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Lecture 2: OO and UML

Today's Plan

- 10:05-10:55:
 - Quiz 2 (assessed, correctness)
 - Important UML concepts
- Break
- 11:05-11:55:
 - PI 2 (assessed, participation)
 - UML sequence diagram
 - Case-study: Airline
- Long break
- 13:00-14:00 OR 14:00-15:00 in BO1028: Lab 2 UML

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QUIZ

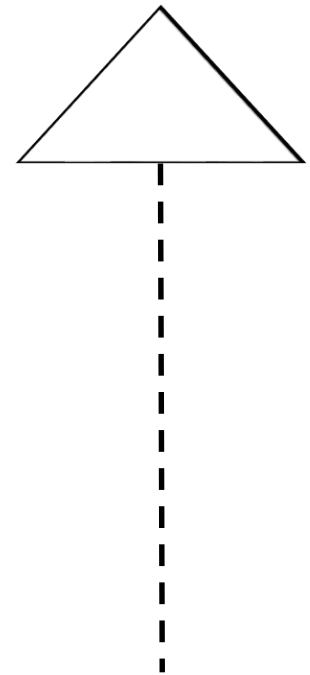
- Go to YACRS
 - <https://classresponse.gla.ac.uk>
 - <https://powcoder.com>
- Join session: **1140**
 - prepare for quiz.
 - raise you hand if your are experiencing problems
 - 180 sec per question (I'll call out 2 min, 1 min and 30 sec)

Q2.1: UML Syntax [solo]

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What does this arrow represent in UML?

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- ☐ A: Inheritance relationship
 - ☐ B: Interface relationship
 - ☐ C: Uses relationships
 - ☐ D: Requires relations
 - ☐ E: Don't know

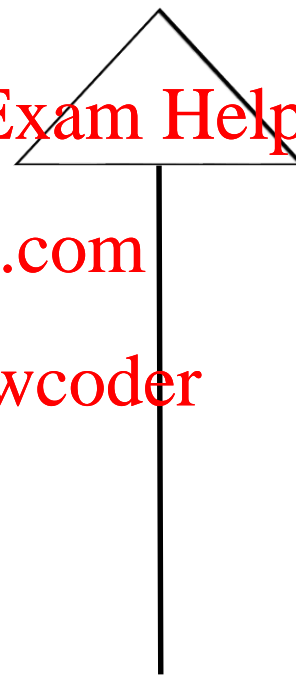


Q2.1: Interfaces Versus Inheritance (solution)

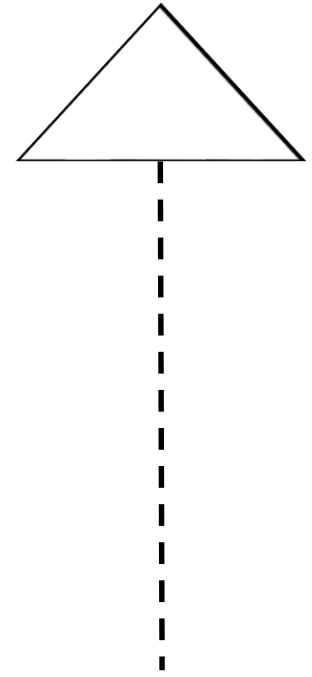
- Don't confuse arrows for inheritance and interfaces.

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- Just need to memorise and get used to identifying different arrows.



Extends



B: Implements

Q2.2: UML Syntax [solo]

This box is used to describe:

- ☐ A: Attributes
- ☐ B: Instances
- ☐ C: Methods
- ☐ D: Objects
- ☐ E: Don't know

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Class Name

Q2.2: UML Syntax (solution)

This box is used to describe:

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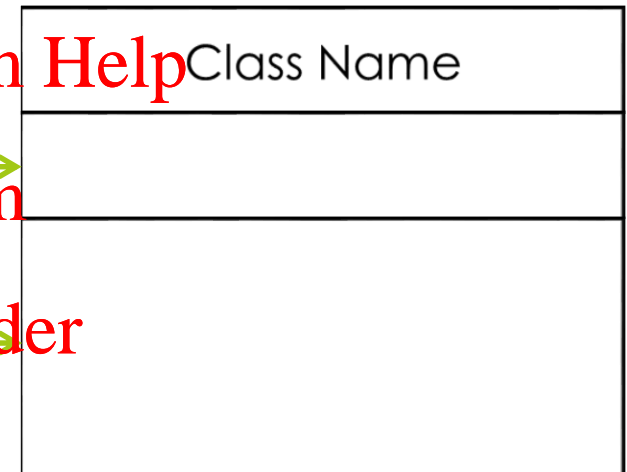
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■ A: Attributes

■ B: Instances

■ C: **Methods**

■ D: Objects



Q2.3: UML Syntax [solo]

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Interfaces are indicated in UML by:

- A: Italic Class Name <https://powcoder.com>
- B: Bold Class Name **Add WeChat powcoder**
- C: Interface Label above Class Name
- D: A diamond-shaped arrow
- E: Don't know

Q2.3: UML Syntax (solution)

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Interfaces are indicated in UML by:

- A: Italic Class Name <– This is used for abstract classes
- B: Bold Class Name <– All class names should be bold
- C: Interface Label above Class Name <– All interfaces should be labeled as such (correct)
- D: A diamond shaped arrow <– this describes a different kind of relationship: Aggregation and Composition

UML

- Class diagrams
 - describe classes and their relationships
- Interaction diagrams
 - show the behaviour of systems in terms of how objects interact with each other
- State diagrams and activity diagrams
 - show how systems behave internally
- Component and deployment diagrams
 - show how the various components of systems are arranged logically and physically

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Why is UML Important?

- One of the few ways to add tangibility to software
 - structure
 - documentation
 - communication/collaboration
 - review
 - ...
- Standard method of communication (also in Industry)
- Implementation
 - Can help in auto-generating code

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Usage

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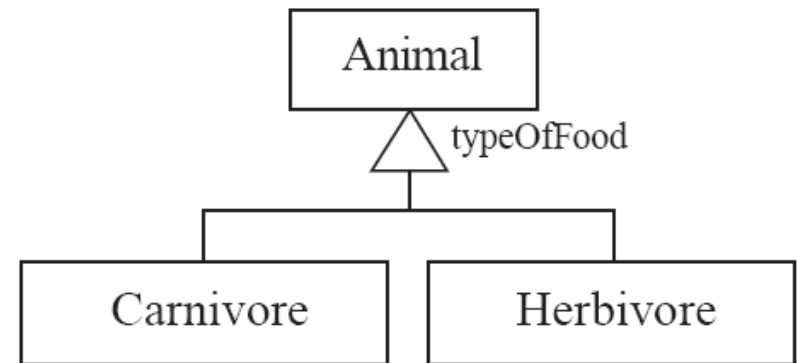
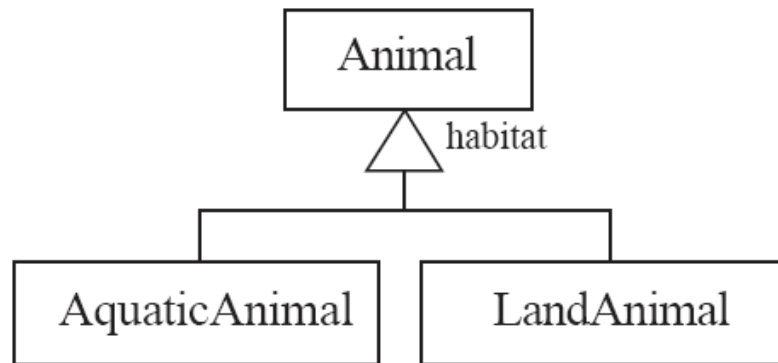
Type of model	<i>Contains elements that represent things in the domain</i>	<i>Models only things that will actually be implemented</i>	<i>Contains elements that do not represent things in the domain, but are needed to build a complete system</i>
Exploratory domain model: developed in domain analysis to learn about the domain	Yes	No	No
System domain model: models those aspects of the domain represented by the system	Yes	Yes	No
System model: includes classes used to build the user interface and system architecture	Yes	Yes	Yes

