M6 (b) - Composition

Jin L.C. Guo

Image source: https://cdn.pixabay.com/photo/2017/11/05/21/21/container-2921882_960_720.jpg

Questions from previous lectures

- Static Keyword during import

  Imports static members from classes, allowing them to be used without class qualification. [REF]

- Can enum have non static and non final filed?

```
public enum Suit
{
   CLUBS, DIAMONDS, SPADES, HEARTS;
   int size = 0;

   void changeSize(int pSize) {
      size = pSize;
   }
   int getSize(){
      return size;
   }
}
```

```
Suit a = Suit.CLUBS;
Suit b = Suit.CLUBS;
System.out.println(a.getSize()); //0
a.changeSize(3);
System.out.println(b.getSize()); //3
```

You can, but need to have a good reason to use it.

Questions from previous lectures

- Is assertEquals comparing reference equality?

In `AssertUtils.class`, this function is called during assertEquals

```
static boolean objectsAreEqual(Object obj1, Object obj2) {
    if (obj1 == null) {
        return obj2 == null;
    } else {
        return obj1.equals(obj2);
    }
}
```

- Are we able to use reflection to modify final field?

If the underlying field is final, the method throws an `IllegalAccessException` unless `setAccessible(true)` has succeeded for this `Field` object and the field is non-static. [REF]

When you have doubt,

Use your debugger and reference the API specification.

Objective

- Design Principle:

Divide and Conquer

- Programming mechanism:

Aggregation and Delegation, Polymorphic Object Cloning

- Design Techniques:

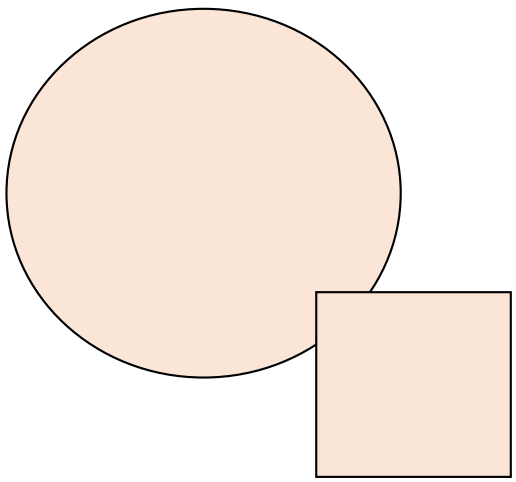
Sequence Diagram

- Patterns and Anti-patterns:

