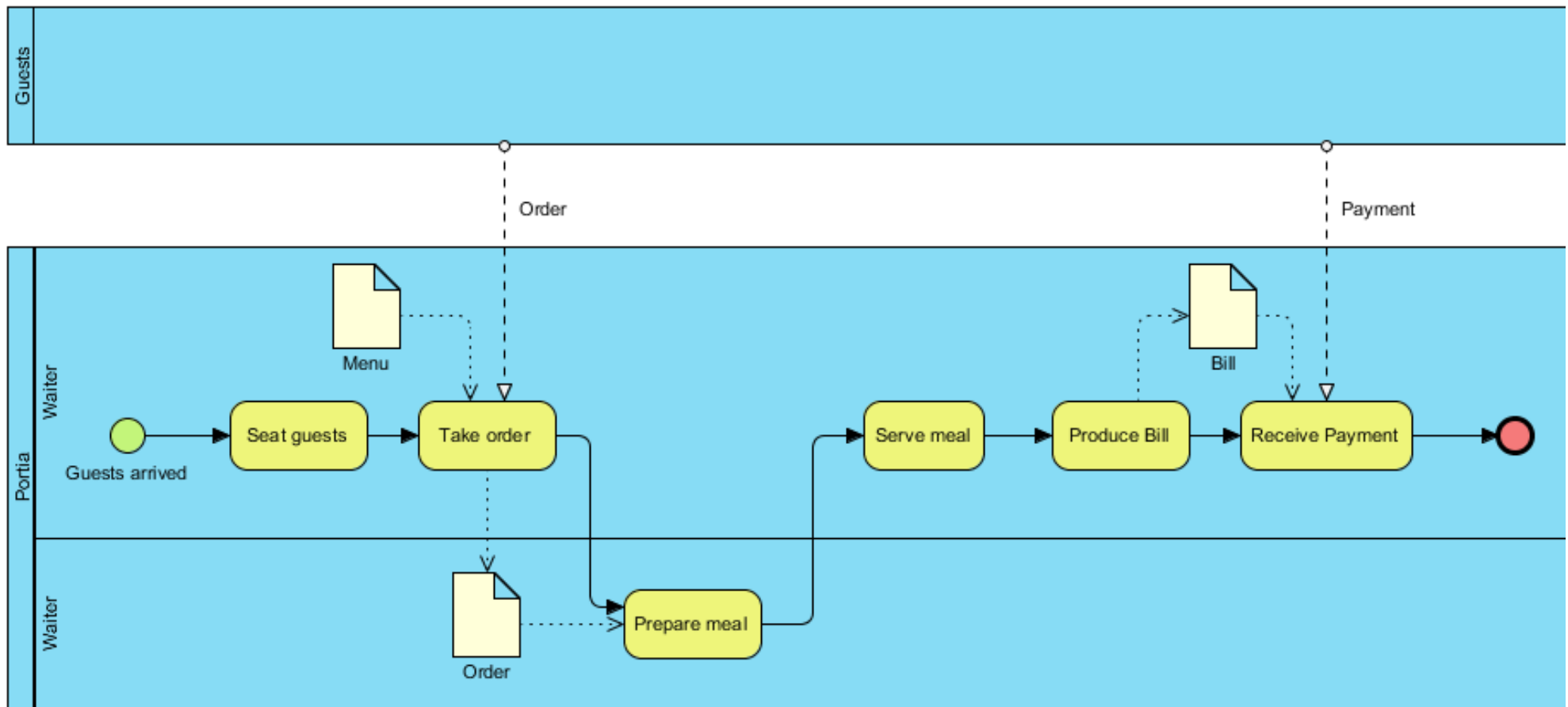# *Modeling Data and Documents*

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An Example Process

- This is a simplified version of the process for serving guests

- There are three data objects. Can you see a difference between these data objects?