UML

- The main symbols shown on class diagrams are:
 - *Classes*
 - represent the types of objects themselves
 - *Generalizations*
 - group classes into inheritance hierarchies
 - *Associations*
 - represent linkages between instances of classes
 - *Attributes*
 - are simple data found in classes and their instances
 - *Operations*
 - represent the functions performed by the classes and their instances

Generalization

- Specializing a superclass into two or more subclasses
- A generalization set is a labeled group of generalizations with a common superclass
- The label (sometimes called the *discriminator*) describes the criteria used in the specialization



Java: extends

Associations

- One-to-many



- Many-to-many



- One-to-one –
Consider is these
should really be two
entities



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Associations in Java

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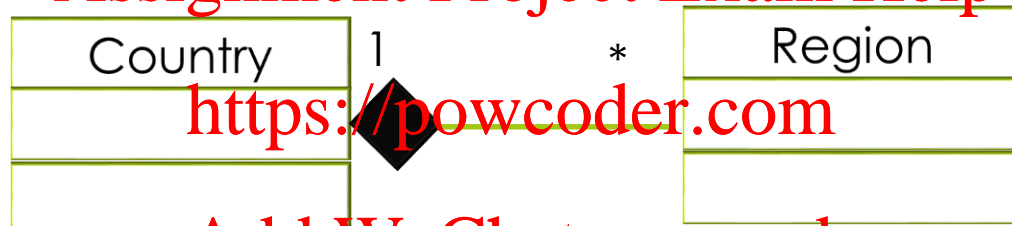
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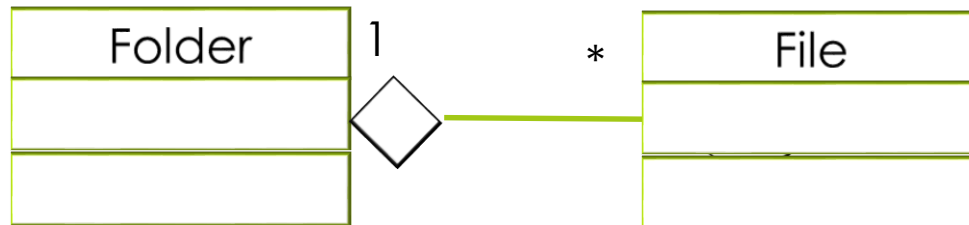
Composition and Aggregation

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Aggregation in Java

- A mechanism where an operation in an aggregate is implemented by having the aggregate perform that operation on its parts
- At the same time, properties of the parts are often propagated back to the aggregate
- Propagation is to aggregation as inheritance is to generalization.
 - The major difference is:
 - inheritance is an implicit mechanism
 - propagation has to be programmed when required

Associations v generalization

- **Associations** describe the relationships that will exist between *instances* at run time.
 - When you show an instance diagram generated from a class diagram, there will be an instance of *both* classes joined by an association.
- **Generalizations** describe relationships between *classes* in class diagrams.
 - They do not appear in instance diagrams at all.
 - An instance of any class should also be considered to be an instance of each of that class's superclasses

PI 2 Question Time

- Please join YACRS now.
 - <https://classresponse.gla.ac.uk>
 - Join session: 1141
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PI 2.1A: Question [solo!]

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A course registration system has classes for **Course** and **Student**.

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These should be represented as:

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A: Composition

B: Attribute

C: Aggregation

D: Inheritance

PI 2.1B: Question [group!]

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A course registration system has classes for **Course** and **Student**.

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These should be represented as:

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A: Composition

B: Attribute

C: Aggregation

D: Inheritance

PI 2.1: Solution

A course registration system has classes for **Course** and **Student**.

