CISC 322

Software Architecture

Lecture 14:

Design Patterns

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Material drawn from [Gamma95, Coplien95]

Slides adapted from Spiros Mancoridis and Ahmed E. Hassan

Motivation

- Good designers know not to solve every problem from first principles. They reuse solutions.
- Practitioners do not do a good job of recording experience in software design for others to use.

What is a Design Pattern

- A **Design Pattern** systematically names, explains, and evaluates an important and recurring design.
- “descriptions of communicating objects and classes that are customized to solve a general problem in a particular context”

Classifying Design Patterns

- **Structural**: concern the process of **assembling** objects and classes

- **Behavioral**: concern the **interaction** between classes or objects

- **Creational**: concern the process of object **creation**

Design Patterns Covered

- **Structural**
  - Adapter
  - Façade
  - Composite
- **Behavioral**
  - Iterator
  - Template
  - Observer
  - Master-Slave
- **Creational**
  - Abstract Factory

For Each Pattern ….

- **Motivation** – the problem we want to solve using the design pattern
- **Intent** – the intended solution the design pattern proposes
- **Structure** – How the design pattern is implemented
- **Participants** – the components of the design pattern

Terminology

- **Objects** package both data and the procedures that operate on that data.
- Procedures are typically called **methods** or **operations**.
- An object performs an operation when it receives a **request** (or **message**) from a **client.**

Terminology

- An object’s implementation is defined by its **class**. The class specifies
  - Object’s internal data and representation
  - Operations that object can perform

- An **abstract class** is one whose main purpose is to define a common interface for its subclass

Terminology

- The set of signatures defined by an object’s operations or methods is called the **interface**

Adapter Pattern - Intent

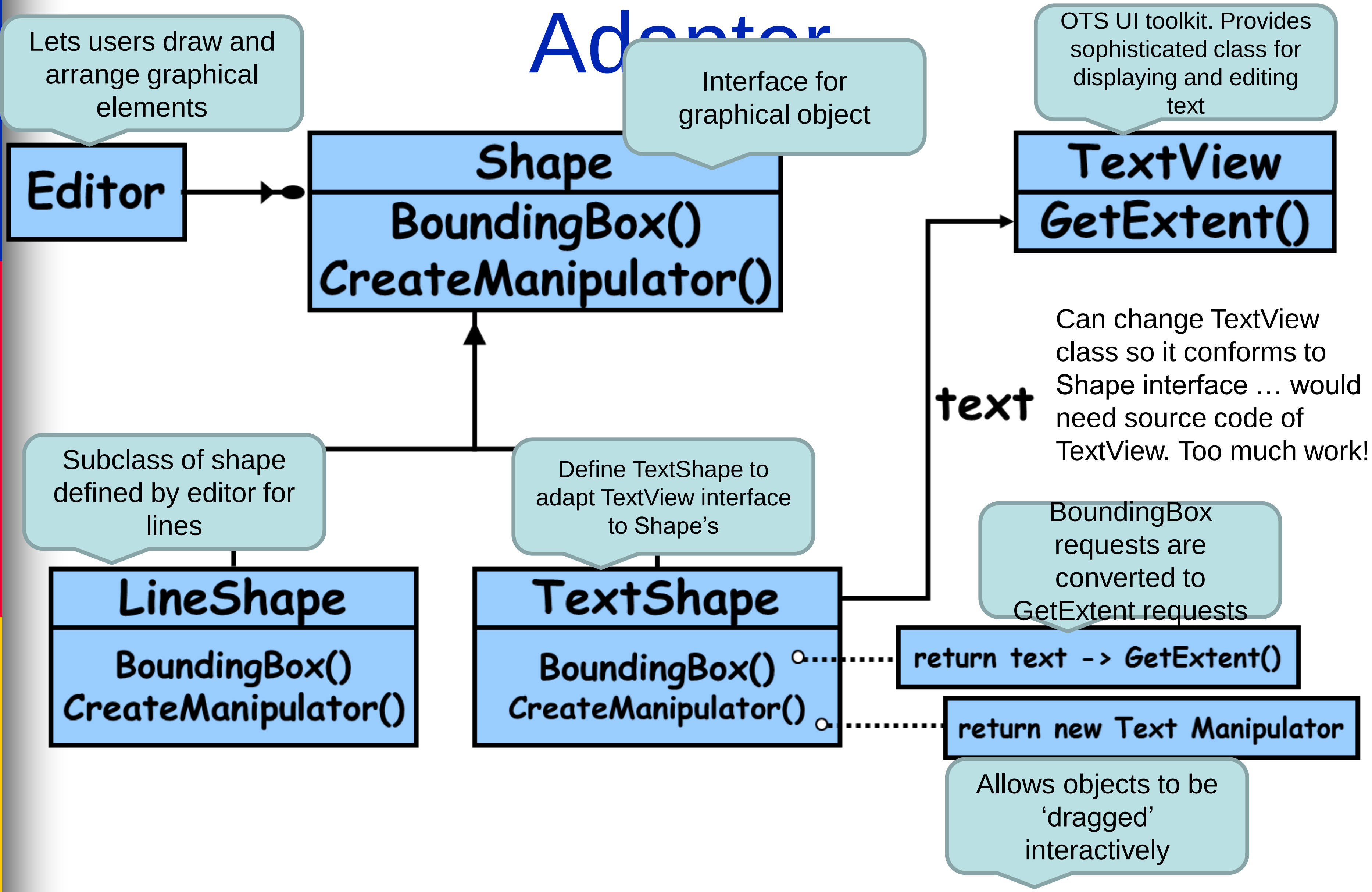
- Convert the interface of a class into another interface clients expect.

