Object Oriented Analysis and Design Using the UML Version 4.2

Introduction to Object Orientation

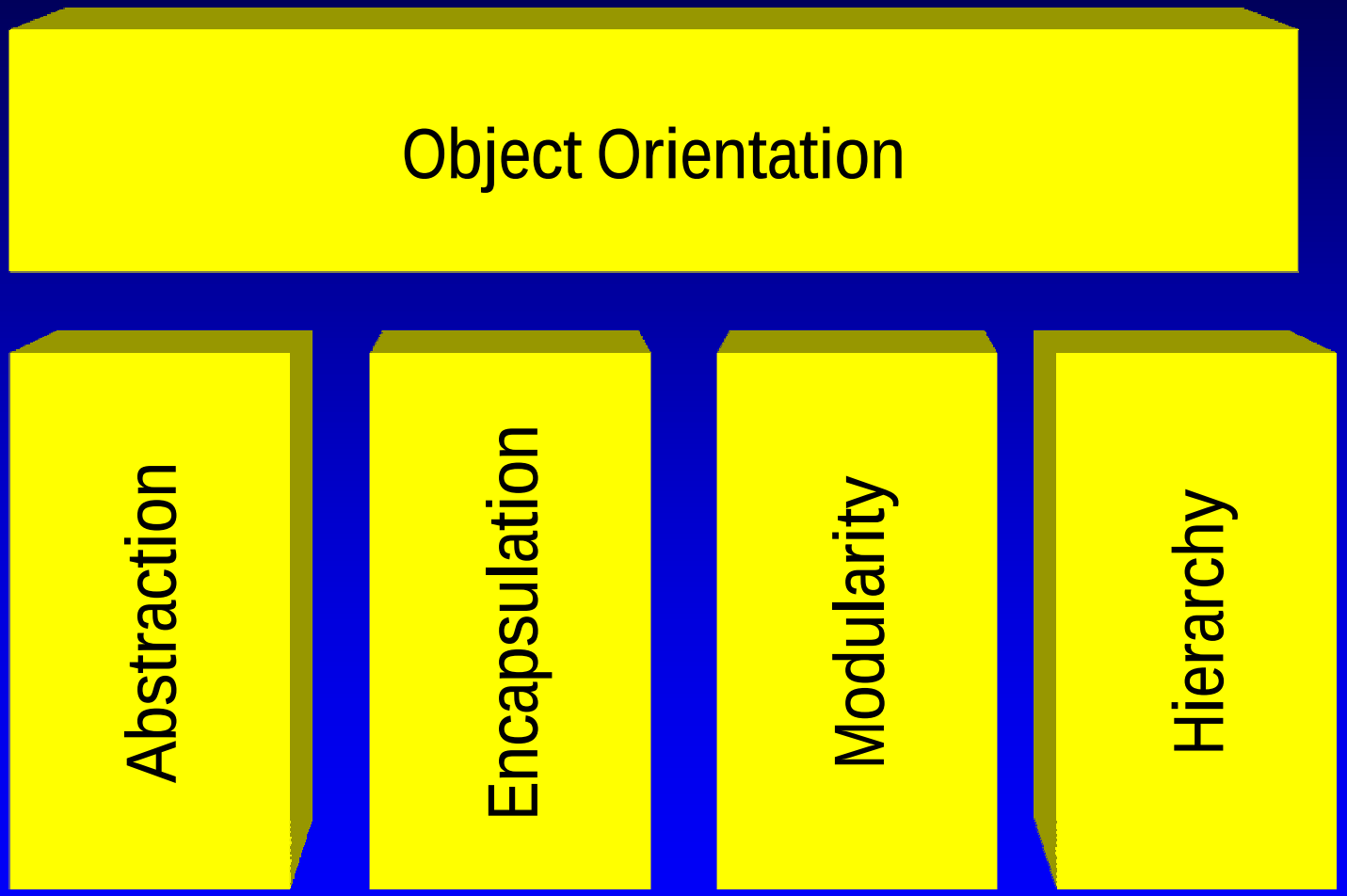
Objectives: Introduction to Object Orientation

- Understand the basic principles of object orientation
- Understand the basic concepts and terms of object orientation and the associated UML notation
- Appreciate the strengths of object orientation
- Understand some basic UML modeling mechanisms

Introduction to Object Orientation Topics

- Basic Principles of Object Orientation
  - Basic Concepts of Object Orientation
  - Strengths of Object Orientation
  - General UML Modeling Mechanisms

Basic Principles of Object Orientation

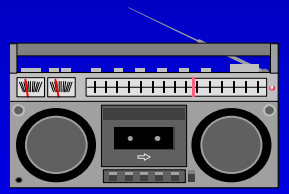


What is Abstraction?

Salesperson

Not saying
Which
salesperson
– just a
salesperson
in general!!!

Customer

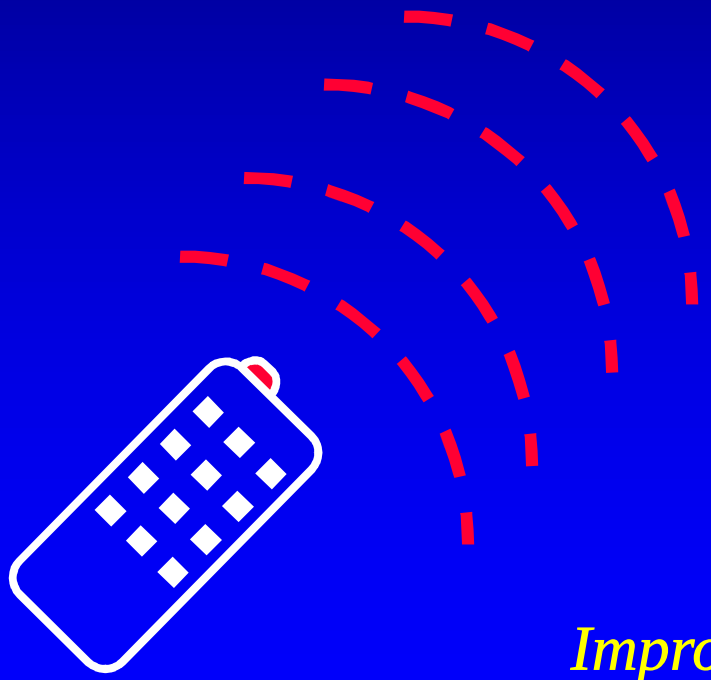


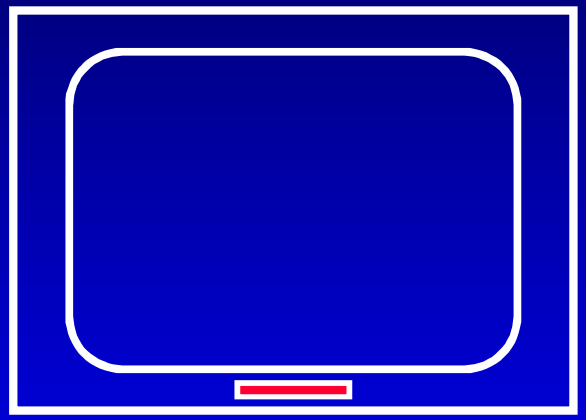
Product

Manages Complexity

What is Encapsulation?

- Hide implementation from clients
  - Clients depend on interface





How does an object encapsulate?
What does it encapsulate?

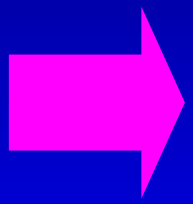
Improves Resiliency

What is Modularity?

- The breaking up of something complex into manageable pieces

Order Entry

Order Processing System



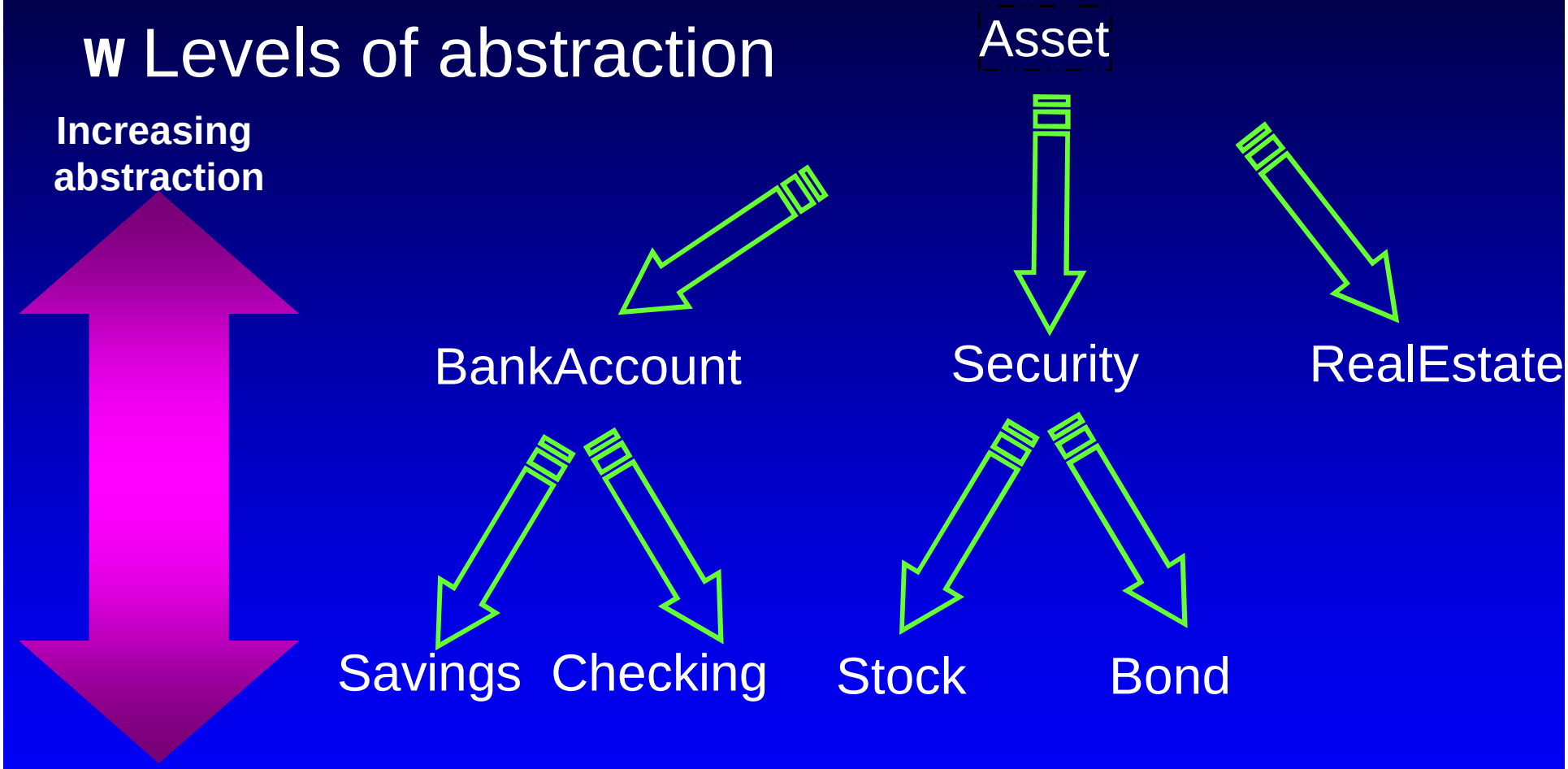
Order Fulfillment

Billing

Manages Complexity

What is Hierarchy?

- Levels of abstraction



Elements at the same level of the hierarchy should be at the same level of abstraction

Introduction to Object Orientation Topics

- Basic Principles of Object Orientation
- Basic Concepts of Object Orientation
- Strengths of Object Orientation
- General UML Modeling Mechanisms

Basic Concepts of Object Orientation

- Object
- Class
- Attribute
- Operation
- Interface (Polymorphism)
- Component
- Package
- Subsystem
- Relationships

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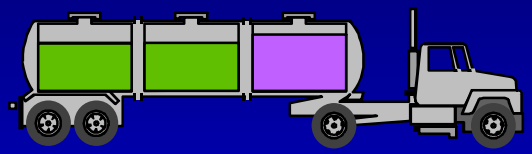
What is an Object?

