Generalization/Specialization

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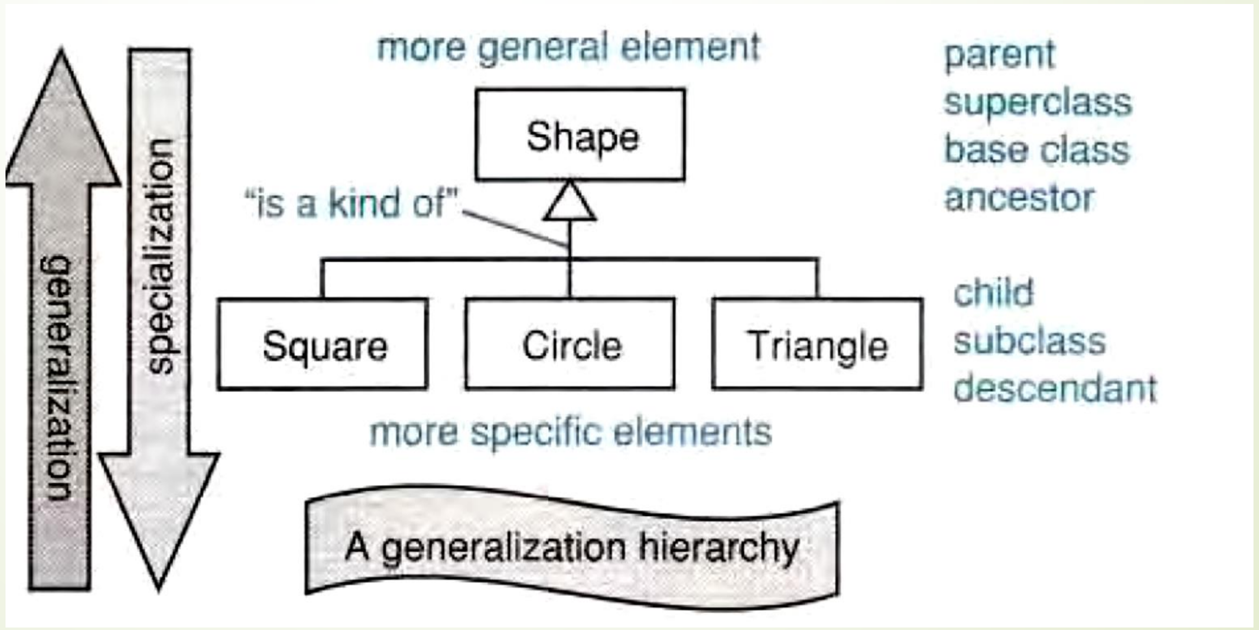
Generalization

- Generalization is a relationship between a more general thing and a more specific thing:
  - the more specific thing is consistent in every way with the more general thing.
  - the *substitutability principle* states that you can substitute the more specific thing anywhere the more general thing is expected.
  - generalization applies to all classifiers and some other modeling elements.

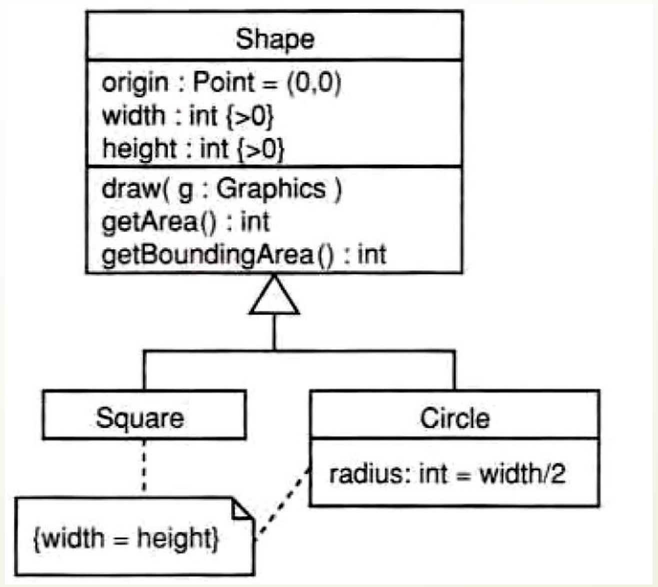
Generalization/Specialization

- Generalization hierarchies may be created by generalizing from specific things or by specializing from general things.



