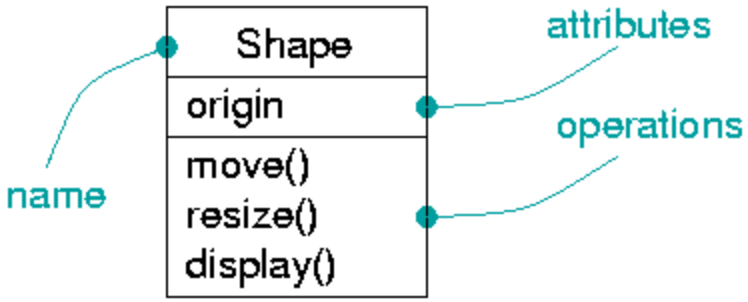
Basic Structural Modeling

Part I

Classes

Classes

- Description of a set of objects sharing the same attributes, operations and semantics
- Abstraction of the things that are part of the application domain vocabulary
- Can represent software, hardware or conceptual things

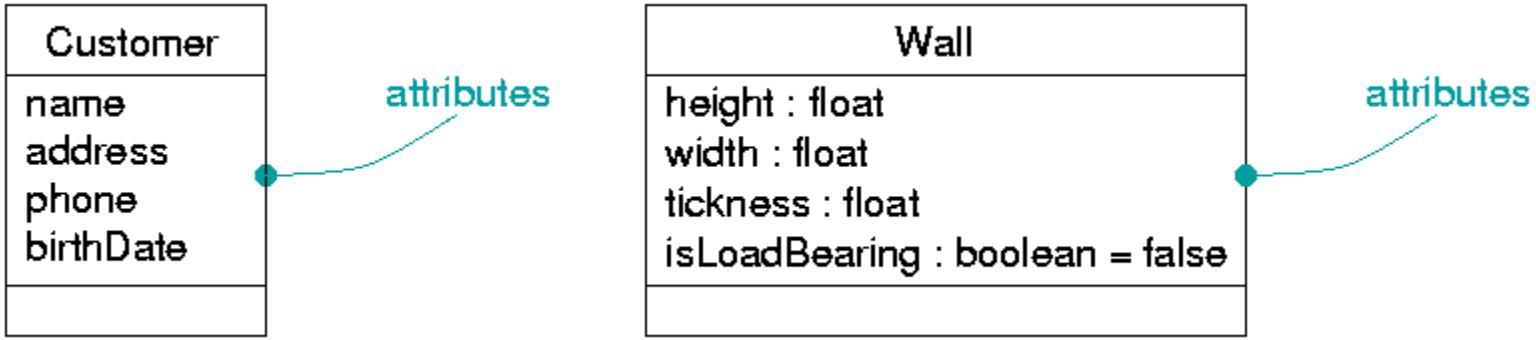


Terms and Concepts

- Names
  - nouns drawn from the application domain vocabulary, beginning with a capital letter
  - short but long enough to carry a meaning
  - can include the path of the package(s) it belongs to

