Class Specification

Association Specification

Class Specification (1)

- name’:’type-expression ‘=‘initial-value ‘{‘property-string‘}’
- operation name‘(‘parameter-list’)’ ’:’return-type-expression
- Primary operations: create, destroy, get and set

BankAccount
accountNumber : Integer accountName : String {not null} balance : Money = 0 /availableBalance : Money overdraftLimit : Money
open(accountName : String) : Boolean close() : Boolean credit(amount:Money) : Boolean debit(amount:Money) : Boolean getBalance() : Money setBalance(newBalance : Money) getAccountName() : String setAccountName(newName : String)

Class Specification (2)

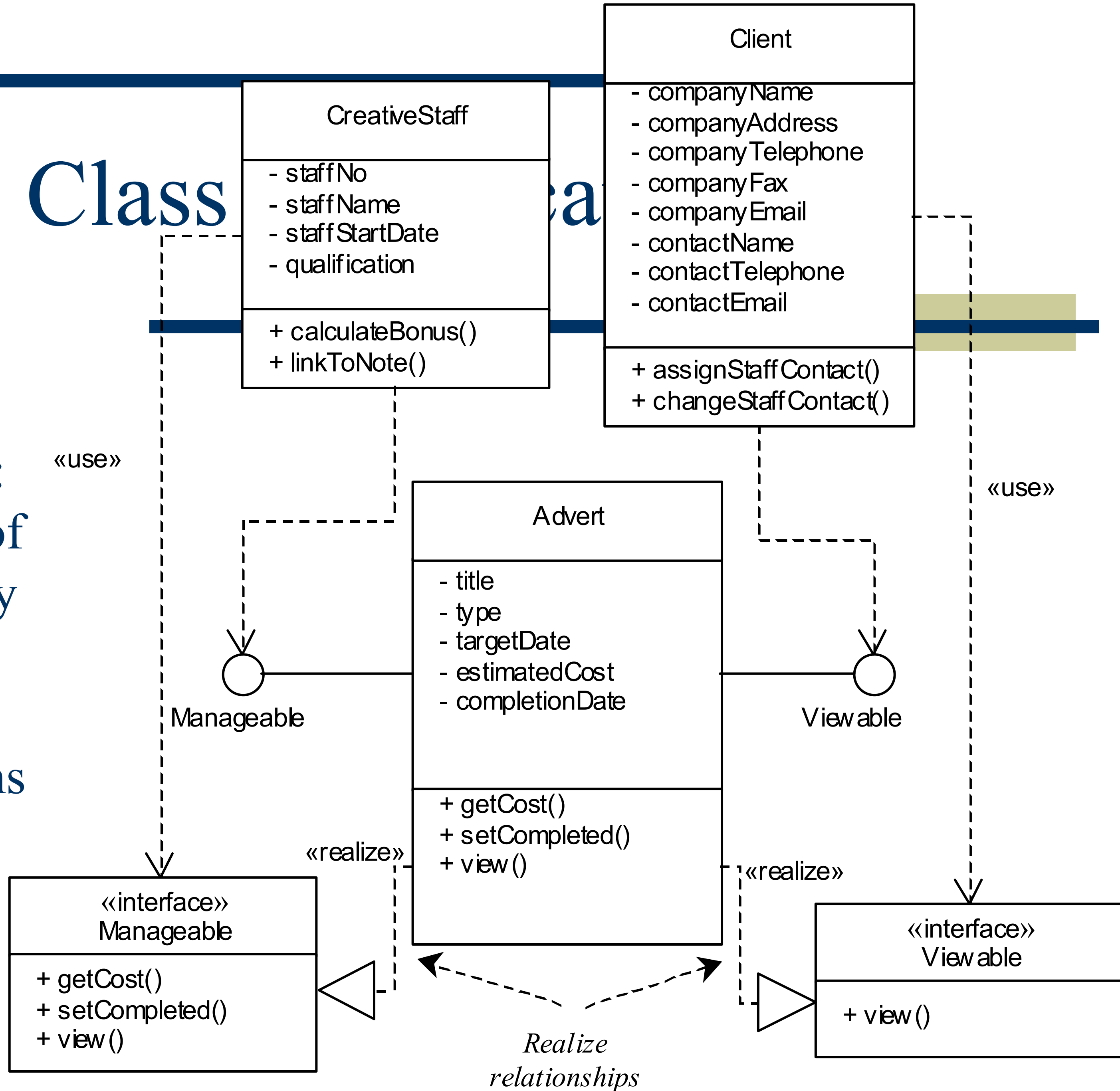
- Visibility: what is publicly accessible
  - May be specified as properties

Visibility symbol	Visibility	Meaning
+	Public	The feature (an operation or an attribute) is directly accessible by an instance of any class.
-	Private	The feature may only be used by an instance the class that includes it.
#	Protected	The feature may be used either by the class that includes it or by a subclass or decendant of that class.
~	Package	The feature is directly accessible only by instances of a class in the same package.

