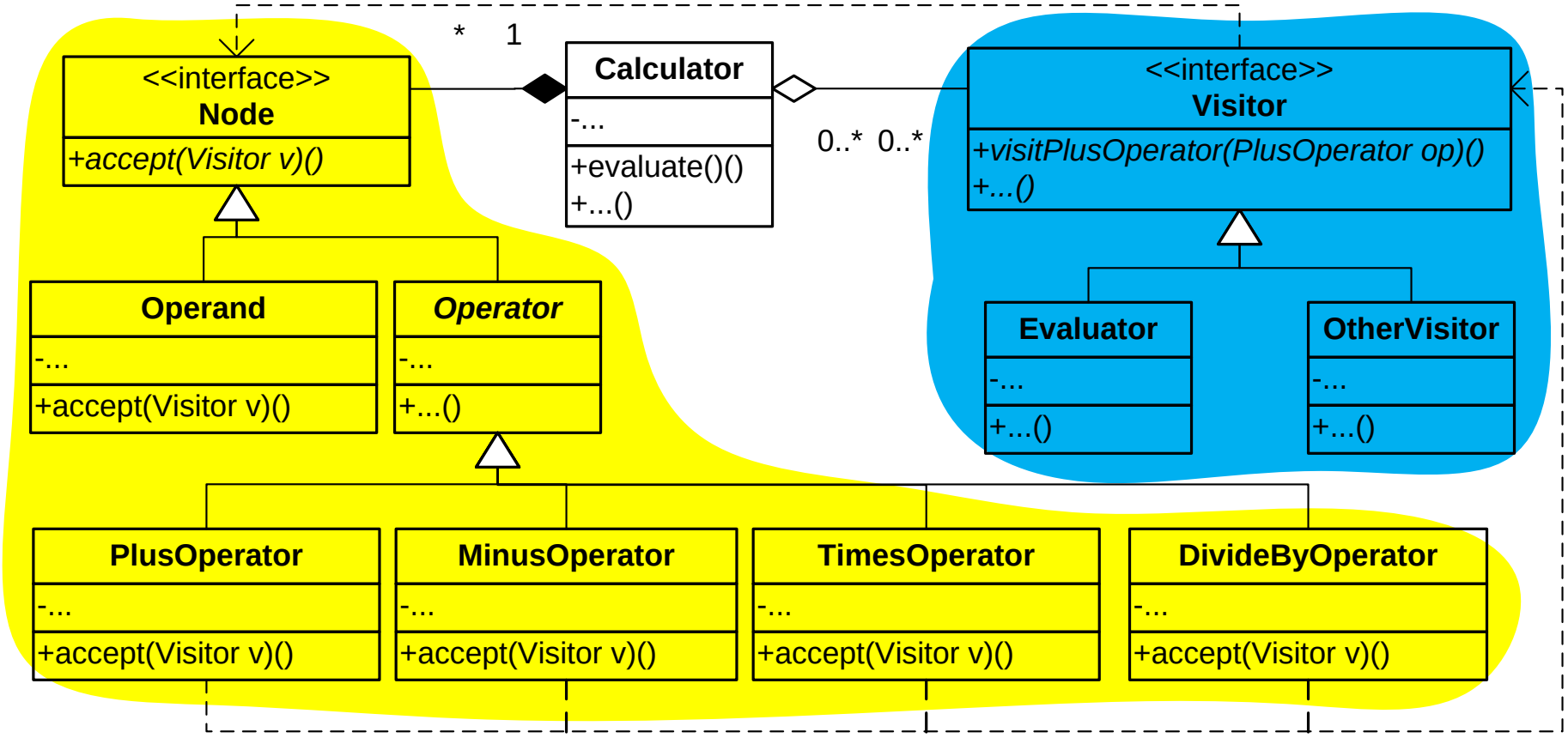
Java and C# in Depth

Exercise Session – Week 3

Agenda

- Assignment I Review
- Class Initialization and Class Instance Creation
- Quizzes
- Assignment II Handout

