

Keyboard Input, Output Formatting, Strings

So far we have “hard coded” all values we want directly in our code. For example, in the twix calorie calculator we input the number of calories, height, weight, and age directly as variables in our program. It would be nice to be able to run our program, have it ask the user to enter their age, weight, and height, then calculate the number of twix bars to eat. This makes the program much more general and functional with easily-changed values instead of having to change the values in the program, recompile it, and then re-run the program.

To input data from the keyboard we use the **Scanner** class. Here is an example:

```
import java.util.Scanner;

class ScannerTest
{
    public static void main(String[] argv)
    {
        int i;
        float f;
        double d;

        Scanner keyboard = new Scanner(System.in);

        System.out.println("Enter an integer. ");
        i = keyboard.nextInt();
        System.out.println("You entered: " + i);

        System.out.println("Enter a double. ");
        d = keyboard.nextDouble();
        System.out.println("You entered: " + d);

        System.out.println("Enter a float. ");
        f = keyboard.nextFloat();
        System.out.println("You entered: " + f);

        // Now sum up all three things entered as a double
        d = d + (double) f + (double) i;
        System.out.println("The sum of all three is: " + d);
    }
}
```

We start with the “import java.util.Scanner” which gives us access to the code library containing the Scanner class, which allows us to input data from the keyboard. This line should be near the top of the file.

Inside the main method the line “Scanner keyboard = new Scanner(System.in);” creates a Scanner object that takes System.in as a parameter, which refers to input from the

keyboard. This is basically defining a variable with a data type of “Scanner” and the name of the variable is “keyboard”. We could have used a different name.

With the keyboard variable we can now use the `nextInt()`, `nextDouble()`, or `nextFloat()` **methods** to return numbers of those particular data types typed from the keyboard. A method is a name for a group of code that performs some specific task – in this case, it reads in whatever is typed “next” as a double, integer, float, etc. This method is defined for you as part of the Java language. Later we will see that we can write our own methods.

Here is the output for a sample run:

```
Enter an integer.  
5  
You entered: 5  
Enter a double.  
2.412  
You entered: 2.412  
Enter a float.  
3.14  
You entered: 3.14 // Note roundoff errors below!  
The sum of all three is: 10.552000104904174
```

Formatted Output

So far we have been using `System.out.println` to output all of our messages. This method outputs whatever is inside the parentheses and then adds a newline (future output goes to the next line).

If you don’t want output to go to the next line then use `System.out.print` instead of `System.out.println`. For example:

```
System.out.print("The Seawolf mascot's name is ");  
System.out.println("Spirit");
```

Outputs:

```
The Seawolf mascot's name is Spirit
```

You can use combinations `print()` and `println()` to control how you output different variables.

You have probably noticed that when you output floating point numbers you are often getting more decimal places than you really want. In an earlier example, the output was `10.552000104904174` but you might want to only output it as `10.55`. An easy way to do this is to use the `printf()` method which allows you to format your output.

Here is an example that shows a few format specifiers, one to print an integer, an integer in a field of 5 spaces, and a floating point number with 2 digits after the decimal point:

```
int num1, num2;
double num3;
num1 = 1;
num2 = 9;
num3 = 5.58831;
System.out.printf("An integer:%d\nAn integer in 5 spaces:%5d\nA
floating point number with 2 decimal places:%.2f\n", num1, num2, num3);
```

Output:

```
An integer:1
An integer in 5 spaces:    9
A floating point number with 2 decimal places:5.59
```

The % symbol is used in the printf statement as placeholders to substitute values that are specified after the string.

In this case “%d” is a placeholder for the first argument to come after the string which is the variable num1. “%d” stands for an integer, so it will output as an integer the value in num1.

“%5d” is the next placeholder and it means to output an integer, but do so in a field of 5 characters. You can use this if you want to make columns of numbers line up nicely, for example, to make a table. In this case it matches up with the second argument, which is the value stored in num2.