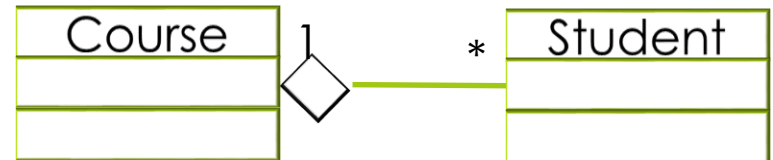
These should be represented as:

A: Composition ← Does course own students, i.e. no course no students?



B: Attribute

C: Aggregation ← Are students part of a course. Can a student exist without a course?



D: Inheritance

PI 2.2A: Question

A grocery store is trying to refactor its system to better use generalization for categories its products. Which structure would you use?

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A: A generalization for each product based on the aisles in the store (for example Aisle 1, Aisle 2,...)

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B: A generalization for each product based on the category (for example Fruit, Dairy, Dry Goods, etc..)

C: A generalization called Product, which all products extend

D: Something else...

PI 2.2B: Question

A grocery store is trying to refactor its system to better use generalization for categories its products. Which structure would you use?

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A: A generalization for each product based on the aisles in the store (for example Aisle 1, Aisle 2,...)

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B: A generalization for each product based on the category (for example Fruit, Dairy, Dry Goods, etc..)

C: A generalization called Product, which all products extend

D: Something else...

PI 2.2: Solution

A grocery store is trying to refactor its system to better use generalization for categories its products. Which structure would you use?

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A: A generalization for each product based on the aisles in the store, for example Aisle 1, Aisle 2, etc. <- The “is a” relationship does not work here. If the product is apples and they are sold on aisle 5, you can't say an apple is an aisle 5

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B: A generalization for each product based on the category, for example Fruit, Dairy, Dry Goods, etc.. <- Do these categories behave differently in meaningful ways (if so then correct); but do not go overboard with subclasses

C: A generalization called Product, which all products extend
<- typically this would be a sensible generalization; here the specific product info would be saved on as attributes

PI 2.3A: Question





A credit card company has a database of all its customers, including those who no longer hold credit account with the company. Customers can have multiple credit accounts.

How would you annotate the following association?

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- A. 
- B. 
- C. 
- D. 

PI 2.3: Solution





A credit card company has a database of all its customers, including those who no longer hold credit account with the company. Customers can have multiple credit accounts.

How would you annotate the following association?

