Java Exception Handling

Handling errors using Java's exception handling mechanism

Approaches For Dealing With Error Conditions

- Use branches/decision making and return values
- Use Java's exception handling mechanism

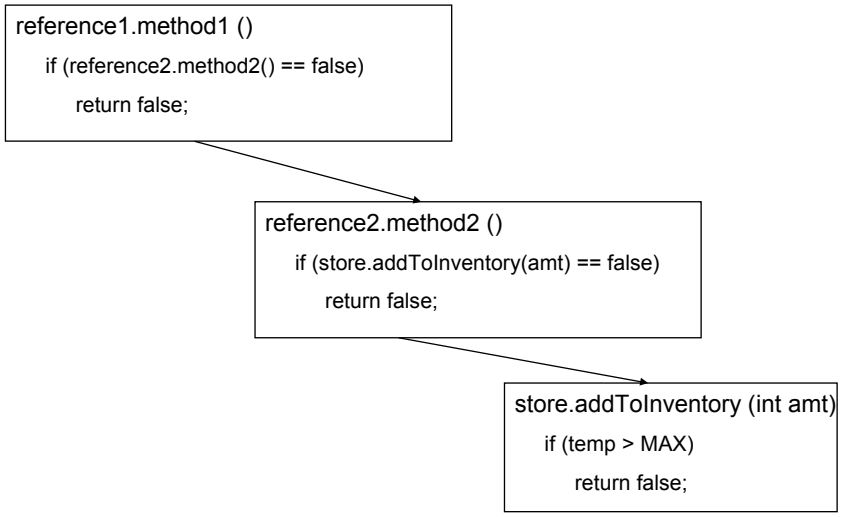
Class Inventory: An Earlier Example

```
public class Inventory
{
   public final int MIN = 0;
   public final int MAX = 100;
   public final int CRITICAL = 10;
   public boolean add (int amount)
   {
      int temp;
       temp = stockLevel + amount;
       if (temp > MAX)
       {
          System.out.print("Adding " + amount + " item will cause stock ");
          System.out.println("to become greater than " + MAX + " units
                    (overstock)");
          return false;
       }
```

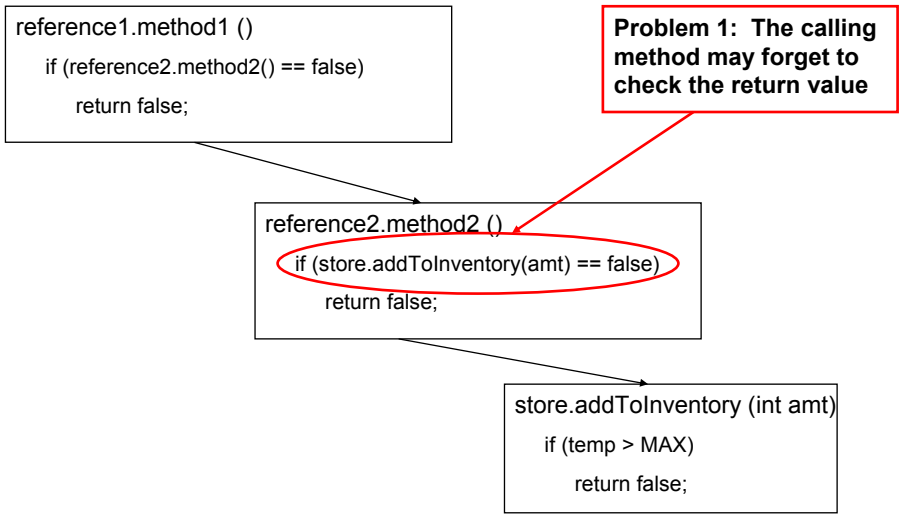
Class Inventory: An Earlier Example (2)

```
       else
       {
          stockLevel = stockLevel + amount;
               return true;
       }
   } // End of method add
   :
```

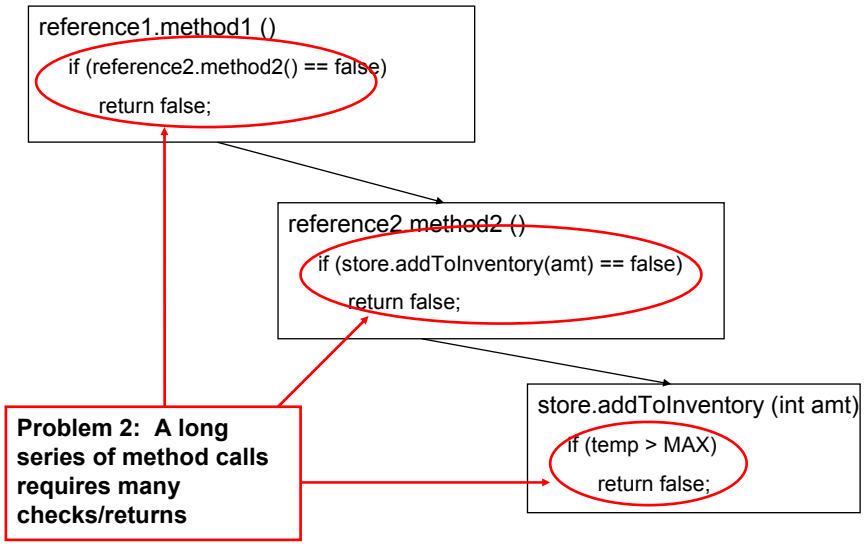
Some Hypothetical Method Calls: Condition/Return