BankAccount
- nextAccountNumber: Integer - accountNumber: Integer - accountName: String {not null} - balance: Money = 0 - /availableBalance: Money - overdraftLimit: Money
+ open(accountName: String): Boolean + close(): Boolean + credit(amount: Money): Boolean + debit(amount: Money): Boolean + viewBalance(): Money # getBalance(): Money - setBalance(newBalance: Money) # getAccountName(): String # setAccountName(newName: String)

Class

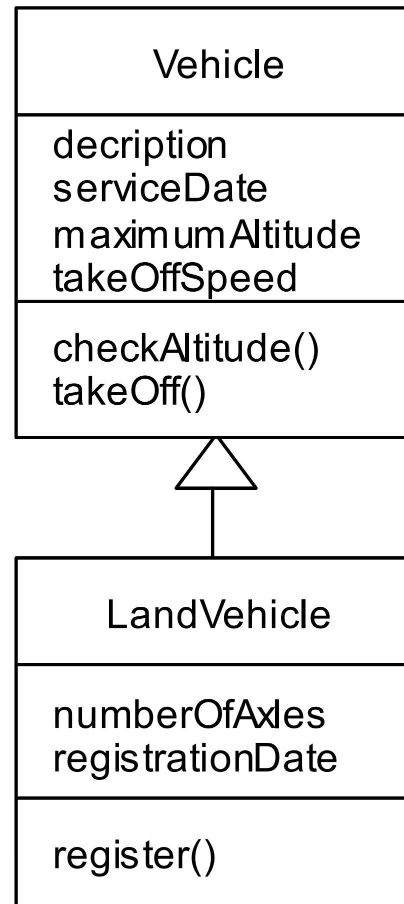
- UML interface: a group of externally visible (public) operations



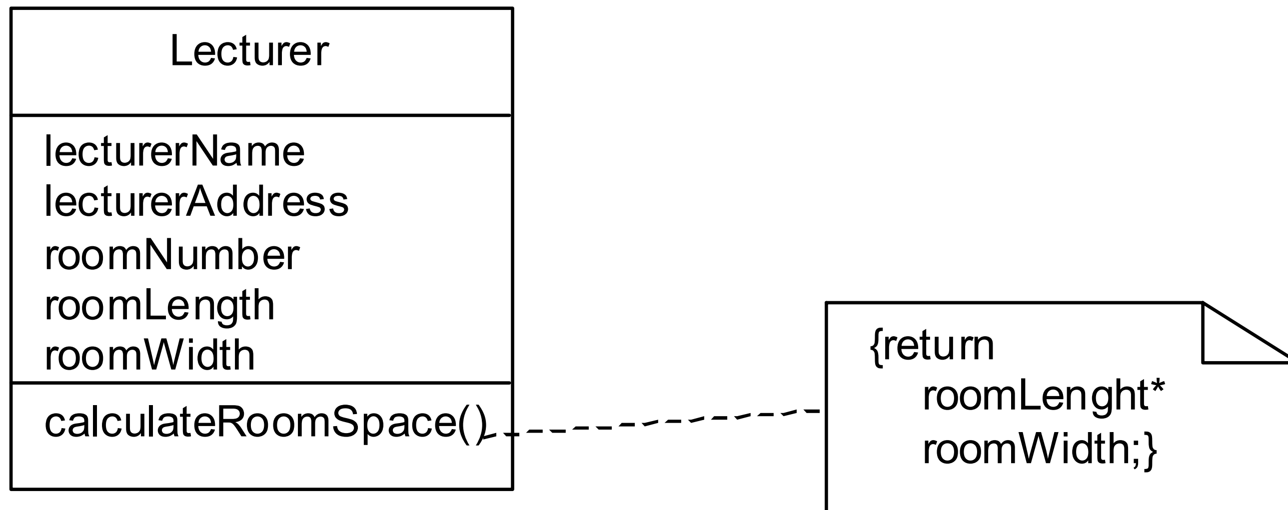
Criteria for Good Design (1)

- Coupling and cohesion
  - Degree of interconnectedness between design components – number of links and degree of interaction
  - Degree to which an element contributes to a single purpose
- Interaction coupling – low
- Inheritance coupling – high
- Operation cohesion – high
- Class cohesion – high
- Specialisation cohesion – high

Criteria for Good Design (2)



Criteria for Good Design (2)