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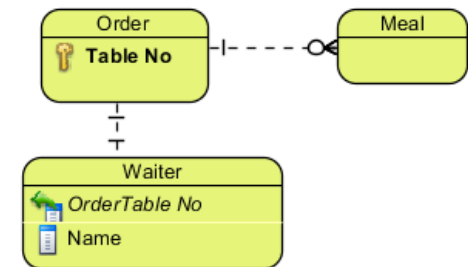MSc Business Information Systems

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2

Modelling Data

■ Data objects in BPMN can represent different kinds of data

♦ structured data

♦ documents

■ Documents themselves either represent

♦ **a document class** represents a generic documents for which a specific instance exists for each process instance

● Example: The bill

♦ a **specific document**

● Example: The menu which the guests get to choose their meals

● Hint: For a specific document we can specify a file name or a URL

■ Another example: An application form is a specific document while an application would be represented as a class
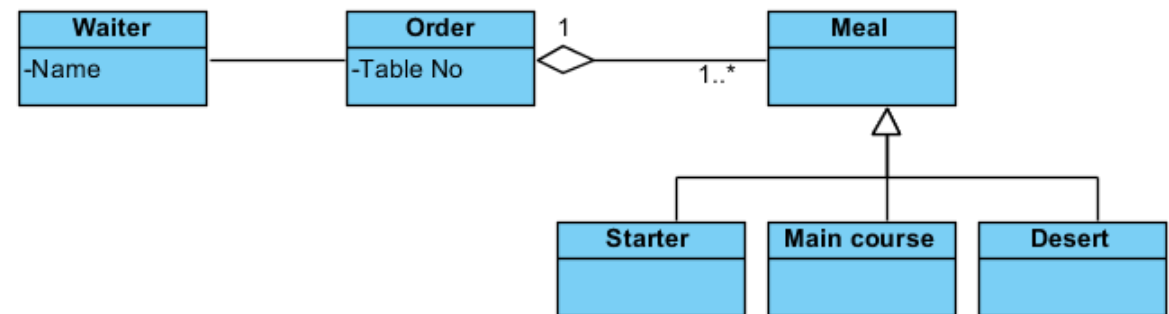
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3

Modelling Structured Data

■ Structured data can be represented for example as

♦ Entity Relationship Diagram

♦ UML Class Diagram/Object Diagrams

ERD:

■ Data models represent

♦ entities/classes

♦ columns/attributes

UML Class Diagram:

♦ relations/associations

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4

UML - MODELING DATA

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5

References

■ OMG Unified Modelling Language - UML, Current Standard Version 2.1.2 http://www.omg.org/spec/UML/2.1.2/

■ Donald Bell: UML basics: The class diagram. http://www.ibm.com/developerworks/rational/library/content/ RationalEdge/sep04/bell/

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UML Class Diagrams

6

Unified Modeling Language UML

- Unified Modeling Language (UML) is a set of standardized modeling languages in the field of software engineering.

- UML includes a set of graphic notation techniques (diagrams) to create visual models of software-intensive systems, including their structure and design

- In UML, you can model
  - any type of application,
  - running on any type and combination of hardware, operating system, programming language, and network

- The UML standard is developed and managed by the Object Management Group OMG and forms a foundation of OMG's Model Driven Architecture (MDA)
  - a UML model can be either platform-independent or platform-specific,

- Using XMI (XML Metadata Interchange, another OMG standard), it is possible to transfer a UML model
  - from one tool into a repository, or
  - into another tool for refinement or the next step in your chosen development process.

