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Test Automation Engineering Fundamentals: Java

Module 3: Language Fundamentals

Module Objective

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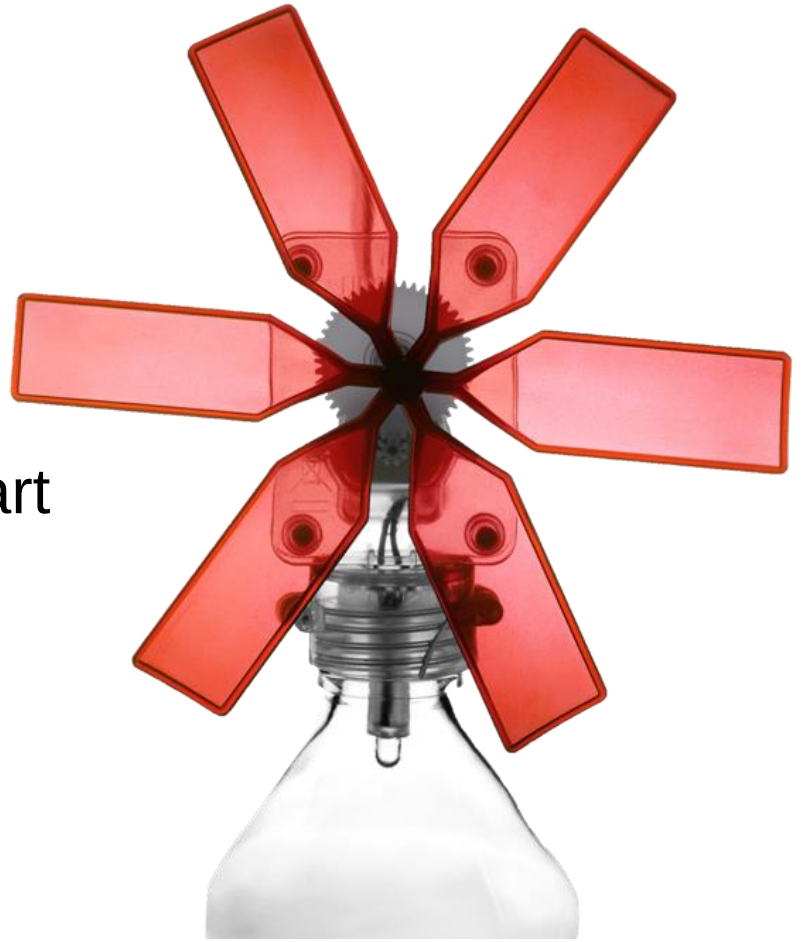
At the end of this module, you will be able to:

- Describe the primary concepts that support Java technology
- Explain how Java achieves platform independence
- Discuss the different tools and libraries available as part of the Standard Java Development KIT (J2SE JDK)
- Install and configure the required software, tools, and libraries to get started with Java
- Write, compile, and execute simple Java applications



Module Objectives (cont.)

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At the end of this module, participants will be able to:

- Explain the concept of controlling ‘program flow’
- Control ‘program flow’ by using the different control flow statements
- Describe the concept of methods
- Identify and create correctly structured methods
- Describe the concept of ‘method calling’

Java Source File Structure

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- Java applications are composed of text files ending with a ‘.java’ suffix that contain source codes
- Each Java source file consists of a ‘class declaration’, which follows a specific structure
- Java source files are compiled into ‘.class’ files which are then run by the Java interpreter

Refer to the MainSample.java sample code

Java Source File Structure

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declaration order

1. Package declaration

Used to organize a collection of related classes.

2. Import statement

Used to reference classes and declared in other packages.

3. Class declaration

A Java source file can have several classes but only one public class is allowed.

```
/*
 * Created on Jun 25, 2008
 *
 * First Java Program
 */
package sef.module3.sample;
import java.lang.*;

/**
 * @author SEF
 */
public class MainSample{

    public static void main(String[] args) {
          // print a message
          System.out.println("Welcome to Java!");
    }
}
```

Java Source File Structure

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Comments

1. Block Comment

```
/*
 * insert comments
here
 */
```

2. Documentation Comment

```
/**
 * insert
documentation
 */
```

3. Single Line Comment

```
// insert comments
here
```

The compiler ignores comments.

```
/*
 * Created on Jun 25, 2008
 *
 * First Java Program
 */
package sef.module3.sample;
import java.lang.*;

/**
 * @author SEF
 */
public class MainSample{

    public static void main(String[] args) {
        // print a message
        System.out.println("Welcome to Java!");
    }

}
```

Java Source File Structure

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Comments

1. Block Comment

```
/*
* insert comments here
*/
```

2. Documentation Comment

```
/**
* insert documentation
*/
```

3. Single Line Comment

```
// insert comments here
```

The compiler ignores comments.

Whitespaces

Tabs and spaces are ignored by the compiler. Used to improve readability of code.

```
/*
 * Created on Jun 25, 2008
 *
 * First Java Program
 */
package sef.module3.sample;
import java.lang.*;

/**
 * @author SEF
 */
public class MainSample{

    public static void main(String[] args) {
        // print a message
        System.out.println("Welcome to Java!");
    }

}
```

Java Source File Structure

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Class

- Class is the fundamental component of all Java programs.
- Every Java program includes at least one public class definition.
- A class definition contains all the variables and methods that make the program work. This is contained in the class body indicated by the opening and closing braces.
- The name of the public class declaration should be the same as the name of the file (case sensitive).

```
/*
 * Created on Jun 25, 2008
 *
 * First Java Program
 */
package sef.module3.sample;
import java.lang.*;

/**
 * @author SEF
 */
public class MainSample{

    public static void main(String[] args){
          // print a message
          System.out.println("Welcome to Java!");
    }

}
```

Java Source File Structure

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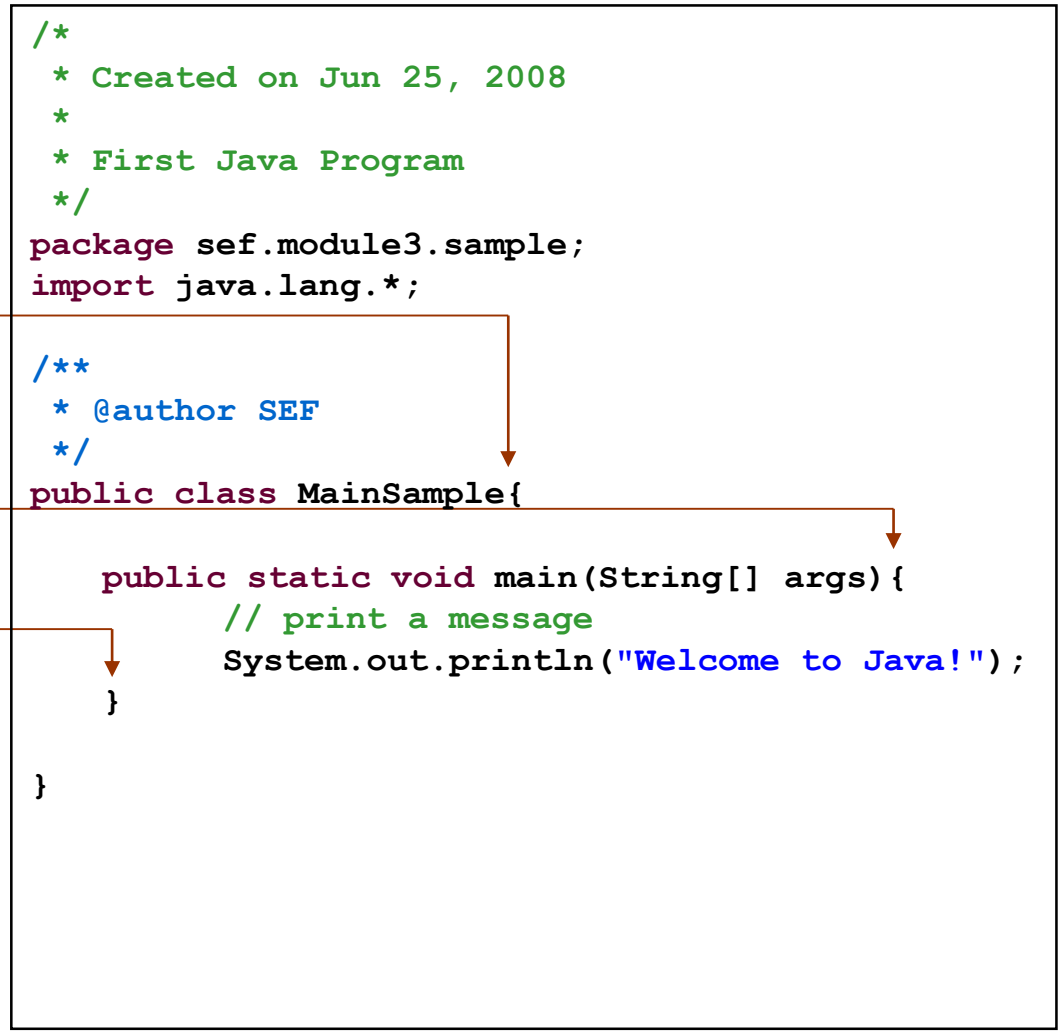
Braces