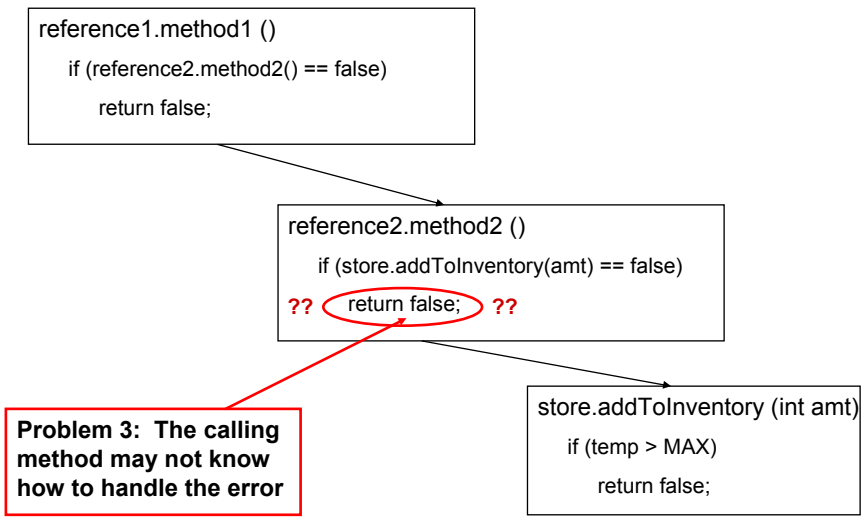
Some Hypothetical Method Calls: Condition/Return



Some Hypothetical Method Calls: Condition/Return



Some Hypothetical Method Calls: Condition/Return



Approaches For Dealing With Error Conditions

- Use branches/decision making constructs and return values
- Use Java's exception handling mechanism

Handling Exceptions

Format:

```
try
{
        // Code that may cause an error/exception to occur
}
catch (ExceptionType identifier)
{
        // Code to handle the exception
}
```

Handling Exceptions: Reading Input

Location of the online example:

/home/233/examples/exceptions/handlingExceptions/inputExample
OR
www.cpsc.ucalgary.ca/~tamj/233/examples/exceptions/handlingExceptions/inputExample

```
import java.io.*;
public class Driver {
   public static void main (String [] args)
   {
      BufferedReader stringInput;
      InputStreamReader characterInput;
      String s;
      int num;
      characterInput = new InputStreamReader(System.in);
      stringInput = new BufferedReader(characterInput);
```

Handling Exceptions: Reading Input (2)

```
      try
      {
          System.out.print("Type an integer: ");
          s = stringInput.readLine();
          System.out.println("You typed in..." + s);
          num = Integer.parseInt (s);
          System.out.println("Converted to an integer..." + num);
      }
      catch (IOException e)
      {
          System.out.println(e);
      }
      catch (NumberFormatException e)
      {
           :        :        :
      }
   }
}
```

Handling Exceptions: Where The Exceptions Occur

```
try
 {
     System.out.print("Type an integer: ");
      s = stringInput.readLine();
      System.out.println("You typed in..." + s);
      num = Integer.parseInt (s);
      System.out.println("Converted to an integer..." + num);
  }
```

Handling Exceptions: Result Of Calling ReadLine ()

```
try
 {
     System.out.print("Type an integer: ");
      s = stringInput.readLine();
      System.out.println("You typed in..." + s);
      num = Integer.parseInt (s);
      System.out.println("Converted to an integer..." + num);
  }
```

The first exception can occur here

Where The Exceptions Occur In Class BufferedReader

- For online documentation for this class go to:
  - http://java.sun.com/javase/7/docs/api/

```
public class BufferedReader
{
   public BufferedReader (Reader in);
   public BufferedReader (Reader in, int sz);
   public String readLine () throws IOException;
                        :
}
```

Handling Exceptions: Result Of Calling ParseInt ()

```
try
 {
    System.out.print("Type an integer: ");
     s = stringInput.readLine();
     System.out.println("You typed in..." + s);
     num = Integer.parseInt (s);
     System.out.println("Converted to an integer..." + num);
  }
```

The second exception can occur here

Where The Exceptions Occur In Class Integer

•For online documentation for this class go to:

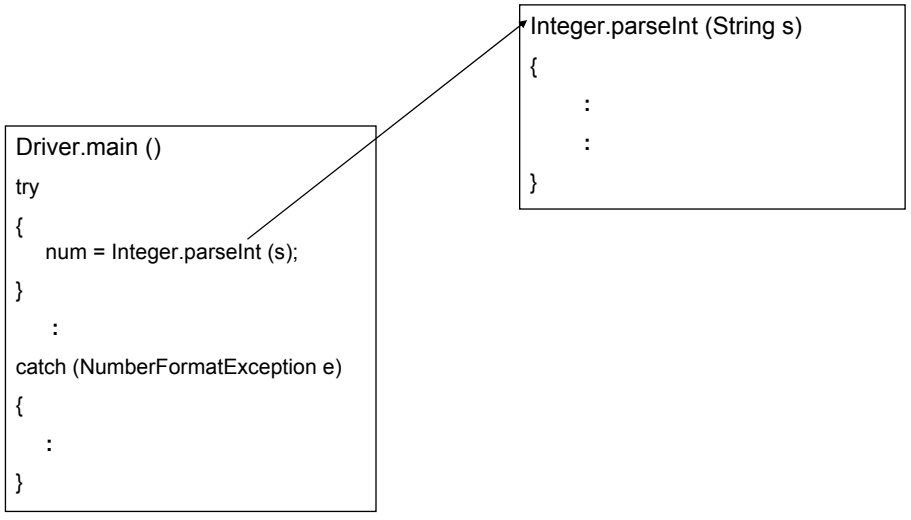
- http://java.sun.com/javase/7/docs/api/

```
public class Integer
{
   public Integer (int value);
   public Integer (String s) throws NumberFormatException;
          :                          :
   public static int parseInt (String s) throws NumberFormatException;
          :                          :
}
```

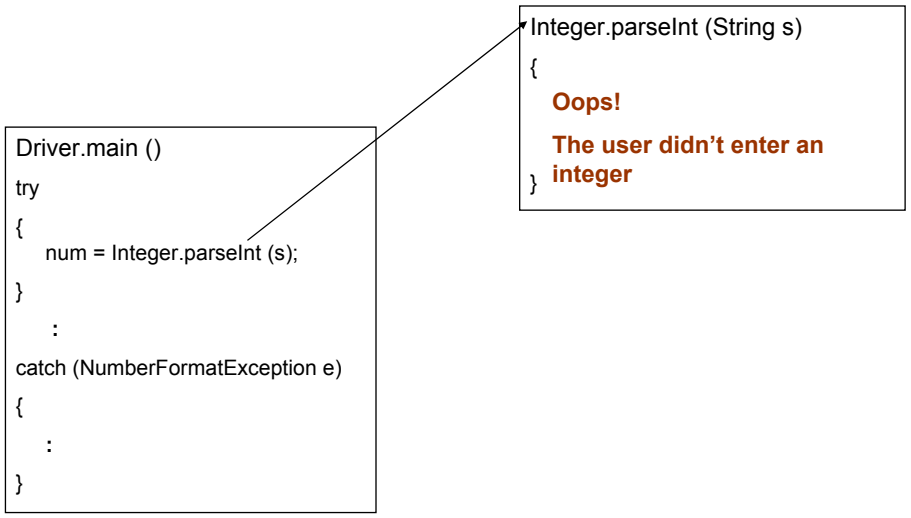
Handling Exceptions: The Details

```
      try
      {
         System.out.print("Type an integer: ");
         s = stringInput.readLine();
         System.out.println("You typed in..." + s);
         num = Integer.parseInt (s);
         System.out.println("Converted to an integer..." + num);
       }
       catch (IOException e)
       {
          System.out.println(e);
       }
       catch (NumberFormatException e)
       {
                    :        :        :
       }
   }
}
```

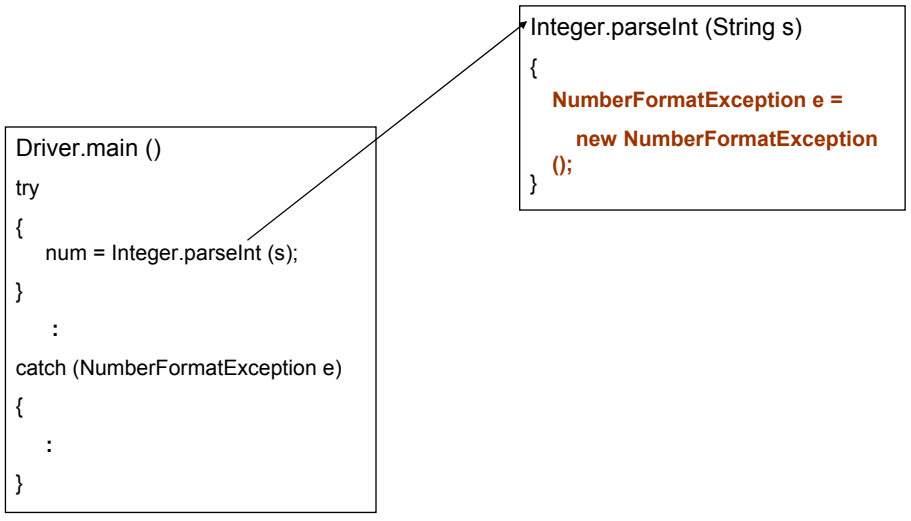
Handling Exceptions: Tracing The Example



