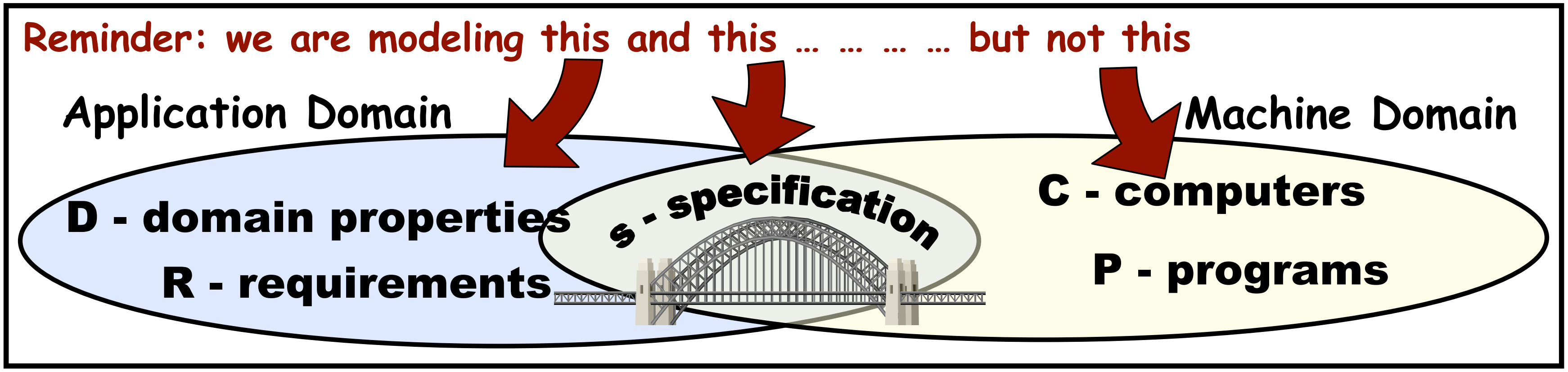
Lecture 11: Object Oriented Modelling

- Object Oriented Analysis
  - Rationale
  - Identifying Classes
  - Attributes and Operations
- UML Class Diagrams
  - Associations
  - Multiplicity
  - Aggregation
  - Composition
  - Generalization

Requirements & Domain Models



→ **Our analysis models should…**

- …represent people, physical things and concepts important to our understanding of what is going on in the application domain
- …show connections and interactions among these people, things and concepts.
- …show the business situation in enough detail to evaluate possible designs.
- …be organized to be useful later, during design and implementation of the software.
- …allow us to check whether the functions we will include in the specification will satisfy the requirements
- …test our understanding of how the new system will interact with the world

Object Oriented Analysis

→ Background

- Model the requirements in terms of objects and the services they provide
- Grew out of object oriented design
  - Applied to modelling the application domain rather than the program

→ Motivation

- OO is (claimed to be) more 'natural'
  - As a system evolves, the functions it performs need to be changed more often than the objects on which they operate…
  - …a model based on objects (rather than functions) will be more stable over time…
  - …hence the claim that object-oriented designs are more maintainable
- OO emphasizes importance of well-defined interfaces between objects
  - compared to ambiguities of dataflow relationships

NOTE: OO applies to requirements engineering because it is a modeling tool. But we are modeling domain objects, not the design of the new system