- Braces are used for grouping statements or block of codes.
- The left brace ({) indicates the beginning of a class body, which contains variables and methods of the class.
- The left brace also indicates the beginning of a method body.
- For every left brace that opens a class or method you need a corresponding right brace (}) to close the class or method.
- A right brace always closes its nearest left brace.



```
/*
 * Created on Jun 25, 2008
 *
 * First Java Program
 */
package sef.module3.sample;
import java.lang.*;

/**
 * @author SEF
 */
public class MainSample{

    public static void main(String[] args){
        // print a message
        System.out.println("Welcome to Java!");
    }

}
```

The ‘main( )’ Method

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- The ‘main’ method is where the execution of a java application begins

```
Syntax: public static void main( String[] args ) {
                    //Main method implementation goes here
                }
```

- Classes that have a main method declared inside serve as the starting point of the application

Refer to the MainSample.java sample code.

The ‘main( )’ Method

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`main()` method

This line begins the `main()` method. This is the line at which the program will begin executing.

`String args[]`

Declares a parameter named `args`, which is an array of String. It represents command-line arguments.

```
/*
 * Created on Jun 25, 2008
 *
 * Hello World Program
 */
package sef.module3.sample;


/**
 * @author SEF
 */
public class MainSample {

    public static void main(String[] args) {
        //Prints out 'Hello World!'
        System.out.println( "Hello World!" );
    }
}
```

Terminating character

Semicolon (`;`) is the terminating character for any java statement.

Java Keywords

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abstract	default	if	package	synchronized
assert	do	implements	private	this
boolean	double	import	protected	throw
break	else	instanceof	public	throws
byte	extends	int	return	transient
case	false	interface	short	true
catch	final	long	static	try
char	finally	native	strictfp	void
class	float	new	super	volatile
continue	for	null	switch	while

const goto

Data Types

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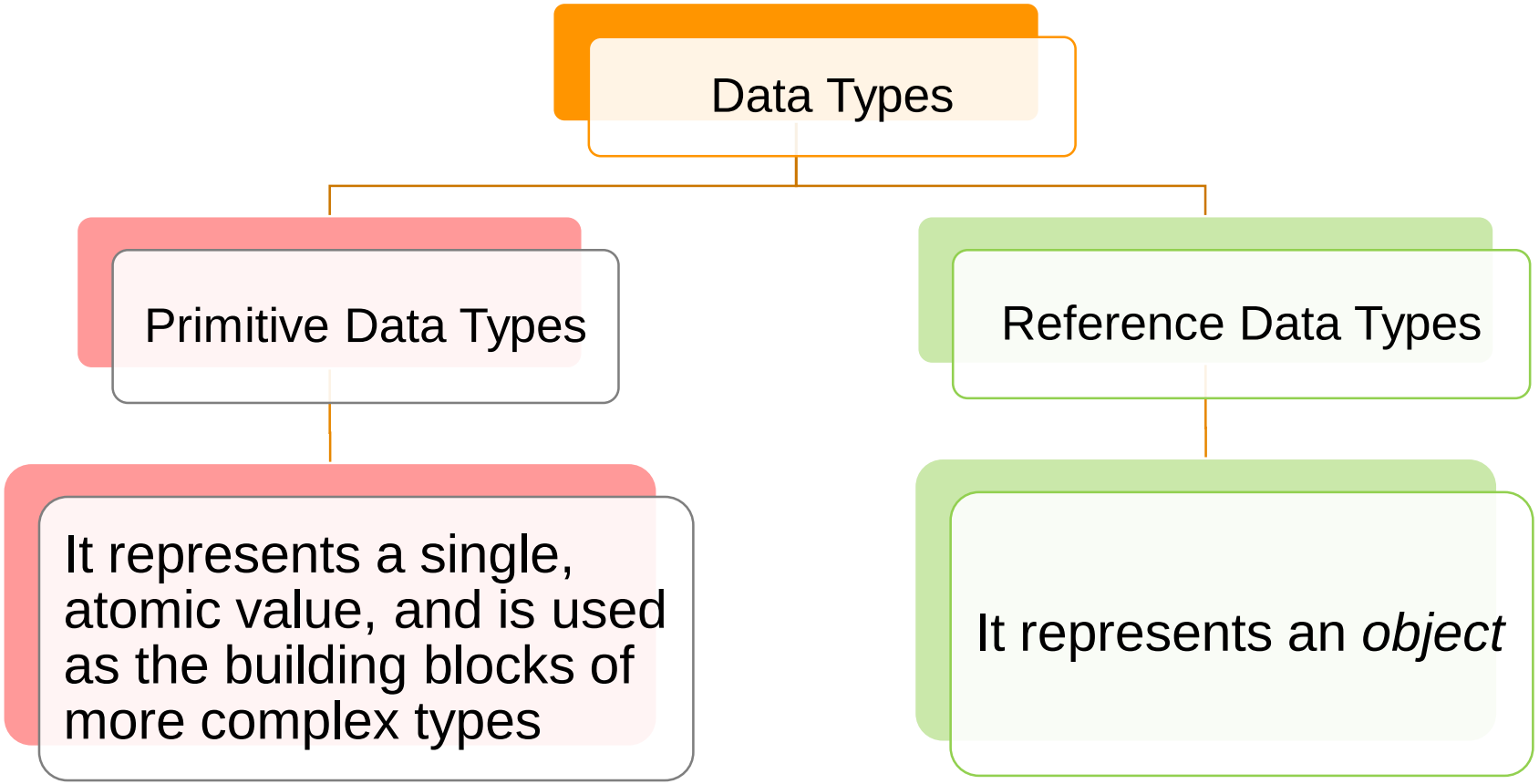
A data type determines the values that a variable can contain, and the operations that can be performed on it.