Composite Pattern, Decorator Pattern, Prototype Pattern, God class

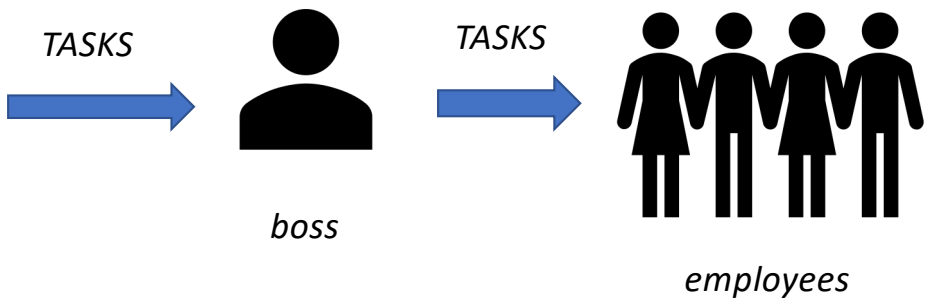
Composition Purpose 1

- Aggregation: Representation of collections



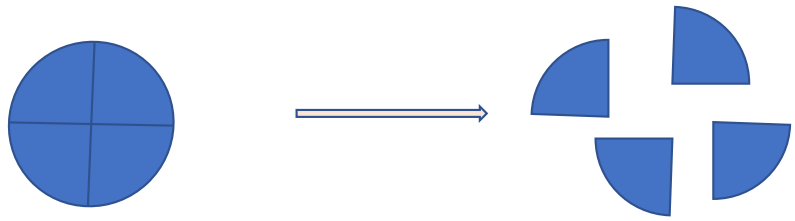
Composition Purpose 2

- Delegation: Redirect duties

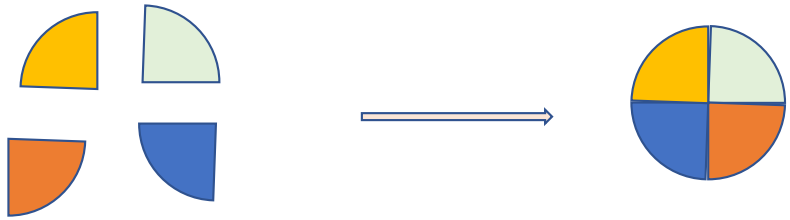


Manage Complexity -- Divide and conquer

