

# Object-Oriented Systems Analysis and Design Using UML

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Systems Analysis and Design,  
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# Object-Oriented Analysis and Design

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- Works well in situations where complicated systems are undergoing continuous maintenance, adaptation, and design
- Objects, classes and reusability
- The Unified Modeling Language (UML) is an industry standard for modeling object-oriented systems

# Object-Oriented Analysis and Design (Continued)

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- Reusability
  - Recycling of program parts should reduce the costs of development in computer-based systems
- Maintaining systems
  - Making a change in one object has a minimal impact on other objects

# Major Topics

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- Object-oriented concepts
- CRC Cards and object
- Unified Modeling Language
- Use case and other UML diagrams
- Packages
- Using UML

# Object-Oriented Concepts

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- Objects
- Classes
- Inheritance

# Objects

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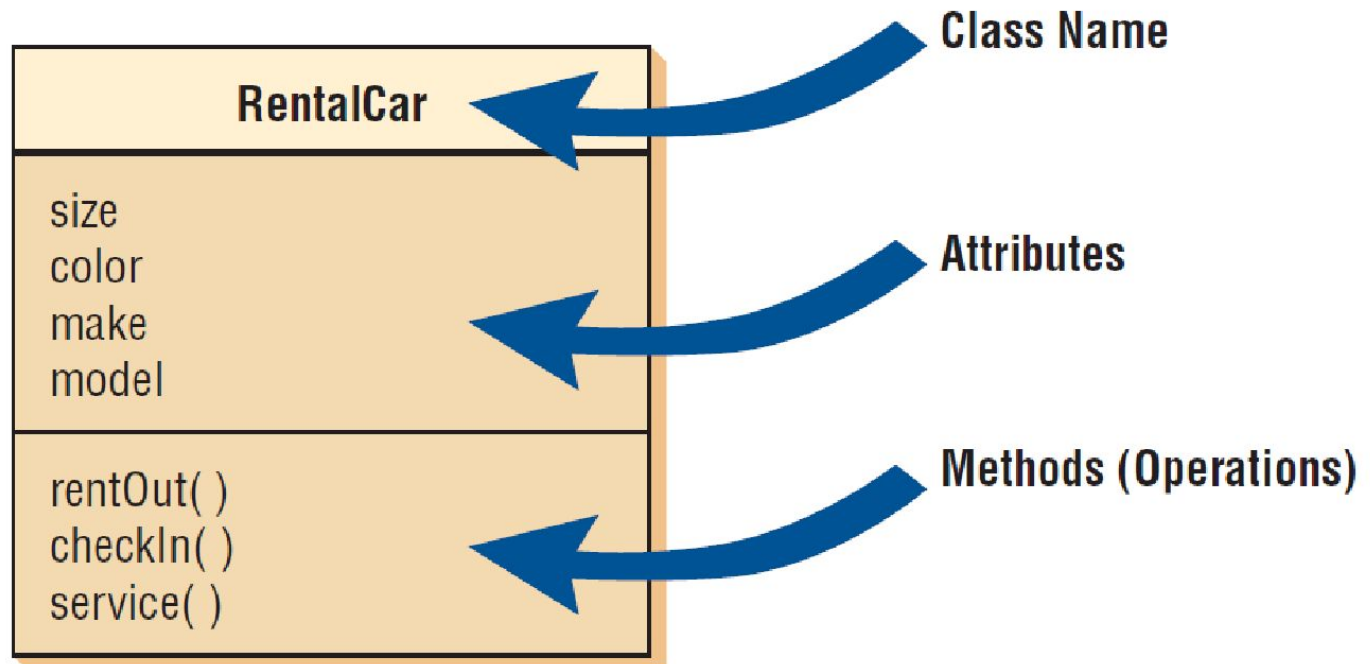
- Persons, places, or things that are relevant to the system being analyzed
- May be customers, items, orders and so on
- May be GUI displays or text areas on a display

# Classes

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- Defines the set of shared attributes and behaviors found in each object in the class
- Should have a name that differentiates it from all other classes
- Instantiate is when an object is created from a class
- An attributes describes some property that is possessed by all objects of the class
- A method is an action that can be requested from any object of the class

**Figure 18.1** An example of a UML class. A class is depicted as a rectangle consisting of the class name, attributes, and methods

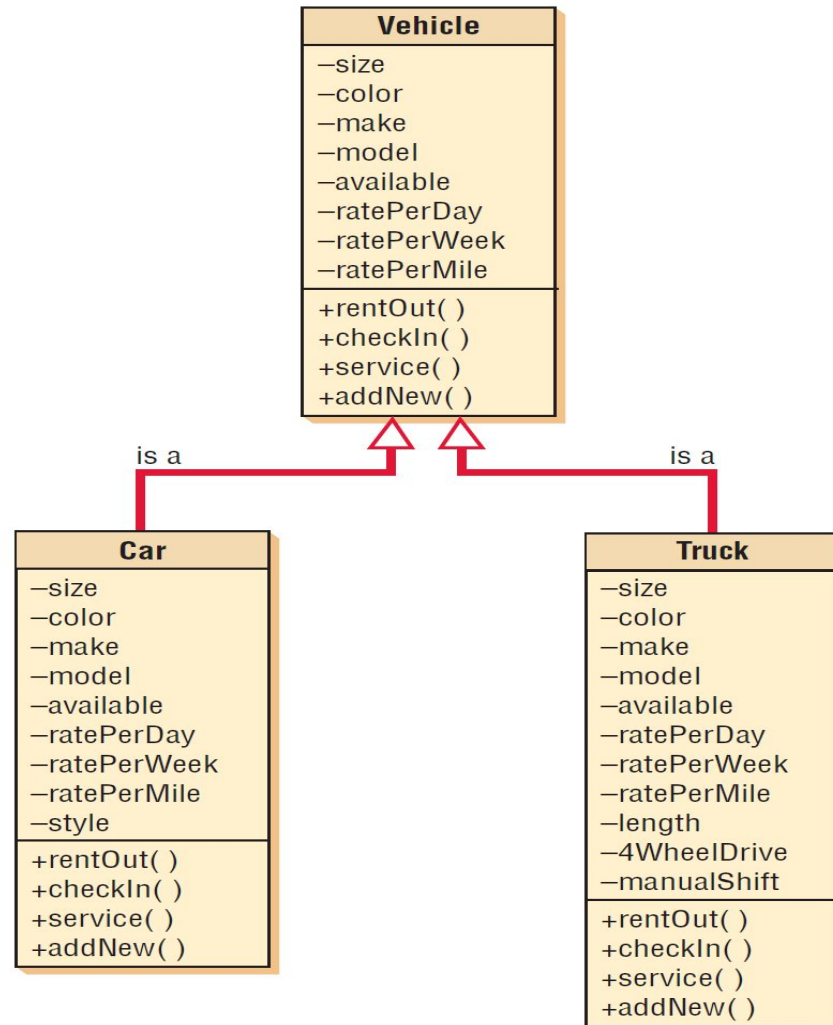


# Inheritance

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- When a derived class inherits all the attributes and behaviors of the base class
- Reduces programming labor by using common objects easily
- A feature only found in object-oriented systems

**Figure 18.2** A class diagram showing inheritance. Car and truck are specific examples of vehicles and inherit the characteristics of the more general class vehicle



# CRC Cards and Object Think

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- CRC
  - Class
  - Responsibilities
  - Collaborators
- CRC cards are used to represent the responsibilities of classes and the interaction between the classes

CRC cards for course offerings show how analysts fill in the details for classes, responsibilities, and collaborators, as well as for object think statements and property names

<b>Class Name:</b> <i>Department</i>			
<b>Superclasses:</b>			
<b>Subclasses:</b>			
<b>Responsibilities</b>	<b>Collaborators</b>	<b>Object Think</b>	<b>Property</b>
<i>Add a new department</i>	<i>Course</i>	<i>I know my name</i>	<i>Department Name</i>
<i>Provide department information</i>		<i>I know my department chair</i>	<i>Chair Name</i>

<b>Class Name:</b> <i>Course</i>			
<b>Superclasses:</b>			
<b>Subclasses:</b>			
<b>Responsibilities</b>	<b>Collaborators</b>	<b>Object Think</b>	<b>Property</b>
<i>Add a new course</i>	<i>Department</i>	<i>I know my course number</i>	<i>Course Number</i>
<i>Change course information</i>	<i>Textbook</i>	<i>I know my description</i>	<i>Course Description</i>
<i>Display course information</i>	<i>Assignment</i>	<i>I know my number of credits</i>	<i>Credits</i>
	<i>Exam</i>		