Data Types

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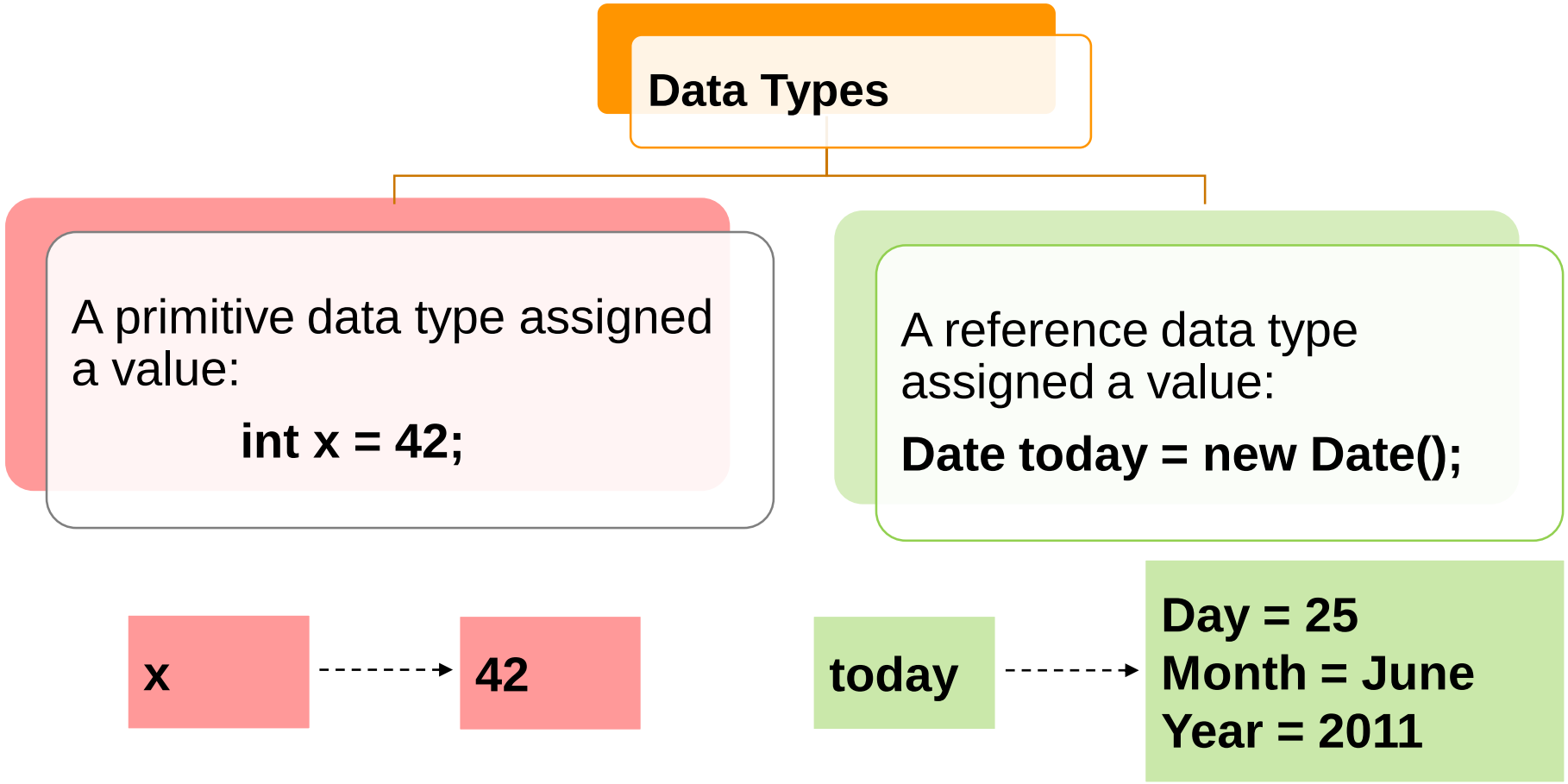

Primitive Data Types

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Type	Bits	Lowest Value	Highest Value
`boolean`	(n/a)	**`false`**	**`true`**
`char`	16	'\u0000' [0]	'\uffff' [2^{16}-1]
`byte`	8	-128 [-2^{7}]	+127 [2^{7}-1]
`short`	16	-32,768 [-2^{15}]	+32,767 [2^{15}-1]
`int`	32	-2,147,483,648 [-2^{31}]	+2,147,483,647 [2^{31}-1]
`long`	64	-9,223,372,036,854,775,808 [-2^{63}]	+9,223,372,036,854,775,807 [2^{63}-1]
`float`	32	±1.4012984632481707e-45	±3.4028234663852860e+38
`double`	64	±4.94065645841246544e-324	±1.79769313486231570e+308

Variables

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- A named storage location used to represent data that can be changed while the program is running
- Declaration specifies a variable's properties, like its data type and the name with which it would be identified
- Basic variable declaration in Java:

Syntax:	**<data type> <identifier_name>;**
Examples:	**int myInteger;** **String myFirstName;** **Date theDateToday;**

Variables: Initialization

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Initializing variables with primitive data type

Syntax: **<identifier_name> = <initial_value>;**
Example: **myInteger = 0;**

Initializing variables with reference data type

Syntax: **<identifier_name> = <initial_value>;**
Examples: **myFirstName = “Jason”;**
theDateToday = new Date( );

Variable Assignment

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- Variables are assigned a value using the assignment operator equal (=)

Syntax: **<variable_name> = <the_value>;**
Example: **myInteger = 0;**

- The data type of the value being assigned must be compatible with the data type of the variable receiving the value

Activity 1

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- Open the file ‘VariableAssignmentActivity.java’ in the package sef.module3.activity
- Perform the following:
  - Declare a variable of type int and assign it default value
  - Update the value
  - Print the updated value to the console

Variables: Scope

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Refers to portions or sections of a program where the variable has value and is said to be ‘visible’

Types of Variables by Scope:

- **Class Variables** — Shared by all instances of a class. Identified by the keyword **static**.
- **Instance Variables** — Belong to an instance of a class. Are unique for each instance.
- **Local Variables** — Are accessible only within their locality and usually declared within a method.

Variables: Scope

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Class Variable

Declared outside methods but inside a class. Denoted by `static` keyword.

Local Variable

Declared inside methods and/or subroutines. *aString* is local to the method *main*

Instance Variables

Declared outside methods but inside a class.

```
package sef.module3.sample;

public class VariableScope {
   /**
    * @param args
    */
   public static void main(String[] args) {
   String aString = "This is a local variable";
   }
}

class Employee {
   public static int totalCount = 0;
   private String myFirstName;
   private String myLastName;
   private int myAge;
}
```

Expressions and Statements

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- An expression is a ‘value’ whereas a statement is an ‘action’
- A Statement is a complete unit of instruction, usually ended by a semicolon (;)
- The example below is a statement assigning the value of the expression to the variable
  - *String greeting = “hello”;*
  - *final static double PIE = 3.14*
  - *z = x + y;*
  - *result = getFactorial(z);*
  - *Date today = new Date();*
- Method calls are also statements
  - *System.out.println(“Hello”);*

Type Casting

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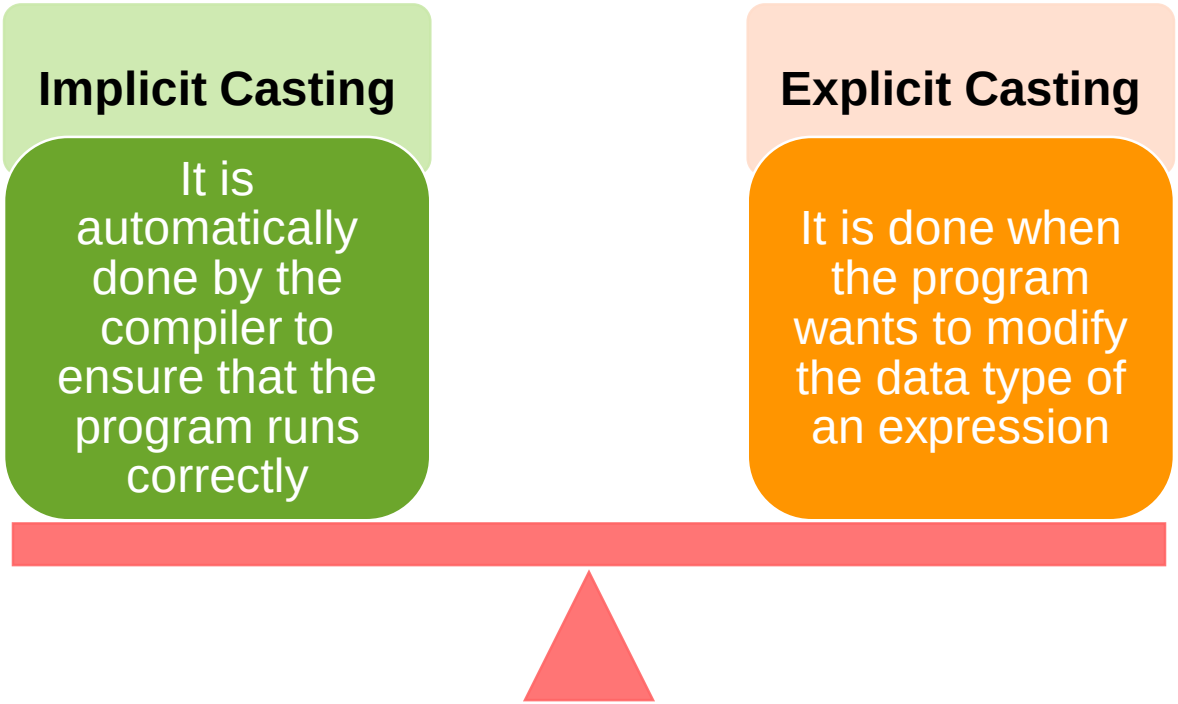
- Refers to the conversion of the data type of a variable value to another data type.
- Java is strongly typed, meaning it expects that values being assigned to each other be compatible. Casting is a way to express this compatibility.