Class Diagram – Assignment 1



Double Dispatching in Visitor Pattern

```
public class ReversePolishNotationCalculator {
      /** Stack of current operands */
   private Stack<Node> stack;
      /** Operation evaluator */
   private Evaluator evaluator;
   ...
      /** Push Plus operator on top of stack. */
   public void pushPlusOperator () {
      stack.add(new PlusOperator()); }
      /** Evaluate stack. */
   public void evaluateStack() throws Exception {
      Node n = stack.pop();
      n.accept (evaluator);
      pushOperand (evaluator.getResult());
   }
}
```

```
public class PlusOperator extends Operator {
   ...
   public void accept(Visitor visitor)
         throws Exception {
      visitor.visitPlusOperator (this);
   }
}
```

→ Dynamic binding

```
public interface Visitor {
   public void
   visitPlusOperator(PlusOperator o)
      throws Exception;
   ...
}
```

```
public class Evaluator
         implements Visitor {
      /** Evaluation result */
   private double result;
      /** Stack to evaluate on */
   private Stack<Node> stack;
   public Evaluator (...) {
       // Initialize stack
       ...
   }
   ...
   public void
   visitPlusOperator(PlusOperator o)
            throws Exception {
      double d1 = getNextOperand();
      double d2 = getNextOperand();
      result = d1 + d2;
   }
}
```

Class Instance Creation in Java

- Creating a new class instance
  - Storage allocation for all the fields (this + super)
  - All instance variables initialized to default values
  - Instance initialization (process the constr.)
    1. If starts with explicit/implicit ***super*** constr. invocation, process the *super* constr. (by applying 1–4 recursively to super constr.), go to 3
    2. If starts with explicit ***this*** constr. invocation, process *this* constructor (recursively), go to 4
    3. Execute all the instance initializers and instance variable initializers in their textual order
    4. Execute the rest of constructor body

```
class A {
  A(String s){
System.out.println(s);}
}
class E {
  { a2=new A("a2"); }
  A a1=new A("a1");
  A a2;
}
class F extends E {
  A a3=new A("a31");
  { a3=new A("a32"); }
  A a4;
  F()
    { this(5); }
  F(int i)
    { a4=new A("a4"); }
}
// what's the output?
F f=new F();
```

```
a2
a1
a31
a32
a4
```

Class Initialization in Java

- Initializing a class
  - When:
    - Before the first "use" of class
    - The direct superclass, but *not* the implemented interfaces, must be initialized before a class
    - Attributes defined in interfaces are initialized when accessed for the first time
  - How
    - Compile time constants initialized first
    - Static initializers and initializers for static fields are executed in *textual order* and *only once*
  - "Use" of class
    - Class instance creation
    - Static member reference
    - Invocation of certain reflective methods in class **Class** and in package **java.lang.reflect**

```
//with the same class A

class B {
   static A s1=
     new A("s11");
   static
     { s1=new A("s12");}
}
interface D
  { A s2=new A("s2"); }
class C extends B
     implements D {
  static
     { s3=new A("s31"); }
  static A s3=
     new A("s32");
}
// what's the output?
C c =new C();
```

```
s11
s12
s31
s32
```

Class Instance Creation in C#

- Creating a new class instance
  - Storage allocation for all the fields (this + super)
  - All instance variables initialized to default values
  - Instance initialization (process the constr.)
    1. If it has an explicit/implicit constr.-initializer of form base(…)
       a. Execute the instance variable initializers in their *textual order*
       b. Process base constructor ★ (recursively)
       c. Go to 3
    2. If it has explicit constr.-initializer of form this(..)
       a. Process this constructor (recursively)
       b. Go to 3
    3. Execute the rest of constructor body

```
//with the same class A
class E {
  A a1=new A("a1");
  A a2=new A("a2");
}

class F : E {
  A a3=new A("a31");
  A a4=new A("a41");

  public F():this(5) {}
  public F(int i)
    {a4=new A("a42");}
}

// what's the output?
F f=new F();
```

```
a31
a41
a1
a2
a42
```