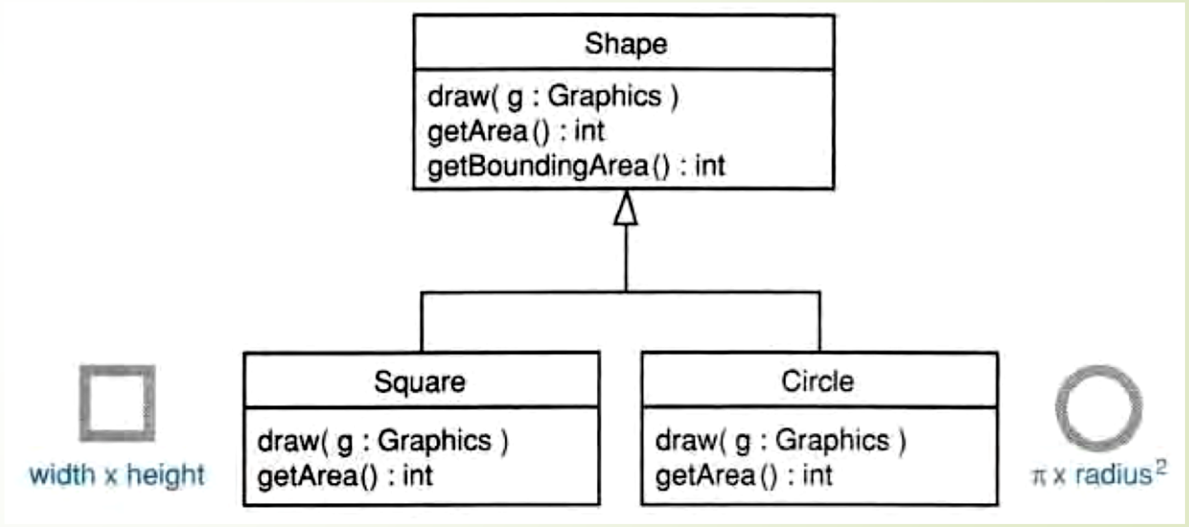
Inheritance

- Class inheritance is implicit in a generalization relationship between classes.
- The subclass inherits the following features from its parents - attributes, operations, relationships, and constraints.



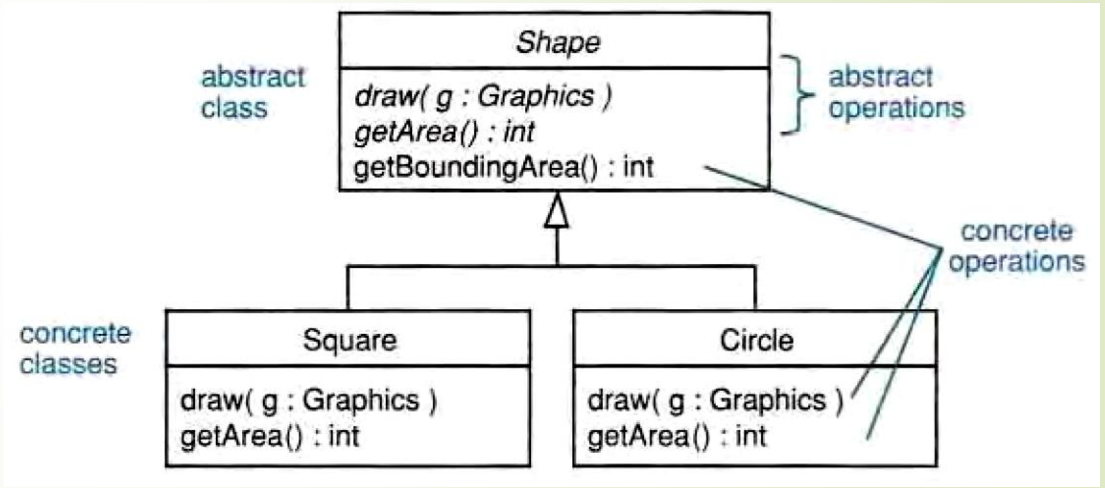
Inheritance: Overriding

- Subclasses may:
  - add new features;
  - override inherited operations:
    - the subclass provides a new operation with exactly the same signature as the parent operation it wishes to override;
    - the operation signature consists of an operation name, types of all parameters in order, and return type.



