香港中文大學(深圳)
The Chinese University of Hong Kong

(Materials of this lecture are NOT included in the midterm and final exams)

CSC3100 Data Structures
Lecture 2: A brief introduction to Java

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Outline

- Why do we use Java to learn data structures?
- What will we learn and NOT learn about Java?
- Basic knowledge of Java
  - JDK/JVM/JRE
  - Keywords, declaration, expressions, class/object, method, others

Why do we choose Java?

- This course is not just about reading and writing — we need to write codes by implementing data structures and algorithms

- Java is one of the most frequently used programming languages

- Used for
  - Developing Android Apps
  - Helps you to create Enterprise Software
  - Wide range of Mobile Applications
  - Scientific Computing
  - Big Data Analytics (e.g., Hadoop and Spark)
  - Programming for Hardware devices
  - Used for Server-Side Technologies like Apache, etc.
  - …
  - much more!

Why do we choose Java?

- Java features
  - It is one of the easy-to-use programming languages to learn
  - Java is platform-independent. Write once, run anywhere!
  - It is designed for building object-oriented applications
  - It is a multithreaded language with automatic memory management
  - It is created for the distributed environment of the Internet
  - …

Java vs C/C++

- Advantages of Java
  - Easier to learn
  - No pointer, safer
  - Automatic memory management, including garbage collection
  - Cross platforms
  - More powerful standard libraries
  - Java and Java-based IDEs are often provided free of charge
  - Often used for research (e.g., Hadoop and Spark)
  - …

What we will learn about Java?

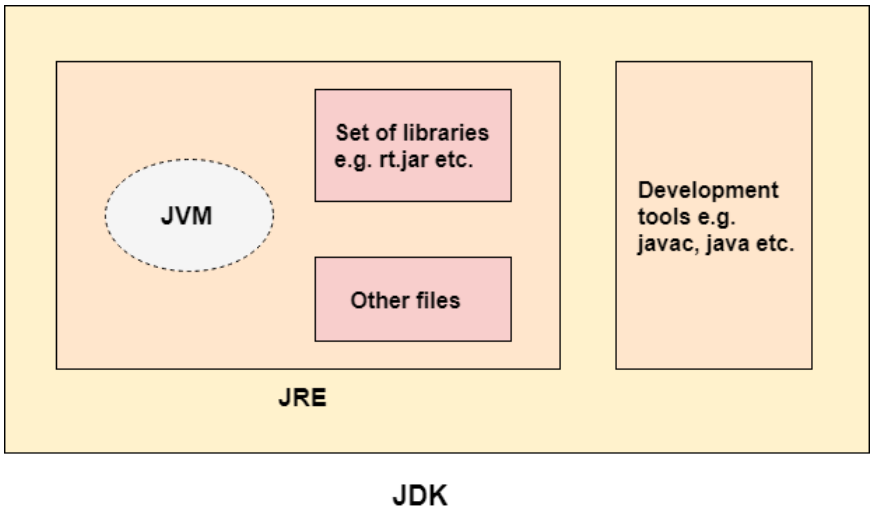
- What we will learn?
  - JDK, JVM, JRE
  - Keywords
  - Simple declarations
  - Statements
  - Classes/objects
  - Methods
  - Exceptions

- What we will NOT learn?
  - Interface
  - Abstract class
  - Inheritance
  - GUI
  - Multi-thread
  - Garbage collection
  - Network communication
  - Web design
  - Android Apps development
  - …
  - Many others

Only focus on the basic knowledge of Java that is used for implementing the data structures and algorithms in this course!

JDK, JVM, JRE

- Java Development Kit (JDK)
  - A software development environment which is used to develop Java applications and applets
- Java Runtime Environment (JRE)
  - It provides the minimum requirements for executing a Java application; it consists of JVM, core classes, etc.
- JVM (Java Virtual Machine)
  - An abstract machine that doesn't physically exist, a specification that provides a runtime environment in which Java bytecode can be executed



Java is platform-independent, but JVM is platform dependent

The first Java program

```java
public class HelloWorld {
    public static void main(String[] args){
        System.out.println("Hello World!");
    }
}
```

- Source codes
  - Declare a class with name
    - public class HelloWorld{…}
  - Declare the main method
    - **public static void main(String args[ ]){…}**
    - Java main method is the entry point of any java program
  - Print "Hello World" to the console
    - **System.out.println("Hello World")**

(1) Java keywords

- Java keywords (reserved words)
  - Keywords are particular words, which acts as a key to a code
  - Keywords cannot be used as variable or object names