“%.2f” is the next placeholder and it means to output a floating point number with 2 places after the decimal point. It matches up with the third argument, which is the value stored in num3. Note that the number is rounded up when it is printed out.

There are more format specifiers the next most common one is %s which is a placeholder for a String – see the book for details.

Class Example – Seconds to Hours, Minutes, and Seconds

Write a program that inputs some number of seconds and outputs how many hours, minutes and seconds it is. For example, 3661 seconds is 1 hour, 1 minute, and 1 second. 122 seconds is 0 hours, 2 minutes, 2 seconds.

What algorithm solves our problems?

To write our solution what variables do we need and what data types?

Use the printf method to output the results.

Introduction to the NetBeans IDE

This document is a brief introduction to writing and compiling a program using the NetBeans Integrated Development Environment (IDE). An IDE is a program that automates and makes easier many tasks that programmers would otherwise have to perform themselves. While many IDEs exist for Java, we will focus only on the NetBeans IDE because at the time of this writing it is free and contains many powerful features.

Installation

The Engineering Lab and NSB 204 already have NetBeans installed. If you plan to work exclusively from the lab, then you can skip this section. If you plan to install NetBeans on your own machine, your system should meet these recommended specifications:

Disk space: 1 GB free space
Memory: 1 GB RAM
Processor: 1.4 Ghz Pentium III processor or better
Operating Systems: Mac OS X, Windows, Linux

You can download NetBeans from <http://www.netbeans.org>. There are numerous download options, e.g. including web development, database, etc. The “Java SE” version is sufficient for purposes of this class.

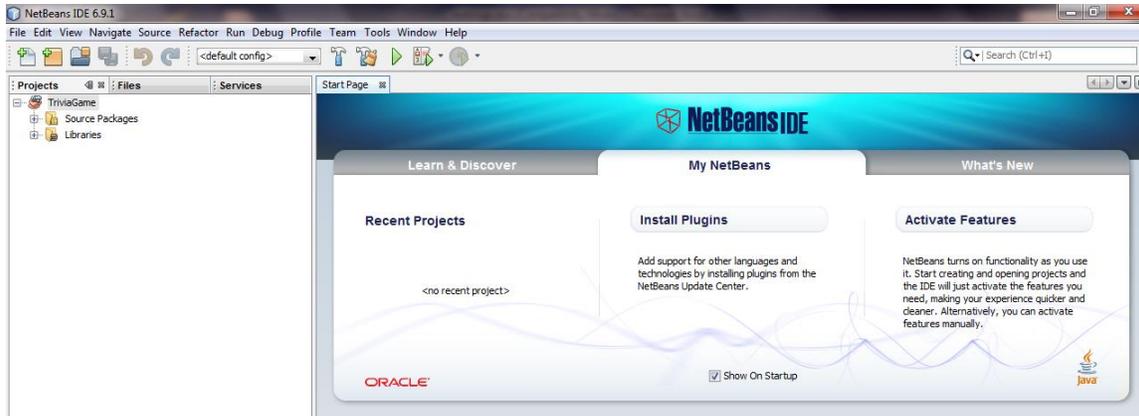
The NetBeans IDE is a big file --- a minimum of around 50 MB. After you have downloaded the file, double-click the file to install the software.

Starting NetBeans

In the following screens I am assuming that you are running Windows and NetBeans 6.9. Some details are different if using a Mac or Linux machine but the overall process is the same. After you have installed NetBeans, double-click on the icon to get started:



NetBeans will take a while to start up. After NetBeans has started it should bring up the main window that looks something like this:

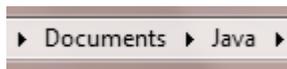


Depending on the version of NetBeans, yours probably won't look exactly the same but should be similar.