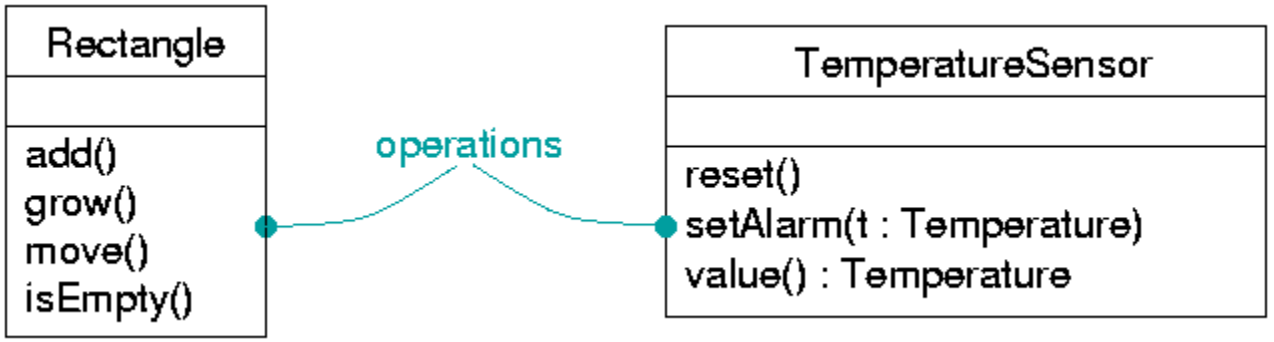
Terms and Concepts

- Attributes
  - named properties of a class representing the state of the objects
  - extension of classical data structures
  - can include type and default values



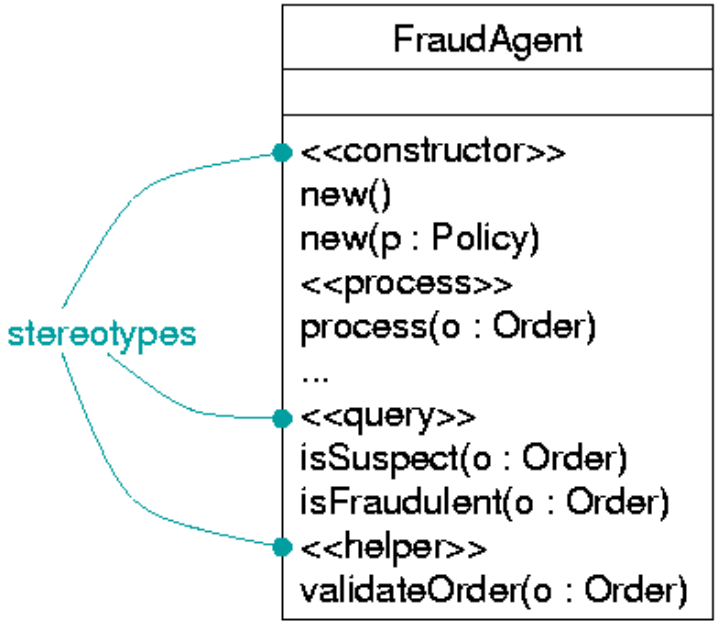
Terms and Concepts

- Operations
  - implementation of a behavior or service
  - messages that can be understood by the class
  - verb or verb phrase describing the intended behavior
  - can define the interface of the functions



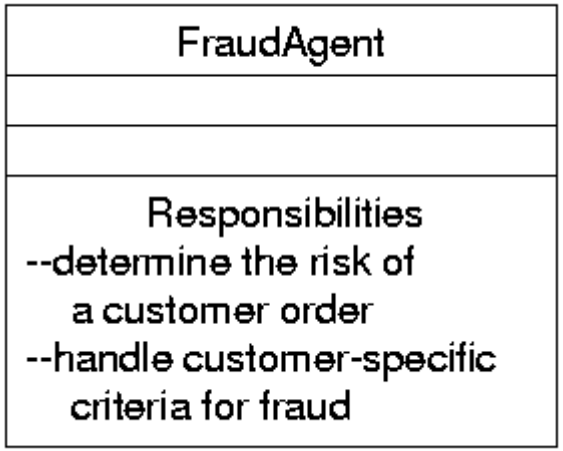
Terms and Concepts

- Organizing Attributes and Operations
  - some attributes and operations can be omitted
  - they can be organized using stereotypes



Terms and Concepts

- Responsibilities
  - defines the requirements of classes
  - expressed as form-free text
  - can be used in early stages for abstraction



Common Modeling Techniques

- Modeling the vocabulary of the system
  - identify things that users use to describe the problem
  - identify things that implementers use to describe the solution
  - for each class, identify a set of responsibilities
  - provide the attributes and operations needed to carry out these responsibilities
  - aggregate related clusters into packages

