BIRZEIT UNIVERSITY

COMPUTER SCIENCE DEPARTMENT FACULTY OF ENGINEERING AND TECHNOLOGY

ADVANCED PROGRAMMING COMP231

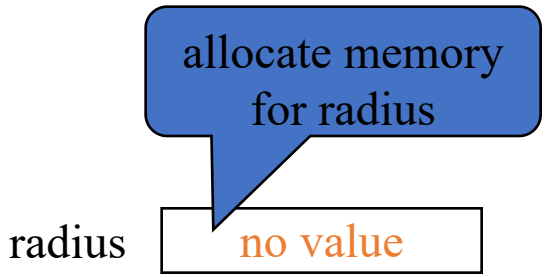
Instructor :Murad Njoum
Office : Masri322

Chapter 2 Elementary Programming

animation

Trace a Program Execution

```
public class ComputeArea {
  /** Main method */    (for documentational
  use : Javadoc Welcome.java --→ Welcome.ht,l)
  public static void main(String[] args) {
    double radius;
    double area;

    // Assign a radius
    radius = 20;

    // Compute area
    area = radius * radius * 3.14159;

    // Display results
    System.out.println("The area for the circle
  of radius " +
      radius + " is " + area);
  }
}
```



animation

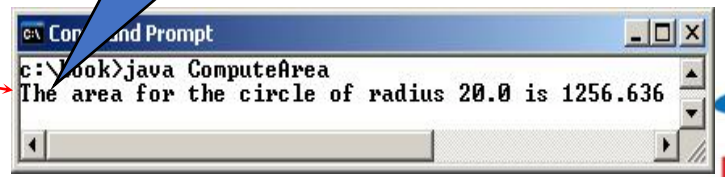
Trace a Program Execution

```
public class ComputeArea {
  /** Main method */
  public static void main(String[] args) {
    double radius;
    double area;

    // Assign a radius
    radius = 20;

    // Compute area
    area = radius * radius * 3.14159;

    // Display results
    System.out.println("The area for the circle of radius " +
      radius + " is " + area);
  }
}
```

memory

radius	20
area	**1256.636**

print a message to the console



Reading Input from the Console

1. Create a Scanner object

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

2. Use the method nextDouble() to obtain to a double value. For example,

```
System.out.print("Enter a double value: ");
Scanner input = new Scanner(System.in);
double d = input.nextDouble();
```

ComputeAreaWithConsoleInput Run

ComputeAverage Run

Implicit Import and Explicit Import

```
java.util.* ; // Implicit import

java.util.Scanner; // Explicit Import
```

No performance difference

Identifiers

- An identifier is a sequence of characters that consist of letters, digits, underscores (_), and dollar signs ($).
- An identifier must start with a letter, an underscore (_), or a dollar sign ($). It cannot start with a digit.
- An identifier cannot be a reserved word. (See Appendix A, "Java Keywords," for a list of reserved words).
- An identifier cannot be `true`, `false`, or `null`.
- An identifier can be of any length.

Variables

```
// Compute the first area
radius = 1.0;
area = radius * radius * 3.14159;
System.out.println("The area is " +
  area + " for radius "+radius);

// Compute the second area
radius = 2.0;
area = radius * radius * 3.14159;
System.out.println("The area is " +
  area + " for radius "+radius);
```

Declaring Variables

```
int x;            // Declare x to be an
                  // integer variable;
double radius;    // Declare radius to
                  // be a double variable;
char a;           // Declare a to be a
                  // character variable;
```

Assignment Statements

```
x = 1;              // Assign 1 to x;

radius = 1.0;       // Assign 1.0 to radius;

a = 'A';            // Assign 'A' to a;
```

Declaring and Initializing in One Step

- `int x = 1;`
- `double d = 1.4;`

Named Constants

```
final datatype CONSTANTNAME = VALUE;
```

```
final double PI = 3.14159;
final int SIZE = 3;
```

Naming Conventions

- Choose meaningful and descriptive names.
- **Variables and method names**:
  - Use lowercase. If the name consists of several words, concatenate all in one, use lowercase for the first word, and capitalize the first letter of each subsequent word in the name. For example, the variables `radius` and `area`, and the method `computeArea`.