- Adapter lets classes work together that otherwise couldn’t because of incompatible interfaces

Adapter Pattern - Motivation

- When we want to reuse classes in an application that expects classes with a different interface, we do not want (and often cannot) to change the reusable classes to suit our application

Adapter



Lets users draw and arrange graphical elements

Interface for graphical object

OTS UI toolkit. Provides sophisticated class for displaying and editing text

Editor

Shape
BoundingBox()
CreateManipulator()

TextView
GetExtent()

text

Can change TextView class so it conforms to Shape interface … would need source code of TextView. Too much work!

Subclass of shape defined by editor for lines

Define TextShape to adapt TextView interface to Shape’s

BoundingBox requests are converted to GetExtent requests

LineShape
BoundingBox()
CreateManipulator()

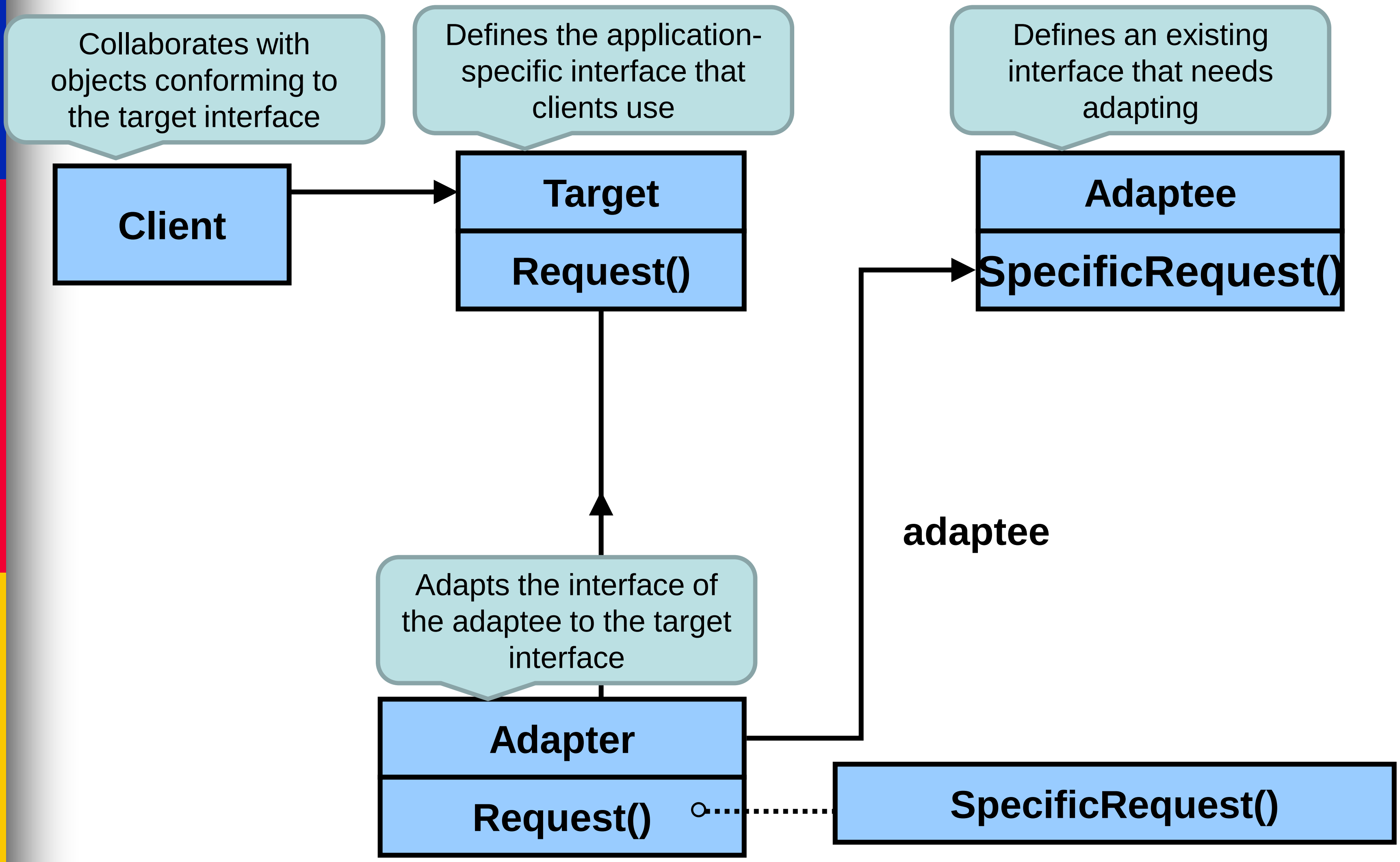
TextShape
BoundingBox()
CreateManipulator()