Common Modeling Techniques

- Modeling the distribution of responsibilities in a system
  - identify a set of classes that work together to carry out some behavior
  - identify a set of responsibilities for these classes
  - aggregate classes that have too few responsibilities
  - split classes that have too many responsibilities
  - consider the workload involved by each responsibility and distribute the load evenly

Hints and Tips

- When you model, define classes that
  - are an abstraction of something drawn either from the vocabulary of the problem or the solution
  - embody a small, well-defined set of responsibilities
  - are understandable, simple, extensible and adaptable

Hints and Tips

- When you draw class diagrams
  - show only those properties of the class that important in the current context
  - organize long lists of attributes and operations using stereotypes
  - show related classes in the same diagrams

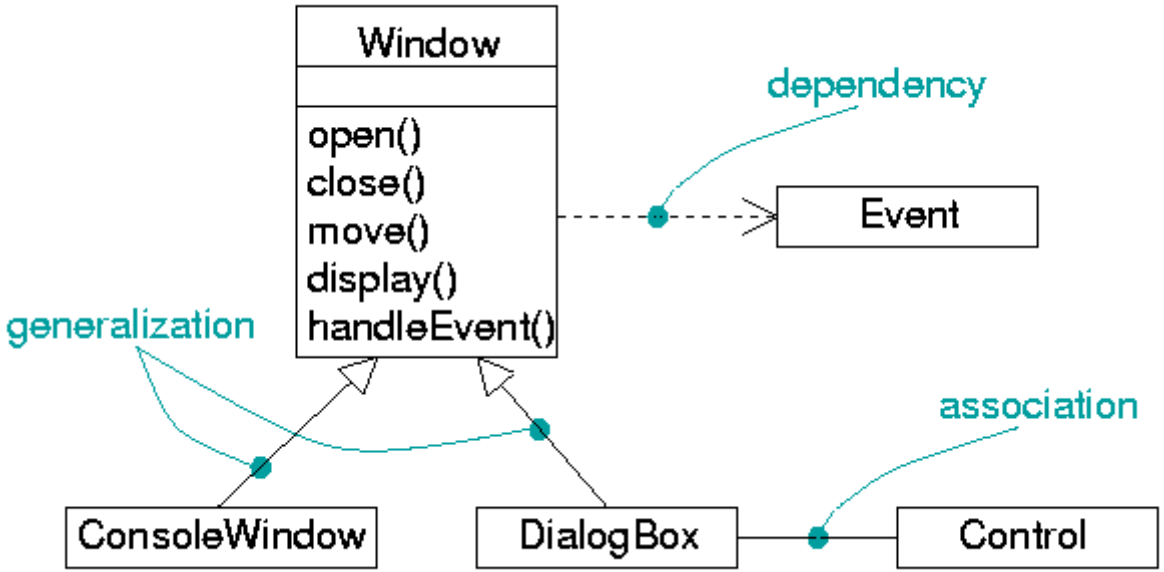
Part II

Relationships

Relationships

- Very few classes stand alone
- Classes collaborate to respond to service requests
- We must model the interactions between objects and classes
  - Dependencies: *uses* relationships
  - Generalizations: subclass/superclass relationships
  - Associations: structural relationships

