Threads in Swing

Using threads for long running tasks.

Other ways to use threads:

1) TimerTask in java.util and javax.swing

2) Executer - manage a thread pool

3) Future - return a result later

3 Kinds of Threads

In a Swing app:

- initial thread starts the application
- Event Dispatcher Thread
  - handles all UI events, updates Swing UI
- Worker Threads (Background Threads)
  - perform long running tasks

Why Bother with Threads?

- Prevent UI from *Freezing* while work is being done
  - connecting to database
  - downloading something
- Avoid *Thread Interference* and memory inconsistency
  - Like in Homework 3

"main" method - the wrong way

- your "main" class runs in the initial thread (any thread)
- this code starts Swing UI on the same thread.

```
public class PurseApp {
  public static void main(String[] args) {
       Purse purse = new Purse( 10 );
       // dependency injection
       PurseUI ui = new PurseUI( purse );
       ui.setVisible(true);
  }
```

Use SwingUtilities to launch UI

- Oracle says you should both create and launch the UI on the *Event Dispatcher thread*.

Use `SwingUtilities.invokeLater( runnable );`

```
public class PurseApp {
   public static void main(String[] args) {
      SwingUtilities.invokeLater(
         new Runnable( ) {
           public void run() {
              // create and start UI
           }
        }
    }
}
```

SwingUtilities

SwingUtilities

invokeLater(Runnable): void

invokeAndWait(Runnable): void

isEventdispatcherThread(): bool

many more methods

Rules for Event Dispatcher Thread

To prevent UI from freezing and to prevent memory inconsistency:

1) operations on UI components should be done <u>*only*</u> in the Event Dispatcher thread
2) time-consuming operations should <u>never</u> be done on the Event Dispatcher thread

Note that all UI events (button press, state change) invoke event handlers on the event dispatcher thread.

Example: Fibonacci

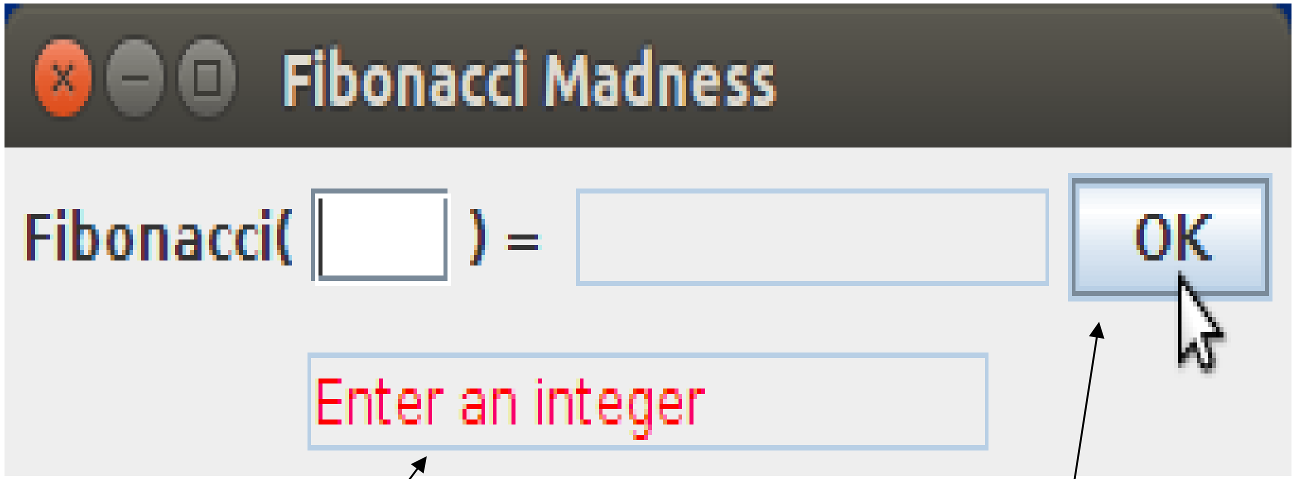
- as an example of a slow operation, let's compute Fibonacci numbers by recursion.
- fib(0) = 1, fib(1) = 1, fib(n) = fib(n-1) + fib(n-2)

```
public class Ribonacci {

    // this method could be static
    public long fibonacci(int n) {
        if (n < 0) return 0;
        if (n <= 1) return 1;
        return fibonacci(n-2) + fibonacci(n-1);
    }

    //TODO: test this code
}
```

UI for Fibonacci



Enter an integer

Status or error message.