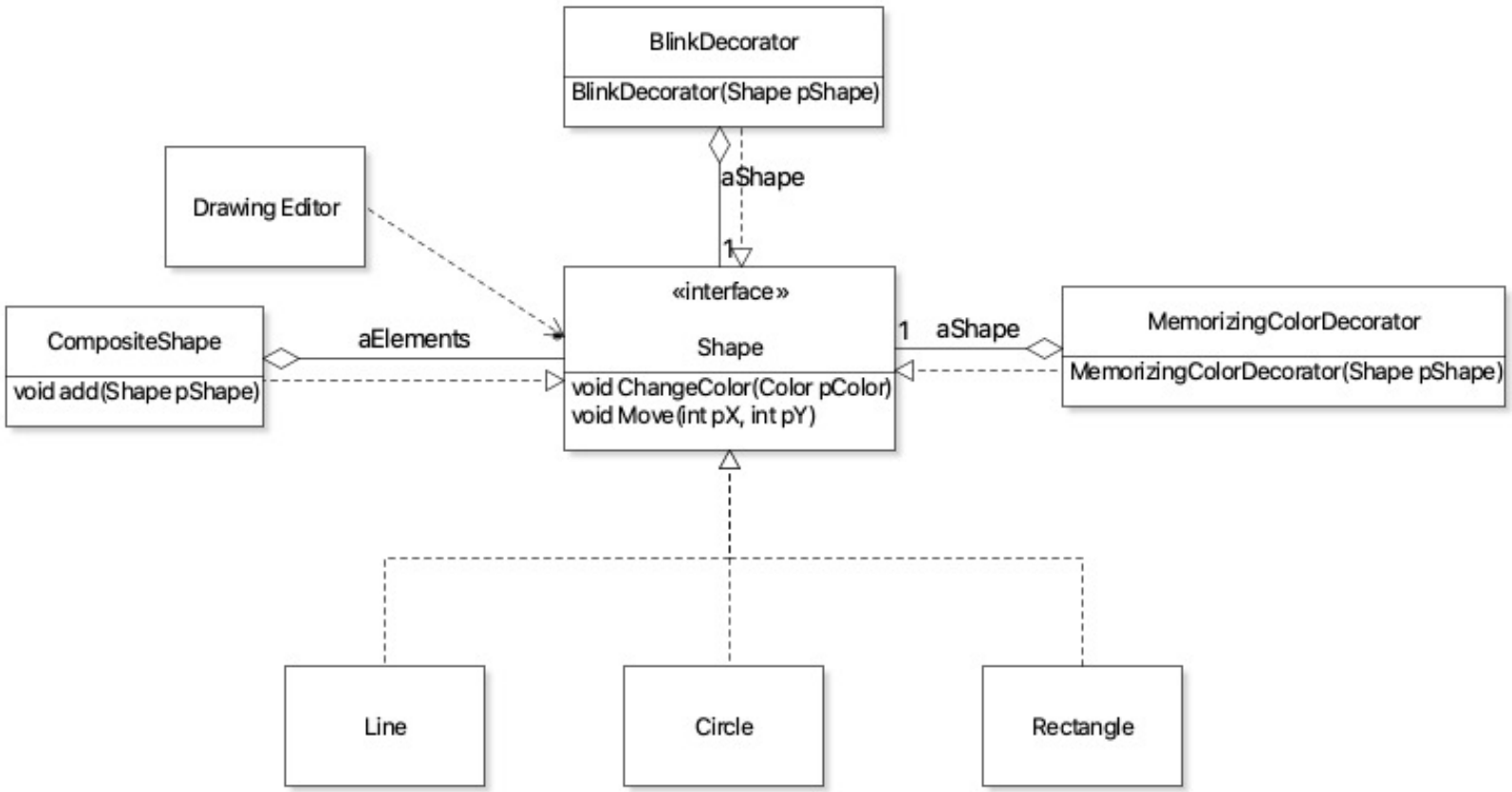
- Modularization
  - Decomposable



  - Composable



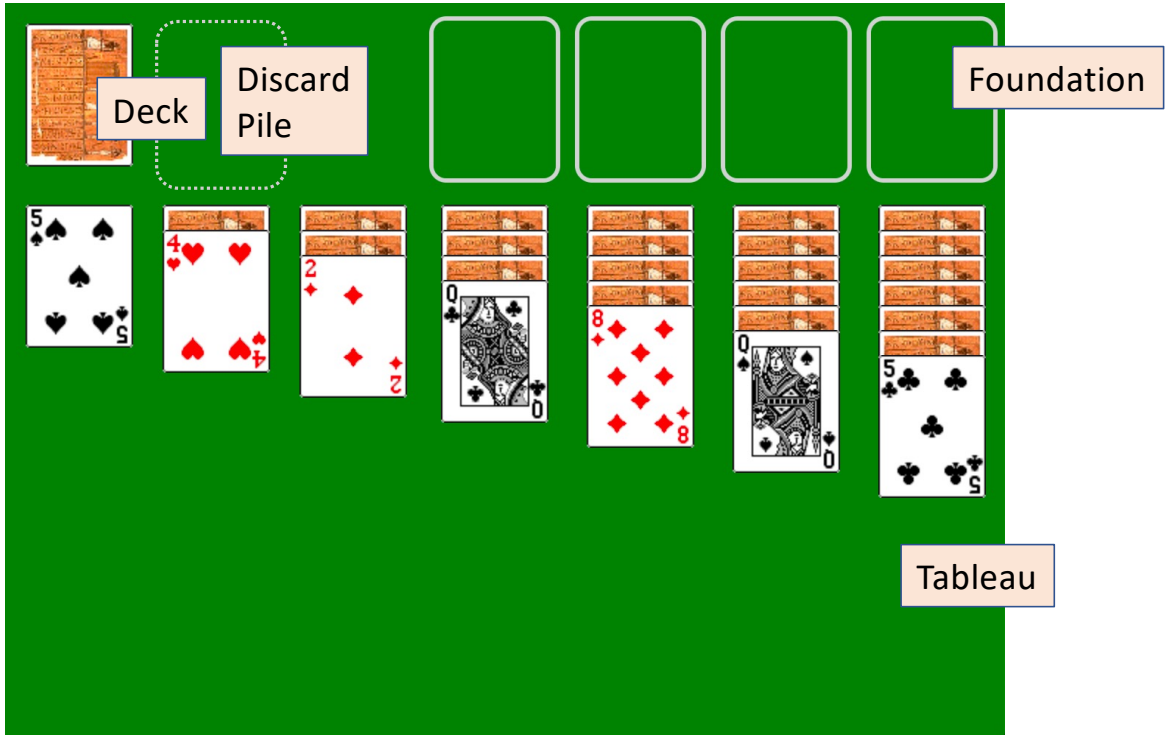
Example: the design of shapes:



Example: GameModel in Solitaire

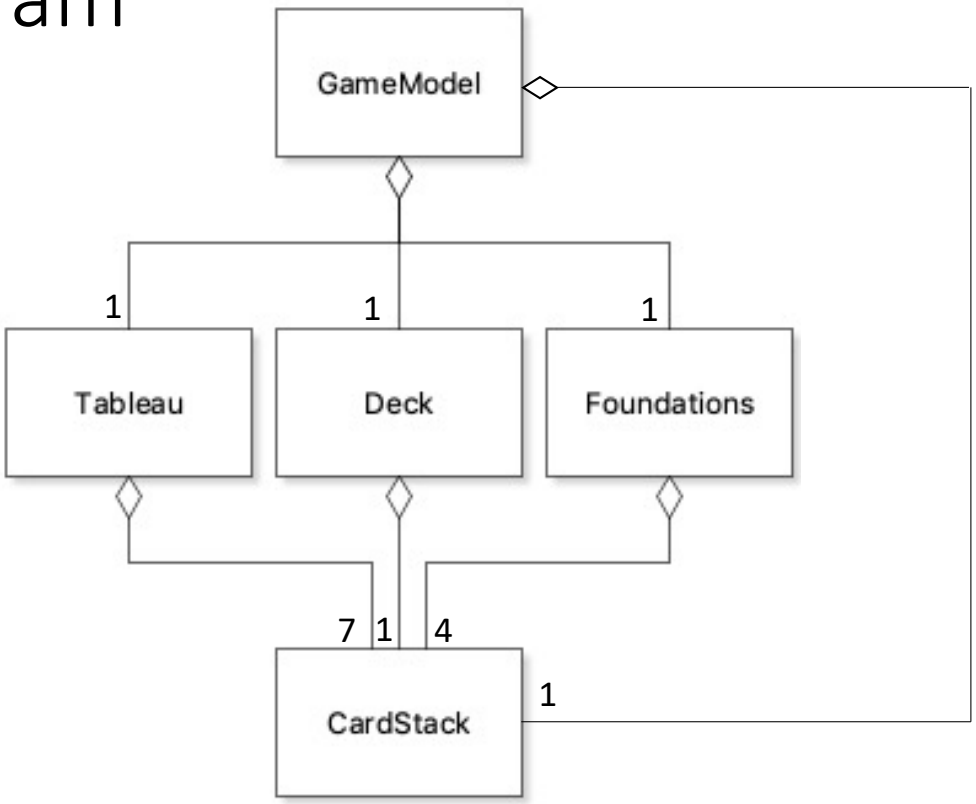
13 piles of cards?

God Class



The elements are the component, and also entities providing services.

