

CHAPTER 4

Loops and Files

starting out with >>>

JAVA™

From Control Structures
through Data Structures

3RD EDITION



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Chapter Topics

Chapter 4 discusses the following main topics:

- The Increment and Decrement Operators
- The `while` Loop
- Using the `while` Loop for Input Validation
- The `do-while` Loop
- The `for` Loop
- Running Totals and Sentinel Values

Chapter Topics

Chapter 4 discusses the following main topics:

- Nested Loops
- The `break` and `continue` Statements
- Deciding Which Loop to Use
- Introduction to File Input and Output
- Generating Random Numbers with the `Random` class

The Increment and Decrement Operators

- There are numerous times where a variable must simply be incremented or decremented.

```
number = number + 1;
```

```
number = number - 1;
```

- Java provide shortened ways to increment and decrement a variable's value.
- Using the `++` or `--` unary operators, this task can be completed quickly.

```
number++;    or    ++number;
```

```
number--;    or    --number;
```

- Example: [IncrementDecrement.java](#)

Differences Between Prefix and Postfix

- When an increment or decrement are the only operations in a statement, there is no difference between prefix and postfix notation.
- When used in an expression:
 - prefix notation indicates that the variable will be incremented or decremented prior to the rest of the equation being evaluated.
 - postfix notation indicates that the variable will be incremented or decremented after the rest of the equation has been evaluated.
- Example: [Prefix.java](#)

The `while` Loop

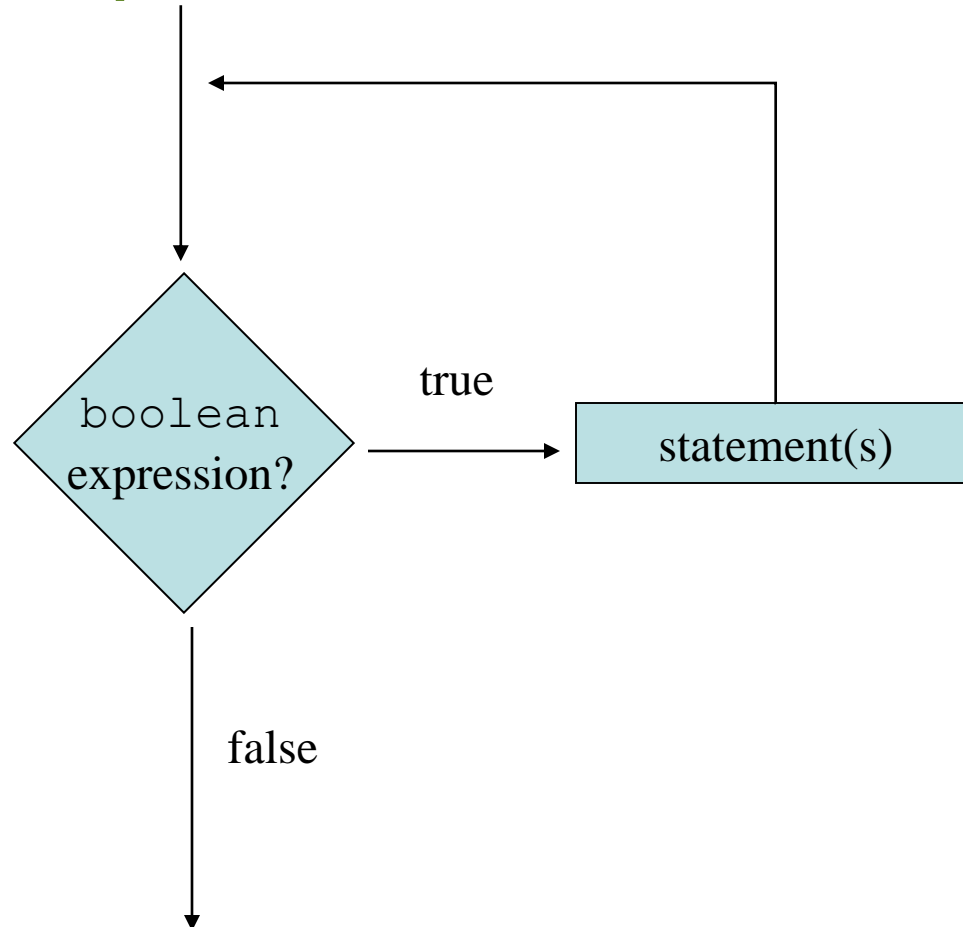
- Java provides three different looping structures.
- The `while` loop has the form:

```
while (condition)  
{  
    statements;  
}
```
- While the condition is true, the statements will execute repeatedly.
- The `while` loop is a *pretest* loop, which means that it will test the value of the condition prior to executing the loop.

