Java Basic

CS 284 C
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Learning Objectives

• Java basic:
  • Java environment (JVM) and classes
  • Primitive data types and reference variables
  • the Math class
  • String class
  • Wrapper class for primitive types
  • Defining your own class
• Array
• Java I/O
Java Virtual Machine (JVM)

- Introduced in 1995 by Sun company
- Write once, run anywhere (WORA)

(source files) \(\rightarrow\) compiler \(\rightarrow\) machine-language instructions

platform dependent, e.g., assembly

(traditional way)
Java Virtual Machine (JVM)

- Introduced in 1995 by Sun company
- Write once, run anywhere (WORA)

Java source files → Java compiler → byte code → JVM for your platform

A: dependent

(platform independent) (platform dependent, e.g., Windows, Linux, Mac)
Java Classes

• A class is a description of a group of entities (objects) that share the same characteristics

```java
public class Person {
    // Data Fields
    /** The given name */
    private String givenName = "Mary";
    /** The age*/
    private int age = 30;
}
```

class  objects

person 1: Mary, age = 30
person 2: Susan, age = 53
…
Java Method

• A method is a collection of statements that provide some tasks and return the result

```java
public class Person {
    /** getting the age of a person */
    public int getAge(int birthYear){
        return 2020 - birthYear;
    }
}
```

```java
int age = getAge(1990);
System.out.println(age);
```

Output: 30
Data Fields and Types

- Variables must be declared with a type before use (unlike Python)

```java
private String givenName = "Mary"; // Java
```
```python
givenName = "Mary"; #Python
```

- Primitive types (numbers, characters) vs. objects types
- 8 primitive types

<table>
<thead>
<tr>
<th>Type</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>byte</td>
<td>-128 to 127</td>
</tr>
<tr>
<td>short</td>
<td>-32,768 to 32,767</td>
</tr>
<tr>
<td>int</td>
<td>-2,147,483,648 to 2,147,483,647</td>
</tr>
<tr>
<td>long</td>
<td>$-2^{63}$ to $2^{63} - 1$</td>
</tr>
<tr>
<td>float</td>
<td>32-bit IEEE 754 floating point</td>
</tr>
<tr>
<td>double</td>
<td>64-bit IEEE 754 floating point</td>
</tr>
<tr>
<td>char</td>
<td>Unicode character set</td>
</tr>
<tr>
<td>boolean</td>
<td>true, false</td>
</tr>
</tbody>
</table>
Type Compatibility and Conversion

• Widening conversion:
  • int -> double
  • double -> int

```
int item = 42;
double realItem = item;  // valid

double y = 3.14;
int x = y;
“Compile-time Error: Type mismatch: cannot convert from double to int”
```
The constructor method initializes the values of an object

```java
public class Person {
    public Person(String givenName, String ID, int age) {
        // ...
    }
    public Person(int age) {
        // ...
    }
}
```

Person mary = new Person(“Mary”, ‘123’, 23);

Person susan = new Person(“Susan”, ‘456’, 53);

Person susan = new Person(23);

Person susan = new Person();

Constructor methods have no return type
The main Method

• The point where execution begins

```java
public class Person {
    public Person(String givenName, String ID, int age) {
        // ...
    }

    public static void main(String[] args){
        Person mary = new Person("Mary", '123', 23);
        // ...
    }
}
```
Modifying/Getting Values of Objects

- Use the set and get method to modify/get the values of an object

```java
public class Person {
    private int age;
    public void setAge(int age) {
        this.age = age;
    }
    public String getAge(){
        return this.age;
    }
}
```

- `this` refers to the current object

```java
public static void main(String[] args){
    Person mary = Person();
    mary.setAge(23);
    System.out.println(mary.getAge());
}
```

```java
public static void main(String[] args){
    Person mary = Person();
    mary.age = 23;  // ??
    System.out.println(mary.age);  // ??
}
```
public class TestPerson {
    public static void main(String[] args) {
        Person mary = new Person("Mary","123", 30);
        Person susan = new Person("Susan", "456", 53);

        System.out.println("Age of Mary is " + mary.getAge());
        // prints: Age of Mary is 30

        mary.setAge(35);

        System.out.println("Age of Mary is " + mary.getAge());
        // prints: Age of Mary is 35
    }
}
Referencing Objects

- The Person object Mary is now referenced by the variable `mary`.
- `mary` stores the address in memory where the specific object Mary is stored.
- Primitive types store the values instead of addresses.
- Demo 1: Person.java

```
Person mary = Person(23);
mary = 101
```

```
string age;
age = 0100101
```

object type  primitive type
Static Variable

```java
public static int age_static = 30;
```