- Informally, an object represents an entity, either physical, conceptual, or software
  - Physical entity



Truck

  - Conceptual entity

Chemical Process

  - Software entity

Linked List

A More Formal Definition

- An object is a concept, abstraction, or thing with sharp boundaries and meaning for an application
- An object is something that has:
  - State
  - Behavior
  - Identity

Representing Objects

- An object is represented as rectangles with underlined names

: Professor

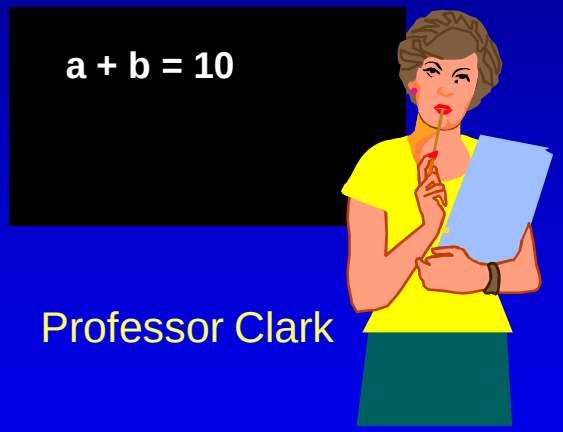
Class Name Only

ProfessorClark

Object Name Only

ProfessorClark : Professor

Class and Object Name



(stay tuned for classes)

Basic Concepts of Object Orientation

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What is a Class?

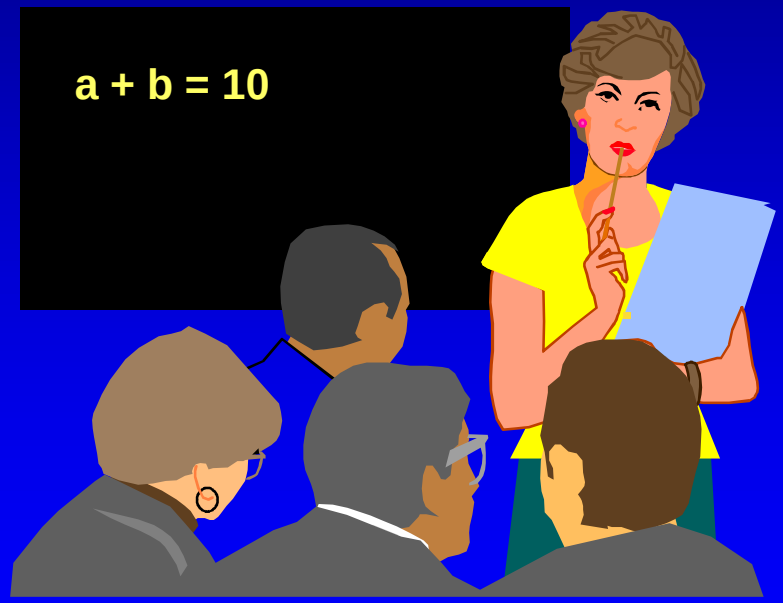
- A class is a description of a group of objects with common properties (attributes), behavior (operations), relationships, and semantics
  - An object is an instance of a class
- A class is an abstraction in that it:
  - Emphasizes relevant characteristics
  - Suppresses other characteristics

OO Principle: Abstraction

Sample Class

Class
Course

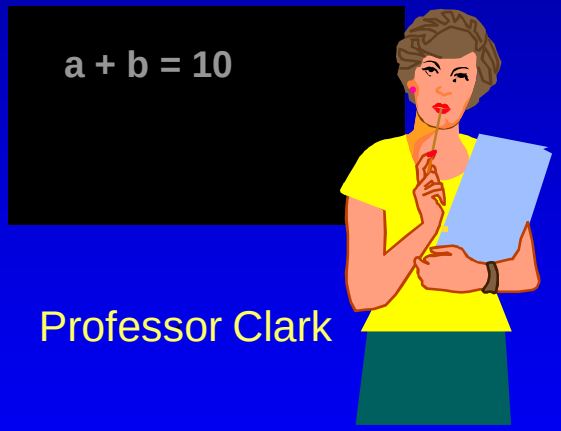
Properties
Name
Location
Days offered
Credit hours
Start time
End time



Behavior
Add a student
Delete a student
Get course roster
Determine if it is full

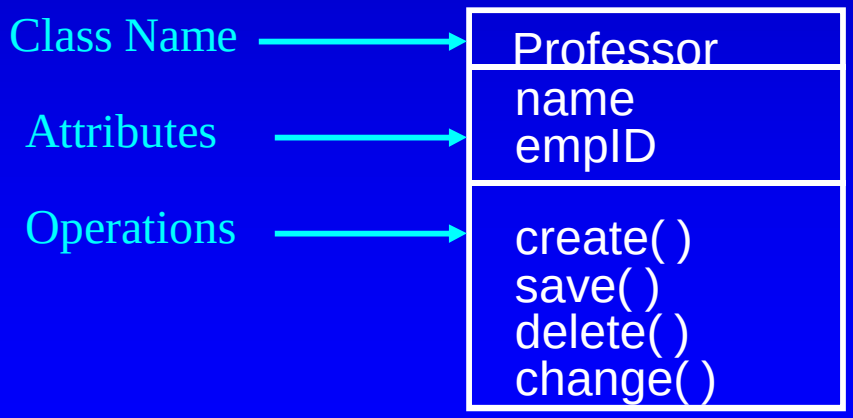
Representing Classes

- A class is represented using a compartmented rectangle



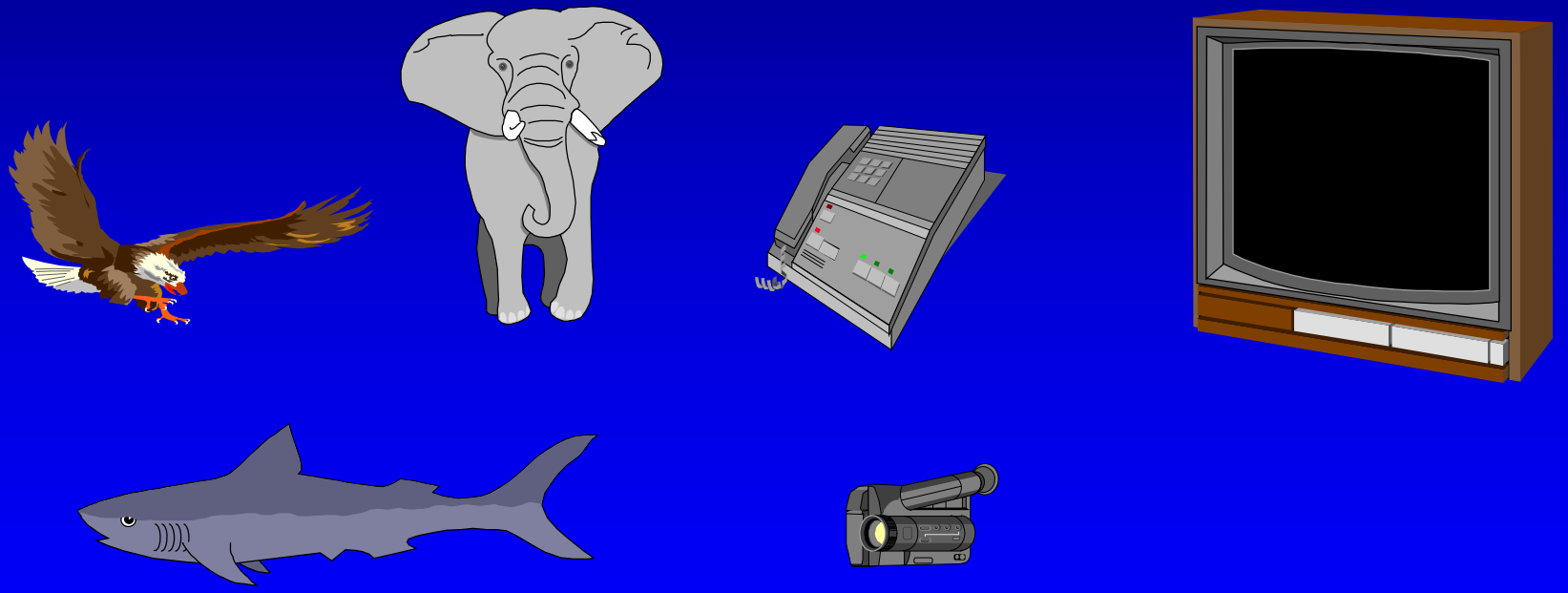
Class Compartments

- A class is comprised of three sections
  - The first section contains the class name
  - The second section shows the structure (attributes)
  - The third section shows the behavior (operations)



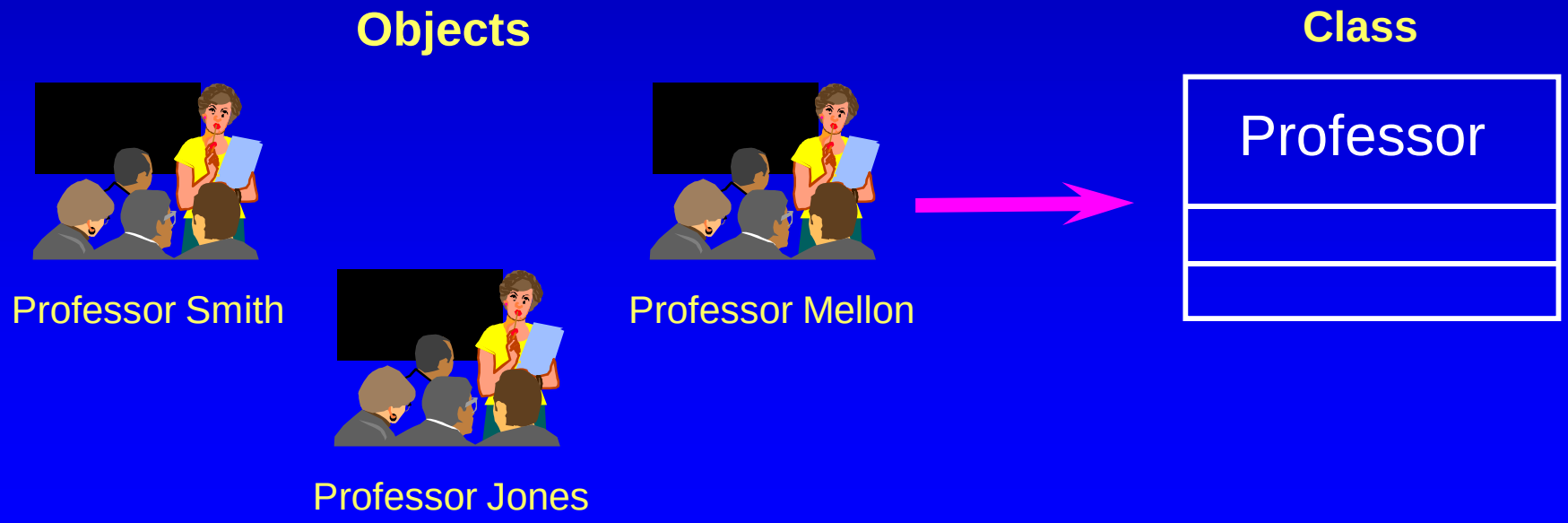
Classes of Objects

- How many classes do you see?