Class Diagram



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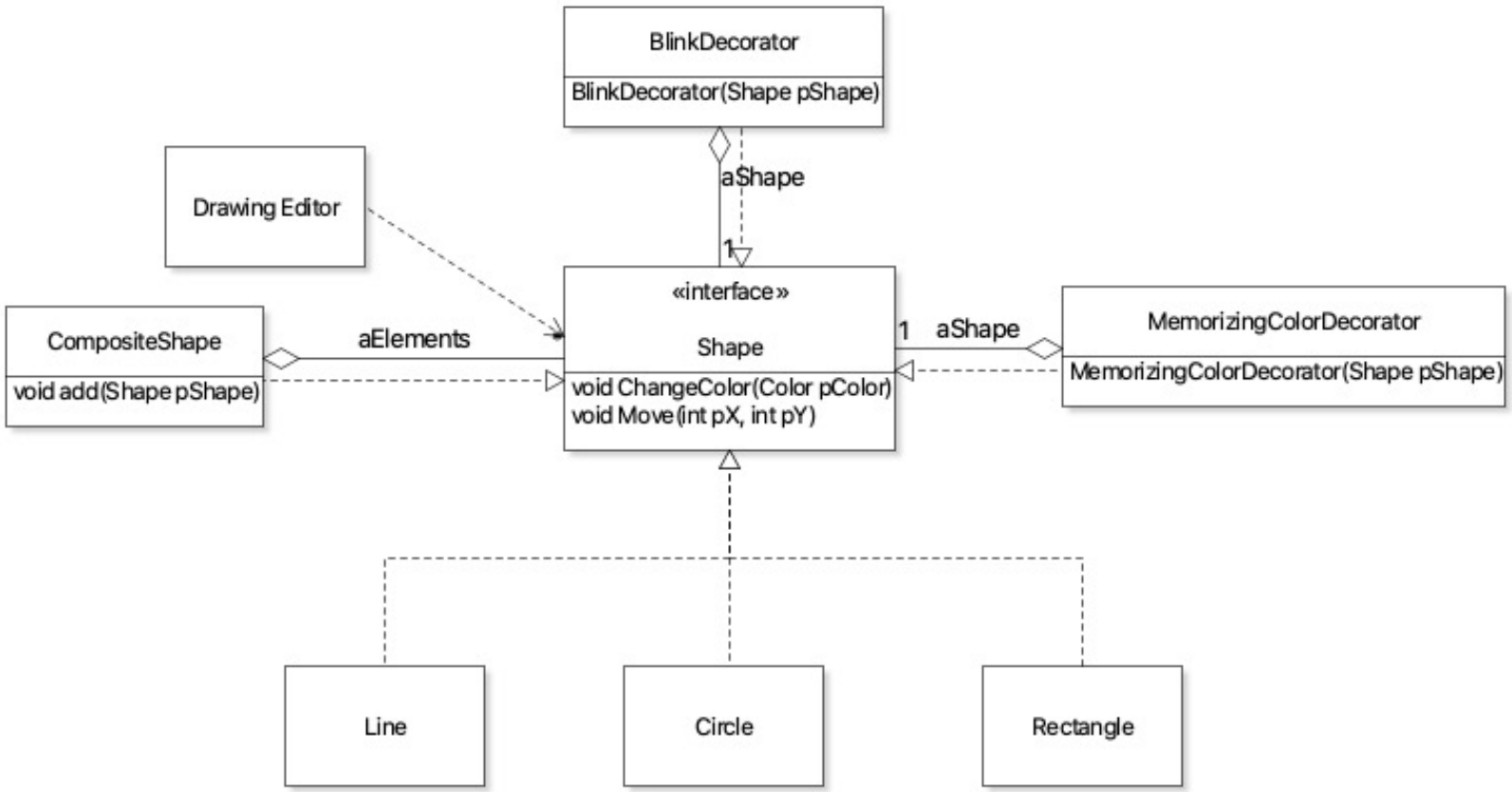
So far, our design of shapes:



```java
/**
 * Aggregate a collection of shapes.
 * The client can get shapes and
 * add new shape on demand
 *
 */
public class ShapeManager
{
    private final List<Shape> aShapes = new ArrayList<>();

    public List<Shape> getShapes()
    {
        // return a copy of aShapes;
    }

    public void addShape(Shape pShape)
    {
        // add a copy of pShape;
    }
}
```

Activity1: How to design the function of making a copy of a Shape object?