Nearly anything can be an object…

Source: *Adapted from Pressman, 1994, p242*

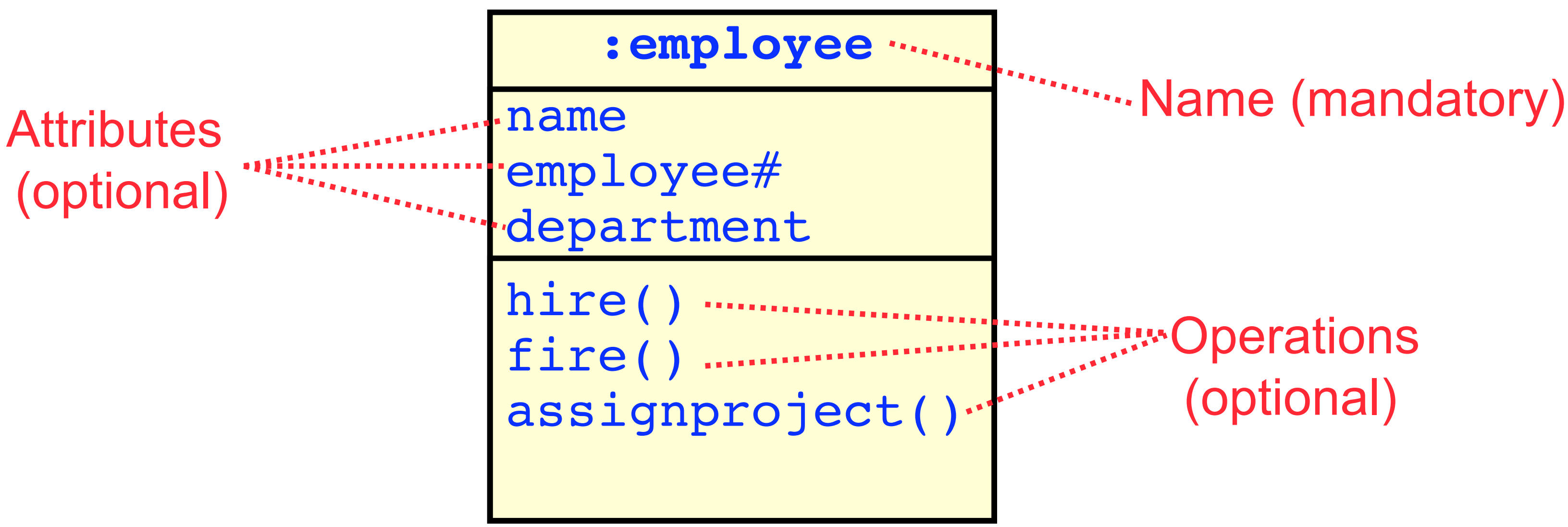
- External Entities
  - …that interact with the system being modeled
    - E.g. people, devices, other systems
- Things
  - …that are part of the domain being modeled
    - E.g. reports, displays, signals, etc.
- Occurrences or Events
  - …that occur in the context of the system
    - E.g. transfer of resources, a control action, etc.
- Roles
  - played by people who interact with the system
- Organizational Units
  - that are relevant to the application
    - E.g. division, group, team, etc.
- Places
  - …that establish the context of the problem being modeled
    - E.g. manufacturing floor, loading dock, etc.
- Structures
  - that define a class or assembly of objects
    - E.g. sensors, four-wheeled vehicles, computers, etc.

Some things cannot be objects:

- *procedures (e.g. print, invert, etc)*
- *attributes (e.g. blue, 50Mb, etc)*

What are classes?

- A class describes a group of objects with
  - similar properties (attributes),
  - common behaviour (operations),
  - common relationships to other objects,
  - and common meaning ("semantics").
- Examples
  - **employee**: has a name, employee# and department; an employee is hired, and fired; an employee works in one or more projects



Finding Classes

- Finding classes from source data:
  - Look for nouns and noun phrases in stakeholders' descriptions of the problem
    - include in the model if they explain the nature or structure of information in the application.
- Finding classes from other sources:
  - Reviewing background information;
  - Users and other stakeholders;
  - Analysis patterns;
- It's better to include many candidate classes at first
  - You can always eliminate them later if they turn out not to be useful
  - Explicitly deciding to discard classes is better than just not thinking about them

Selecting Classes

- Discard classes for concepts which:
  - Are beyond the scope of the analysis;
  - Refer to the system as a whole;
  - Duplicate other classes;
  - Are too vague or too specific
    - e.g. have too many or too few instances
  - Coad & Yourdon's criteria:
    - Retained information: Will the system need to remember information about this class of objects?
    - Needed Services: Do objects in this class have identifiable operations that change the values of their attributes?
    - Multiple Attributes: If the class only has one attribute, it may be better represented as an attribute of another class
    - Common Attributes: Does the class have attributes that are shared with all instances of its objects?
    - Common Operations: Does the class have operations that are shared with all instances of its objects?
  - External entities that produce or consume information essential to the system should be included as classes

