UT ECE | THE UNIVERSITY OF TEXAS AT AUSTIN
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

EE360T/382V Software Testing

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Overview

Last time – Symbolic execution

Today

- Testing multi-threaded code
- Testing websites

Next time – Review for Exam 3

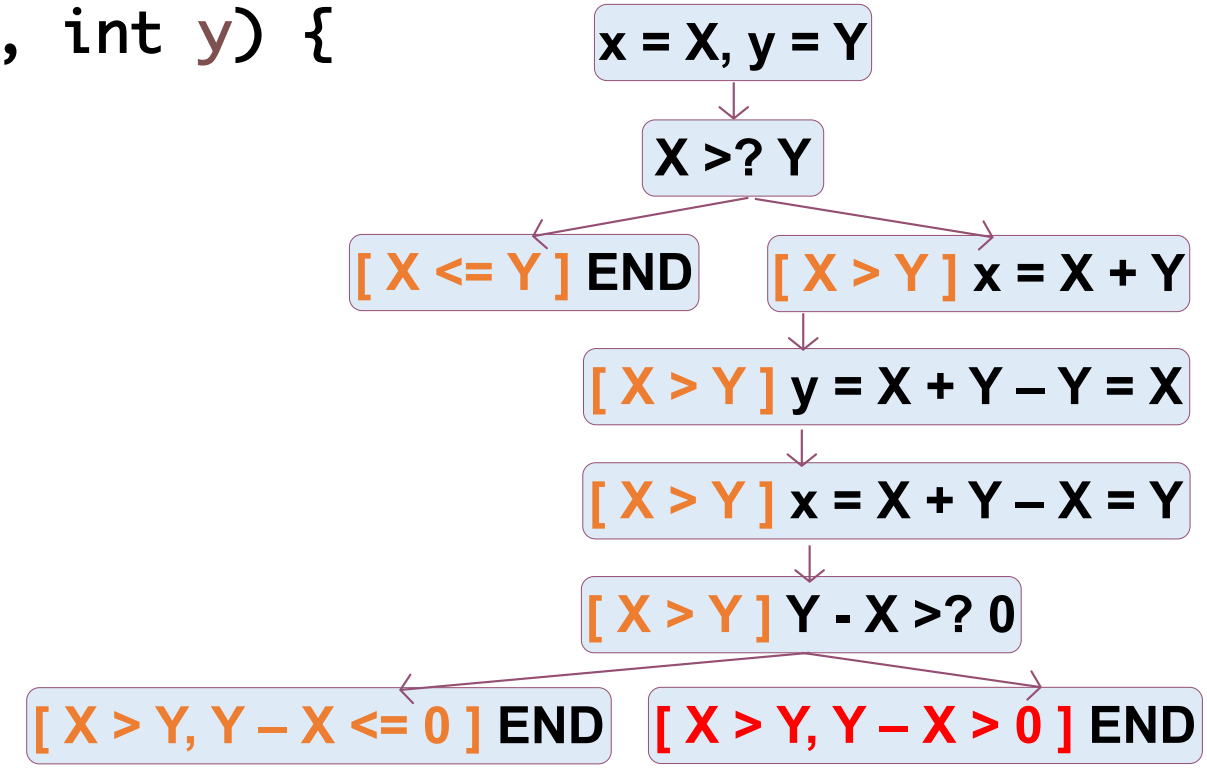
Reminder

- **Exam 3 on Monday, April 30** – in-class, closed book
  - Focus: Practical considerations (Text), systematic testing, non-det. choice, symbolic execution

Problem Set 6 is out – Due: 5/4 11:59pm

Quick recap: Symbolic execution

```
static void m(int x, int y) {
  if (x > y) {
    x = x + y;
    y = x - y;
    x = x - y;
    if (x - y > 0)
      assert false;
  }
}
```



Exercise

List the path conditions for the following program, and provide a solution for each path condition

```
static boolean isSum2(int[] a, int sum) {
  for (int i = 0; i < a.length; i++) {
    for (int j = i + 1; j < a.length; j++) {
      if (a[i] + a[j] == sum) return true;
    }
  }
  return false;
}
```

Assume: `a != null && a.length == 3`

Path conditions for isSum2

PC: ((A[0] + A[1]) != X), ((A[0] + A[2]) != X), ((A[1] + A[2]) != X)

- Solution: <[1, 1, 0], 0>; Output: false

PC: ((A[0] + A[1]) != X), ((A[0] + A[2]) != X), ((A[1] + A[2]) == X)