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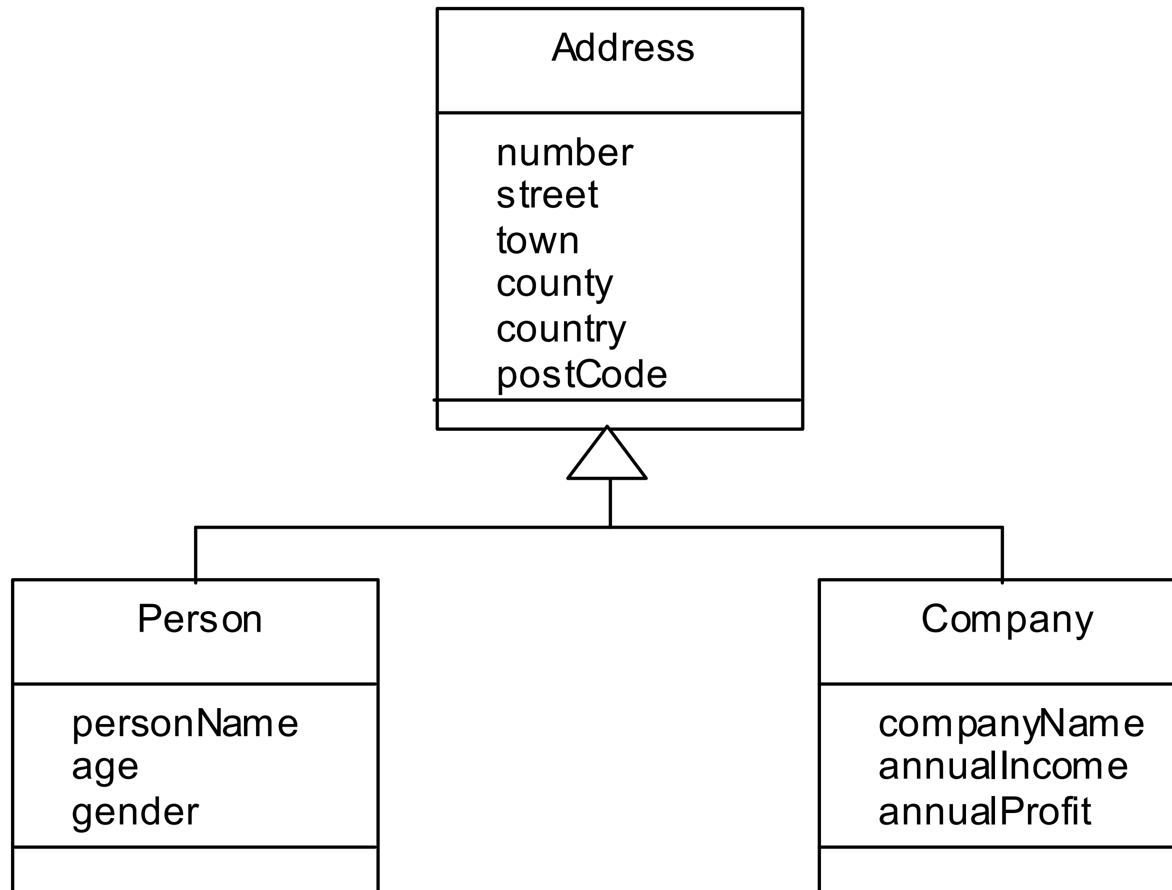