Source: Introduction to OMG's Unified Modeling Language™ (UML®),
http://www.omg.org/gettingstarted/what_is_uml.htm

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UML Class Diagrams

7

Types of UML Diagrams

UML contains diagrams for modelling structure (data and IT) and behavior of software systems

Structure diagrams

Data
1. **Class diagram**
2. **Object diagram**

IT systems
3. Component diagram
4. Deployment diagram
5. Composite structure diagram (*)
6. Package diagram

Behavior diagrams
7. Use-case diagram
8. State machine diagram
9. Activity diagram

Interaction diagrams
10. Sequence diagram
11. Communication diagram
12. Interaction overview diagram (*)
13. Timing diagram (*)

(*) not existing in UML 1.x, added in UML 2.0

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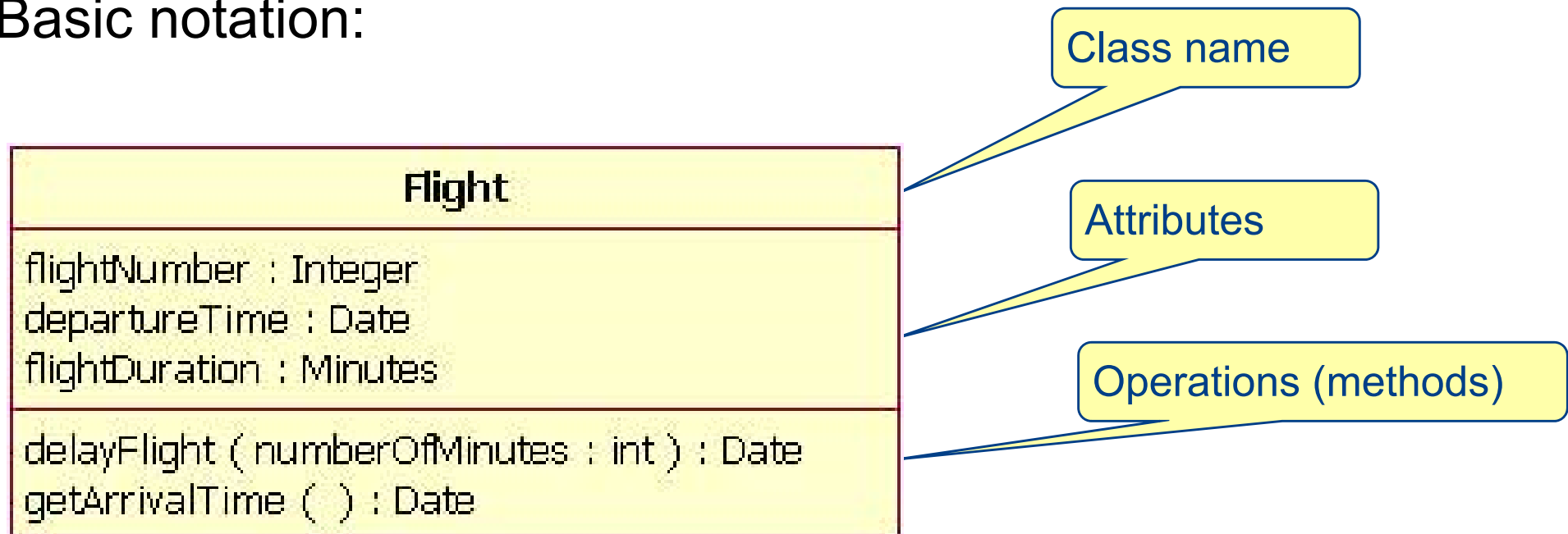
UML Class Diagrams

8

Class Diagrams / Object Diagrams

- UML Class Diagrams are inspired by Object orientation (Object-oriented programming)

- Main concepts:

  - ◆ **Class** – abstraction for a set of objects with common data and operations

  - ◆ **Object** – individual unit as instance of a class

  - ◆ **Associations** – Relationship between (objects of) classes

  - ◆ **Inheritance** – technique for reusability and extendibility

- **A Class diagram** gives an overview of a system by showing its classes and the relationships among them