The Relationship Between Classes and Objects

- A class is an abstract definition of an object
  - It defines the structure and behavior of each object in the class
  - It serves as a template for creating objects
- Objects are grouped into classes



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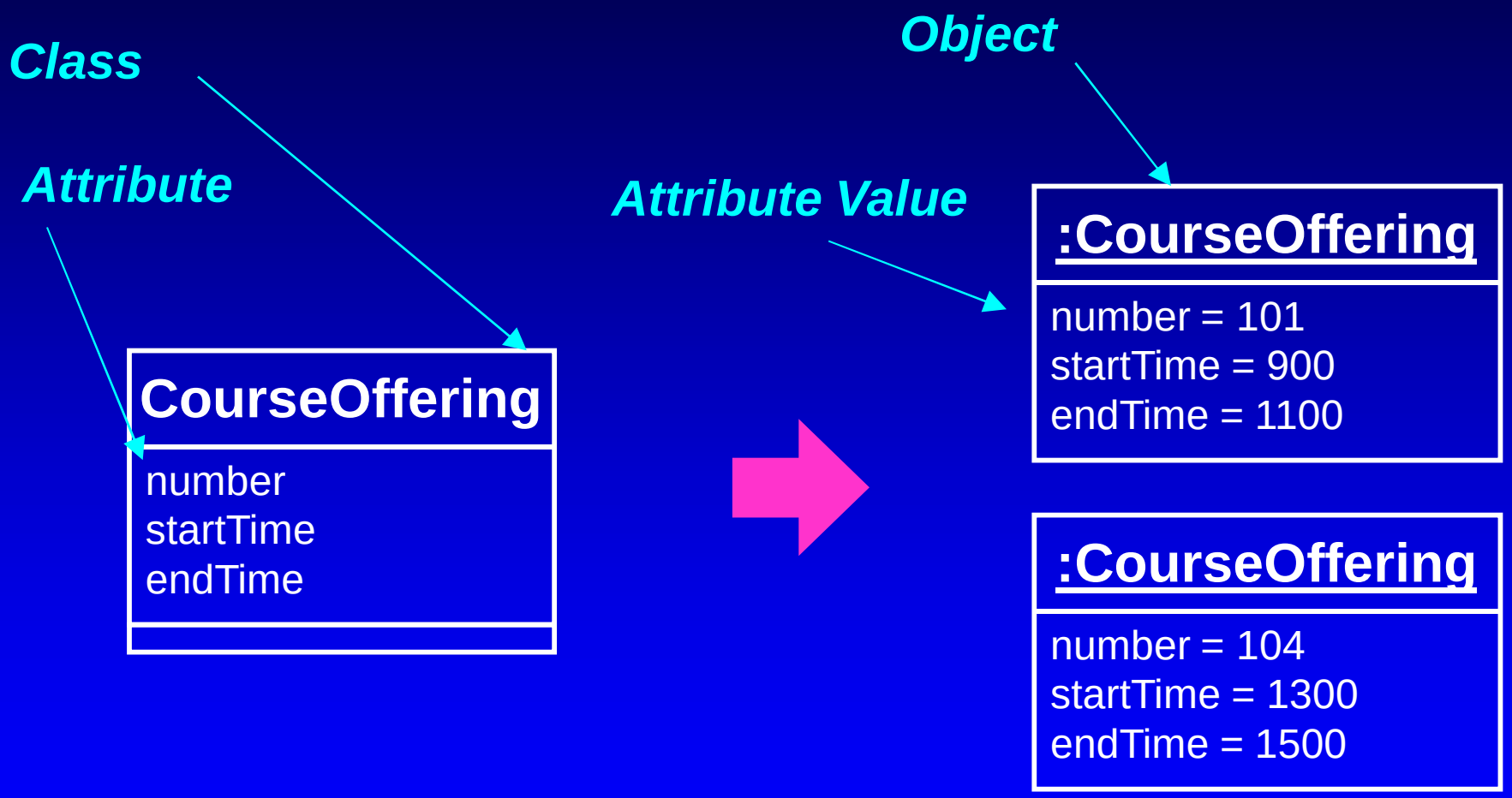
What is an Attribute?



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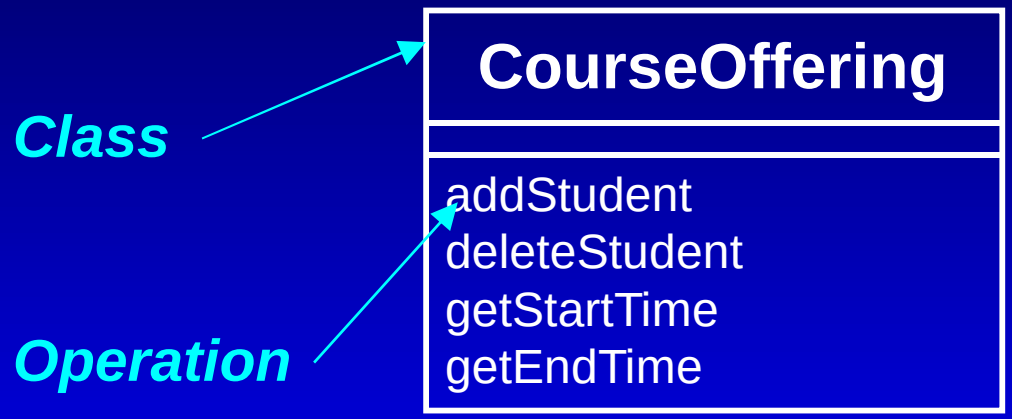
What is an Operation?



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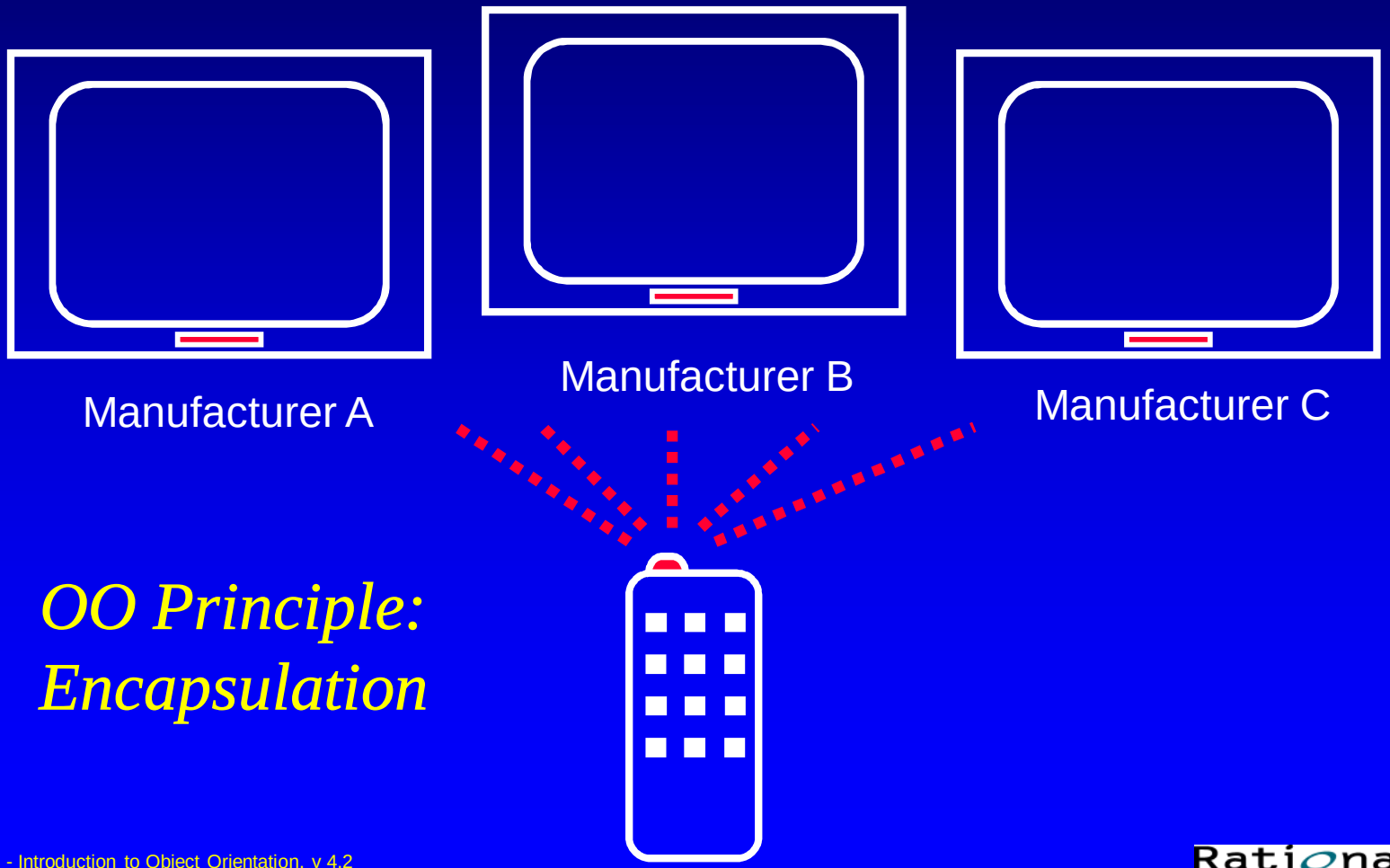
What is Polymorphism?

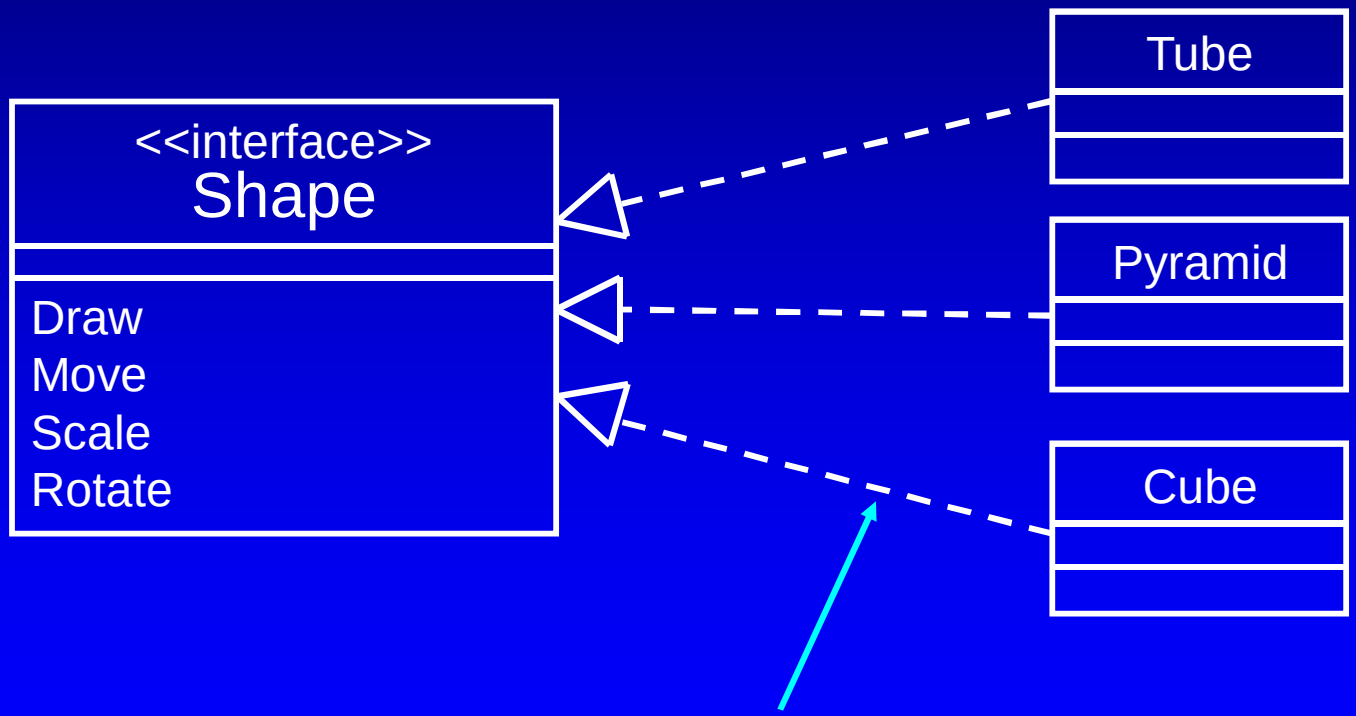
- The ability to hide many different implementations behind a single interface



OO Principle: Encapsulation

What is an Interface?