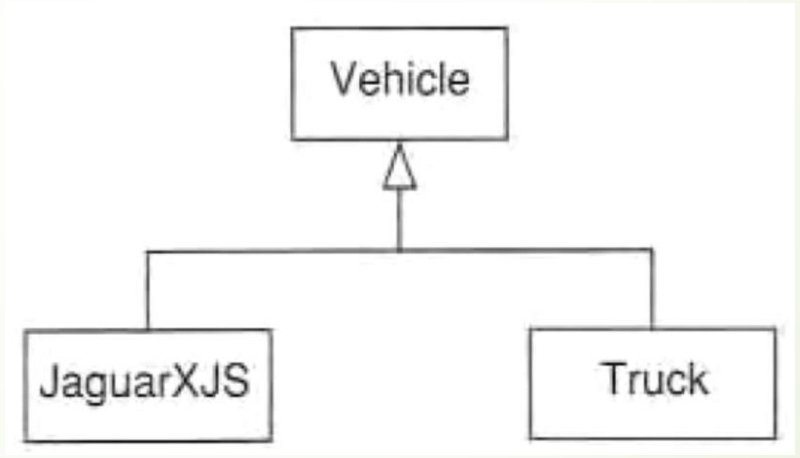
Abstract Operations and Classes

- Abstract operations are designed to have no implementation:
  - they serve as placeholders;
  - all concrete subclasses must implement all inherited abstract operations.
- An abstract class has one or more abstract operations:
  - abstract classes can't be instantiated;
  - abstract classes define a contract as a set of abstract operations that concrete subclasses must implement.



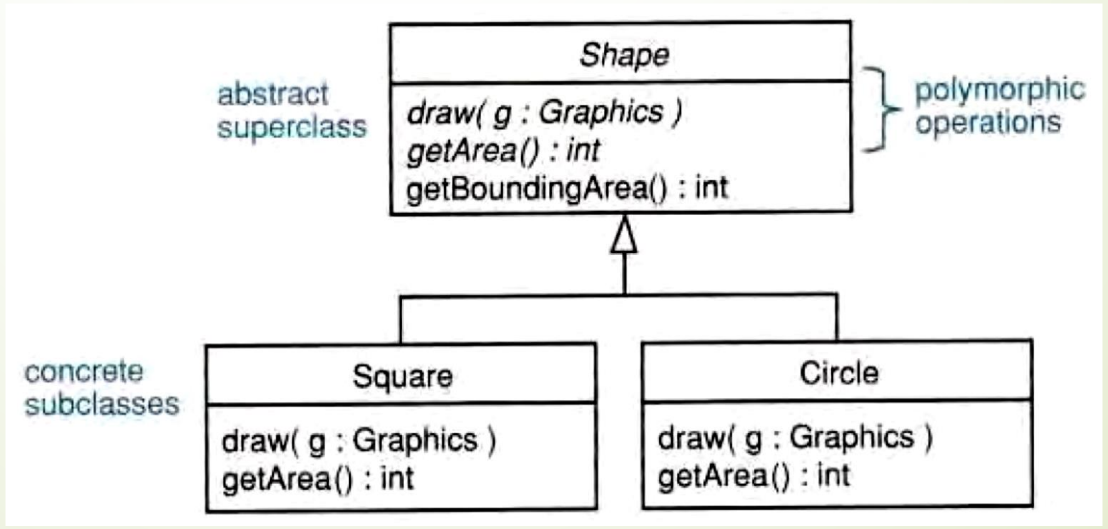
Abstraction Level

- all things at the same level in a generalization hierarchy should be at the same level of abstraction.