- Keywords of primitive types
  - int: used to declare a variable that can hold a 32-bit signed integer
  - boolean: used to declare a variable as a boolean type (true or false)
  - double: used to declare a variable that can hold a 64-bit floating-point numbers
  - char: used to declare a variable that can hold unsigned 16-bit Unicode characters
  - short: used to declare a variable that can hold a 16-bit integer
  - long: used to declare a variable that can hold a 64-bit integer
  - float: used to declare a variable that can hold a 32-bit floating-point number
  - byte: used to declare a variable that can hold an 8-bit data values

(1) Java keywords

- Keywords of loops
  - for: used to create a for loop (a variable initialization, a boolean expression, and an incrementation)
  - while: used to create a while loop, which tests a boolean expression and executes some statements if the expression is true
  - continue: used to continue the loop; it continues the current flow of the program and skips the remaining code at the specified condition
  - break: used to break loop or switch statement; it breaks the current flow of the program at specified condition

- Keywords of conditions
  - if: Java if keyword tests the condition. It executes the if block if condition is true
  - else: used to indicate the alternative branches in an if statement

- Keywords of classes and objects
  - class: used to declare a class
  - new: used to create new objects

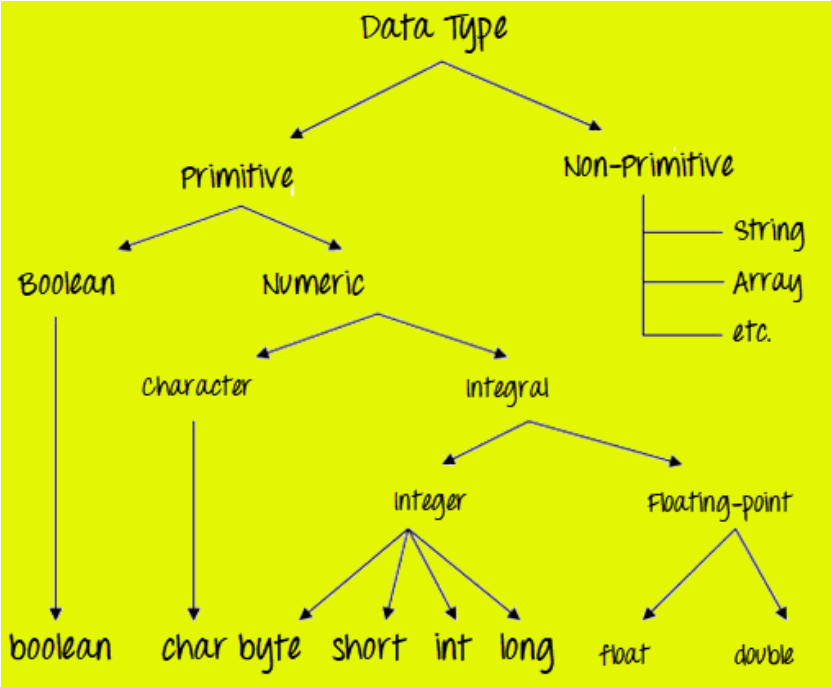
(1) Java keywords

- Keywords of exceptions
  - try: used to start a block of code that will be tested for exceptions. The try block must be followed by either catch or finally block
  - catch: used to catch the exceptions generated by try statements. It must be used after the try block only
  - finally: used to create a block of code following a try block; its block always executes whether an exception occurs or not

- Keywords of others
  - import: used to make classes and interfaces available and accessible to the current source code
  - package: used to declare a Java package that includes the classes
  - public: It is an access modifier. It is used to indicate that an item is accessible anywhere. It has the widest scope among all other modifiers
  - return: used to return from a method when its execution is complete
  - null: used to indicate that a reference does not refer to anything. It removes the garbage value

(2) Simple declaration

- Variable in Java is a data container, storing the data values during Java program execution
- Every variable is assigned data type which designates the type and quantity of value it can hold
- Variable is a memory location name of the data
- To use variables
  - Variable declaration
  - Variable initialization



(2) Simple declaration

- Variable declaration

```
int m, n;        // Two integer variables
double x, y;     // Two real coordinates
boolean b;       // Either 'true' or 'false'
char ch;         // A character, such as 'P' or '@'
```

type

variable name

semicolon

(2) Simple declaration

- Numeric expressions are written in much the same way as in other languages

```
n = 3 * (5 + 2);
x = y / 3.141592653;
n = m % 8;      // Modulo, i.e. n is now (m mod 8)
b = true;
ch = 'x';
```

