Announcements for This Lecture

Prelim 1

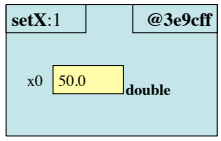
- TONIGHT 7:30-9pm
  - Abel–Price (Upson B17)
  - Rabbit–Teo (Upson 111)
  - Ting–Zytariuk (Upson 109)
- Graded late tonight
  - Will have grade Fri morn
  - In time for drop day
- Make-up, Friday 4:30
  - For preapproved students

Assignments

- A4 due next Thursday
  - Last weekend to work on it
  - Should be straight-forward after this exam.
  - Graded when you get back
- A5 posted next Thursday
  - Have 1.5 weeks after Spring Break to do it
  - Welcome, but not expected, to do it over the break

Review: Method Calls

- Method calls require frames
  - Model how the call works
- Steps to the method call:
  1. Draw a frame for the call
  2. Assign the argument value to the parameter (in frame)
  3. Execute the method body
     - Look for variables in the frame
     - If not there, look in folder given by the scope box
  4. Erase the frame for the call



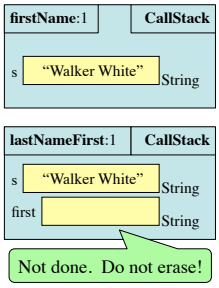

```
public void setX(double x0) {
    x = x0;
}
```

Only at the End!

Frames and Helper Methods

```
/** Precondition: s is in form
 * <first-name> <last-name> */
public static String
      lastNameFirst(String s) {
  String first = firstName(s);  // Line 1
  String last  = lastName(s);   // Line 2
  return last+","+first;        // Line 3
}

/** Precondition: see lastNameFirst */
public static String firstName(String s) {
  int end = s.indexOf(" ")
  return s.subString(0,end);
}
```



Not done. Do not erase!

Frames and Helper Methods

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/** Precondition: s is in form
 * <first-name> <last-name> */
public static String
      lastNameFirst(String s) {
  String first = firstName(s);  // Line 1
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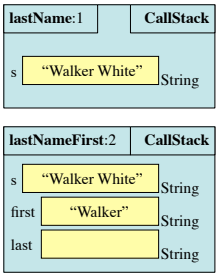
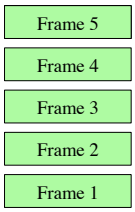


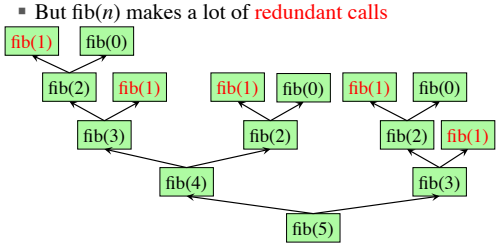
The Call Stack

- Methods are "stacked"
  - Like a stack of plates
  - Cannot remove one below w/o removing above
- Stack represents memory "high water mark"
  - Must have enough to keep the stack in memory
  - StackOverflow if cannot hold the entire stack.



Fibonacci: # of Frames vs. # of Calls

- Fibonacci is very inefficient.
  - fib(n) has a stack that is always $\leq n$
  - But fib(n) makes a lot of redundant calls



Debugging and the Call Stack

- Errors or Exceptions in Java give current call stack

```
06  /** Yields: String s truncated …. */
07  public static String truncate5(String s) {
08      int b = 10 / 0;
09      if (s.length() <= 5) { return s; }
10
11      return s.substring(0,5);
12  }
```

Turn on line numbering in DrJava. Preferences / Display Options

important part

call stack

```
ArithmeticException: / by zero
 at A4Methods.truncate5(A4Methods.java:8)
 at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
 at sun.reflect.NativeMethodAccessorImpl.invoke(….java:39)
 at sun.reflect.DelegatingMethodAccessorImpl.invoke(….java:25)
 at java.lang.reflect.Method.invoke(Method.java:585)
```

Debugging Strategies

Black Box Testing

- Method is "opaque"
  - Test looks at what it does
  - Functions: what it returns
  - Procedures: what changes
- **Example**: JUnit tests
- **Problems**:
  - Are the tests everything?
  - What caused the error?

White Box Testing

- Method is "transparent"
  - Tests/debugging takes place inside of the method
  - Focuses on where error is
- **Example**: ?????
- **Problems**:
  - Much harder to do
  - Hurts code performance

Assert Statements

```
assert <boolean>;  // Creates Exception if <boolean> false
assert <boolean> : <String>; // As above, but displays <String>
```

- Can write and forget
  - Only used if debugging turned on in Java
  - Otherwise, Java treats it like a comment
- Code defensively!

```
/** Set worker's last name to n
 * Precondition: Cannot be null */
public void setName(String n) {
  assert n!= null;
  lname = n;
}
```

Print-Statements: Invasive Debugging

- System.out.print(String):
  - Prints a String to console (next to Interaction Pane)
  - Works outside of DrJava (if no Interactions Pane)
- System.out.println(String):
  - Same, but provides a "carriage return"
- **Strategy**: Put inside method to see what it does
  - **Variables**: look at current value
  - ***Traces***: figure out the "code path"

Tracing with Print Statements

- Method to right is buggy
  - w.setName("White") sets the name to null (???)
  - Violates the specification
- Observation: not all code should be executed
  - Should skip over if
  - Use traces to see if it actually skips over if

```
public class Worker {
…
  /** Sets name to n; "<none>"
   *  if n null or "" */
  public void setName(String n) {
    name = n;
    if (n == null || n.equals("" )); {
      name = "<none>";
    }
  }
…
```

Tracing with Print Statements

Console

- 1: …
- 2: White
- 3: White
- 4: <none>

After a command

Invasive
Must remove all statements from "shipping" code.

At the start

```
public void setName(String n) {
  System.out.println("1:"+name);
  name = n;
  System.out.println("2:"+name);
  if (n == null || n.equals("" )); {
    System.out.println("3:"+name);
    name = "<none>";
    System.out.println("4:"+name);
  }
}
```