return text -> GetExtent()

return new Text Manipulator

Allows objects to be ‘dragged’ interactively

Adapter Pattern Structure



Collaborates with objects conforming to the target interface

Defines the application-specific interface that clients use

Defines an existing interface that needs adapting

Adapts the interface of the adaptee to the target interface

Façade Pattern Intent

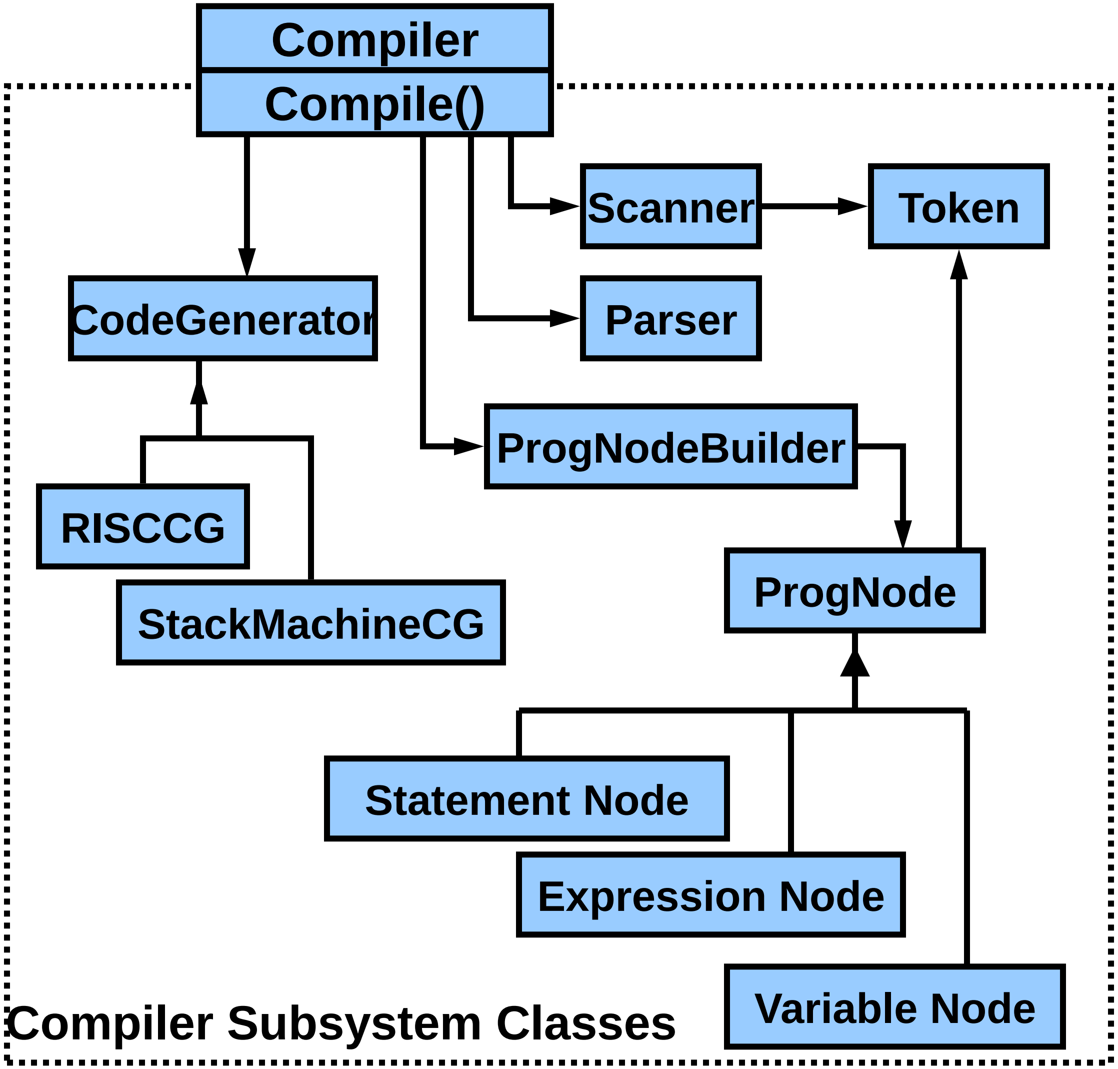
- Provide a unified interface to a set of interfaces in a subsystem.
- Facade defines a higher-level interface that makes the subsystem easier to use.

Façade Pattern Motivation

- Structuring a system into subsystems helps reduce complexity.
- A common design goal is to minimize the communication and dependencies between subsystems.
- Use a facade object to provide a single, simplified interface to the more general facilities of a subsystem.