Primitive Data Type Casting Flow

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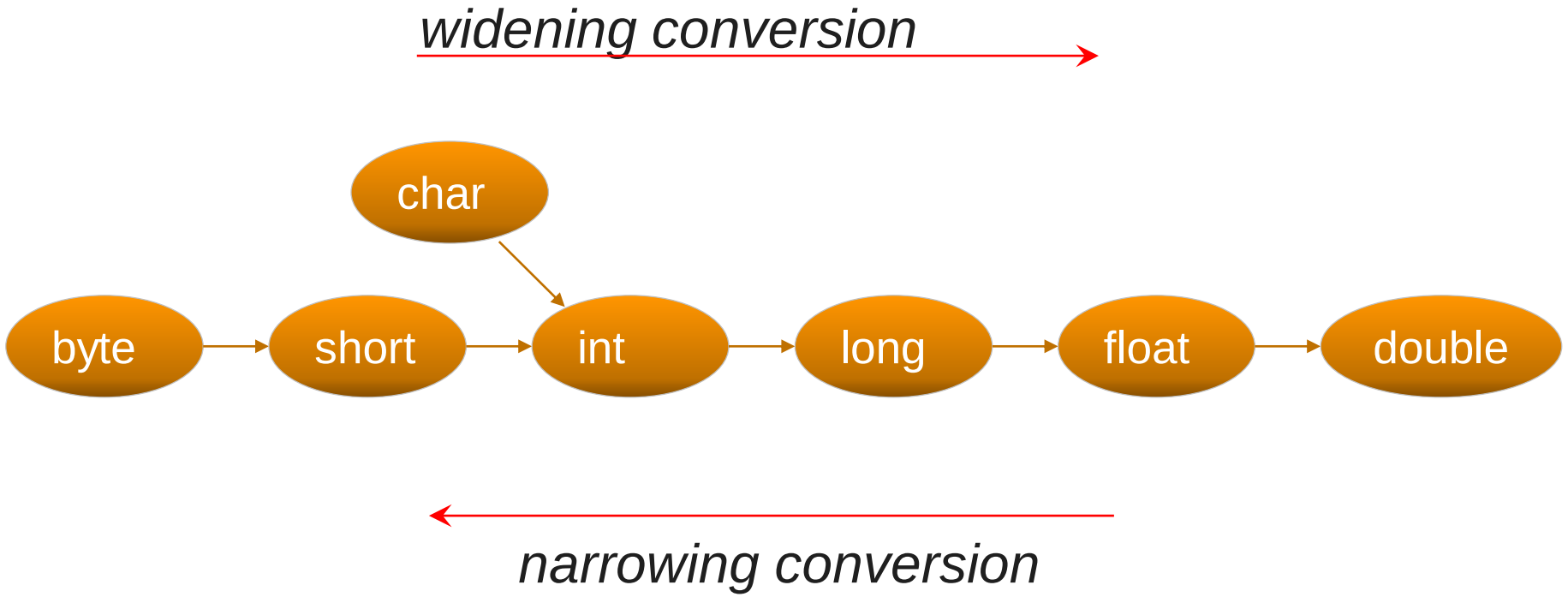

Implicit Casting

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- Implicit casting is an implied casting operation.
- Implicit casting usually takes place when casting from a narrower data type to a broader data type, this can also be referred to as widening conversion.

Example A:	**int a = 1;** **double b = a;**
Example B:	**float x = 1.0;** **double y = x;**

- Since a double is ‘wider’ than either an integer or a floating point, it is able to accept and cast their values implicitly.

Explicit Casting

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- Explicit casting is a required casting operation.
- It usually takes place when casting from a broader data type to a narrower data type, this can also be referred to as narrowing conversion.

Syntax: **<destination variable> = (<destination data type>) <source variable>**

Example A:

```
double a = 1.5;
int b;
 b = ( int ) a
```

- Because an integer is ‘narrower’ than the double being assigned, it has to be explicitly stated that the assignment is intentional.
- A narrowing conversion will sometimes lose a part of the original value during conversion. For instance, in Example A, variable ‘b’ will be assigned the value 1.

Reference Casting

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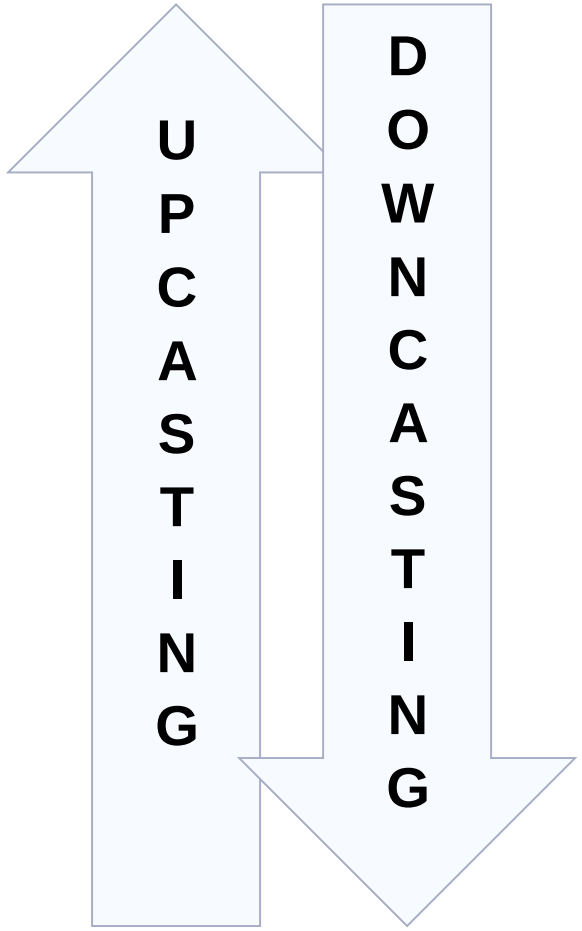
Refers to the conversion of a reference data type (an object) to another reference data type



Java Operators

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Arithmetic operators are used to perform mathematical operations on numeric values

<operand 1> + <operand 2>	**Addition**
<operand 1> - <operand 2>	**Subtraction**
<operand 1> / <operand 2>	**Division**
<operand 1> * <operand 2>	**Multiplication**
<operand 1> % <operand 2>	**Modulo**

Examples:
1 + 1
A * (Z + 1)

Java Operators

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- *Assignment operators* are used to assign values to variables

```
<variable> = <expression>;
Examples:
name = “John Doe”;
age = 23;
Date today = new Date();
```

- The following are unary operators
  - prefix
    - *Y = ++x; Add 1 to x before being assigned to y*
    - *Y = --x; Subtract 1 from x before being assigned to y*
  - postfix:
    - *Y = x++; Assign x to y before adding 1*
    - *Y = x--; Assign x to y before subtracting 1*

