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Java Fundamentals I

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Lecture Topics

- Programming Language Concepts
- Primitive Data Types
  - Variables- Declaration, Initialization, Assignment
  - Literals
- Strings
- Standard Streams
- Comments/Documentation

Colors/Fonts

- Local Variable Names – Brown
- Primitive data types – Fuchsia
- Literals – Blue
- Keywords – Orange
- Object names – Green
- Operators/Punctuation – Black
- Field Names – Lt Blue
- Method Names – Purple
- Parameter Names – Gold
- Comments – Gray
- Package Names – Pink

Source Code – **Consolas**
Output – Courier New

Basics of a Programming Language

- Modern, high-level languages, programming languages incorporate the following concepts:
  - Keywords
  - Operators
  - Punctuation
  - Syntax
  - Variables

Keywords

- A ***keyword*** (or reserved word) is word that has special meaning to a programming language.
  - The word is *reserved* from being used in other contexts within programs written in the language.
  - Keywords are typically used in a language for performing some specific process.

- For example, in many languages the word “if” is a reserved word.
  - The if keyword begins a special statement that allows a program to make a decision.
  - **if** *this is true* then do *that*

- Many different languages utilize the same keywords.

Operators

- An ***operator*** is (usually) a symbol that performs an operation on one or more operands(values/data).

- In the mathematical expression 1 + 2, the plus sign is an operator that adds the two operands together.
  - In this example:
    - **1** and **2** are operands
    - **+** is the operator
    - **Addition** is the overall operation performed by the operator.

- Many languages use the same operators for performing common operations, like arithmetic and comparisons.

- In some cases, keywords can take the form of an operator.

Punctuation

- ***Punctuation*** is characters or symbols used when writing statements in a programming language.
  - A *statement* is like a sentence or an instruction in a programming language.

- Consider the sentence *I went to the park, the mall, and the college.*
  - We used punctuation for listing multiple places (commas) and a period to end the sentence.
  - Programming languages will use characters in similar ways.
    - For example, commas are often used in programming languages when specifying a list of values.

- Punctuation varies among different languages.
  - Some languages, like Java and C++ require ending statements with semicolons.
  - Languages like Python do not require punctuation at the end of statements.

Syntax

- ***Syntax*** is the language's rules for how keywords, operators, punctuation, and identifiers must be arranged in statements.

- Syntax ensures the statements and instructions of a program are correctly executed.

- "Tall, he is."
  - We can kind-of understand what this English statement is saying.
  - A computer can't "guess" our intentions when we give it instructions.
    - A statement is syntactically correct, or it is not. There can be no ambiguity.

Syntax

- A language's syntax is usually the most notable difference among different programming languages.
  - How languages accomplish tasks is comparable, but how we write those statements to accomplish the task differs.

- Some languages have comparable syntax.
  - Many languages are derived from or inspired by other languages.
  - Java and C++ have comparable syntax as they are both heavily based on the C programming language.
  - Python and Java have some similarities, but overall have many differences in syntax.

Data Types

- A ***data type*** (aka ***type***) specifies the kind of information that data can be.

- It is the *meaning* of the data.
  - The type identifies how the data can be used.

- Data types are used for
  - Specifying the possible values the data can be interpreted as.
  - Specifying what operations can be performed on the data.

Data Types

- All languages have low-level data types for use.
  - Often called ***primitive*** or ***standard data types.***

- These low-level types typically share similarities across different languages.

- The building blocks for more complex types.

Numeric Types

- Programming languages generally have two types for numeric values.
  - Integers
  - Floating Point Numbers (“Floats”)

- Some languages, like Java, have multiple types for integers and floating-point numbers.
  - Other languages, like Python, only have one for each.

Integers

- An ***integer*** is a whole number.
  - 26
  - 0
  - -5

- Integers do not have fractional portions.
  - 45.7 is not an integer.

Floating-Point Numbers

- A floating-point number is used to represent a rational number, or numbers with fractional amounts.
  - 56.7
  - 0.86
  - 4.019999
  - -31.5

- The binary information that makes up a floating-point number (“float”) is organized in a special way.

Signed and Unsigned Numbers

- In computing, there exists signed and unsigned numbers.
  - ***Signed numbers*** are numbers that can be positive or negative.
  - ***Unsigned numbers*** are numbers that can only be positive.

- All numeric primitive data types in Java are signed.