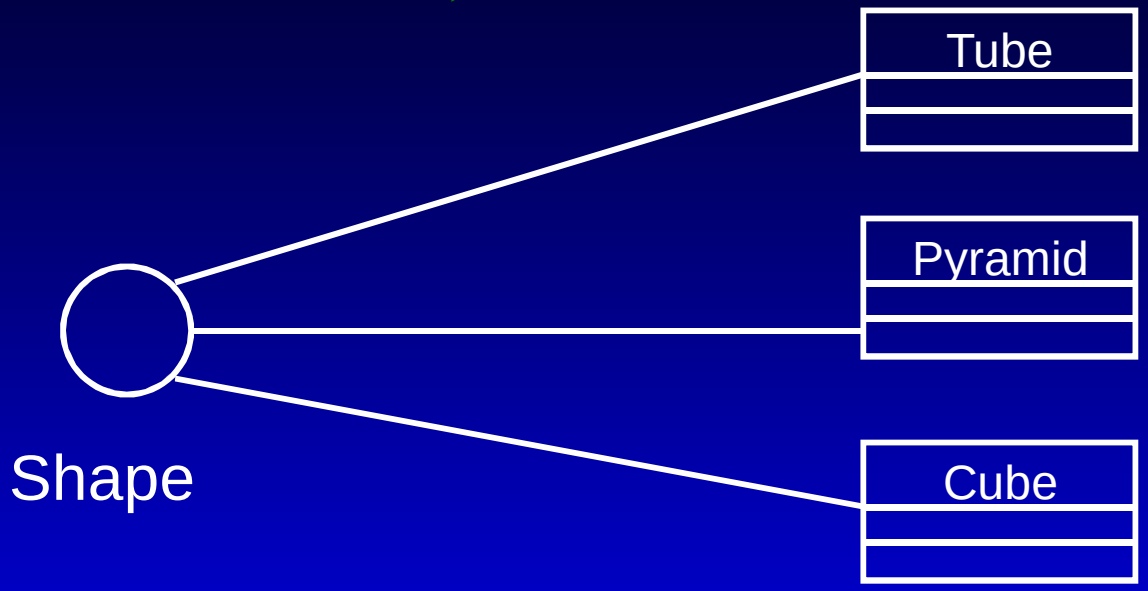
- Interfaces formalize polymorphism
- Interfaces support “plug-and-play” architectures



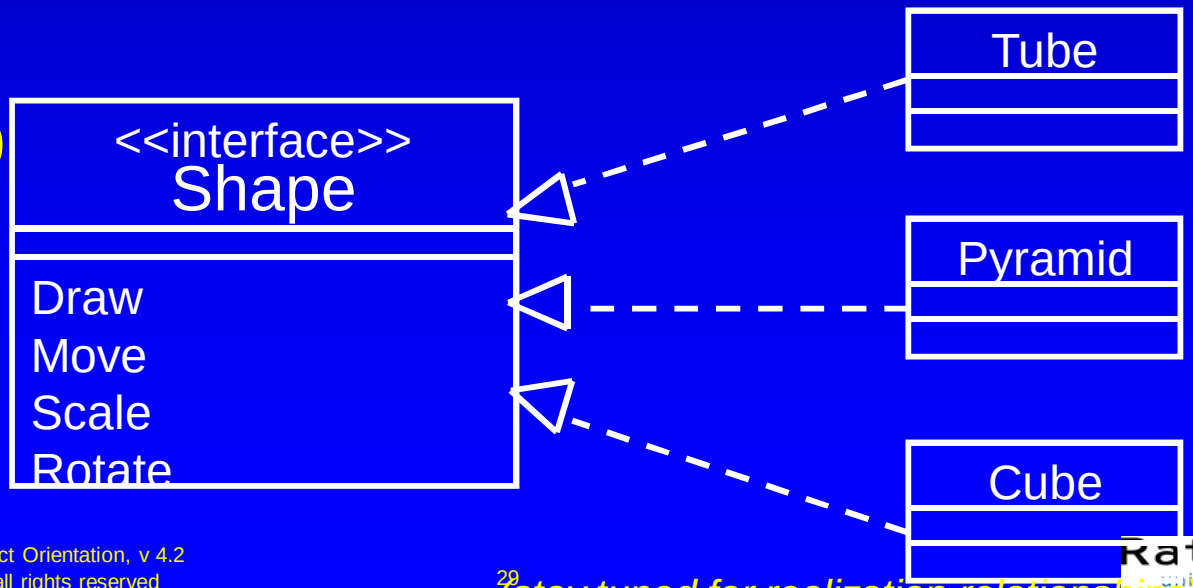
(stay tuned for realization relationships)

Interface Representations

Elided/Iconic Representation ("lollipop")



Canonical (Class/Stereotype) Representation



(stay tuned for realization relationships)

Basic Concepts of Object Orientation

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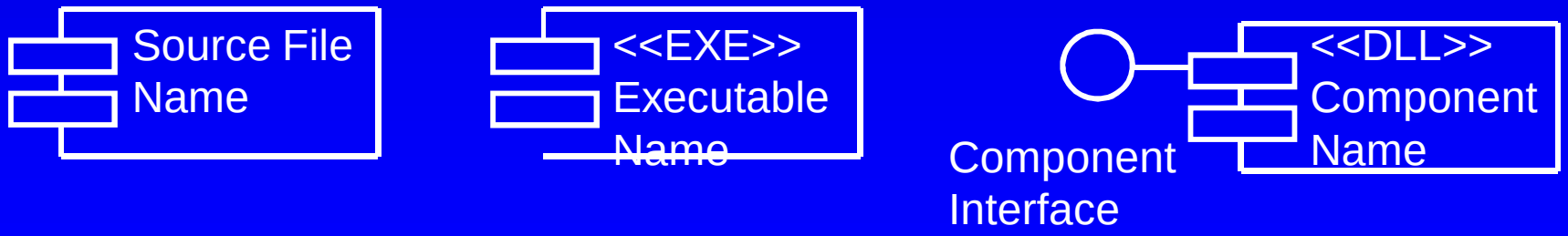
What is a Component?

- A non-trivial, nearly independent, and replaceable part of a system that fulfills a clear function in the context of a well-defined architecture
- A component may be
  - A source code component
  - A run time components or
  - An executable component

OO Principle: Encapsulation



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What is a Package?

- A package is a general purpose mechanism for organizing elements into groups
- A model element which can contain other model elements

OO Principle: Modularity

- Uses
  - Organize the model under development
  - A unit of configuration management

Basic Concepts of Object Orientation

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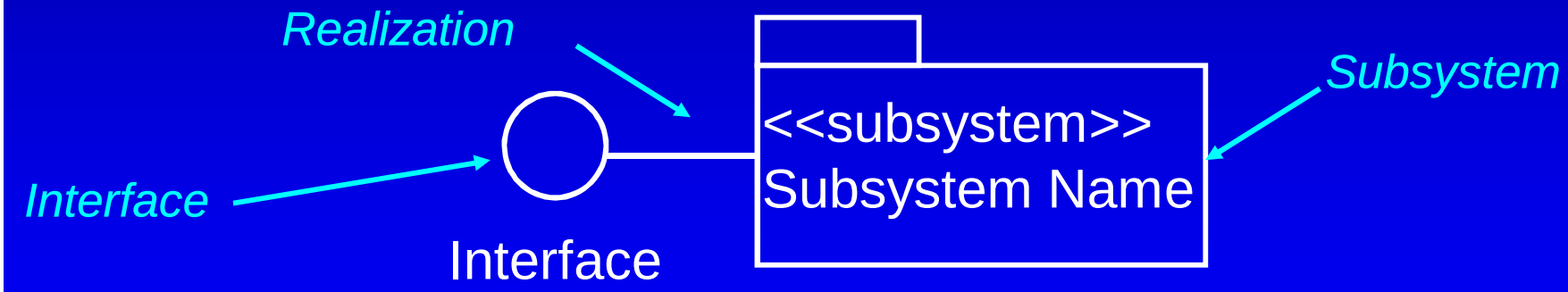
What is a Subsystem?

- A combination of a package (can contain other model elements) **and** a class (has behavior)
- Realizes one or more interfaces which define its behavior



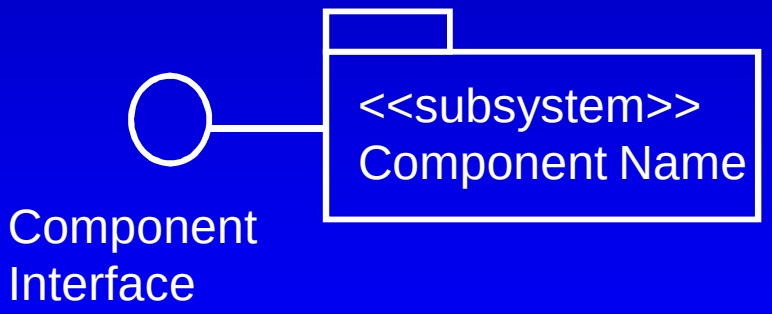
OO Principles: Encapsulation and Modularity

(stay tuned for realization relationship)

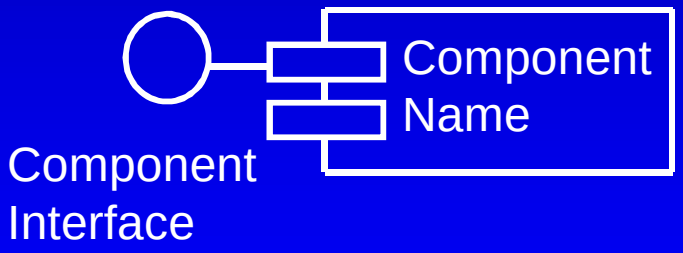
Subsystems and Components

- Components are the physical realization of an abstraction in the design
- Subsystems can be used to represent the component in the design