- An **Object diagram** additionally shows objects

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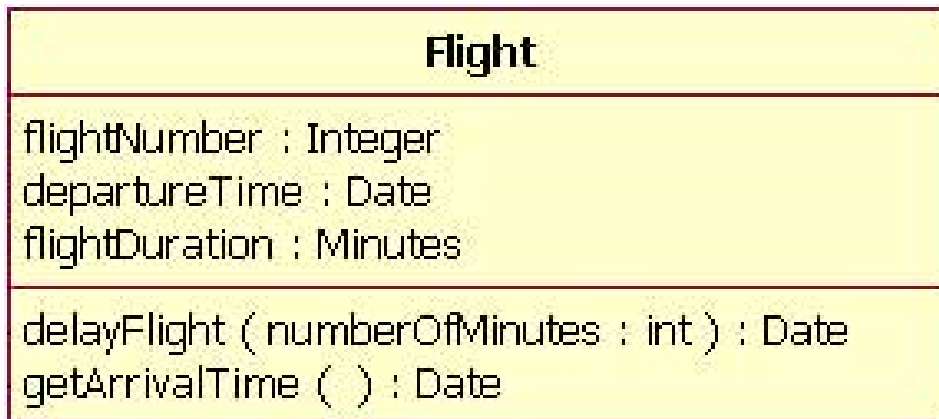MSc Business Information Systems

UML Class Diagrams

9

UML Class

- Gives the type of a set of objects

- Declares a collection of attributes and operations (methods) that describe the structure and behavior of its objects
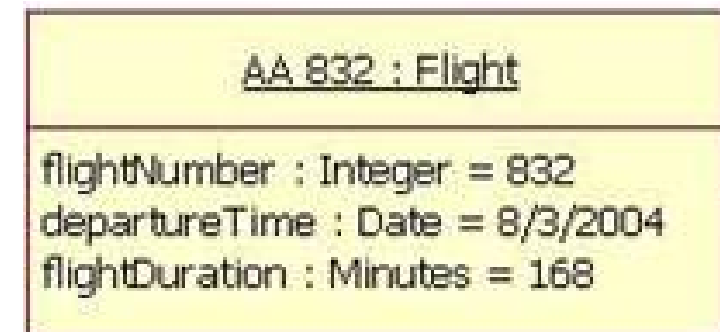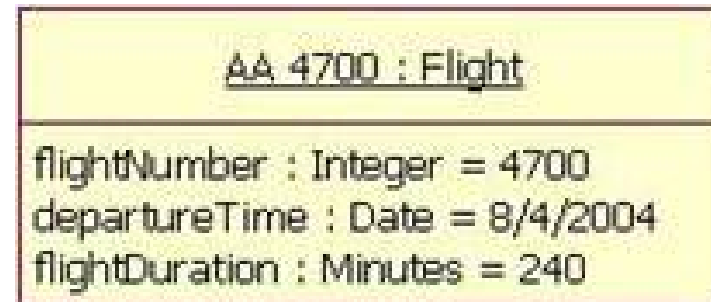
- Basic notation:

Flight
flightNumber : Integer departureTime : Date flightDuration : Minutes
delayFlight (numberOfMinutes : int) : Date getArrivalTime ( ) : Date

Class name

Attributes

Operations (methods)