Relationships



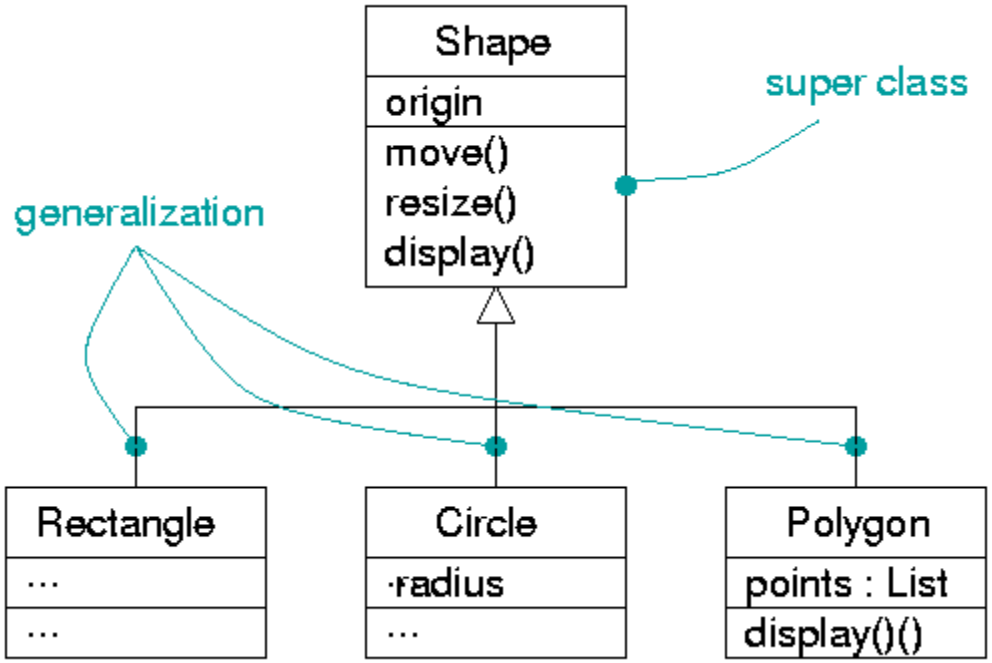
Terms and Concepts

- Dependencies
  - a change in the state of an object may affect the behavior of the depending object
  - a class uses another in its behavior
  - drawn as a dashed directed line
  - most often used to show that one of the operations uses another class as an argument
  - dependencies can be used at various levels of abstraction

Terms and Concepts

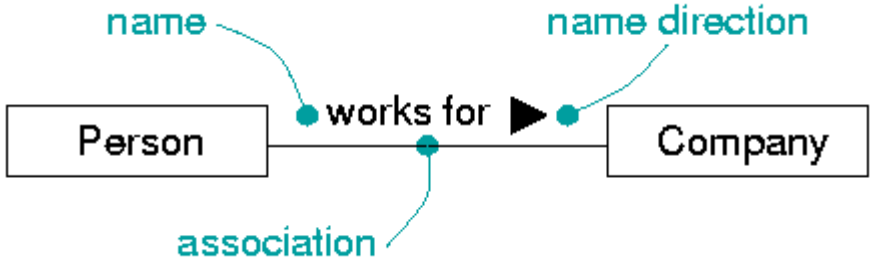
- Generalizations
  - relationship between a general thing (parent) and a more specific thing (child) of the same kind
  - the child inherits the attributes and operations of the parent class
  - operations can be redefined in the child and override the operations of the parent (polymorphism)
  - drawn as a directed line with open arrowhead

Terms and Concepts



Terms and Concepts

- Associations
  - used to show structural relationships where none of the classes is part of the other
  - drawn as a solid line connecting classes
- Name of an association
  - describes the nature of the relationship
  - can include the direction of the relationship
  - drawn as a tag on the middle of the association

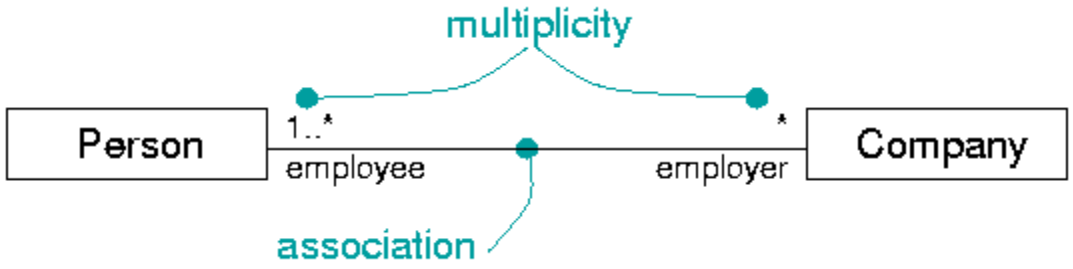


Terms and Concepts

- Roles of an association
  - identifies the role that each class plays in the relationship
  - drawn as a tag on the near end of the association
  - same class can play different roles in different contexts

