CIT 103 & CIT 104

Object Oriented Programming

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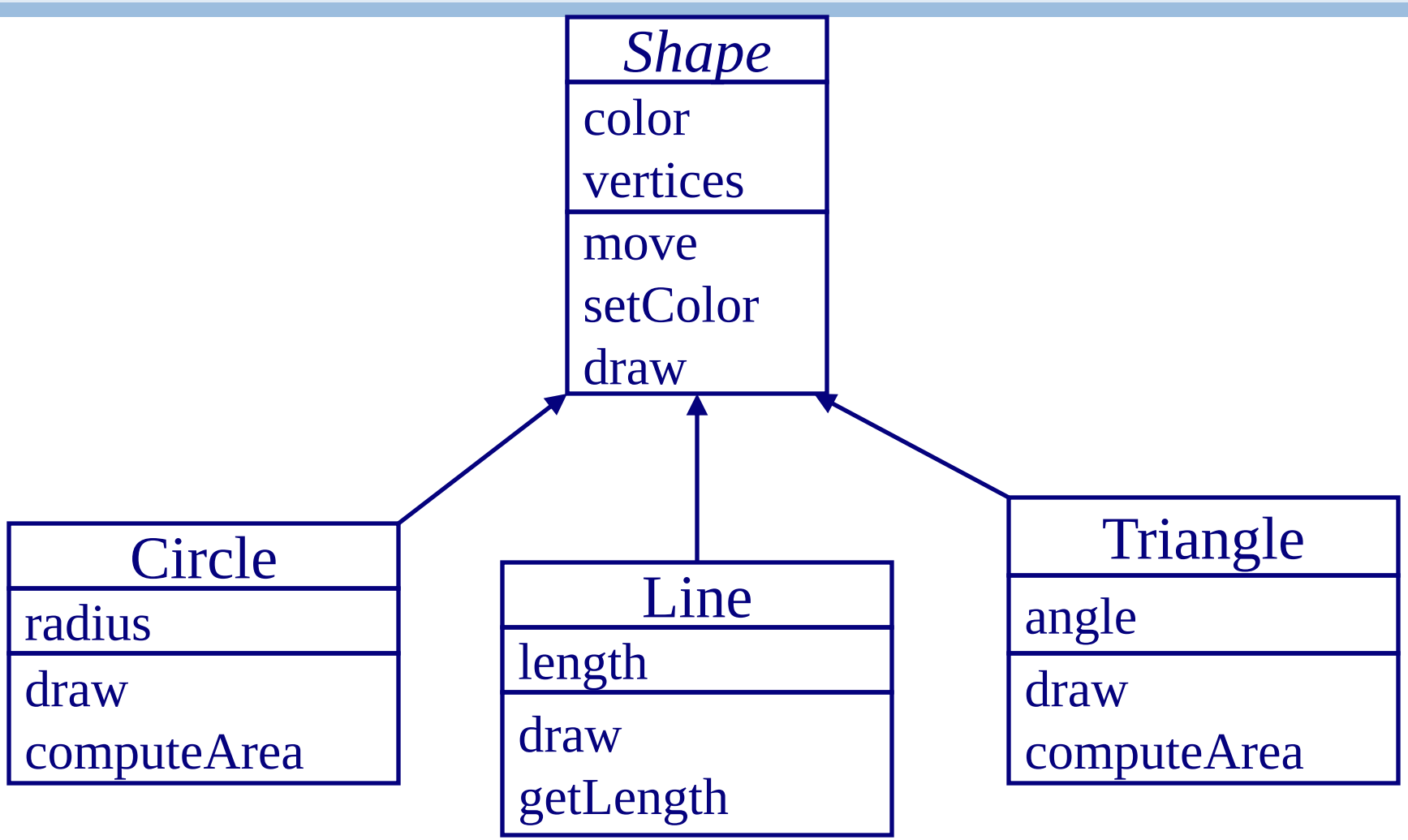
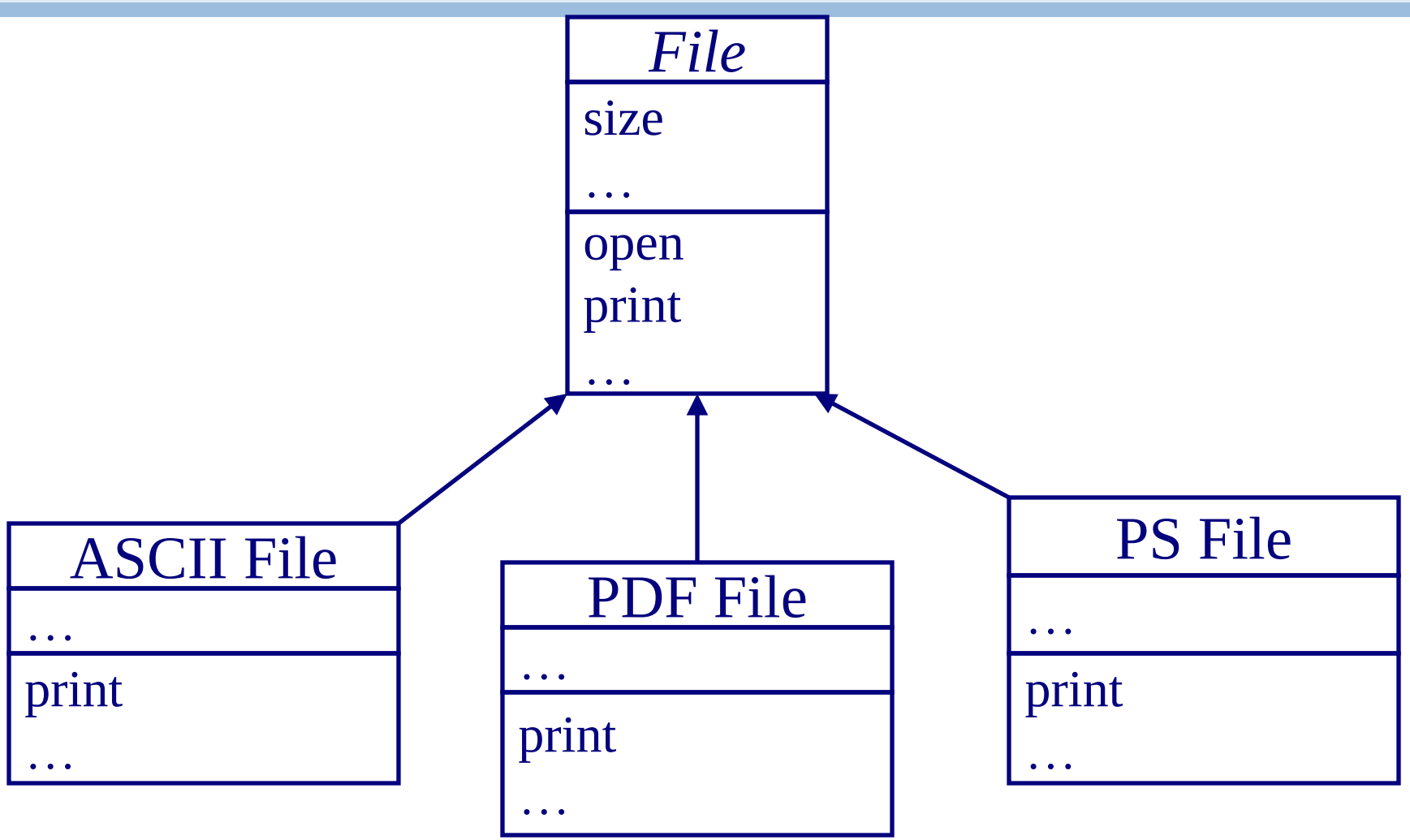
Class Compatibility