Primitive Data Types

- Java has eight primitive data types
  - Four Integer Types
    `byte`, **`short`**, **`int`**, **`long`**
  - Two Floating-Point Types
    `float`, **`double`**
  - One Boolean Type
    `boolean`
  - One Character Type
    `char`

Primitive Data Types

- Integer Types
  - `byte` (8 bits)
    - Can represent any integer between -128 and 127
  - `short` (16 bits)
    - Can represent any integer between -32,768 and 32,767
  - `int` (32 bits)
    - Can represent any integer between -2,147,483,648 and 2,147,483,647
    - Most frequently used integer primitive.
  - `long` (64 bits)
    - Can represent any integer between -2^{63} and $2^{63}-1$

Primitive Data Types

- Floating-Point Types
  - `float` (32 bits)
    - Can represent values between ~ $\pm 3.4 \times 10^{38}$ with 7 significant digits.
  - `double` (64 bits)
    - Can represent values between ~ $\pm 1.7 \times 10^{308}$ with 15 significant digits.

- Boolean Type
  - `boolean` (1 bit)
    - Can be `true` or `false`.
    - Used for decision making.
  - Depending on the OS's memory management, it may not be able to allocate a single bit of memory.
    - The OS may allocate an entire byte (8 bits), though only one of the bits will be used.

Primitive Data Types

- Character type

  `char` (16 bits)

  - Can represent a single, 16-bit Unicode character.
  - UTF-16 character table for reference:

    http://www.fileformat.info/info/charset/UTF-16/list.htm

- Together, multiple chars make up a `String` object.
  - Strings are not primitive types in Java, they are *objects* (discussed in later lectures).

Variables

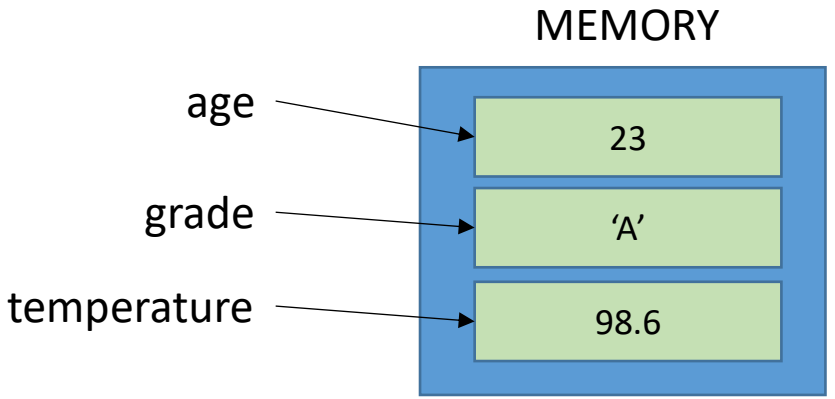
- A ***variable*** (aka ***field*** or ***identifier***) is a programmer-defined name that references the location of an area of memory.

- Like the name suggests, the data referenced by a variable may vary.
  - New values/data can be assigned to the memory location the variable references.

- All variables must have a type associated with it.
  - This restriction ensures the data at that memory location referenced by the variable is interpreted correctly.

Variables

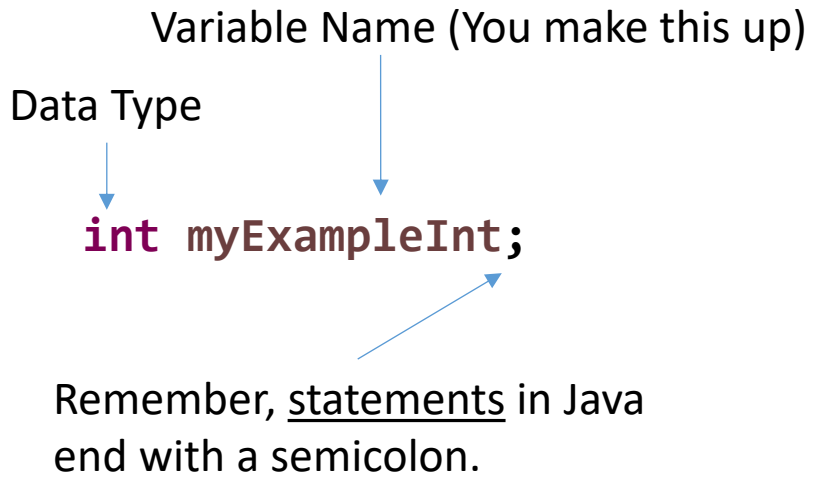
- Variable names are programmer defined.
  - We choose variable names based on the data they represent in our programs.