Naming Conventions, cont.

- Class names:
  - Capitalize the first letter of each word in the name. For example, the class name **`ComputeArea`**.

- Constants:
  - Capitalize all letters in constants, and use underscores to connect words. For example, the constant `PI` and MAX_VALUE

Numerical Data Types

Name	Range	Storage Size
`byte`	-2^7 to $2^7 - 1$ (-128 to 127)	8-bit signed
`short`	-2^{15} to $2^{15} - 1$ (-32768 to 32767)	16-bit signed
`int`	-2^{31} to $2^{31} - 1$ (-2147483648 to 2147483647)	32-bit signed
`long`	-2^{63} to $2^{63} - 1$ (i.e., -9223372036854775808 to 9223372036854775807)	64-bit signed
`float`	Negative range: -3.4028235E+38 to -1.4E-45 Positive range: 1.4E-45 to 3.4028235E+38	32-bit IEEE 754
`double`	Negative range: -1.7976931348623157E+308 to -4.9E-324 Positive range: 4.9E-324 to 1.7976931348623157E+308	64-bit IEEE 754

Reading Numbers from the Keyboard

```
Scanner input = new Scanner(System.in);
int value = input.nextInt();
```

Method	Description
`nextByte()`	reads an integer of the `byte` type.
`nextShort()`	reads an integer of the `short` type.
`nextInt()`	reads an integer of the `int` type.
`nextLong()`	reads an integer of the `long` type.
`nextFloat()`	reads a number of the `float` type.
`nextDouble()`	reads a number of the `double` type.

Numeric Operators

Name	Meaning	Example	Result
+	Addition	34 + 1	35
-	Subtraction	34.0 - 0.1	33.9
*	Multiplication	300 * 30	9000
/	Division	1.0 / 2.0	0.5
%	Remainder	20 % 3	2

Problem: Displaying Time

Write a program that obtains minutes and remaining seconds from seconds.

```
import java.util.Scanner;
 public class DisplayTime {
        public static void main(String[] args) {
           Scanner input = new Scanner(System.in); // Prompt the user for input
           System.out.print("Enter an integer for seconds: ");
           int seconds = input.nextInt(); int minutes = seconds / 60; // Find minutes in seconds
           int remainingSeconds = seconds % 60; // Seconds remaining
           System.out.println(seconds + " seconds is " + minutes + " minutes and " + remainingSeconds + " seconds");
}
 }
```

DisplayTime Run

NOTE

Calculations involving floating-point numbers are approximated because these numbers are not stored with complete accuracy. For example,

System.out.println(1.0 - 0.1 - 0.1 - 0.1 - 0.1 - 0.1);

displays 0.5000000000000001, not 0.5, and

System.out.println(1.0 - 0.9);

displays 0.09999999999999998, not 0.1. Integers are stored precisely. Therefore, calculations with integers yield a precise integer result.

Exponent Operations

```
System.out.println(Math.pow(2, 3));
// Displays 8.0
System.out.println(Math.pow(4, 0.5));
// Displays 2.0
System.out.println(Math.pow(2.5, 2));
// Displays 6.25
System.out.println(Math.pow(2.5, -2));
// Displays 0.16
```

Integer Literals

An integer literal can be assigned to an integer variable as long as it can fit into the variable. A compilation error would occur if the literal were too large for the variable to hold. For example, the statement byte b = 1000 would cause a compilation error, because 1000 cannot be stored in a variable of the byte type.

An integer literal is assumed to be of the int type, whose value is between -2^{31} (-2147483648) to $2^{31}-1$ (2147483647). To denote an integer literal of the long type, append it with the letter **L** or **l**. L is preferred because l (lowercase L) can easily be confused with 1 (the digit one).

Floating-Point Literals

Floating-point literals are written with a decimal point. **By default**, a floating-point literal is treated as a double type value. For example, 5.0 is considered a double value, **not** a float value. You can make a number a float by appending the letter f or F, and make a number a double by appending the letter d or D. For example, you can use for a float number, and 100.2d or 100.2D for a double number.

