Introduction to Java

Objects and Classes

COMP2603
Object Oriented Programming 1

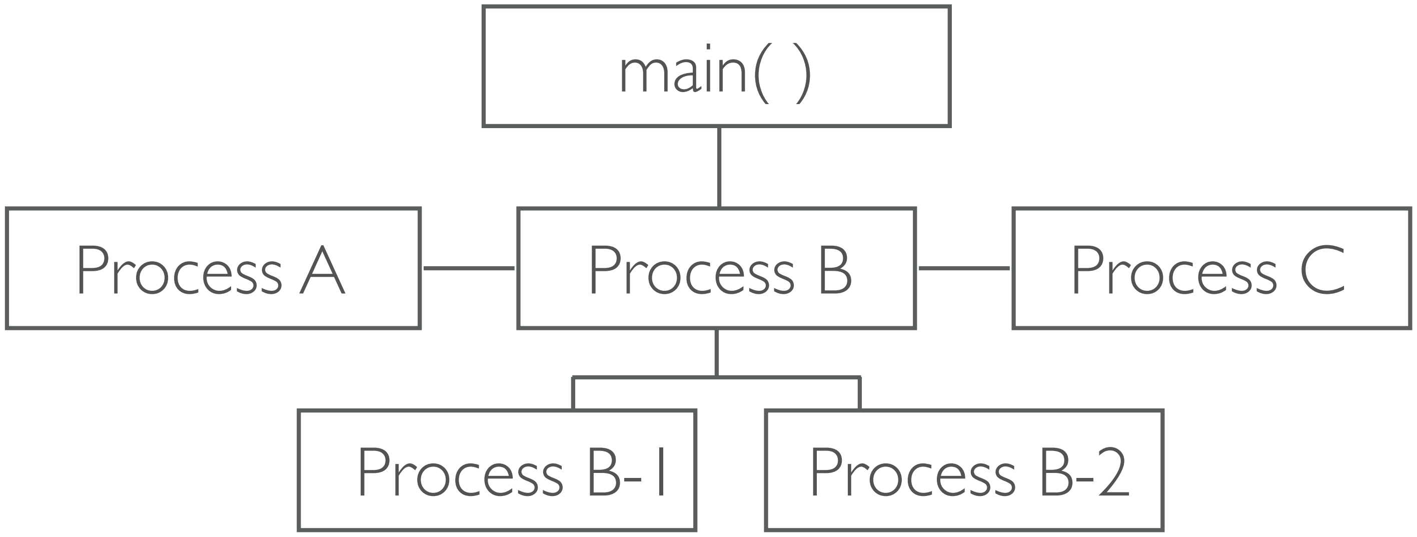
Week 1

Outline

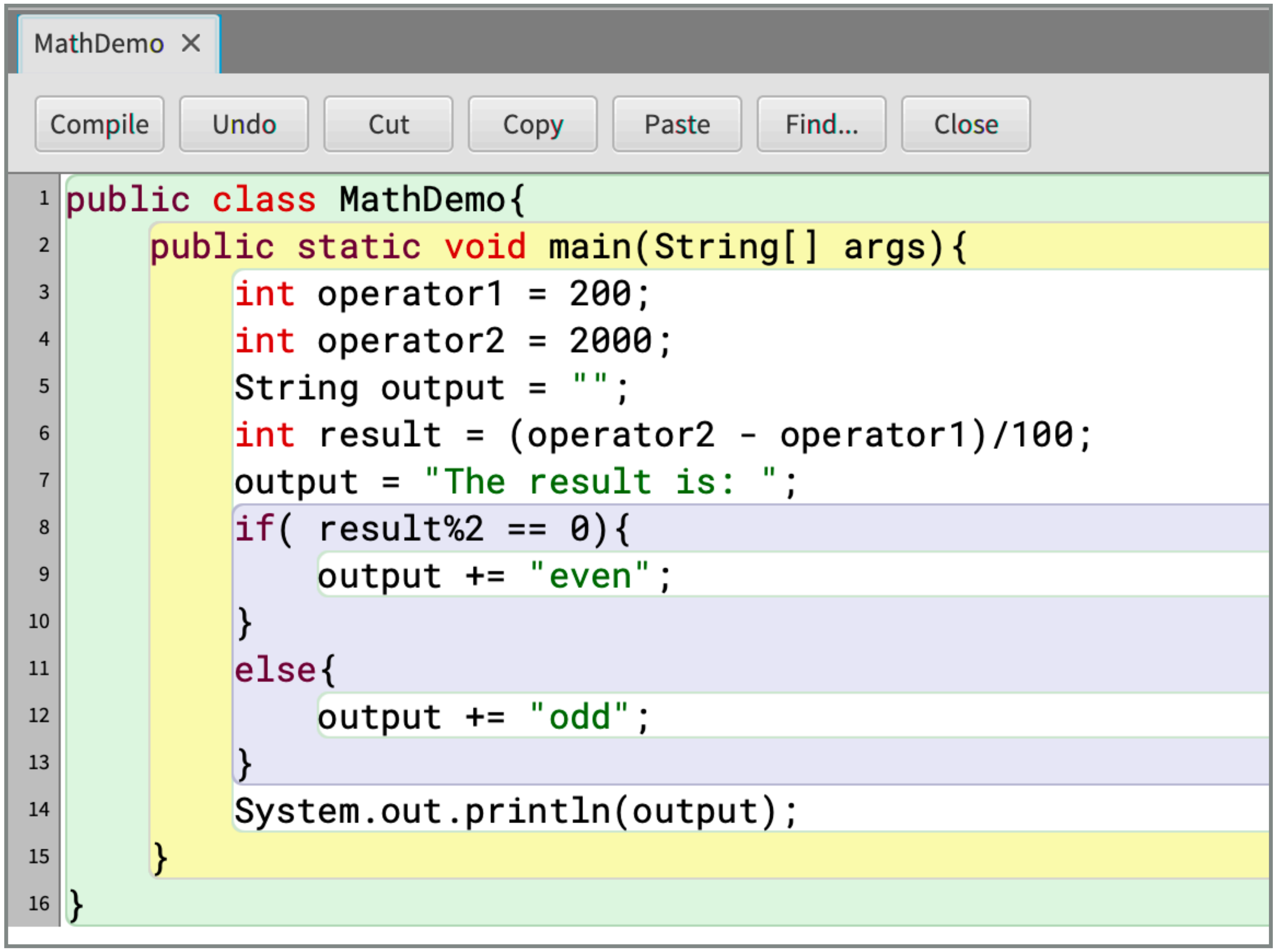
- Programming Paradigms
- Differences with C, C++
- Java Language Features
  - Primitive Data Types: Numeric, Character, Boolean
  - Arithmetic, Relational Operators
  - Class Types: Arrays, Strings
  - Conditional Statements
  - Loops, Switch Constructs

Programming Paradigms

- **Procedural**: Consists of a set of processes that are hierarchically connected.



A Procedural Java Program



```
public class MathDemo{
    public static void main(String[] args){
        int operator1 = 200;
        int operator2 = 2000;
        String output = "";
        int result = (operator2 - operator1)/100;
        output = "The result is: ";
        if( result%2 == 0){
            output += "even";
        }
        else{
            output += "odd";
        }
        System.out.println(output);
    }
}
```

Output:

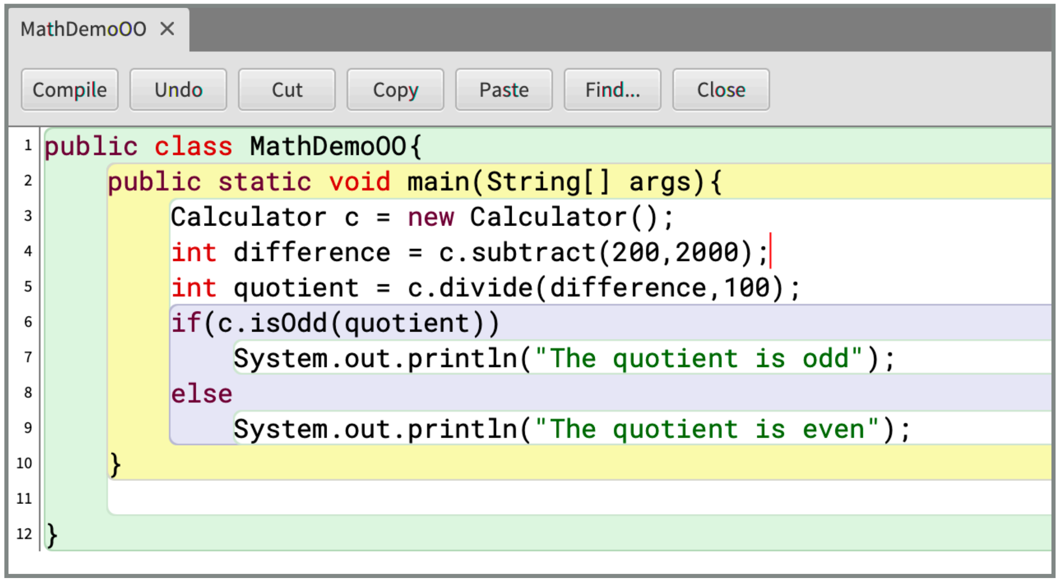
The quotient is odd

Programming Paradigms

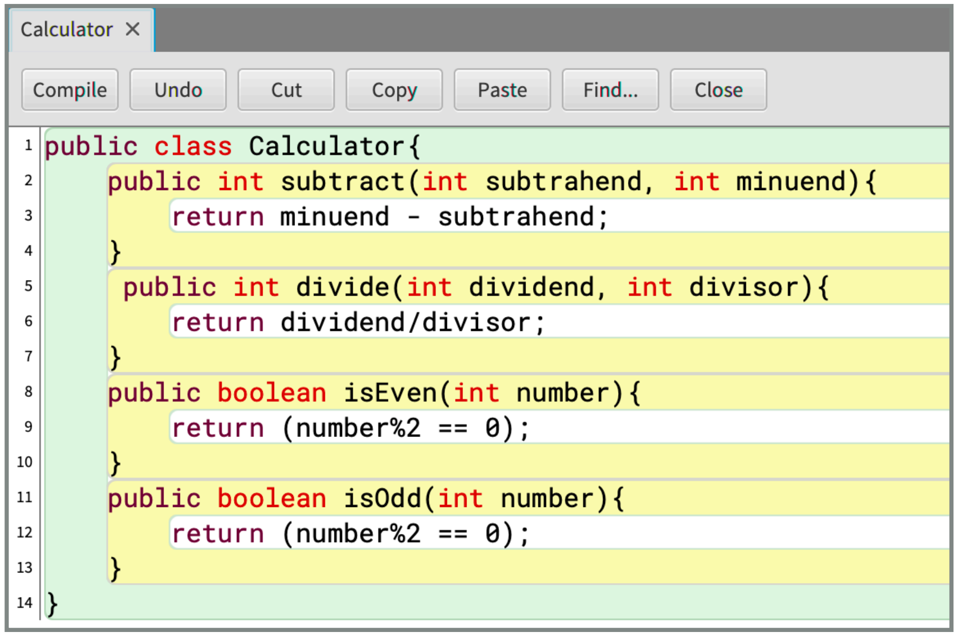
Object-Oriented:
Set of objects collaborating to achieve the goals of the application.

- Focuses on interactions between objects
- Iterative, incremental development
- Represents real-world problems and domains

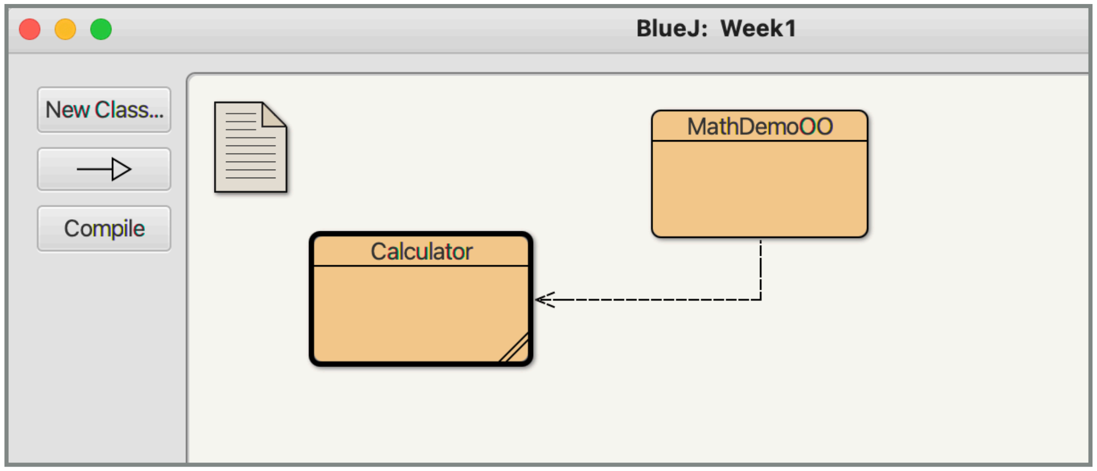
An Object-Oriented Java Program



```java
public class MathDemoOO{
    public static void main(String[] args){
        Calculator c = new Calculator();
        int difference = c.subtract(200,2000);
        int quotient = c.divide(difference,100);
        if(c.isOdd(quotient))
            System.out.println("The quotient is odd");
        else
            System.out.println("The quotient is even");
    }

}
```



```java
public class Calculator{
    public int subtract(int subtrahend, int minuend){
        return minuend - subtrahend;
    }
     public int divide(int dividend, int divisor){
        return dividend/divisor;
    }
    public boolean isEven(int number){
        return (number%2 == 0);
    }
    public boolean isOdd(int number){
        return (number%2 == 0);
    }
}
```