TODO:
add ActionListener

Frozen UI

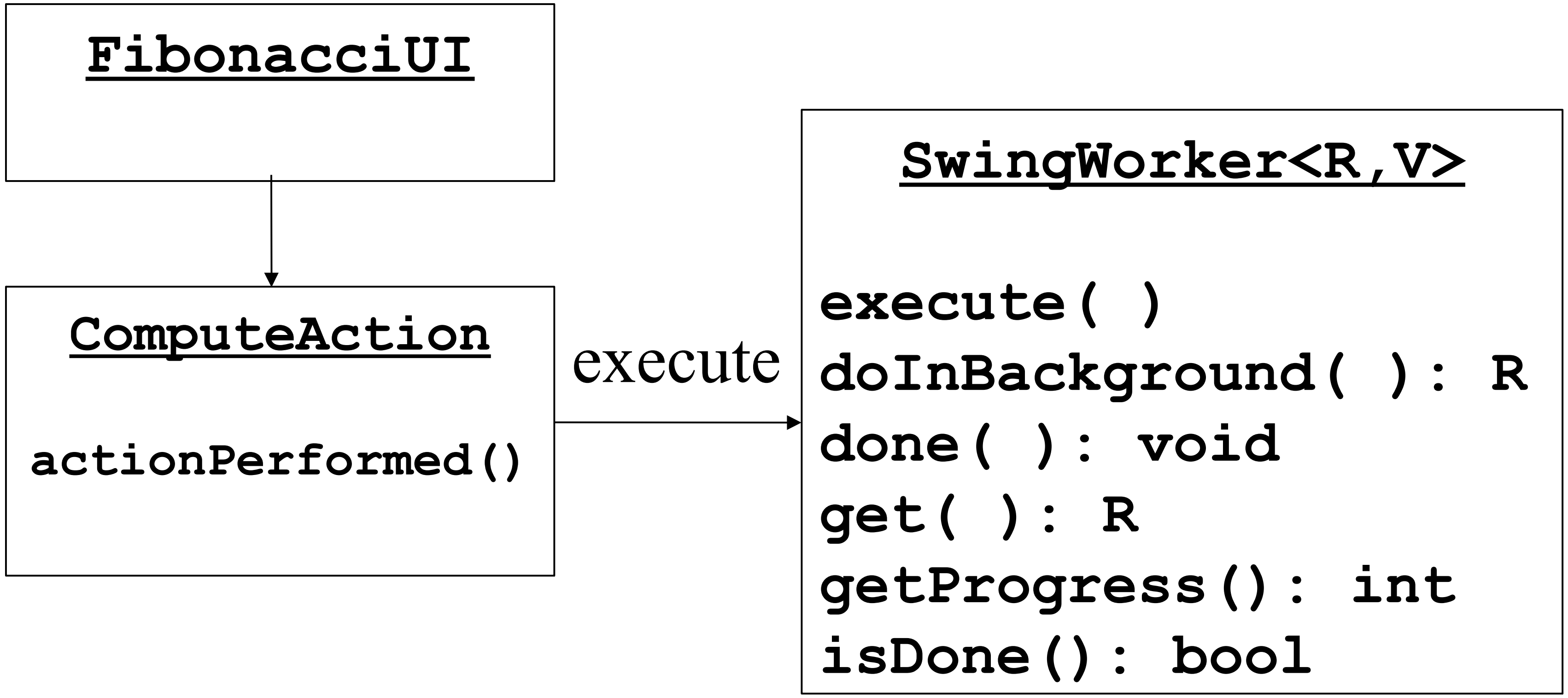
UI freezed (unresponsive) if you use try to compute fibonacci on the event dispatcher thread.

```
// ActionListener method for fibonacci UI
public void actionPerformed(ActionEvent evt) {
    String value = inputField.getText().trim();
    if (value.isEmpty()) return;
    int n = Integer.parseInt( value );
    setMessage( "working" );
    long result = Fibonacci.fibonacci( n );
    outputField.setText( Long.toString(result) );
    setMessage( "" );
}
```

SwingWorker

SwingWorker runs a task in a background thread.

SwingWorker communicates result to Event Dispatcher Thread.



How to Use SwingWorker

1) Create a subclass of SwingWorker for your task.

2) Override 2 methods:

`doInBackground( )` - do the work (on background thread)

`done( )` - communicate the result to UI (this method runs on event dispatcher thread)

Optional:

`publish( V stuff )` - publish intermediate results

More About SwingWorker

1) Can invoke only one time. Create a new instance each time you need to do a task.

2) Can "cancel" a SwingWorker, but requires cooperation of the task. See *Java Tutorial*.

3) Status methods:

```
getProgress( )
isDone( )
isCancelled( )
```

References

The Java Tutorial:
https://docs.oracle.com/javase/tutorial

Concurrency in Swing

https://docs.oracle.com/javase/tutorial/uiswing/concurrency/index.html

Concurrency (general)

https://docs.oracle.com/javase/tutorial/essential/concurrency/index.html