Design Model



Implementation Model



OO Principles: Encapsulation and Modularity

Basic Concepts of Object Orientation

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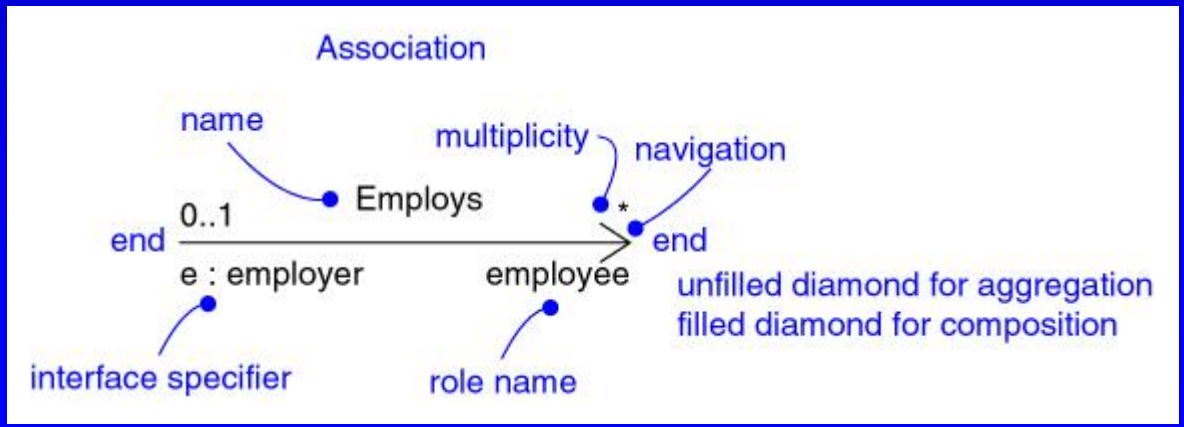
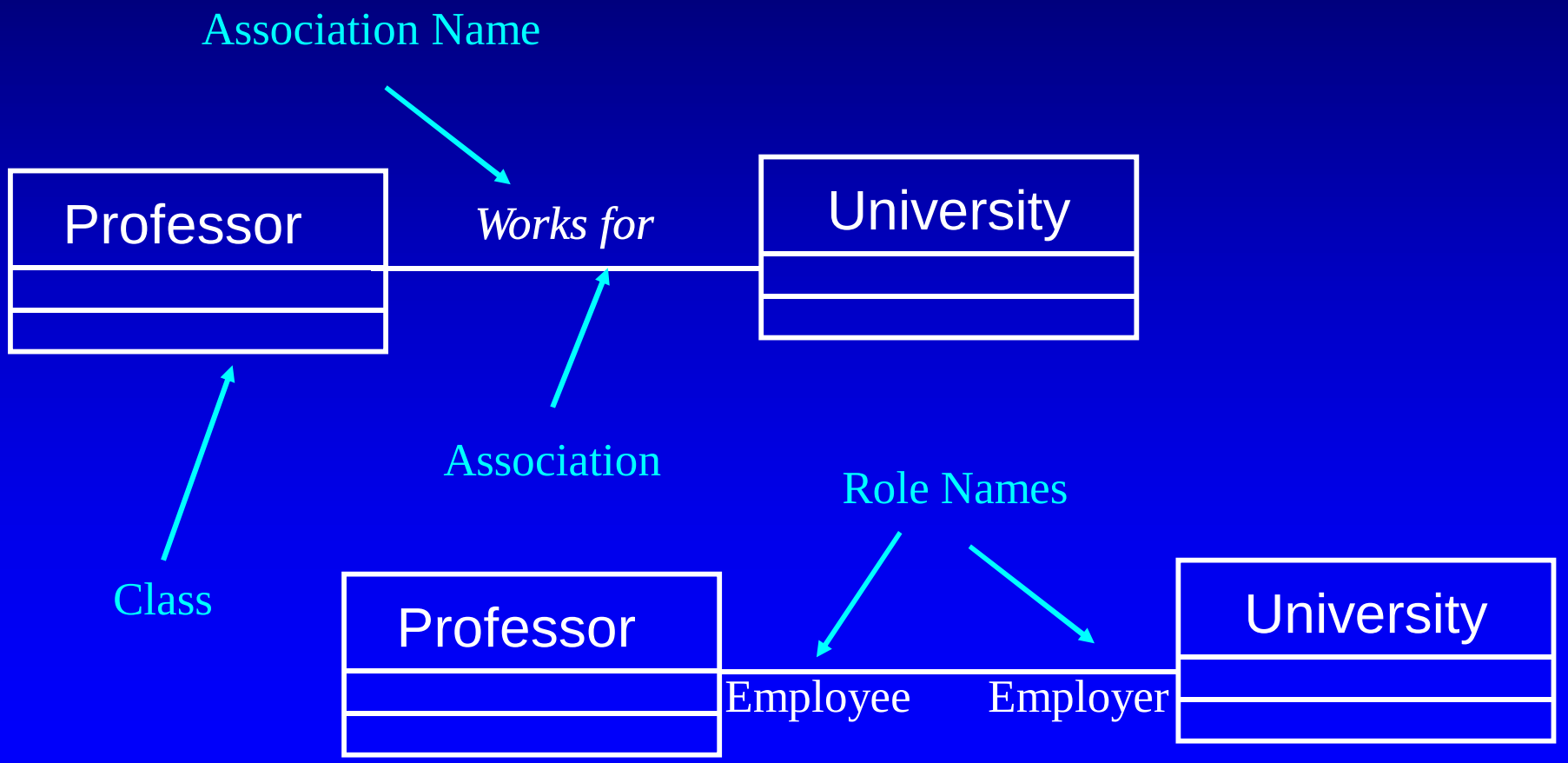
Relationships

- Association
  - Aggregation
  - Composition
- Dependency
- Generalization
- Realization



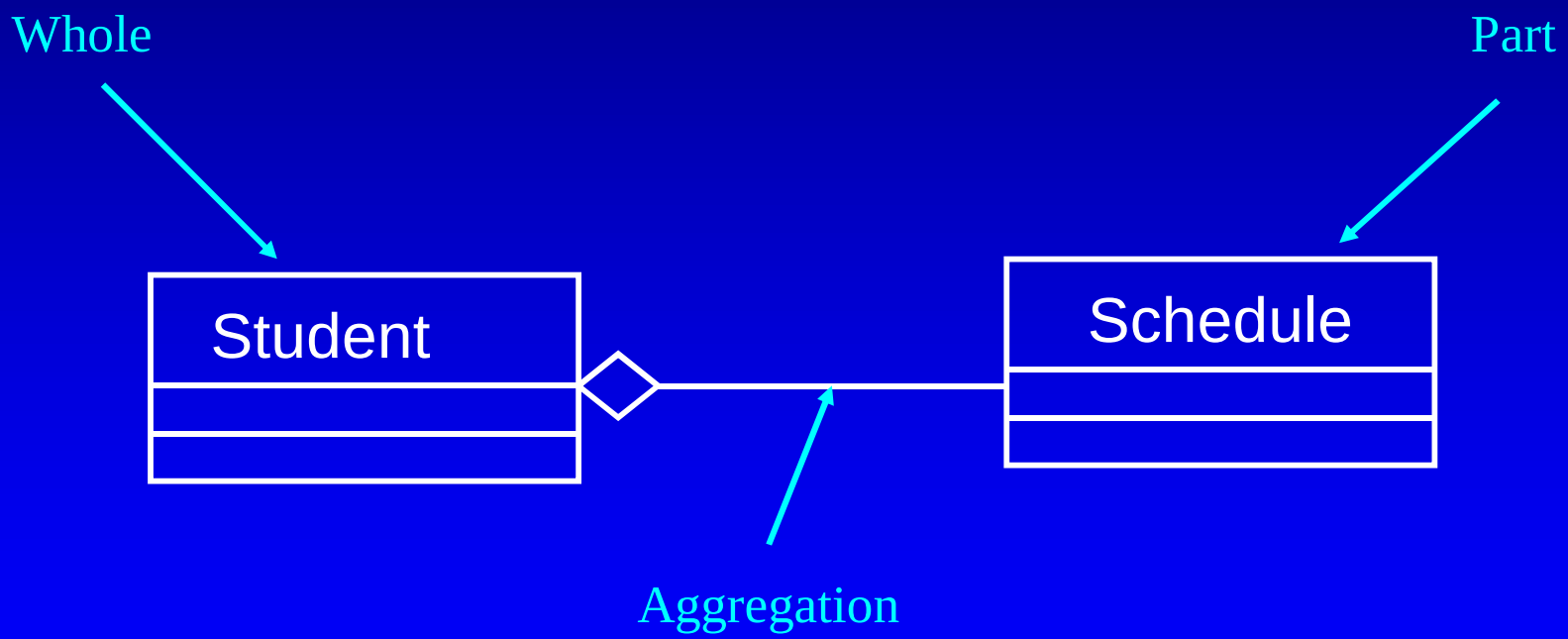
Relationships: Association

- Models a semantic connection among classes



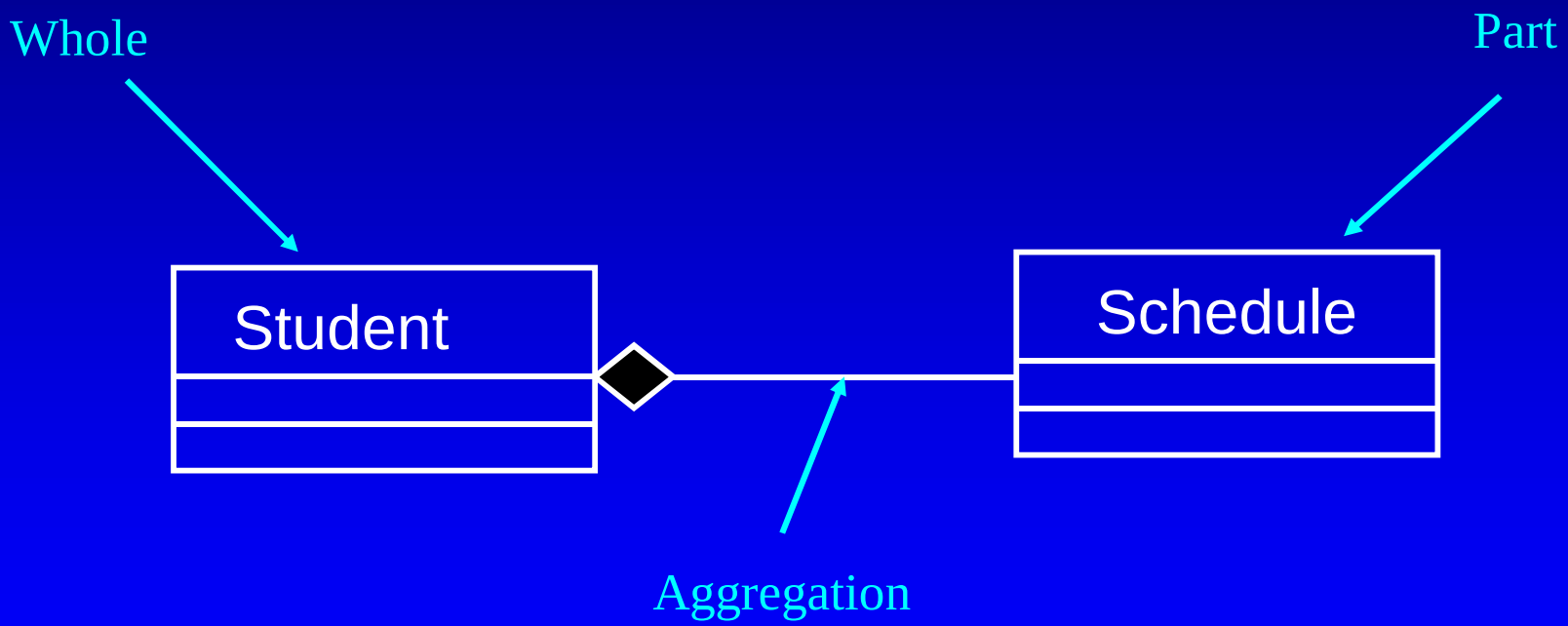
Relationships: Aggregation

- A special form of association that models a whole-part relationship between an aggregate (the whole) and its parts



Relationships: Composition

- A form of aggregation with strong ownership and coincident lifetimes
  - The parts cannot survive the whole/aggregate



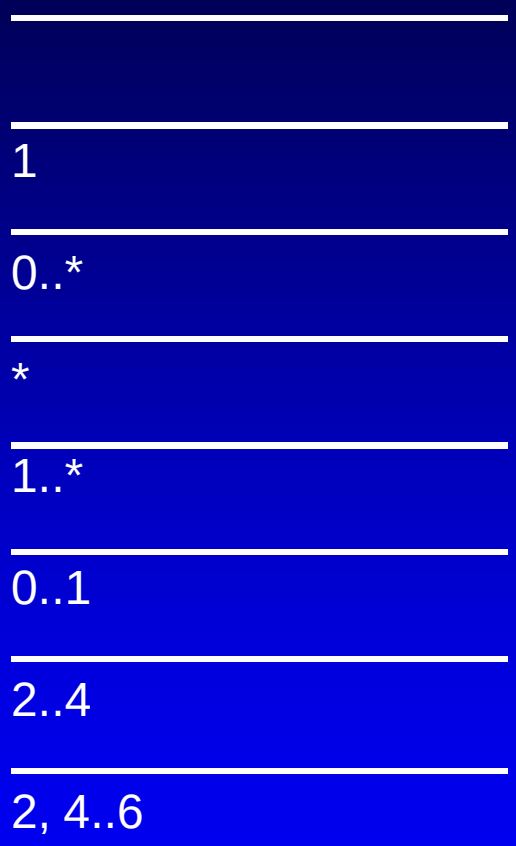
Association: Multiplicity and Navigation

- Multiplicity defines how many objects participate in a relationships
  - The number of instances of one class related to ONE instance of the other class
  - Specified for each end of the association
- Associations and aggregations are bi-directional by default, but it is often desirable to restrict navigation to one direction
  - If navigation is restricted, an arrowhead is added to indicate the direction of the navigation

