

Class Diagrams

- Basic Concepts
- Type/Class
- Attribute
- Association
- Association Role
- Multiplicity
- Navigability
- Aggregation and Composition
- Association Class
- n-Ary Associations
- Generalization

Basic Concepts

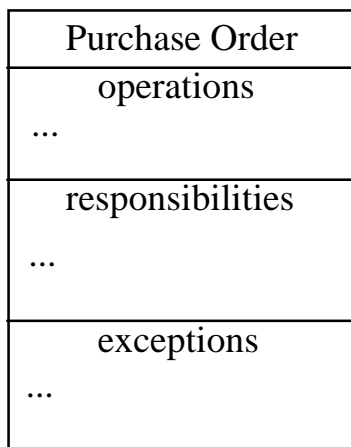
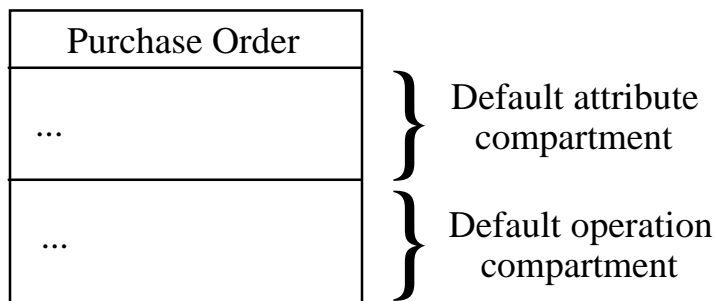
- This is the main “internal” view of the system
 - The focus is on static structure, things about the business policy/business process that should (effectively) always be true
 - * A formal methods person would call these “invariants”

- The main concepts in class models are
 - Type/Class
 - Attribute
 - Association
 - Generalization

Type/Class

- A Class is the descriptor for a set of objects with similar structure, behavior, and relationships
 - “Class” tends to be interpreted as a design and implementation concept while “Type” tends to be interpreted as an analysis concept

- Notation(s)



- Think of a type or class as representing a stencil from which the actual objects are created

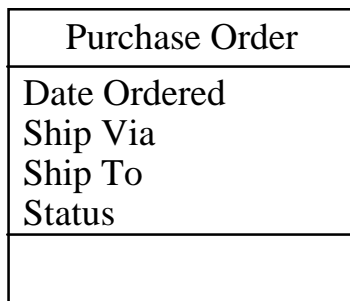
Type/Class (cont)

- The following kinds of real-world things tend to end up being modeled as classes
 - Physical things
 - * e.g., Airplane, Aardvark, Cyclotron
 - Important concepts
 - * e.g., Account, Purchase Order
 - Roles (uses) of physical things or concepts
 - * e.g., Customer, Branch Manager, Active Runway
 - Incidents (significant happenings)
 - * e.g., Trouble Report, Milestone
 - Characteristics
 - * e.g., Airplane-type, Computer-model, Recipe
 - Associations
 - * e.g., Enrollment, License
 - ...

- Include each of the actors from the use cases on the class diagram
 - Suggestion: stereotype them as <<actor>>