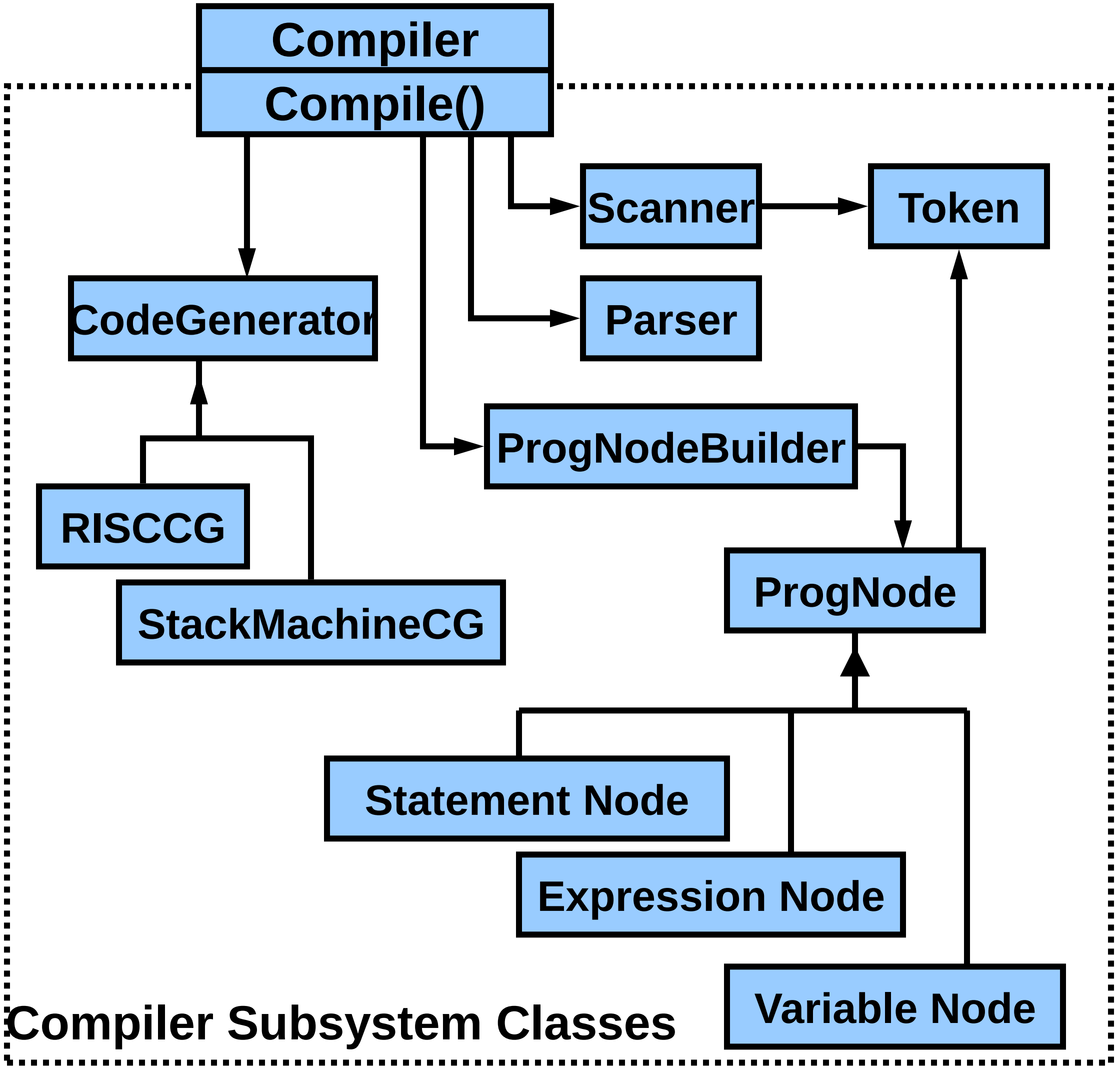
Façade Example – Programming Environment

- Programming environment that provides access to its compiler
- Contains many classes (e.g. scanner, parser)
- Most clients don’t care about details like parsing and code generation…just compile my code!
- The low-level interfaces just complicate their task

