

11. Exceptions

- Objectives - when we have completed this set of notes, you should be familiar with:
 - the purpose of exceptions
 - exception messages
 - try-catch-finally blocks
 - propagating exceptions
 - checked and unchecked exceptions
 - reading and writing text files
 - try-catch blocks and exceptions for files
 - exception messages
 - opening files in the default web browser



Exceptions

- An **exception** is an object that describes an unusual or erroneous situation
- Exceptions are **thrown** (or raised) by a program during execution; they may be **caught** and **handled**, or they may be ignored (as we've been doing)
- A program can be separated into normal execution flow and **exception execution flow**
- An **error** is also represented as an object in Java, but usually represents an unrecoverable situation and should not be caught



Exception Handling

- If an exception is ignored by the program, a run-time error will occur. *An example you've likely seen:*

```
----jGRASP exec: java Test

Exception in thread "main" java.lang.NullPointerException
    at Test.main(Test.java:6)

----jGRASP wedge2: exit code for process is 1.
----jGRASP: operation complete.
```

- A *call stack trace* where the exception occurred (was raised) is included in the output
- The call stack trace shows the method call trail that led to the attempted execution of the offending line
- See [Zero1.java](#)



Exception Handling

- Java has a predefined set of exceptions and errors that can occur during execution.
Examples:
 - `ArrayIndexOutOfBoundsException` in the `java.lang` package
 - `NullPointerException` in the `java.lang` package
- A program can deal with an exception in one of three ways:
 - ignore it
 - handle it where it occurs
 - handle it in another place in the program



try-catch Blocks

- To process an exception where it occurs, the statement that throws (or raises) the exception is executed within a *try block*
- A try block is usually followed by one or more *catch* blocks that specify the exception(s) to be caught and handled. A try block must be followed by a catch or finally (unless it's a try-with-resources, which will not be covered)
- When an exception occurs, processing continues at the first catch block that matches the exception type

[Zero2.java](#) [AbsoluteValue1.java](#)
[AbsoluteValue2.java](#)



The *finally* Block

- A try block can be followed by a *finally* block
- Once a program enters the try block, the statements in the finally block are always executed [unless System.exit() is called]
 - If no exception is generated, the statements in the **finally** block are executed **after the statements in the try block complete**
 - If an exception occurs, control jumps to the matching **catch** block, if any, and its statements are executed, and then the statements in the **finally** block are executed.
- See [Zero3.java](#) [Zero4.java](#)
[GuessNumber1.java](#) [GuessNumber2.java](#)



Exception Propagation

- An exception can be handled at a higher level if it is not appropriate to handle it where it occurs
- Exceptions *propagate* up through the method calling hierarchy until they are caught and handled or until they reach the level of the `main` method
- A try block that contains a call to a method in which an exception is thrown can be used to catch that exception
- See [Propagation.java](#) [ExceptionScope.java](#)



The throw Statement

- You may want to throw an exception in a method
 - Often better than just ignoring incorrect input / actions
- Exceptions are thrown using the *throw* statement
- Usually an if statement evaluates the condition to see if the exception should be thrown
- You can create your own exceptions if there is not an appropriate exception in the Java API
See [PolygonCreator.java](#)



Checked Exceptions

- An exception is either *checked* or *unchecked*
- A *checked exception* either must be caught by a method, or must be listed in the *throws clause* of any method that may throw or propagate it
- A throws clause is appended to the method header
- The compiler will issue an error if a checked exception is not handled appropriately



Unchecked Exceptions

- An unchecked exception does not require you to handle it (recall, you have used `Double.parseDouble` without try-catch blocks or a throws clause)
- The only unchecked exceptions in Java are objects of type `RuntimeException` or any of its descendants
- Error objects are similar to `RuntimeException` objects in that they are unchecked
 - Errors do not require a throws clause
 - Errors should not be caught (e.g., `OutOfMemoryError`)



I/O Streams

- A *stream* is a sequence of bytes that flow from a source to a destination
- In a program, we read information from an input stream and write information to an output stream
- A program can manage multiple streams simultaneously