Object Copying

- Copy Constructor

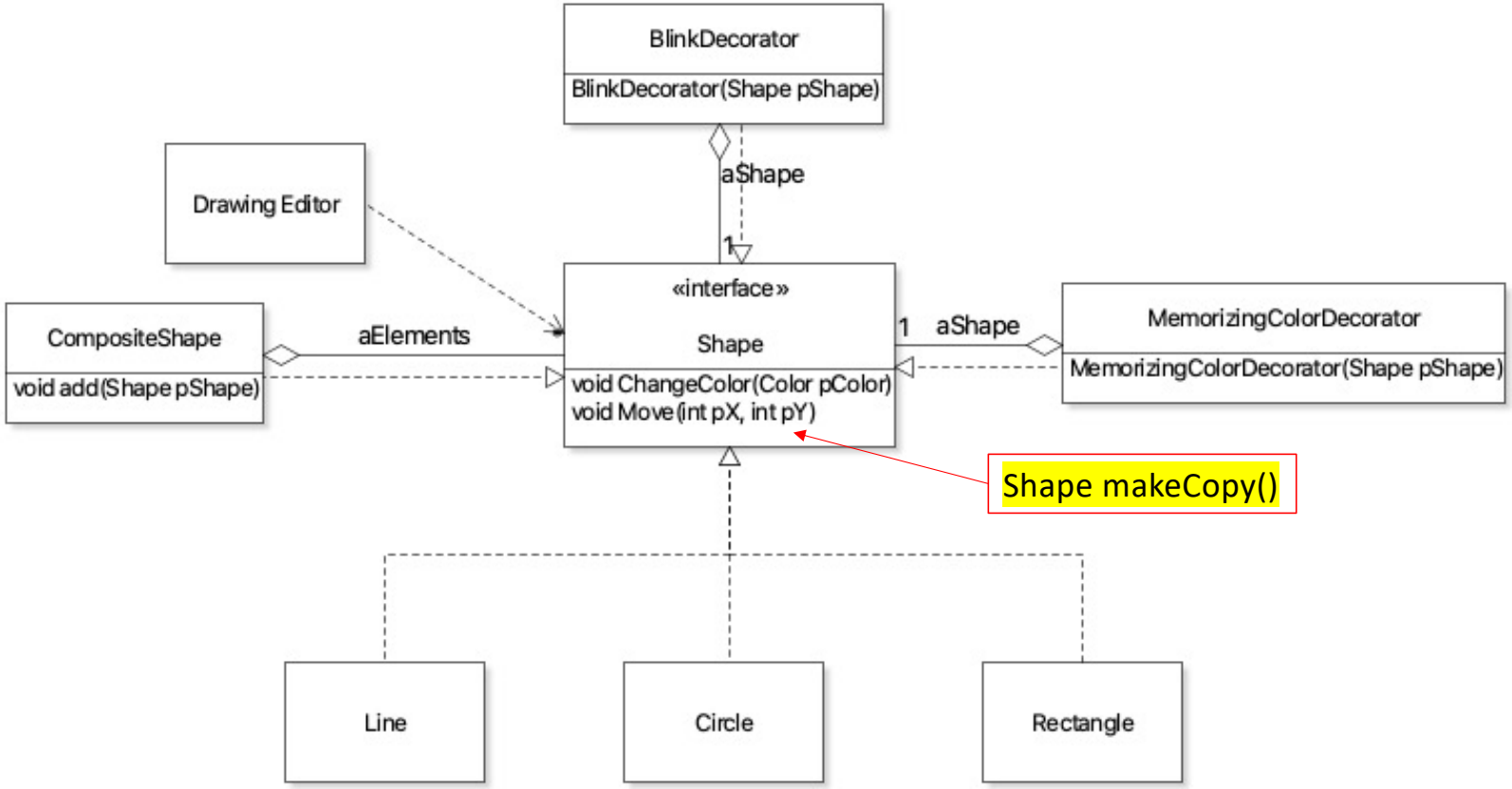
```
public  Line(Line pLine) {
    this.x_start = pLine.x_start;
    this.y_start = pLine.y_start;
    this.x_end = pLine.x_end;
    this.y_end = pLine.y_end;
}
```

- Static factory method

```
public static Line newInstance(Line pLine)
{
    return new Line(pLine);
}
```

```java
public List<Shape> getShapess()
{
    // return a copy of aShapes;
    List<Shape> shapesCopy = new ArrayList<>();
    for(Shape sp:aShapes)
    {
        if (sp instanceof Line)
        {
            shapesCopy.add(new Line(sp));
        }
        else if (sp instanceof Circle)
        {
            shapesCopy.add(new Circle(sp));
        }
        else if (sp instanceof CompositeShape)
        {
            ……
        }
        ……
    }
    return shapesCopy;
}
```

How to achieve polymorphic object copying?


BlinkDecorator
BlinkDecorator(Shape pShape)
aShape
1
Drawing Editor
«interface»
Shape
void ChangeColor(Color pColor)
void Move(int pX, int pY)
CompositeShape
void add(Shape pShape)
aElements
1
aShape
MemorizingColorDecorator
MemorizingColorDecorator(Shape pShape)
Shape makeCopy()
Line
Circle
Rectangle