Output:

The quotient is odd

Object

- **Object**: a primary modelling element in OOP
- Distinct Entity
  - current state
  - well-defined behaviour
- Created from *Classes*

Classes

- **Classes** define
    - **Attributes** : set of properties
    - **Behaviour**: common to all members of the class
- Template for creating objects of the same type
- Individual objects have different values for attributes
- Examples of Classes: Account, Student

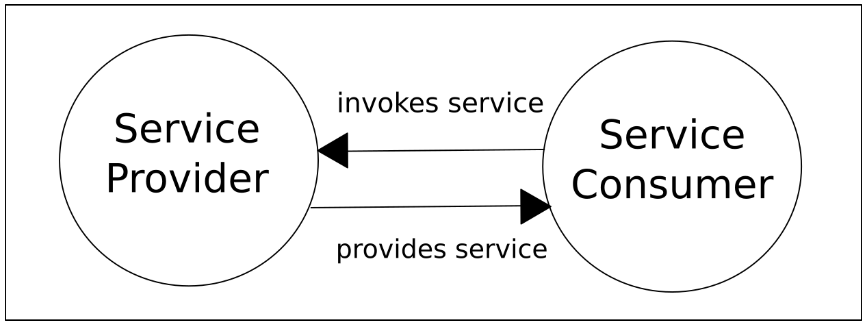
Attributes

- Attributes are **properties** of an object
- Store data about an object
- The **state** of an object is the set of values of each of its attributes
- Typically given noun-like names e.g. number, balance, firstName, lastName
  - Match the purpose served in the app.
- Have types e.g. int, double, String

```
/* e.g. Account object
attributes */

int number;
double balance;
```

Behaviour

- Regarded as a **service** provided by an object
- Particular action or task that the object performs
- Depends on the current state, sometimes it results in the modification of that state
- Implemented as **methods**
- Typically given verb-like names e.g. deposit, withdraw
  - Represents a particular task



Implementing Behaviours

- **Accessors**: allow access to the state of an object

```
/* Account behaviour */

//Accessor for balance
public double getBalance(){
  return balance;
}

//Accessor for account number
public double getNumber(){
 return number;
}

//To String
public String toString(){
  String s;
  s = “Number:” + number + “ Balance: “+ balance;
  return s;
}
```

Implementing Behaviours

- **Mutators**: modify the state of an object

```
/* Account behaviour */



//Deposit funds into account
public void deposit(double amount){
 balance = balance + amount;
}

//Remove funds from account
public void withdraw(double amount){
 if(balance >= amount)
   balance = balance - amount;
}
```

Creating a Class

- A **class** is ‘template’ from which objects are created
- Particular combination of attribute values differentiate objects
- An **object** is referred to as an **instance** of a class

```
public class Account{

  //Declare attributes
  int number;
  int balance;

  //Declare and define methods
  public double getBalance(){
    return balance;
  }

  public double getNumber(){
   return number;
  }

  public String toString(){
    String s;
    s = “Number:” + number + “ Balance: “+ balance;
    return s;
  }

  public void deposit(double amount){
    balance = balance + amount;
  }

  public void withdraw(double amount){
    if(balance >= amount)
      balance = balance - amount;
  }
}
```