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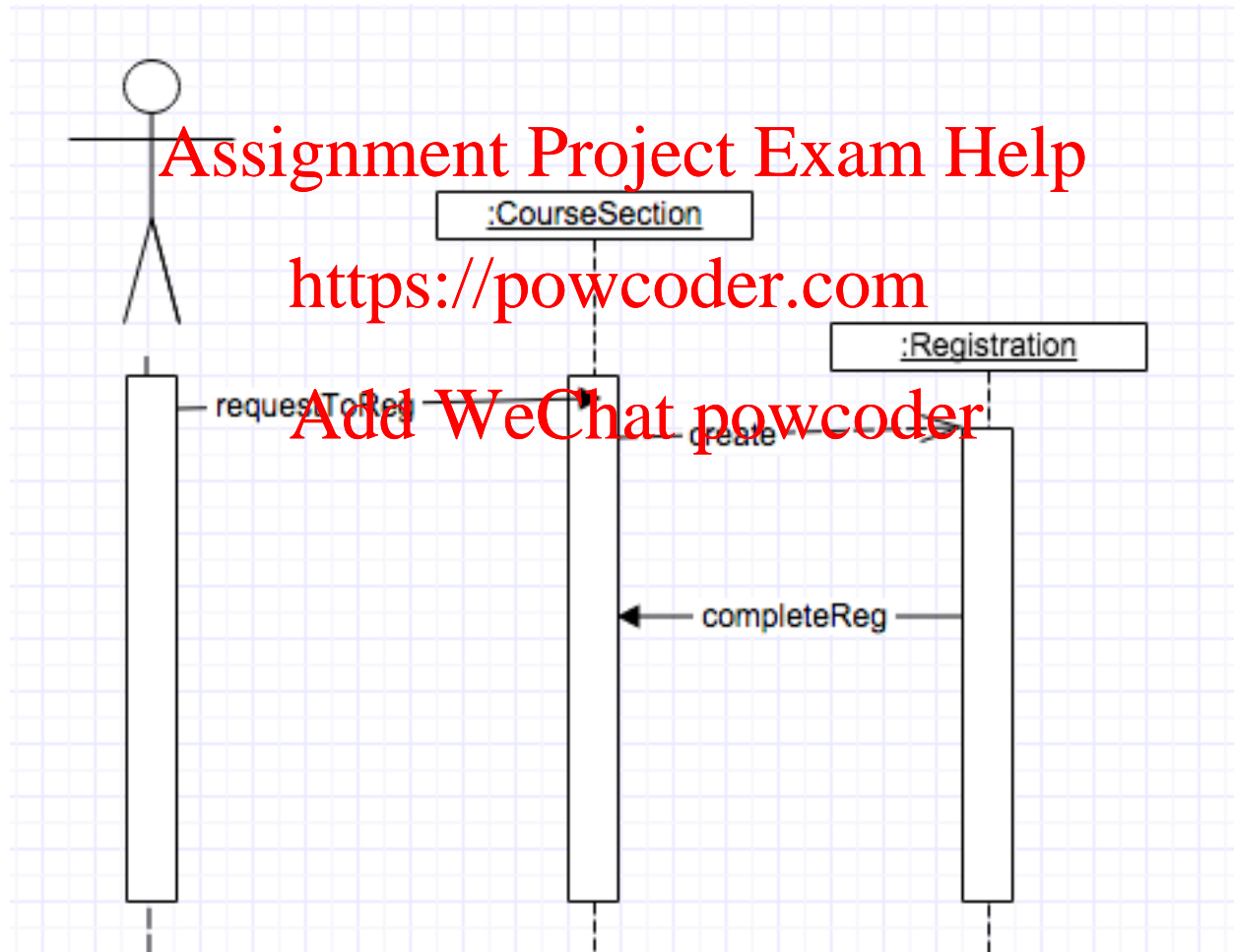
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- A.  Credit Account * — 1 Customer
- B.  Credit Account *..1 — 1 Customer
- C.  Credit Account 1 — * Customer
- D.  Credit Account 1 — 1 Customer

Sequence Diagrams

- Modeling behavior in an interactive system
 - Instances of classes and actors
 - Messages between instances classes and actors
 - In general, sequence diagrams come after class modeling is basically complete
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- **Notice:** Necessary syntax included here (and in following lectures), but you may want to read OOSE Chapter 8.

Simple Sequence Diagram



Key Syntax

- Instances are underlined, labeled like this.
 - instanceName: instanceClass
- Lifeline is a vertical dashed line
- Messages are horizontal lines
 - Synchronous message with filled arrowhead
 - Asynchronous message with unfilled arrowhead
- Your books also recommends dash line for “create” message, but it’s not standard by IBM specification
 - A good overview at <http://www.ibm.com/developerworks/rational/library/3101.html>

Class Responsibilities

- Setting and Getting
- Creating and Initialising
- Loading and Saving
- Destroying
- Adding and Deleting (associations)
- Copying, converting, transforming, transmitting, outputting
- Computing
- Navigating and Searching
- Specialised Work

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Case-study: Airline Reservation System (OOSE: Appendix C)

- Ootumlia Airlines runs sightseeing flights from Java Valley, the capitol of Ootumlia. The reservation system keeps track of passengers who will be flying in specific seats on various flights, as well as people who will form the crew. For the crew, the system needs to track what everyone does, and who supervised whom. Ootmulia Airlines runs several daily numbered flights on a regular schedule. Ootumlia Airlines expects to expand in the future, and therefore the system needs to be flexible; in particular, it will be adding a frequent flier plan.

Domain Modeling: Classes

- Identify all the nouns and noun phrases.
- Which should become classes?

