JAVA THREADS

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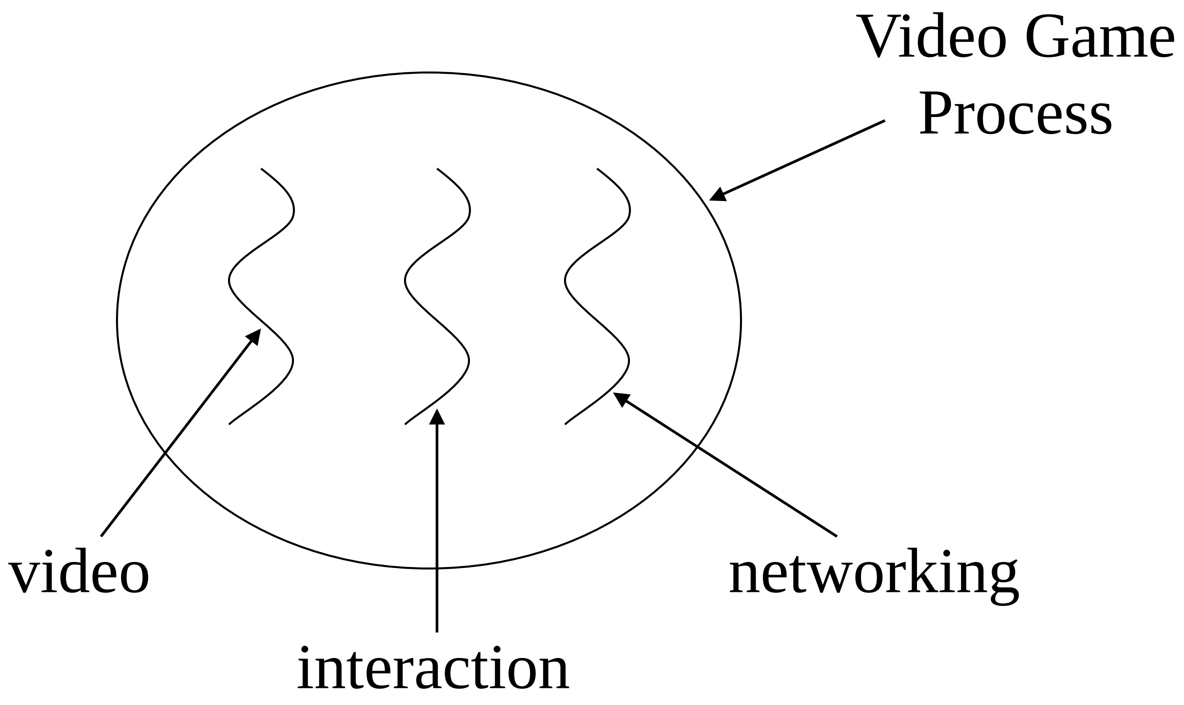
WHAT IS A THREAD?

- **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

***wait()* and *notify()*: for synchronization**

- more on this later

_.*stop()*: kills a specific thread (deprecated)

_.*suspend()* and *resume()*: deprecated

_.*join()*: wait for specific thread to finish

_.*setPriority()*: 0 to 10 (MIN_PRIORITY to MAX_PRIORITY); 5 is default (NORM_PRIORITY)

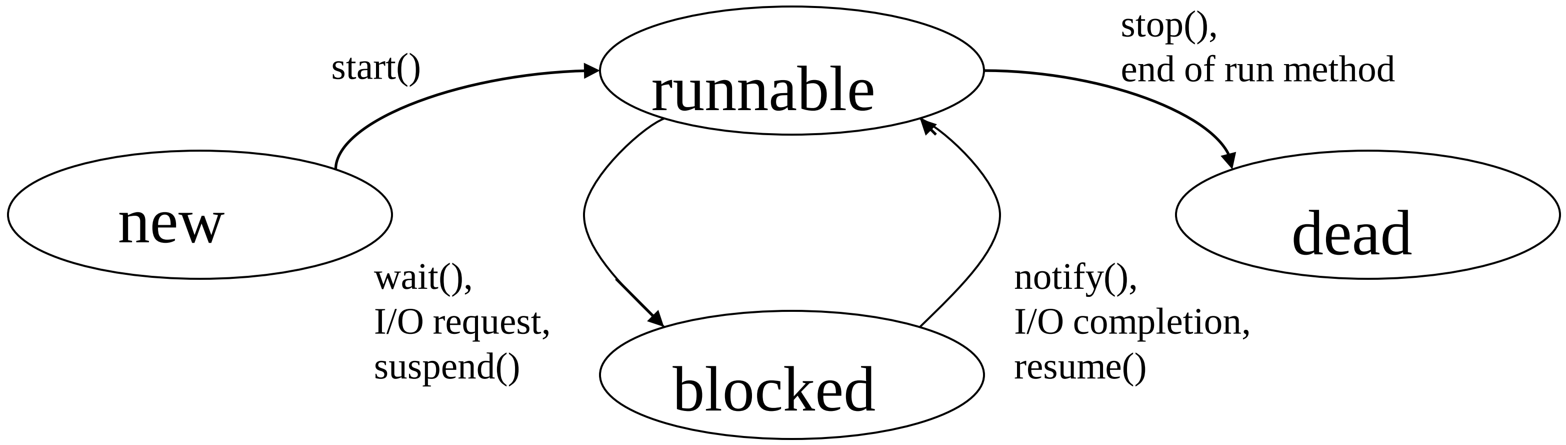
JAVA THREAD SCHEDULING

- **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); }
        }
}
```

JAVA THREAD EXAMPLE 2

```
class Schedule implements Runnable {
        private static Thread [] jobs = new Thread[4];
        private int threadID;
        public Schedule(int ID) {
                threadID = ID;
        }
        public void run() { do something }
        public static void  main(String [] args) {
                int nextThread = 0;
                setPriority(Thread.MAX_PRIORITY);
                for(int i=0; i<jobs.length; i++) {
                  jobs[i] = new Thread(new Job(i));
                  jobs[i].setPriority(Thread.MIN_PRIORITY);
                  jobs[i].start();
                }
                try {
                  for(;;) {
                    jobs[nextThread].setPriority(Thread.NORM_PRIORITY);
                    Thread.sleep(1000);
                    jobs[nextThread].setPriority(Thread.MIN_PRIORITY);
                    nextThread = (nextThread + 1) % jobs.length;
                  }
                } catch(InterruptedException e) { System.out.println(e); }
        }
}
```