Example:

float x=100.2f; or float x=100.2F; // without f or F its considered as error by compiler

Double y=100.2d , z=100.2D;

double vs. float

The double type values are more accurate than the float type values. For example,

```
System.out.println("1.0 / 3.0 is " + 1.0 / 3.0);
```

displays `1.0 / 3.0 is 0.3333333333333333`

16 digits

```
System.out.println("1.0F / 3.0F is " + 1.0F / 3.0F);
```

displays `1.0F / 3.0F is 0.33333334`

7 digits

Scientific Notation

Floating-point literals can also be specified in scientific notation, for example, 1.23456e+2, same as 1.23456e2, is equivalent to 123.456, and 1.23456e-2 is equivalent to 0.0123456. E (or e) represents an exponent and it can be either in lowercase or uppercase.

Arithmetic Expressions

$$\frac{3+4x}{5} - \frac{10(y-5)(a+b+c)}{x} + 9\left(\frac{4}{x} + \frac{9+x}{y}\right)$$

is translated to

```
(3+4*x)/5 – 10*(y-5)*(a+b+c)/x + 9*(4/x + (9+x)/y)
```

Problem: Converting Temperatures

Write a program that converts a Fahrenheit degree to Celsius using the formula:

$$celsius = (\frac{5}{9})(fahrenheit - 32)$$

Note: you have to write

celsius = (5.0 / 9) * (fahrenheit – 32)

```
import java.util.Scanner;
 public class FahrenheitToCelsius {
      public static void main(String[] args)
       {  Scanner input = new Scanner(System.in);
          System.out.print("Enter a degree in Fahrenheit: ");
          double fahrenheit = input.nextDouble(); // Convert     Fahrenheit to Celsius
          double celsius = (5.0 / 9) * (fahrenheit - 32);
          System.out.println("Fahrenheit " + fahrenheit + " is " + celsius + " in Celsius");
    }
}
```

Augmented Assignment Operators

Operator	*Name*	*Example*	*Equivalent*
`+=`	Addition assignment	`i += 8`	`i = i + 8`
`-=`	Subtraction assignment	`i -= 8`	`i = i - 8`
`*=`	Multiplication assignment	`i *= 8`	`i = i * 8`
`/=`	Division assignment	`i /= 8`	`i = i / 8`
`%=`	Remainder assignment	`i %= 8`	`i = i % 8`

Increment and Decrement Operators

Operator	*Name*	*Description*	*Example (assume i = 1)*
`++var`	preincrement	Increment `var` by `1`, and use the new `var` value in the statement	`int j = ++i;` `// j is 2, i is 2`
`var++`	postincrement	Increment `var` by `1`, but use the original `var` value in the statement	`int j = i++;` `// j is 1, i is 2`
`--var`	predecrement	Decrement `var` by `1`, and use the new `var` value in the statement	`int j = --i;` `// j is 0, i is 0`
`var--`	postdecrement	Decrement `var` by `1`, and use the original `var` value in the statement	`int j = i--;` `// j is 1, i is 0`

Increment and Decrement Operators, cont.

```
int i = 10;
int newNum = 10 * i++;
```

Same effect as

```
int newNum = 10 * i;
i = i + 1;
```

```
int i = 10;
int newNum = 10 * (++i);
```

Same effect as

```
i = i + 1;
int newNum = 10 * i;
```

Increment and Decrement Operators, cont.

Using increment and decrement operators makes expressions short, but it also makes them complex and difficult to read. Avoid using these operators in expressions that modify multiple variables, or the same variable for multiple times such as this: int k = ++i + i.

Assignment Expressions and Assignment Statements

Prior to Java 2, all the expressions can be used as statements. Since Java 2, only the following types of expressions can be statements:

variable op= expression; // Where op is +, -, *, /, or %

++variable;

variable++;

--variable;

variable--;

Numeric Type Conversion

Consider the following statements:

```
byte i = 100;
long k = i * 3 + 4;
double d = i * 3.1 + k / 2;
```

Conversion Rules

When performing a binary operation involving two operands of different types, Java automatically converts the operand based on the following rules:

1. If one of the operands is double, the other is converted into double.
2. Otherwise, if one of the operands is float, the other is converted into float.
3. Otherwise, if one of the operands is long, the other is converted into long.
4. Otherwise, both operands are converted into int.