- A class is behaviorally **compatible with another** if it supports all the operations of the other class
- Such a class is called **subtype**
- A class can be replaced by its **subtype**
- **Derived class** is usually a **subtype** of the **base class**
- It can handle all the **legal messages** (operations) of the **base class**
- Therefore, **base class** can always be **replaced** by the **derived class**

Example – Class Compatibility



Example – Class Compatibility



Polymorphism

- In general, polymorphism refers to **existence of different forms of a single entity**
- For example, both **Diamond** and **Coal** are different forms of **Carbon**

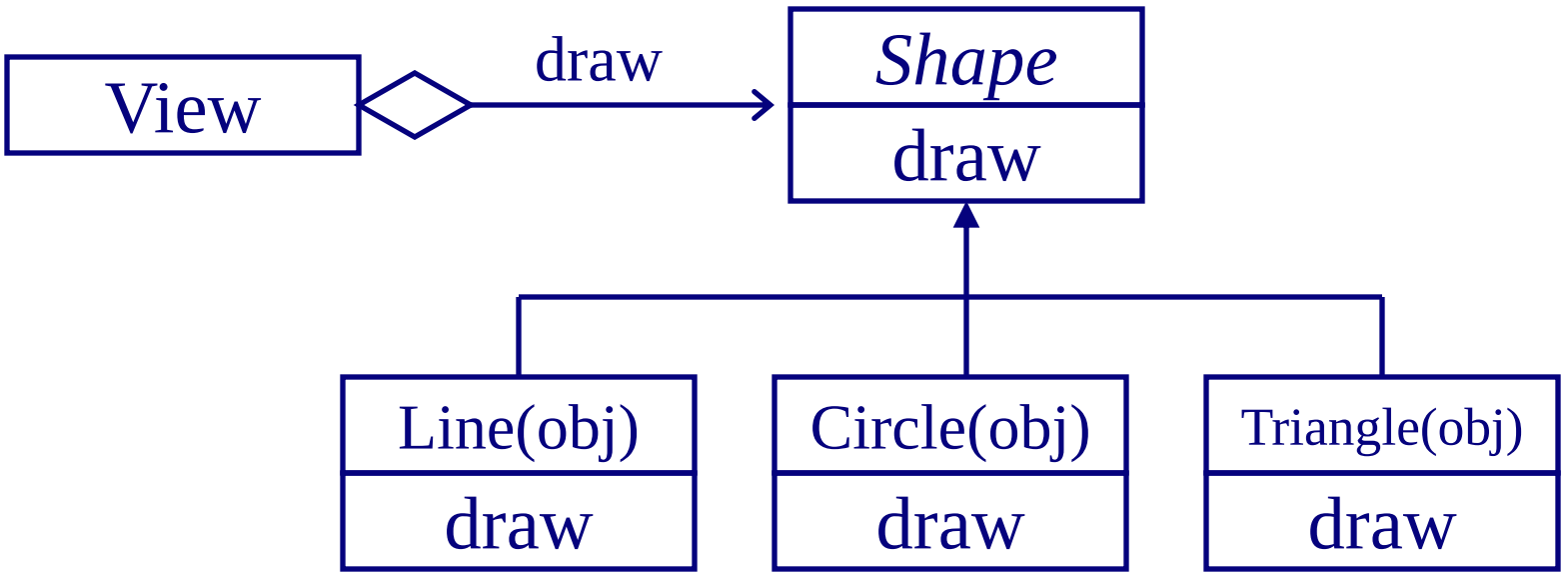
Polymorphism in OO Model

- In OO model, polymorphism means that **different objects** can behave in **different ways** for the **same message** (stimulus)
- Consequently, sender of a message does not need to know exact class of the receiver
- Also termed as **Overloading**