The `while` Loop

- Care must be taken to set the condition to false somewhere in the loop so the loop will end.
- Loops that do not end are called *infinite loops*.
- A `while` loop executes 0 or more times. If the condition is false, the loop will not execute.
- Example: [WhileLoop.java](#)

The `while` loop Flowchart



Infinite Loops

- In order for a `while` loop to end, the condition must become false. The following loop will not end:

```
int x = 20;
while(x > 0)
{
    System.out.println("x is greater than 0");
}
```

- The variable `x` never gets decremented so it will always be greater than 0.
- Adding the `x--` above fixes the problem.

Infinite Loops

- This version of the loop decrements `x` during each iteration:

```
int x = 20;
while(x > 0)
{
    System.out.println("x is greater than 0");
    x--;
}
```

Block Statements in Loops

- Curly braces are required to enclose block statement while loops. (like block `if` statements)

```
while (condition)  
{  
    statement;  
    statement;  
    statement;  
}
```

The `while` Loop for Input Validation

- *Input validation* is the process of ensuring that user input is valid.

```
System.out.print("Enter a number in the " +  
                  "range of 1 through 100: ");  
number = keyboard.nextInt();  
// Validate the input.  
while (number < 1 || number > 100)  
{  
    System.out.println("That number is invalid.");  
    System.out.print("Enter a number in the " +  
                      "range of 1 through 100: ");  
    number = keyboard.nextInt();  
}
```

- Example: [SoccerTeams.java](#)

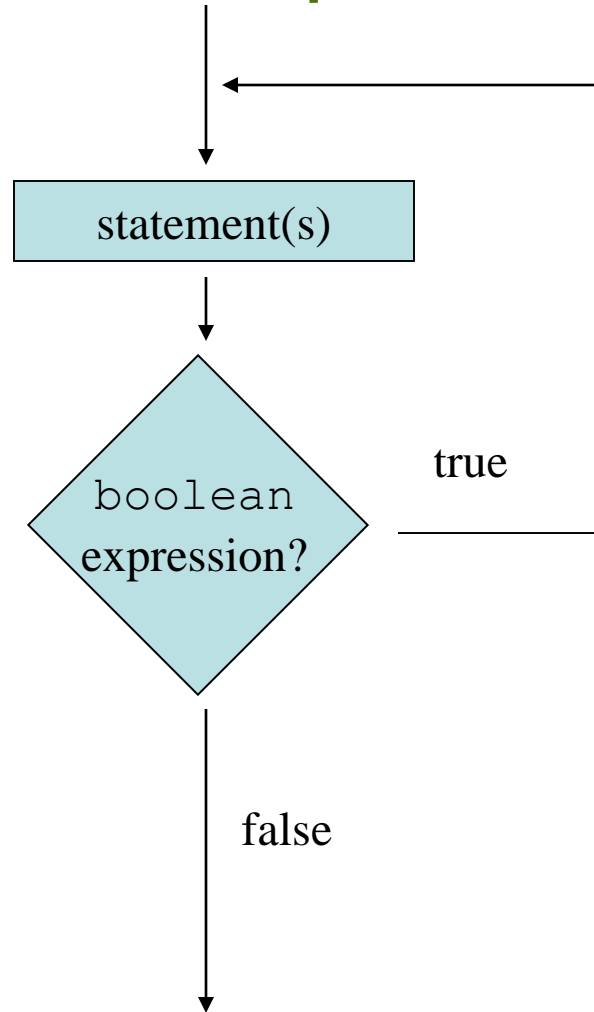
The do-while Loop

- The do-while loop is a *post-test* loop, which means it will execute the loop prior to testing the condition.
- The do-while loop (sometimes called a do loop) takes the form:

```
do
{
    statement(s) ;
}while (condition) ;
```

- Example: [TestAverage1.java](#)

