CS342: Software Design

September 12, 2017

Agenda

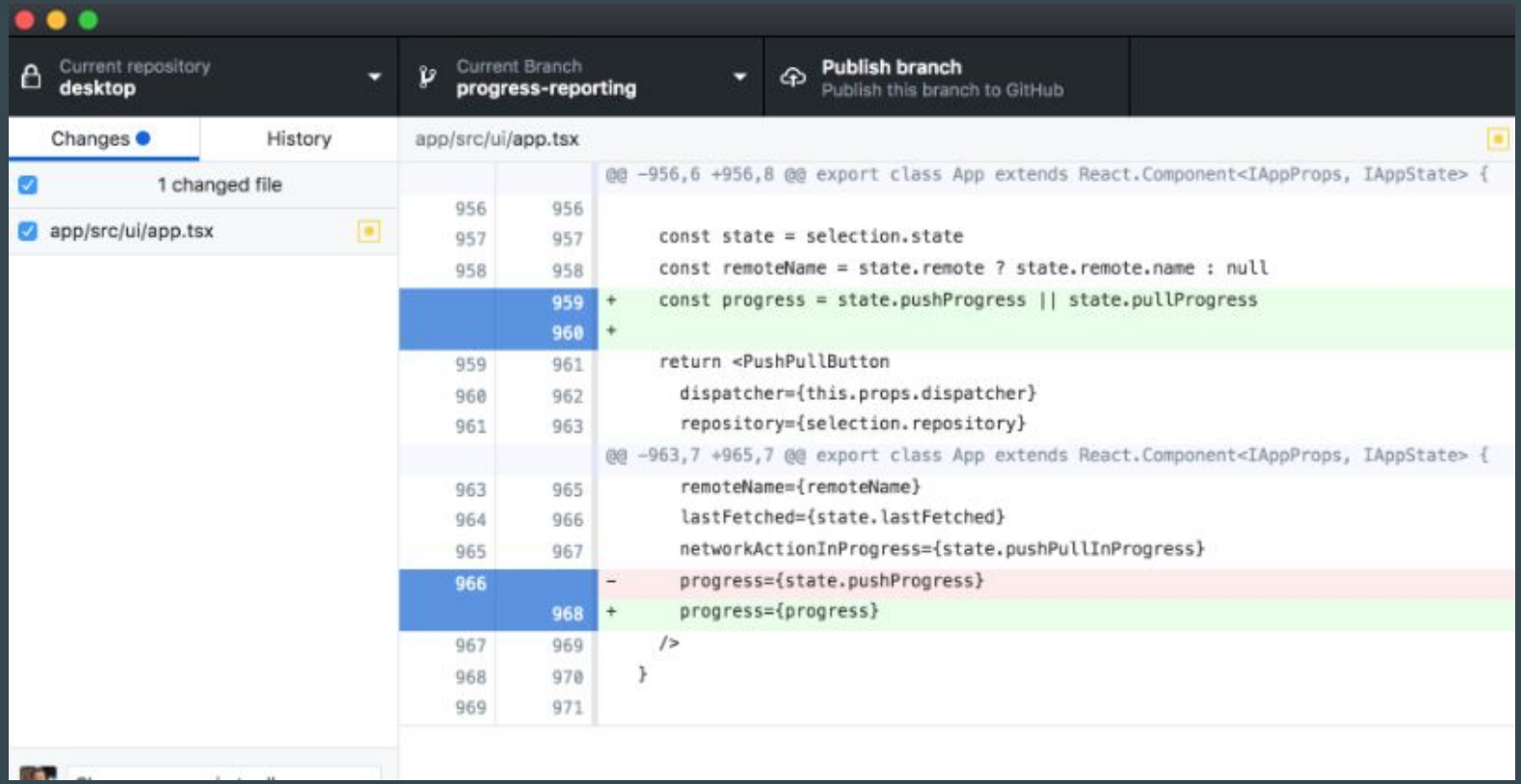
GitHub introduction

Timer

Thread

- Why threading?
- Runnable Interface, thread lifecycle
- sleep and interrupt
- Synchronize threads: synchronized methods
- Code example: wait/notify
- Code example: round robin, time slicing, priority
- sleep vs. wait vs. yield
- Thread pooling and concurrency utilities

GitHub - web-based Git or version control repository



Track change history

Commits on Nov 19, 2015

starting to upgrade jasmine version and fix broken tests
derickbailey committed on Nov 19, 2015

89757af

Commits on Mar 9, 2015

ensuring steps run one at a time, sequentially
derickbailey committed on Mar 9, 2015

2caee6c

Commits on Jan 1, 2015

renamed project to migroose, to avoid naming conflict
derickbailey committed on Jan 1, 2015