Declaring a Variable

- When a variable is ***declared***, you are stating:
  - The type of data this variable will reference.
  - The name of the variable.
- Examples:

```
int myExampleInt;
double myExampleDouble;
char myExampleCharacter;
boolean myExampleBoolean;
```



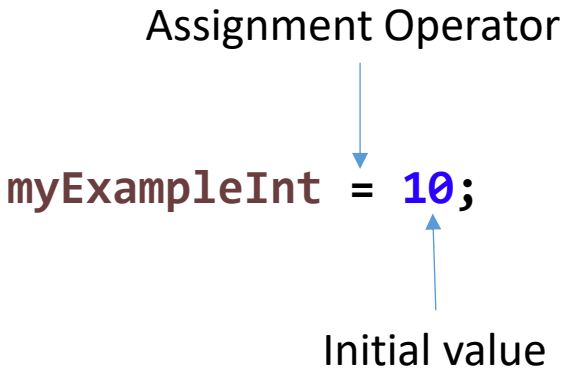
- Declare multiple variables at once:

```
int myOtherExampleInt, myThirdExampleInt, myOtherExampleInt;
```

Initializing a Variable

- A variable becomes ***initialized*** when an initial value/data is stored to the memory location referenced by the variable.
- Assignment operator: **=**
  - Used to store a value to the memory location referenced by a variable.
- Examples (all previously declared in the last slide):

```
myExampleInt = 10;
myExampleDouble = 15.3;
myExampleCharacter = 'A';
myExampleBoolean = false;
```



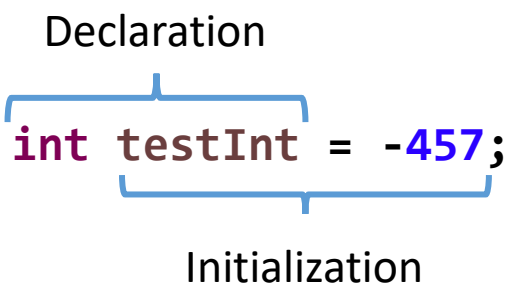
- Note: You cannot initialize a variable that has not yet been declared!

Declare and Initialize a Variable

- You can assign an initial value when you declare a new variable.

- Examples:

```
int testInt = -457;
double testDouble = 356.45;
char testCharacter = 'Z';
boolean testBoolean = true;
```



- You can declare and initialize more than one new variable at once:

```
int testInt1 = 246, testInt2 = -76, testInt3 = 10;
```

(Re)Assignment

- ***Assignment*** is simply replacing the existing value at the memory location referenced by a variable with a new value.
  - The new data must be of the correct type.

- Like initialization, also uses the Assignment Operator, **=**

- Example:

```
double currentTemperature = 67.5;
currentTemperature = 68.2;
```

A few notes on variables

- The default values of the primitive data types (their values before any initialization is performed) are:
  - byte, short, int, long : 0
  - float, double : 0.0
  - char : ' '
  - boolean : false

- Variable names must be unique, regardless of data type.

- A variable's data type cannot be changed after declaration.

- The names of the primitive data types are all Java keywords.
  - They cannot be the name of a variable.

Copying values from one variable to another

- Use the Assignment Operator, **=**
- Examples:

```
double currentSpeed = 35.2;
double copyOfCurrentSpeed = currentSpeed;
```

Value located at the memory location referenced by currentSpeed is copied to the memory location referenced by copyOfCurrentSpeed

```
int numberOfApples = 10;
int copyOfApples;
copyOfApples = numberOfApples;
```

Value located at the memory location referenced by numberOfApples is copied to the memory location referenced by copyOfApples

Constants

- A ***constant*** is a value that cannot be changed.
- Constants are declared by using the **final** keyword.
- Examples:

```
final int FREEZING_POINT = 32;
final double PI = 3.14159;
final char LETTER_ZEE = 'Z';
```

- Trying to assign a constant with a new value will result in a compile time error.
  - A compile-time error occurs when you compile your code.
  - A run-time error occurs when your program is running.