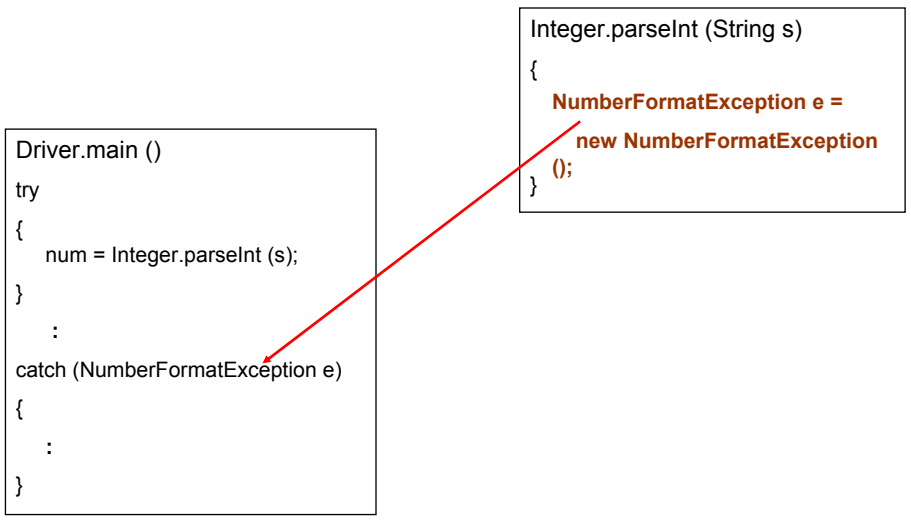
Handling Exceptions: Tracing The Example



Handling Exceptions: Tracing The Example



Handling Exceptions: Tracing The Example



Handling Exceptions: Tracing The Example

```
Integer.parseInt (String s)
{



}
```

```
Driver.main ()
try
{
    num = Integer.parseInt (s);
}
    :
catch (NumberFormatException e)
{
   Exception must be dealt with
   here
}
```

Handling Exceptions: Catching The Exception

```
        catch (NumberFormatException e)
        {
              :          :          :
        }
    }
}
```

Catching The Exception: Error Messages

```
        catch (NumberFormatException e)
        {
            System.out.println("You entered a non-integer value.');
           System.out.println(e.getMessage());
           System.out.println(e);
           e.printStackTrace();
        }
    }
}
```

Catching The Exception: Error Messages

```
        catch (NumberFormatException e)
        {
            System.out.println("You entered a non-integer value.');
            System.out.println(e.getMessage());
            System.out.println(e);
            e.printStackTrace();
        }
    }
}
```

For input string: "james tam"

java.lang.NumberFormatException: For input string: "james tam"

java.lang.NumberFormatException: For input string: "james tam"

at java.lang.NumberFormatException.forInputString(NumberFormatException.java:48)

at java.lang.Integer.parseInt(Integer.java:426)

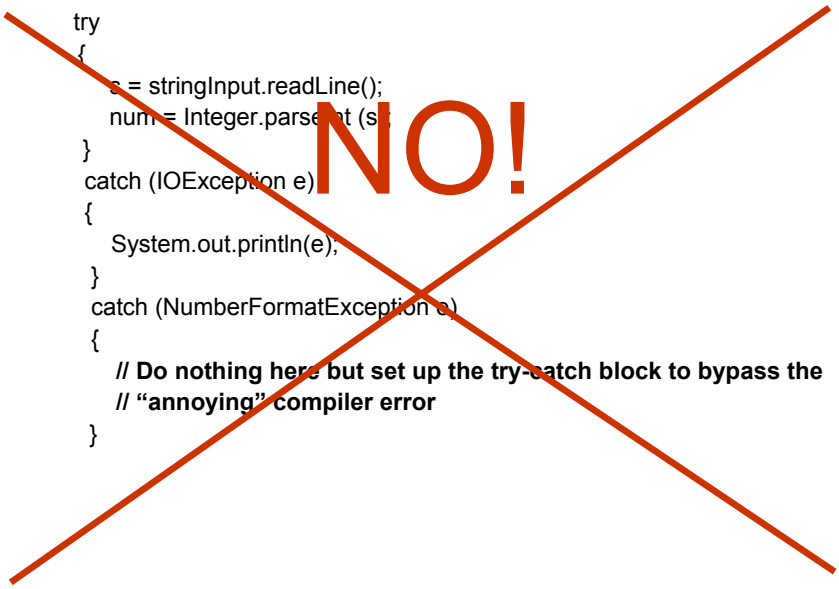
at java.lang.Integer.parseInt(Integer.java:476)

at Driver.main(Driver.java:39)

Avoid Squelching Your Exceptions

```
try
{
    s = stringInput.readLine();
    num = Integer.parseInt (s);
}
 catch (IOException e)
{
    System.out.println(e);
 }
 catch (NumberFormatException e)
 {
    // Do nothing here but set up the try-catch block to bypass the
    // "annoying" compiler error
 }
```

Avoid Squelching Your Exceptions




```
try
{
    s = stringInput.readLine();
    num = Integer.parseInt (s);
}
 catch (IOException e)
{
    System.out.println(e);
 }
 catch (NumberFormatException e)
 {
    // Do nothing here but set up the try-catch block to bypass the
    // "annoying" compiler error
 }
```

Avoid Squelching Your Exceptions

```
try
{
     s = stringInput.readLine();
     num = Integer.parseInt (s);
}
 catch (IOException e)
{
     System.out.println(e);
}
 catch (NumberFormatException e)
 {
     // Minimal but still somewhat useful response
     System.out.println("A non integer value entered instead of an
     integer");
}
```

The Finally Clause

- An additional part of Java's exception handling model (try-catch-*finally*).
- Used to enclose statements that must always be executed whether or not an exception occurs.