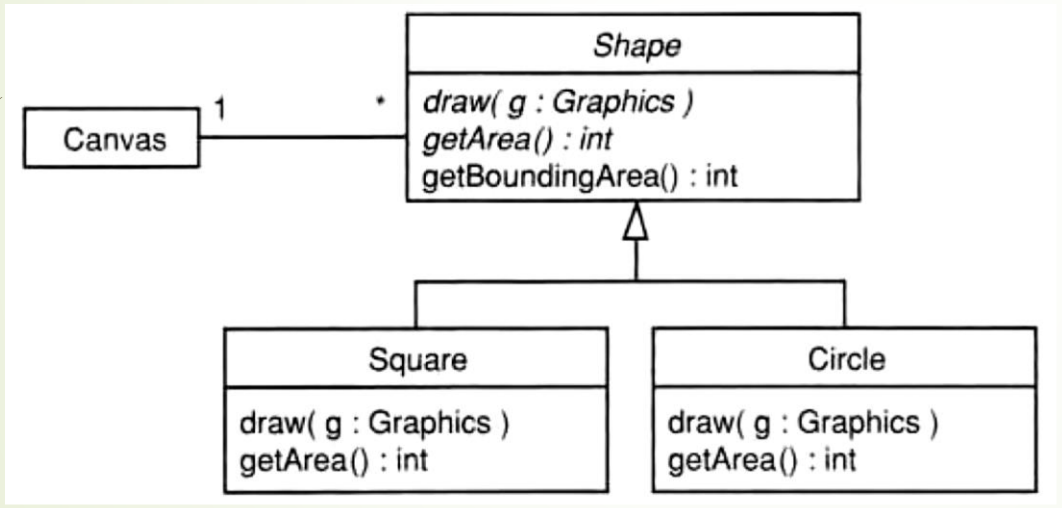


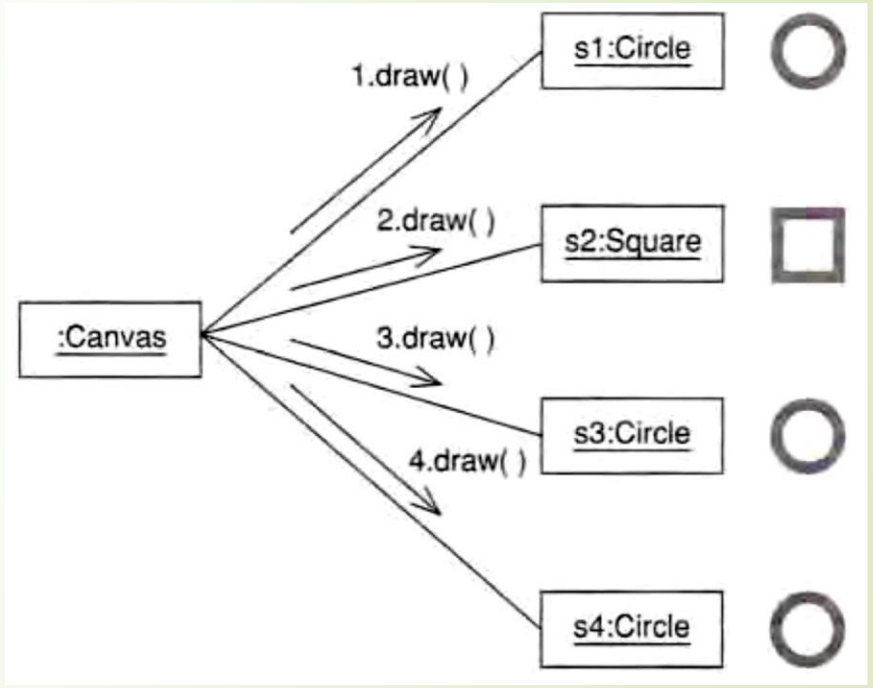
Polymorphism

- Polymorphism means "many forms". It allows you to design systems using an abstract class, then substitute concrete subclasses at runtime - such systems are very flexible and easy to extend; just add more subclasses.
- Encapsulation, inheritance, and polymorphism are the "three pillars" of OO.