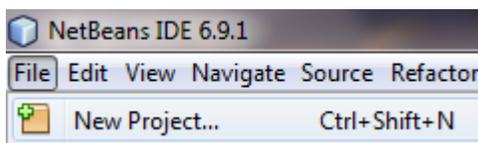
Building a Sample Project – Input Two Numbers, Calculate Sum

Let's start by creating in NetBeans a sample program that asks the user to input two numbers and calculates the sum. The process will be similar when working on your own programs.

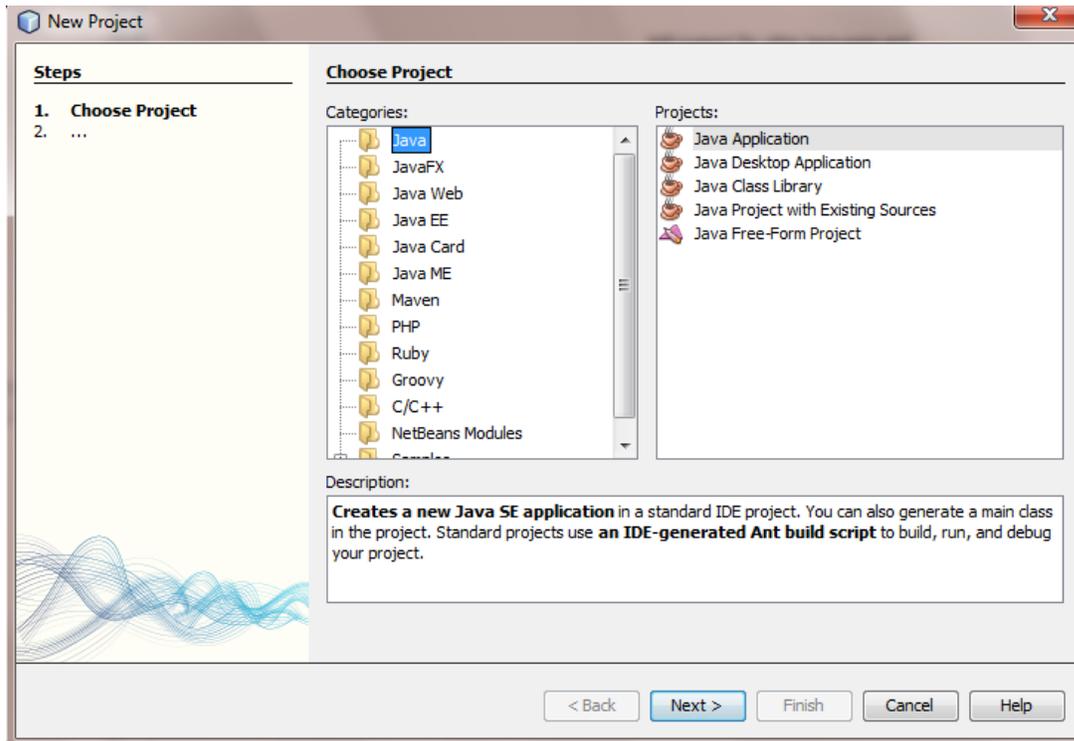
First, let's make a folder to store our Java files. In this case I'll create a folder called "Java" in my "Documents" folder but you could make the folder anywhere you have access. In the CS Lab and classroom you only have the ability to write files in your Documents or My Documents folder. Go back to Windows, open up a File Explorer or My Computer, and right click in your selected folder to create a folder named Java:



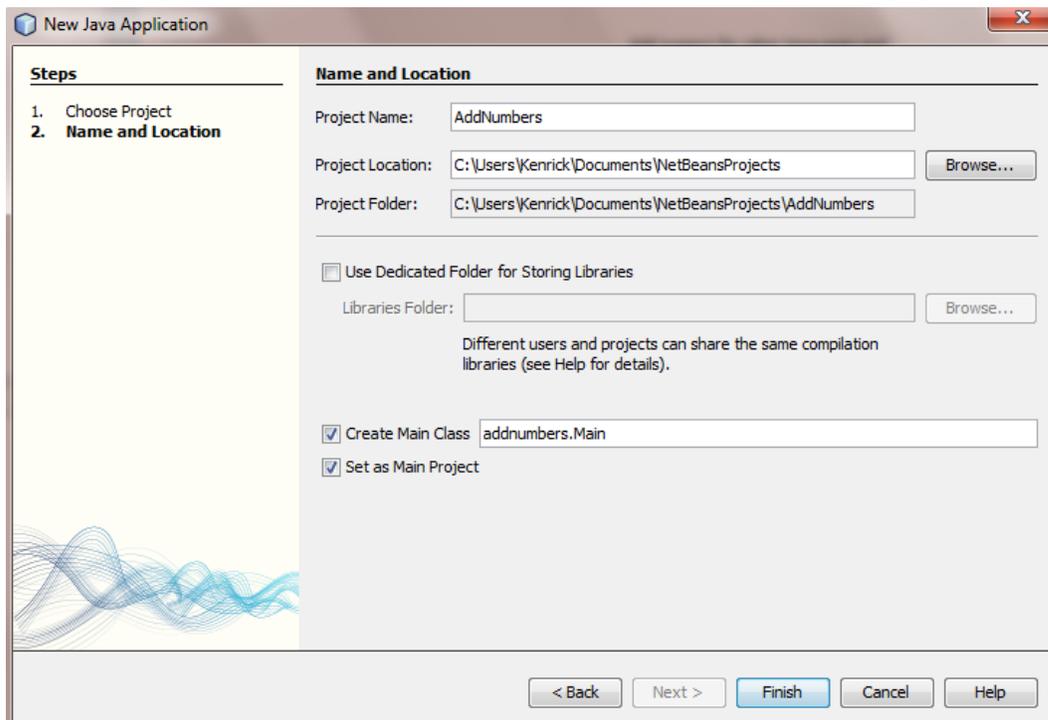
Back in NetBeans, from the main menu select File and New Project:



Choose “Java” for the category and “Java Application” for the project and click Next:



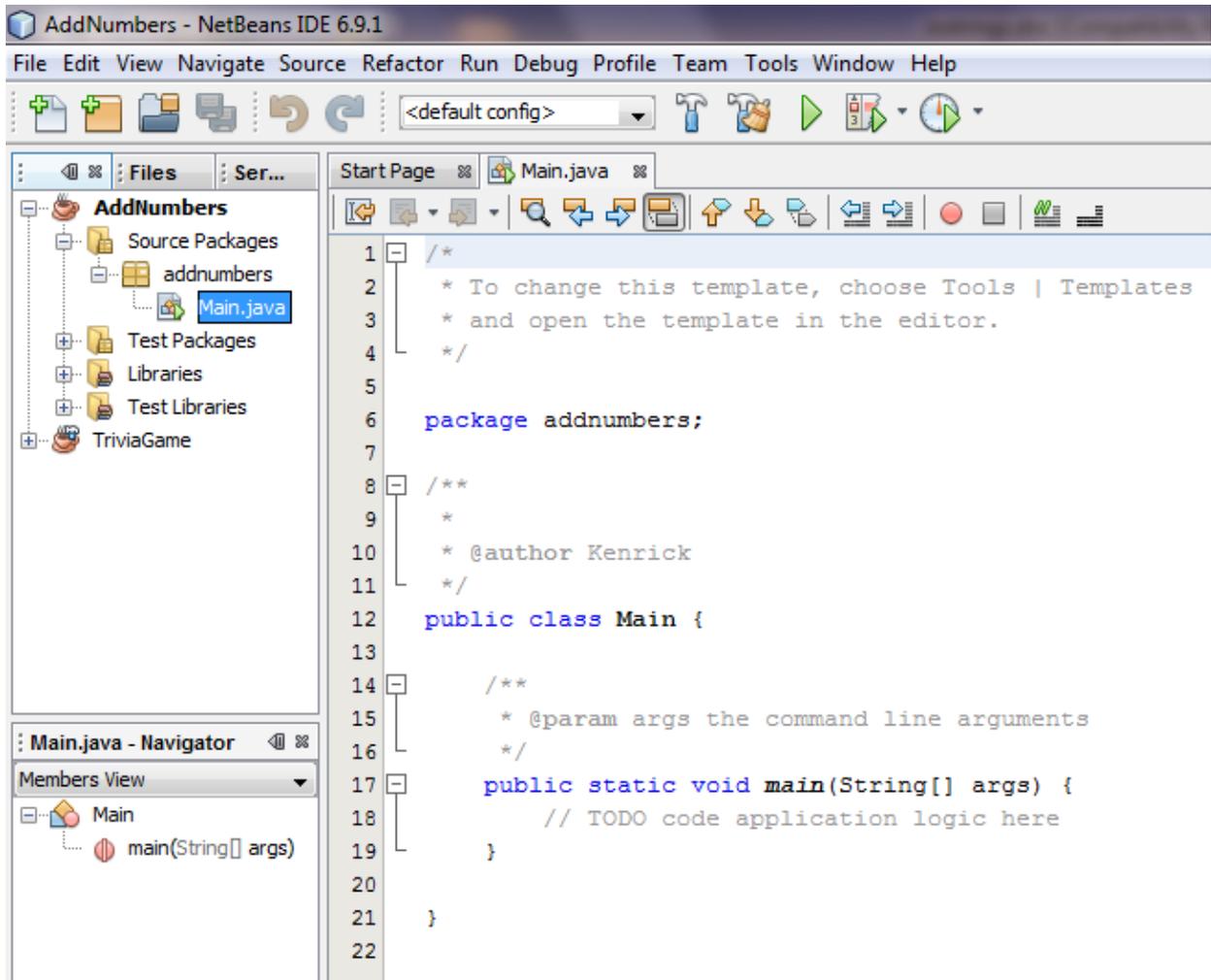
On the next screen NetBeans will ask what you would like to name your project and where you would like to create it. Give it the name of “AddNumbers” and you can leave the other defaults.



Normally you would be giving this a project name indicative of your homework, e.g. “Homework1” or such.

Click on Finish and NetBeans will create your project.

In the upper left corner of the screen is a Projects tab. The “AddNumbers” project we just created should now be listed as a project. NetBeans will create a program for you with the main method



This will create a new Java class called “Main” and the default template creates the main method for you. Don’t worry about the package stuff, we will discuss that later.

We can now start typing in the code:

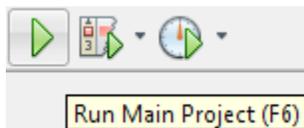
```

1  /*
2  * To change this template, choose Tools | Templates
3  * and open the template in the editor.
4  */
5
6  package addnumbers;
7
8  import java.util.Scanner;
9
10 /**
11  *
12  * @author Kenrick
13  */
14 public class Main {
15
16     /**
17     * @param args the command line arguments
18     */
19     public static void main(String[] args) {
20         Scanner keyboard = new Scanner(System.in);
21         int num1, num2;
22         System.out.println("Enter first number.");
23         num1 = keyboard.nextInt();
24         System.out.println("Enter second number.");
25         num2 = keyboard.nextInt();
26         int sum = num1 + num2;
27         System.out.printf("You entered %d and %d. The sum is %d.\n", num1, num2, sum);
28     }
29 }
30

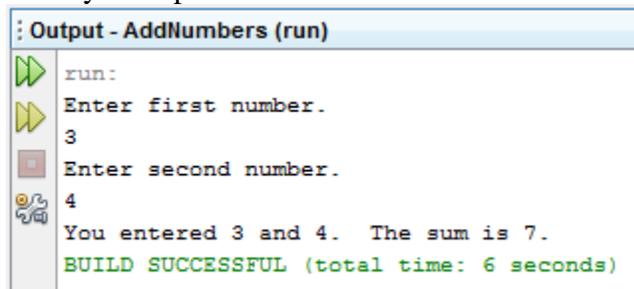
```

As you type, notice that NetBeans does useful things for you, like have a pop-up of possible choices when typing a period, color coding, underlining where it detects errors, etc.