UML Class and Object

■ An Object is a specific instance of a class

■ It has a state which is characterized by concrete values for the attributes defined for the class
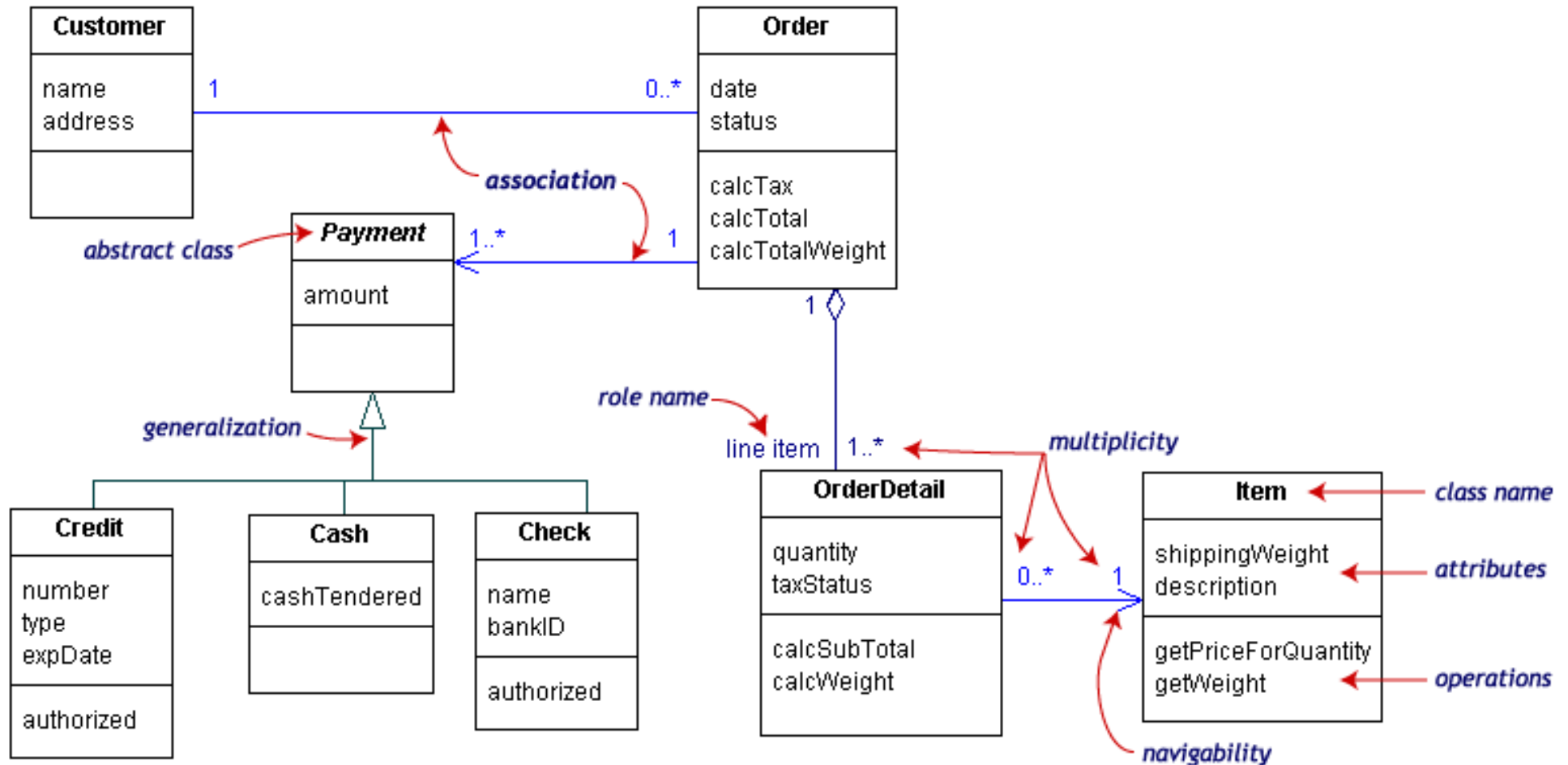
Class:

Flight
flightNumber : Integer departureTime : Date flightDuration : Minutes
delayFlight (numberOfMinutes : int) : Date getArrivalTime ( ) : Date

Two Objects for the class "Flight":

<u>AA 4700 : Flight</u>
flightNumber : Integer = 4700 departureTime : Date = 8/4/2004 flightDuration : Minutes = 240