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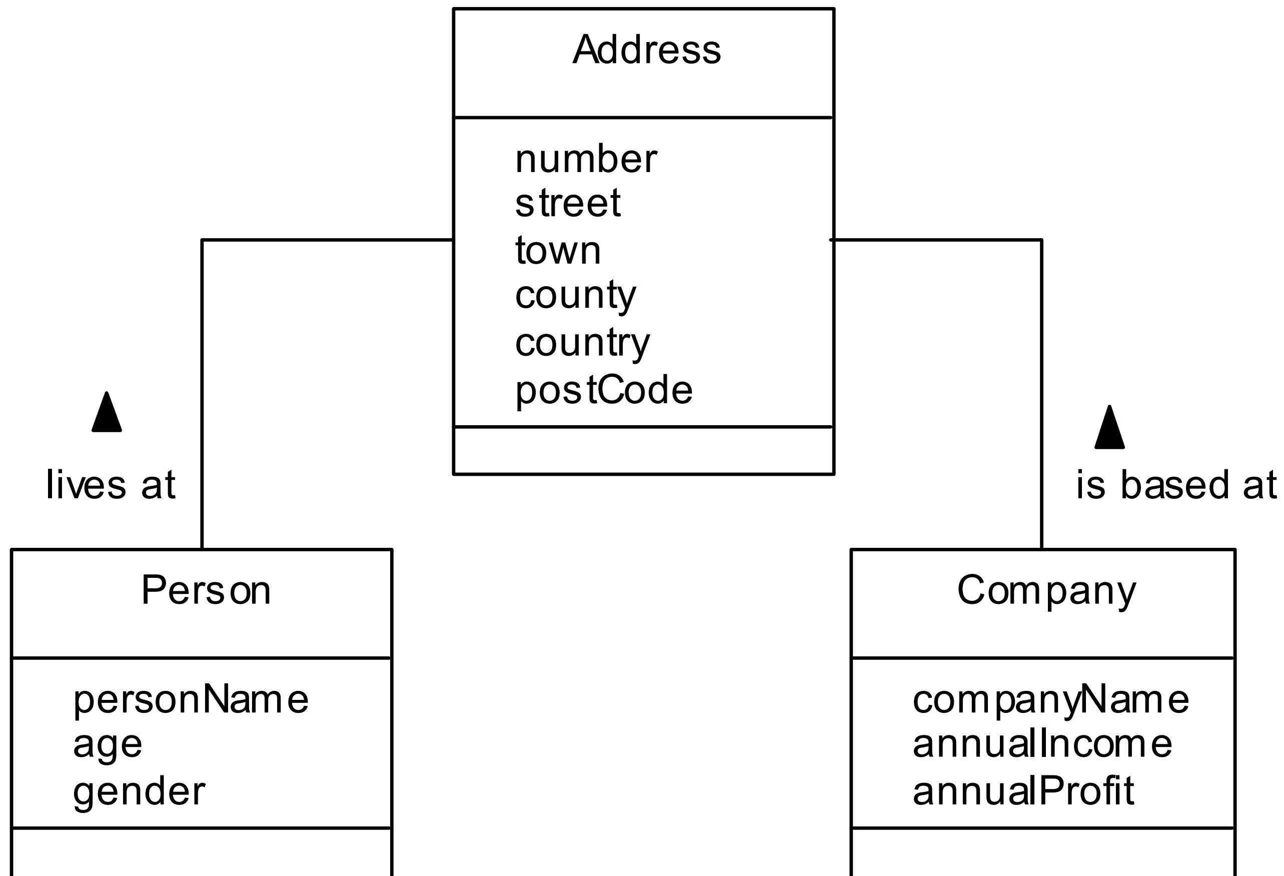
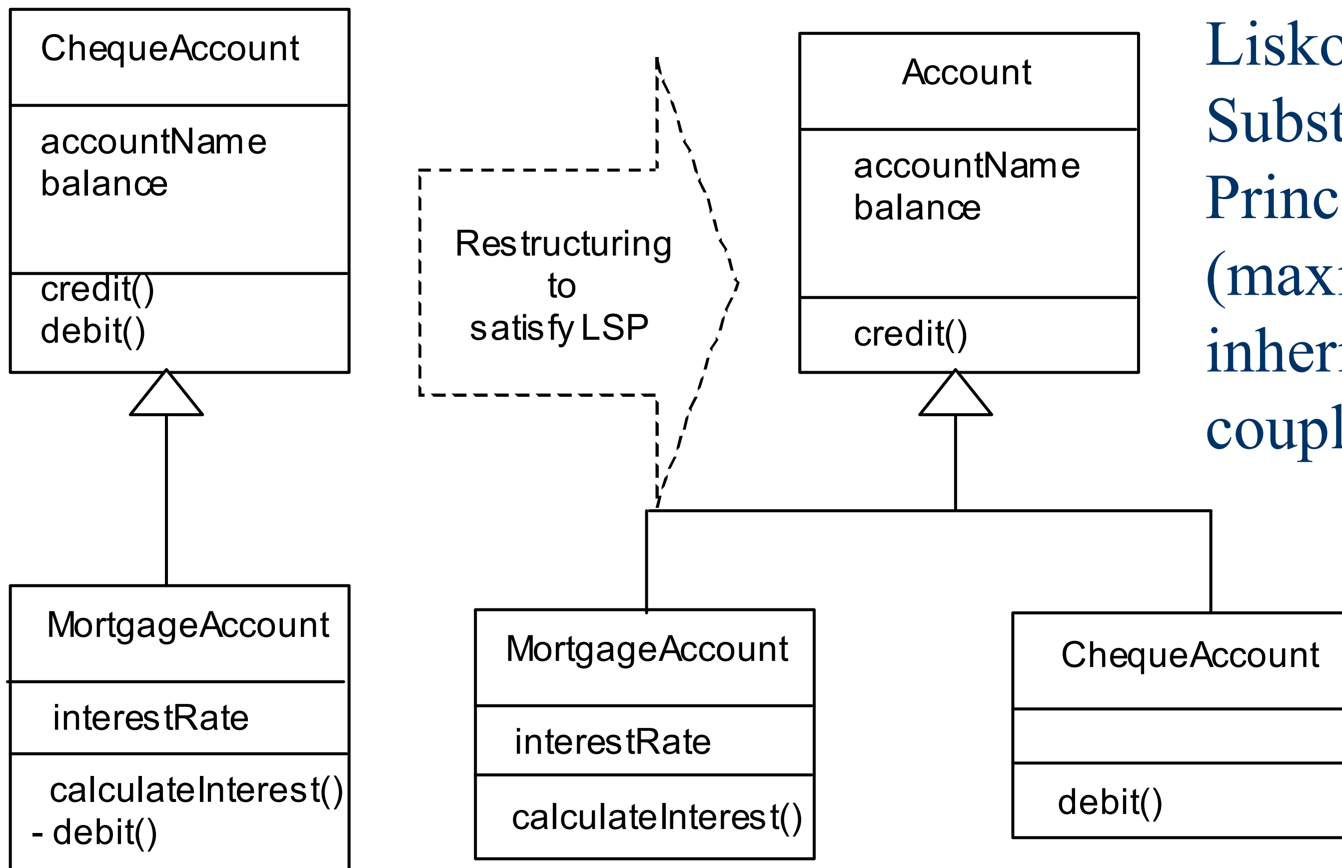


Criteria for Good Design (3)



Liskov Substitutability Principle (maximising inheritance coupling)

Criteria for Good Design (4)

- Design guidelines
  - Design clarity
  - Don’t over design (designing flexibility has a cost)
  - Control inheritance hierarchies (4 or 5 levels)
  - Keep messages and operations simple
  - Design volatility
  - Evaluate by scenario
  - Design by delegation
  - Keep classes separate

Generalisation and Inheritance (1)

- Generalisation and inheritance are not the same!
  - Generalisation is a semantic relationship between classes – superclass and subclass have the same interface
    - Substitution principle is central
    - Substitution leads to reduction of associations in the class diagram
  - Inheritance is the mechanism by which subclasses incorporate the structure and behaviour of their superclass
    - Inheritance may defeat substitutability!
    - Inheritance compromises encapsulation – protected features
    - Inheritance is a class concept – except in Smalltalk