The do-while Loop Flowchart

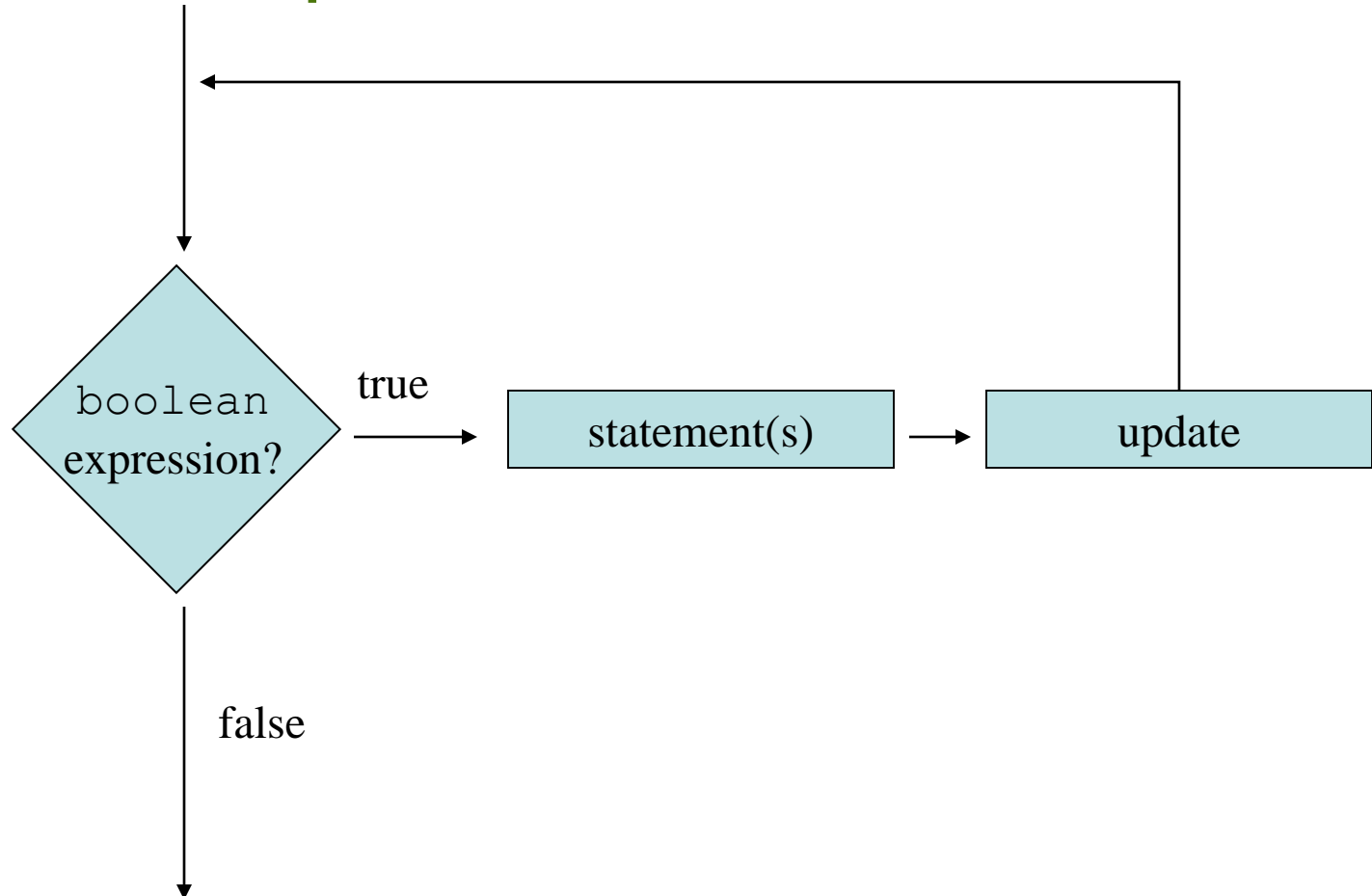


The `for` Loop

- The `for` loop is a pre-test loop.
- The `for` loop allows the programmer to initialize a control variable, test a condition, and modify the control variable all in one line of code.
- The `for` loop takes the form:

```
for(initialization; test; update)  
{  
    statement(s) ;  
}
```
- See example: [Squares.java](#)

The `for` Loop Flowchart



The Sections of The `for` Loop

- The *initialization section* of the `for` loop allows the loop to initialize its own control variable.
- The *test section* of the `for` statement acts in the same manner as the condition section of a `while` loop.
- The *update section* of the `for` loop is the last thing to execute at the end of each loop.
- Example: [UserSquares.java](#)

The `for` Loop Initialization

- The initialization section of a `for` loop is optional; however, it is usually provided.
- Typically, `for` loops initialize a counter variable that will be tested by the test section of the loop and updated by the update section.
- The initialization section can initialize multiple variables.
- Variables declared in this section have scope only for the `for` loop.