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    // return a copy of aShapes;
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    for(Shape sp:aShapes)
    {
        if (sp instanceof Line)
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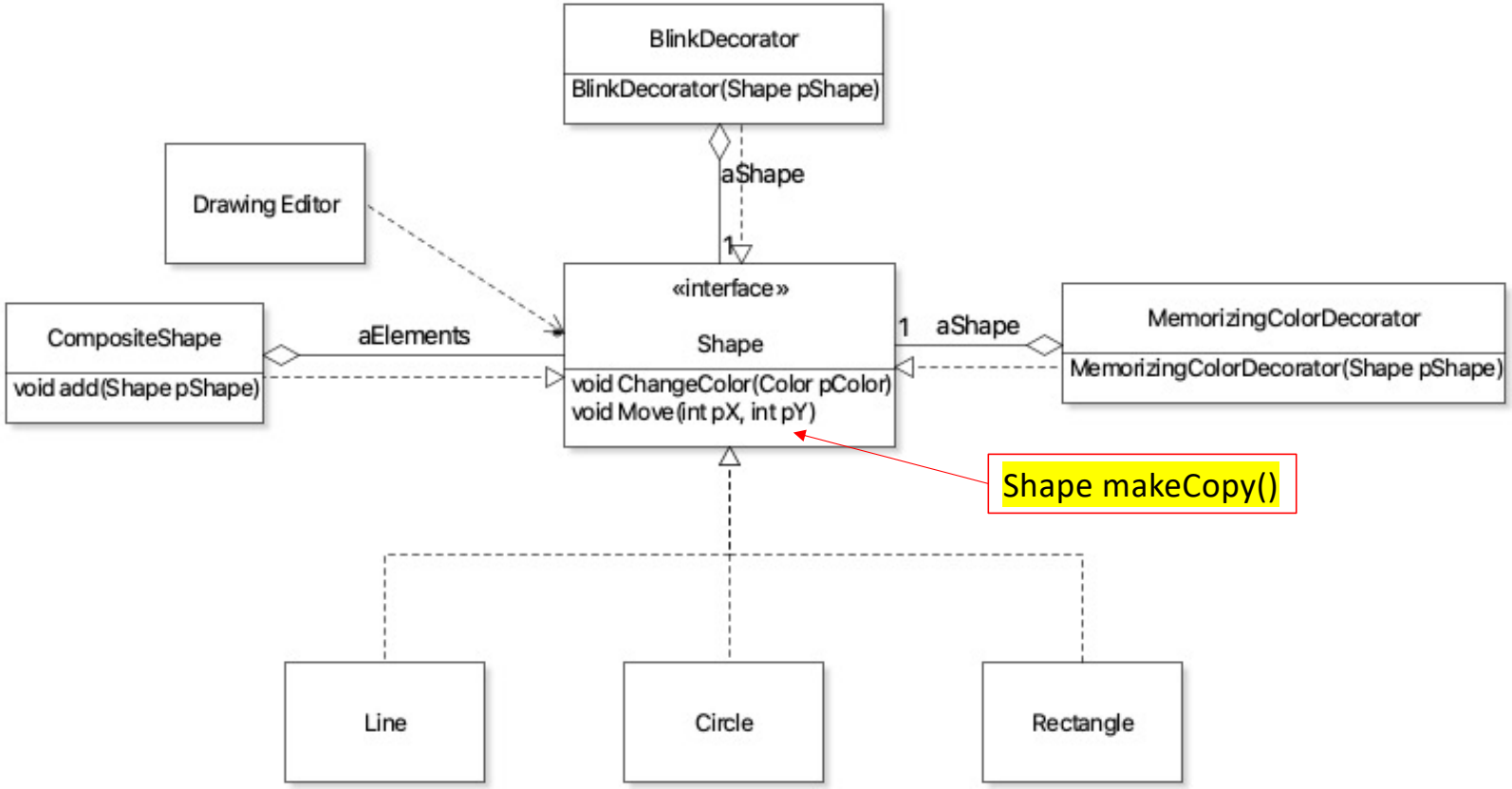
            shapesCopy.add(new Line(sp));
        }
        else if (sp instanceof Circle)
        {
            shapesCopy.add(new Circle(sp));
        }
        else if (sp instanceof CompositeShape)
        {
            ……
        }
        ……
    }
    return shapesCopy;
}
```

```java
public List<Shape> getShapess()
{
    // return a copy of aShapes;
    List<Shape> shapesCopy = new ArrayList<>();
    for(Shape sp:aShapes)
    {

        shapesCopy.add(sp.makeCopy());

    }
    return shapesCopy;
}
```

```java
/**
 * Aggregate a collection of shapes.
 * The client can get shapes and
 * add new shape on demand
 *
 */
public class ShapeManager
{
    private final List<Shape> aShapes = new ArrayList<>();

    public List<Shape> getShapes()
    {
        // return a copy of aShapes;
    }

    public void addShape(Shape pShape)
    {
        aShapes.add(pShape.makeCopy());
    }
}
```