Type Casting

Implicit casting

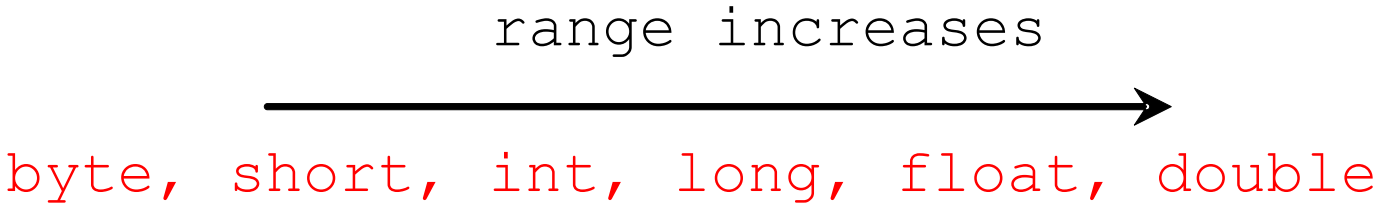
```
double d = 3;
```
(type widening)

Explicit casting

```
int i = (int)3.0;
```
(type narrowing)

```
int i = (int)3.9;
```
(Fraction part is truncated)

What is wrong? int x = 5 / 2.0;



Problem: Keeping Two Digits After Decimal Points

Write a program that displays the sales tax with two digits after the decimal point.

```
import java.util.Scanner;
public class SalesTax {
        public static void main(String[] args)
         { Scanner input = new Scanner(System.in);
          System.out.print("Enter purchase amount: ");
          double purchaseAmount = input.nextDouble();
          double tax = purchaseAmount * 0.06;
         System.out.println("Sales tax is " + (int)(tax * 100) / 100.0);
    }
 }
```