- Solution: <[1, 0, 0], 0>; Output: true

PC: ((A[0] + A[1]) != X), ((A[0] + A[2]) == X)

- Solution: <[0, 1, 0], 0>; Output: true

PC: ((A[0] + A[1]) == X)

- Solution: <[0, 0, ?,], 0>; Output: true

Recall: Creating threads in Java
[Oracle Java documentation/Java tutorials]

Each thread has an associated thread object

There are 2 ways to create a thread object

- Implement Runnable interface's run method

```
public class MyThreadIR implements Runnable {
   public void run() { System.out.println("hello!"); }
   public static void main(String[] a) { new Thread(new MyThreadIR()).start(); }
}
```

- Subclass java.lang.Thread

```
public class MyThreadST extends Thread {
   public void run() { System.out.println("hello!"); }
   public static void main(String[] a) { new MyThreadST().start(); }
}
```

Example: Does the assertion fail?

```
public class ThreadExample extends Thread {
    static int x = 0;

    public void run() {
        x++;
    }

    public static void main(String[] a) {
        new ThreadExample().start();
        new ThreadExample().start();
        assert x == 2;
    }
}
```

JPF output on checking the assertion

```
====================================================== error 1
gov.nasa.jpf.vm.NoUncaughtExceptionsProperty
java.lang.AssertionError
        at apr232018.ThreadExample.main(ThreadExample.java:13)
====================================================== snapshot #1
thread java.lang.Thread:{id:0,name:main,status:RUNNING,priority:5,
isDaemon:false,lockCount:0,suspendCount:0}
  call stack:
        at apr232018.ThreadExample.main(ThreadExample.java:13)

thread apr232018.ThreadExample:{id:2,name:Thread-
2,status:RUNNING,priority:5,isDaemon:false,lockCount:0,suspendCount:0}
  call stack:

====================================================== results
error #1: gov.nasa.jpf.vm.NoUncaughtExceptionsProperty
"java.lang.AssertionError  at apr232018.ThreadExamp..."
```

Testing web apps

Problem: how to automate testing of web apps such as the Graph Coverage Web Application?

A solution: web browser automation

A tool-set: Selenium

- www.seleniumhq.org

Selenium is a suite of tools to automate web browsers across many platforms.

Structure of an HTML doc [w3.org]

Preamble

- <!DOCTYPE html>

Root element

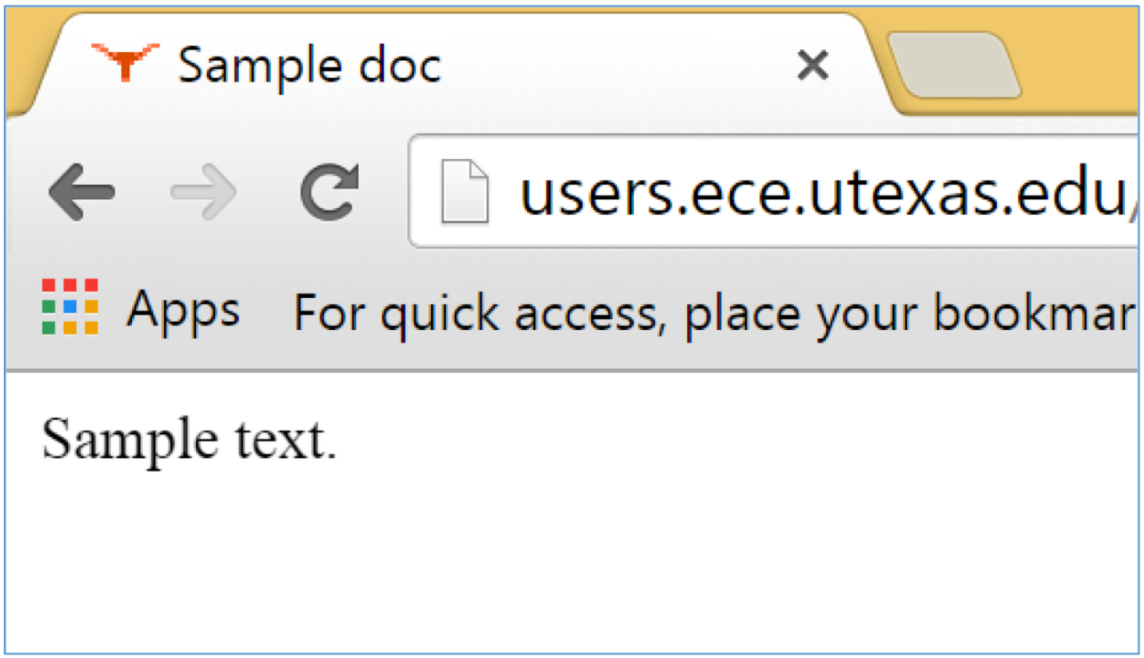
- <HTML>…</HTML>

Other elements

- Header – contains info about the doc
  - <HEAD>…</HEAD>
    - <TITLE>…</TITLE>
- Body – contains the doc's actual content
  - <BODY>…</BODY>