Class Initialization in C#

- Initializing a class
  - Static constr.
    - Its execution is triggered by first "use" of class
  - Static field initializer
    - Executed right before the static constructor, if any;
    - Otherwise, before first class member reference
    - In their *textual order* and *only once*
  - "Use" of class
    - Creation of an instance of the class
    - Reference to any of the static members of the class

```
// with the same class A
class B {
   static A s1 =
     new A("s11");
   static B()
     {s1 = new A("s12");}
}
class C : B {
     static C() {
        s3 = new A("s31");
     }
     static A s3=
        new A ("s32");
}
// what's the output?
C c=new C();
```

```
s32
s31
s11
s12
```

Comparison

- Initialization code
  - (Java) Multiple static or non-static block initializers, constructors
  - (C#) Static and non-static constructors

- Instance variable initialization
  - (Java) superclass -> subclass
  - (C#) subclass -> superclass

```
// Java.object
a2
a1
a31
a32
a4
```

```
// C#.object
a31
a41
a1
a2
a42
```

- Class variable initialization
  - (Java) superclass -> subclass
  - (C#) subclass -> superclass

```
// Java.class
s11
s12
s31
s32
```

```
// C#.class
s31
s32
s11
s12
```

  - a1, a2, s1, s2 are from superclass; a3, a4, s3, s4 are from subclass

Quiz 1: Class Initialization Dependence

```
class G {
  static int i = f();
  static int j = 7;
  static int f() {
      return j;
  }
}

public class Initialization{
  public static void main(String[] args){
      System.out.printf("G.i=%d, G.j=%d",
            G.i, G.j);
    }
```

```
G.i=0, G.j=7
```

```
class G {
  public static int i = f();
  public static int j = 7;
  static int f() {
      return j;
  }
}

public class Initialization{
  static void Main(string[] args){
    Console.WriteLine("G.i={0}, G.j={1}",
            G.i, G.j);
    }
```

```
G.i=0, G.j=7
```

Problem: With wrong order of static initializer, it is possible to observe a static field before it is initialized to the chosen value.

Recommended practice: Using static methods to initialize the class variables in proper order.

Quiz 2: Object Initialization and Polymorphism

```
public class Point {
  protected final int x, y;
  private final String name;

  public Point(int x, int y) {
    this.x = x;
    this.y = y;
    // 3. Invoke subclass method
    name = makeName();
  }

  protected String makeName() {
    return "["+x+", "+y+"]";
  }

  public final String toString(){
    return name;
  }
}
```

```
public class ColorPoint extends Point {
  private final String color;

  public ColorPoint(int x,int y, String color){
    // 2. Chain to Point constructor
    super(x, y);
    // 5. Initialize blank final
    // Too late!
    this.color = color;
  }

  protected String makeName() {
    // 4. Execute before subclass
    // constructor body!
    return super.makeName() + ":" + color;
  }

  public static void main(String[] args) {
    // 1. Invoke subclass constructor
    System.out.println(
      new ColorPoint(4, 2, "purple"));
  }
}
```

```
[4,2]:null
```

Quiz 2: Object Initialization and Polymorphism (Cont.)

- Constructor calls a method overridden in its subclass
  - The method runs before the instance has been *fully* initialized

Problem: With calls to overridden methods in a constructor, it is possible to observe the state of an object before it is fully initialized.

- Recommended practice
  - Never call overridable methods from constructors
  - Lazy initialization
    vs.
    eager initialization

```
public class Point {
   protected final int x, y;
   private final String name;
   public Point(int x, int y) {
      this.x = x;
      this.y = y;
      // name = makeName()
   }
   protected String makeName() { ... }
   public String getName(){
      if (name == null) name = makeName;
      return name;
   }
   public final String toString(){
      return getName;
   }
}
```

Questions?

Assignment 2

- See published pdf
- Java implementation due before 11 March
- C# implementation due before 18 March

THE END