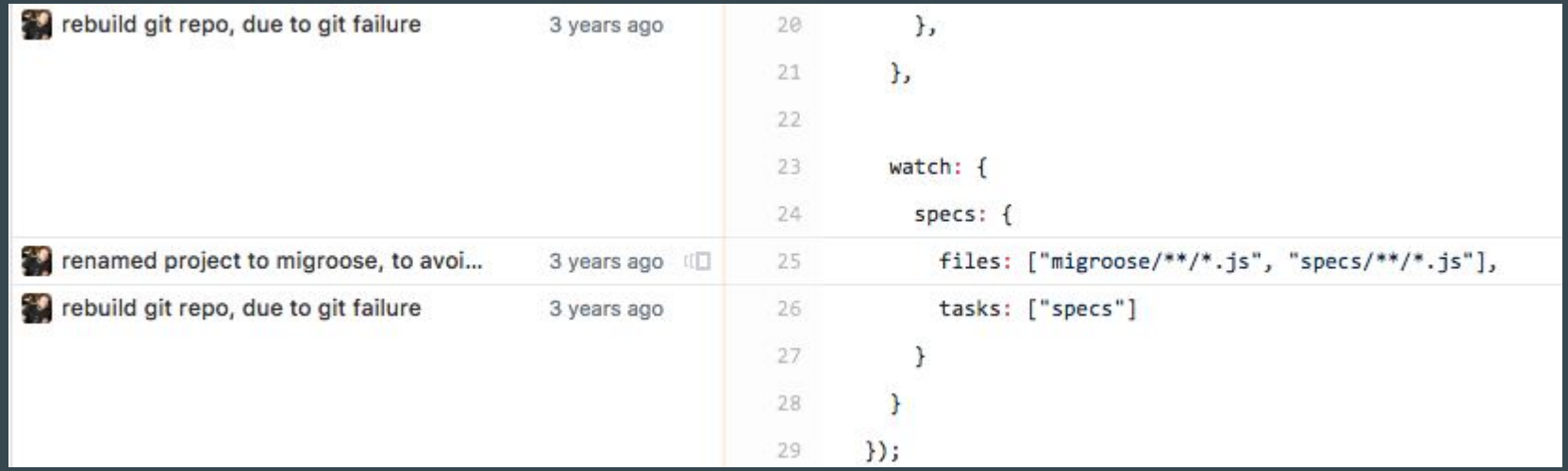
93c77cd

Commits on Dec 31, 2014

rebuild git repo, due to git failure
derickbailey committed on Dec 31, 2014

cd59efa

Who wrote this line of code?



But it’s much more than that...

Branch, merge, flow control

Knowledge sharing

Issue tracking

Analytics - contributors, pulse, activities...

Project management: ZenHub extension, filters

Your name card as a developer

Timer class

Scheduler to set up something to run at designated time

Each object is a background thread watching clock

When scheduled time comes, it triggers the task

```
import java.util.*;
public class Y2K {
    public static void main(String[] args) {
        Timer timer = new Timer( );
        TimerTask task = new TimerTask( ) {
            public void run( ) {
                System.out.println("Y2K!");
            }
        };
        Calendar cal = new GregorianCalendar( 2000, Calendar.JANUARY, 1 );
        timer.schedule( task, cal.getTime( ));
    }
}
```

Schedule Task at certain frequency

```
import java.util.*;
import java.util.Date.*;
import java.text.SimpleDateFormat;
public class Clock {
    public static void main(String[] args) {
        Timer timer = new Timer( );
        TimerTask task = new TimerTask( ) {
            public void run( ) {
                SimpleDateFormat dateFormat = new SimpleDateFormat("yyyy/MM/dd HH:mm:ss");
                Date date = new Date();
                System.out.println(dateFormat.format(date));
            }
        };
        timer.scheduleAtFixedRate( task, 0, 1000 );
    }
}
```

Why Thread?

Event driven programming means things happen simultaneously

Better usage of computing resource

Commonly used in GUI - event dispatching thread (EDT) - AWT

Not so much explicitly in backend, however:

- By nature, backend (server) supports multiple clients at the same time
- “Thread-safe”
- Enterprise email dispatching example