Java Operators

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- *Relational operators* are used to perform comparisons
- They always evaluate to either a *true* or *false (boolean expression)*

<Expression 1> < <Expression 2> Expression 1 is less than Expression 2
<Expression 1 > > <Expression 2> Expression 1 is greater than Expression 2
<Expression 1 > <= <Expression 2> Expression 1 is less than or equal to Expression 2
<Expression 1 > >= <Expression 2> Expression 1 is greater than or equal to Expression 2
<Expression 1> != <Expression 2> Expression 1 is not equal to Expression 2

Example:
boolean test = x < y;

Java Operators

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- *Logical operators* are used to evaluate *boolean* expressions

<Expression 1> ***&&*** *<Expression 2>* *Short-circuited AND*
<Expression 1> **||** *<Expression 2>* *Short-circuited OR*
<Expression 1> ***&*** *<Expression 2>* *bitwise AND* *(Non Short Circuited AND)*
<Expression 1 > **|** *<Expression 2>* *bitwise OR* *(Non Short Circuited OR)*
<Expression 1 > **^** *<Expression 2>* *XOR*
!(*<Expression 2>*) *NOT*

Example:
boolean test = x >= 1 && x <= 10

Activity 2

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- Open the file ‘OperatorActivity.java’ in the package sef.module3.activity
- Perform the following:
  - Find the difference of the given integers
  - Print the result

Flow Control

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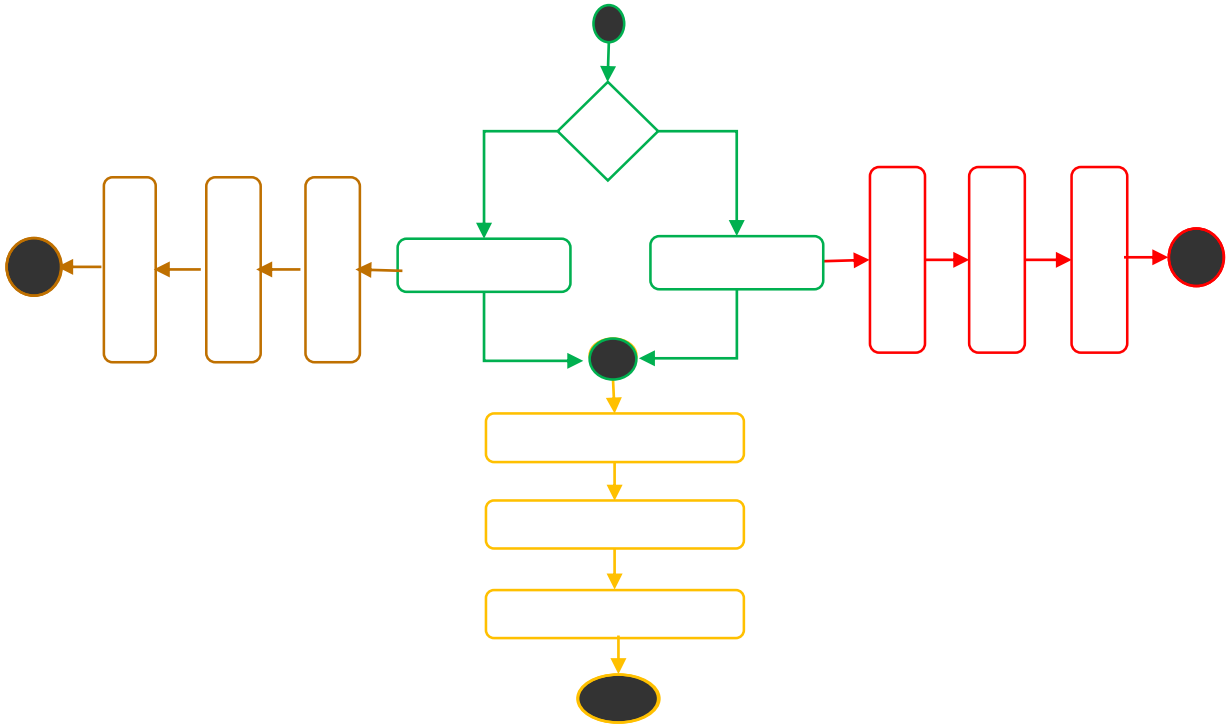
- A programs ‘flow’ refers to the order in which statements are executed.
- By default, statements are executed sequentially.
- Flow control statements are used to alter or modify the path of execution of instructions when certain conditions are present.



Types of Flow Control

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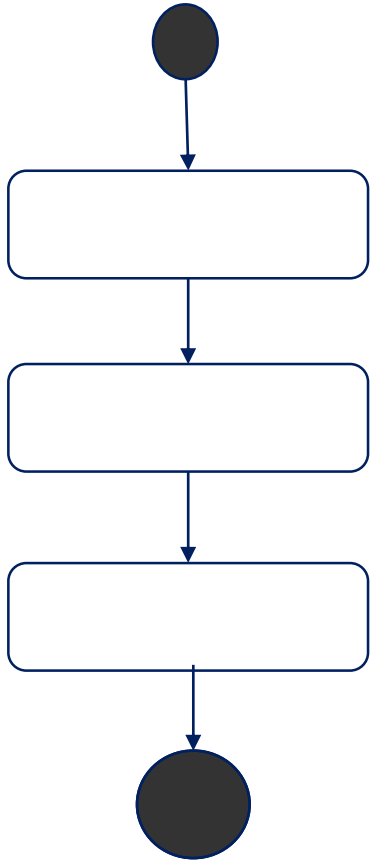
- ***Sequential*** statements are executed in the order they are written
- This is the default flow of a program as instructions are executed in the order they appear



Types of Flow Control

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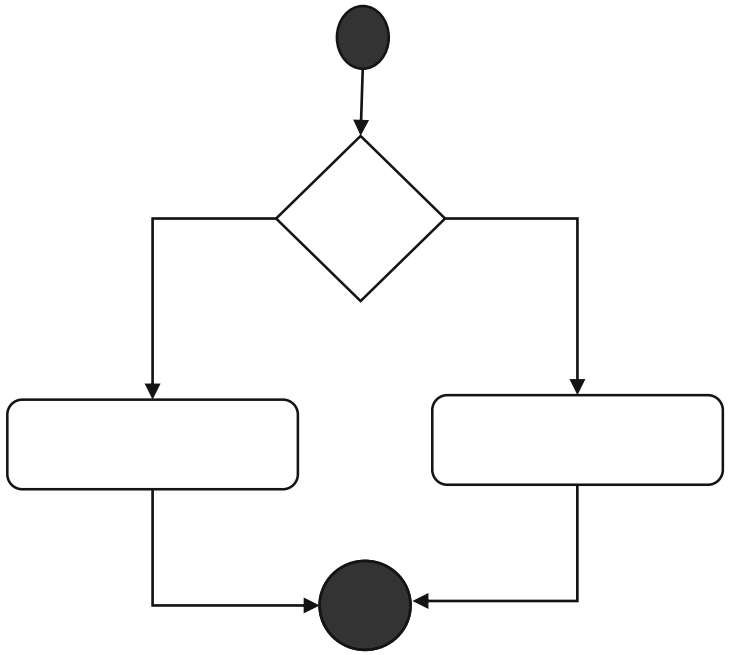
- Selection structures execute a certain branch based on the results of a boolean condition
- This flow is useful in decision-making scenarios and can be implemented by using the if-else or switch-case statements