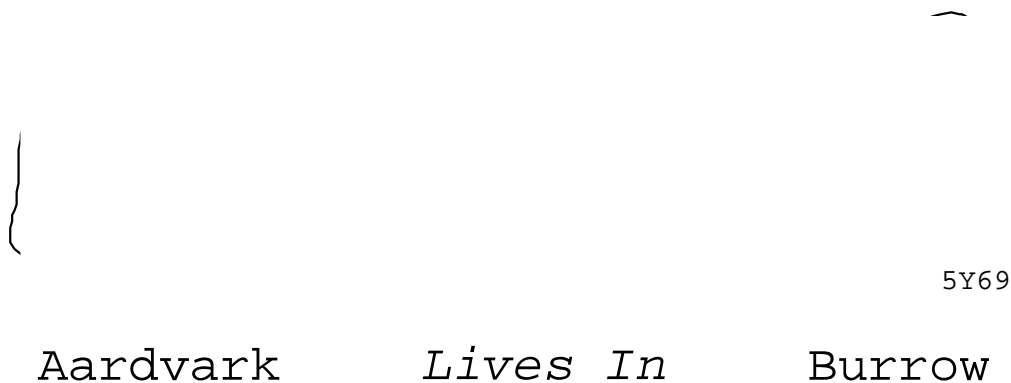
Attribute

- An Attribute is a single, named fragment of the persistent state
- Notation



Association

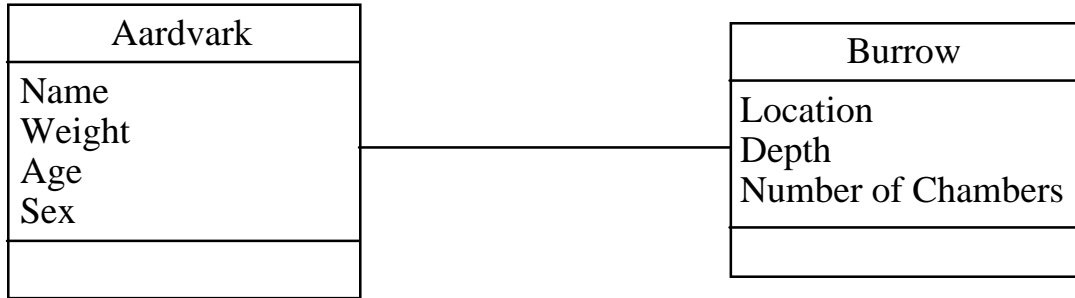
- An Association exists when some number of objects are connected (linked) in some significant manner and it is necessary to remember that connection
 - In set theory terms, each class corresponds to a set of things, and an association corresponds to a mapping between members of these sets



- Associations permit dynamics of the form
Given some member of set A, which member or members of set B is it linked with?

*Given an aardvark, which burrow does it live in?
 Given a burrow, which aardvark lives in it?*

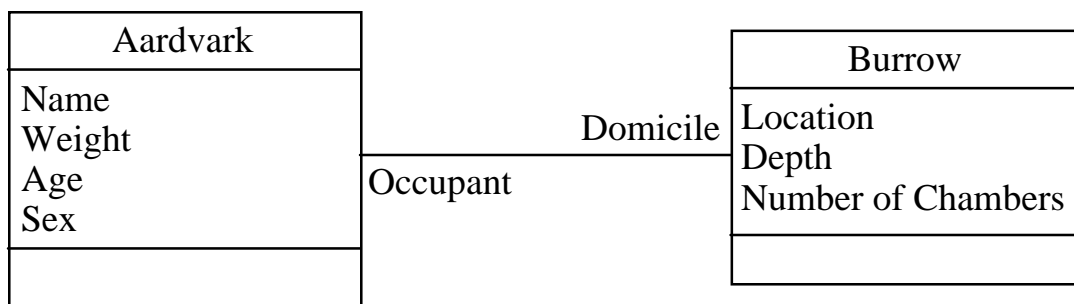
- Basic notation



Association Role

- An Association Role indicates the role (purpose) that the class plays in the association

- Notation



- Roles can be explicitly named, but they don't have to be
 - If not explicitly named, the role "defaults" to the name of the target class

Multiplicity

- Describes the rules about the number of objects in each class that may or may not be linked

- “Anchor point analysis” [Flavin81] is a useful tactic to help you determine multiplicity. It is based on the question *“Assuming that I am an object of this class, what is the minimum and maximum number of objects in that class can I be linked with?”*

The question is repeated from the point of view (“anchored at”) each of the participating classes

- Example

If I were an Aardvark, what is the minimum and maximum number of Burrows I could live in?
If I were a Burrow, what is the minimum and maximum number of Aardvarks that could live in me?