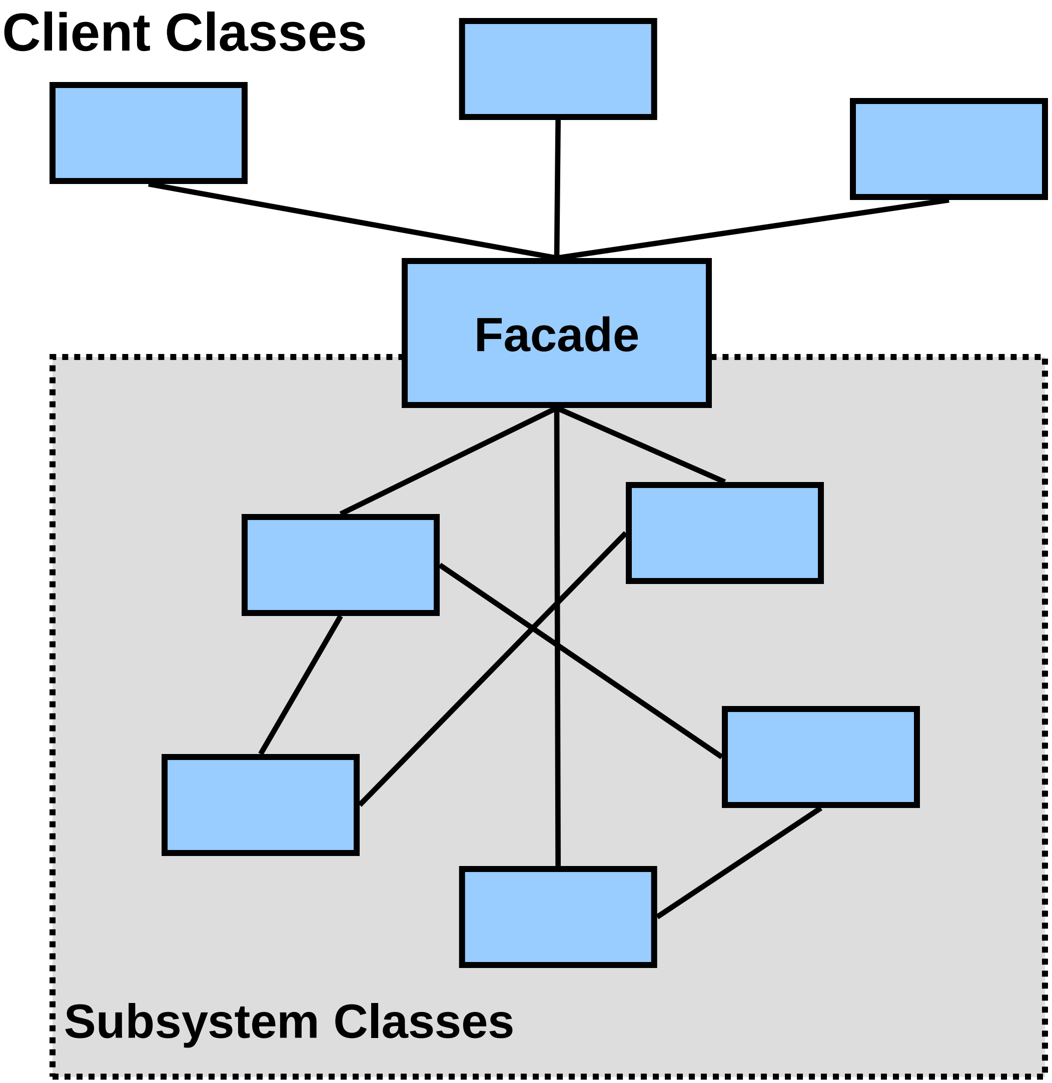


Façade Example – Programming Environment

- Higher-level interface (i.e., Compiler class) shields clients from low level classes
- Compiler class defines a unified interface to the compiler's functionality
- Compiler class acts as a Façade. It offers clients a simple interface to the compiler subsystem



Façade Pattern Structure



Participants of Façade Pattern

- Façade (compiler)
  - Knows which subsystem classes are responsible for a request
  - Delegates client requests to appropriate subsystem objects
- Subsystem classes (Scanner, Parser,etc..)
  - Implements subsystem functionality
  - Handles work assigned by the façade object

Façade Pattern Applicability

- Use a façade when
  - To provide a simple interface to a complex subsystem
  - To decouple clients and implementation classes
  - To define an entry point to a layered subsystem

Façade Pattern Collaborations

- Clients communicate with the subsystem by sending requests to façade, which then forwards requests to the appropriate subsystems
- Clients that use the façade don’t have access to its subsystem objects directly. However, clients can access subsystem classes if they need to