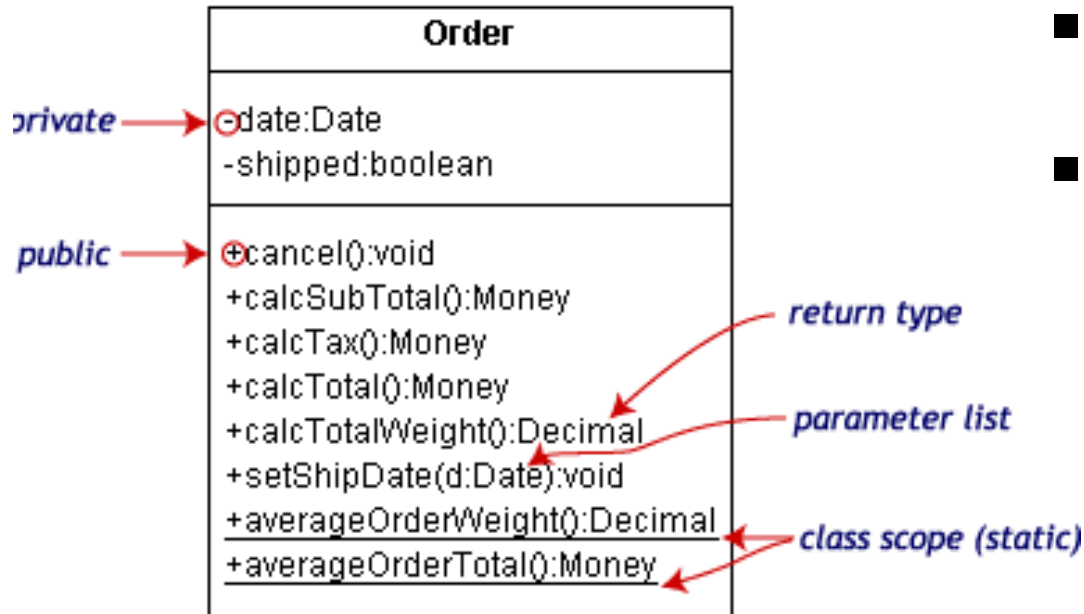| <u>AA 832 : Flight</u> |
| --- |
| flightNumber : Integer = 832
departureTime : Date = 8/3/2004
flightDuration : Minutes = 168 |

Class Diagram Example

The class diagram below models a customer order from a retail catalog. The central class is the **Order**. Associated with it are the **Customer** making the purchase and the **Payment**. A **Payment** is one of three kinds: **Cash**, **Check**, or **Credit**. The order contains **OrderDetails** (line items), each with its associated **Item**.

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UML Class Diagrams

12

Class Information

- private → ⊖ date:Date
- public → ⊕ cancel():void

Access specifiers:

Symbol	Access
+	public: they are visible to all
–	private: not visible to callers outside the class
#	protected: only visible to children of the class

■ UML class notation is a rectangle divided into three parts: class name, attributes, and operations.

■ Attributes and operations can be labeled according to access and scope.

■ The illustration uses the following UML™ conventions.

♦ Static members are <u>underlined</u>. Instance members are not.

♦ The operations follow this form: *<access specifier> <name> (<parameter list>) : <return type>*

♦ The parameter list shows each parameter type preceded by a colon.

♦ Access specifiers appear in front of each member.

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UML Class Diagrams

13

Associations

■ **Association** -- a relationship between instances of the two classes. In a diagram, an association is a link connecting two classes.

■ There are two special kinds of associations:

♦ **Generalization** -- an inheritance link indicating one class is a superclass of the other. A generalization has a triangle pointing to the superclass.

● *Payment* is a superclass of **Cash**, **Check**, and **Credit**.

♦ **Aggregation** -- an association in which one class belongs to a collection. An aggregation has a diamond end pointing to the part containing the whole.

● **Order** has a collection of **OrderDetails**.

■ An end of an assiciation may have a **role name** to clarify the nature of the association.

♦ **OrderDetail** is a line item of each **Order**

■ A **navigability** arrow on an association shows which direction the association can be traversed or queried. The arrow also indicates who "owns" the association's implementation

♦ **OrderDetail** has an **Item**..

♦ An **OrderDetail** can be queried about its **Item**, but not the other way around

Associations with no navigability arrows are bi-directional

Generalization - Inheritance

■ Inheritance is a very important concept in object-oriented design

■ *Inheritance* refers to the ability of one class (child class) to *inherit* the identical functionality of another class (super class), and then add new functionality of its own.