To compile and run your program click on the green triangle “Play” button:



Enter your input in the window near the bottom of the screen:



Congratulations, you have just created your first project in NetBeans! You should follow a similar process when working on programs assigned as homework.

If you are going to turn in your project then the easiest way is to locate the project folder in the file explorer (in this example, “AddNumbers” located in “Documents/Java”) and then compress the entire folder into a zip file. You can make a zip file by right-clicking on the entire folder and selecting “Send To” and “Compressed Zip Folder”. You can then send the zip file. Note that in the future some instructors may only want your java source files (.java located in the src subdirectory). Sending the entire project folder includes NetBeans gunk that some may not care for if they don’t use NetBeans.

If you want to copy your project from one computer to another then copy the entire project folder to the other computer (e.g. using a flash drive).

For those that do have NetBeans though, compressing the whole folder is much easier because it includes the NetBeans project and other meta-data used to create the project.

If you want to work on the project at a later date, simply restart NetBeans and all of your files will be visible if you are using the same computer. If you have copied the folder to another computer then use “Open Project” from the “File” menu to open the project. If you start to work on many files you may wish to delete some of the .class files or copy out old folders that you no longer use. In particular, the .class files can take up a lot of space.

We have only touched on the basics of using NetBeans here; feel free to explore on your own the many other options that are available. In particular, you may notice that NetBeans will detect many errors as you are typing them. This can be quite helpful in avoiding many common problems.

Later we will look at using NetBeans debugging tools which are quite helpful in tracking down mysterious runtime errors.

NetBeans vs. DrJava or TextPad?

As you can see NetBeans offers a lot more features than writing your programs in DrJava and directly compiling them. However, it also has a lot more baggage if you only want to edit, compile, and run a short program. For small programs I tend to prefer the direct editor/compile approach. However for larger programs with many files or classes an IDE like NetBeans is the superior way to go.

Inputting Strings

Reading input from the keyboard for strings is almost the same as inputting numbers, except there is a pitfall when reading an entire line vs. reading a single number or word.

To read in a single word (surrounded by whitespace, i.e. spaces, tabs, carriage returns, etc.) use the next() method:

```
public static void main(String[] argv)
{
    int i;
    String s;
    Scanner keyboard = new Scanner(System.in);

    System.out.println("Enter an integer. ");
    i = keyboard.nextInt();
    System.out.println("You entered: " + i);

    System.out.println("Enter a word. ");
    s = keyboard.next();
    System.out.println("Your word was: " + s);
}
```

This program reads in an integer, prints it out, then reads in a word and prints it out.

For example:

```
Enter an integer.
5
You entered: 5
Enter a word.
coffee
Your word was: coffee
```

If you enter more than one word note that the next() method ONLY reads the next word:

```
Enter an integer.
5
You entered: 5
Enter a word.
need more coffee
Your word was: need
```

To read a whole line we can use the method nextLine():

```

public static void main(String[] argv)
{
    int i;
    String s;
    Scanner keyboard = new Scanner(System.in);

    System.out.println("Enter an integer. ");
    i = keyboard.nextInt();
    System.out.println("You entered: " + i);

    System.out.println("Enter a line of text. ");
    s = keyboard.nextLine();
    System.out.println("Your line was: " + s);
}

```

You would probably expect it to behave like the first program, but the program immediately ends without prompting you to enter a line of text. The reason is because the `nextLine()` method behaves a little differently than the other methods.

Java interprets its input as a stream of characters. When you press the enter key, a newline character is inserted into the stream. Let's say that you are giving the input of "50" for the integer and "hello" for the text. Java sees this input as:

50\nhello\n
 ↑
 next character to read

The `\n` is a single character for newline.