Generalisation and Inheritance (2)

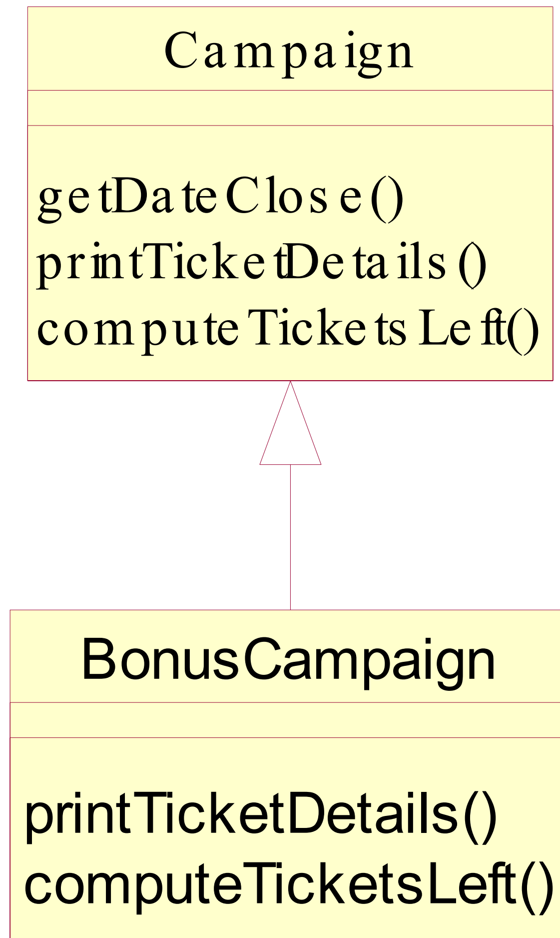
- Interface inheritance (subtyping, type inheritance)
  - Harmless
  - Abstract classes for interface declaration
- Implementation inheritance (subclassing, code inheritance, class inheritance)
  - Can be dangerous!
  - Code reuse and polymorphism
  - Overriding – up calls
  - Extension inheritance (proper) – incremental class definition
    - Overriding – more specific but with the same meaning

Generalisation and Inheritance (3)

- Restriction inheritance (problematic) – reuse of class properties
  - Maintenance problems
- Convenience inheritance (improper)
  - Extensive overriding

- Problems with implementation inheritance
  - Fragile base class – allow evolution of parent classes
    - Immutable public interfaces?
  - Overriding and callbacks (up calls)
    - Inherit interface and implementation without changes in the implementation
    - Inherit code and call it within own method with unchanged signature
    - Inherit code and and completely override it maintaining the signature
    - Inherit empty code declaration and provide an implementation
    - Inherit the method interface and provide an implementation

Generalisation and Inheritance (4)



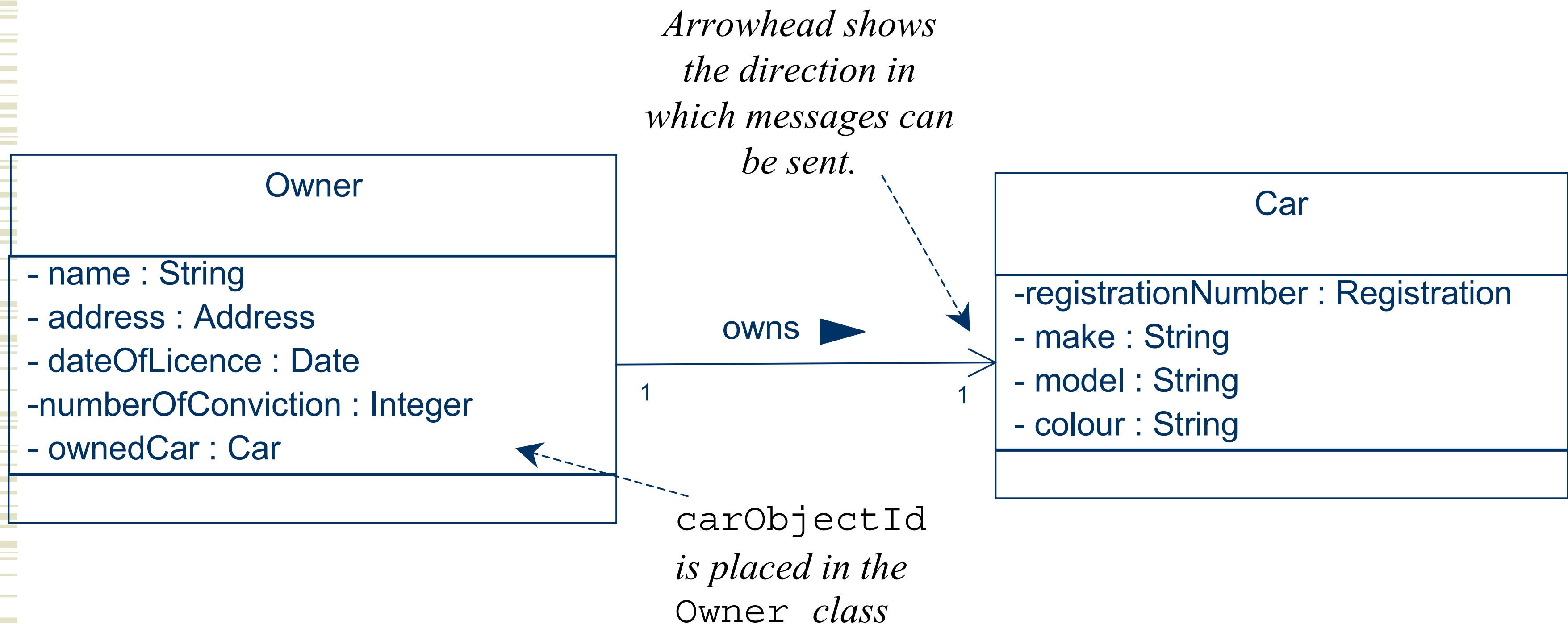
- Multiple inheritance
  - Interface – merging of interface contracts
  - Implementation
    - Operation renaming