Composite Pattern Intent

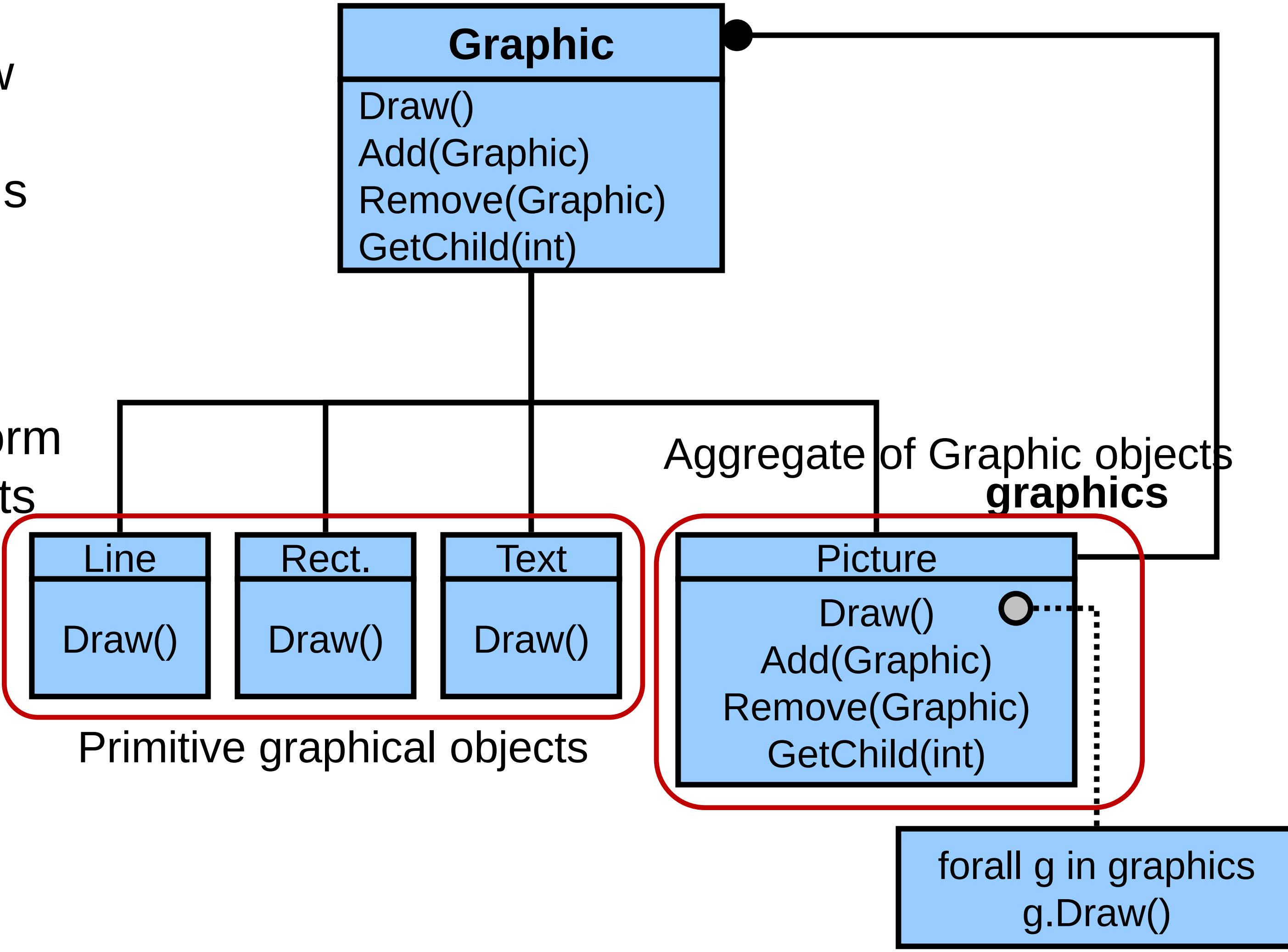
- Lets clients treat individual objects and compositions of objects uniformly

Composite Pattern Motivation

- If the composite pattern is not used, client code must treat primitive and container classes differently, making the application more complex than necessary