# Interacting during a CRC Session

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- Identify all the classes you can
- Creating scenarios
- Identify and refine responsibilities

# The Unified Modeling Language (UML) Concepts and Diagrams

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- Things
- Relationships
- Diagrams

UML Category	UML Elements	Specific UML Details
Things	Structural Things	Classes Interfaces Collaborations Use Cases Active Classes Components Nodes
	Behavioral Things	Interactions State Machines
	Grouping Things	Packages
	Annotational Things	Notes
Relationships	Structural Relationships	Dependencies Aggregations Associations Generalizations
	Behavioral Relationships	Communicates Includes Extends Generalizes
Diagrams	Structural Diagrams	Class Diagrams Component Diagrams Deployment Diagrams
	Behavioral Diagrams	Use Case Diagrams Sequence Diagrams Communication Diagrams Statechart Diagrams Activity Diagrams

# Commonly Used UML Diagrams

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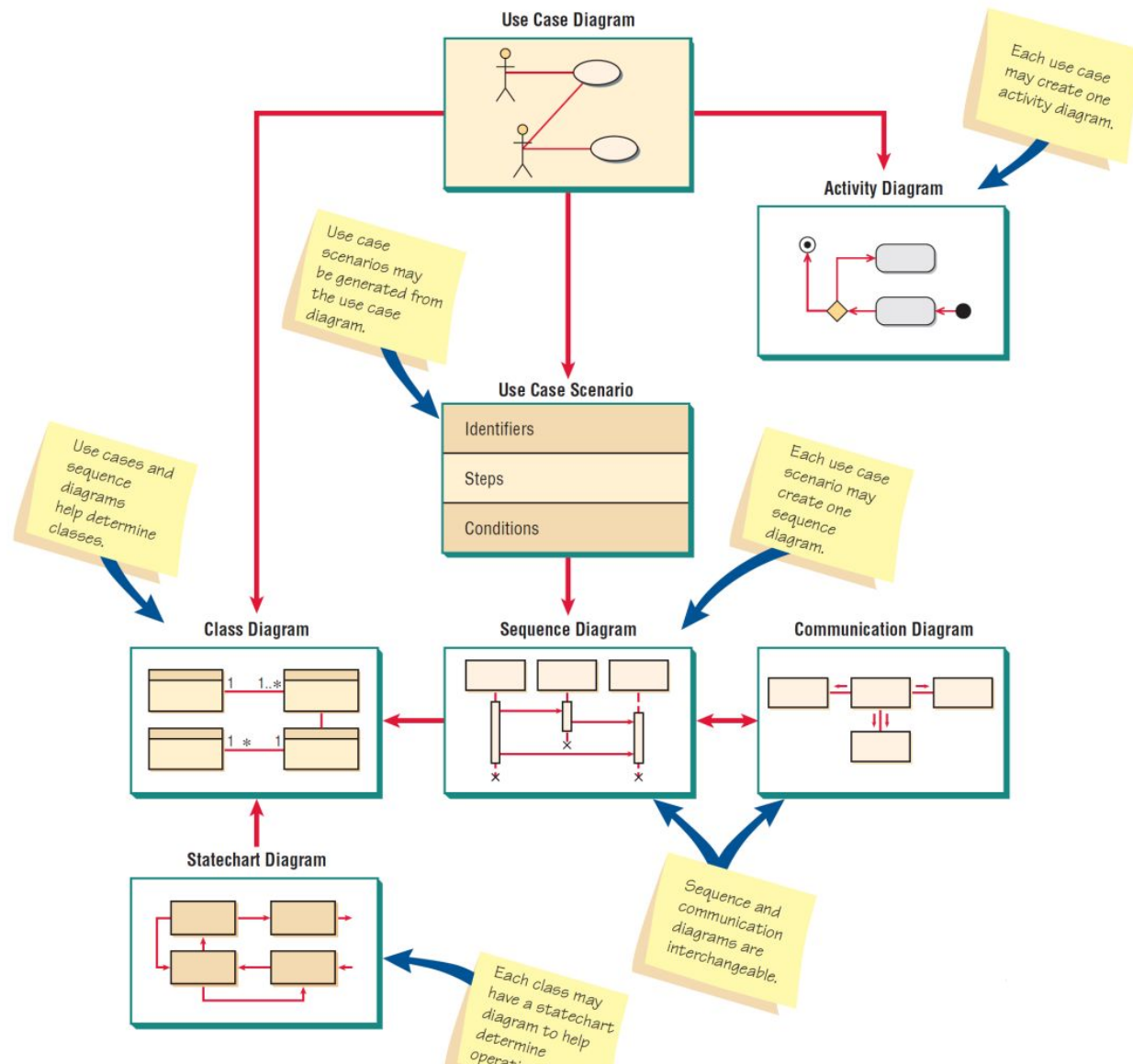
- Use case diagram
  - Describing how the system is used
  - The starting point for UML modeling
- Use case scenario
  - A verbal articulation of exceptions to the main behavior described by the primary use case
- Activity diagram
  - Illustrates the overall flow of activities

# Commonly Used UML Diagrams (Continued)

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- Sequence diagrams
  - Show the sequence of activities and class relationships
- Class diagrams
  - Show classes and relationships
- Statechart diagrams
  - Show the state transitions

**Figure 18.5** An overview of UML diagrams showing how each diagram leads to the development of other UML diagrams

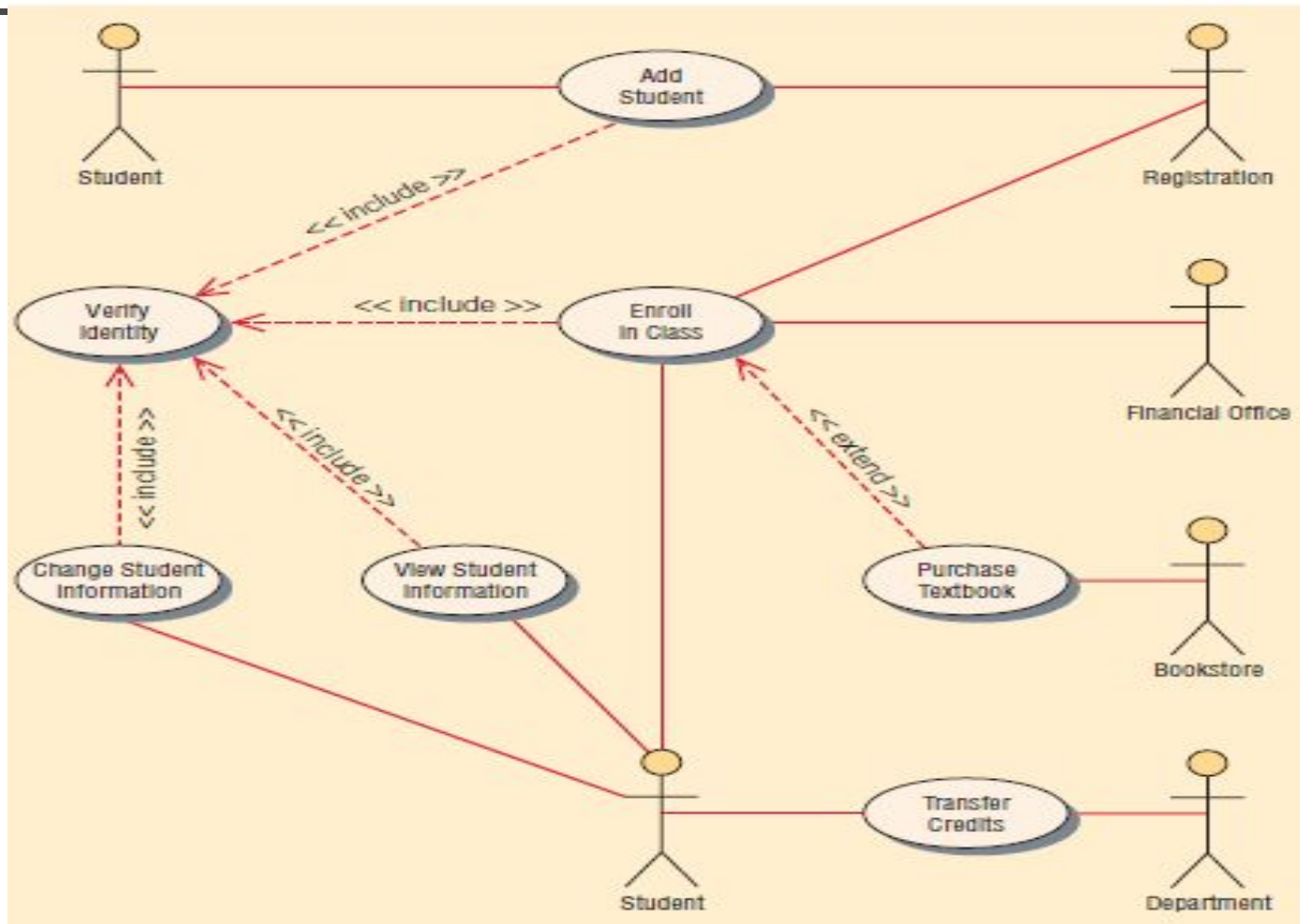


# Use Case Modeling

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- Describes what the system does, without describing how the system does it
- Based on the interactions and relationships of individual use cases
- Use case describes
  - Actor
  - Event
  - Use case