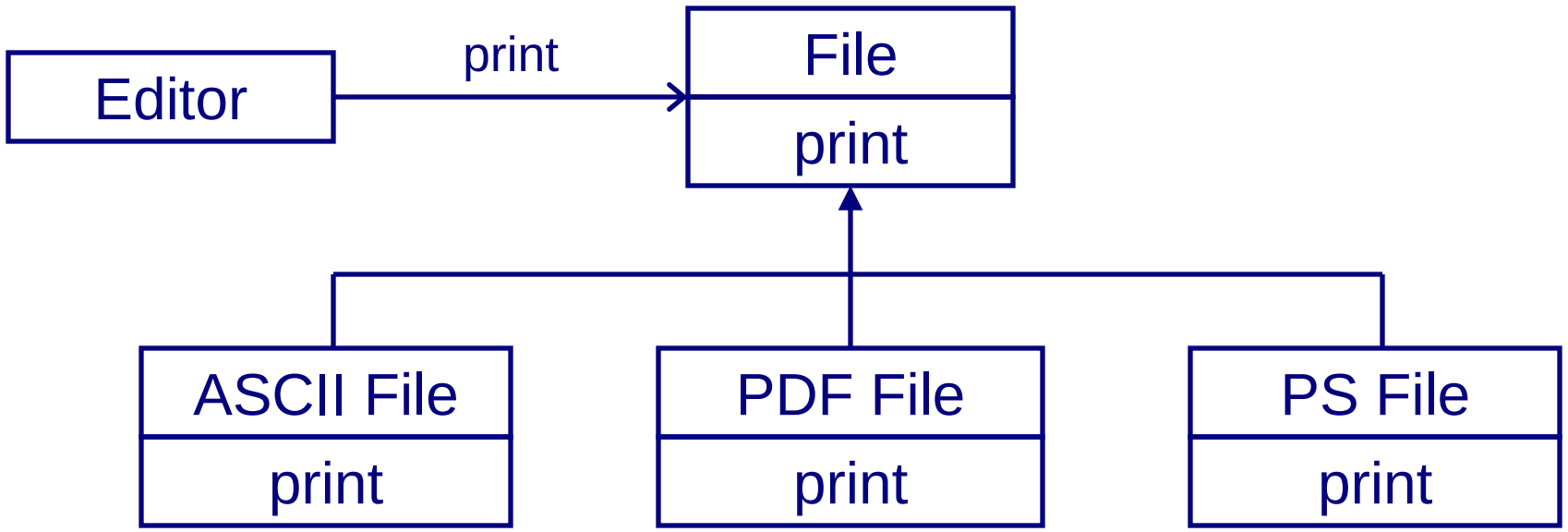
Polymorphism in OO Model

- **Two Types:**
- **Operator overloading**
  - An **operation** may exhibit **different behaviors** in **different instances**
  - The **behavior depends** upon the **types of data used** in the operation
  - For example, consider the operation of **addition**. For **two numbers**, the operation will generate a **sum**. If the operands are strings, the operation would produce a third string by **concatenation**
- **Function overloading**
  - Using a single **function name** to perform **different types of tasks** depending on the **different number and different types of arguments**

Example – Polymorphism

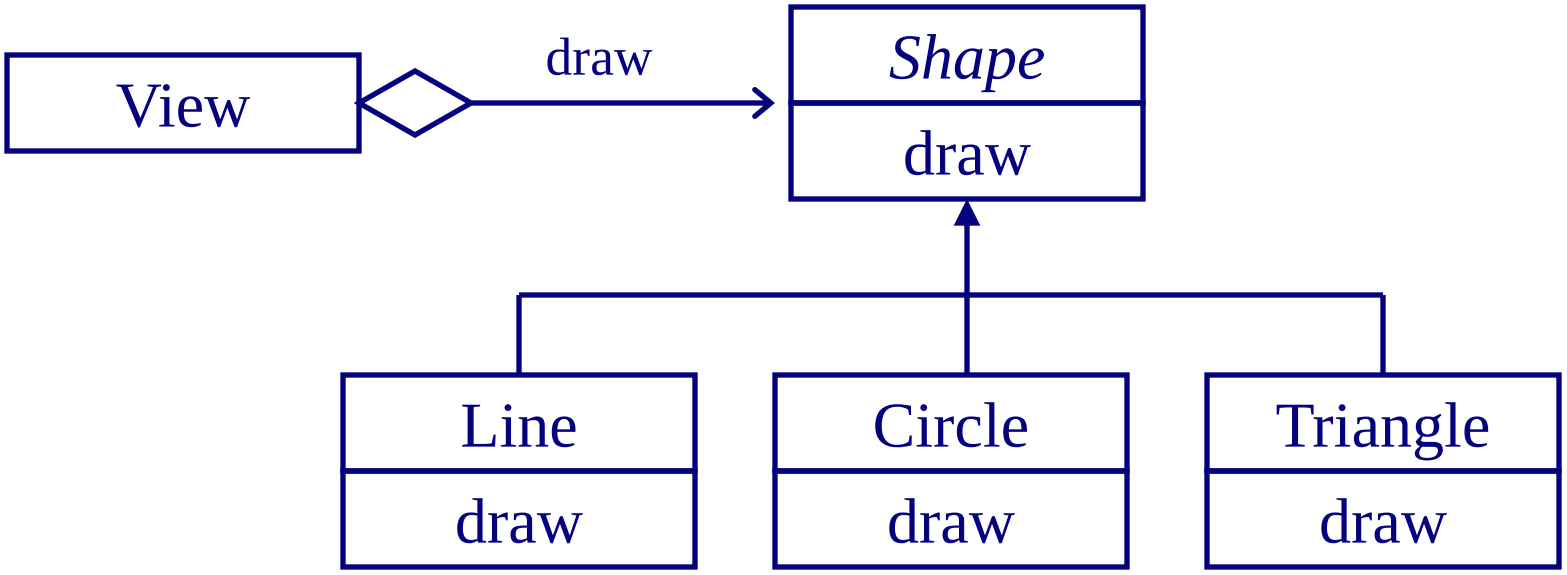


Example – Polymorphism



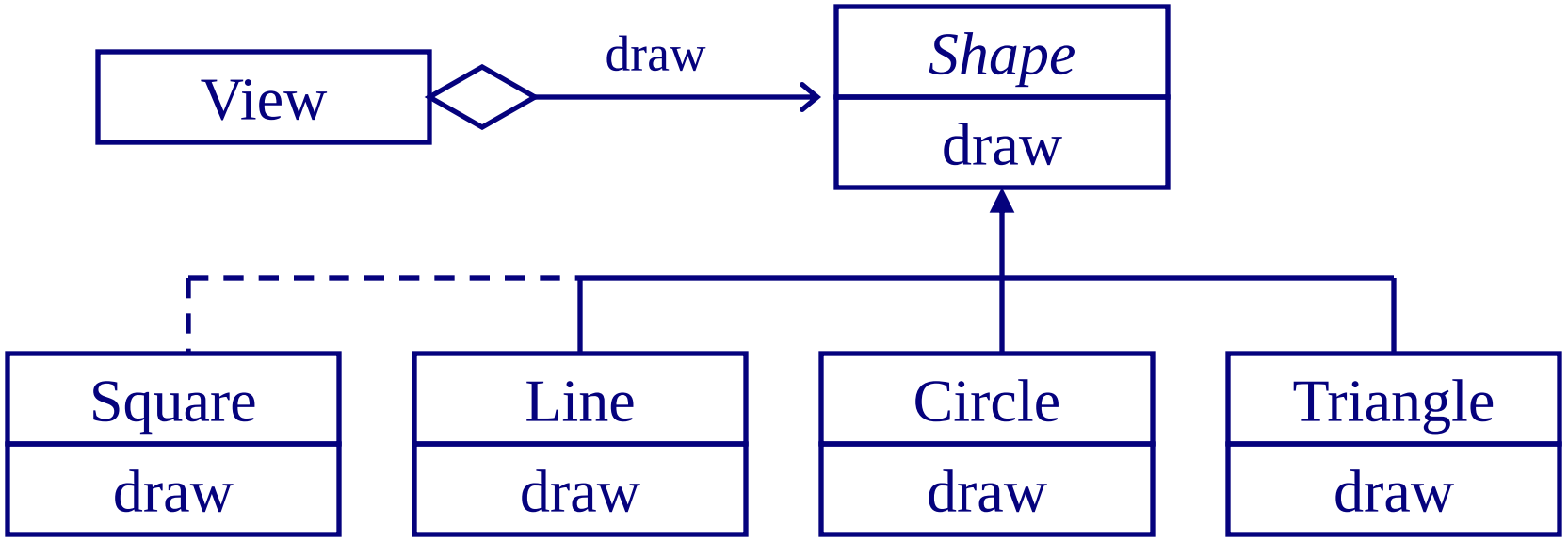
Polymorphism – Advantages

- Messages can be **interpreted** in different ways depending upon the receiver class