- Static variables are class variables
  - Shared across all instances
  - Allocated only 1 time

- Instance variables
  - Belong to a specific object
  - Allocated once every object is created

- Demo: Person_2.java
Static Method

• Methods that can be called before any objects being constructed

```java
public class Car {
    public void setMileage(int mileage) {
        this.mileage = mileage;
    }

    public static void convertMpgToKpl(int Mpg) {
        // ……
    }
}
```
# The Math Class

- Collection of useful math operations
- All static

<table>
<thead>
<tr>
<th>Method</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>static numeric abs(numeric)</td>
<td>Returns the absolute value of its numeric argument (the result type is the same as the argument type)</td>
</tr>
<tr>
<td>static double ceil(double)</td>
<td>Returns the smallest whole number that is not less than its argument</td>
</tr>
<tr>
<td>static double cos(double)</td>
<td>Returns the trigonometric cosine of its argument (an angle in radians)</td>
</tr>
<tr>
<td>static double exp(double)</td>
<td>Returns the exponential number $e$ (i.e., $2.718 \ldots$) raised to the power of its argument</td>
</tr>
<tr>
<td>static double floor(double)</td>
<td>Returns the largest whole number that is not greater than its argument</td>
</tr>
<tr>
<td>static double log(double)</td>
<td>Returns the natural logarithm of its argument</td>
</tr>
</tbody>
</table>
Recitation Week 1

- Install Eclipse, test code from class
- Joshua: RE, Bhagyesh: RF
Static Variable

```java
public static int age_static = 30;
```

- Static variables are class variables
  - Shared across all instances
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- Instance variables
  - Belong to a specific object
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- Demo: Person_2.java
Static Variable Naming Convention

• Primitive type static variables are all in capital letters

```java
// Constants
/** The age at which a person can vote */
private static final int VOTE_AGE = 18;
/** Age at which person considered senior citizen */
private static final int SENIOR_AGE = 65;
```
Static Method Cannot Call Instance Methods/Variables

• Static method cannot call instance method without first creating an object

```java
public static void incAgeTwice() {
    Person.incAge();
    Person.incAge();
}

public static void incAge() {
    Person.age_static = Person.age_static + 1;
}
```
Referencing Objects

- Primitive types store the values of variables
- Object types store the addresses of variables
- What happens when variables serve as arguments in a function?
Call-by-Value vs. Call-by-Reference

- Java is call-by-value
  - Primitive type: call-by-value
  - Object type: call-by-reference

- PLs that are call-by-value
  - Java, C#, Python, Ruby, etc.

- PLs that are NOT call-by-value
  - Fortran is call-by-reference

- Demo: Person_3.java Person_4.java

```java
public class Person {
    public void incAge(int age) {
        age = age + 1;
    }

    public static void main(String[] args) {
        Person mary = new Person(23);
        int mary_age = 23;
        incAge(mary_age); // what is mary_age?
    }
}
```
Object-Oriented Programming

- Object-oriented programming is a programming paradigm based on the concept of "objects", which can contain data, in the form of fields, and code, in the form of procedures.

- C is not object-oriented
  - C is procedural

- What is the advantage of object-oriented programming language over procedure-based language?

  Encapsulation; inheritance; polymorphism; abstract
UML Diagrams

• The unified modeling language (UML) represents the unification of earlier object-oriented design modeling techniques

• Why UML?

<table>
<thead>
<tr>
<th>Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>String givenName</td>
</tr>
<tr>
<td>String familyName</td>
</tr>
<tr>
<td>String IDNumber</td>
</tr>
<tr>
<td>int birthYear</td>
</tr>
</tbody>
</table>

int age()
boolean canVote()
boolean isSenior()
Style of UML diagrams

- The classes are represented by rectangles
- Lines between classes represent the relationships between classes
- Use of camel case notations such as `givenName`
UML Diagrams Show Essential Information

- A class carries a lot of information
  - If all the information is included in the UML diagram, the diagram will look cluttered
  - In practice, we show only the essential information
UML diagrams

- Interface indicator: use double angle brackets to indicate the class is an interface
  - e.g., {abstract}

- Visibility indicators, static attributes, and parameter name and types
Arrays

- In Java, Array is an object

- Different ways to declare array and allocate its storage

  \[
  \text{int[]} \text{ scores} = \text{new int}[5]; \quad \text{int[]} \text{ scores} = \{1, 2, 3\}; \quad \text{int[]} \text{ scores}; \quad \text{scores} = \{1,2,3\};
  \]

- Array of user-defined type

  \[
  \text{Person[]} \text{ people;}
  \text{int } n \quad = 3+4;
  \text{people} \quad = \text{new Person}[n];
  \text{people}[0] = \text{new Person("Elliot","Koffman","123",1942)};
  \]
Arrays are Initialized by 0

```java
int[] scores = new int[5];
for (int i=0; i<5; i++) {
    System.out.println(scores[i]);
}
```

Output:
0
0
0
0
0
0

```java
String[] scores = new String[5];
for (int i=0; i<5; i++) {
    System.out.println(scores[i]);
}
```

Output: ?