- Notation

Lower bound	Upper bound	Notation
0	1	0..1
0	Many	*
1	1	1

1	Many	1..*
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[Flavin81]

Matt Flavin, Fundamental Concepts of Information Modeling, Yourdon Press, 1981

Multiplicity (cont)

- The following are examples of the various forms of multiplicity

On-Duty Crew IS ASSIGNED TO Ship at Sea (1:1)

Operating Power Supply POWERS Amplifier (0..1:1)

Batch of Chocolate IS CONTAINED IN Vat (0..1:0..1)

Slum Lord OWNS Apartment (1:1..*)

Ada Variable HAS DEFINED Data Type (1:*)

Secretary IS ASSIGNED TO Manager (0..1:*)

Student IS ENROLLED IN Course (1..*:1..*)

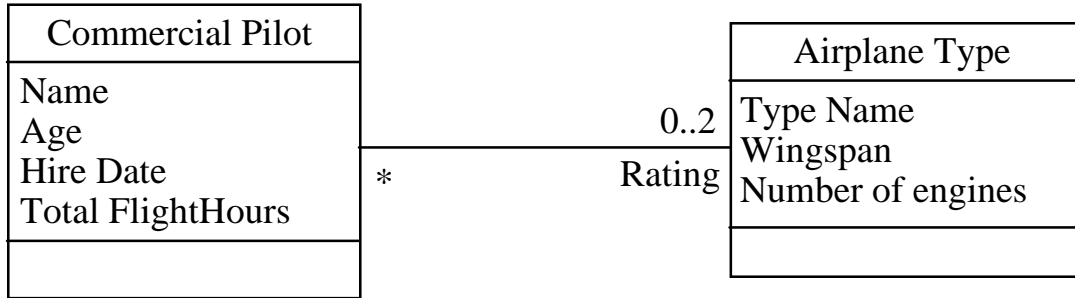
Clubmember IS MEMBER OF Committee (1..*:*)

Traveler HAS RESERVATION ON Scheduled Flight (*:*)

- Multiplicity may be even further constrained by the business policy/business process

Commercial Pilot HOLDS RATING IN Airplane-Type (*:0..2)

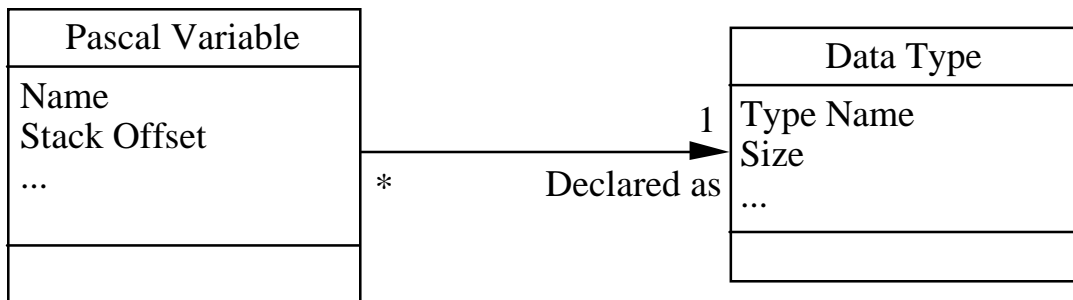
- Document the policy-constrained limits in the model



Navigability

- In some cases, an association is constrained to be traversed in certain directions and it may be useful to include this information in the model
 - Uni-directional associations can be traversed in a single direction only
 - Bi-directional association can be traversed in either direction

- Notation

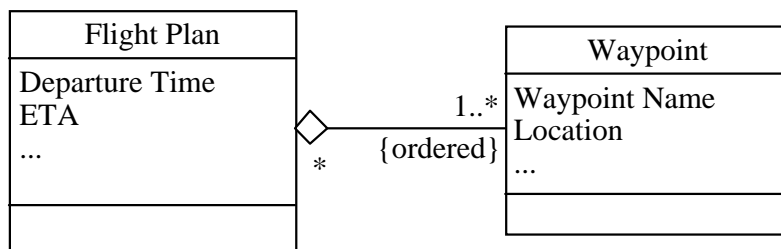


- If navigability is not specified, it is safest to assume that it is “undecided”