Polymorphism – Advantages

- New classes can be added without changing the existing model



Polymorphism – Advantages

- In general, polymorphism is a powerful tool to develop **flexible and reusable systems**

Dynamic Binding

- Binding refers to the **linking of a procedure call** to the code to be executed **in response to the call**
- Dynamic binding (late binding) means that the **code** associated with a given procedure call is **not known until** the time of the call at **run-time**
- A function call associated with a polymorphic reference depends on the dynamic type of that references
- It is associated with **polymorphism** and **inheritance**

Object-Oriented Modeling

An Example

Problem Statement

- Develop a graphic editor that can draw different geometric shapes such as line, circle and triangle. User can select, move or rotate a shape. To do so, editor provides user with a menu listing different commands. Individual shapes can be grouped together and can behave as a single shape.

Identify Classes

- **Extract nouns in the problem statement**
- Develop a graphic **editor** that can draw different geometric **shapes** such as **line**, **circle** and **triangle**. **User** can select, move or rotate a **shape**. To do so, **editor** provides **user** with a **menu** listing different **commands**. Individual **shapes** can be grouped together and can behave as a single **shape**.

…Identify Classes

- Eliminate irrelevant classes
- Editor – Very broad scope
- User – Out of system boundary

…Identify Classes

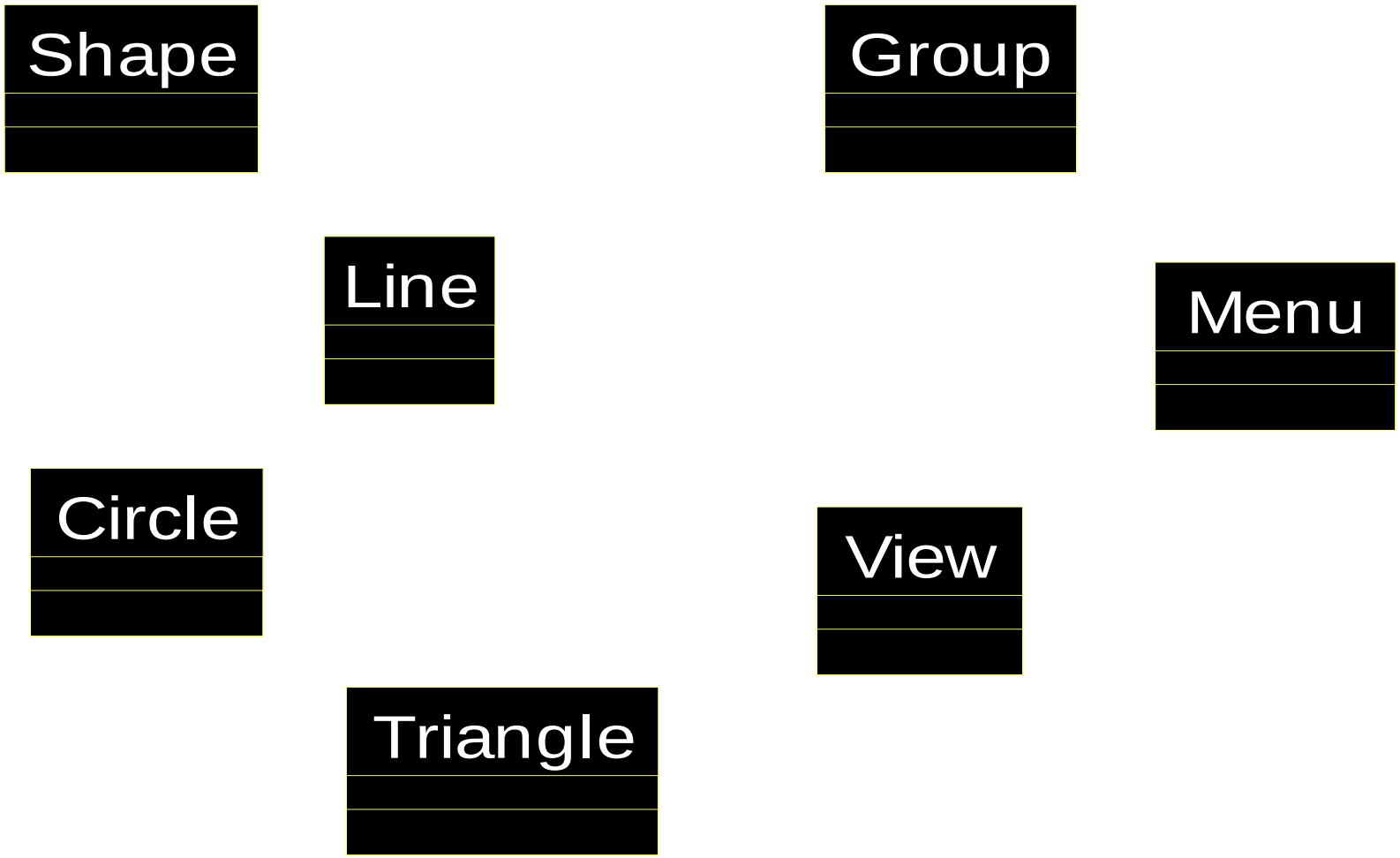
- Add classes by analyzing requirements
- **Group** – required to behave as a shape
  - "Individual shapes can be **grouped** together and can behave as a single shape"
- **View** – editor must have a display area