Objects vs. Classes

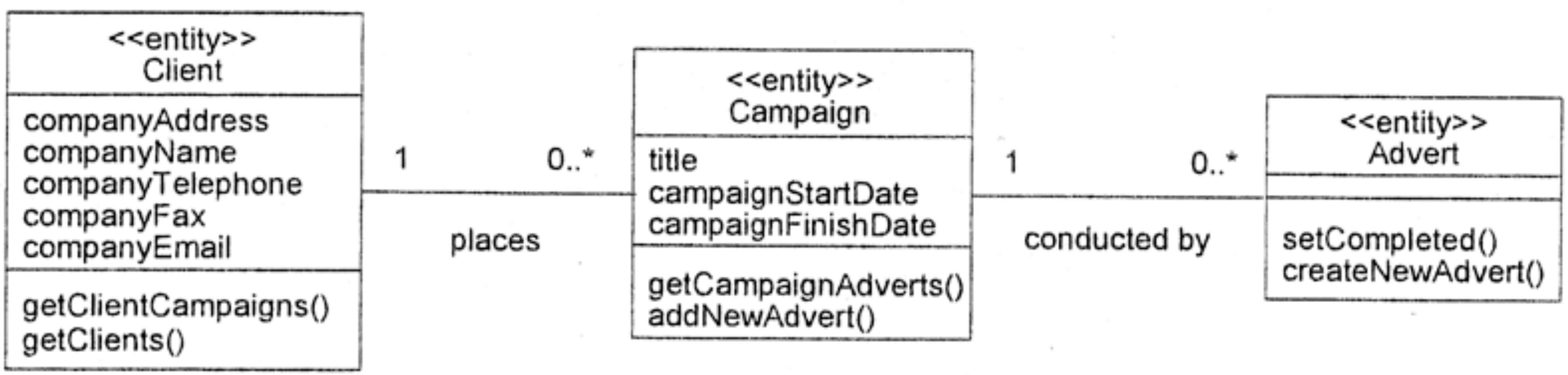
- The instances of a class are called objects.
  - Objects are represented as:

Fred_Bloggs:Employee
name: Fred Bloggs Employee #: 234609234 Department: Marketing

  - Two different objects may have identical attribute values (like two people with identical name and address)
- Objects have associations with other objects
  - E.g. Fred_Bloggs:employee is associated with the KillerApp:project object
  - But we will capture these relationships at the class level (why?)
  - Note: Make sure attributes are associated with the right class
    - E.g. you don't want both managerName and manager# as attributes of Project! (…Why??)

Associations

- Objects do not exist in isolation from one another
  - A relationship represents a connection among things.
  - In UML, there are different types of relationships:
    - Association
    - Aggregation and Composition
    - Generalization
    - Dependency
    - Realization
  - Note: The last two are not useful during requirements analysis
- Class diagrams show classes and their relationships