The Update Expression

- The update expression is usually used to increment or decrement the counter variable(s) declared in the initialization section of the for loop.
- The update section of the loop executes last in the loop.
- The update section may update multiple variables.
- Each variable updated is executed as if it were on a line by itself.

Modifying The Control Variable

- You should avoid updating the control variable of a `for` loop within the body of the loop.
- The update section should be used to update the control variable.
- Updating the control variable in the `for` loop body leads to hard to maintain code and difficult debugging.

Multiple Initializations and Updates

- The `for` loop may initialize and update multiple variables.

```
for(int i = 5, int j = 0; i < 10 || j < 20; i++, j+=2)
{
    statement(s);
}
```

- Note that the only parts of a `for` loop that are mandatory are the semicolons.

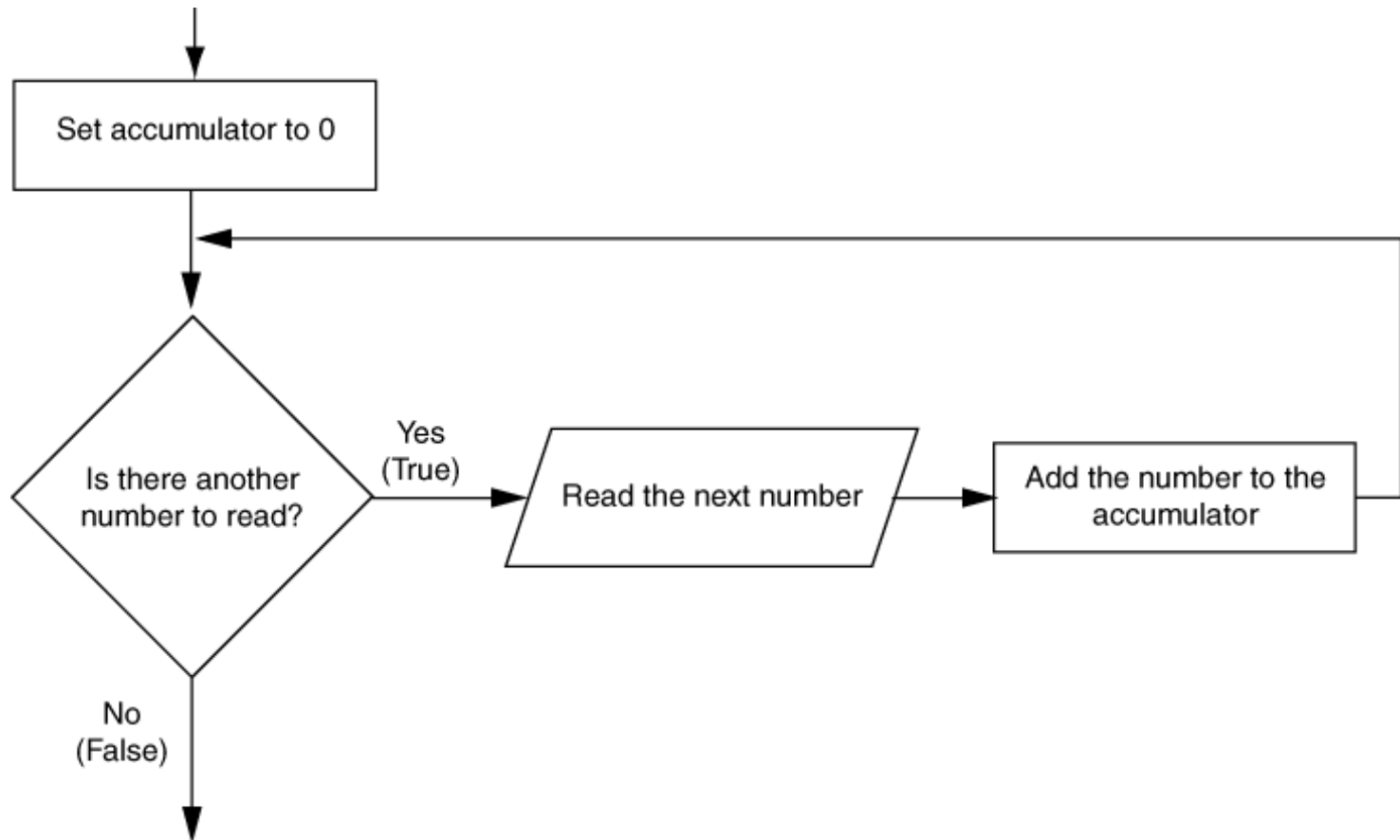
```
for(;;)
{
    statement(s);
} // infinite loop
```

- If left out, the test section defaults to true.