# Figure 18.6 A use case example of student enrollment

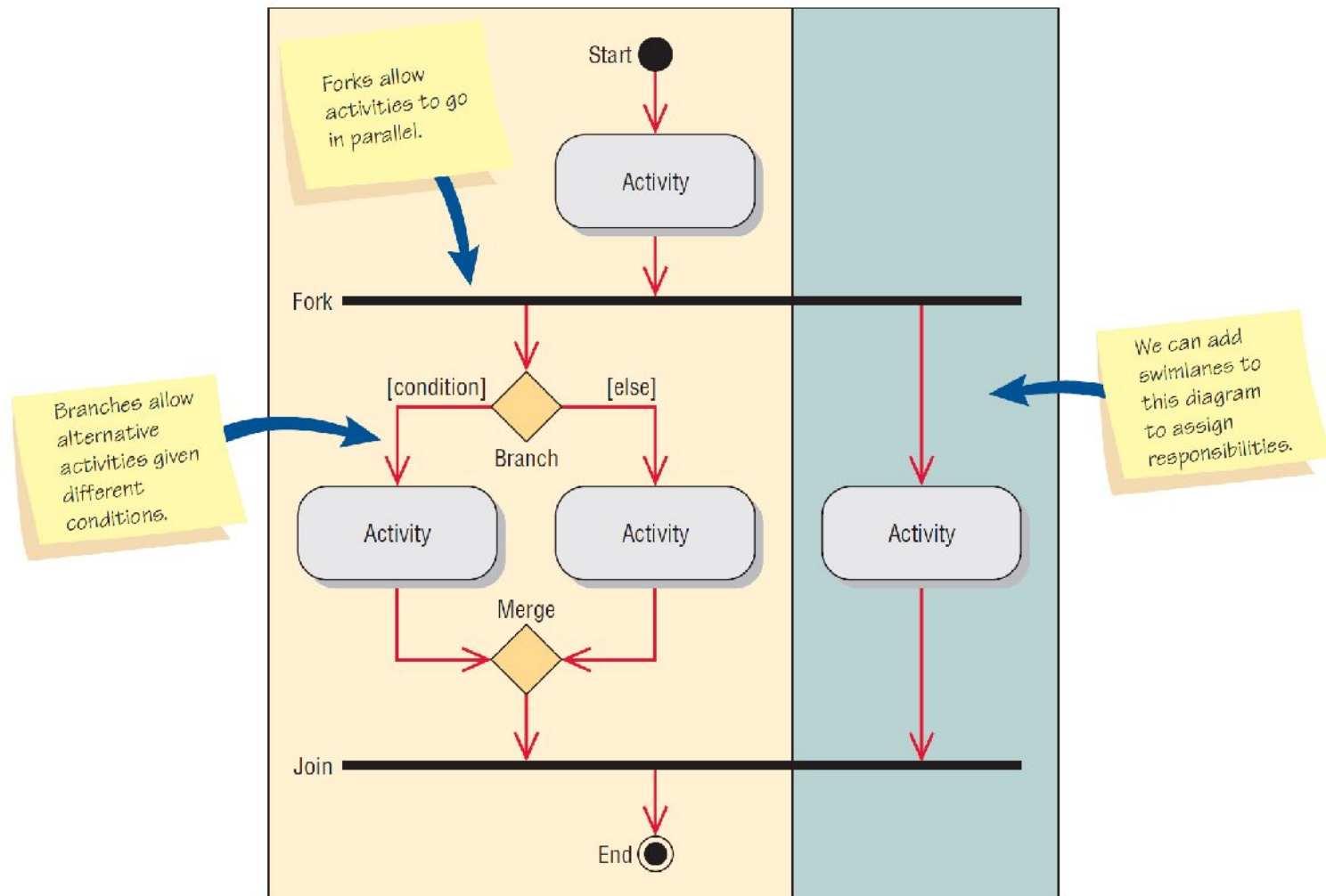


# Activity Diagrams

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- Show the sequence of activities in a process, including sequential and parallel activities, and decisions that are made
- Symbols
  - Rectangle with rounded ends
  - Arrow
  - Diamond
  - Long, flat rectangle
  - Filled-in circle
  - Black circle surrounded by a white circle
  - Swimlanes

# Figure 18.8 Specialized symbols are used to draw an activity diagram



# Creating Activity Diagrams

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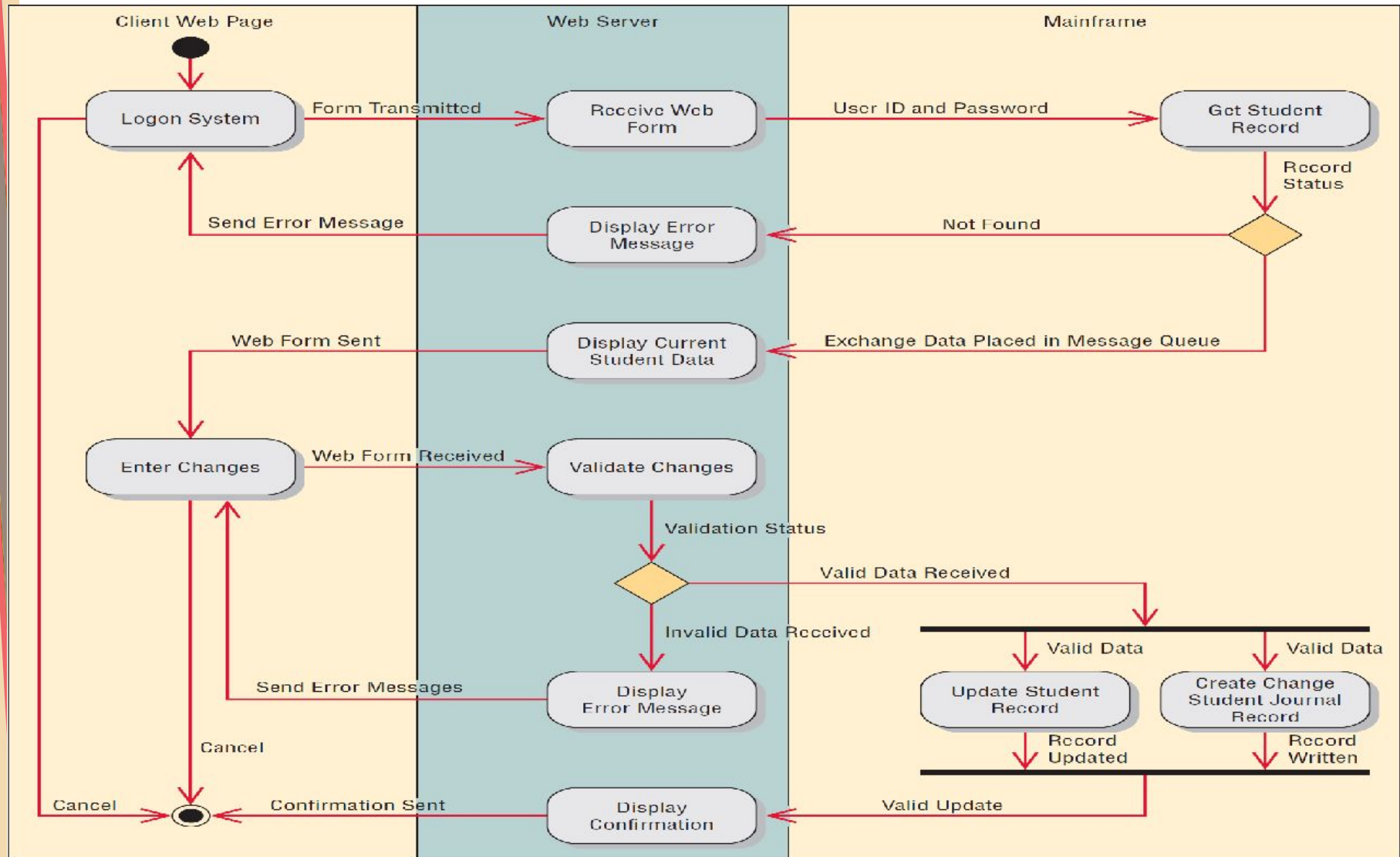
- Created by asking what happens first, what happens second, and so on
- Must determine what activities are done in sequence or in parallel
- The sequence of activities can be determined from physical data flow diagrams
- Can be created by examining all the scenarios for a use case