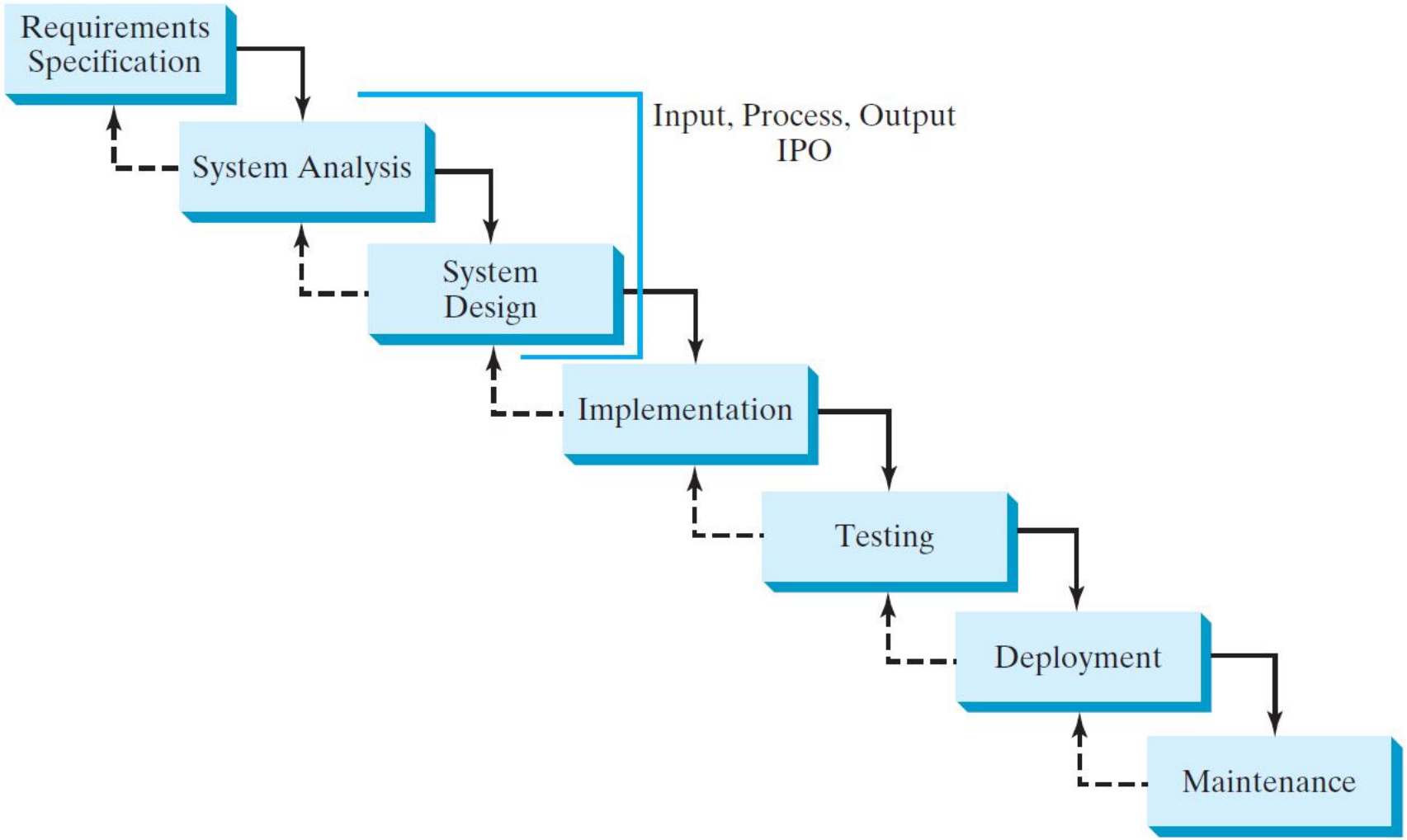
Casting in an Augmented Expression

In Java, an augmented expression of the form **x1 op= x2** is implemented as **x1 = (T)(x1 op x2)**, where **T** is the type for **x1**. Therefore, the following code is correct.

```
int sum = 0;
sum += 4.5; // sum becomes 4 after this statement
```

sum += 4.5 is equivalent to **sum = (int)(sum + 4.5)**.

Software Development Process



Problem:

Computing Loan Payments

This program lets the user enter the interest rate, number of years, and loan amount, and computes monthly payment and total payment.

$$monthlyPayment = \frac{loanAmount \times monthlyInterestRate}{1 - \frac{1}{(1 + monthlyInterestRate)^{numberOfYears \times 12}}}$$

ComputeLoan Run

Problem: Monetary Units

This program lets the user enter the amount in decimal representing dollars and cents and output a report listing the monetary equivalent in single dollars, quarters, dimes, nickels, and pennies. Your program should report maximum number of dollars, then the maximum number of quarters, and so on, in this order.

Enter an amount in double, for example 11.56: 11.56
Your amount 11.56 consists of 11 dollars 2 quarters 0 dimes 1 nickels 1 pennies

ComputeChange Run

Common Errors and Pitfalls

- Common Error 1: Undeclared/Uninitialized Variables and Unused Variables
- Common Error 2: Integer Overflow
- Common Error 3: Round-off Errors
- Common Error 4: Unintended Integer Division
- Common Error 5: Redundant Input Objects

- Common Pitfall 1: Redundant Input Objects

Common Error 1: Undeclared/Uninitialized Variables and Unused Variables

```
double interestRate = 0.05;
double interest = interestrate * 45;
```

Common Error 2: Integer Overflow

```
int value = 2147483647 + 1;
// value will actually be -2147483648
```

Common Error 3: Round-off Errors

```
System.out.println(1.0 - 0.1 - 0.1 - 0.1 - 0.1 - 0.1);

System.out.println(1.0 - 0.9);
```

Common Error 4: Unintended Integer Division

```java
int number1 = 1;
int number2 = 2;
double average = (number1 + number2) / 2;
System.out.println(average);
```

(a)

```java
int number1 = 1;
int number2 = 2;
double average = (number1 + number2) / 2.0;
System.out.println(average);
```

(b)

Common Pitfall 1: Redundant Input Objects

```
Scanner input = new Scanner(System.in);
System.out.print("Enter an integer: ");
int v1 = input.nextInt();

Scanner input1 = new Scanner(System.in);
System.out.print("Enter a double value: ");
double v2 = input1.nextDouble();
```