The Finally Clause: Exception Thrown

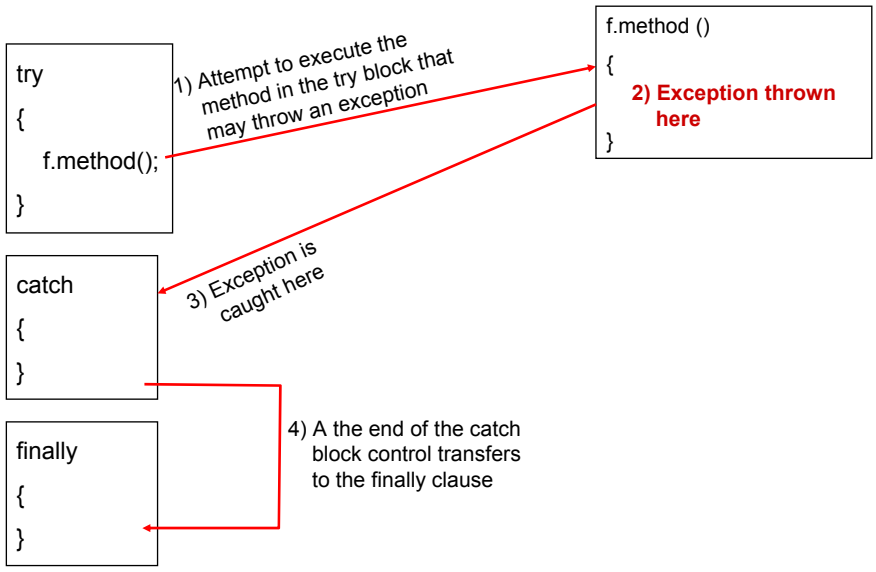
```
try
{
    f.method();
}
```

```
catch
{
}
```

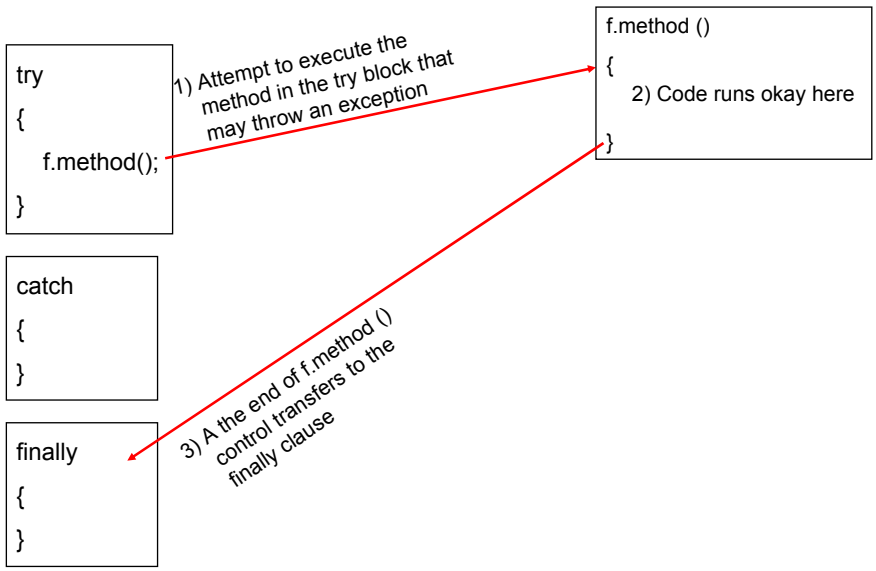
```
finally
{
}
```

```
f.method ()
{

}
```

The Finally Clause: Exception Thrown



The Finally Clause: No Exception Thrown



Try-Catch-Finally: An Example

Location of the online example:
/home/233/examples/exceptions/handlingExceptions/tryCatchFinallyExample
OR
www.cpsc.ucalgary.ca/~tamj/233/examples/exceptions/handlingExceptions/
tryCatchFinallyExample

```
public class Driver
{
   public static void main (String [] args)
   {
      TCFExample eg = new TCFExample ();
      eg.method();
   }
}
```

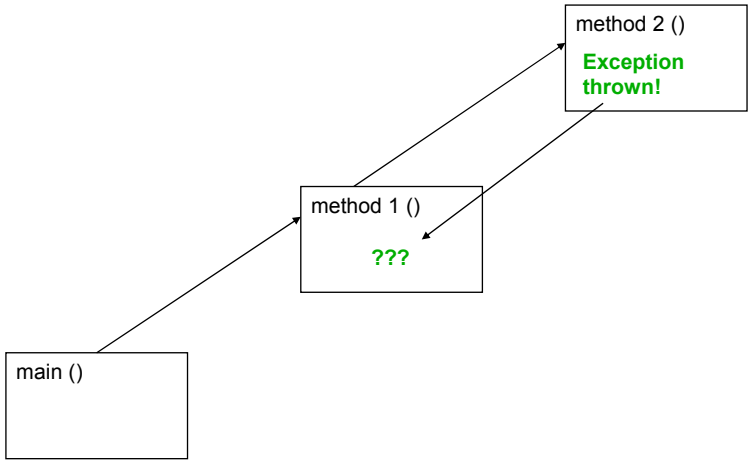
Try-Catch-Finally: An Example (2)

```
public class TCFExample
{
  public void method ()
    {
        BufferedReader br;
        String s;
        int num;
        try
        {
            System.out.print("Type in an integer: ");
            br = new BufferedReader(new InputStreamReader(System.in));
            s = br.readLine();
            num = Integer.parseInt(s);
            return;
        }
```