…Identify Classes

- Shape
- Line
- Circle
- Triangle
- Menu

- Group
- View

Object Model – Graphic Editor

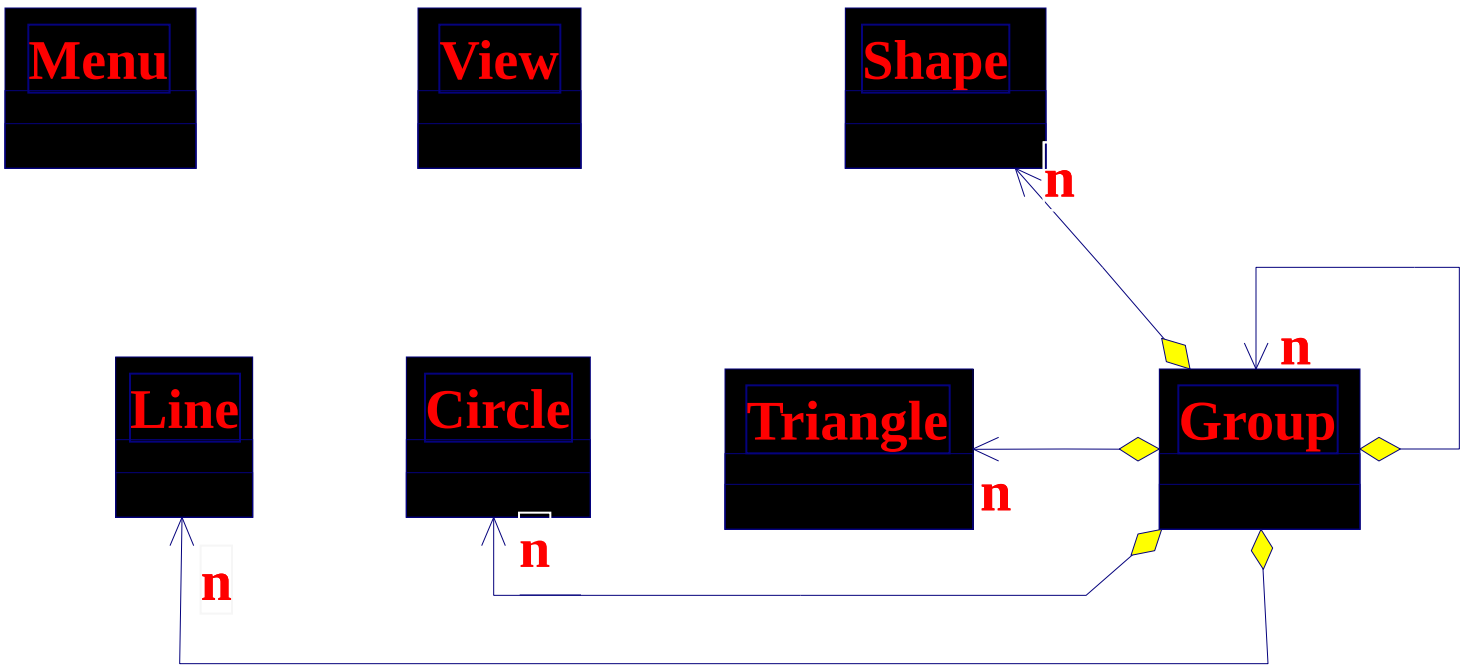


Identify Associations

- Extract verbs connecting objects
- "Individual shapes can be **grouped** together"
  - Group **consists** of lines, circles, triangles
  - Group can also **consists** of other groups

(Composition)

Object Model – Graphic Editor

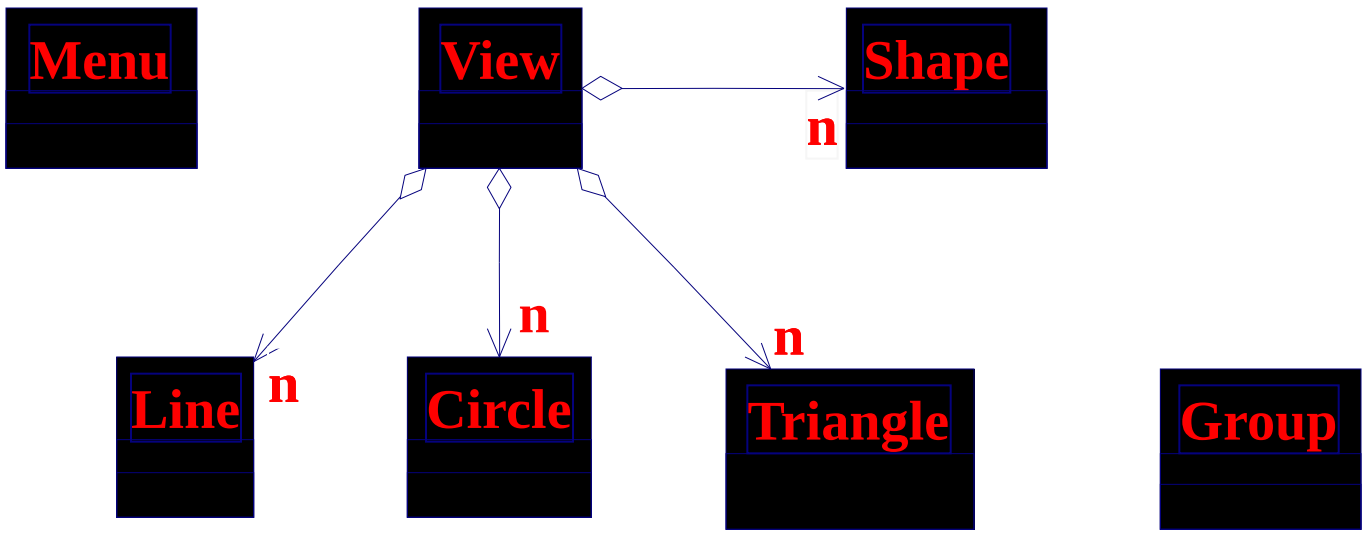


… Identify Associations

- Verify access paths
- View contains shapes
  - View contains lines
  - View contains circles
  - View contains triangles
  - View contains groups

(Aggregation)