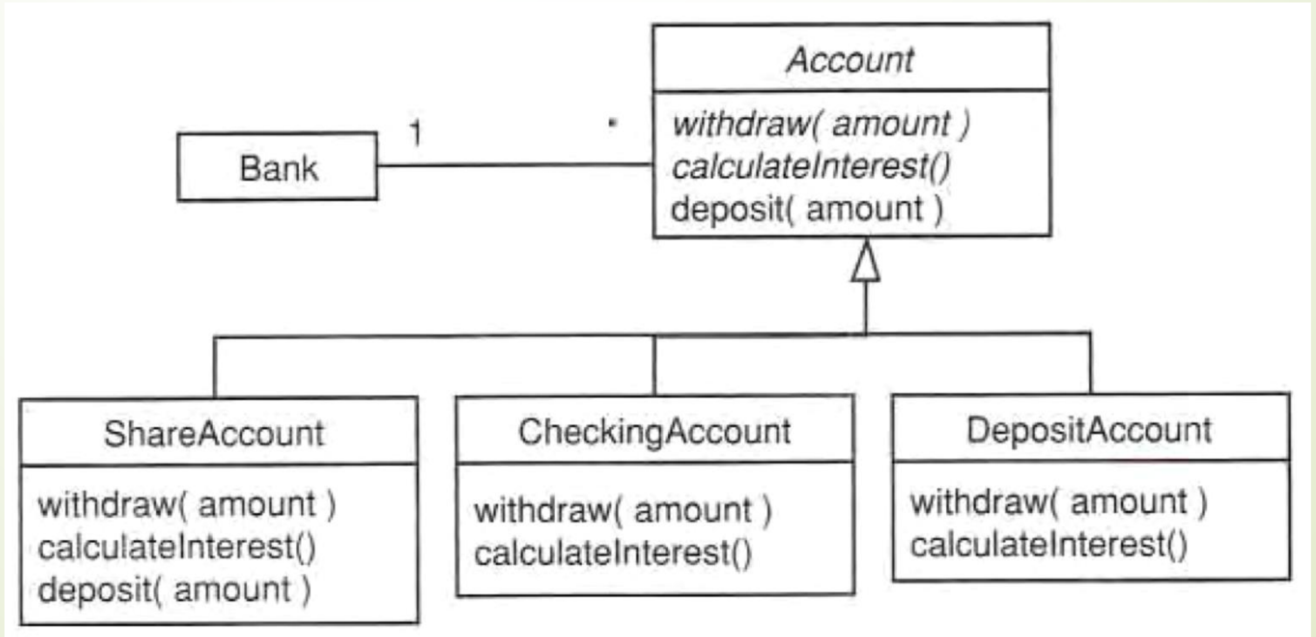
Polymorphism: Example





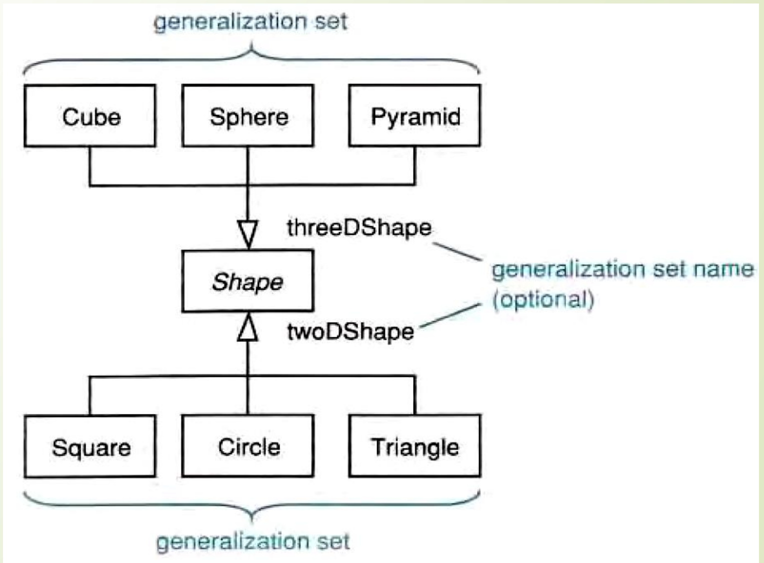
Polymorphism: Concrete Operations

- Polymorphic operations have more than one implementation:
  - different classes may implement the same polymorphic (abstract/concrete) operation differently;
  - polymorphism allows instances of different classes to respond to the same message in different ways.