Example HTML page

```
<!DOCTYPE html>
<HTML>
  <HEAD>
    <TITLE> Sample doc </TITLE>
  </HEAD>
  <BODY> Sample text. </BODY>
</HTML>
```

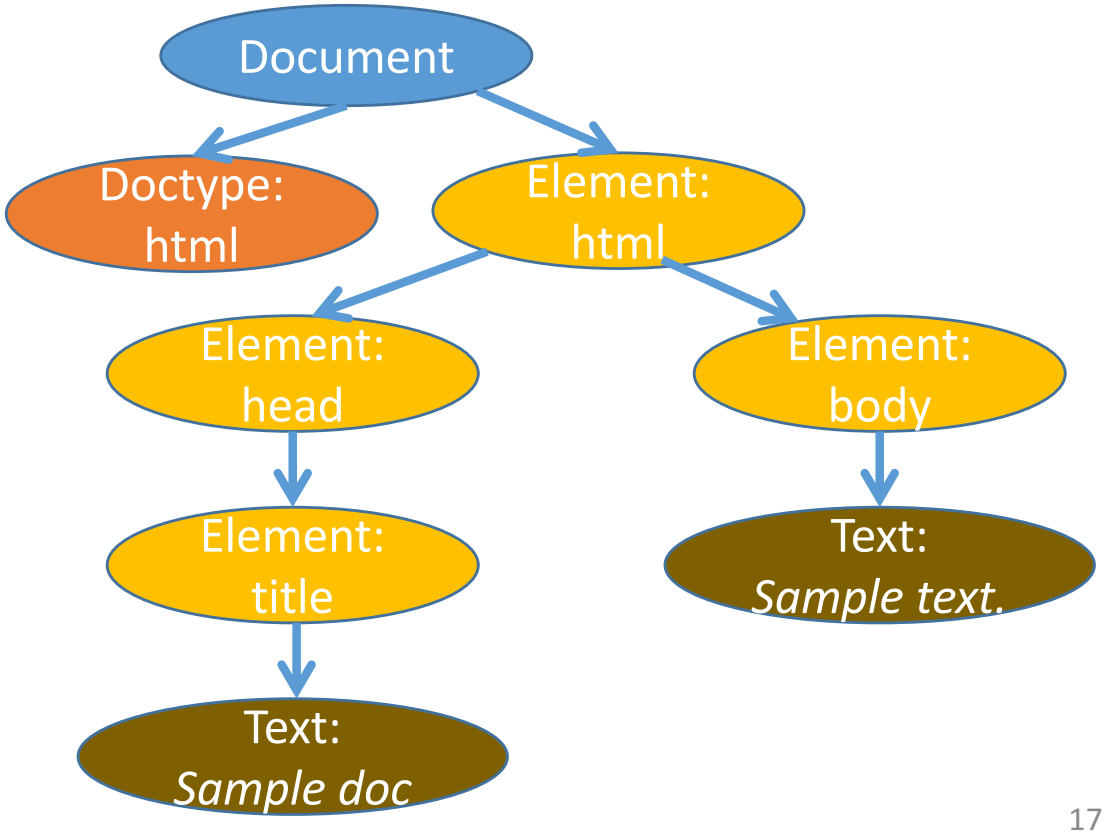


Document object model (DOM) www.w3.org/TR/domcore

Platform/language-independent interface for accessing and modifying documents (e.g., HTML)

A document is represented as a *structure* – node tree

```
<!DOCTYPE html>
<HTML>
  <HEAD>
    <TITLE> Sample doc </TITLE>
  </HEAD>
  <BODY> Sample text. </BODY>
</HTML>
```



Selenium [www.seleniumhq.org]

Selenium is a suite of tools to automate web browsers across many platforms.

Enables automated testing of web apps

Has two key components:

- WebDriver
  - Browser-based regression tests
- IDE
  - Firefox add-on for record-and-replay

?/!