Object Model – Graphic Editor

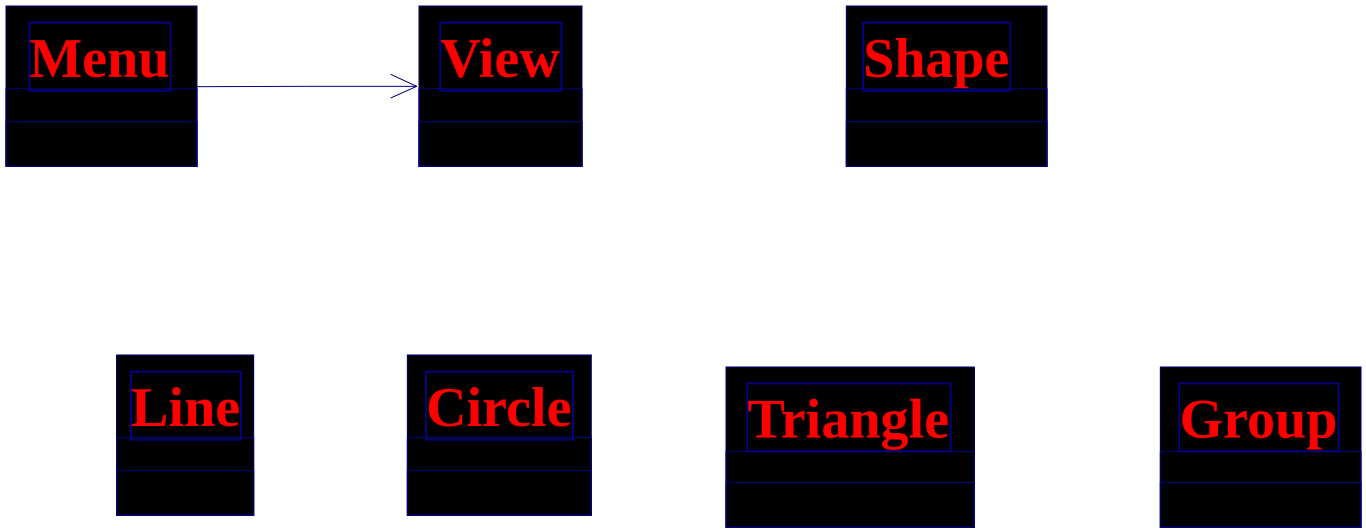


… Identify Associations

- Verify access paths
- **Menu sends** message to **View**

  (Simple One-Way Association)

Object Model – Graphic Editor



Identify Attributes (Abstraction)

- Extract **properties (Data)** of the object
  - From the problem statement
- Properties are not mentioned

Identify Attributes (Abstraction)

Extract properties of the object

— From the domain knowledge

- **Line**
  - Color
  - Vertices
  - Length
- **Circle**
  - Color
  - Vertices
  - Radius
- **Triangle**
  - Color
  - Vertices
  - Angle
- **Shape**
  - Color
  - Vertices

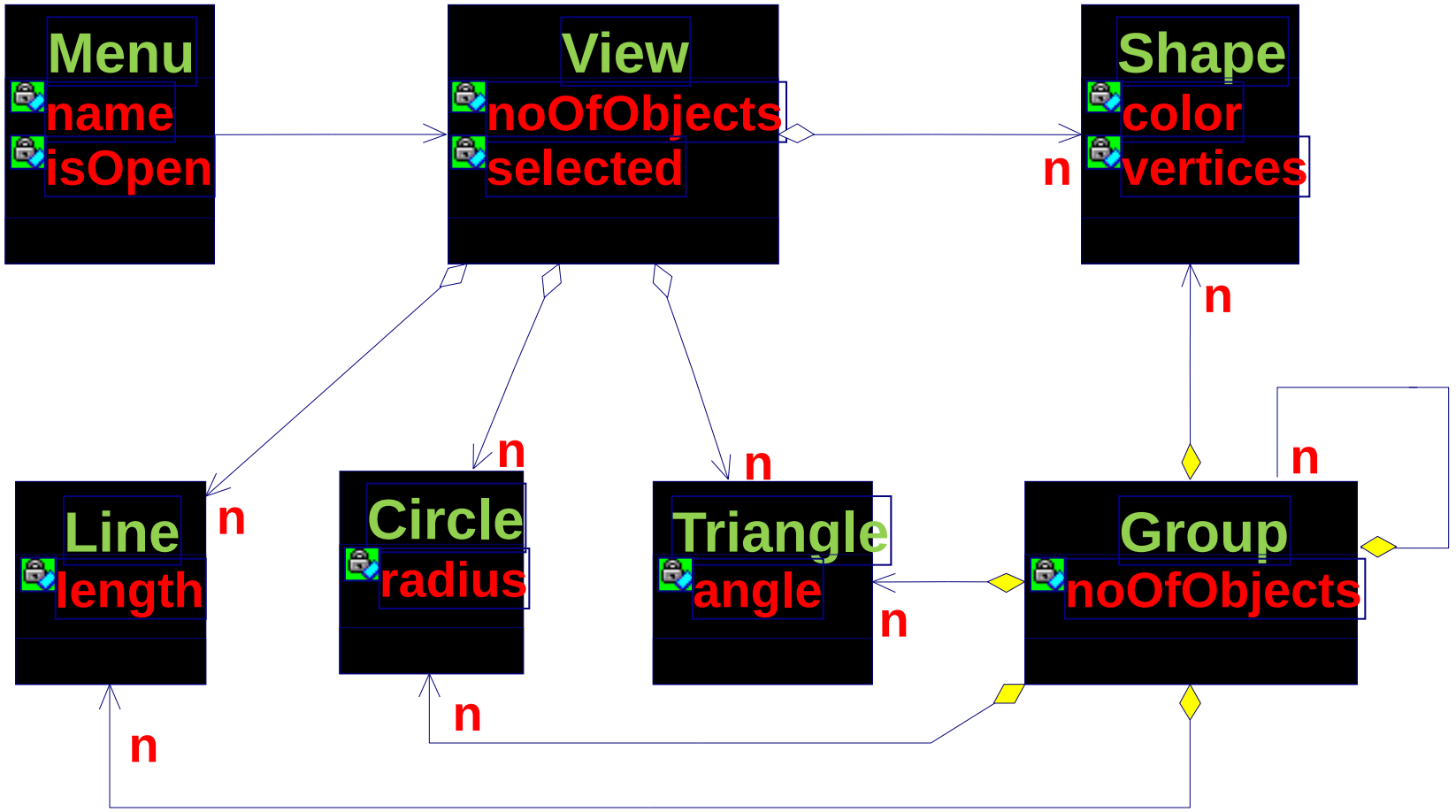
Identify Attributes (Abstraction)

Extract properties of the object

— From the domain knowledge

- Group
  - noOfObjects
- View
  - noOfObjects
  - selected
- Menu
  - Name
  - isOpen

Object Model – Graphic Editor



Identify Operations (Abstraction)

- Extract **verbs** connected with an object
- **Develop** a graphic editor that can **draw** different geometric shapes such as line, circle and triangle. User can **select**, **move** or **rotate** a shape. To do so, editor **provides** user with a menu listing different commands. Individual shapes can be **grouped** together and can **behave** as a single shape.