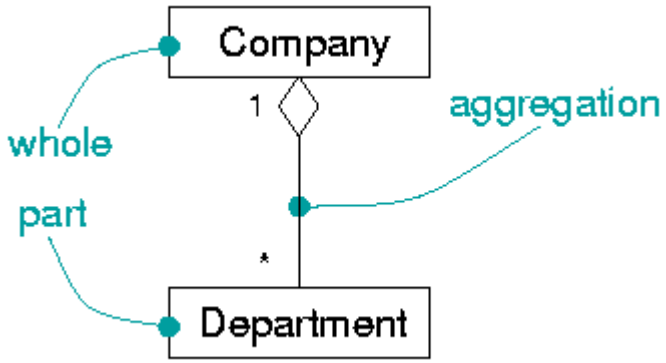
Terms and Concepts

- Defining multiplicity in an association
  - shows how many objects of the same type are involved in the association
  - similar to multiplicity defined in entity-relationship diagrams



Terms and Concepts

- Aggregation
  - an association where one class is part of the other (*has-a* relationship)
  - drawn as a solid line with a diamond on the whole side of the relation



Common Modeling Techniques

- Modeling simple dependencies
  - e.g. dependency between a class and a class being a parameter in one of its operations
  - can be omitted if the signature of the operations is provided in the class description

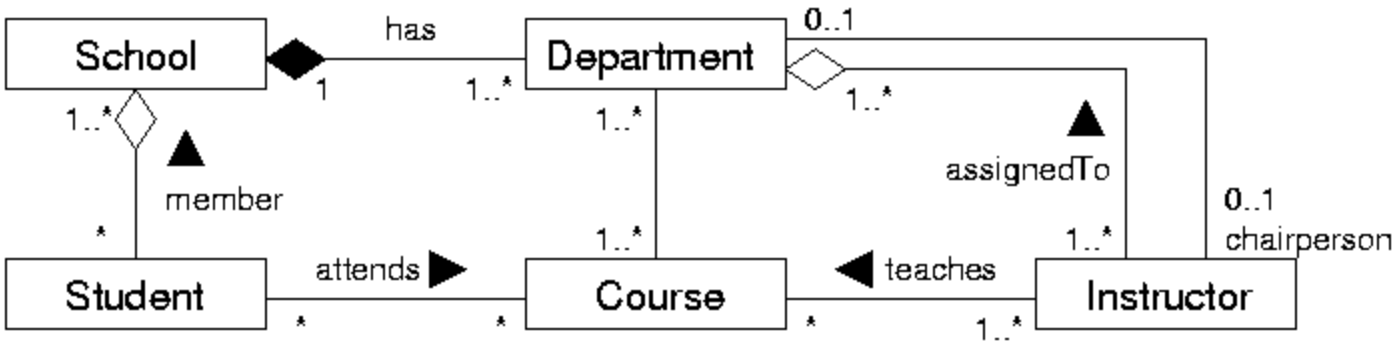
Common Modeling Techniques

- Modeling single inheritance
  - some classes that have common behavior or structure can be have a common superclass
  - given a set of classes, look for responsibilities, attributes and operations common to two or more classes
  - elevate these elements to a more general class without introducing too many levels
  - specify that the children inherit from the parent using a generalization relationship from children to parent
  - multiple inheritance is allowed, cyclic inheritance is not

Common Modeling Techniques

- Modeling structural relationships
  - for each pair of classes, if you need to navigate between the two, define an association between them (data-driven associations)
  - for each pair of classes, if an interaction is needed between the two (other than parameters to an operation) specify an association between the two (behavior-driven associations)
  - for each of these associations, define their multiplicity
  - if one of the classes is a part of the other, make it an aggregation

Common Modeling Techniques



Hints and Tips

- When you model
  - use dependencies only when the relationship is not structural
  - use generalizations only when you have a *is-kind-of* relationship
  - cyclical generalization is not allowed
  - inheritance trees should not be too deep nor too wide