- Division operator has two different things:

```
double f;
f = 1 / 3;          // f is now 0.0
f = 1.0 / 3.0;      // f is now 0.33333333...
```

(2) Simple declaration

```
class Guru99 {
    static int a = 1; //static variable
    int data = 99; //instance variable
    void method() {
        int b = 90; //local variable
    }
}
```

- Three types of variables
  - Local variables are declared inside the body of a method
  - Instance variables are defined without STATIC keyword, and they are defined Outside a method declaration, i.e., they are Object specific
  - Static variables are initialized only once, at the start of the program execution; These variables should be initialized first, before the initialization of any instance variables, i.e., they are Class specific

(2) Simple declaration

- Type conversion (casting)
  - Assign a real value to an integer value: need a cast

```
double radians;
int degrees;
...
degrees = radians * 180 / 3.141592653;          // Error
degrees = (int) (radians * 180 / 3.141592653);  // OK
```

  - Assigning an integer to a real variable does not need casting

(2) Simple declaration

- A string is a sequence of characters, or an array of characters

```
//String is an array of characters
char[] arrSample = {'R', 'O', 'S', 'E'};
String strSample_1 = new String (arrSample);
```

- Use String class to handle strings

```
package codes;
import java.lang.String;

public class StringMethods {

    public static void main(String[] args) {

        String str1 = "Software";
        String str2 = "Testing";
        System.out.println(str1 + str2);
        System.out.println(str1.concat(str2));
    }
}
```

Output:

```
Problems  @ Javadoc  Declaration  Console
<terminated> StringMethods [Java Application] C:\Program Files\Java\
SoftwareTesting
SoftwareTesting
```

(3) Statements

- Statements can be grouped in blocks using "{ }"
- If and if-else statements

```
if (n == 3)
    x = 3.2;
```

Note:

- There is no `then` keyword
- The condition must be of boolean type and written within parentheses
- Comparison is made using '`==`'

- Comparison operators: >, <, ==, >=, <=, !=

```
if (x != 0)
    y = 3.0 / x;        // Executed when x is non-zero
else
    y = 1;              // Executed when x is zero
```

(3) Statements

- More about Boolean expressions

and	&&
or	||
not	!

```
int x, y;
boolean b;
...
if ((x <= 9 || y > 3) && !b) {
    b = true;
}
```

- while loop statement: need the stopping criterion

```
// Calculate exp(1). End when the term is less than 0.00001
double sum = 0.0;
double term = 1.0;
int k = 1;
while (term >= 0.00001) {
    sum = sum + term;
    term = term / k;
    k++;                    // Shortcut for 'k = k + 1'
}
```

(3) Statements

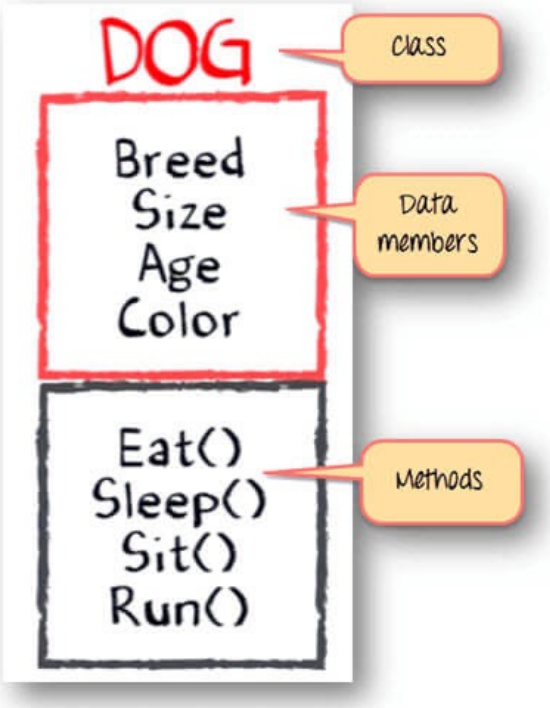
- for loop statement
  - Initial value of value i
  - Stopping criterion of the loop
  - How to change the value of i in each iteration

```
// Calculate 1 + (1/2) + (1/3) + ... + (1/100)
int i;
double sum = 0.0;
for (i = 1; i <= 100; i++) {
    sum = sum + 1.0 / i;
}
```

(4) Class/object

- A class is a blueprint or prototype that defines the variables and the methods (functions) common to all Java objects of a certain kind

- An object is a specimen of a class
  - An object is an instance of a class
  - Software objects are often used to model real-world objects you find in everyday life



(4) Class

- A class declaration contains
  - A set of attributes (called instance variables)
  - A set of functions (called methods in Java)

```
class Turtle {
    private boolean penDown;
    protected int x, y;

    // Declare some more stuff
}
```