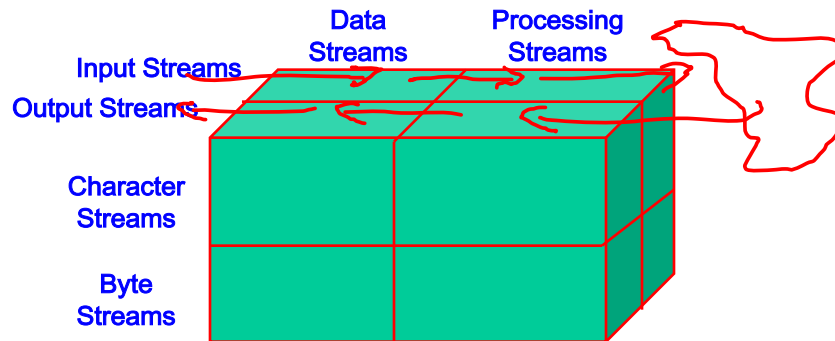


I/O Streams

- The `java.io` package contains many classes that allow us to define various streams with particular characteristics
- Some classes assume that the data consists of characters
- Others assume that the data consists of raw bytes of binary information
- Streams can be further subdivided as follows:
 - *data stream*, which acts as either a source or destination
 - *processing stream*, which alters or manipulates the basic data in the stream



I/O Streams



Standard I/O

- There are three standard I/O streams:
 - *standard input* – defined by `System.in`
 - *standard output* – defined by `System.out`
 - *standard error* – defined by `System.err`
- `System.in` is typically keyboard input
 - We've been using the `Scanner` class to read from `System.in`
- `System.out` and `System.err` are typically shown in a particular window on the screen
 - We use `System.out` when we execute `println` statements



File I/O

- Objectives - when we have completed this set of notes, you should be familiar with:
 - reading and writing text files
 - try-catch and exceptions for files
 - exception messages
 - opening files in the default web browser



I/O Streams

- The `java.io` package contains many classes that allow us to define various I/O streams
- You know about standard input and output. Now let's consider the details of reading and writing to files
- For reading from a file, we use the following:
 - `java.io.File` and `java.util.Scanner`
- For writing to a file, we use the following:
 - `java.io.PrintWriter`



Files

- The extension of a file specifies what program is used by the operating system to open the file.
 - input.txt
 - input.dat
 - input.xyzabc
- If a file contains text and does not have extension .txt, you'll have to specify what program to use to view the file's contents
- See [input.xyzabc](#)



Reading from a File

- In order to read from a file, you will have to create an instance of the File class in java.io
- You can then instantiate a Scanner object using the File object that you created.
- At that point you can use any of the methods that you have been using in Scanner to read the file:
 - The next method reads a "token"
 - The nextLine method reads a whole line
 - The hasNext and hasNextLine are also useful (see API documentation for more information and methods)



Reading from a File

- Look at the Java API documentation for Scanner. The constructor that accepts a File object as a parameter throws a FileNotFoundException.
- FileNotFoundException is a checked exception; you have to do one of two things ...
 - Handle the exception with a try-catch
 - Specify throws FileNotFoundException in the method header
- Your program doesn't care what the extension of the file is.
- See [ReadLines.java](#)



Writing to a File

- Instantiate a PrintWriter object using the file name (a String).
 - The PrintWriter constructor throws FileNotFoundException.
- PrintWriter has methods similar to System.out
 - print: writes a specified String to a file
 - println: writes a specified String and a new line to a file
- **Do not forget to invoke the close() method on the PrintWriter object; otherwise nothing may be written to the file!**
- See [WriteLines.java](#)



Writing HTML to a File

- Similar to writing plain text
- Use PrintWriter
- Add HTML tags to the text (here are a few)
 - Heading `<h1> . . . </h1>`
 - Paragraph `<p> . . . </p>`
 - Line break `
`
 - Bold ` . . . `
 - Font color ` . . . `
- Opening HTML file in default browser
- [WriteLinesHTML.java](#)
- [WriteReadRandom.java](#) [WriteRandomHTML.java](#)