Hints and Tips

- When you draw
  - use rectilinear or oblique lines consistently
  - avoid lines that cross
  - show only relationships that are necessary to the understanding of the diagram in the current context

Part III

Common Mechanisms

Common Mechanisms

- Some important facts about a design might not be expressible in the basic UML notation
  - notes
  - version number of components
  - constraints on dependencies

Terms and Concepts

- Notes
  - a graphical symbol used to attach comments or constraints to an element
  - drawn as a rectangle with a dog-eared corner containing a textual or graphical comment
  - it does not carry any semantic impact
- Tagged values
  - extension of the properties of a UML element
  - drawn as a string enclosed in {brackets}

Terms and Concepts

- Stereotypes
  - extension of the vocabulary of the UML
  - used to create new kinds of building blocks
  - drawn as a name enclosed in <<guillemets>>
  - can be represented as a new kind of icon
- Constraint
  - extension of the semantics of a UML element
  - drawn as a string enclosed in {brackets}
  - can be put in a note

Hints and Tips

- Use notes only for facts that can't be expressed using the UML
- Use notes to specify work in progress
- Don't use too many or large notes
- Standardize the use of stereotypes, tagged values and constraints
- Don't use too many graphical stereotypes
- Use only general and simple additions

Part IV

Diagrams

Diagrams

- Simplification of reality
- Using a limited set of general-use building blocks
- Different types of diagrams are used to represent the system in different perspectives
- Good diagrams make the system more understandable
- Choosing the right diagrams forces you to ask the right questions and illuminate their implications

Terms and Concepts

- Structural diagrams
  - Used to visualize, specify, construct and document the static aspects of the system
  - Represents the “skeleton” of the system

Terms and Concepts

- Structural diagrams
  - Class diagram
    - a set of classes interfaces, collaborations and their relationships
    - used to render the static design view of a system
  - Object diagram
    - same as class diagram, but for instances
    - “snapshot” of the relations between objects in a hypothetical situation

Terms and Concepts

- Structural diagrams
  - Component diagrams
    - shows a set of software components and their relationships
    - used to render a static implementation view of the system
  - Deployment diagrams
    - shows a set of nodes and their relations
    - used to render the static deployment view of the system
    - more abstract version of component diagrams

Terms and Concepts

- Behavioral diagrams
  - Used to visualize, specify, construct and document the dynamic aspects of the system
  - Represents the behavior of the system

Terms and Concepts

- Behavioral diagrams
  - Use case diagrams
    - shows a set of use cases and actors and their relationships
    - shows the different views that are possible on the system
    - defines subsets of classes (and their interactions) that are needed to achieve a certain goal of the system

Terms and Concepts

- Behavioral diagrams
  - Sequence diagrams
    - defines the time ordering of messages exchanged between a set of objects
    - shows a set of objects and the messages sent and received between these objects towards the realization of a certain service

Terms and Concepts

- Behavioral diagrams
  - Collaboration diagrams
    - defines all the dynamic interactions between a set of objects
    - shows a set of objects, links among those objects, and messages sent and received by those objects in the general case (not related to a specific service)
  - Sequence and collaboration diagrams carry the same information but not in the same context

Terms and Concepts

- Behavioral diagrams
  - Statechart diagram
    - defines a behavior that specifies the sequences of states an object goes through during its lifetime in response to events, together with its responses to those events
    - emphasizes the event-ordered behavior of an object
    - used to model the behavior of an interface, class or collaboration between classes

Terms and Concepts

- Behavioral diagrams
  - Activity diagram
    - defines the flow of control among objects
    - shows the flow from activity to activity within the system
    - shows a set of activities, the sequential or branching flow between activities and objects that act or are acted upon in the activity

Common Modeling Techniques

- Modeling different views of a system
  - views are the different dimensions from which the system can be represented
  - different views expose different aspects of the problem or see the same aspect in a different context
  - must find the right set of views
  - must focus on different views separately, and then find a compromise for common parts