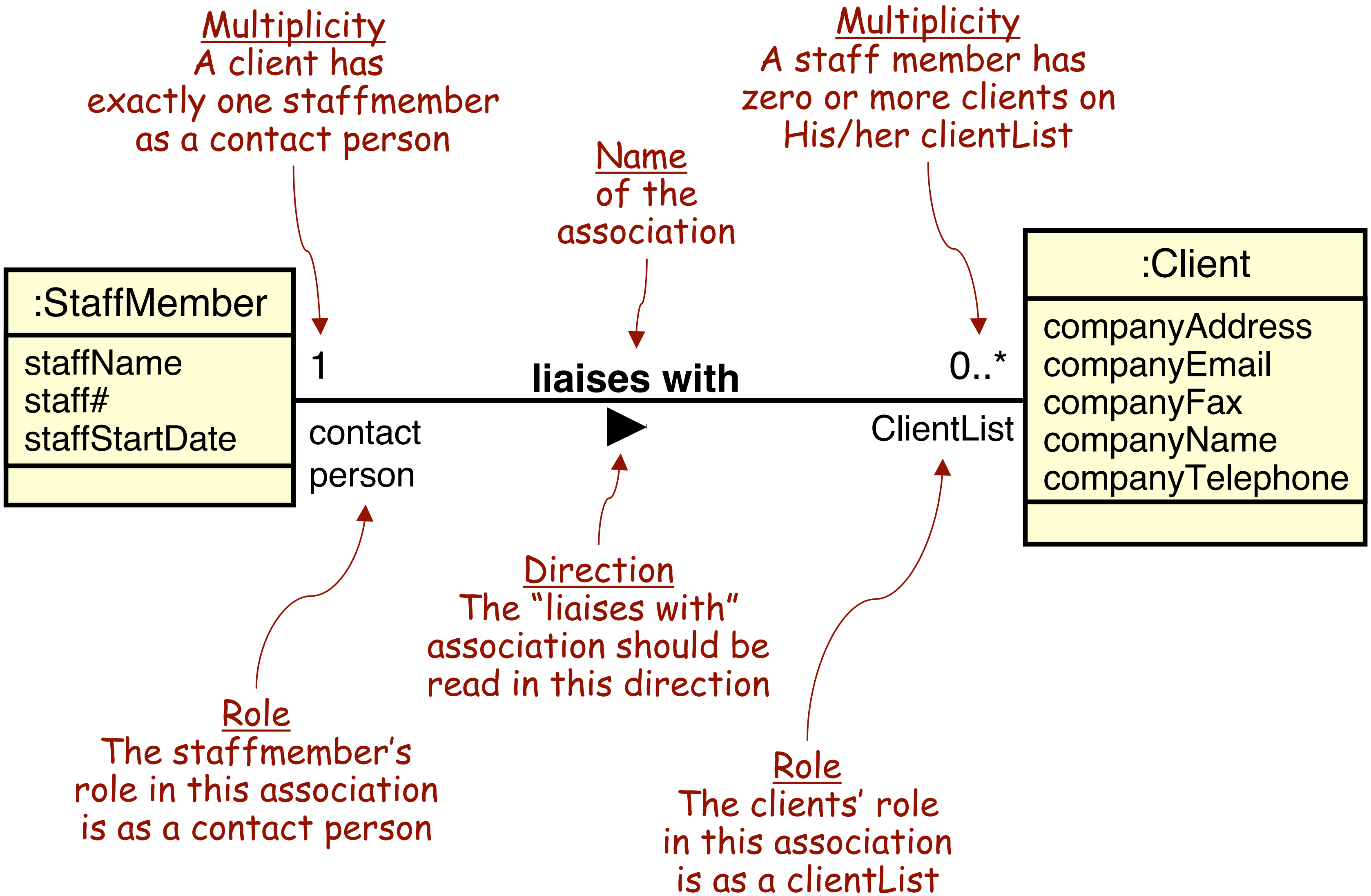
Association Multiplicity

- Ask questions about the associations:
  - Can a campaign exist without a member of staff to manage it?
    - If yes, then the association is optional at the Staff end - zero or more (0..*)
    - If no, then it is not optional - one or more (1..*)