Naming Variables

- Variable names are case-sensitive.

```
int someNumberValue;
int somenumbervalue;
```

- In the lines of code above, someNumberVariable and somenumbervariable are two separate variables.

```
double myDoubleValue;
mydoublevalue = 100.1;
```

- These lines of code will NOT work. The variable declared is named my**D**ouble**V**alue not the same as my**d**ouble**v**alue.

Naming Variables

- Names must start with a letter, dollar sign, or underscore.
- Names may contain numbers, but cannot start with numbers!
- Aside from letters, dollar signs, underscores, and numbers, no other characters may be used.

```
int someName;
int _someName;
int some_Name;
int $someName;
int some$Name;
int 3someName;
int some3Name;
```

Valid.

Valid. Can start with underscore.
Valid. Can contain any underscores.

Valid. Can start with dollar sign.
Valid. Can contain any dollar signs.

INVALID. Can't start with a number.
Valid. Can contain any numbers.

Naming Variables

- Names cannot contain spaces. Use underscores, if necessary.

```
int some Name;      INVALID
int some_Name;      Valid
```

- Names cannot be a Java keyword.

```
int double;         INVALID
```

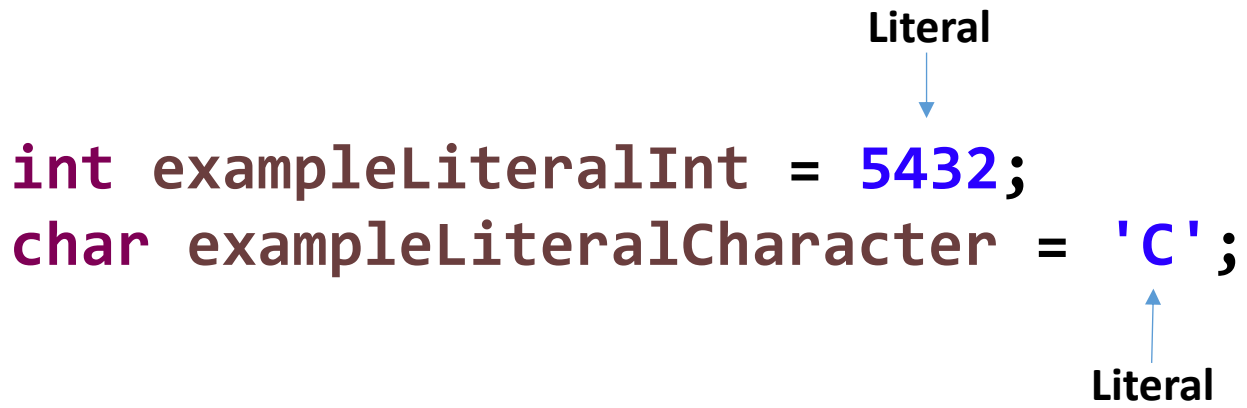
Naming Variables

- Variable names normally begin with a lowercase letter; Class/Object names normally begin with an uppercase letter.
- “Camel-case” is the typical convention used for variable names.
  - For variable names that are multiple words long, the first letter of every subsequent word should be capitalized.
- Constants are typically ALL CAPS with underscore spacing.
- This is not mandatory, but these are conventions followed by just about every professional software engineer.

```
int bottlesOfBeerOnTheWall = 99;
boolean hasGoneToTheMarket;
final int PENNIES_IN_A_DOLLAR = 100;
```

Literals

- A ***literal*** is a source code representation of a fixed value.
  - It is represented without any computation.
- Sometimes referred to as *hard coded values*.



Literals (Numeric)

- byte, int, short, and long literals can be expressed in
  - Decimal (Base 10)
  - Octal (Base 8), or
  - Hexadecimal (Base 16)

- Decimal Literal (No prefix): `int decimalNumber = 100;`
- Octal Literal (0 prefix): `int octalNumber = 0144;`
- Hexadecimal Literal (0x prefix): `int hexNumber = 0x64;`

For the purpose of this course, we will only be using decimal (base 10) values.
It's good to know that other numeric literals exist, though.

Literals (Fractionals)

- Double literals (Nothing special needs to be done):

```
double exampleDoubleLiteral = 255.23;
```

- Float literals (Must add lowercase f to the end):

```
float myExampleFloat = 15.5f;
```

The compiler (like with many other programming languages/compilers) interprets literal decimal numbers as doubles by default. To differentiate float literals from double literals, float literals must end with a lowercase f.