Common Modeling Techniques

- Modeling different views of a system
  - decide which views best express the architecture and expose all problems
  - for each of these views, chose which kind of diagrams you will use to capture its details
  - decide which of these will be part of the documentation
  - unused diagrams should not be thrown away

Common Modeling Techniques

- Modeling different levels of abstraction
  - different people involved in the development have different needs
  - the different kinds of diagrams propose a different view on the system
  - some people need abstract information, others need exact information
  - several versions of the same diagram, at various levels of abstraction, might be needed

Common Modeling Techniques

- Modeling different levels of abstraction
  - consider the different needs of the readers
  - create different abstraction levels for diagrams that are read by different readers
  - hide or reveal building blocks and relationships
  - hide or expand messages and transitions that are essential to understanding
  - reveal only adornments that are essential to understanding (e.g. classifying stereotypes)

Hints and Tips

- When you design a diagram
  - diagrams are a tool, they do not need to be cute
  - not all diagrams are meant to be preserved
  - find an goal and an audience for each diagram and show only the information needed to explain the solution to the intended audience
  - give meaningful names to all diagrams
  - group diagrams into packages

Hints and Tips

- A well structured diagram
  - is focused on communicating one aspect of the system
  - contains only those elements that are essential to understanding that aspect
  - provides details consistent with its level of abstraction

Hints and Tips

- When you draw a diagram
  - give it a name that communicates its purpose
  - lay out elements to minimize lines that cross
  - lay out related elements close to one another
  - use colors and notes to draw attention on important features

Part V

Class Diagrams

Class Diagrams

- Most common diagram used to model object-oriented systems
- Shows a set of classes, interfaces, and collaborations and their relationships
- Models the static design view of the system
- Involves modeling the vocabulary of the system requirements specifications

Terms and Concepts

- Class diagrams commonly contain
  - classes
  - interfaces
  - collaborations
  - relationships
  - notes and constraints
  - packages or subsystems