    - If it must be managed by one and only one member of staff - exactly one (1)
  - What about the other end of the association?
    - Does every member of staff have to manage exactly one campaign?
    - No. So the correct multiplicity is zero or more.

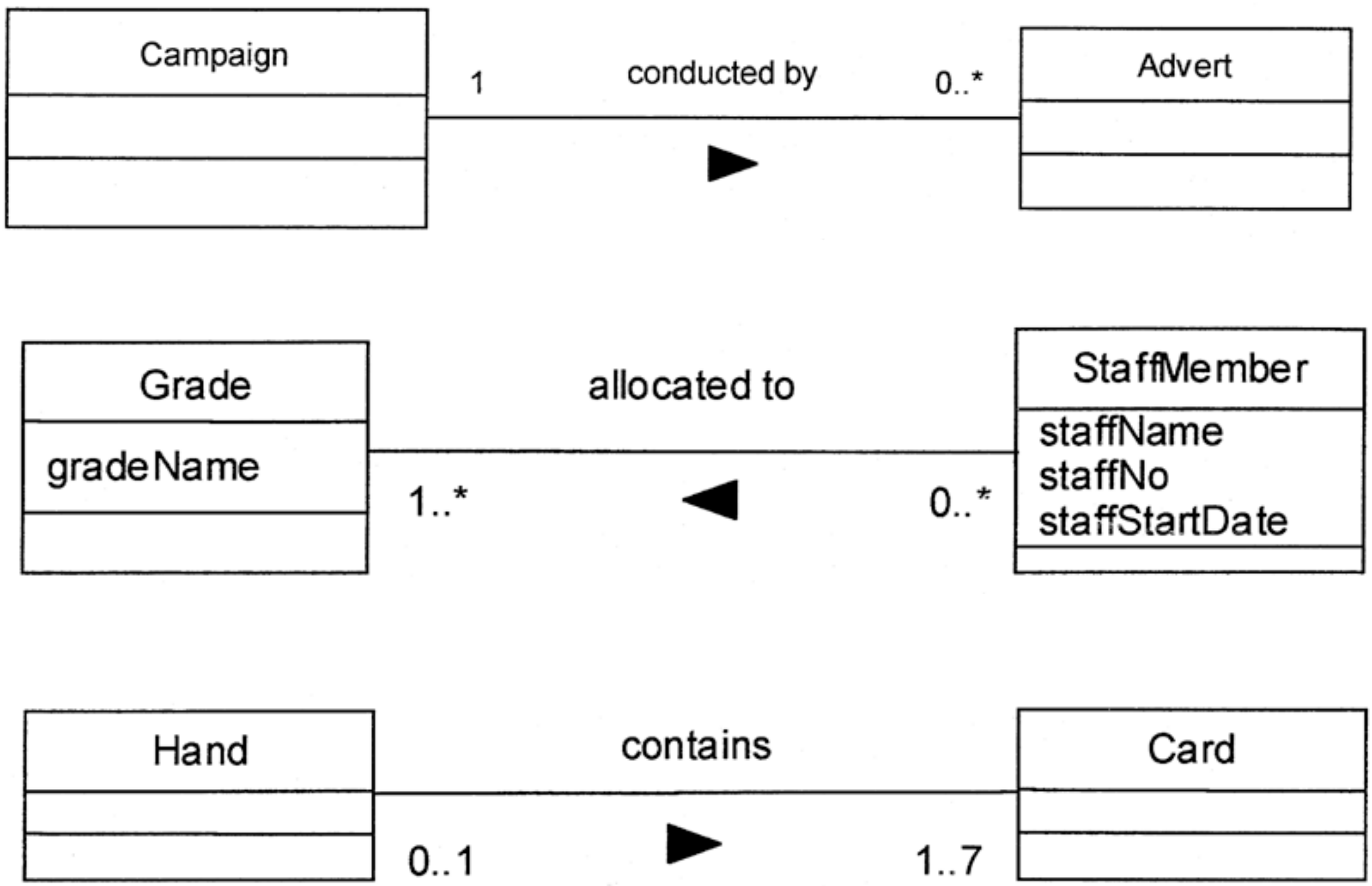
- Some examples of specifying multiplicity:

Optional (0 or 1)	0..1	
Exactly one	1	= 1..1
Zero or more	0..*	= *
One or more	1..*	
A range of values	2..6	

Class associations

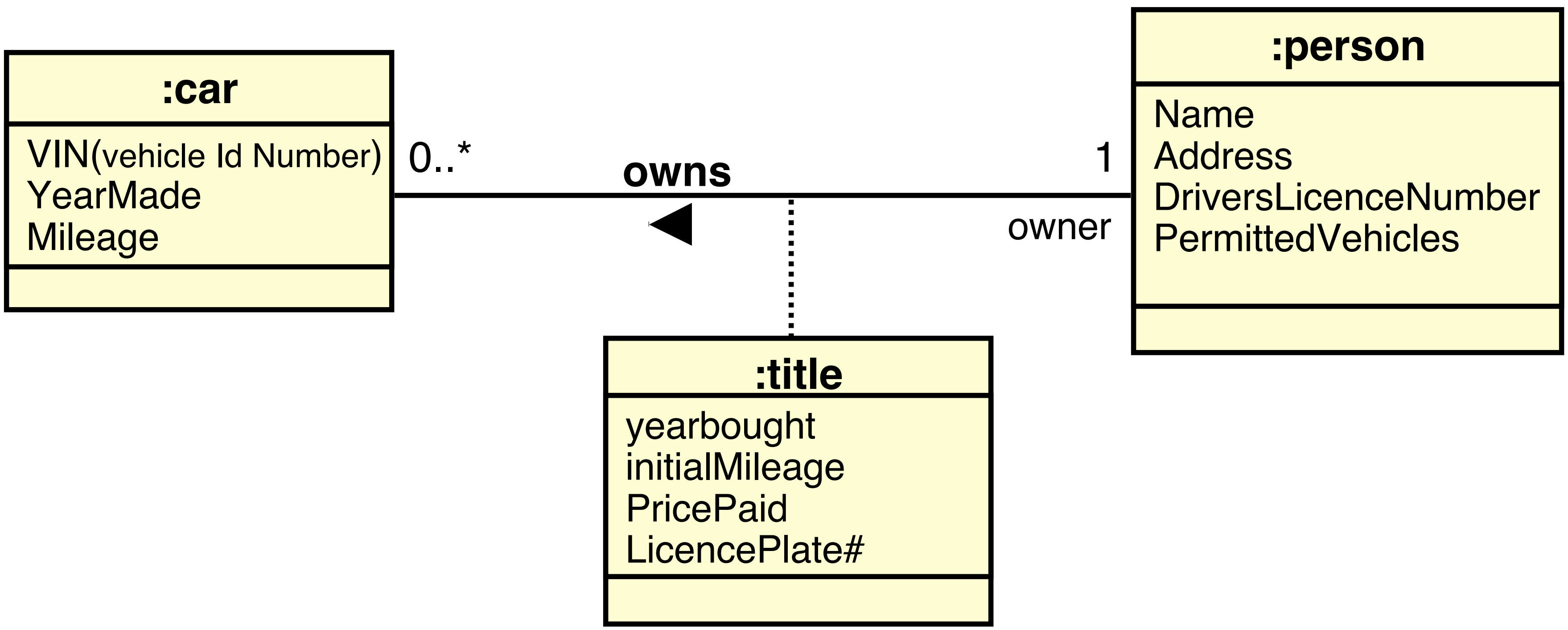


More Examples



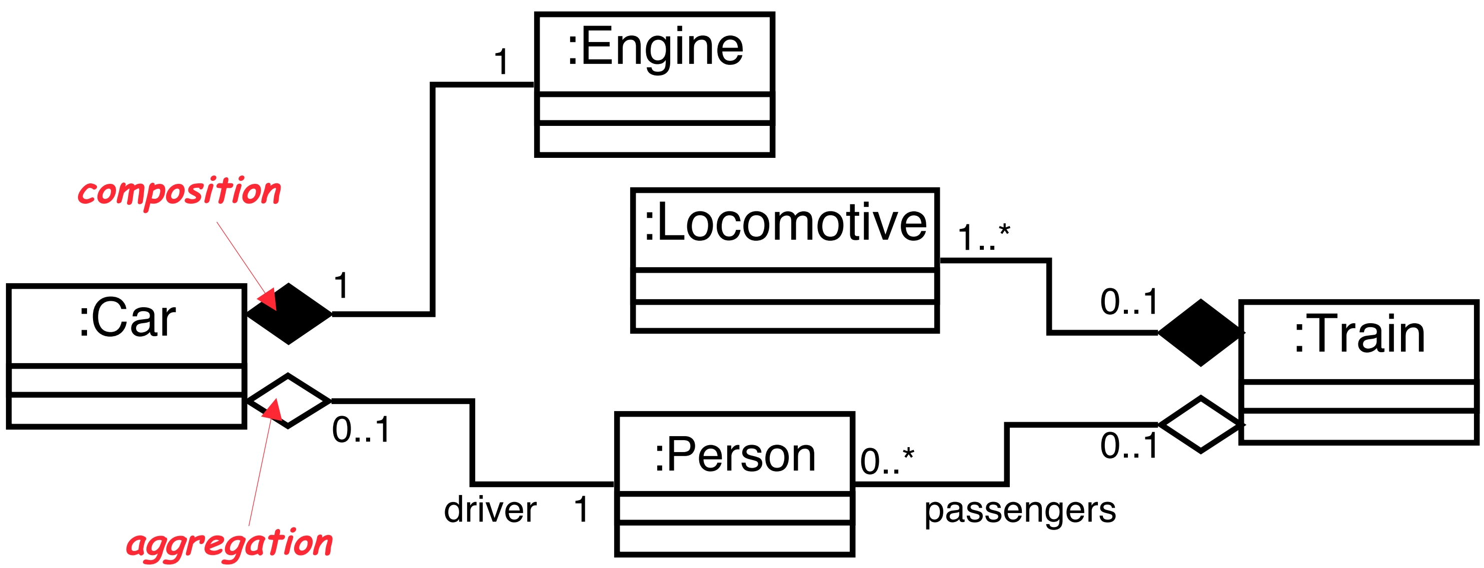
Association Classes

- Sometimes the association is itself a class
  - …because we need to retain information about the association
  - …and that information doesn't naturally live in the classes at the ends of the association
    - E.g. a "title" is an object that represents information about the relationship between an owner and her car