Types of Flow Control

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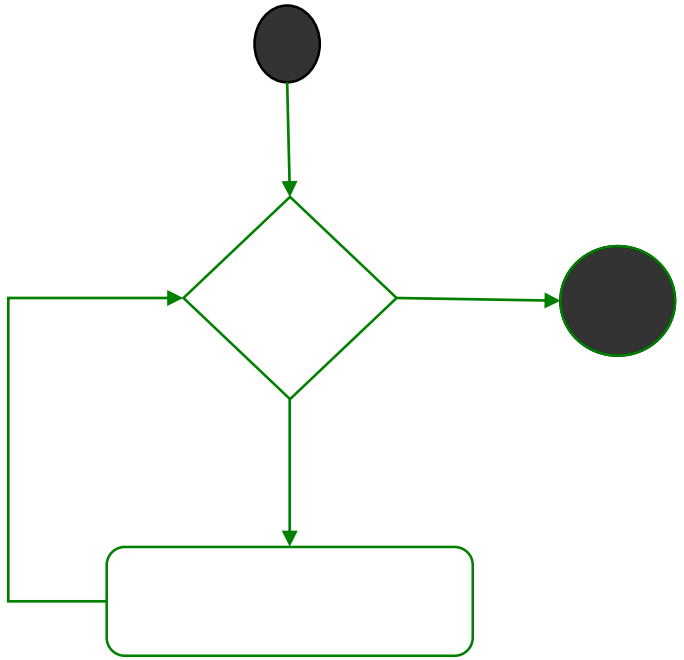
- Iteration structures execute instructions repeatedly based on a condition
- This type of flow control can be implemented by making use of the different loop statements:
  - for-loop
  - while-loop
  - do-while loop



If-Else

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The outcome of an if-else performs statement is based on a condition

```
Syntax:    if ( condition ) {
                    // statement(s) to be executed If condition is met
           } else { // ( else statement is optional )
                    // statement(s) to be executed If condition is NOT met
           }

Example: int x = 1;
           if ( x > 0 ) {
                    System.out.println( “The value of x is greater than zero” );
           } else {
                    System.out.println( “The value of x is less than or equal to zero” );
           }
```

Activity 3

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- Open the file ‘FindLargest.java’ in the package sef.module3.activity
- Perform the following:
  - Complete the code. Use if-else statement to find the larger of the two given numbers
  - Print the result

Switch-Case

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A switch-case allows the program to choose which statement(s) to perform based on a condition

Syntax:

```
switch (exp) {
case val1: // statements here
            break;
case val2: // statements here
            break;
default:   // statements here
}
```

Example:

```
int x = 1;
switch (x) {
case 1:   System.out.println ( “Value of x is 1”);
            break;
case 2:   System.out.println ( “Value of x is NOT 1”);
            break;
default:  System.out.println ( “Value of x is NULL”);
}
```

Activity 4

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- Open the file ‘NumToWords.java’ in the package sef.module3.activity
- Perform the following:
  - Complete the code and print text value of number 5

For Loop

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A for-loop performs statement(s) repeatedly if a certain condition is satisfied

Syntax:

```
for ( init; condition; exp ) {
        //statements here
}
```

Example:

```
for ( int i = 1; i < 11; i++ ) {
        System.out.println ( “The value of i is: “ + i );
}
```

Activity 5

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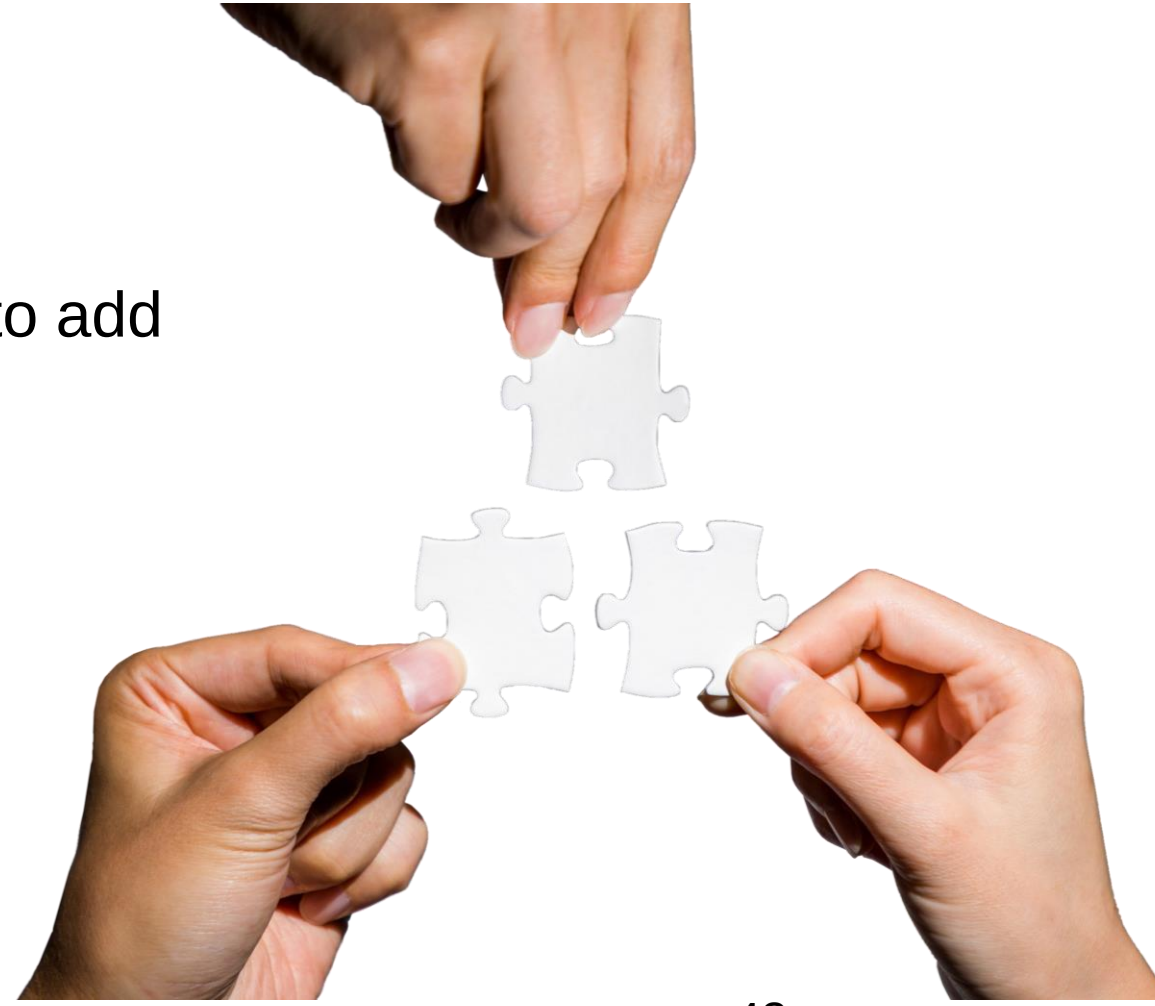
- Open the file ‘AddWholeNum.java’ in the package sef.module3.activity
- Perform the following:
  - Complete the code and write a for loop to add all whole numbers from 1 to 50
  - Print the result