Identify Operations (Abstraction)

- Eliminate irrelevant operations
- **Develop** – out of system boundary
- **Behave** – have broad semantics

Identify Operations (Abstraction)

Following are selected operations:

- **Line**
  - Draw
  - Select
  - Move
  - Rotate
- **Circle**
  - Draw
  - Select
  - Move
  - Rotate

Identify Operations (Abstraction)

Following are selected operations:

- **Triangle**
  - Draw
  - Select
  - Move
  - Rotate
- **Shape**
  - Draw
  - Select
  - Move
  - Rotate

Identify Operations (Abstraction)

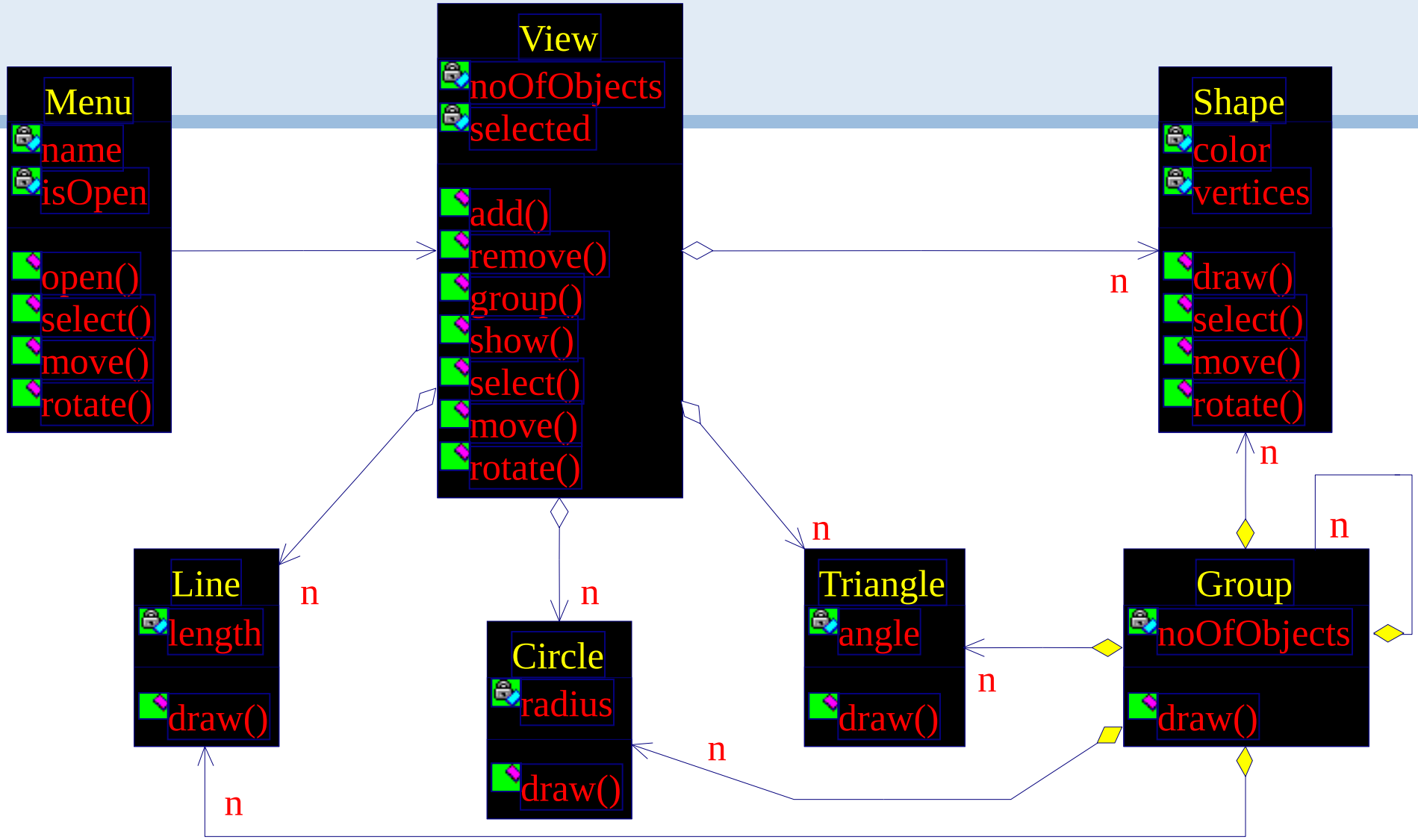
Following are selected operations:

- **Group**
  - Draw
  - Select
  - Move
  - Rotate
- **Menu**
  - Open
  - Select
  - Move
  - Rotate

Identify Operations (Abstraction)

Extract operations using domain knowledge

- View
  - Add
  - Remove
  - Group
  - Show
  - Select
  - Move
  - Rotate


View
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group()
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Menu
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move()
rotate()
Shape
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draw()
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move()
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Line
length
draw()
Circle
radius
draw()
Triangle
angle
draw()
Group
noOfObjects
draw()

Identify Inheritance

- **Search** "**is a kind of**" by looking at keywords like "**such as**", "for example", etc

  "…shapes **such as** line, circle and triangle…"

  Line, Circle and Triangle **inherits** from **Shape**

…Identify Inheritance

- By analyzing requirements
  - "Individual shapes can be grouped together and can behave as a single shape"
  - **Group inherits from Shape**

Refining the Object Model

- Application of inheritance demands an iteration over the whole object model
- In the inheritance hierarchy,
  - All attributes are shared
  - All associations are shared
  - Some operations are shared
  - Others are overridden

…Refining the Object Model

- Share associations
  - View contains all kind of shapes
  - Group consists of all kind of shapes