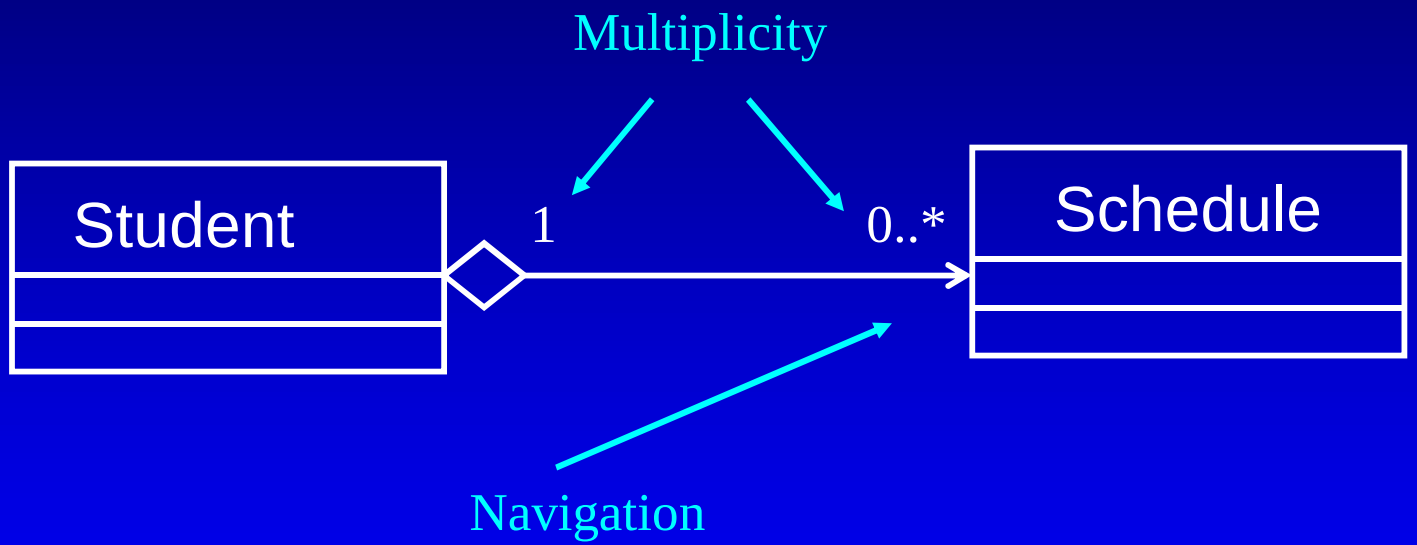
Association: Multiplicity

- Unspecified
- Exactly one
- Zero or more (many, unlimited)

- One or more
- Zero or one
- Specified range
- Multiple, disjoint ranges

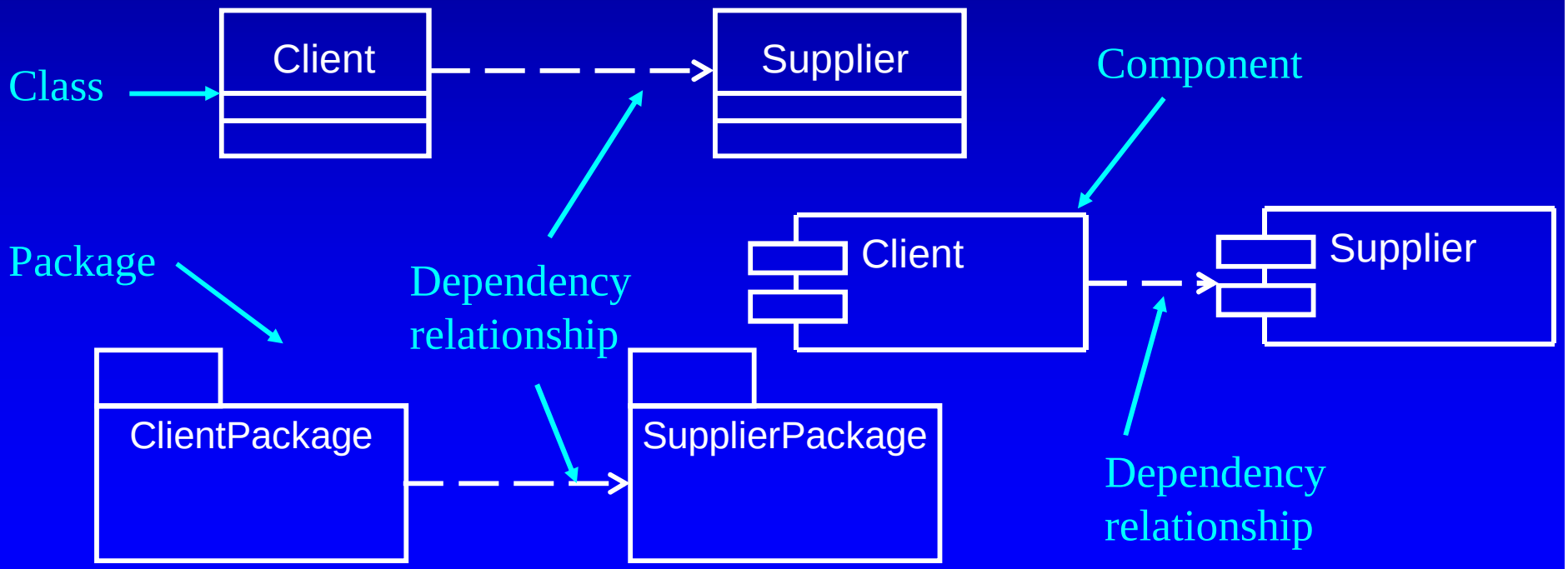


Example: Multiplicity and Navigation



Relationships: Dependency

- A relationship between two model elements where a change in one **may** cause a change in the other
- Non-structural, “using” relationship

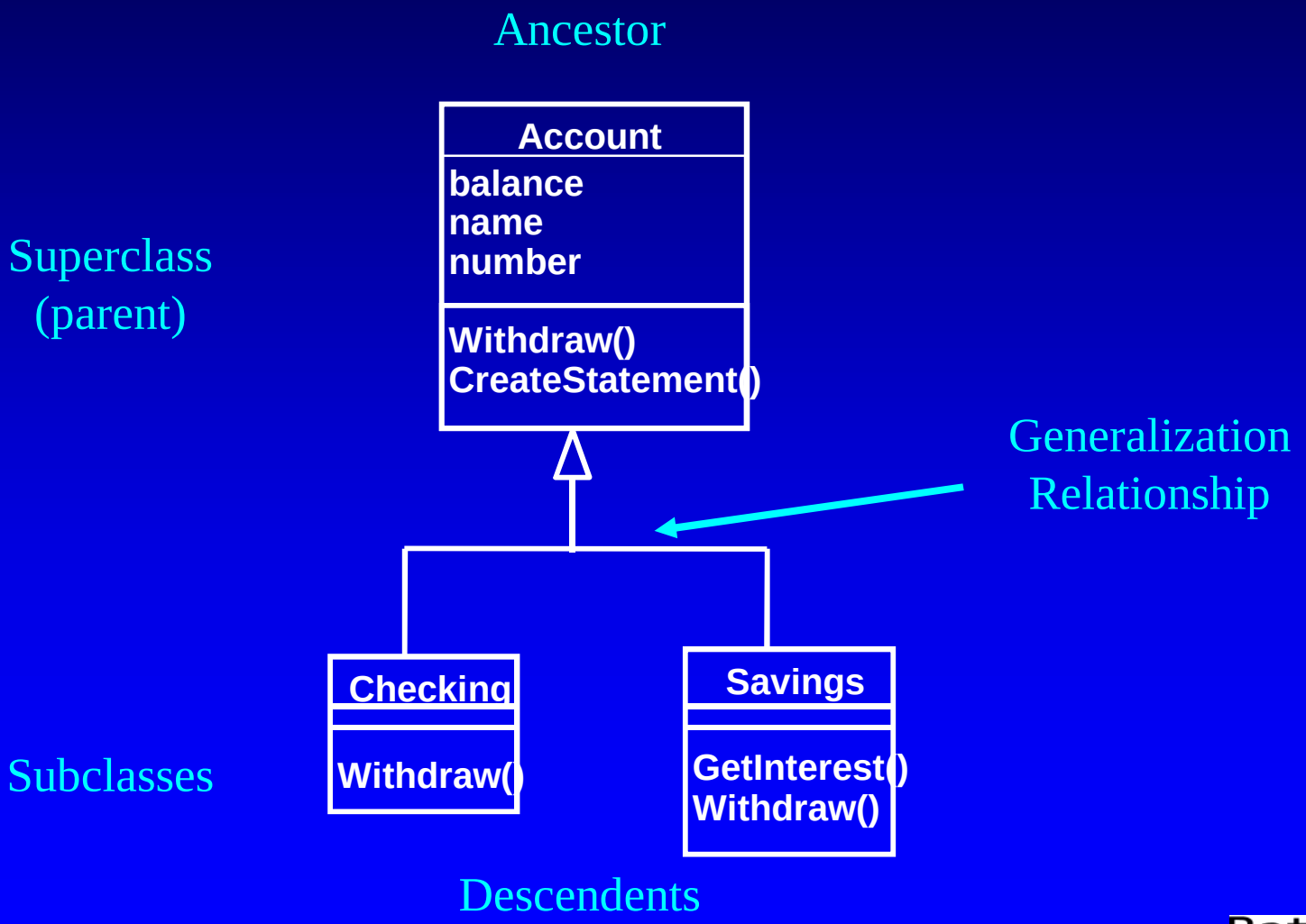


Relationships: Generalization

- A relationship among classes where one class shares the structure and/or behavior of one or more classes
- Defines a hierarchy of abstractions in which a subclass inherits from one or more superclasses
  - Single inheritance
  - Multiple inheritance
- Generalization is an “is-a-kind of” relationship