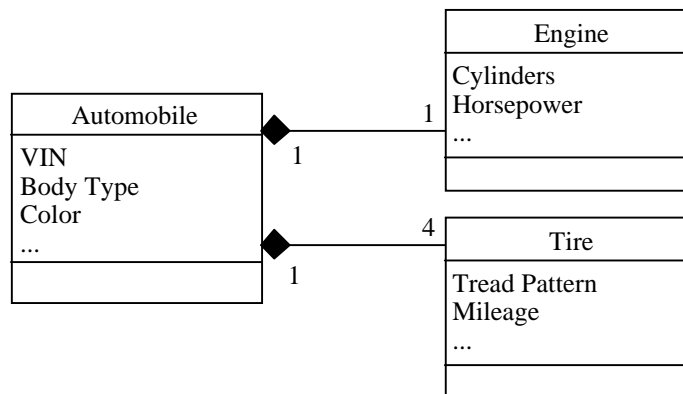
Aggregation and Composition

- Aggregation is a kind of association that represents a whole-part relationship
 - The implication is that if the whole is created or deleted, the parts must also be created or deleted at the same time

- Notation for Aggregation



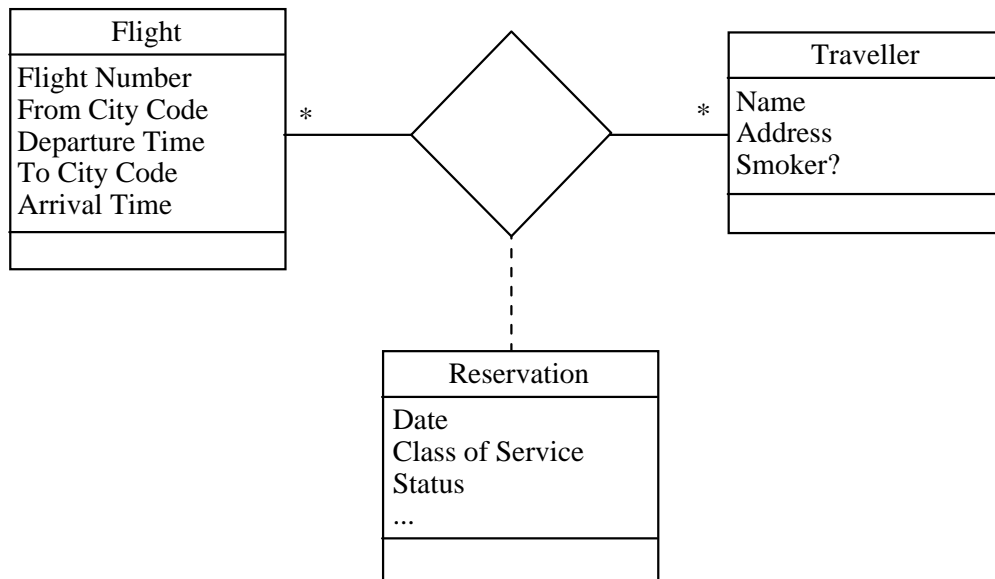
- Composition is like aggregation with the added constraint that the part may be the part of exactly one whole



- It might help to think of aggregation and composition as “patterns” for an association and its behavior

Association Class

- Associations may take on the characteristics of a class
 - Associations may have attributes
 - Associations may have important states and actions
- Notation

