- main is a bit more complex
- everything else identical for the most part

Advantage of Using Runnable

- remember - can only extend one class
- implementing runnable allows class to extend something else

Controlling Java Threads

- _.*start()*: begins a thread running
- _.*stop()*: kills a specific thread (deprecated)
- _.*join()*: wait for specific thread to finish

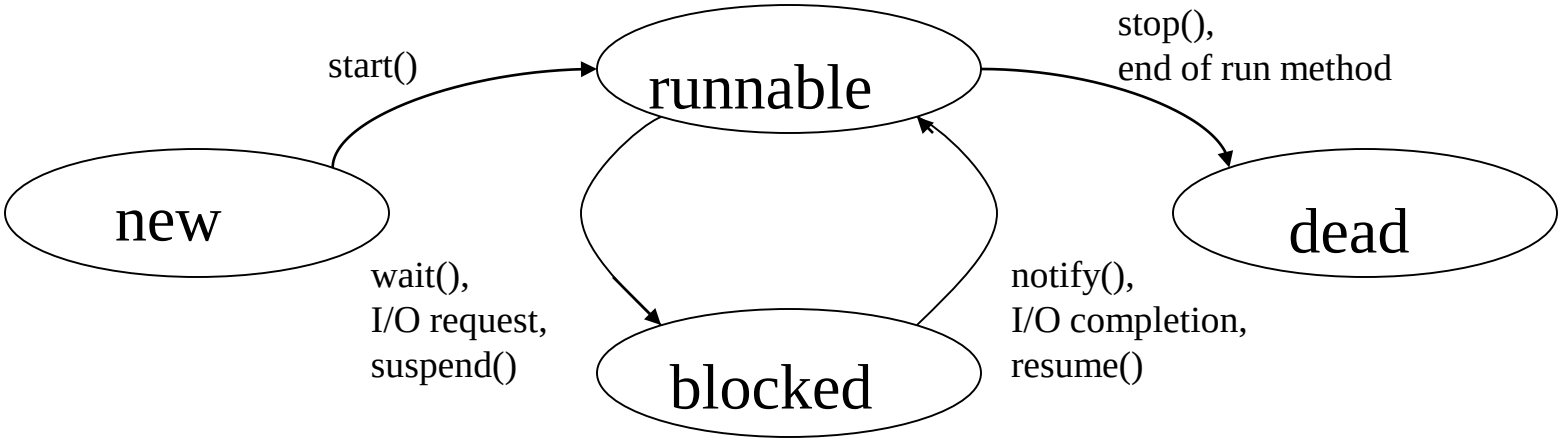
Java Thread Scheduling

- highest priority thread runs
  - if more than one, arbitrary
- *yield()*: current thread gives up processor so another of equal priority can run
  - if none of equal priority, it runs again
- *sleep(msec)*: stop executing for set time
  - lower priority thread can run

States of Java Threads

- 4 separate states
  - new: just created but not started
  - runnable: created, started, and able to run
  - blocked: created and started but unable to run because it is waiting for some event to occur
  - dead: thread has finished or been stopped

States of Java Threads



Java Thread Example 1

```
class Job implements Runnable {
    private static Thread [] jobs = new Thread[4];
    private int threadID;
    public Job(int ID) {
        threadID = ID;
    }
    public void run() { do something }
    public static void main(String [] args) {
        for(int i=0; i<jobs.length; i++) {
            jobs[i] = new Thread(new Job(i));
            jobs[i].start();
        }
        try {
            for(int i=0; i<jobs.length; i++) {
                jobs[i].join();
            }
        } catch(InterruptedException e) { System.out.println(e); }
    }}
```