Running Totals

- Loops allow the program to keep running totals while evaluating data.
- Imagine needing to keep a running total of user input.
- Example: [TotalSales.java](#)

Logic for Calculating a Running Total



Sentinel Values

- Sometimes the end point of input data is not known.
- A *sentinel value* can be used to notify the program to stop acquiring input.
- If it is a user input, the user could be prompted to input data that is not normally in the input data range (i.e. -1 where normal input would be positive.)
- Programs that get file input typically use the end-of-file marker to stop acquiring input data.
- Example: [SoccerPoints.java](#)

Nested Loops

- Like `if` statements, loops can be nested.
- If a loop is nested, the inner loop will execute all of its iterations for each time the outer loop executes once.

```
for(int i = 0; i < 10; i++)  
    for(int j = 0; j < 10; j++)  
        loop statements;
```

- The loop statements in this example will execute 100 times.
- Example: [Clock.java](#)

The `break` Statement

- The `break` statement can be used to abnormally terminate a loop.
- The use of the `break` statement in loops bypasses the normal mechanisms and makes the code hard to read and maintain.
- It is considered bad form to use the `break` statement in this manner.

The `continue` Statement

- The `continue` statement will cause the currently executing iteration of a loop to terminate and the next iteration will begin.
- The `continue` statement will cause the evaluation of the condition in `while` and `for` loops.
- Like the `break` statement, the `continue` statement should be avoided because it makes the code hard to read and debug.

Deciding Which Loops to Use

- The `while` loop:
 - Pretest loop
 - Use it where you do not want the statements to execute if the condition is false in the beginning.
- The `do-while` loop:
 - Post-test loop
 - Use it where you want the statements to execute at least one time.
- The `for` loop:
 - Pretest loop
 - Use it where there is some type of counting variable that can be evaluated.

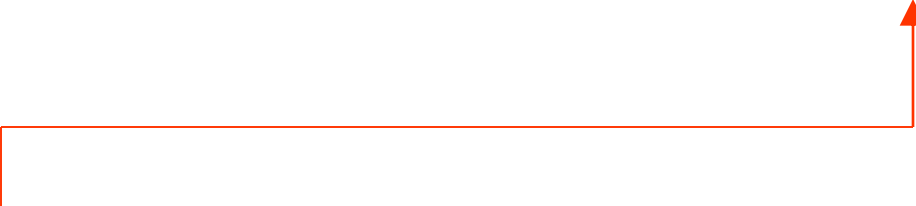
File Input and Output

- Reentering data all the time could get tedious for the user.
- The data can be saved to a file.
 - Files can be *input files* or *output files*.
- Files:
 - Files have to be opened.
 - Data is then written to the file.
 - The file must be closed prior to program termination.
- In general, there are two types of files:
 - binary
 - text

Writing Text To a File

- To open a file for text output you create an instance of the `PrintWriter` class.

```
PrintWriter outputFile = new PrintWriter("StudentData.txt");
```



Pass the name of the file that you wish to open as an argument to the `PrintWriter` constructor.

Warning: if the file already exists, it will be erased and replaced with a new file.

The `PrintWriter` Class

- The `PrintWriter` class allows you to write data to a file using the `print` and `println` methods, as you have been using to display data on the screen.
- Just as with the `System.out` object, the `println` method of the `PrintWriter` class will place a newline character after the written data.
- The `print` method writes data without writing the newline character.

The PrintWriter Class

Open the file.

```
PrintWriter outputFile = new PrintWriter("Names.txt");  
outputFile.println("Chris");  
outputFile.println("Kathryn");  
outputFile.println("Jean");  
outputFile.close();
```

Close the file.

Write data to the file.