# Swimlanes

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- Useful to show how the data must be transmitted or converted
- Help to divide up the tasks in a team
- Makes the activity diagram one that people want to use to communicate with others

# This activity diagram shows three swimlanes: Client Web Page, Web Server, and Mainframe

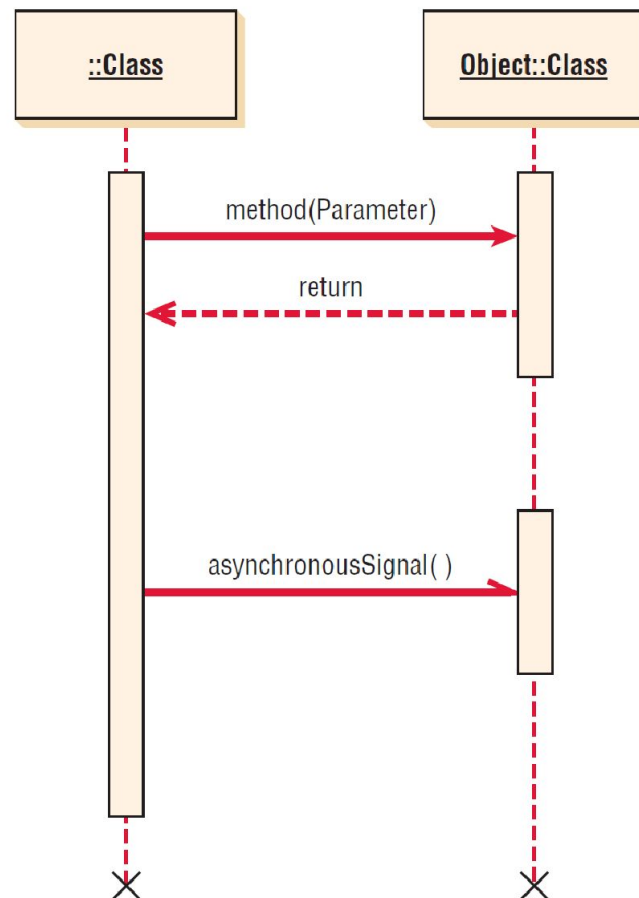


# Sequence Diagrams

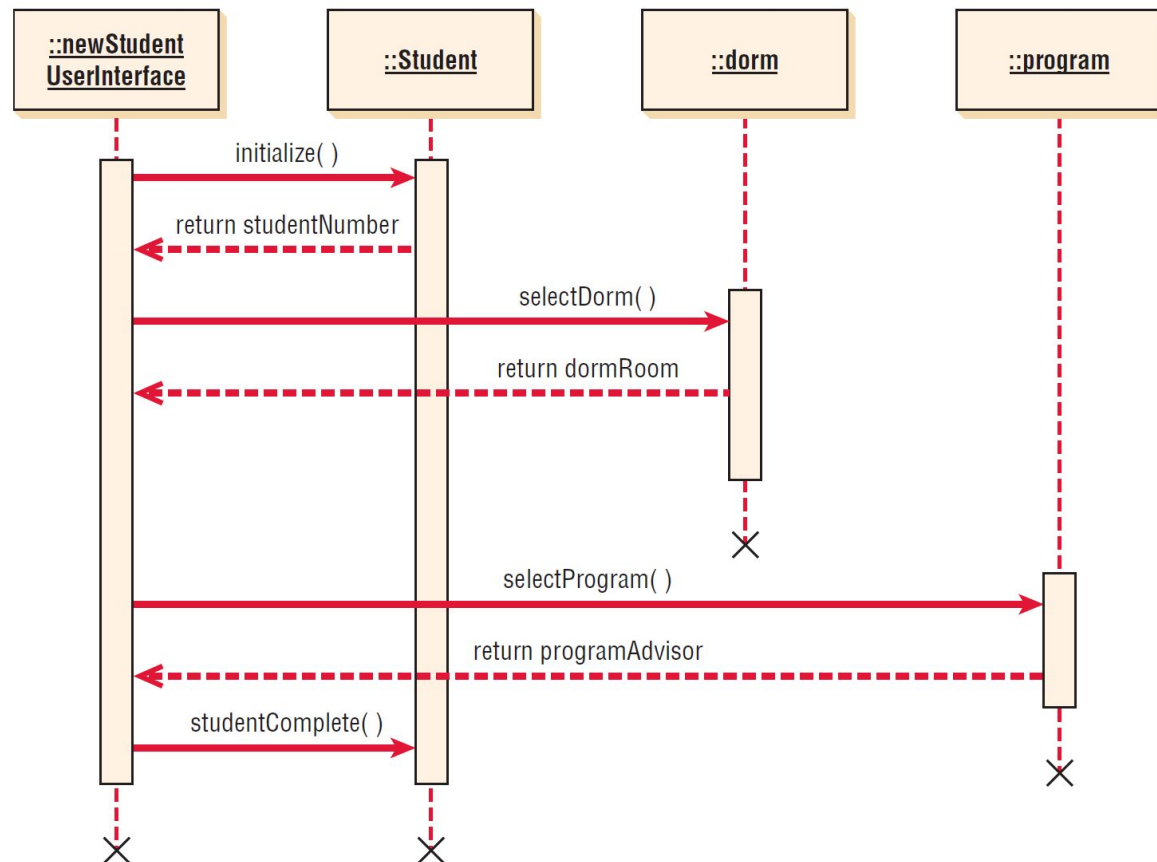
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- Illustrate a succession of interactions between classes or object instances over time
- Often used to show the processing described in use case scenarios
- Used to show the overall pattern of the activities or interactions in a use case