When we execute: `i = keyboard.nextInt();`
 Java reads the 50 and advances its input buffer to reference the next character in the stream, the `\n`:

50\nhello\n
 ↑
 next character to read

If we execute: `s = keyboard.next();` (or `nextInt()` or `nextDouble()`, etc.)

then Java will **skip any whitespace** characters looking for a word that is surrounded by whitespace. You can test this by entering leading spaces, newlines, tabs, etc. They will all be skipped and Java will return back only the word you enter.

However, if we execute: `s = keyboard.nextLine();`

then Java will stop until it hits a newline character, and consume it. It just so happens that the next whitespace is the `\n` so we end up with:

50\nhello\n



next character to read

And the string `s` contains a blank string.

The solution? Use an extra `nextLine()` after reading an int or word to skip the whitespace character if you want to later read in an entire line:

```
public static void main(String[] argv)
{
    int i;
    String s;

    Scanner keyboard = new Scanner(System.in);

    System.out.println("Enter an integer. ");
    i = keyboard.nextInt();
    System.out.println("You entered: " + i);

    keyboard.nextLine(); // Skip \n character

    System.out.println("Enter a line of text. ");
    s = keyboard.nextLine();
    System.out.println("Your line was: " + s);
}
```

Working with Strings

The `String` type is actually a class, as opposed to a primitive data type like `int`'s or `char`'s. As a class, this means that the `String` type stores both data and methods. The methods perform various operations on the string data that it holds.

Concatenation: The “+” operator, when applied to numbers, performs addition. However, when applied to strings, this concatenates two strings together. For example:

```
String s1 = "hello";
String s2;

s2 = s1 + "there";
System.out.println(s2);
```

This code fragment will output “hellothere”. Notice there is no space that is added. If we want to explicitly add a space, we must put one there:

```
s2 = s1 + " there";
```

Concatenation will convert any other data types in the expression into strings. For example:

```
s2 = s1 + " " + 100;
System.out.println(s2);
```

This will output “hello 100”. What Java really does is take the number 100 and turn it into a string before concatenating it with s1.

String Methods

Once we have set a string variable to something, there are many methods we can invoke to manipulate that string. Here are listed a few methods. To invoke them, use the name of the string variable followed by a “.” and the method name. Here is a list of methods, assuming the String variable we are working with is named “s1”:

Method	Description	Example
length()	Returns the length of the string object	String s = “hello”; int x; x = s.length(); // x = 5
equals(String s2)	Returns true if s1 = s2, false otherwise	String s1 = “hello”; String s2 = “hello”; if (s1.equals(s2)) then ... // TRUE
equalsIgnoreCase(String s2)	Returns true if s1 = s2 ignoring case, false otherwise	See above
toLowerCase()	Returns a converted string to lowercase	String s1 = “HeLIO”; String s2; s2 = s1.toLowerCase(); System.out.println(s2); // “hello” System.out.println(s1); // “HeLIO”
toUpperCase()	Returns a converted string to uppercase	See above
trim()	Returns a string with same characters but leading and trailing whitespace removed	String s1 = “ hi ”; s1 = s1.trim(); // s1 = “hi”
charAt(int pos)	Returns the character at position pos; pos starts from 0	String s1 = “hello”; System.out.println(s1.charAt(0)); // h System.out.println(s1.charAt(4)); // o

substring(int start, int end)	Returns a substring from start to end, including start but excluding end	String s1 = "hello"; String s2; s2 = s1.substring(0,4); // s2 = "hell"
indexOf(String s2)	Returns position in s1 where s2 occurs	String s1 = "hello"; int i; i = s1.indexOf("lo"); // i = 3
compareTo(String s2)	Returns a negative value if s1 < s2, zero if s1 == s2, positive value if s1 > s2	String s1 = "Jones"; int x; x = s1.compareTo("Adams"); // x > 0