```java
public class Line implements Shape
{
    …


    @Override
    public Line makeCopy()
    {
        return new Line(this);
    }

}
```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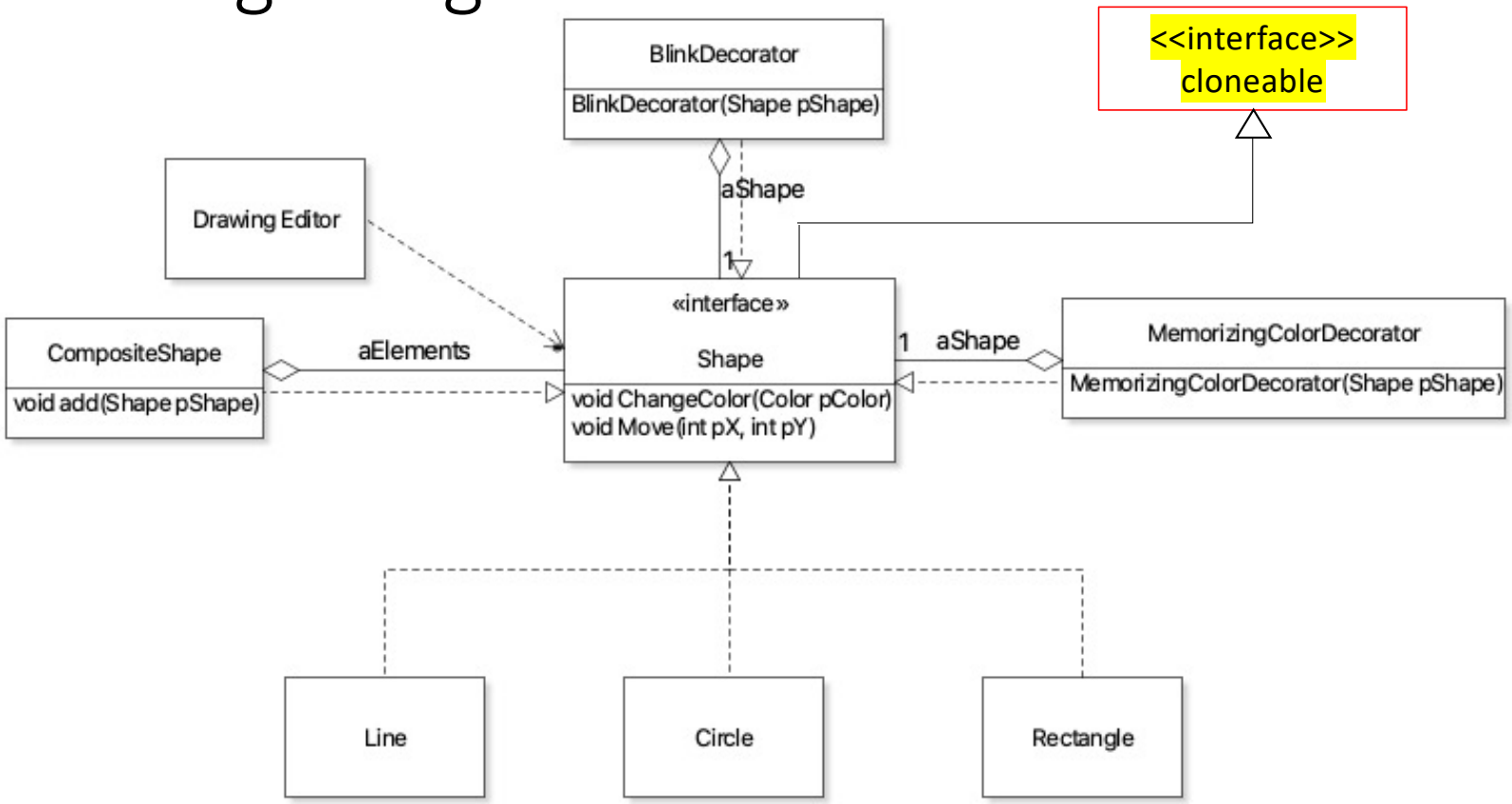
Achieving using Java API



Implements Cloneable

“Tough the specification doesn’t say it, in practice, a class implementing Cloneable is expected to provide a properly Functioning public clone Method.

In order to achieve this, the class and all of its super classes must obey a complex, unenforceable, thinly documented protocol. The resulting mechanism is fragile, dangerous, and extralinguistic: it creates object without calling a constructor.”

Effective Java by Joshua Bloch, 3rd ed., 2018.

Implements Cloneable

- java.lang.Cloneable

this interface does *not* contain the clone method.

implement this interface should override Object.clone with a public method.

A class implements the Cloneable interface to indicate to the Object.clone() method that it is legal for that method to make a field-for-field copy of instances of that class.

Invoking Object's clone method on an instance that does not implement the Cloneable interface results in the exception CloneNotSupportedException being thrown.

Override Object.clone()

protected Object clone()
throws CloneNotSupportedException

Creates and returns a copy of this object.