# Figure 18.10 Specialized symbols used to draw a Sequence Diagram



**Figure 18.11** A sequence diagram for student admission. Sequence diagrams emphasize the time ordering of messages



# Class Diagrams

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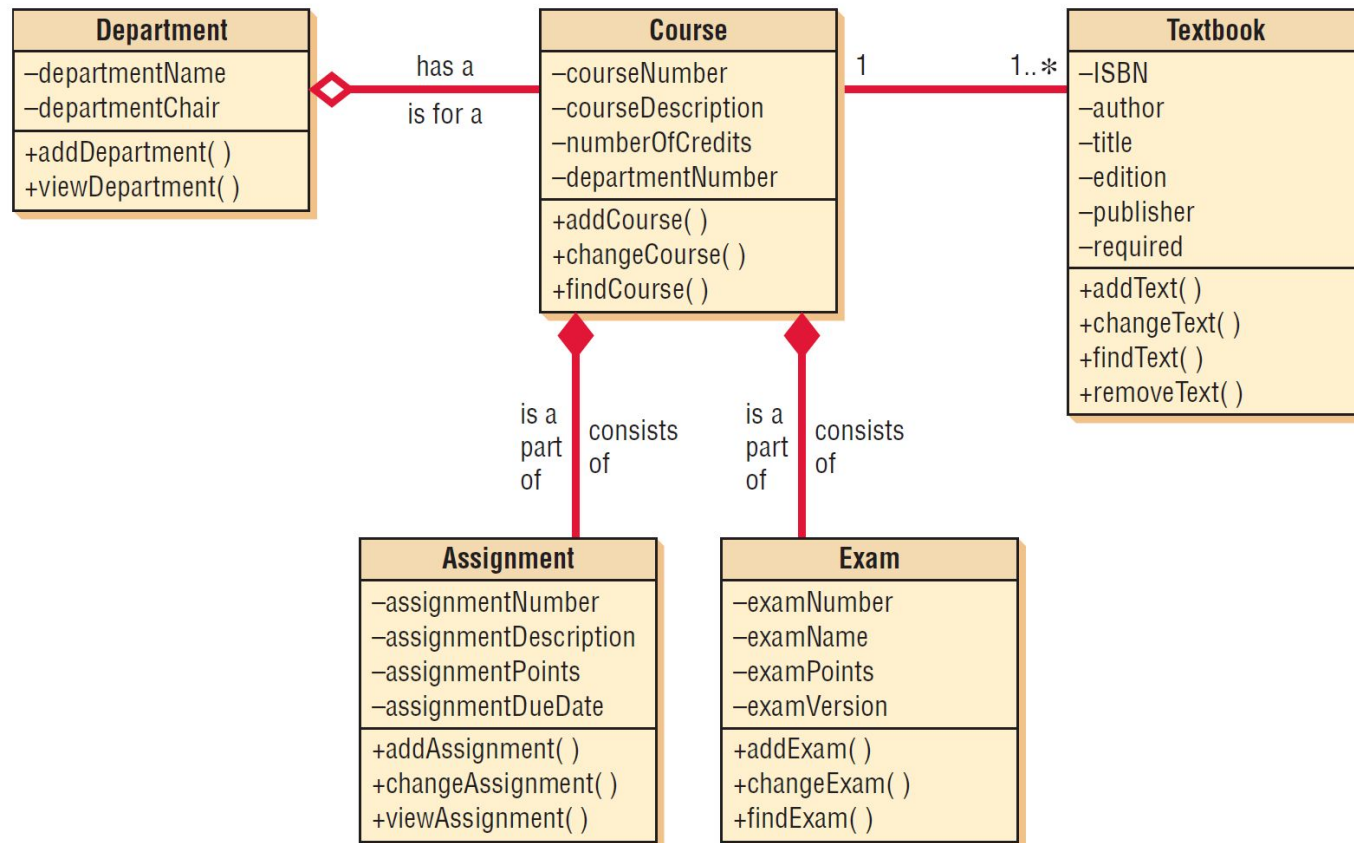
- Show the static features of the system and do not represent any particular processing
- Shows the nature of the relationships between classes
- Shows data storage requirements as well as processing requirements

# Class Diagrams (Continued)

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- Classes
- Attributes
  - Private
  - Public
  - Protected
- Methods
  - Standard
  - Custom

**Figure 18.13** A class diagram for course offerings. The filled-in diamonds show aggregation and the empty diamond shows a whole-part relationship



# Method Overloading

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- Including the same method (or operation) several times in a class
- The same method may be defined more than once in a given class, as long as the parameters sent as part of the message are different

# Types of Classes

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- Entity classes
- Interface classes
- Abstract classes
- Control classes

# Entity Classes

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- Represent real-world items
- The entities represented on an entity-relationship diagram

# Interface or Boundary Classes

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- Provide a means for users to work with the system
- Human interfaces may be a display, window, Web form, dialogue box, touch-tone telephone, or other way for users to interact with the system
- System interfaces involve sending data to or receiving data from other

# Abstract Classes

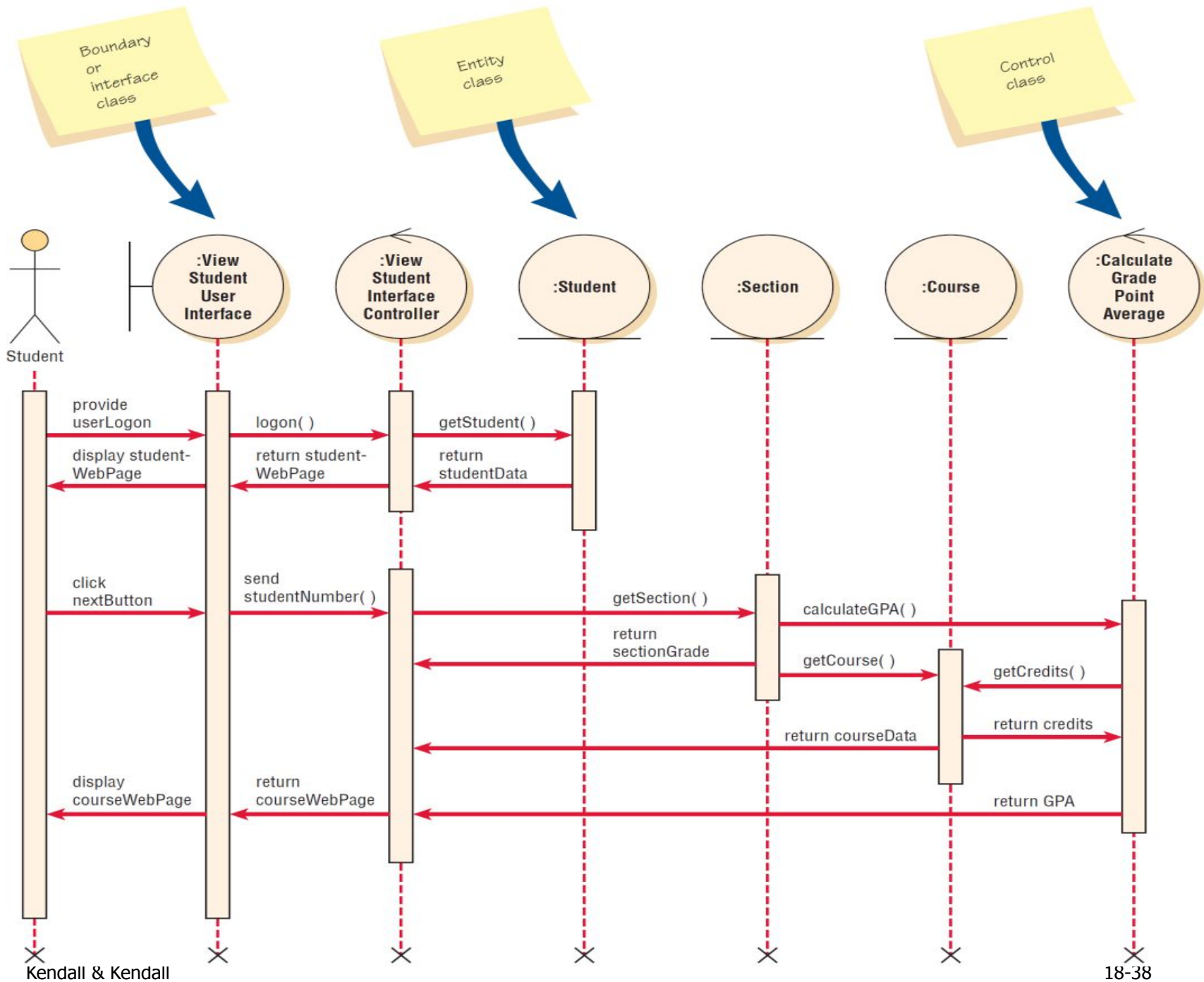
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- Linked to concrete classes in a generalization/specialization relationship
- Cannot be directly instantiated

# Control Classes

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- Used to control the flow of activities
- Many small control classes can be used to achieve classes that are reusable