Try-Catch-Finally: An Example (3)

```
        catch (IOException e)
        {
            e.printStackTrace();
            return;
        }
        catch (NumberFormatException e)
        {
            e.printStackTrace ();
            return;
        }
        finally
        {
            System.out.println("<<<This code will always execute>>>");
            return;
        }
    }
}
```

When The Caller Can't Handle The Exceptions



When The Caller Can't Handle The Exceptions: An Example

Location of the online example:

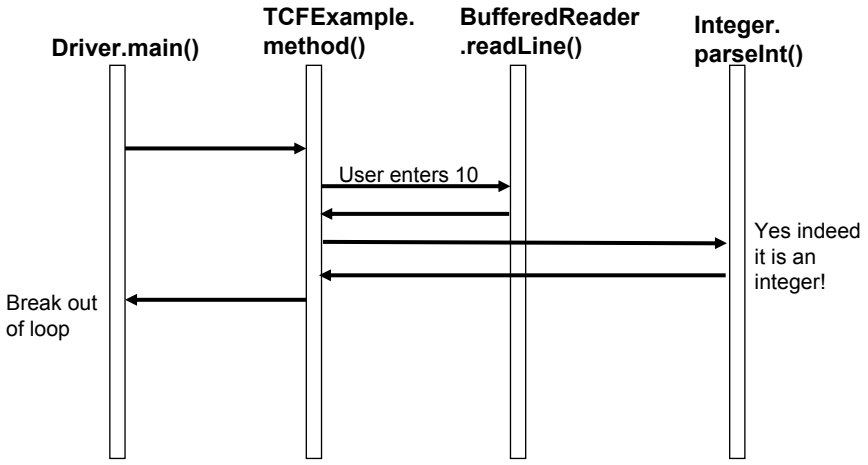
/home/233/examples/exceptions/handlingExceptions/delegatingExceptions

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/exceptions/handlingExceptions/delegatingExceptions

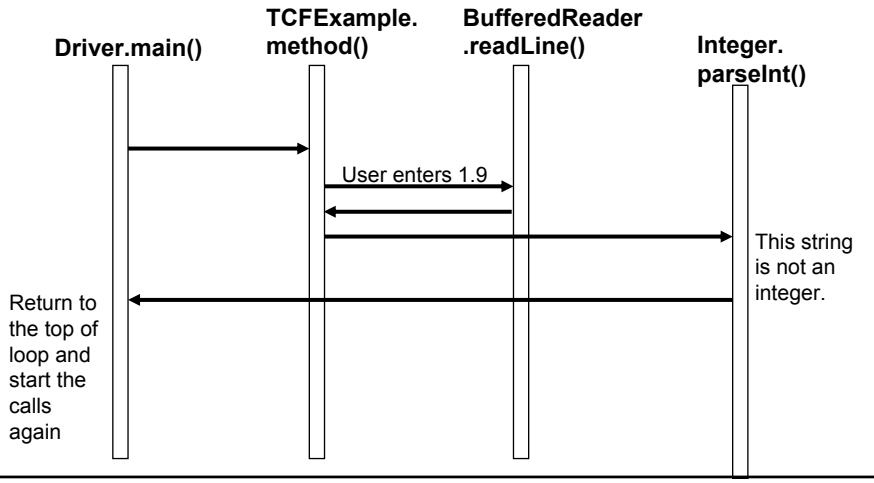
When The Caller Can't Handle The Exceptions: An Example (2)

•Tracing the method calls when *no exception occurs*:



When The Caller Can't Handle The Exceptions: An Example (3)

•Tracing the method calls when an *exception does occur*:



When The Caller Can't Handle The Exceptions: An Example (4)

```
public class Driver
{
   public static void main (String [] args)
   {
      TCExample eg = new TCExample ();
      boolean inputOkay = true;
```

When The Caller Can't Handle The Exceptions: An Example (5)

```
      do
      {
         try
         {
            eg.method();
            inputOkay = true;
         }
         catch (IOException e)
         {
            e.printStackTrace();
         }
         catch (NumberFormatException e)
         {
            inputOkay = false;
            System.out.println("Please enter a whole number.");
         }
      } while (inputOkay == false);
   }        // End of main
} // End of Driver class
```