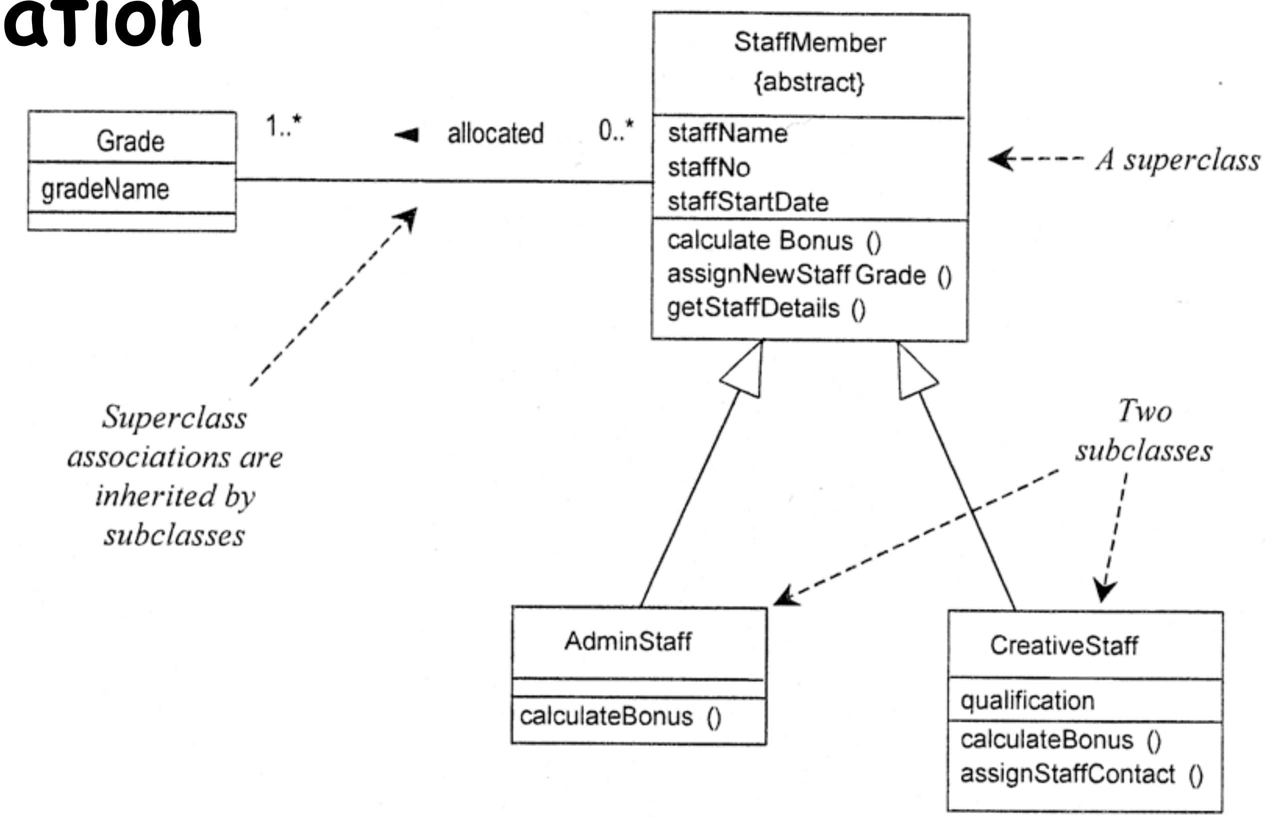


Aggregation and Composition

- Aggregation
  - This is the "Has-a" or "Whole/part" relationship
- Composition
  - Strong form of aggregation that implies ownership:
    - if the whole is removed from the model, so is the part.
    - the whole is responsible for the disposition of its parts