# Relationships

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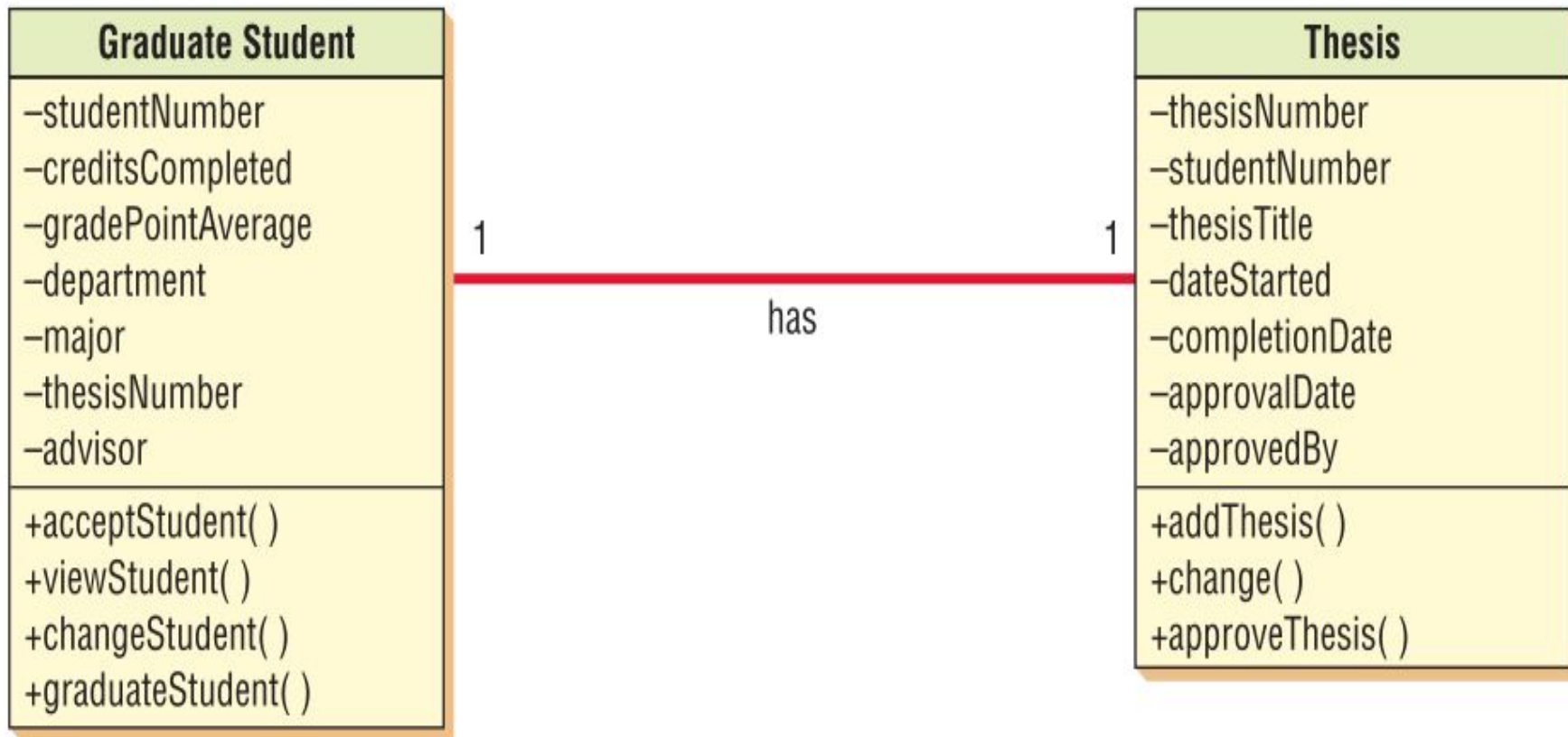
- The connections between classes
  - Associations
  - Whole/part

# Associations

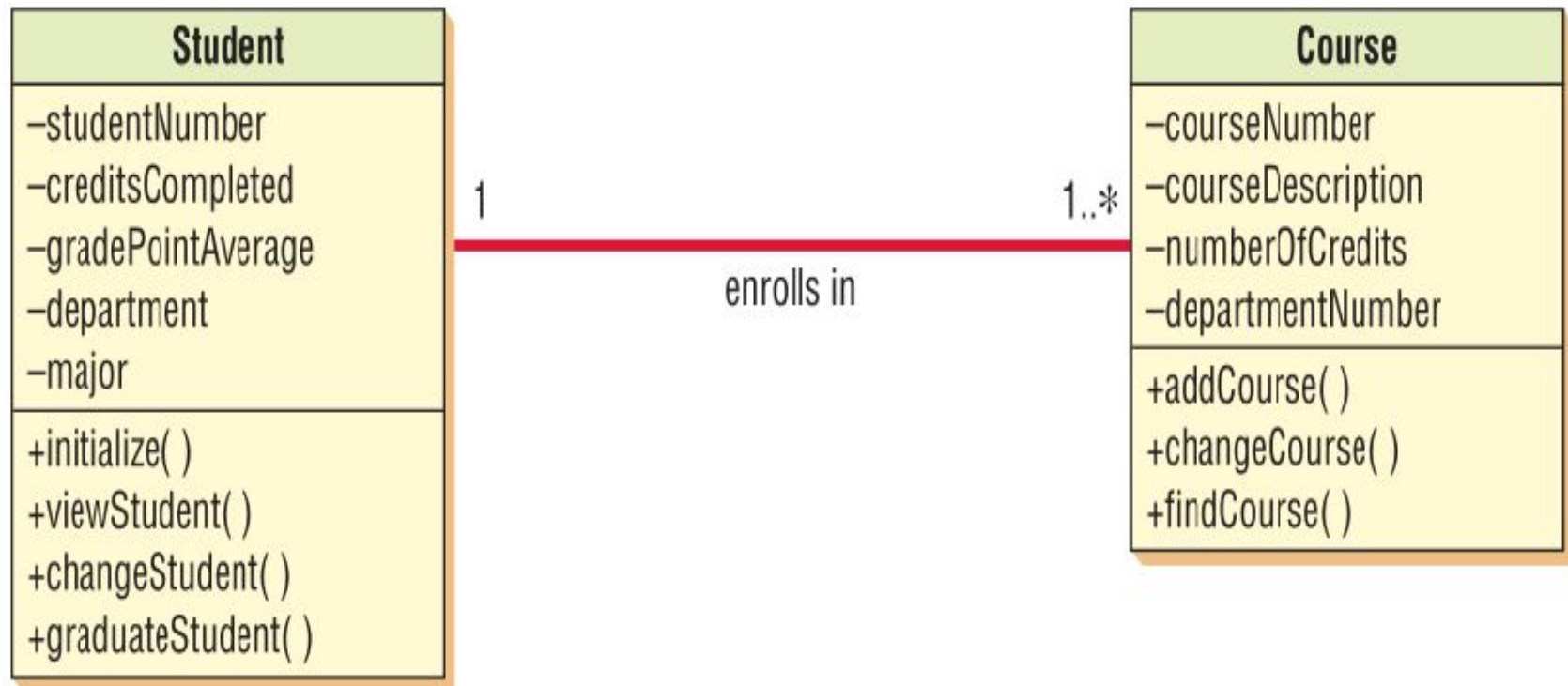
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- The simplest type of relationship
- Association classes are those that are used to break up a many-to-many association between classes
- An object in a class may have a relationship to other objects in the same class, called a reflexive association