Designing Associations (1)

- Associations indicate possibility of links
- Message-passing requires link
- Multiplicities restrict the number of links
- Association navigability
  - Do you have to send message?
  - Do you have to provide references?
  - But, references may be passed in messages!
  - Minimising the number of two way associations keeps coupling low

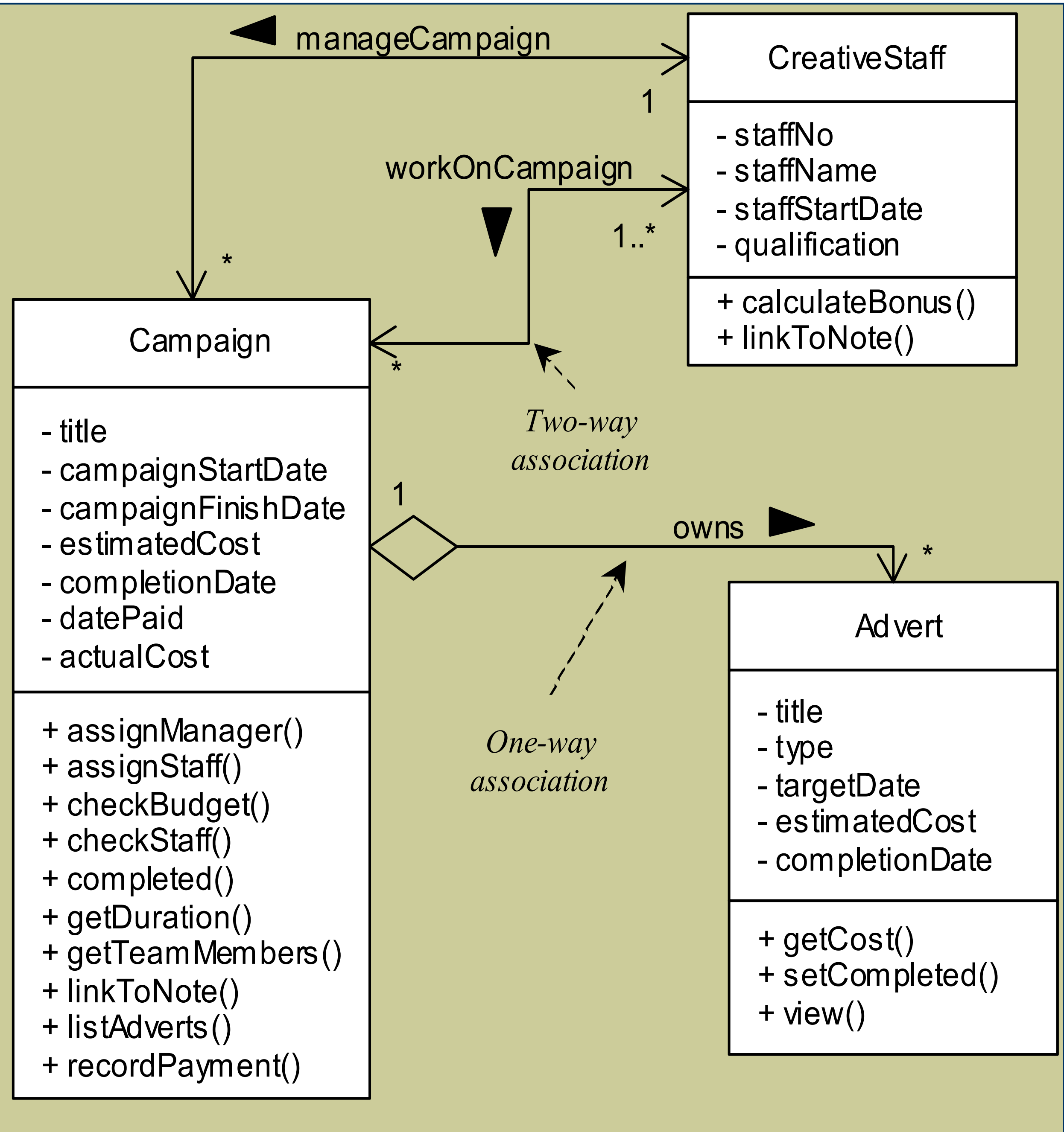
Designing Associations (2)