Activity 6

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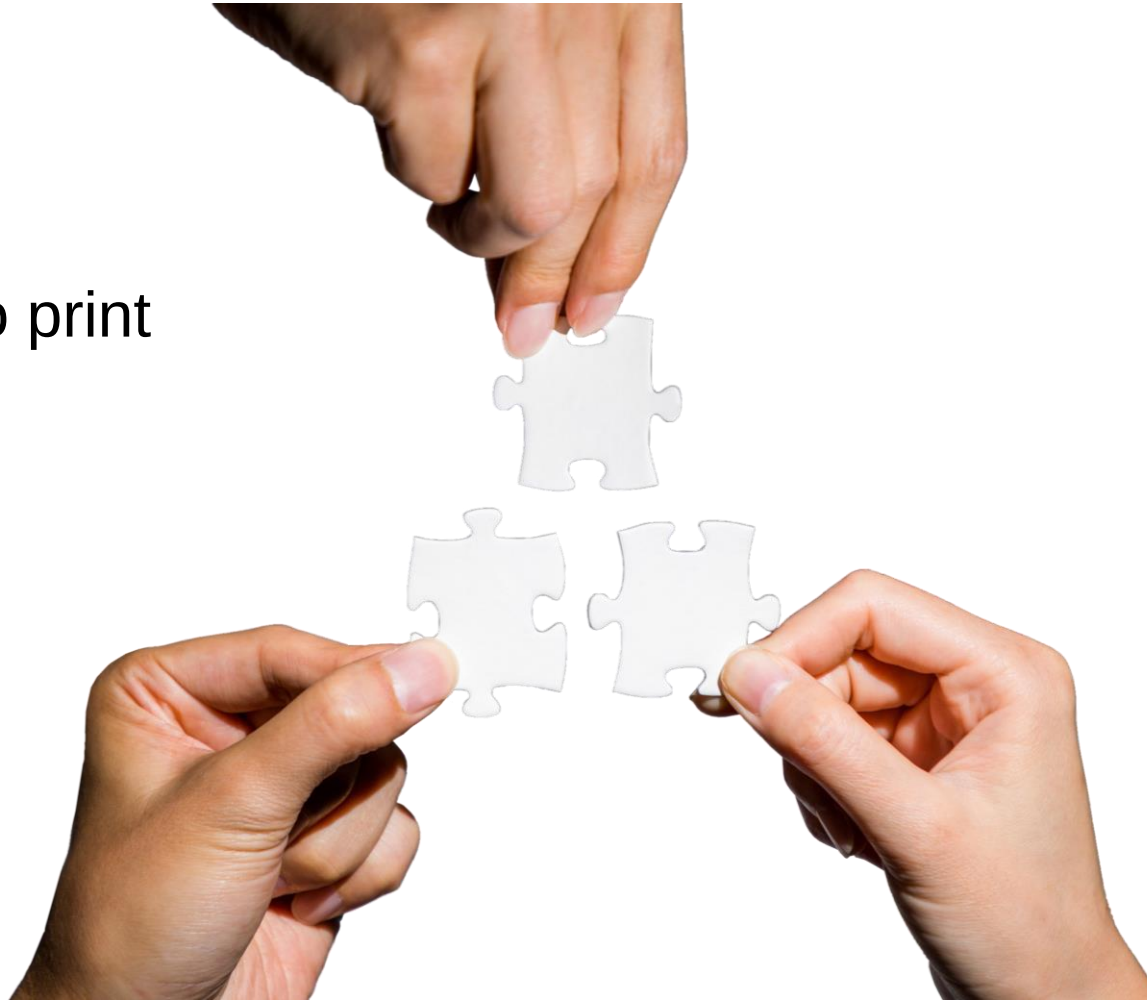
- Open the file ‘MultiplicationTable.java’ in the package sef.module3.activity
- Perform the following:
  - Complete the code and write for loops to print multiplication table from 1 to 10



While Loop

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while() performs statements repeatedly while a condition remains true

Syntax:

```
while ( condition ) {
 //statements here
}
```

Example:

```
int x = 1;
while ( x < 11) {
        System.out.println ( “The value of x is: “ + x );
}
```

Refer to the WhileLoopSample.java sample code.

Activity 7

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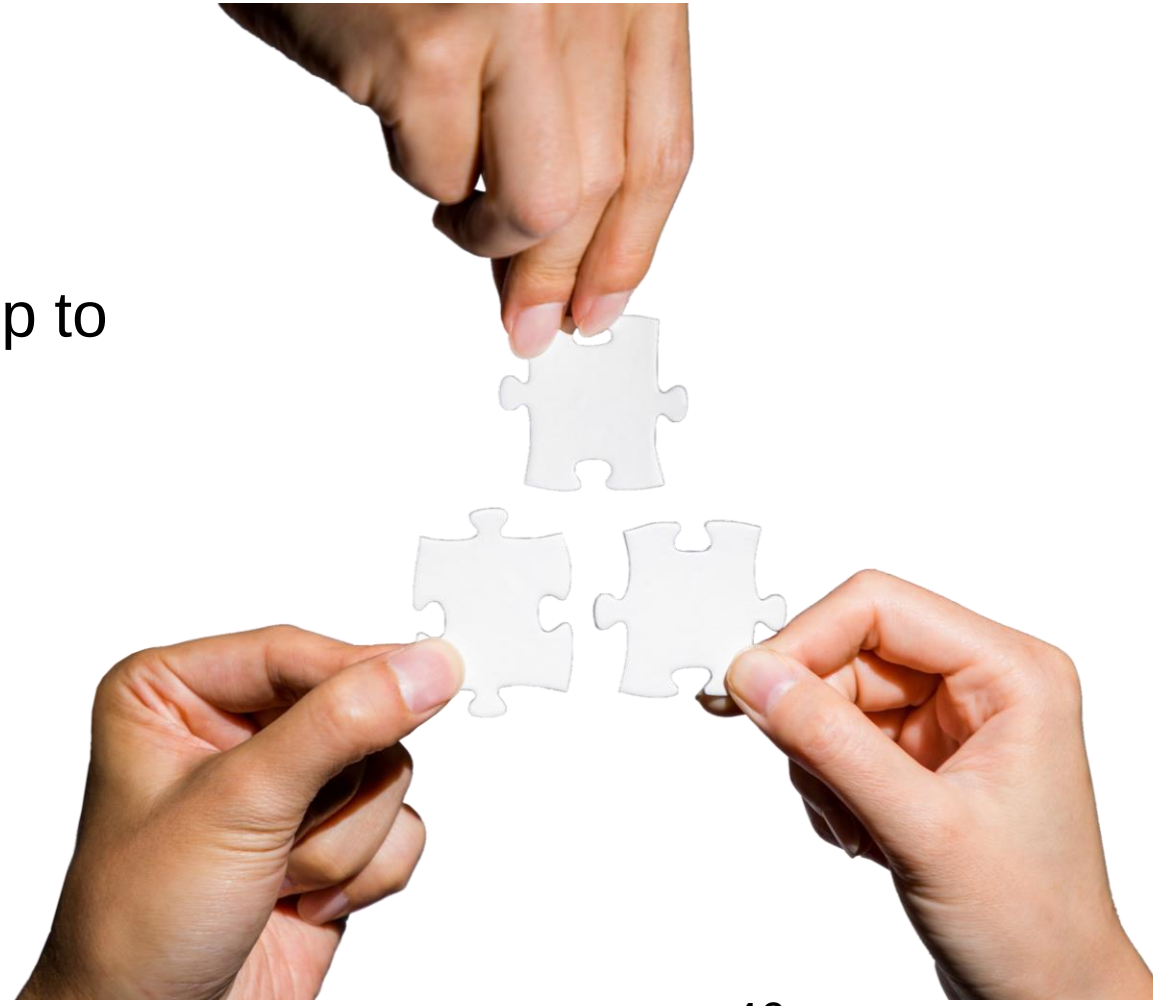
- Open the file ‘PrintNumWithWhile.java’ in the package sef.module3.activity
- Perform the following:
  - Complete the code and write a while loop to print all even numbers less than 100



Do-While Loop

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do-while() performs statements repeatedly (at least once) while condition remains true

Syntax:

```
do {
        //place statements here
} while ( condition )
```

Example:

```
int x = 1;
do {
        System.out.println ( “The value of x is: “ + x );
} while ( x < 11)
```

Refer to the WhileLoopSample.java sample code.

Arrays

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- An array is a sequence of either objects or primitives, all of the same type under one identifier name
- Basic array declaration syntax:

```
Syntax:          <data_type> [ ] <variable_name>;
                 <data_type> <variable_name> [ ];
                 <data_type> [ ] <variable_name> [ ];

Examples :       int [ ] myIntegerArray;
                 String myStringArray [ ];
                 char [ ] myCharArray [ ];
```

Arrays: Manipulation

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- *Values* in arrays can be accessed and manipulated by their *index*
- An array's index always start with 0

```
String[] anotherStringArray = {“Hello", “There”, “How“, “Are”, ”You”};
System.out.println(“The first string is “ + anotherStringArray[0]);
```

ARRAY					
INDEX	0	1	2	3	4
VALUE	"Hello"	"There"	"How"	"Are"	"You"

Activity 8

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- Open the file ‘FindInArray.java’ in the package sef.module3.activity
- Perform the following:
  - Complete the code to find the smallest number in the given array

Arrays: Multi-Dimensional Arrays

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- A multi-dimensional array can simply be thought of as arrays of arrays
- Each pair of square brackets ([ ]), represent one dimension

Syntax:	**<data type>[ ] [ ] <variable name>;** **<data type>[ ] [ ] [ ] <variable name>;**
Example:	**int[ ][ ] aGridOfIntegers;** **int[ ][ ][ ] aCubeOfIntegers;**

Refer to the MultiDimensionalArraySample.java sample code.