Literals (Characters)

- char literals can be expressed as a character literal, a Unicode literal, or a decimal number.
- **Must be in single quotes!!**

```
char exampleCharLiteral = 'A';
char exampleCharUnicodeLiteral = '\u0041';
char exampleCharDecimalLiteral = 65;
```

- UTF-16 character table for reference:

  http://www.fileformat.info/info/charset/UTF-16/list.htm

  Any lab examples/homework will use character literals like exampleCharLiteral above.

Strings

- A ***String*** is an object (not a primitive) that contains a sequence of characters.

- The sequence of characters in a String can include any number of:
  - Letters
  - Numbers
  - Symbols
  - Spaces

Strings

- Since a String is an object, it provides ***methods*** (internal processes) we can call.

- A String provides many methods that make the manipulation of its data relatively painless.
  - We will only see a few today and see others later in the course.

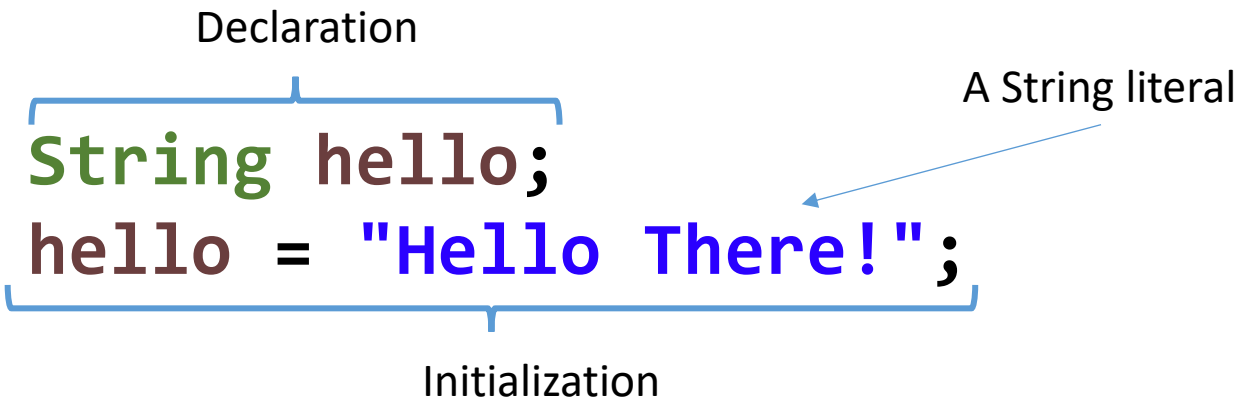
Declaring a String object

- Strings, like primitives, are declared:
  - First stating the data type.
  - Then stating the variable name.

```
String hello;
```

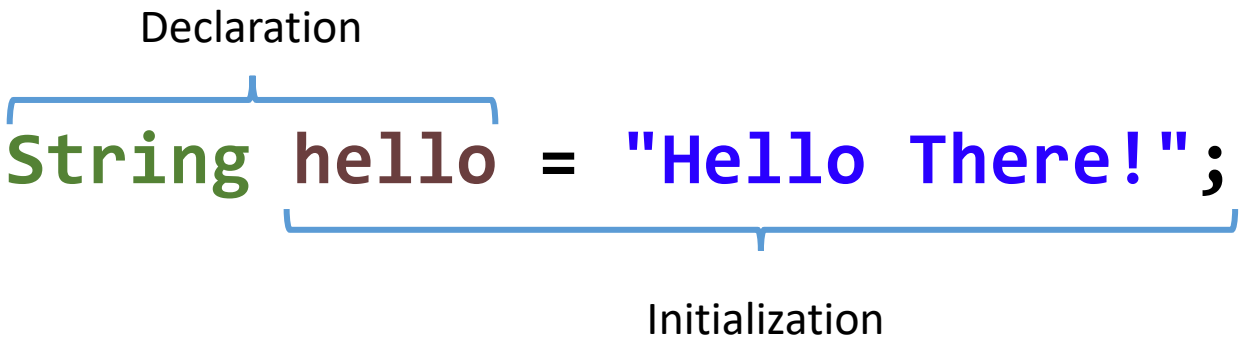
Initializing a String object

- Use the assignment operator: =
- A ***String literal*** is any source code representation of a sequence of characters in double quotation marks.