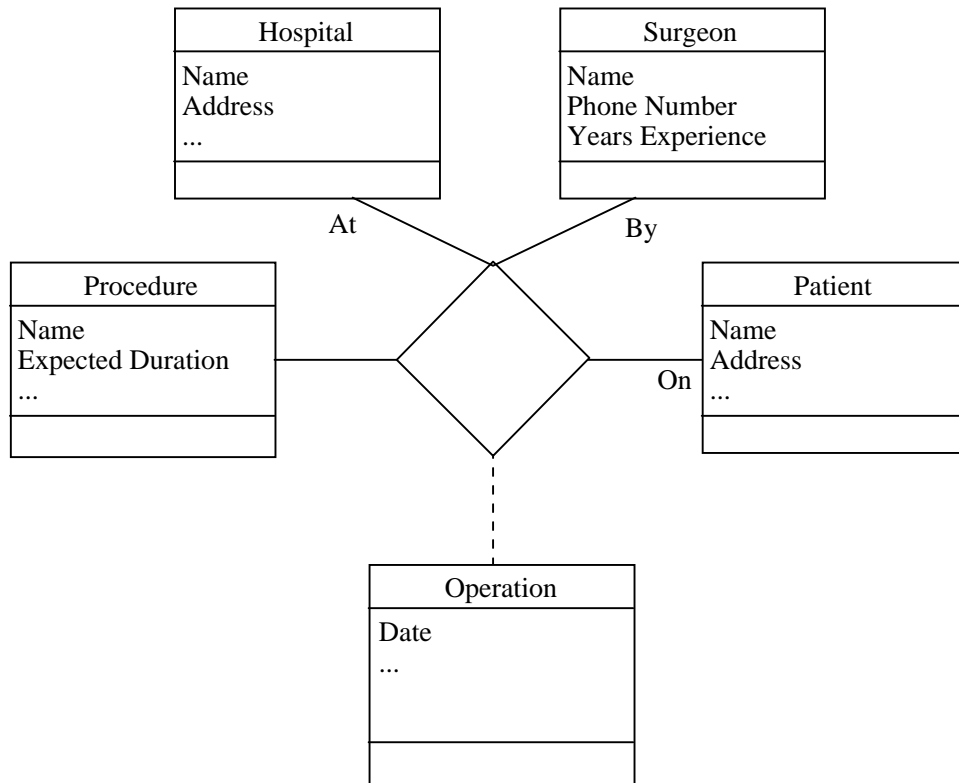


- Even though in the notation it appears as an association and a class separately, semantically it is a single element in the model

n-Ary Associations

- So far, we have only seen associations between two classes
 - This is the usual case, but some associations involve more than two classes