- One-to-one associations



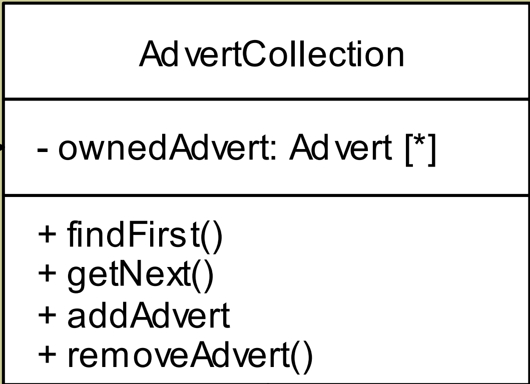
Des

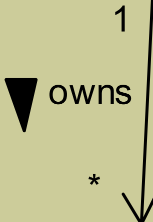
- One-to-many associations

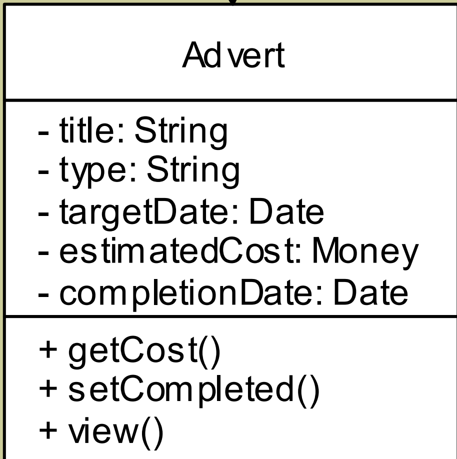


Campaign
- title: String
- campaignStartDate: Date
- campaignFinishDate: Date
- estimatedCost: Money
- completionDate: Date
- datePaid: Date
- actualCost: Money
- ownedAdvertCollection: AdvertCollection
+ assignManager()
+ assignStaff()
+ checkBudget()
+ checkStaff()
+ completed()
+ getDuration()
+ getTeamMembers()
+ linkToNote()
+ listAdverts()
+ recordPayment()

1
has
1


AdvertCollection
- ownedAdvert: Advert [*]
+ findFirst()
+ getNext()
+ addAdvert
+ removeAdvert()


1
owns
*


Advert
- title: String
- type: String
- targetDate: Date
- estimatedCost: Money
- completionDate: Date
+ getCost()
+ setCompleted()
+ view()

Designing Associations (5)

:Campaign

:AdvertCollection

:Advert

listAdverts()

advert = findFirst()

advertTitle = getTitle()

[until no more adverts]
loop

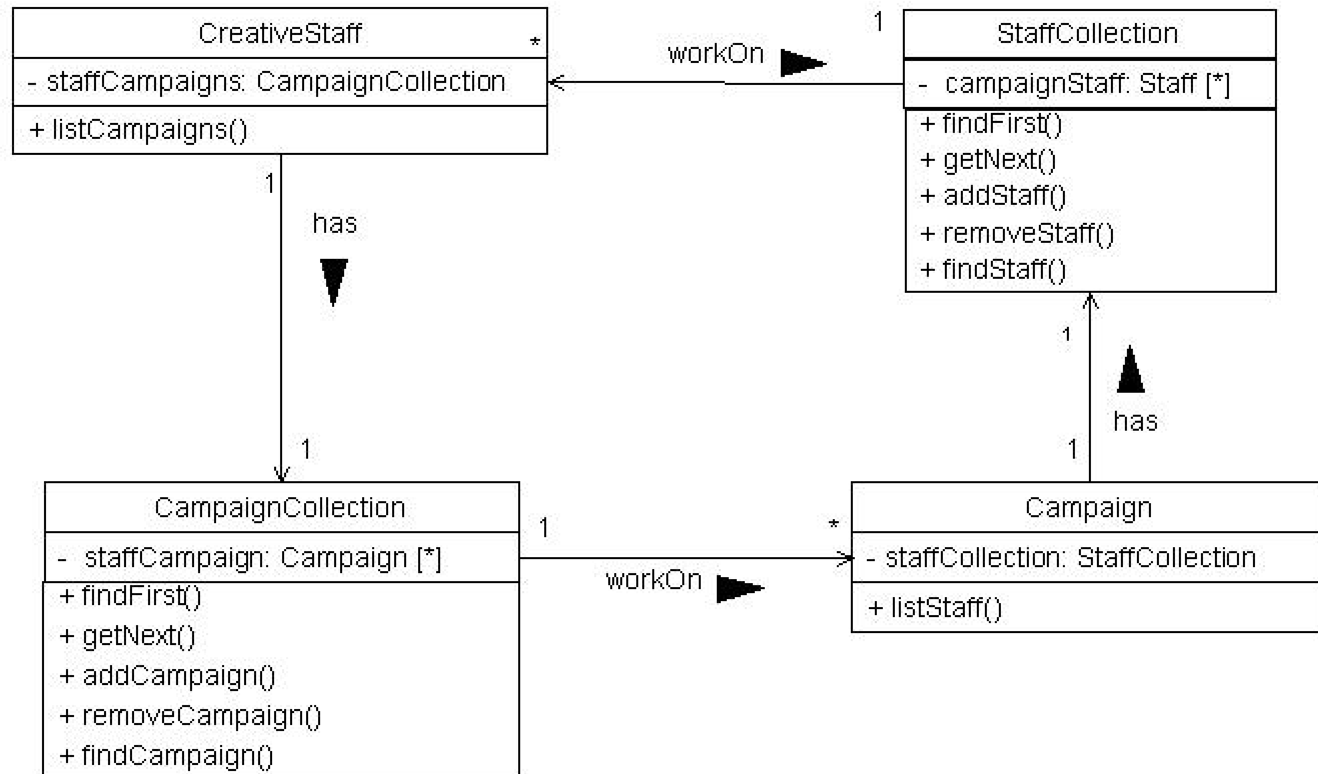
advert = *getNext()

advertTitle = getTitle()

end loop

Designing Associations (6)