- Methods in Java
  - Main methods
    - public static void main(String [ ] args){…}
  - Constructor methods
    - public Turtle( ){…}
  - General methods
    - public void jumpTo(int newX, int newY) {…}

(4) Class

- Java constructor
  - A special method for initializing a newly created object and is called just after the memory is allocated for the object
  - It can be used to initialize the objects to desired values or default values at the time of object creation
  - It is not mandatory to write a constructor for a class
- Rules for creating a java constructor
  - It has the same name as the class
  - It should not return a value (not even void)

(4) Class

- Java method
  - Method name, input parameters, method body, return type

```
class Turtle {
    // Attribute declarations, as above

    public void jumpTo(int newX, int newY) {
        x = newX;
        y = newY;
    }

    public int getX() {
        return x;
    }
}
```

```
public Turtle(int initX, int initY) {
    x = initX;
    y = initY;
    penDown = false;
}
```

(4) Class

Modifier	Class	Package	Subclass	Global
Public	Yes	Yes	Yes	Yes
Protected	Yes	Yes	Yes	No
Default	Yes	Yes	No	No
Private	Yes	No	No	No

- Access modifiers
  - The public keyword is used to declare that something can be accessed from other classes
  - The protected keyword specifies that something can be accessed from within the class and all its subclasses, but not from the outside
  - When we do not mention any access modifier, it is called default access modifier, and the scope of this modifier is limited to the package only
  - The private declaration means that those attributes cannot be accessed outside of the class. In general, attributes should be kept private

(4) Class

- In Java, statements can only be written within methods in classes
  - There must be some method which is called by the system when the program starts executing, which is main method

```java
public class HelloWorld {
    public static void main(String[] args){
        System.out.println("Hello World!");
    }
}
```

- Notes
  - static keyword: when the main method is called, it is not associated with an object, but with the class
  - The parameter args: if the Java interpreter is given any more information than the class name, this data is passed on to the main method in this parameter

(4) Class

- The keyword new is used to create an object of a class

```
Turtle t;
t = new Turtle(100, 100);
```

- Calling methods in objects

```
int a = t.getX();
t.jumpTo(300, 200);
```

  - Java has garbage collection, so no need to destroy objects manually

```
public class ConfunDemo3 {
    public static void main(String[] args){
        Person z=new Person("zhangsan",3);
        z.show();
    }
}

class Person{
    private String name;
    private int age;
    public Person(String n,int m){
        name=n;
        age=m;
    }
    //getter
    public String getName(){
        return name;
    }
    public int getAget(){
        return age;
    }
    public void show(){
        System.out.println(name+"\n"+age);
    }
}
```

(5) Exception

- Many things can go wrong during the execution of a program (programmers may introduce faults)
  - E.g., division by zero or calling a method with a null reference

- Throw exceptions
  - E.g., consider a method to read a positive integer from the keyboard; what if the input character is not an integer?

```
public int getNatural() throws IOException {
    char ch;
    while (more input) {
        ch = (read character);
        if (ch < '0' || ch > '9') {
            throw new IOException("bad natural number");
        }
        ...
    }
    ...
}
```

(5) Exception

- Catch exceptions
  - The statement(s) within the try clause are executed as usual, but whenever an exception occurs, the try clause is interrupted and the statements within the corresponding catch clause are executed

```
int m, n;
try {
    n = getNatural();
    m = n * 2; // If an exception is thrown, this is not executed
}
catch (IOException e) {
    // The user entered something wrong. Use 1 as default.
    n = 1;
    m = 2;
}
```

(6) Others

- Print something: writing to the console
  - System.out.print(xxx)
  - System.out.println(xxx)

```
System.out.print("Jag vill bo ");
System.out.println("i en svamp");
System.out.println("Annars får jag kramp");
```

The resulting output is:

```
Jag vill bo i en svamp
Annars får jag kramp
```

Variable values can be printed like this:

```
int a;
a = 6 * 7;
System.out.println("6 * 7 = " + a);
```

(6) Others

- Packages
  - **Package in Java** is a collection of classes, sub-packages, and interfaces
  - It helps organize your classes into a folder structure and make it easy to locate and use them
  - More importantly, it helps improve code reusability

```
import java.awt.*;
```