…Refining the Object Model

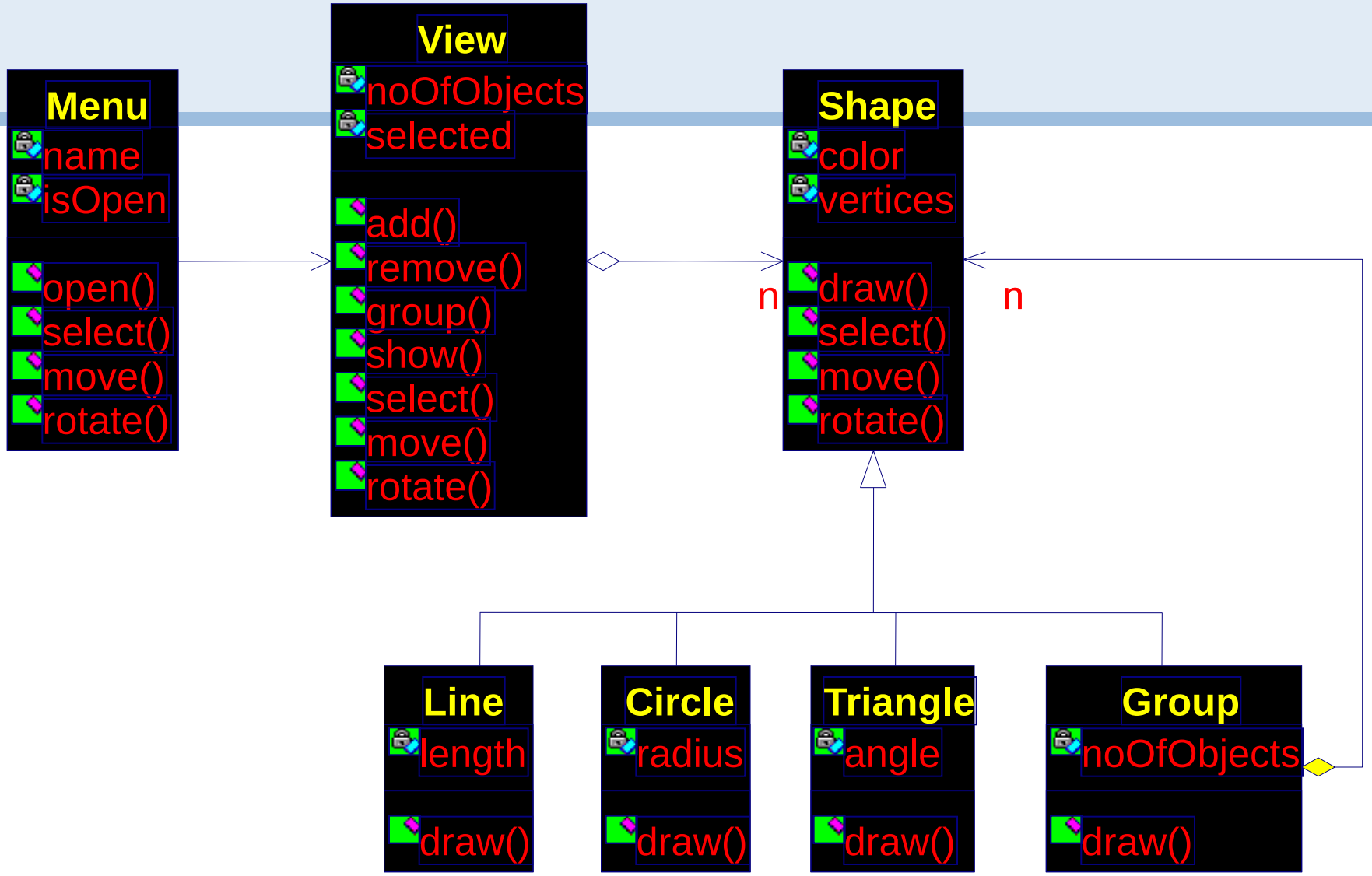
- **Share attributes**
  - Shape – Line, Circle, Triangle and Group
    - *Color, vertices*

…Refining the Object Model

- Share operations
  - Shape – Line, Circle, Triangle and Group
    - *Select*
    - *Move*
    - *Rotate*

…Refining the Object Model

- Share the interface and override implementation
  - Shape – Line, Circle, Triangle and Group
    - *Draw*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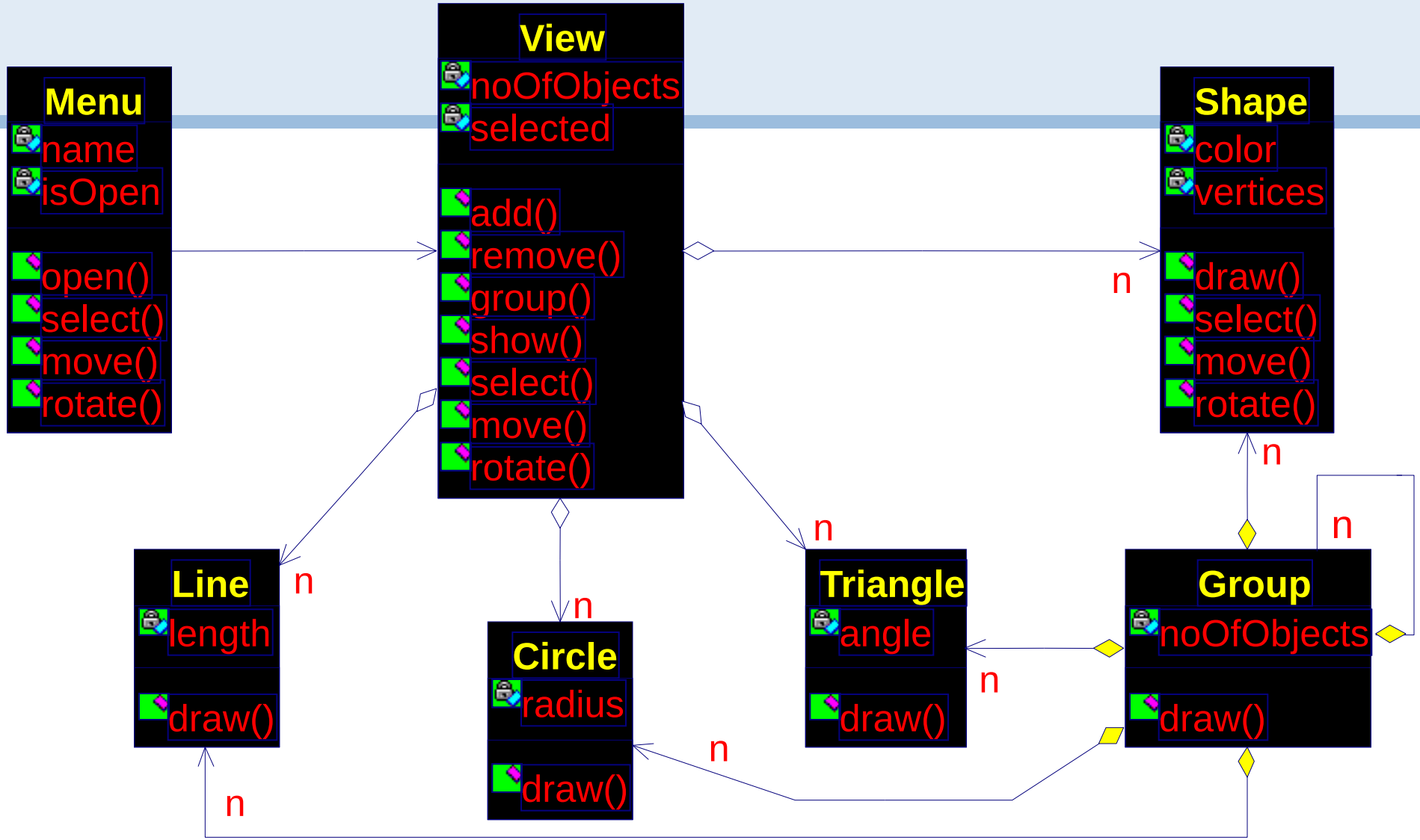
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