Thread could be messy, so be careful

Thread vs. Process

Runnable interface: create “threading” object

Thread is a flow of control within a program

Thread vs. process

All execution in Java is associated with a Thread object. Main thread

Thread begins by run() method of implementation of Runnable

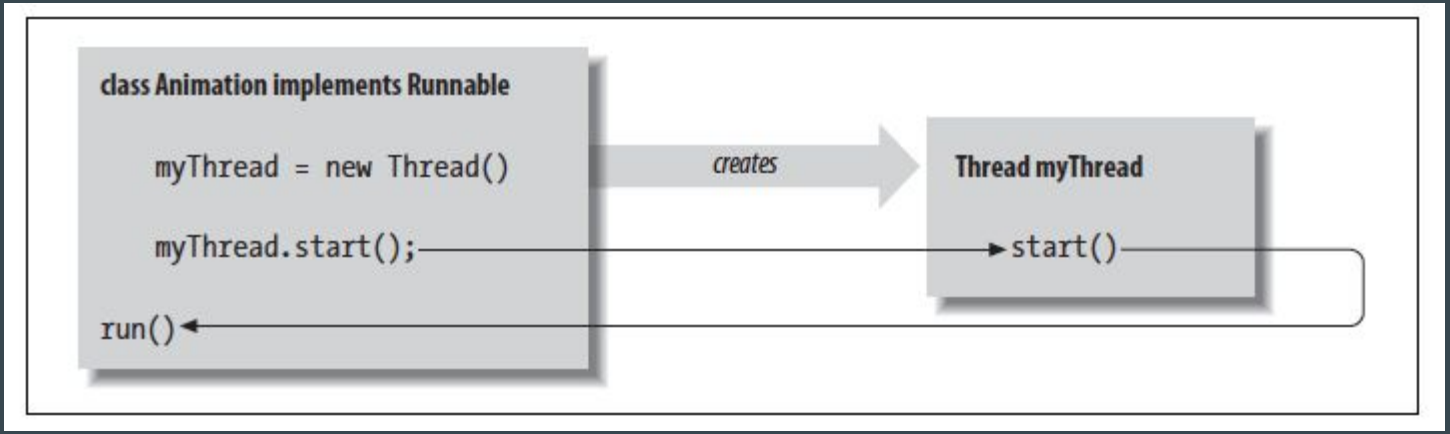
Create a thread by implementing Runnable

Thread myThread = new Thread(targetObject);

myThread.start();

```
1  class HelloComponent4 extends JComponent
2      implements MouseMotionListener, ActionListener, Runnable
3  {
4      public HelloComponent4( String message ) {
5          Thread t = new Thread( this );
6          t.start( );
7      }
8      public void run( ) {
9          try {
10         while(true) {
11             blinkState = !blinkState; // Toggle blinkState.
12             repaint( ); // Show the change.
13             Thread.sleep(300);
14         }
15         } catch (InterruptedException ie) { }
16     }
```

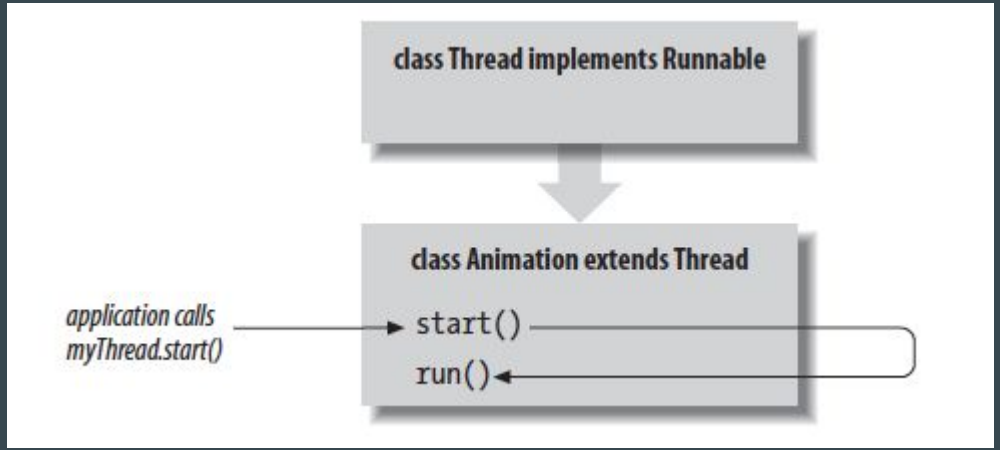
How does this work?



Create a thread by inherit Thread class

This is so convenient, right?

```
class DrawPicture extends Thread {
    boolean keepGoing = true;
    public void run( ) {
        while ( keepGoing ) {
        // do something
        }
    }
}
```



Why do we favor implementing Runnable interface?

By subclassing Thread, the new object is an instance of Thread

- It getting heavy and dirty
- Exposing all public properties and function

I want my class to have ability to thread, not special case of a thread

Implement vs. Inherit

Example: I want to be able to program with Java..