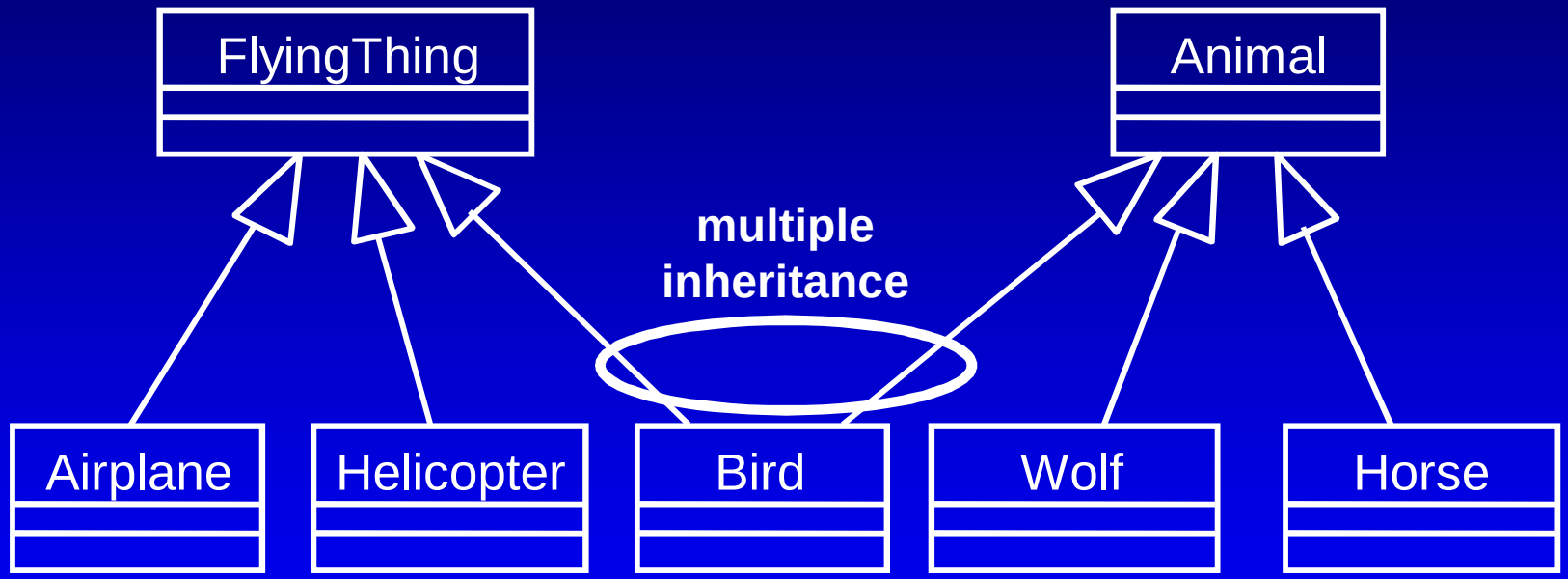
Example: Single Inheritance

- One class inherits from another



Example: Multiple Inheritance

- A class can inherit from several other classes



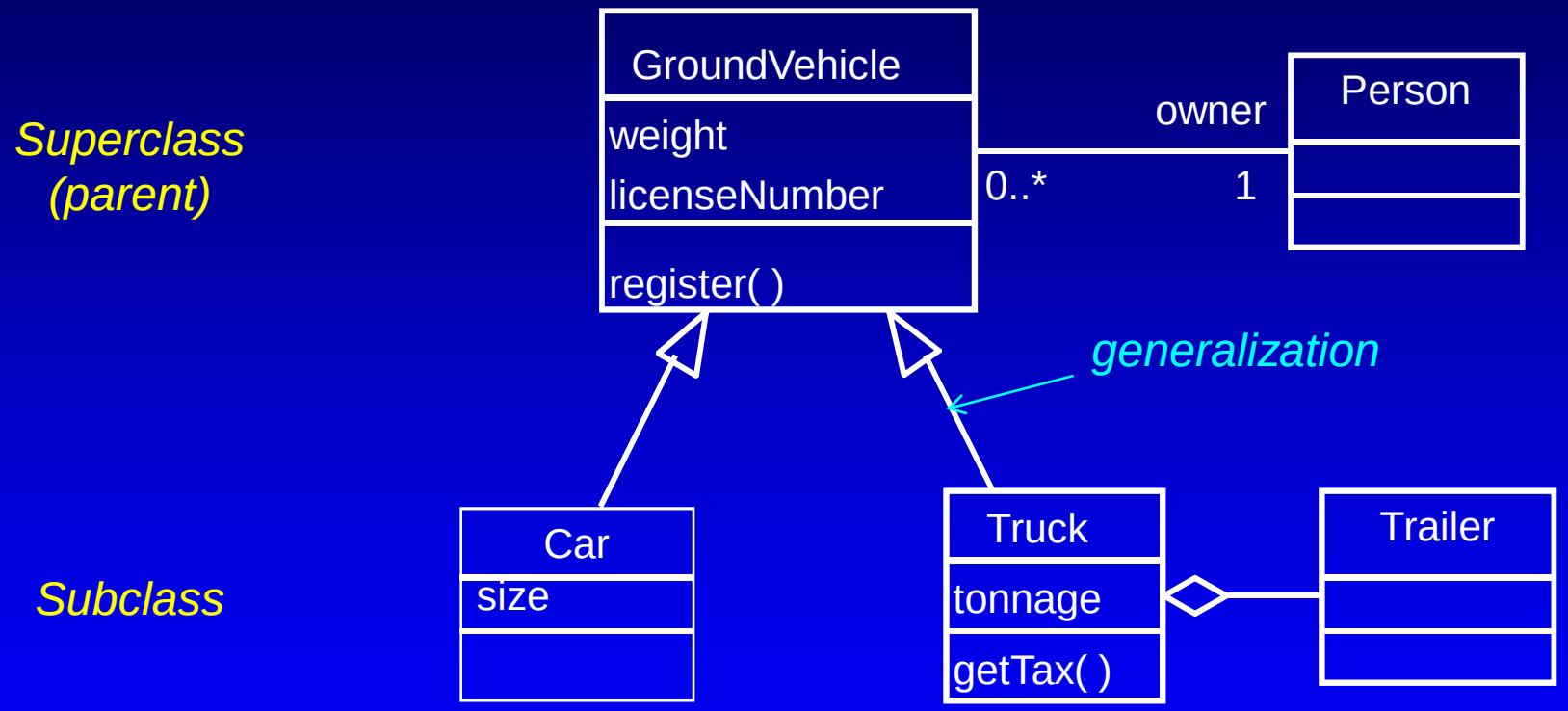
Use multiple inheritance only when needed, and always with caution !

What Gets Inherited?

- A subclass inherits its parent's attributes, operations, and relationships
- A subclass may:
  - Add additional attributes, operations, relationships
  - Redefine inherited operations (use caution!)
- Common attributes, operations, and/or relationships are shown at the highest applicable level in the hierarchy

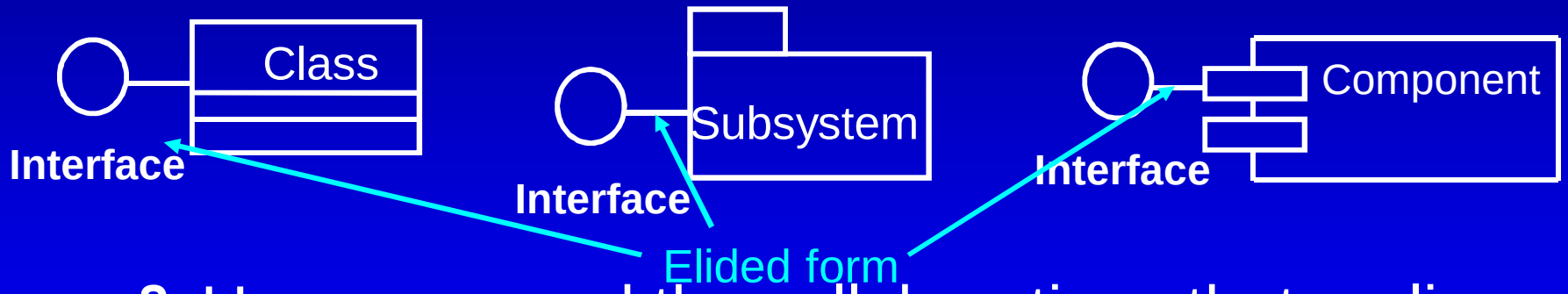
Inheritance leverages the similarities among classes

Example: What Gets Inherited

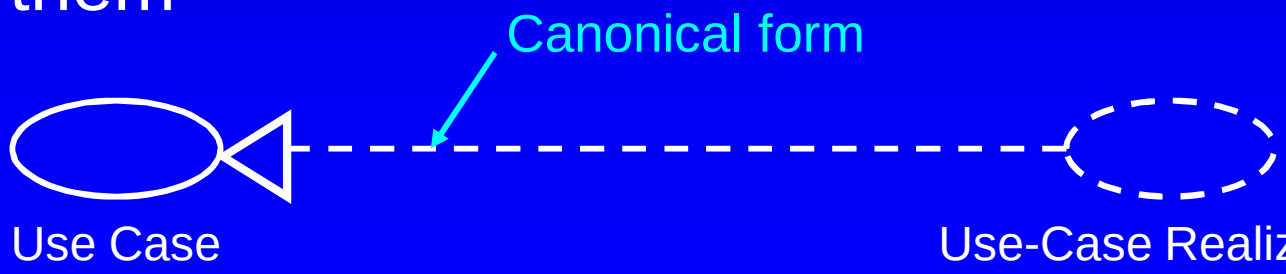


Relationships: Realization

- One classifier serves as the contract that the other classifier agrees to carry out
- Found between:
  - Interfaces and the classifiers that realize them



  - Use cases and the collaborations that realize them



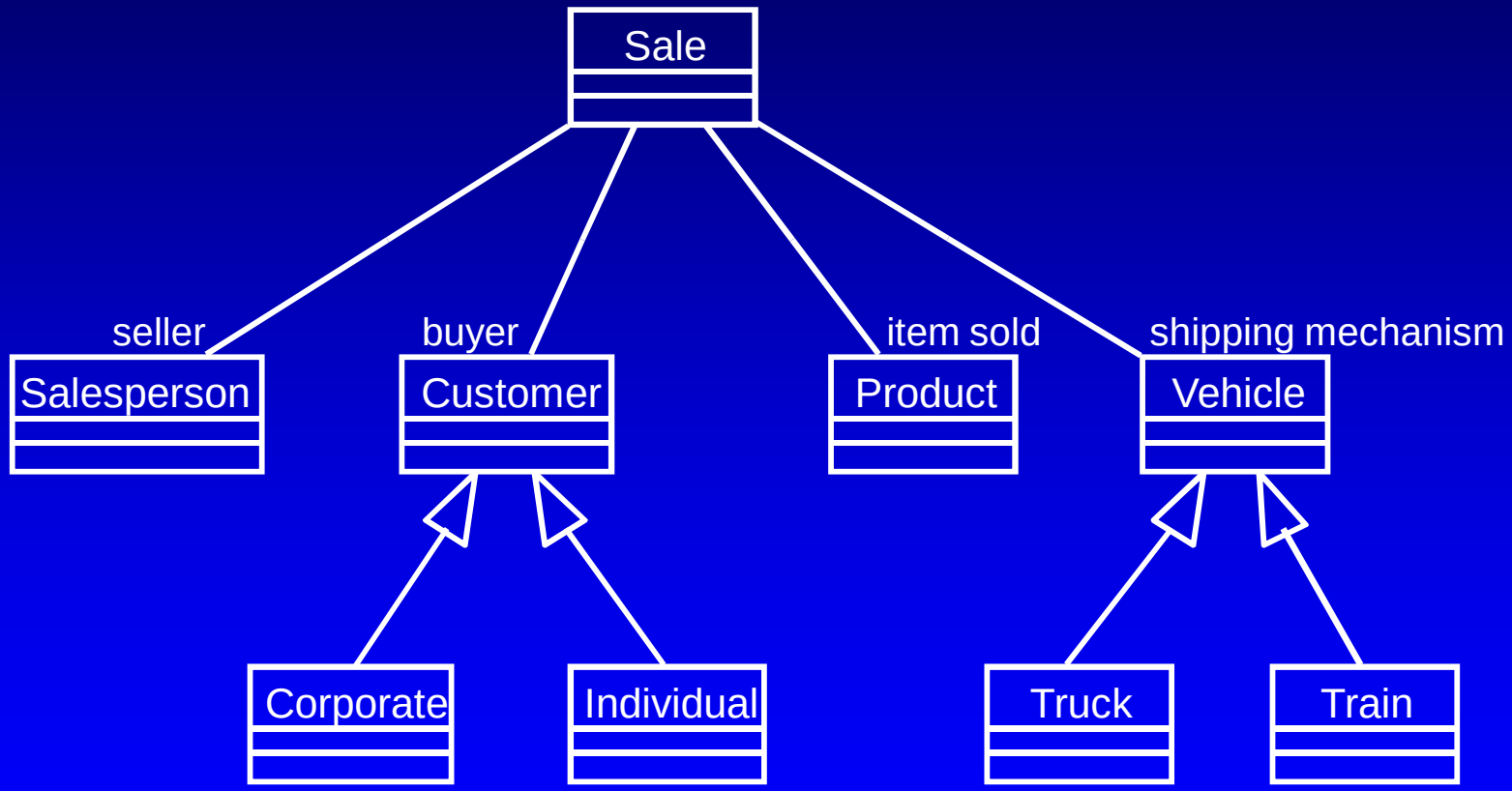
In

- Basic Principles of Object Orientation
- Basic Concepts of Object Orientation
- Strengths of Object Orientation
- General UML Modeling Mechanisms

