COSC 123
Computer Creativity

I/O Streams and Exceptions

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Objectives

Explain the purpose of exceptions.

Examine the try-catch-finally statement for handling exceptions.

Show how to throw exceptions to other methods.

Identify I/O streams with specific focus on reading and writing text files and handling I/O exceptions.

Exception Handling

An ***exception*** is an error situation that must be handled or the program will fail.

- ***Exception handling*** is a mechanism for communicating error conditions between methods of your program.

Examples:

- Attempting to divide by zero
- An array index that is out of bounds
- A specified file that could not be found
- A requested I/O operation that could not be completed normally
- Attempting to follow a null reference
- Attempting to execute an operation that violates some kind of security measure

Uncaught Exceptions

If a program does not handle the exception, it will terminate abnormally and produce the message that describes the exception that occurred and where in the code it was produced.

Example:

```
Exception in thread "main" java.lang.NullPointerException
        at Asteroids.printScores(Asteroids.java:86)
        at Asteroids.addScore(Asteroids.java:78)
        at Asteroids.main(Asteroids.java:14)
```

- The output is the call stack trace that indicates where the exception occurred.

The try-catch Statement

The ***try-catch statement*** identifies a block of statements that may throw an exception.

A ***catch clause*** defines how a particular kind of exception is handled. Each catch clause is called an ***exception handler***.

When the try-catch statement is executed, the statements in the `try` block are executed.

If an exception is thrown at any point during the execution of the `try` block, control is immediately transferred to the appropriate `catch` handler.

Catching Exceptions Example Code

```
try
{
   Scanner sc = new Scanner(System.in);
   System.out.print("Enter your age? ");
   int age = sc.nextInt();
   System.out.println("You are: "+age+" years old!!!");
}
catch (InputMismatchException e)
{  System.out.println("Input was not a number.");
}
```

The finally Clause

A `try-catch` statement can have an optional `finally` clause which defines a section of code that is executed *no matter* how the try block is exited.

If no exception is generated, the statements in the `finally` clause are executed after the `try` block is complete.

If an exception is generated in the `try` block, control first transfers to the appropriate `catch` clause, then to `finally` clause.

Finally Example

```
try
{
   Scanner sc = new Scanner(System.in);
   System.out.println("Enter your age?");
   int age = sc.nextInt();
   System.out.println("You are: "+age+" years old!!!");
}
catch (InputMismatchException e)
{  System.out.println("Input was not a number.");
}
finally
{  System.out.println("We always go in here!");
}
```

Throwing Exceptions

Your method has two ways of handling exceptions:

- 1) It can handle them inside the method using a `try-catch-finally` block.
- 2) It can throw the exception to the method that called it and force that method to handle it.

To throw an exception you must do two things:

- 1) List the type of exception that is thrown in the method header.
- 2) Not catch an exception (do not use try-catch block) or create a new exception and call `throw` to pass it to the caller.

When an exception is thrown, the **method exits immediately** similar to a return statement.

Throwing Exceptions Example Code

```
public class ThrowException
{
   public static void main(String[] args)
   {
      System.out.println("This isn't smart...");
      doSomethingDumb();
   }

   public static int doSomethingDumb()
                     throws ArithmeticException
   {
      int num1 = 5, num2 = 0;
      int result = num1/num2; // Divide by zero
      return result;
   }
}
```

Checked and Unchecked Exceptions

Checked exceptions are exceptions that you must tell the compiler how your code is handling them.

- A checked exception *must* be either caught or thrown.
  - Checked exceptions are typically exceptions that are not your fault.
  - e.g. `IOException` (and all its subclasses)

Unchecked exceptions are exceptions that the compiler does not force your program to handle.

- An unchecked exception is automatically passed to the caller method if it is not handled by the method that generated the exception.
  - Unchecked exceptions include `NumberFormatException`, `IllegalArgumentException`, and `NullPointException`.
  - Exceptions that are a subclass of `RuntimeException` are unchecked.

Exceptions

Question: TRUE or FALSE: A good programmer can always avoid exceptions.

A) TRUE

B) FALSE

Exceptions

Question: TRUE or FALSE: An uncaught exception may be passed through several methods before the program crashes.