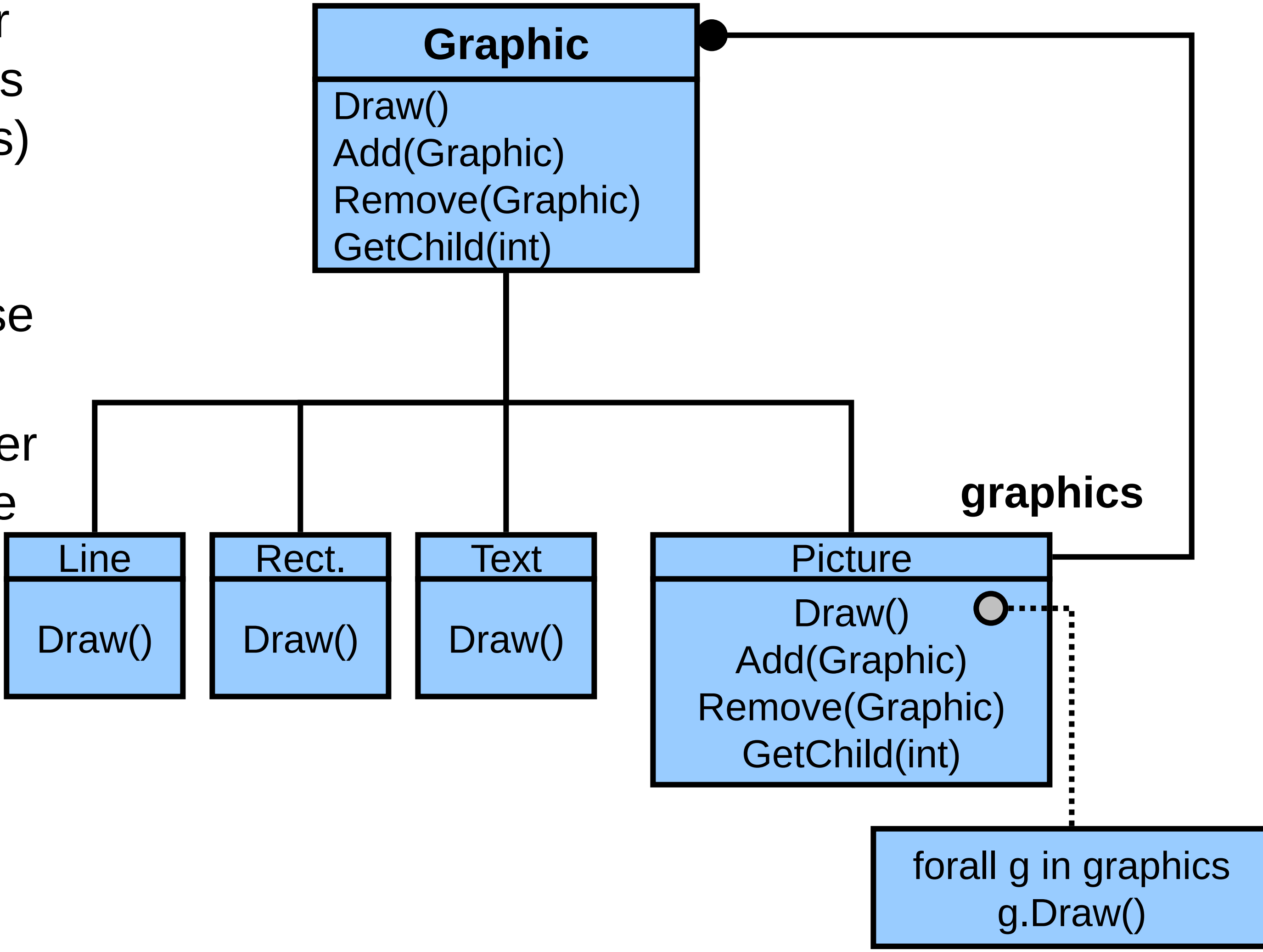
Composite Pattern Example

- Graphic applications allow users to build complex diagrams out of simple components
- Users group components to form larger components



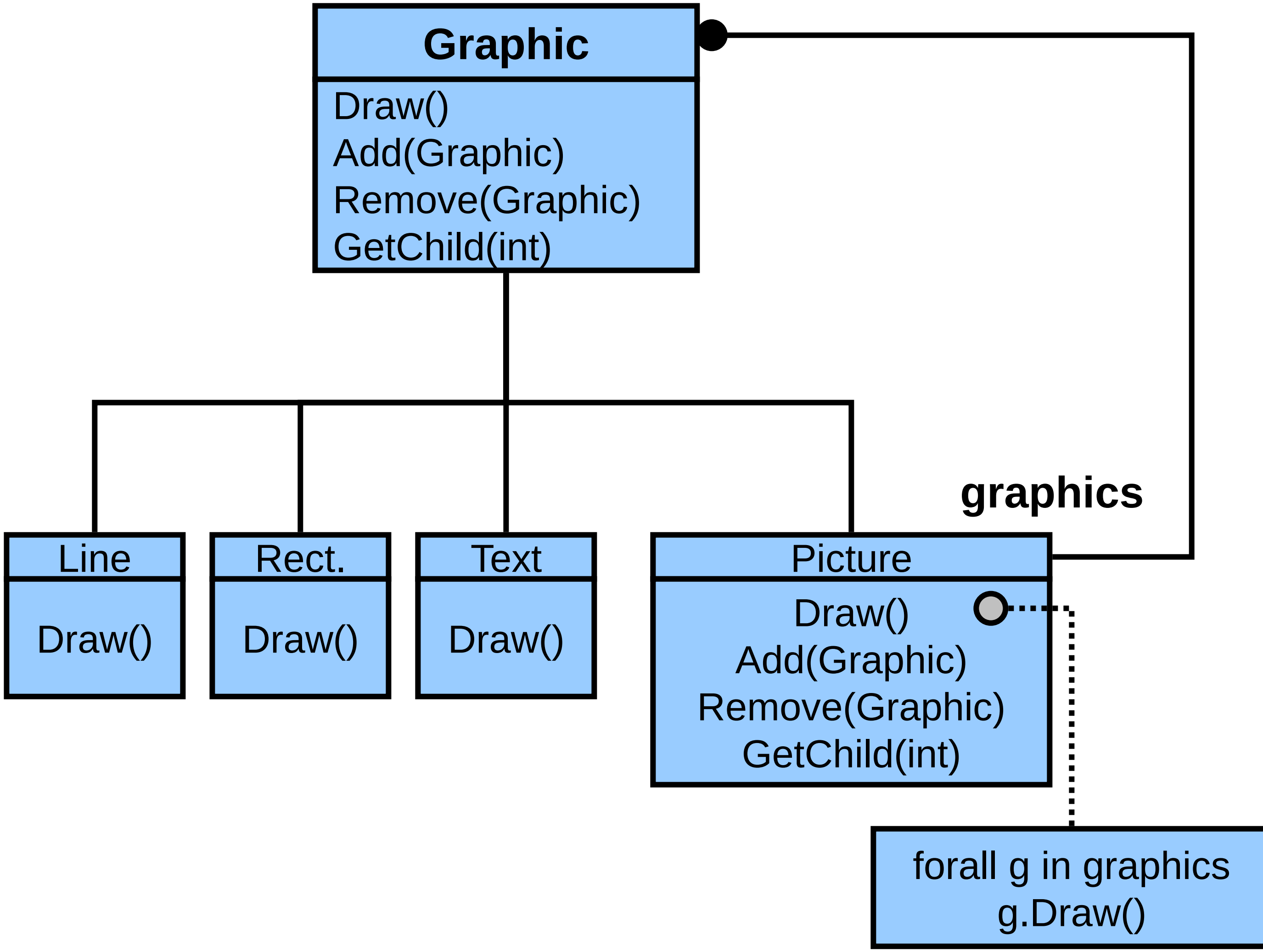
Composite Pattern Example

- A simple implementation defines classes for graphical primitives (e.g. Text and lines) plus other classes that act as containers for these primitives
- The problem is user must treat primitive and container objects differently
- Having to distinguish these objects makes applications more complex