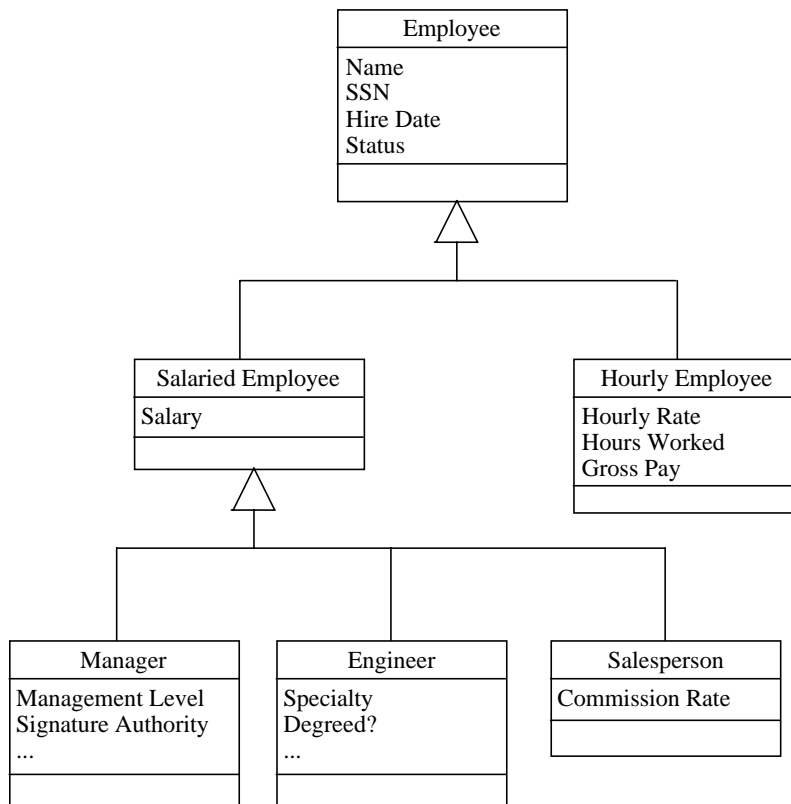
- Notation



Generalization

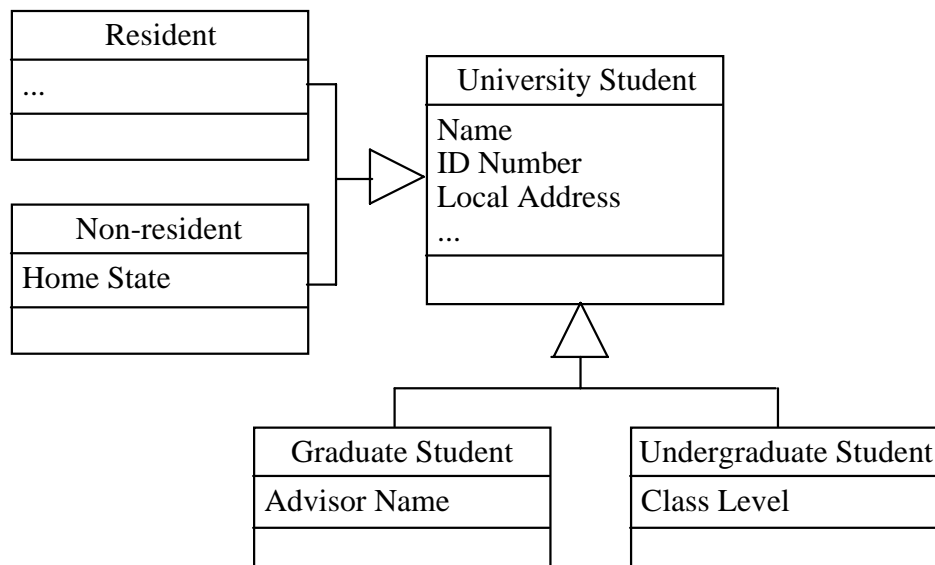
- Generalization is a way of saying
 - At one level of abstraction, the objects in this class are all the same but at a finer level of detail, they may be different*
 - Represents an is-a or is-a-kind-of relationship

- Notation



Generalization (cont)

- The subclasses may represent a complete or incomplete breakdown of the superset (are all subsets represented?)
 - Use the constraint {complete} or {incomplete}
- The subsets may represent (non-)mutually exclusive groupings
 - Use the constraint {disjoint} or {overlapping}
- Multiple and Dynamic Classification
 - Multiple classification means that the same superset can be specialized in multiple dimensions
 - Dynamic classification means that an instance of a superset can change from one subset to another



Key Points

- The class diagram is the main “internal” view
 - The focus is on static structure, things about the business policy/business process that should (effectively) always be true
- A Class is the descriptor for a set of objects with similar structure, behavior, and relationships
- An Attribute is a single, named fragment of the persistent state
- An Association exists when some number of objects are connected (linked) in some significant manner and it is necessary to remember that connection
- An Association Role indicates the role (purpose) that the class plays in the association
- Multiplicity describes the rules about the number of objects in each class that may or may not be linked
- Aggregation is a kind of association that represents a whole-part relationship
 - Composition is like aggregation with the added constraint that the part may be the part of exactly one whole
- Associations may take on the characteristics of a class

- Generalization is a way of saying, “At one level of abstraction, the objects in this class are all the same but at a finer level of detail, they may be different”