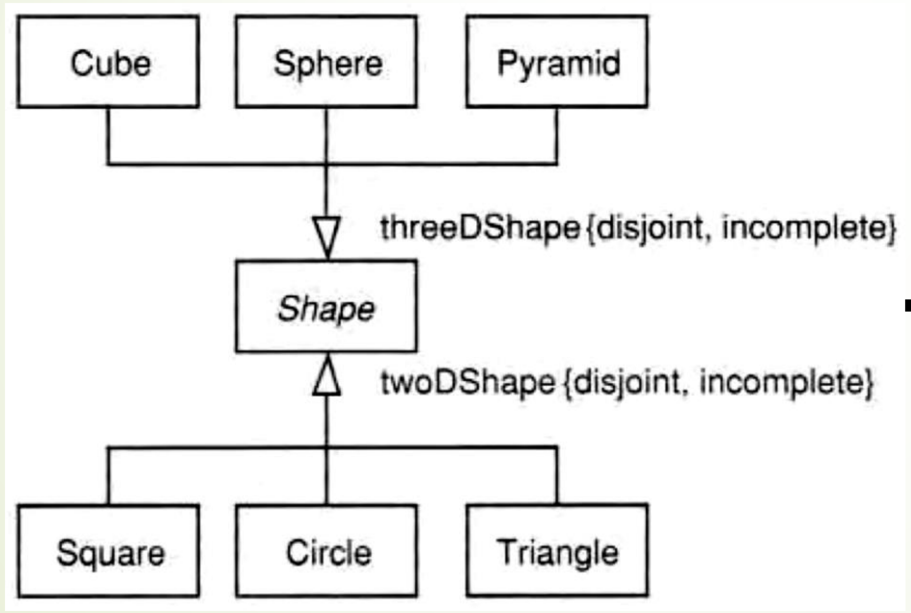


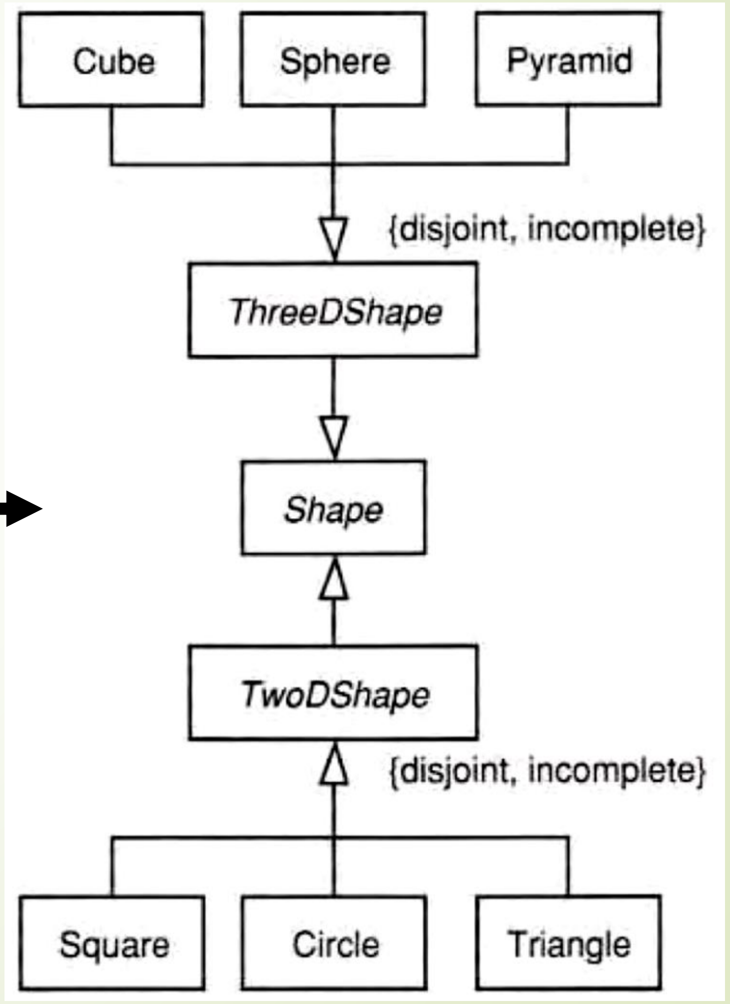
Generalization Sets

- Generalization set - a set of subclasses organized according to a particular rule; constraints:
  - **{complete}** - generalization set contains all possible members;
  - **{incomplete}** - generalization set does not contain all possible members;
  - **{disjoint}** - an object may be an instance of no more than one of the members of the generalization set;
  - **{overlapping}** - an object may be an instance of more than one of the members of the generalization set;
  - **{incomplete, disjoint}** - the default.



Generalization Sets: Implementation


Cube
Sphere
Pyramid
threeDShape {disjoint, incomplete}
Shape
twoDShape {disjoint, incomplete}
Square
Circle
Triangle



References

- Arlow, J., Neustadt, I., *UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design*, 2nd Ed. Addison-Wesley, 2005.
- Ramsin, Raman. "Home." Department of Computer Science and Engineering, Sharif University of Technology. Accessed February 15, 2025. https://sharif.edu/~ramsin/index.htm.