Strengths of Object Orientation

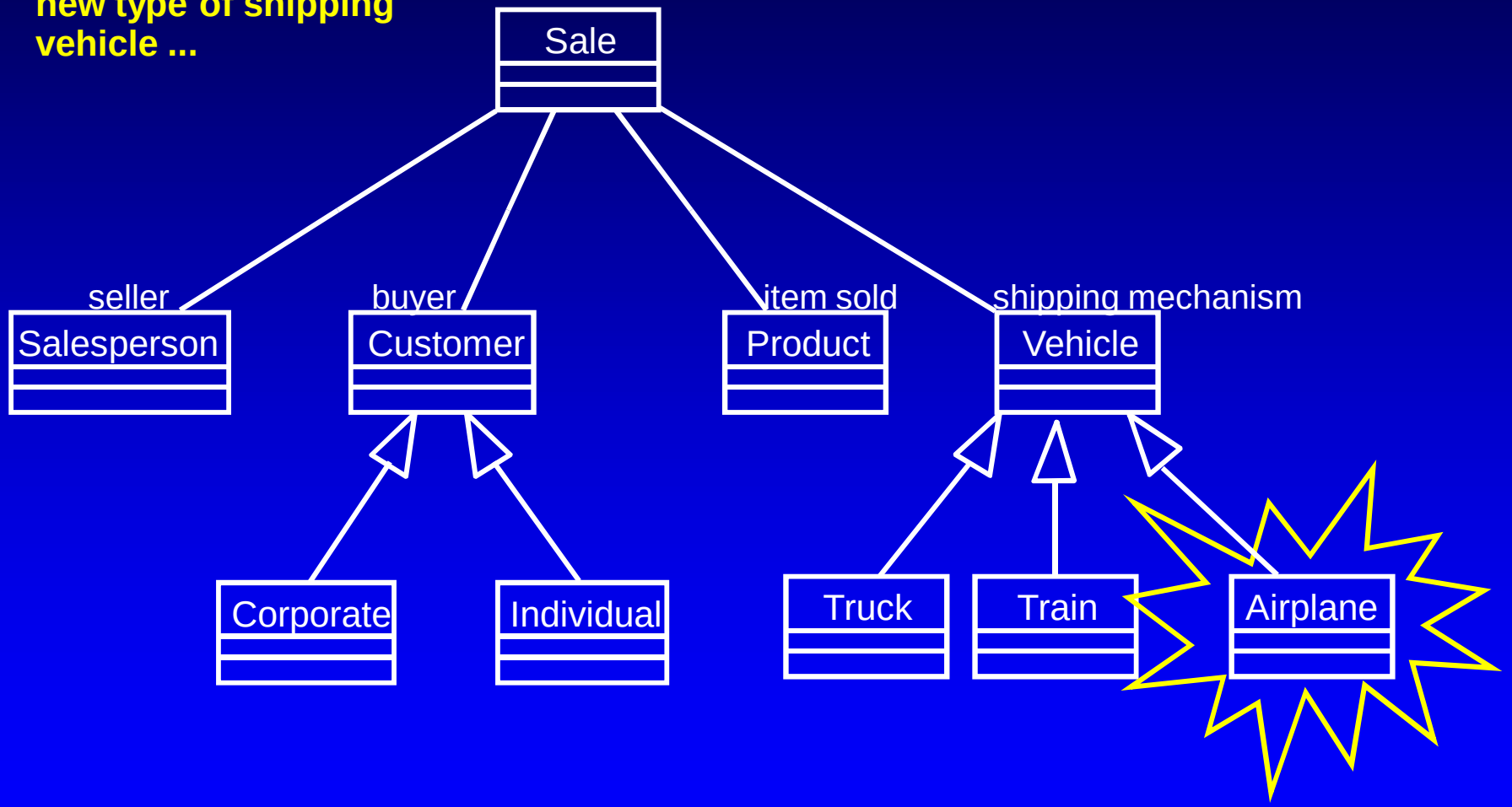
- A single paradigm
- Facilitates architectural and code reuse
- Models more closely reflect the real world
  - More accurately describe corporate data and processes
  - Decomposed based on natural partitioning
  - Easier to understand and maintain
- Stability
  - A small change in requirements does not mean massive changes in the system under development

Class Diagram for the Sales Example



Effect of Requirements Change

Suppose you need a new type of shipping vehicle ...



Change involves adding a new subclass

Introduction to Object Orientation Topics

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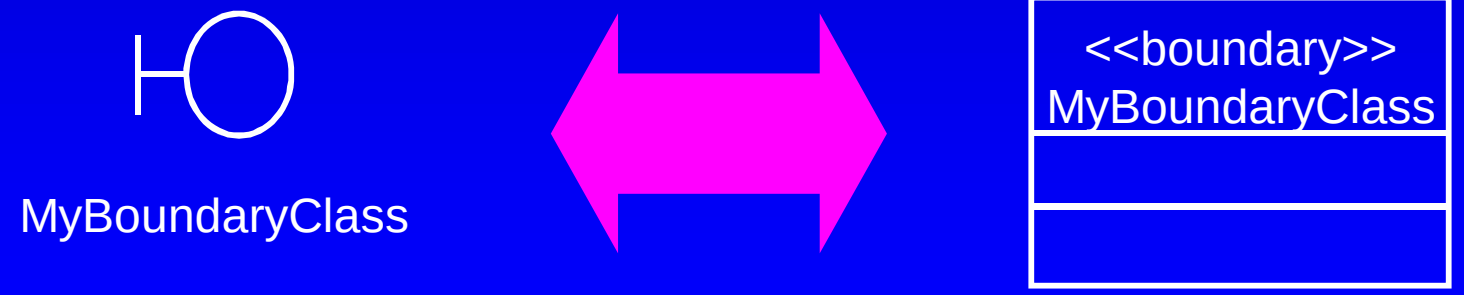
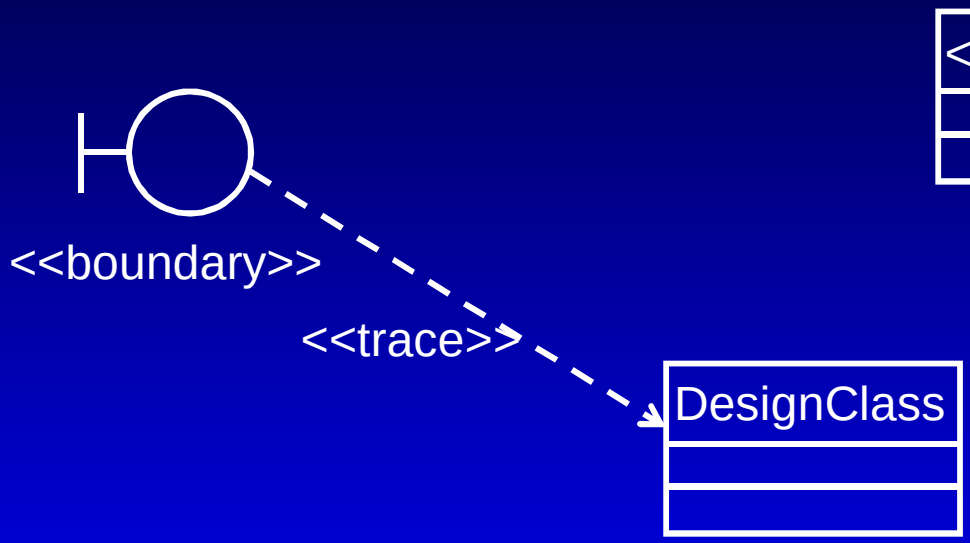
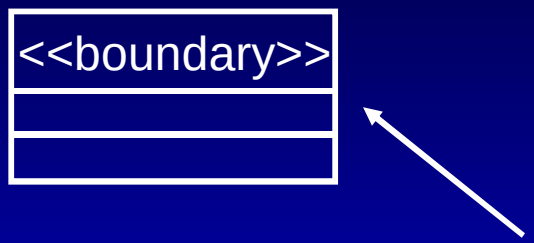
Stereotypes

- Classify and extend the UML notational elements
- Define a new model element in terms of another model element
- May be applied to all modeling elements
- Represented with name in guillemets or as a different icon



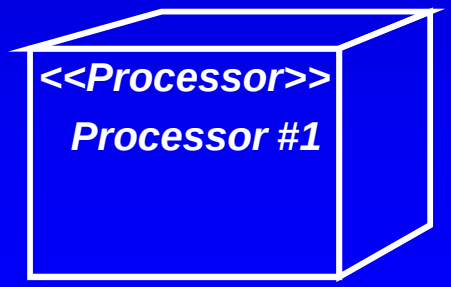
Example: Stereotypes

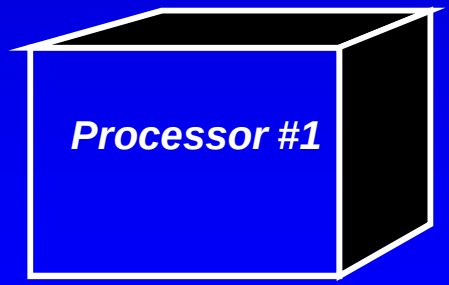




Sample boundary class (stereotype)
Stereotype of 'dependency relation'
Stereotype of <<Processor>>

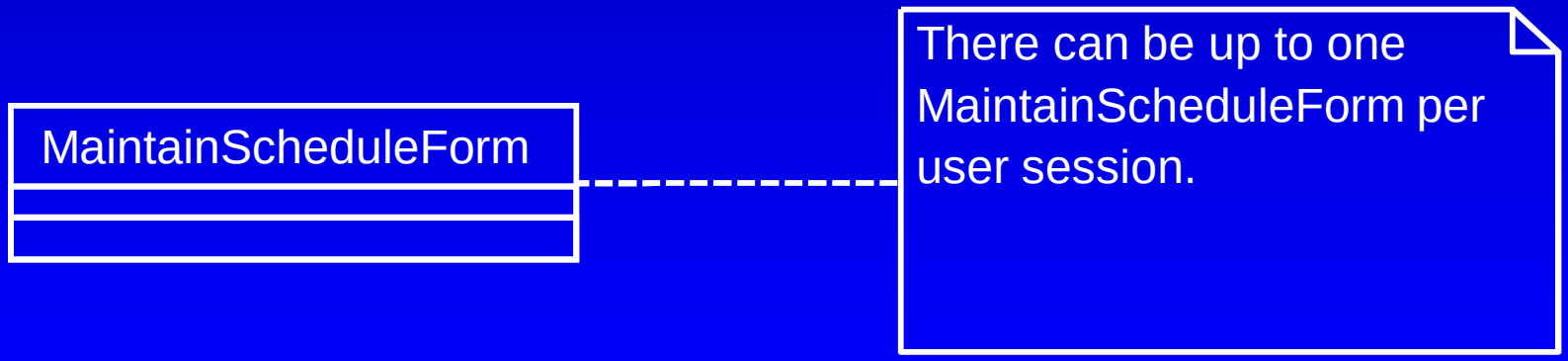
These create new symbols using accustomed graphics.





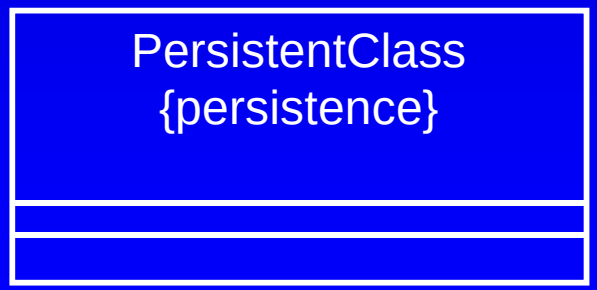
Notes

- A note can be added to any UML element
- Notes may be added to add more information to the diagram
- It is a ‘dog eared’ rectangle
- The note may be anchored to an element with a dashed line



Tagged Values

- Extensions of the properties, or specific attributes, of a UML element
- Some properties are defined by UML
  - Persistence
  - Location (e.g., client, server)
- Properties can be created by UML modelers for any purpose



Constraints

- Supports the addition of new rules or modification of existing rules

This notation is used to capture two relationships between Professor-type objects and Department-type objects; where one relationship is a subset of another….

Shows how UML can be tailored to correctly modeling exact relationships….

Review: Introduction to Object Orientation

- What are the four basic principles of object orientation? Provide a brief description of each.
- What is an Object and what is a Class? What is the difference between them?
- What is an Attribute?
- What is an Operation?
- What is an Interface? What is Polymorphism?
- What is a Component?

(continued)

Review: Introduction to Object Orientation (cont.)

- What is a Package?
- What is Subsystem? How does it relate to a Component? How does it relate to a package? How does it relate to a class?
- Name the 4 basic UML relationships and describe each.
- Describe the strengths of object orientation.
- Name and describe some general UML mechanisms.
- What are stereotypes? Name some common uses of stereotypes.