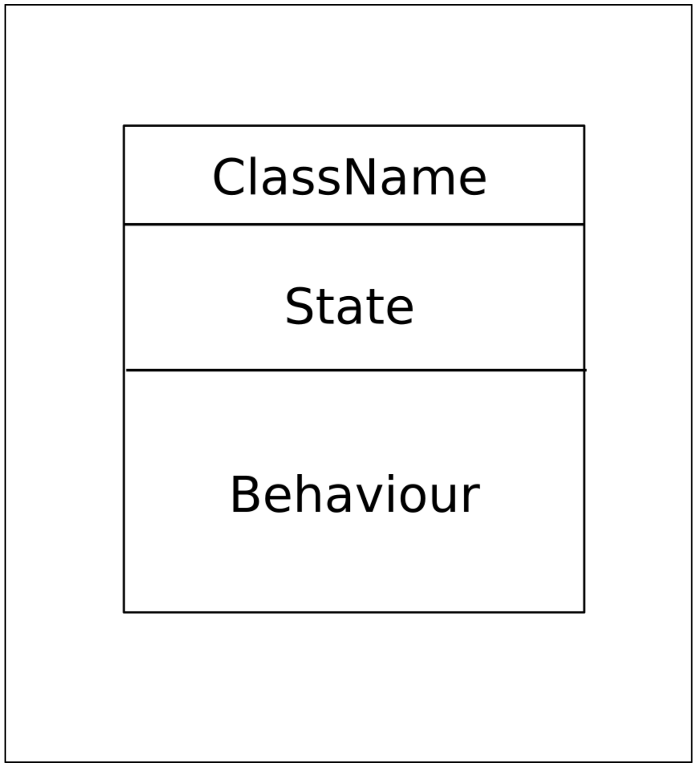
Creating a Class

- **Access Modifier**: keywords that restrict access to the features of an object
  - **public**
  - **private**
- Classes are public so that other objects can create and use objects of the class
- Methods are public so that services can be invoked by another class
- Attributes are private because the object should control access of and updates to its state

```
public class Account{

   //Declare attributes
   private int number;
   private int balance;

   //Declare and define methods

   public double getNumber(){
    return number;
   }
   public double getNumber(){
    return number;
   }
   public double getBalance(){
     return balance;
   }

   public double getNumber(){
    return number;
   }

   public String toString(){
      String s;
      s = “Number:” + number + “ Balance: “+ balance;
      return s;
   }

   public void deposit(double amount){
      balance = balance + amount;
   }

   public void withdraw(double amount){
      if(balance >= amount)
         balance = balance - amount;
   }
}
```

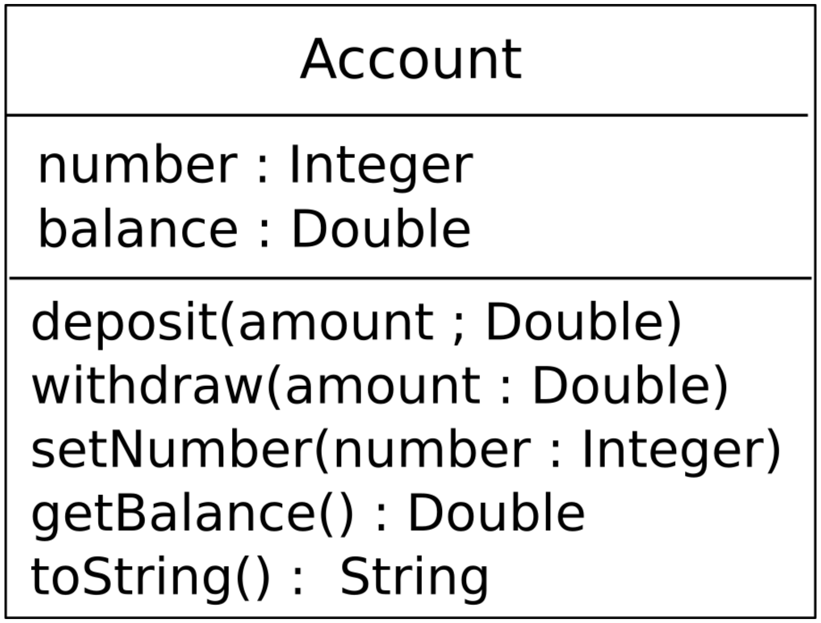
UML Notation

- UML: Unified Modelling Language
- Graphical Language
  - Widely used for OOP apps.
- Provides a visual representation of a class and the collaboration between objects of different classes