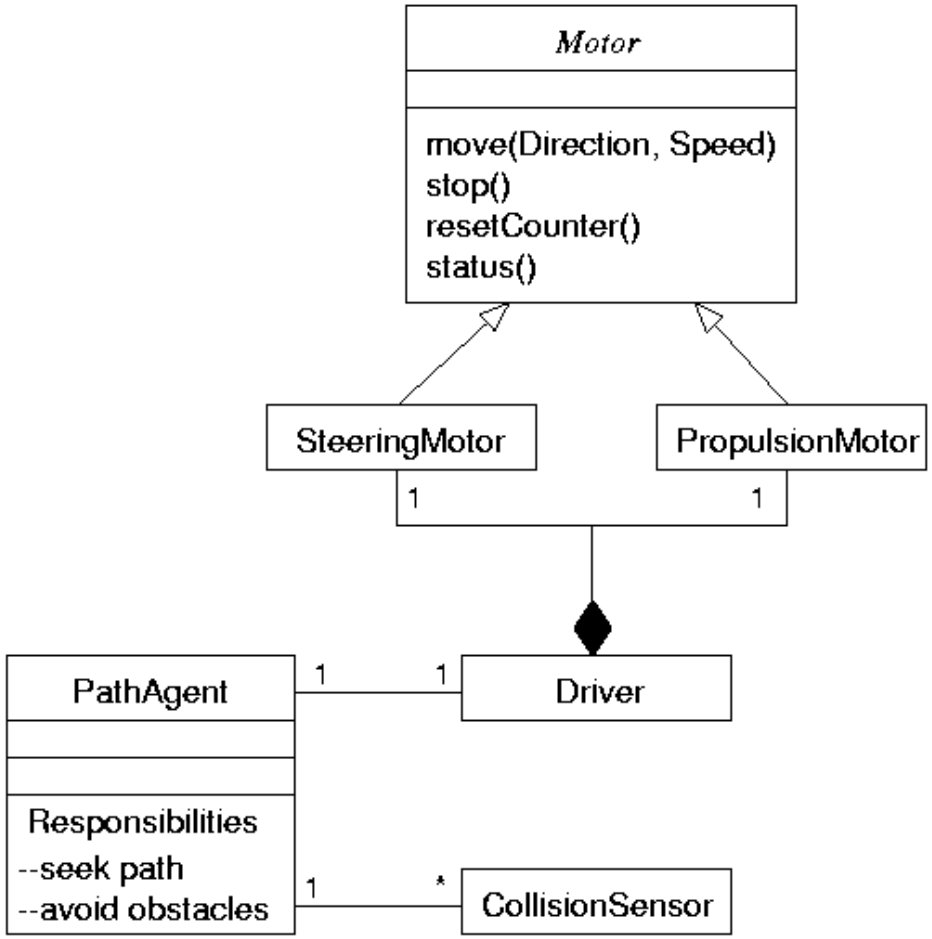
Terms and Concepts

- Common uses
  - model the static design view to support the functional requirements of the system
    - model the vocabulary of the system: first define classes and their responsibilities, and then refine towards attributes, operations
    - model simple collaborations: define the interactions between classes towards the definition of a common behavior
    - model a database schema: data elements are attributes, tables are classes, and relationships are…relationships

Common Modeling Techniques

- Modeling simple collaborations
  - identify the mechanism to model.
  - for each mechanism, identify the classes, interfaces, and other collaborations that participate in this collaboration; as well as their relationships
  - use scenarios to walk through these things
  - populate these elements with their required contents (attributes and operations) first starting with responsibilities

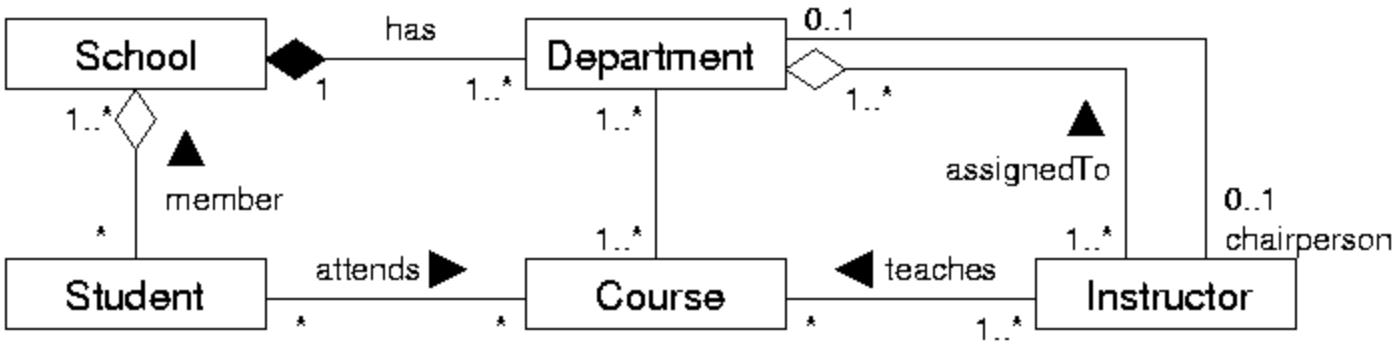
Example



Common Modeling Techniques

- Modeling a logical database schema
  - identify the classes whose state must transcend the lifetime of their application
  - create a class diagram for these and mark them as <<persistent>> with a tagged value
  - define their attributes and associations (and their cardinalities)
  - define data-specific operations on these classes

Example of Database Schema



Hints and Tips

- A well-structured class diagram
  - is focused on communicating only one aspect of the system's static design
  - provides only the details that are consistent with its associated level of abstraction
  - is not minimalist

Hints and Tips

- When you draw a class diagram
  - give it a name that communicates its purpose
  - minimize line crossing
  - use colors and notes to emphasize important aspects
  - lay out related elements close to one another