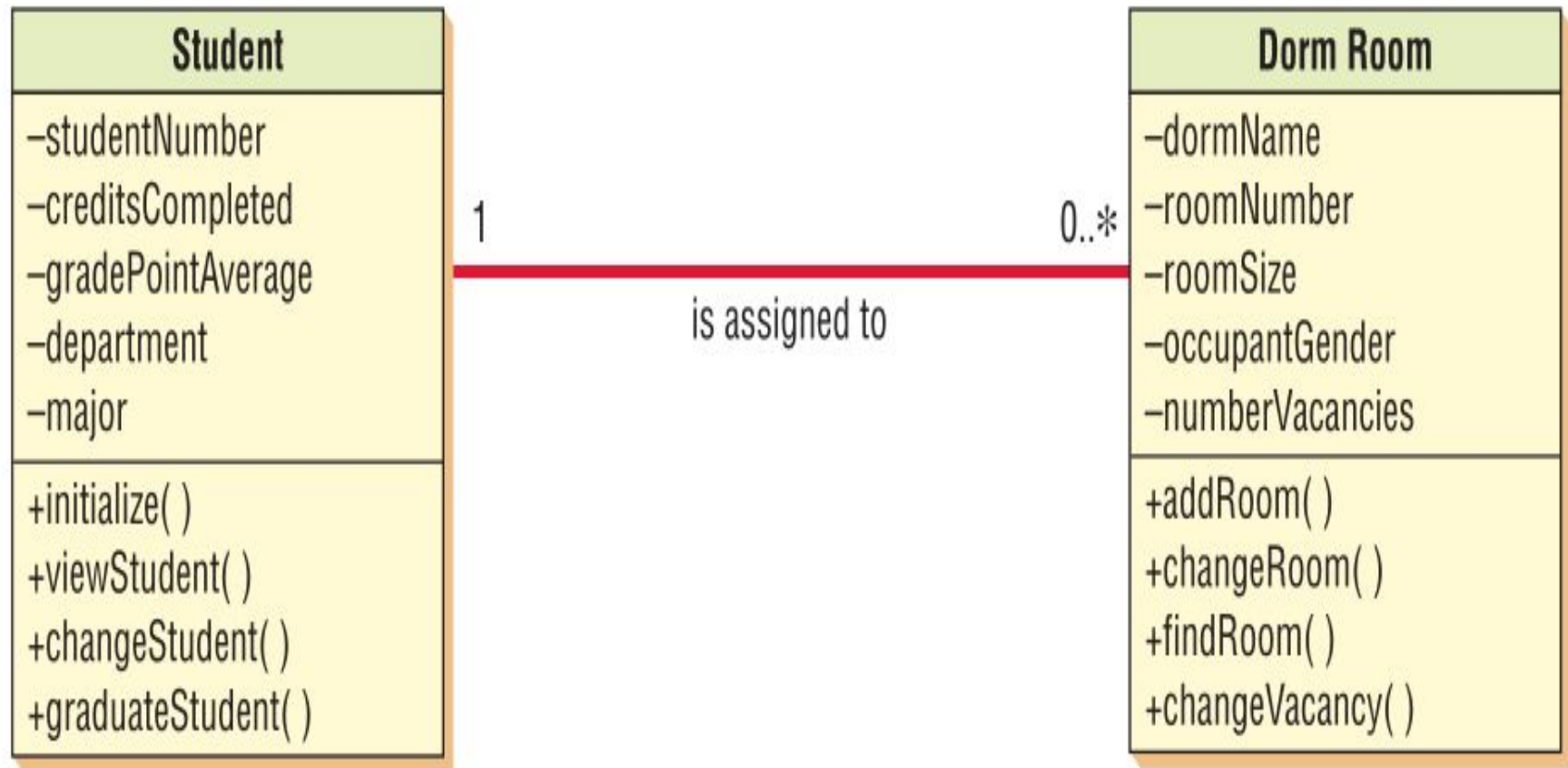
# Association



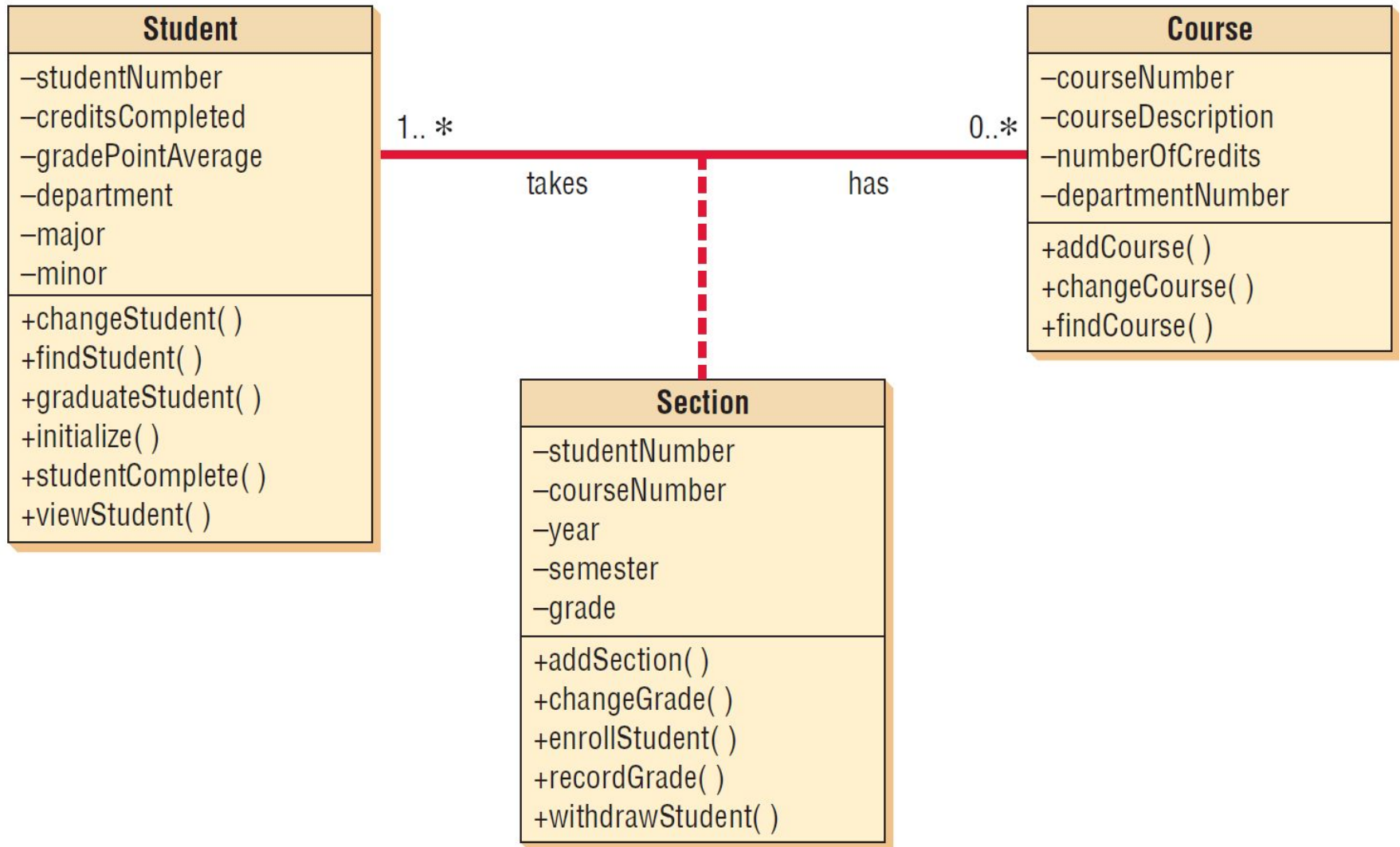
# Association



# Association



# Association Class



# Whole/Part Relationships

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- When one class represents the whole object, and other classes represent parts
- Categories
  - Aggregation
  - Collection
  - Composition

# Aggregation

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- A “has a” relationship
- Provides a means of showing that the whole object is composed of the sum of its parts

# Collection

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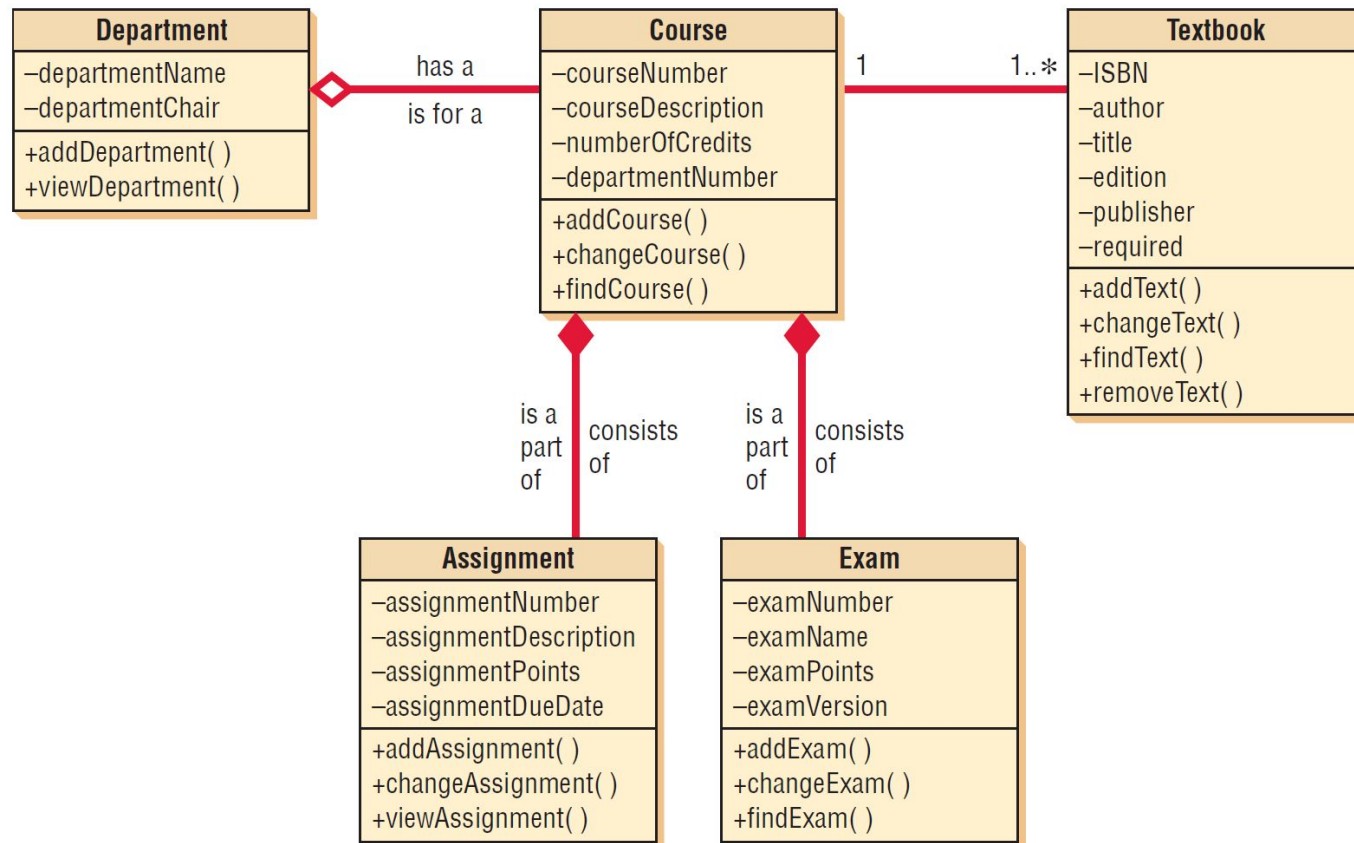
- Consists of a whole and its members
- Members may change, but the whole retains its identity
- A weak association