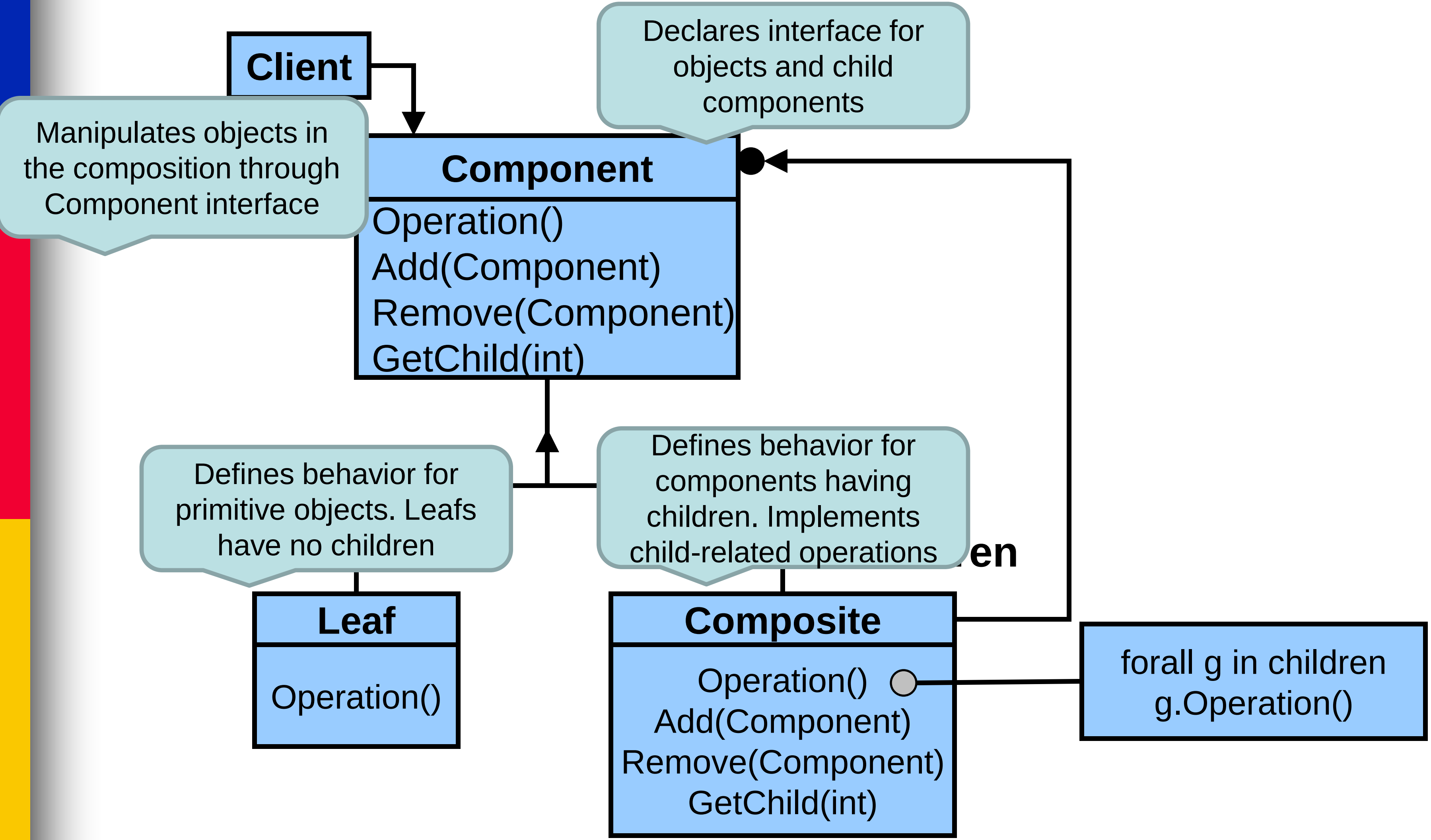


Composite Pattern Example

- Key is an abstract class that represents both primitives and their containers
- Graphic declares operations such as draw that are specific to graphical objects
- Also operations for accessing and managing children



Structure of Composite Pattern



Manipulates objects in the composition through Component interface

Declares interface for objects and child components

Defines behavior for primitive objects. Leafs have no children

Defines behavior for components having children. Implements child-related operations

forall g in children
g.Operation()