---

System.arraycopy

- Deep copy an array:

  System.arraycopy(source, sourcePos, destination, desPos, numElements);

```java
int[] scores = new int[5];
int[] double_scores = new int[5];
scores = double_scores;
double_scores[1] = 5;
System.out.println(scores[1]);
```

Output: ?
Alternative Ways of For-loop for Array

• There is an enhanced way of writing for-loop for collections, array included

• Rather than

```java
for (int i=0; i<5; i++) {
    System.out.println(scores[i]);
}
```

• We can write

```java
for (int i : scores) {
    System.out.println(scores[i]);
}
```
System.arraycopy

• Deep copy an array:

System.arraycopy(source, sourcePos, destination, desPos, numElements);

```java
int[] scores   = new int[5];
int[] double_scores = new int[5];
scores = double_scores;
double_scores[1] = 5;
System.out.println(scores[1]);
```

Output: ?
Two Dimensional Arrays

- The statement allocates storage for a two dimensional array

```java
double[][] matrix = new double[5][10];
```

```java
double[][] matrix = new double[5, 10];
```

```java
double[][] matrix = new double[5][10];
```

![Diagram showing matrix allocation and indexing]

```java
matrix[0][9]
```

```java
matrix[4][9]
```
Java String Operations

• String operations process sequence of characters

• Assume keyboard is a String variable that contains “qwerty”

```java
keyboard.charAt(0) // q
keyboard.length() // 6
keyboard.indexOf('o') // -1
keyboard.indexOf('y') // 5
String upper=keyboard.toUpperCase();
```

• toUpperCase() does not change the value of keyboard
Strings are Immutable

• You cannot modify a String object:

```java
myName[0] = 'X'; // invalid, String is not an Array
myName.charAt(0) = 'X'; // invalid
```

• When modifying a String object, Java will create a new object that contains the modified sequence, the original object still exists
StringBuffer and StringTokenizer

- StringBuffer also stores string objects
  - However, the content can be changed

```java
StringBuffer sB3 = new StringBuffer("happy");
sB3.append("birthday to you");
```

- StringTokenizer
  - Turn a sentence into sequence of words

```java
String personData = "Doe, John 5/15/65";
StringTokenizer st = new StringTokenizer(personData, ",/");
```
Tokenize a String

• Split a list of numbers by comma

```java
String personData = "12, 3,456, 78";
String[] newData = personData.split("", -1);
System.out.println(newData.length);
```

• Split a list of numbers by regular expression

```java
String personData = "12, 3,456, 78";
String[] newData = personData.split(" ,", -1);
System.out.println(newData.length);
```
The toString method creates a string object that represents the information stored in an object

```java
public String toString() {
    return "Given name: " + givenName + "\n" + "Family name: " + familyName + "\n" + "ID number: " + IDNumber + "\n" + "Year of birth: " + birthYear + "\n";
}
```

Automatically apply toString:

```java
System.out.println(person.toString());
System.out.println(person);
```
/** Compares two Person objects for equality.
   * @param per The second Person object
   * @return true if the Person objects have same
        ID number; false if they don’t
   */

public boolean equals(Person per) {
    if (per == null)
        return false;
    else
        return IDNumber.equals(per.getIDNumber());
}
Programming Style

• Some programmers unnecessarily write if statements to return a boolean value:

  ```java
  return IDNumber.equals(per.IDNumber);
  ```

• They write

  ```java
  if (IDNumber.equals(per.IDNumber))
      return true;
  else
      return false;
  ```
Wrapper Class for Primitive Types

- Primitive numeric types are not objects, but sometimes they need to be processed like objects
- e.g., When primitive types must be inserted into collections
- Java provides wrapper classes whose objects contain primitive-type value

```java
byte a = new Integer(1);
int b = a;
```
public class Person {
  // Data Fields
  /** The given name */
  private String givenName;
  /** The family name */
  /** Initializes a Computer object with all properties specified. */
  @param givenName The person’s first name
  @param age The person’s age
  */
  public Person(String givenName, int age){…}
  //vs/** ... */vs/** ... */
Garbage Collection

• Storage space for objects no longer referenced is automatically reclaimed by Java garbage collector

• C and C++ do not have a garbage collection, programmers have to delete the objects they create