# Composition

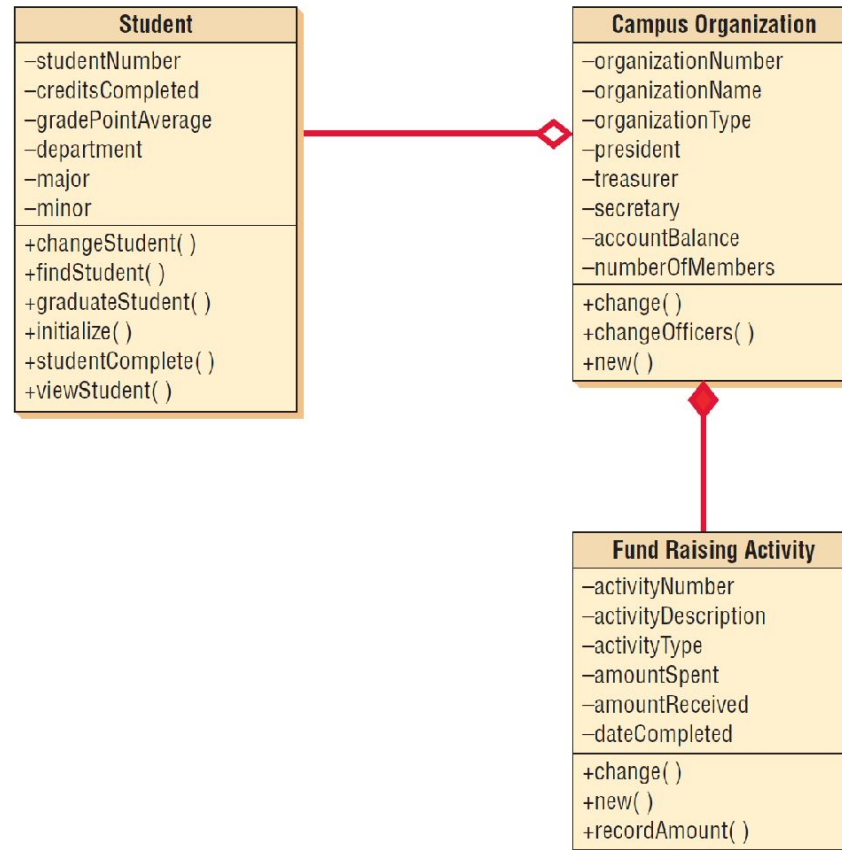
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- The whole has a responsibility for the parts, and is a stronger relationship
- If the whole is deleted, all parts are deleted

**Figure 18.13** A class diagram for course offerings. The filled-in diamonds show aggregation and the empty diamond shows a whole-part relationship



# Figure 18.19 An example of whole-part and aggregation relationships



# Generalization/Specialization Diagrams

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- Generalization
- Inheritance
- Polymorphism
- Abstract classes
- Messages

# Generalization

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- Describes a relationship between a general kind of thing and a more specific kind of thing
- Described as an “is a” relationship
- Used for modeling class inheritance and specialization
- General class is a parent, base, or superclass
- Specialized class is a child, derived, or subclass

# Inheritance

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- Helps to foster reuse
- Helps to maintain existing program code

# Polymorphism

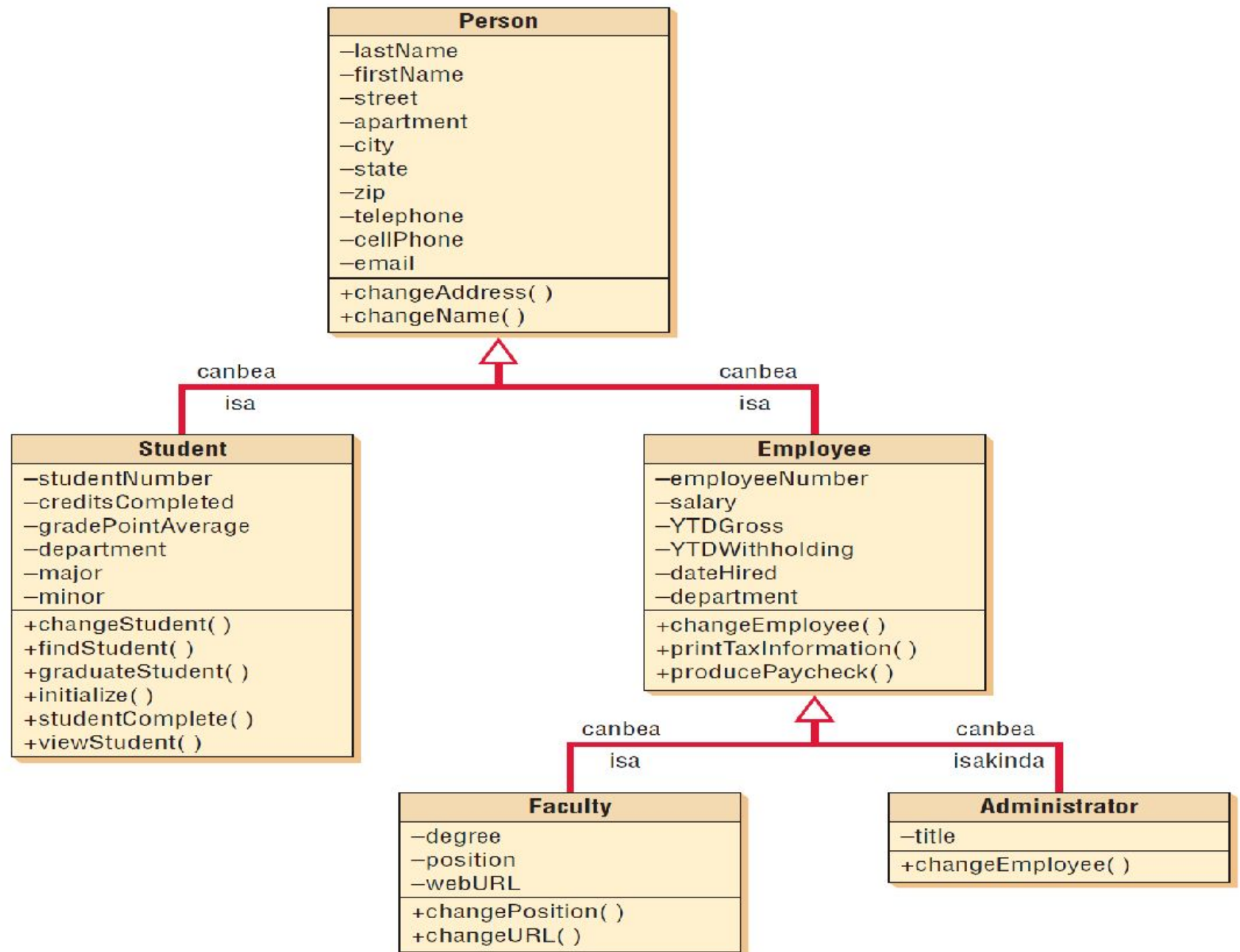
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- The capability of an object-oriented program to have several versions of the same method with the same name within a superclass/subclass relationship
- The subclass method overrides the superclass method
- When attributes or methods are defined more than once, the most specific one is used

# Abstract Classes

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- Abstract classes are general classes
- No direct objects or class instances, and is only used in conjunction with specialized classes
- Usually have attributes and may have a few methods



# Packages

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- Containers for other UML things
- Show system partitioning
- Can be component packages
- Can be physical subsystems
- Use a folder symbol
- May have relationships

# Figure 18.23 Use cases can be grouped into packages