```
x.clone() != x

x.clone().getClass() == x.getClass()

x.clone().equals(x)
```

object should be obtained by calling super.clone

the object returned by this method should be independent of this object

```java
public class CompositeShape implements Shape
{
    private List<Shape> aElements = new ArrayList<>();

    @Override
    public CompositeShape clone()
    {
        try
        {
            CompositeShape clone = (CompositeShape) super.clone();
            clone.aElements = new ArrayList< Shape>();
            for (Shape sp:aElements)
            {
                clone.aElements.add(sp.clone());
            }
            return clone;
        }
        catch (CloneNotSupportedException e)
        {
            assert false;
            return null;
        }
    }
}
```

Making a shallow copy

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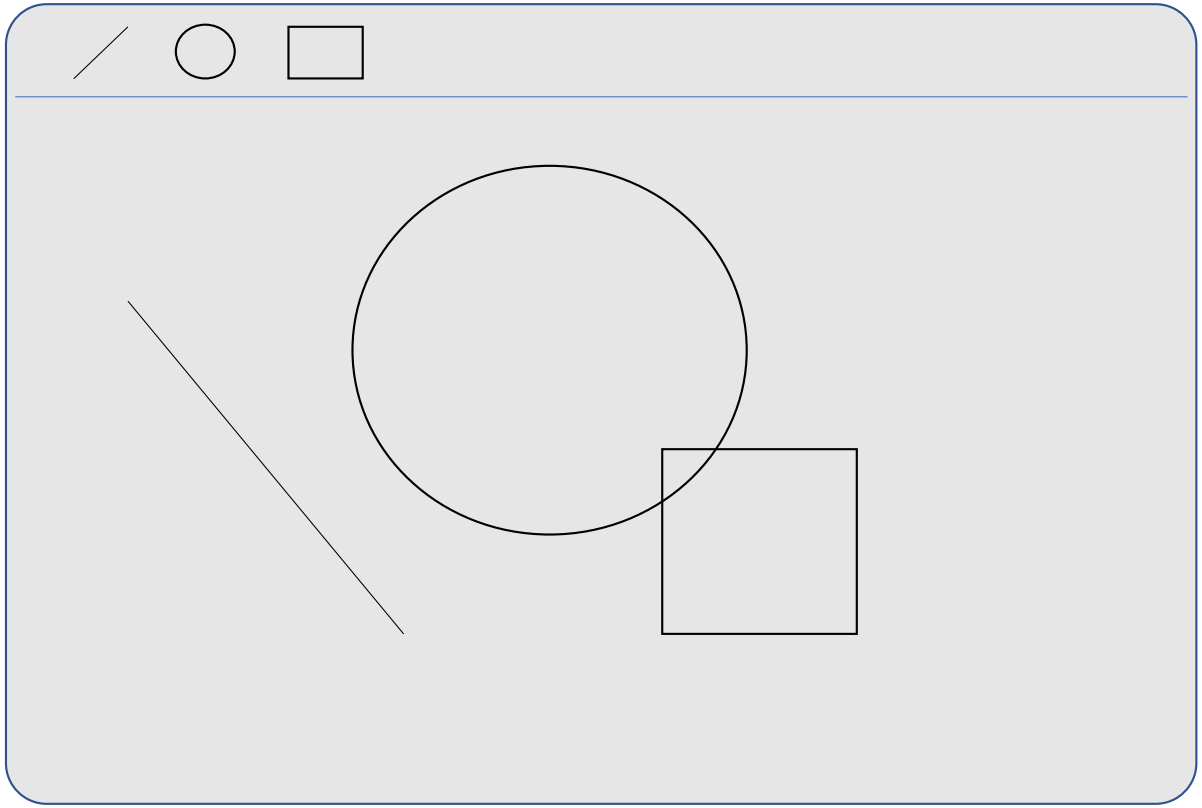
Design Problem

Allow the user to add shortcut to create predefined (any) shape, e.g., a red circle on top of a green rectangle what blinks twice.



```java
/**
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 * add new shape on demand
 *
 */
public class ShapeManager
{
    private final List<Shape> aShapes = new ArrayList<>();
                                        private Shape aPrototype;

    public List<Shape> getShapes()
    {
        // return a copy of aShapes;
    }

    public void addShape(Shape pShape)
    {
        // add a copy of pShape;
    }
}
```

```java
/**
 * Aggregate a collection of shapes.
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 */
public class ShapeManager
{
    private final List<Shape> aShapes = new ArrayList<>();
                                        private Shape aPrototype;

    public List<Shape> getShapes()
    {
        // return a copy of aShapes;
    }

    public void setProptypeShape(Shape pShape)
    {
        aPrototype = pShape.clone();
    }
}    public void addShape()
     {
         aShapes.add(aPrototype.clone());
     }
```

Prototype

- Intent
  - Specify the kinds of objects to create using a prototypical instance, and create new objects by copying this prototype.
- Participants
  - Prototype

    declares an interface for cloning itself.

  - Product (Concrete Prototype)

    implements an operation for cloning itself.

  - Client

    creates a new object by asking a prototype to clone itself.

Activity 2: Consider what are the benefits and drawbacks of using Prototype Pattern?

Potential benefit:

- Concrete objects (e.g., objects of Line, Circle, Composite Shape, etc.) is going be hidden form the clients, so that it reduces the Classes the clients need to know about;
- You have the flexibility of adding or removing classes without affecting the client's code;
- The client can build complex object by updating fields of porotype.

Potential drawback:

- You need to override the clone method for all the subclasses of the porotype which might not be easy to achieve.