UML Notation

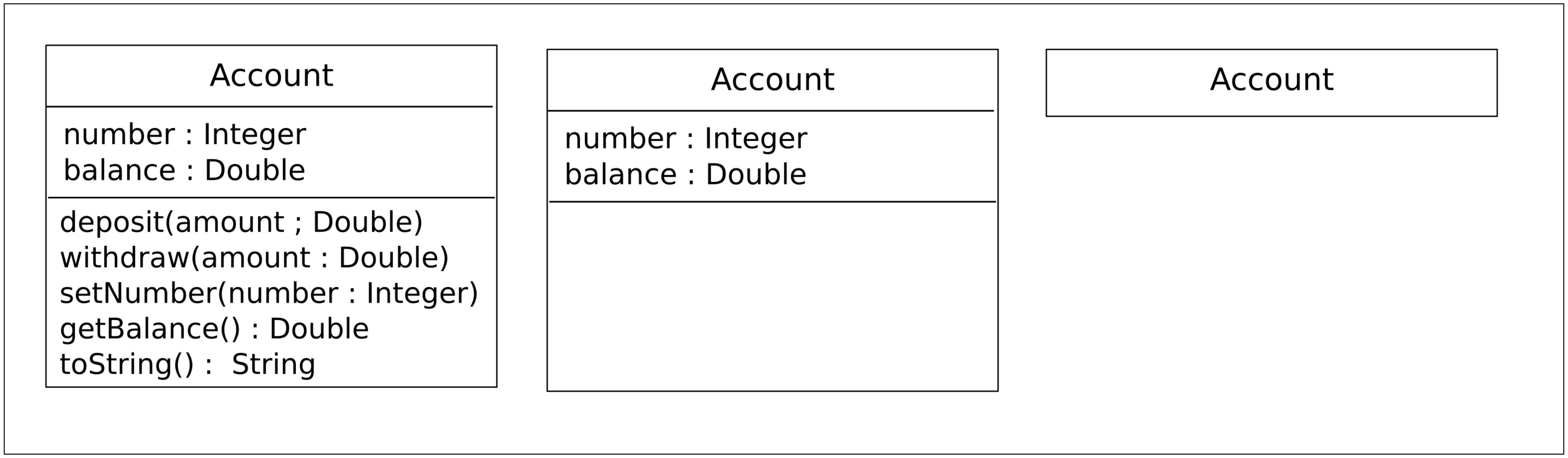
- Class diagram: 3 components
  - Top: class name
  - Middle: attributes with type specifiers if necessary
  - Bottom: methods of the class



UML Notation

Class Diagram Variations

(a) (b) (c)



Creating Instances

- An instance of a class must first be created in order to use the services of an object
- **Instantiating** the class : **new** keyword

```
new Account(); // Creates a new Account object
```

- Creates a new Account object in memory
- Need to refer to the object using an object variable

Creating Instances

```
Account a;             // Declare an object variable
a = new Account(); // Assign a new object to a
```

- Object variable *a* must be declared to be the same type as the object to which it will refer
- Reference is for one Account object

```
Account b;
b = null;          // b does not refer to a specific
                   //   Account object right now.
```

Manipulating Instances

```
a.setNumber(10); // Account has a number
a.deposit (1000.00); // Deposit $1000.00 to account
```

- The object reference can be used to request services using method invocations
- Services request: *objectVariableName.methodName(arguments);*
- Client object supplies arguments

Manipulating Instances

```
b.setNumber(20); // b is null
```

- *b* does not refer any object
- Requesting a service from *b* results in a serious programming error
- Compiler sometimes detects this, but if it occurs at run-time: NullPointerException and program halts

Creating a Client Class

```
public class BankApplication{

  public static void main(String[] args){
    Account a;
    a = new Account();
    a.setNumber (10);
    a.deposit(1000.00);
    System.out.println(a.toString());
  }

}
```

- BankApplication.class file must be in the same folder as the Account.class file
- Complete program: Two collaborating classes.