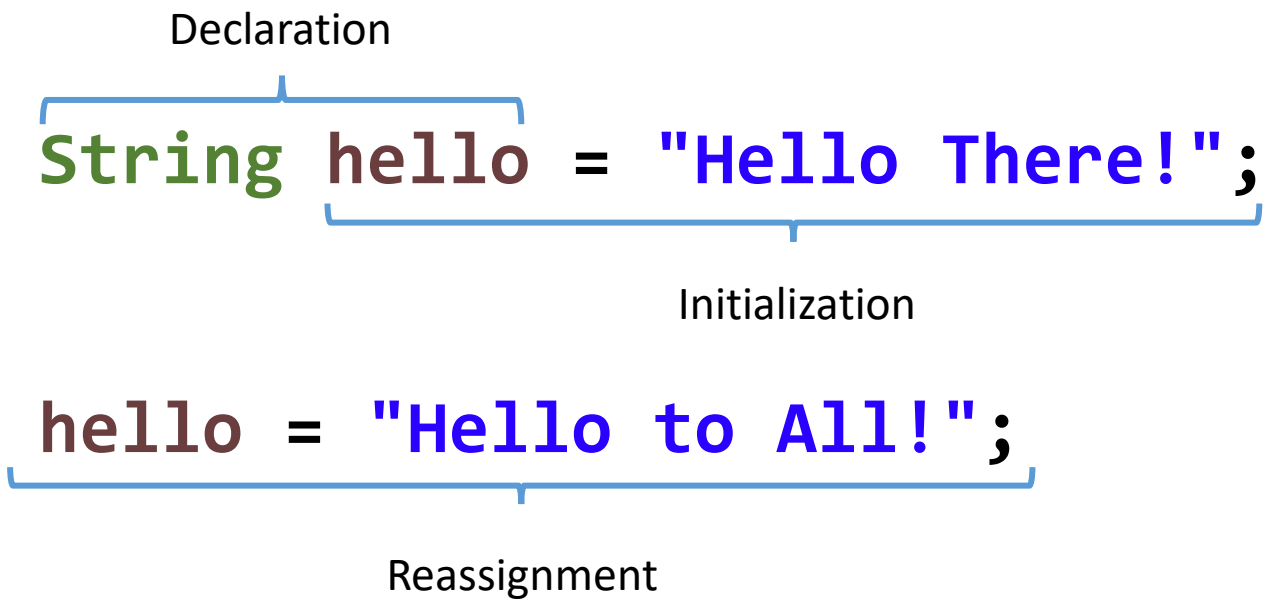
Declare and Initialize a String object

- Declaration and initialization can be done in one statement.



Reassigning Strings

- Use the assignment operator: =

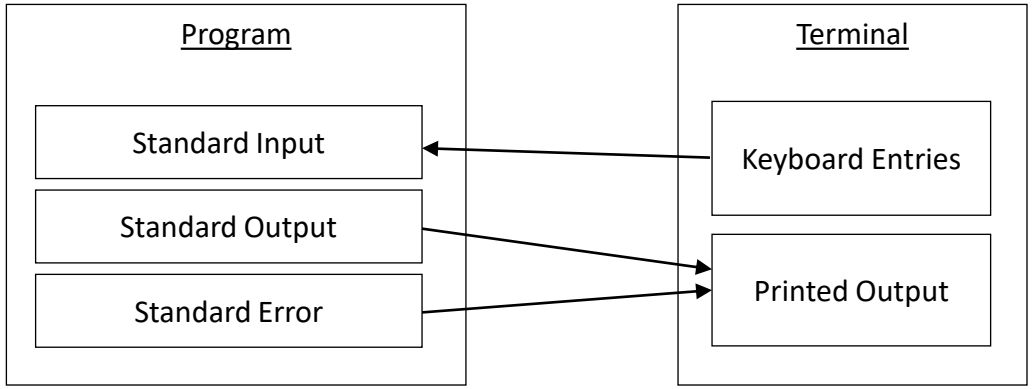


Standard Streams

- A computer program uses data streams for handling incoming and outgoing data.

- Three standard streams
  - Standard Output (“stdout”, “standard out”)
  - Standard Input (“stdin”, “standard in”)
  - Standard Error (“stderr”, “standard error”)

Standard Streams



Standard Output

- ***Standard Output*** refers to the standard data stream used to print information/text to a terminal.
  - The term *console* or *terminal* is used to describe a text-only interface.

- The System object is provided by Java and allows access to standard output, input, and error.