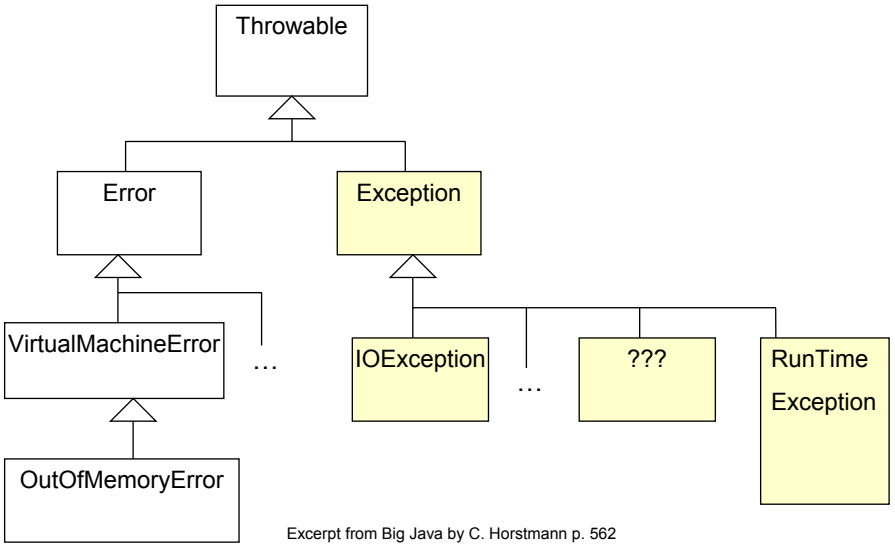
When The Caller Can't Handle The Exceptions: An Example (6)

```
import java.io.*;

public class TCExample
{

  public void method () throws IOException, NumberFormatException
   {
      BufferedReader br;
      String s;
      int num;

      System.out.print("Type in an integer: ");
      br = new BufferedReader(new InputStreamReader(System.in));
      s = br.readLine();
      num = Integer.parseInt(s);
   }
}
```

When The Main () Method Can't Handle The Exception

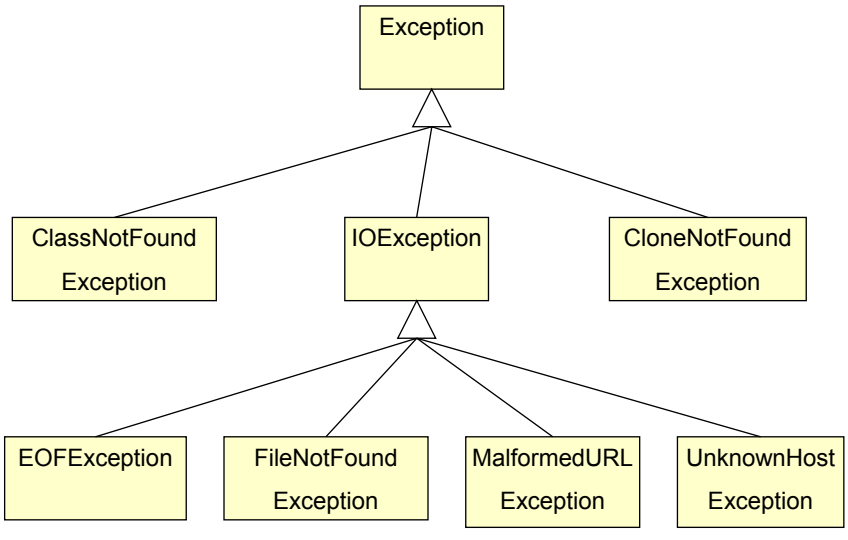
```
public class Driver
{
    public static void main (String [] args) throws IOException,
       NumberFormatException
    {
        TCExample eg = new TCExample ();
        eg.method();
    }
}
```

Creating Your Own Exceptions



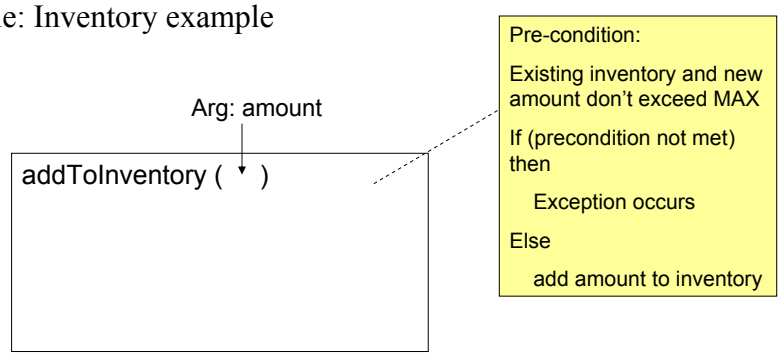
Excerpt from Big Java by C. Horstmann p. 562

Class Exception: The Local Inheritance Hierarchy



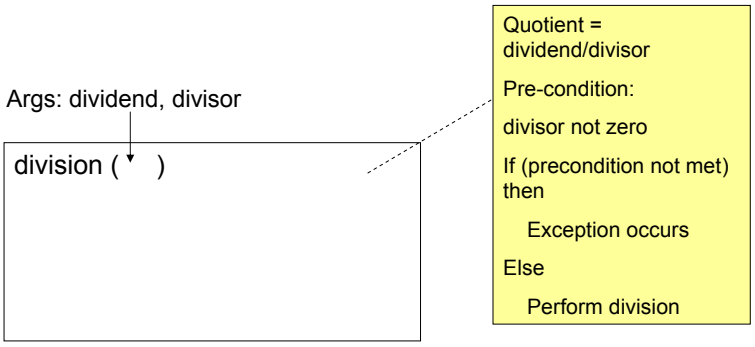
Writing New Exceptions

- Typical approach: tie the exception into preconditions
- Remember: preconditions are things that must be true when a function is called.
- Example: Inventory example



Writing New Exceptions (2)

- Example 2: Division



Writing New Exceptions: An Example

Location of the online example:

/home/233/examples/exceptions/writingExceptions/inventoryExample

OR

www.cpsc.ucalgary.ca/~tamj/233/examples/writingExceptions/
inventoryExample

Writing New Exceptions: Driver Class

```
public class Driver
{
   public static void main (String [] args)
   {
      Inventory chinook = new Inventory ();
      try
      {
        chinook.add (10);
      }
      catch (InventoryOverMaxException e)
      {
        System.out.print(">>Too much to be added to stock<<");
      }
```

Writing New Exceptions: Driver Class (2)

```
System.out.println(chinook.showStockLevel ());
try
{
   chinook.add (10);
}
catch (InventoryOverMaxException e)
{
   System.out.println(">>Too much to be added to stock<<");
}
```

Writing New Exceptions: Driver Class (3)

```
System.out.println(chinook.showStockLevel ());
try
{
   chinook.add (100);
}
catch (InventoryOverMaxException e)
{
   System.out.println(">>Too much to be added to stock<<");
}
```

Writing New Exceptions: Driver Class (4)

```
        System.out.println(chinook.showStockLevel ());
         try
         {
            chinook.remove (21);
         }
         catch (InventoryUnderMinException e)
         {
            System.out.println(">>Too much to remove from stock<<");
         }
         System.out.println(chinook.showStockLevel ());
      }
   }
```

Writing New Exceptions: Class Inventory

```
public class Inventory
{
    public final int CRITICAL = 10;
    public final int MIN = 0;
    public final int MAX = 100;
    private int stockLevel = 0;

     public boolean inventoryTooLow ()
     {
         if (stockLevel < CRITICAL)
            return true;
         else
            return false;
    }
```

Writing New Exceptions: Class Inventory (2)

```
public void add (int amount) throws InventoryOverMaxException
 {
    int temp;
    temp = stockLevel + amount;
    if (temp > MAX)
    {
       throw new InventoryOverMaxException ("Adding " + amount + " item(s) "
         + "will cause stock to become greater than " + MAX + " units");
    }
   else
        stockLevel = stockLevel + amount;
  }
```

Writing New Exceptions: Class Inventory (3)

```
 public void remove (int amount) throws InventoryUnderMinException
 {
   int temp;
   temp = stockLevel - amount;
   if (temp < MIN)
   {
      throw new InventoryUnderMinException ("Removing " + amount +
       " item(s) will cause stock to become less than " + MIN + " units");
    }
    else
       stockLevel = temp;
 }

  public String showStockLevel ()  {
     return("Inventory: " + stockLevel);
  }
}
```

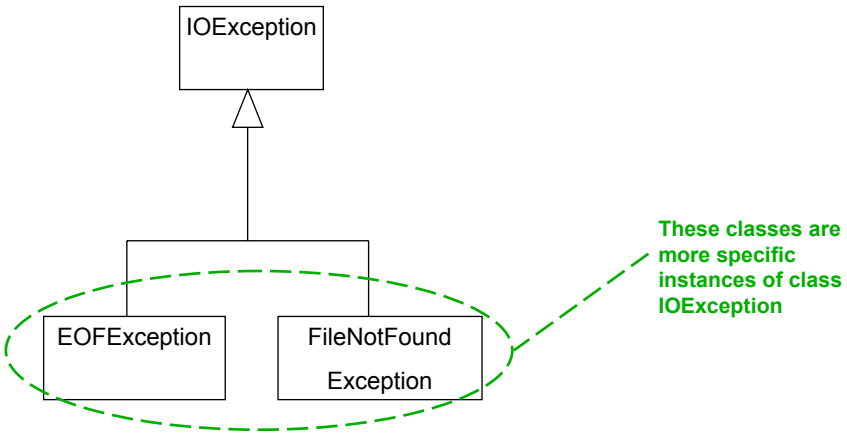
Writing New Exceptions: Class InventoryOverMaxException

```
public class InventoryOverMaxException extends Exception
{
   public InventoryOverMaxException ()
   {
      super ();
   }

   public InventoryOverMaxException (String s)
   {
      super (s);
   }
}
```

Writing New Exceptions: Class InventoryUnderMinException

```
public class InventoryUnderMinException extends Exception
{
   public InventoryUnderMinException ()
   {
      super();
   }

   public InventoryUnderMinException (String s)
   {
      super(s);
   }
}
```

Inheritance Hierarchy For IOExceptions



Inheritance And Catching Exceptions

- If you are catching a sequence of exceptions then make sure that you catch the exceptions for the child classes before you catch the exceptions for the parent classes
- Deal with the more specific case before handling the more general case

Inheritance And Catching Exceptions (2)

Correct

```
try
{

}
catch (EOFException e)
{

}
catch (IOException e)
{

}
```

Incorrect

```
try
{

}
catch (IOException e)
{

}
catch (EOFException e)
{

}
```

You Should Now Know

- The benefits of handling errors with an exception handler rather than employing a series of return values and conditional statements/branches.
- How to handle exceptions
  - Being able to call a method that may throw an exception by using a try-catch block
  - What to do if the caller cannot properly handle the exception
  - What is the finally clause, how does it work and when should it be used
- What is the difference between a checked and an unchecked exception
- How to write your classes of exceptions
- The effect of the inheritance hierarchy when catching exceptions