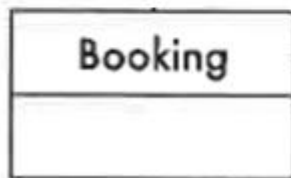
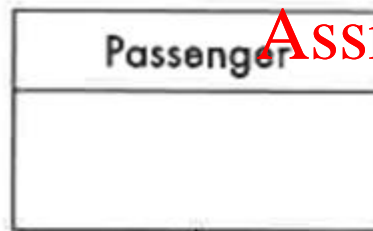
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Domain modelling: Attributes & Associations

- **Assignment Project Exam Help** Which attributes and associations should we include?

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Passenger
name
number

Employee
name
employeeNumber
jobFunction

RegularFlight
time
flightNumber

Booking
seatNumber

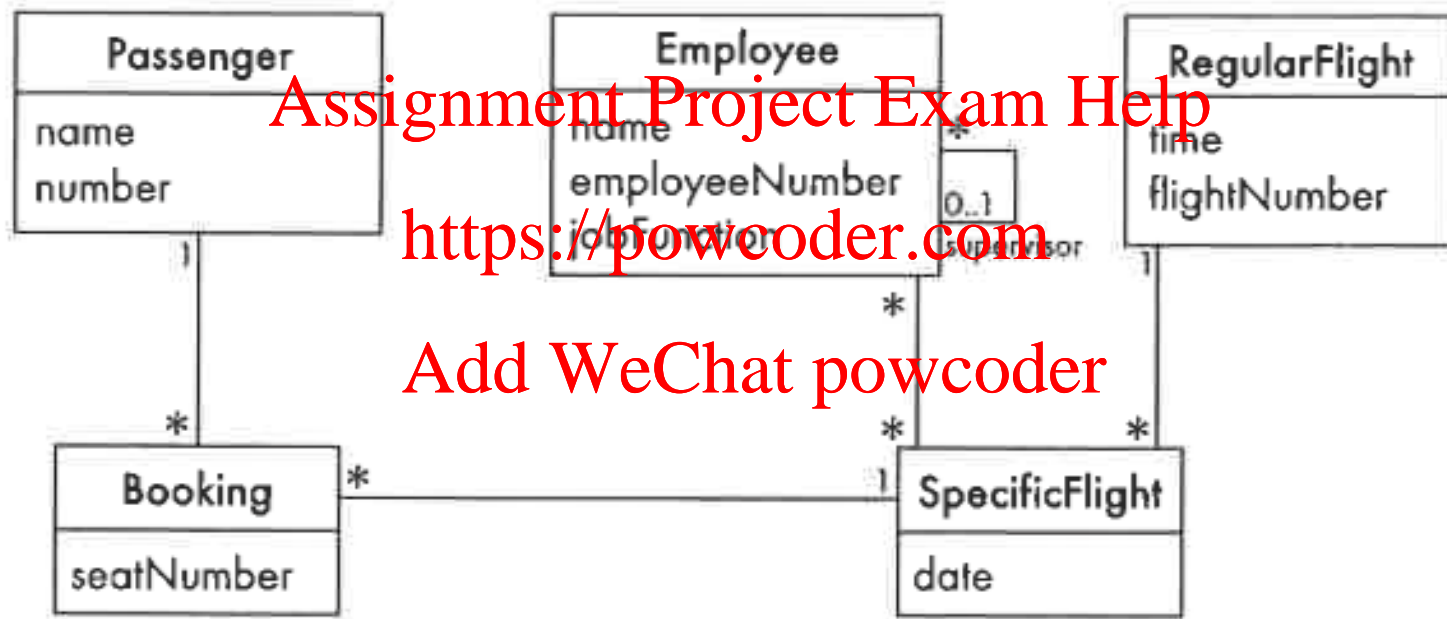
SpecificFlight
date

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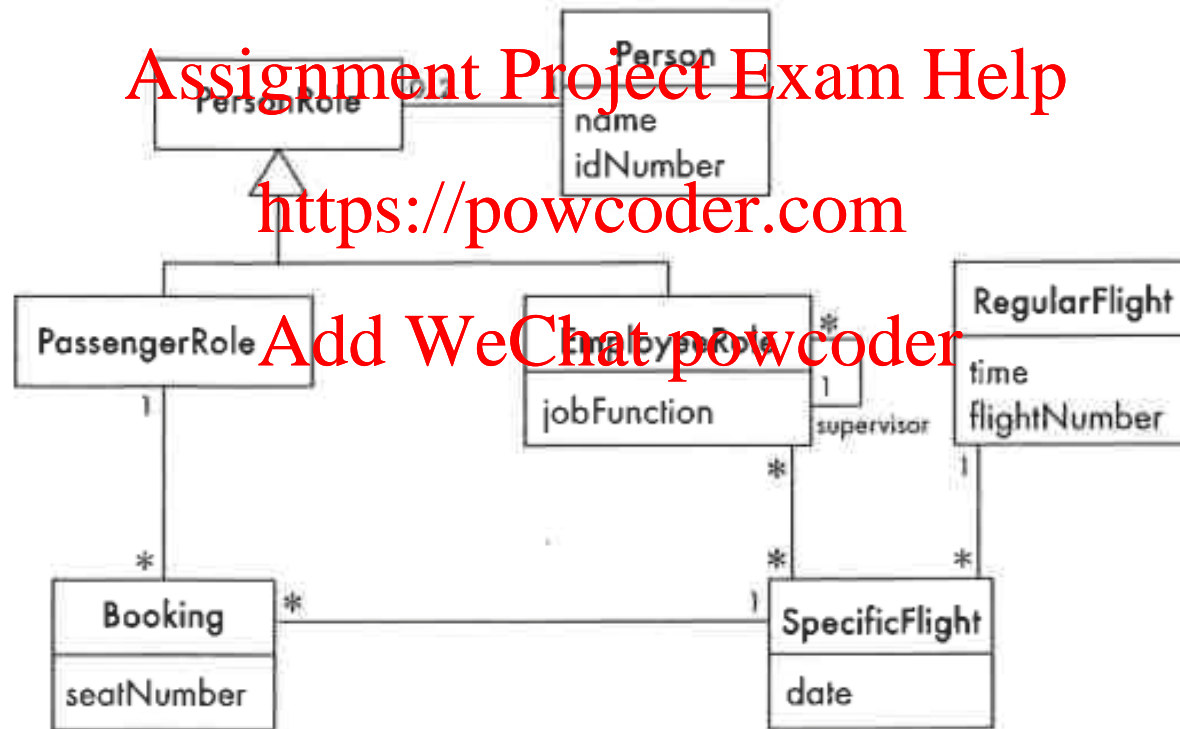
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Associations