Thread methods and coordination

Deprecated methods

- resume, stop, suspend
- Unexpected behavior, deadlock

sleep() method: make thread to sit idle for specified time

interrupt(): wakes up a thread

join(): block the caller until thread completes.

yield(), wait(), notify(), notifyAll()

Sleep and interrupt

```
public static void main(String[] args) {
    MyClass si = new MyClass();
    Thread t = new Thread(si);
    t.start();
    try {
        Thread.sleep(2000);
    } catch (InterruptedException x) { }

    System.out.println("in main() - interrupting other thread");
    t.interrupt();
    System.out.println("in main() - leaving");
}
```

Synchronized methods

“Serializing” Access to Methods - execution can’t enter two such methods at the same time

```
synchronized private void changeColor( ) {
    if (++colorIndex == someColors.length)
        colorIndex = 0;
    setForeground( currentColor( ) );
    repaint( );
}

private void changeColor( ) {
    synchronized (this) {
        if (++colorIndex == someColors.length)
            colorIndex = 0;
        setForeground( currentColor( ) );
        repaint( );
    }
}
```

Cost of synchronized methods is high..

yield(): hey scheduler, i’m a nice guy...

wait(): wait until another thread invokes the notify() method or the notifyAll()

notify(), notifyAll(): wakes up one or multiple waiter methods

Producer and consumer example

Thread State - threadObj.getState()

NEW

RUNNABLE

BLOCKED

WAITING

TERMINATED

Thread State - threadObj.getState()

NEW

RUNNABLE

BLOCKED

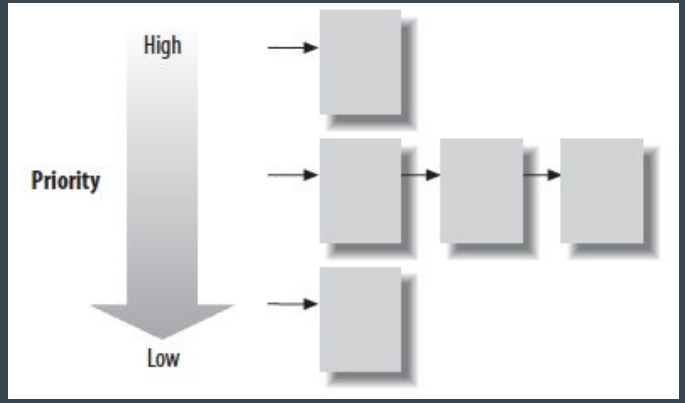
WAITING

TERMINATED

Thread scheduling - round-robin

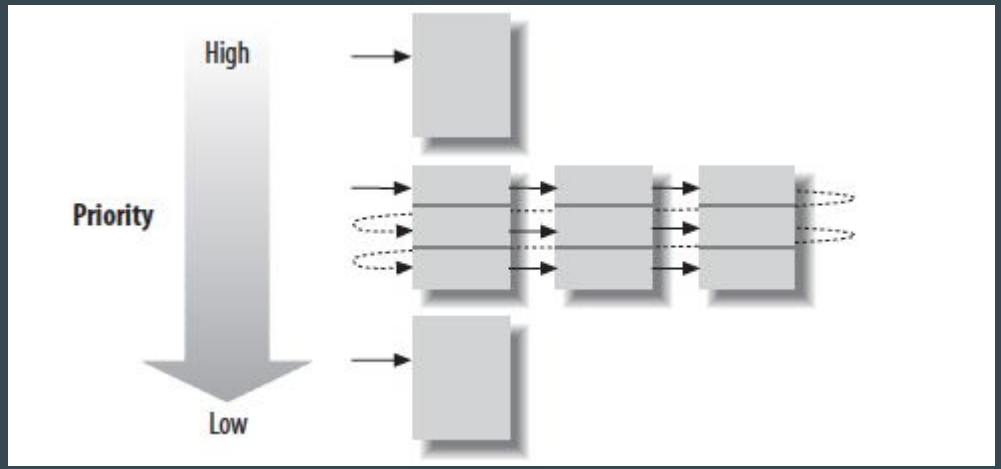
Scheduler picks up next thread when

- Sleeps, by calling Thread.sleep( ) or wait( )
- Waits for a lock, in order to run a synchronized method
- Blocks on I/O, for example, in a read( ) or accept( ) call
- Explicitly yields control, by calling yield( )
- Terminates, by completing its target method or with a stop( ) call (deprecated)



Thread scheduling - time slicing

Thread processing is chopped up so that each thread runs for a short period



How do i know?

```
public class Thready {
    public static void main( String args [] ) {
        new ShowThread("Foo").start( );
        new ShowThread("Bar").start( );
    }

    static class ShowThread extends Thread {
        String message;
        ShowThread( String message ) {
            this.message = message;
        }
        public void run( ) {
            while ( true )
                System.out.println( message );
        }
    }
}
```

However, you should assume round-robin!!!

Set thread priority

```
public class ThreadyPriority {
    public static void main( String args [] ) {
        new ShowThread("Foo").start( );
        foo.setPriority( Thread.MIN_PRIORITY );
        new ShowThread("Bar").start( );
        bar.setPriority( Thread.MAX_PRIORITY );
    }
```

Yielding

```
        }
        public void run( ) {
            while ( true ) {
                System.out.println( message );
                yield();
            }
        }
    }
```