- Many-to-many associations
  - Inner collection classes
  - Library collection classes

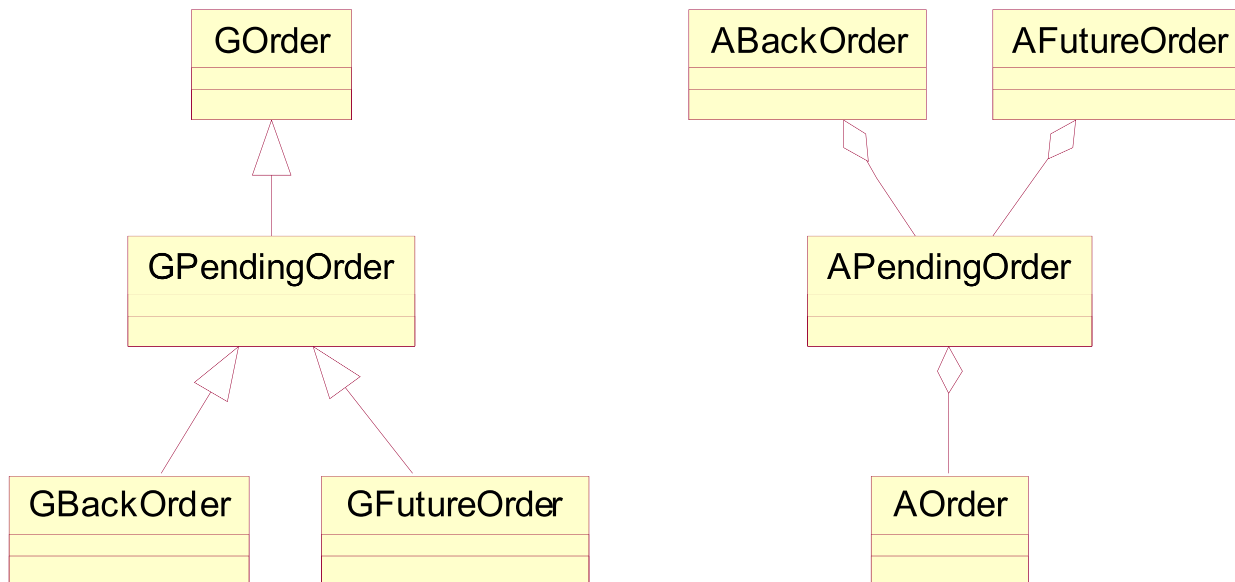


Aggregation and delegation (1)

- Aggregation and composition are kinds of associations
- Aggregation and composition are containment relationships
- Composition is a a kind of aggregation with existence dependency
- Different kinds of aggregation
  - Exclusive owns (composition, frozen)
  - Owns (composition)
  - Has (aggregation with transitivity and asymetricity)
  - Member (aggregation with many-to-many multiplicity)

Aggregation and delegation (2)

- Generalisation versus aggregation
  - Classes versus objects
  - Inheritance versus delegation



Aggregation and delegation (3)

- Delegation and prototypical systems
  - Delegation: composite object (outer) – component objects (inner)
  - Object (prototype) cloning
  - Aggregation – exposing the inner classes
  - Composition – encapsulating the inner classes
- Treaty of Orlando: same system functionality can be delivered with inheritance or delegation
  - Self-recursion has to be explicitly planned and designed into delegation
    - Fragile base class problem is a result of unplanned reuse
  - Delegation enables dynamic sharing and reuse
    - Anticipatory and un-anticipatory sharing

Integrity Constraints

- Referential integrity
  - Two-way associations
  - What happens when objects are removed?
  - Cascading deletes
- Dependency constraints
  - Derived attributes and associations
  - Synchronising operations
  - Prevention and exceptions
- Domain integrity
  - Ensure maintenance of invariants in update operations

Designing Operations

- Algorithm design
  - Cost of implementation
  - Performance constraints
  - Requirements for accuracy
  - Capabilities of the implementation platform
- Computational complexity
- Ease of implementation and understandability
- Flexibility
- Fine-tuning the object model
- Operation design documents
  - Activity diagrams
  - Formal specifications
- Some guidelines
  - Operation should reside in the same class as the attributes that manipulate
  - Minimise object interaction
  - Simplicity
  - Place operation that not owned by entity classes in control classes

Normalisation

- Functional dependencies
  - Attribute A is functionally dependent on attribute B if for every value of B there is precisely one value of A associated with it at any given time
  - Rules of normalisation group attributed along functional dependencies – redundancy reduction