System.out

- The System object is the first external class we will be using in the course.
- Another way to look at this is that we are utilizing the objects and code contained in the System object within our own program.
- We need not be concerned with the System object's code. You can just call on it from within your own program whenever you need it.
- Inside of the System object, it has a PrintStream* object named "out".
  - This object handles all default output, which is ultimately printed out to the terminal/console.
- To access an object (or *field*) within an object, we use ***dot notation***.
  - To access the "out" object from within the System object – `System.out`

* You don't have to worry about the technical specifics of a PrintStream is right now.

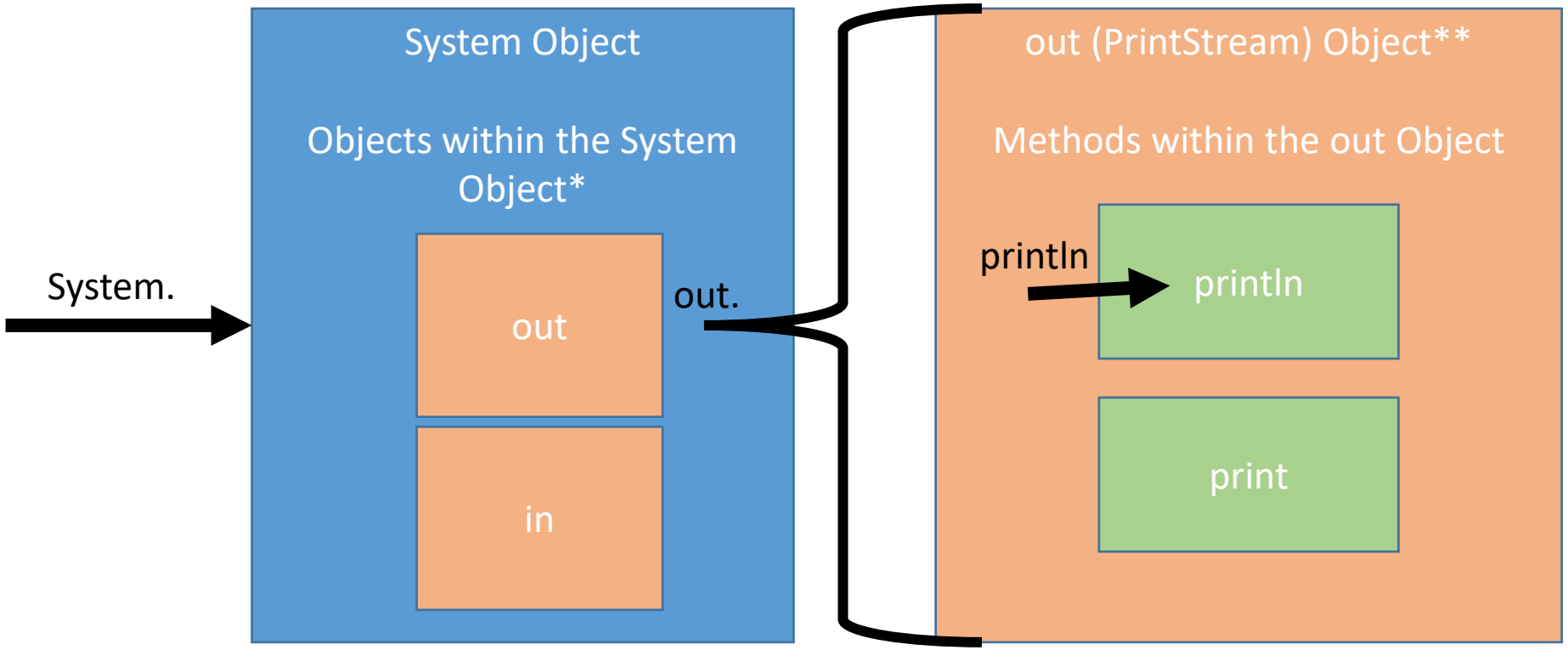
System.out

- There are two methods (sections of pre-written and reusable code) we will be using from System.out – print and println

- To access an object's methods, we again use dot notation - `System.out.println()`
  - We are basically saying, "In the System object's out object, execute the println method's code."

- The parentheses after the method name is for the parameter list.
  - Any data passed as a parameter to the print or println methods will be printed on the screen.

System.out.println() Walkthrough



* System object contains much more than just those two objects. This is just a generalization.