Generalization



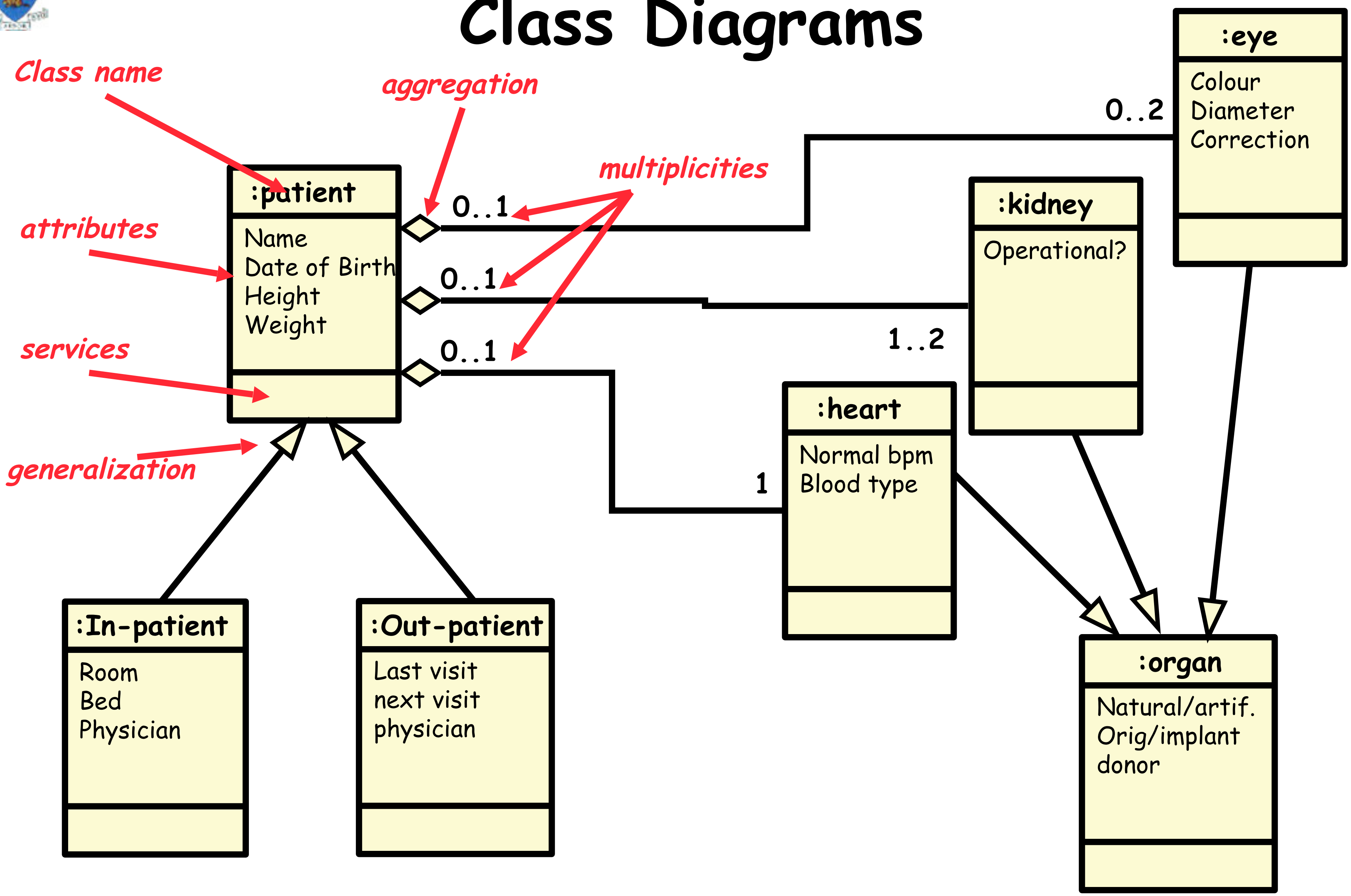
→ **Notes:**

- Subclasses inherit attributes, associations, & operations from the superclass
- A subclass may override an inherited aspect
  - e.g. AdminStaff & CreativeStaff have different methods for calculating bonuses
- Superclasses may be declared {abstract}, meaning they have no instances
  - Implies that the subclasses cover all possibilities
  - e.g. there are no other staff than AdminStaff and CreativeStaff

More on Generalization

- **Usefulness of generalization**
  - Can easily add new subclasses if the organization changes
- **Look for generalizations in two ways:**
  - Top Down
    - You have a class, and discover it can be subdivided
    - Or you have an association that expresses a "kind of" relationship
    - *E.g. "Most of our work is on advertising for the press, that's newspapers and magazines, also for advertising hoardings, as well as for videos"*
  - Bottom Up
    - You notice similarities between classes you have identified
    - E.g. *"We have books and we have CDs in the collection, but they are all filed using the Dewey system, and they can all be lent out and reserved"*
- **But don't generalize just for the sake of it**
  - Be sure that everything about the superclass applies to the subclasses
  - Be sure that the superclass is useful as a class in its own right
    - I.e. not one that we would discard using our tests for useful classes
  - Don't add subclasses or superclasses that are not relevant to your analysis

Class Diagrams



Summary

- Understand the objects in the application domain
  - Identify all objects that stakeholders refer to
  - Decide which objects are important for your analysis
  - Class diagrams good for:
    - Visualizing relationships between domain objects
    - Exploring business rules and assumptions via multiplicities
    - Specifying the structure of information to be (eventually) stored
- OO is a good way to explore details of the problem
  - Avoids the fragmentary nature of structured analysis
  - provides a coherent way of understanding the world
- But beware…
  - temptation to do design rather than problem analysis
    - In RE, class diagrams DO NOT represent programming (e.g. Java) classes
  - For analysis, use UML diagrams as sketches, not as blueprints
    - But may become blueprints when used in a specification