Arrays: Manipulation

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- Multi-dimensional arrays can be accessed the same way
- Each bracket pair represents one dimension of the array

```
char][] anotherCharArray = {{a,b,c},{d,e,f},{g,h,i}};
System.out.println("Accessing center of grid" + anotherCharArray[1][1]);
```

	0	1	2
0	a	b	c
1	d	e	f
2	g	h	i

Refer to the MultiDimensionalArraySample.java sample code.

Methods

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- A method is a collection of one or more statements that performs a specific task

- Basic syntax of a Java method declaration:

```
Syntax:          <return_type> <identifier_name> ( <parameter(s)> ) {
                         //method implementation here
                         return <return_value>;
                 }
```

- A method's *signature* is a combination of a method's *name* and *parameters* that uniquely identify a method

Method Declaration

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greet()

No parameters with a 'void' return type. This means the method does not return any value

greet(String)

- You can pass parameters to a method. These are considered local variables
- It has the same name as the previous method, but different parameters
- Note a 'static' modifier. This means this method is a class method and can be called without an object reference

```
package sef.module3.sample;

public class MethodSample {

    public void greet(){
        System.out.println("Hello!");
    }

    public static void greet(String name){
        System.out.println("Hello " + name +
    "!");
    }

    public int sum(int x, int y) {
        return x + y;
    }
}
```

thirdMethod

This method has a *int* return type. This requires the method to have a 'return' statement that returns an integer value.

Calling Methods

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- To ‘call’ a method, use the method’s name and pass the appropriate number and type of parameters according to the method’s signature.
- When calling a method, flow control will ‘jump’ to that method.
- When the method finishes, flow control will return to the point where the method was called.
- Instance methods are attached to an instance of an object. These will need to be called through an object reference.
- Static methods are attached to a class, and can be called via its class name.

Parameter Passing

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- Parameters in Java are Passed By Value

  - Passing Primitive Data Type Arguments
    - A copy of the value is passed to the method.
    - Any changes to the value exists only within the scope of the method.
    - When the method returns, any changes to the value are lost. The original value remains.

  - Passing Reference Data Type Arguments
    - A copy of the object's reference's value is being passed.
    - The values of the object's fields can be changed inside the method, if they have the proper access level.
    - When the method returns, the passed-in reference still references the same object as before. However, the changes in the object's fields will be retained.

Method Declaration

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Call an instance method through its object

Call class methods statically and pass parameters

Call an instance method that accepts parameters and returns values

```
package sef.module3.sample;

public class MethodSample {

    public void greet(){
          System.out.println("Hello!");
    }

    public static void greet(String name){
          System.out.println("Hello " + name + "!");
    }

    public int sum(int x, int y) {
          return x + y;
    }

    public static void main(String arg[]){
          MethodSample sample = new MethodSample();
          sample.greet();
          greet("Java Teacher");
          MethodSample.greet("Java Student");
          System.out.println("Sum of 1 and 2 is " +
                    sample.sum(1, 2));
    }
}
```

Activity 9

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- Open the file ‘NumToWordsUsingMethod.java’ in the package sef.module3.activity
- Perform the following:
  - Take a look at NumToWords.java in which we wrote code to convert integer numbers into their text value
  - NumToWordsUsingMethod.java will perform the same function using method printWord()
  - Complete the code in NumToWordsUsingMethod.java

Activity 10

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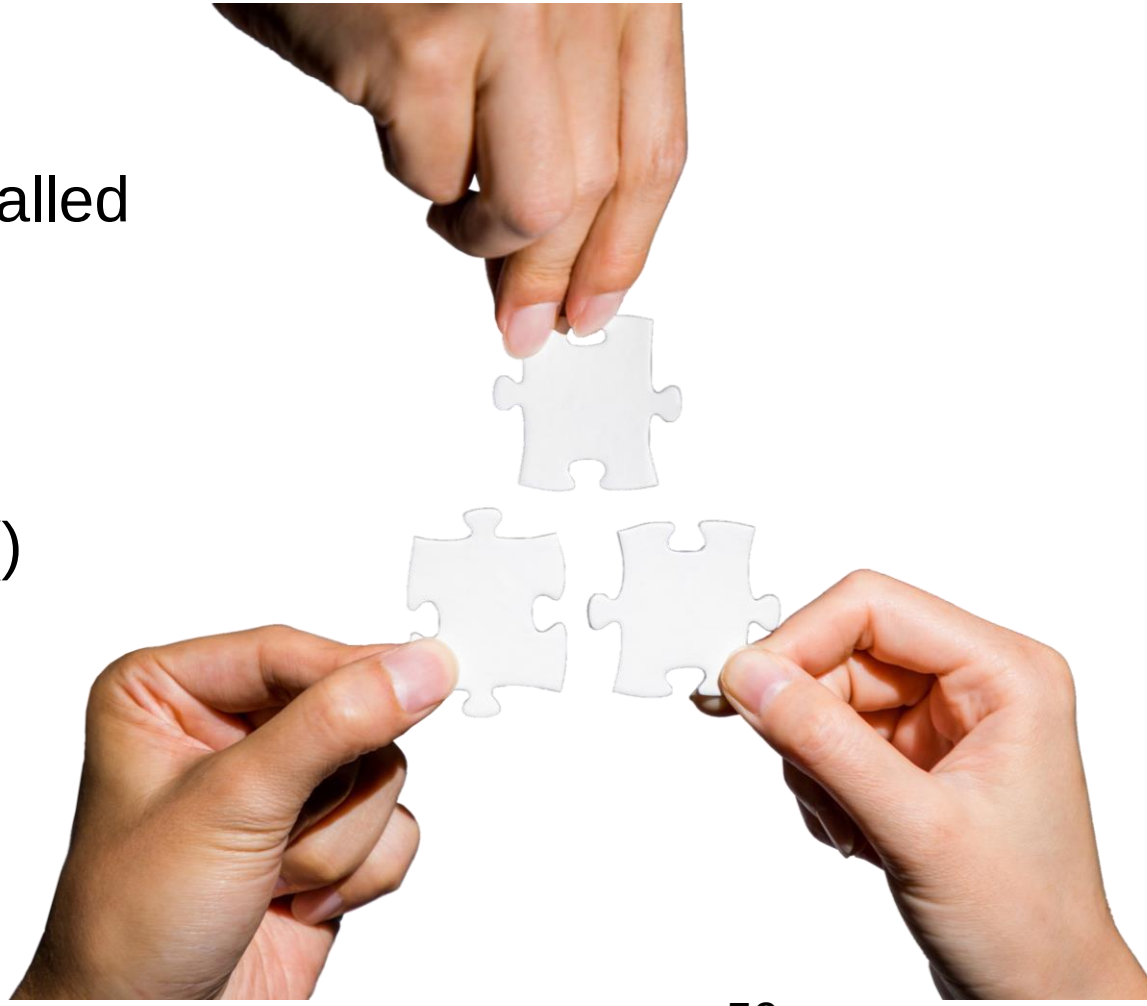
- Open the file ‘Calculator.java’ in the package sef.module3.activity.
- Notice that method add() and multiply() are called from inside main() method
- Perform following:
  - Complete the code for add() and multiply() methods
  - Print the Results



Questions and Comments

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- What questions or comments do you have?