A) TRUE

B) FALSE

Exceptions

Question: What does this code output if the user enters "32"?

```
try
{  Scanner sc = new Scanner(System.in);
   System.out.print("Enter a number: ");
   int num = sc.nextInt();
   System.out.print(num+" ");
}
catch (InputMismatchException e)
{  System.out.print("Input was not a number. ");
}
finally
{  System.out.print("HELLO!");
}
```

A) nothing

B) `32`

C) `Input was not a number.`

D) `32 HELLO!`

Exceptions

Question: What does this code output if the user enters "abc"?

```
try
{  Scanner sc = new Scanner(System.in);
   System.out.print("Enter a number: ");
   int num = sc.nextInt();
   System.out.print(num+" ");
}
catch (InputMismatchException e)
{  System.out.print("Input was not a number. ");
}
finally
{  System.out.print("HELLO!");
}
```

A) `abc`

B) `Input was not a number.`

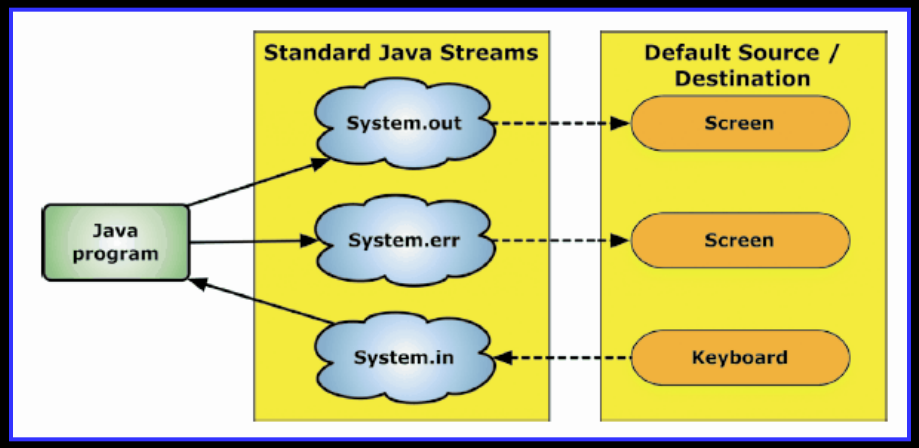
C) `abc HELLO!`

D) `Input was not a number. HELLO!`

Java File Input/Output

A ***stream*** is an ordered sequence of bytes.

A stream may be either an input stream or an output stream.
An ***input stream*** is a stream from which information is read.
An ***output stream*** is a stream to which information is written.
Streams may generate exceptions such as `IOException`.
The `System` class contains three object reference variables:



Reading and Writing Text Files

A file is opened as a stream for reading or writing.

Programmers need to know the contents of the file and how to translate it to a usable form.

If for some reason there is a problem finding or opening a file, the attempt to create a `File` object will throw an `IOException`.

- To put a backslash ("\") in a filename string, you must enter each backslash TWICE as backslash is an escape character.
  - e.g. `File in = new File("c:\\homework\\input.dat");`

Output file streams should be explicitly closed or they may not correctly retain the data written to them.

Read Text File with Scanner

```
Scanner sc = null;
try
{  sc = new Scanner(new File("MyFile.txt"));
   while (sc.hasNextLine())
   {  String st = sc.nextLine();
      System.out.println(st);
   }
}
catch (FileNotFoundException e)
{  System.out.println("Did not find input file: "+e);
}
finally
{  if (sc != null)
      sc.close();
}
```

Note: The Scanner class handles some exceptions for you.

Write Text File with PrintWriter

```
PrintWriter out = null;
try
{
   out = new PrintWriter("output.txt");
   // Write the numbers 1 to 10 in the file
   for (int i=1; i <=10; i++)
      out.println(i);
}
catch (FileNotFoundException e)
{  System.out.println("Could not create output file: "+e);
}
finally
{  if (out != null)
      out.close();
}
```

Streams and Exceptions Practice Question

1) Write a program that prompts the user for a filename then opens the text file and counts the number of lines in the file.

Conclusions

An ***exception*** is an error situation that must be handled or the program will fail.

- ***Exception handling*** is a mechanism for communicating error conditions between methods of your program.

There are two ways for handling exceptions:

- 1) Instead method using a `try-catch-finally` block.
- 2) By throwing it to the caller method.
- Checked exceptions must always be handled.

A stream is a sequential sequence of bytes which can be used for input or output. Files are streams as is `System.out`.

Reading from text files can be done using `Scanner` class similar to reading from `System.in`.

Writing to text files is done using the `PrintWriter` class.

- Make sure to close all files!

Objectives

Key terms:

- exceptions and exception handling

Java skills:

- exception handling using try-catch-finally statement
- uncaught exceptions and the call stack trace
- throwing exceptions (`throws` in method header)
- checked vs. unchecked exception
- streams and the standard I/O streams in the System class
- Reading from a text file using `Scanner`
- Writing to a text file using `PrintWriter`