Generalization



Domain modelling: Responsibilities and Operations

- What Responsibilities does each class have?
- Identify verbs and verb phrases

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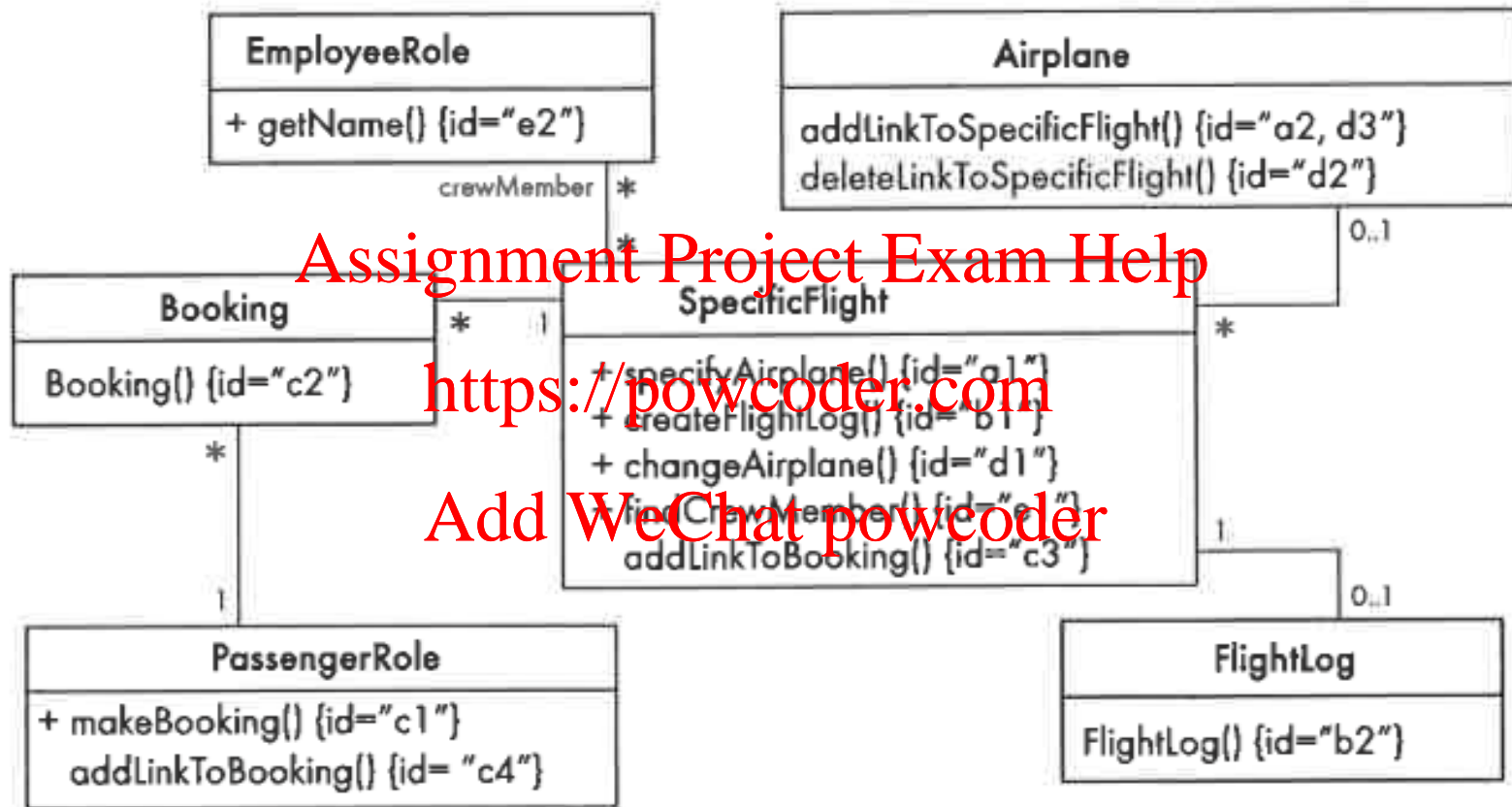
Responsibilities

- Creating a new Regular Flight
- Searching for a Regular Flight
- Modifying the attributes of a Regular Flight
- Creating a specific flight
- Cancelling a Specific Flight
- Cancelling a Booking
- ...

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You can review this complete example at home

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See Appendix C description of “Airline Reservation System” and Example 5.2 to Example 5.5 for more details
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Summary - UML

- How readable is the diagram? Can you easily figure out “what’s going on?”
- By looking at the diagram, do you have a clear vision of the underlying Java code?
- Does each class in the diagram have a 1:1 correspondence to a class in Java?
- For non-specific (not implements or extends) relationships, how would these be represented in code? Are they implicit or explicit?
- Can you see coupling and cohesion in the code? Can you describe it?

Lab 2: Domain Modeling with UML

Lab 2: Available on Moodle (12:30)

■ 13:00-14:00 BO1028 <https://powcoder.com>

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■ 14:00-15:00 BO1028

Next Week (Week 3)

- Design Pattern mania **Assignment Project Exam Help**
- Reading: Chapter 4 of **<https://powcoder.com>**
- Quiz on **Design Patterns** (more details will follow on Moodle) **Add WeChat powcoder**

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<EOL>