** A PrintStream contains much more than just those two methods. This is also just a generalization.

System.out.println()

- After printing the supplied information, the println method will return to the next line.

```
char gradeLetter1 = 'A';
char gradeLetter2 = 'B';
System.out.println(gradeLetter1);
System.out.println(gradeLetter2);
```

```
A
B
```

System.out.print()

- Unlike the println method, the **print** method will stay on the same line.

```
char gradeLetter1 = 'A';
char gradeLetter2 = 'B';
System.out.print(gradeLetter1);
System.out.print(gradeLetter2);
```

```
AB
```

Standard Input

- ***Standard Input*** refers to the data stream used to receive keyboard entries.

- Inside of the System object, it has a InputStream* object named “in”.
  - This object handles all default input, which is keyboard entries.

- To access the “in” object from within the System object – `System.in`

Scanner object

- A Scanner object provides an easy way to get input.
- Unlike other objects we have seen, Scanners will need to be ***imported***.
  - Some objects provided by Java aren't available by default.
- You must include the following line at the very beginning of your source code (before the class header)

```
import java.util.Scanner;
```

This allows the Scanner object to be accessible by your code. The Scanner object is located in Java's util (short for utility) package.

Scanner object

- Unlike other objects we have seen, Scanners will need to be ***instantiated***.
  - When you instantiate, you create a new instance of an object. It then becomes its own entity with its own data.
- Objects are instantiated using the **new** keyword.

```
Scanner keyboard = new Scanner(System.in);
```

When using a Scanner to get keyboard input, I usually name it “keyboard.” You can name it whatever you like, though.

Scanner object

- When instantiating a Scanner, you MUST give it an input source.
- The System object's "in" object is an InputStream object, which a Scanner will accept.
- This allows us access to the default input, which in most cases is the keyboard.

```
Scanner keyboard = new Scanner(System.in);
```

Scanner object

```
String someString;
Scanner keyboard = new Scanner(System.in);
System.out.print("Enter a String: ");
someString = keyboard.nextLine();
System.out.println("The String you entered "
                   + "is: " + someString);
```

```
Enter a String: Hello World!
The String you entered is: Hello World!
```

Scanner object

- A Scanner object can be used more than once:

```
String someString;
String someString2;
Scanner keyboard = new Scanner(System.in);
System.out.print("Enter a String: ");
someString = keyboard.nextLine();
System.out.print("Enter another String: ");
someString2 = keyboard.nextLine();
System.out.println("The String you entered "
                   + "is: " + someString);
System.out.println("The other string you entered "
                   + "is: " + someString2);
```

Scanner object methods*

Method	Return Type	Description	Possible Exceptions**
nextLine()	String	Returns the next line of input in String form.	NoSuchElementException IllegalStateException

*- There are more than just this one method. We will use more as the semester progresses.
**- It is unlikely you will see these exceptions when using System.in as the input stream.

Comments

- Comments are normally used to document your code.

- This makes it easy to:
  - Leave notes to yourself.
  - Leave notes to other programmers who may work on your code.
  - Describe what a section or line of code does (it may not always be obvious)

- Alternatively, comments are useful for omitting single or multiple lines when debugging.

Comments

- Single line comments begin with //

```
//Single line comment
```

- Multiple line comments begin with /* and end with */

```
/* Everything between slash-asterisk
   and asterisk-slash
   will be
   ignored*/
```

- Comments are entirely ignored by the compiler. You can type whatever you want in a comment.

Comments

```
int i = 10; //Comments can be left after a statement.
```

- Omit an entire line/statement by adding // at the beginning:

```
//int j = 10;
```

- Omit multiple lines/statements by adding // at the beginning of each, or use multi-line comments:

```
//int j = 10;
//int k = 15;
```

```
/*int j = 10;
int k = 15;*/
```

Comments

- Comments can be useful when debugging and testing.
- They allow you to omit sections of code without actually deleting them.
- You can later uncomment them, or delete them once you are confident you no longer need the lines any more.
  - If you leave in commented lines of code, you will normally leave another comment explaining why you left them in.

Comments (cont.)

```
int length = 5;
int width = 10;
int area = length * width;

//Uncomment for debugging the area value
/*System.out.print(“area is “);
System.out.println(area);*/
```

Typical Convention for Commenting

```
/**
 * This program will ask users for input
 * and then display some output.
 */
public static void main(String[] args) {
   int temp = 10; //Initialize temperature to ten.
   …
}
```