(6) Others

- Comments
  - Single sentence: two forward slashes //
  - A block of codes: /* xxx */

```java
import java.util.*;

/**
 * This program demonstrates object construction.
 * @version 1.01 2004-02-19
 * @author Cay Horstmann
 */
public class ConstructorTest
{
   public static void main(String[] args)
   {
      // fill the staff array with three Employee objects
      Employee[] staff = new Employee[3];

      staff[0] = new Employee("Harry", 40000);
      staff[1] = new Employee(60000);
      staff[2] = new Employee();

      // print out information about all Employee objects
      for (Employee e : staff)
         System.out.println("name=" + e.getName() + ",id=" + e.getId() + ",salary="
               + e.getSalary());
   }
}
```

(6) Others

- Array
  - Declaration

```
int[] someInts;        // An integer array
Turtle[] turtleFarm;   // An array of references to Turtles
```

  - Initialization

```
someInts = new int[30];
turtleFarm = new Turtle[100];
```

What is the maximum array size?

  - Use arrays: 0 ~ size-1

```
int i;
for (i = 0; i < someInts.length; i = i + 1) {
    someInts[i] = i * i;
}
```

(6) Others

- ArrayList is a data structure that can
  - be stretched to accommodate additional elements within itself
  - shrink back to a smaller size when elements are removed

- Notes
  - A key data structure for handling dynamic behaviors of elements
  - Although it provides more flexibility, it may take more space cost than an array, especially when the array is fully used

```
ArrayList<Object> a = new ArrayList<Object>();
add(Object o);
remove(Object o);
```

(6) Others

- Keyword "this"
  - **this keyword in Java** is a reference variable that refers to the current object of a method or a constructor
  - The main purpose of using this keyword is to remove the confusion between class attributes and parameters that have same names

eclipse-workspace1 - OnlineProgramming/src/JournalDev/Item.java - Eclipse

File Edit Source Refactor Navigate Search Project Run Window Help

Item.java

```java
package JournalDev;

public class  Item{
      String name;

      // Constructor with a parameter
      public Item(String name) {
        name = name;
      }

      // Call the constructor
      public static void main(String[] args) {
        Item Obj = new Item("car");
        System.out.println(Obj.name);
      }
    }
```

Console

<terminated> Item

```
null
```

eclipse-workspace1 - OnlineProgramming/src/JournalDev/Item.java - Eclipse

File Edit Source Refactor Navigate Search Project Run Window Help

Item.java

```java
package JournalDev;

public class  Item{
      String name;

      // Constructor with a parameter
      public Item(String name) {
        this.name = name;
      }

      // Call the constructor
      public static void main(String[] args) {
        Item Obj = new Item("car");
        System.out.println(Obj.name);
      }
    }
```

Console

<terminated> Item [

```
car
```

(6) Others

eclipse-workspace - CSC3100/src/javaIO/MyIOClass.java - Eclipse

Package Explorer

- CSC3100
  - JRE System Library [JavaSE-
  - src
    - javaIO
      - MyIOClass.java

MyIOClass.java

```java
package javaIO;
import java.io.BufferedReader;

public class MyIOClass {

    public static void main(String[] args) {
        String inFilePath = "/Users/yxfang/Documents/eclipse-workspace/inputInfo";
        String outFilePath  = "/Users/yxfang/Desktop/eclipse-workspace/outputInfo";
        try {
            FileReader fileReader = new FileReader(inFilePath);
            BufferedReader stdin = new BufferedReader(fileReader);

            FileWriter fileWriter = new FileWriter(outFilePath);
            BufferedWriter stdout = new BufferedWriter(fileWriter);

            String line = null;
            while((line = stdin.readLine()) != null) {
                String s[ ] = line.split(" ");
                int a = Integer.parseInt(s[0]);
                int b = Integer.parseInt(s[1]);

                int sum = a + b;
                String sumStr = String.valueOf(sum);
                stdout.write(sumStr);
                stdout.newLine();
            }

            stdout.flush();
            stdout.close();
            stdin.close();
        }catch(IOException e) {
            System.out.println("something wrong");
            e.printStackTrace();
            System.exit(0);
        }
    }

}
```

inputInfo

```
1 3
2 4
5 6
```

outputInfo

```
4
6
11
```

Problems | Javadoc | Declaration | Console

<terminated> MyIOClass [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/bin/java (2021年6月4日 下午3:06:24)

javaIO.MyIOClass.java - CSC3100/src

More information

- Shortcut keys in IDE
  - E.g., in Eclipse IDE, to import packages automatically, we can use shortcut key: "Shit" + "Ctrl" + "o"

- More online materials
  - https://www.guru99.com/java-tutorial.html
  - https://fileadmin.cs.lth.se/cs/Education/EDA040/common/java21.pdf
  - Book: Think in Java