The `PrintWriter` Class

- To use the `PrintWriter` class, put the following `import` statement at the top of the source file:

```
import java.io.*;
```

- See example: [FileWriteDemo.java](#)

Exceptions

- When something unexpected happens in a Java program, an *exception* is thrown.
- The method that is executing when the exception is thrown must either handle the exception or pass it up the line.
- Handling the exception will be discussed later.
- To pass it up the line, the method needs a `throws` clause in the method header.

Exceptions

- To insert a `throws` clause in a method header, simply add the word *throws* and the name of the expected exception.
- `PrintWriter` objects can throw an `IOException`, so we write the `throws` clause like this:

```
public static void main(String[] args) throws IOException
```

Appending Text to a File

- To avoid erasing a file that already exists, create a `FileWriter` object in this manner:

```
FileWriter fw =  
    new FileWriter("names.txt", true);
```

- Then, create a `PrintWriter` object in this manner:

```
PrintWriter fw = new PrintWriter(fw);
```

Specifying a File Location

- On a Windows computer, paths contain backslash (\) characters.
- Remember, if the backslash is used in a string literal, it is the escape character so you must use two of them:

```
PrintWriter outFile =  
    new PrintWriter("A:\\PriceList.txt");
```

Specifying a File Location

- This is only necessary if the backslash is in a string literal.
- If the backslash is in a `String` object then it will be handled properly.
- Fortunately, Java allows Unix style filenames using the forward slash (/) to separate directories:

```
PrintWriter outFile = new  
    PrintWriter("/home/rharrison/names.txt");
```

Reading Data From a File

- You use the `File` class and the `Scanner` class to read data from a file:

Pass the name of the file as an argument to the `File` class constructor.

```
File myFile = new File("Customers.txt");  
Scanner inputFile = new Scanner(myFile);
```

Pass the `File` object as an argument to the `Scanner` class constructor.

Reading Data From a File

```
Scanner keyboard = new Scanner(System.in);  
System.out.print("Enter the filename: ");  
String filename = keyboard.nextLine();  
File file = new File(filename);  
Scanner inputFile = new Scanner(file);
```

- The lines above:
 - Creates an instance of the `Scanner` class to read from the keyboard
 - Prompt the user for a filename
 - Get the filename from the user
 - Create an instance of the `File` class to represent the file
 - Create an instance of the `Scanner` class that reads from the file

Reading Data From a File

- Once an instance of `Scanner` is created, data can be read using the same methods that you have used to read keyboard input (`nextLine`, `nextInt`, `nextDouble`, etc).

```
// Open the file.  
File file = new File("Names.txt");  
Scanner inputFile = new Scanner(file);  
// Read a line from the file.  
String str = inputFile.nextLine();  
// Close the file.  
inputFile.close();
```

Exceptions

- The `Scanner` class can throw an `IOException` when a `File` object is passed to its constructor.
- So, we put a `throws IOException` clause in the header of the method that instantiates the `Scanner` class.
- See Example: [ReadFirstLine.java](#)

Detecting The End of a File

- The Scanner class's hasNext () method will return true if another item can be read from the file.

```
// Open the file.
File file = new File(filename);
Scanner inputFile = new Scanner(file);
// Read until the end of the file.
while (inputFile.hasNext())
{
    String str = inputFile.nextLine();
    System.out.println(str);
}
inputFile.close(); // close the file when done.
```

Detecting the End of a File

- See example: [FileReadDemo.java](#)

Generating Random Numbers with the Random Class

- Some applications, such as games and simulations, require the use of randomly generated numbers.
- The Java API has a class, `Random`, for this purpose. To use the `Random` class, use the following `import` statement and create an instance of the class.

```
import java.util.Random;
```

```
Random randomNumbers = new Random();
```

Some Methods of the Random Class

Method	Description
<code>nextDouble()</code>	Returns the next random number as a <code>double</code> . The number will be within the range of 0.0 and 1.0.
<code>nextFloat()</code>	Returns the next random number as a <code>float</code> . The number will be within the range of 0.0 and 1.0.
<code>nextInt()</code>	Returns the next random number as an <code>int</code> . The number will be within the range of an <code>int</code> , which is $-2,147,483,648$ to $+2,147,483,648$.
<code>nextInt(int n)</code>	This method accepts an integer argument, <code>n</code> . It returns a random number as an <code>int</code> . The number will be within the range of 0 to <code>n</code> .

See example: [RollDice.java](#)