■ Inheritance is modeled with the Generalization line from the child class to the super class.
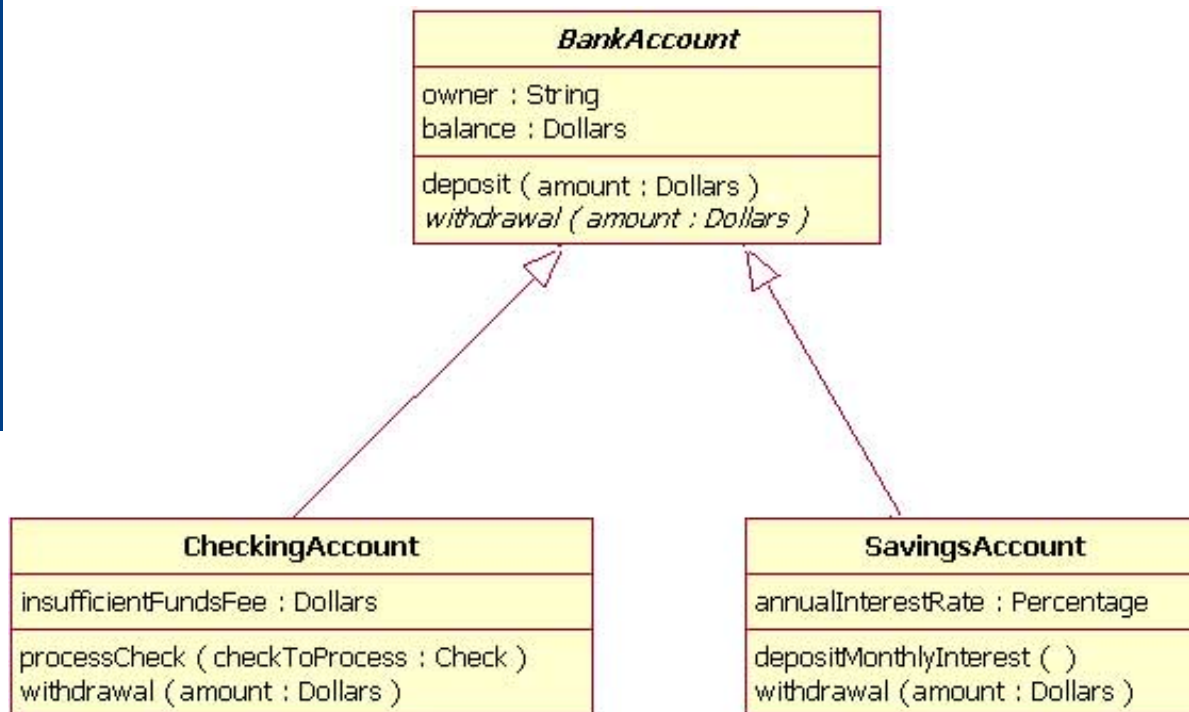
In this example, the classes CheckingAccount and SavingsAccount inherit from the BankAccount.

In addition to the attributes and operations explicitly mentioned, the classes CheckingAccount and SavingsAccount also have the attributes *owner* and *balance* as well as the operations *deposit()* and *withdrawal()*.

Associations

- **Associations define relationships between objects**

- **There are five kinds of associations:**

  - ♦ *Standard associations* which can be

    - ● bi-directional
    - ● uni-directional

  - ♦ *Association classes* define valuable information for associations

- **Associations are always assumed to be bi-directional unless you qualify the association as some other type**

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UML Class Diagrams

16

Bi-directional Associations

■ For bi-directional associations - indicated by a solid line between two classes - both classes are aware of each other and their relationship

■ At either end of the line, you place a role name and a multiplicity value.

■ This example shows that a Flight is associated with a specific Plane and a Flight. The Plane takes on the role of "assignedPlane" and the Flight the rule of "assignedFlights"

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UML Class Diagrams

17
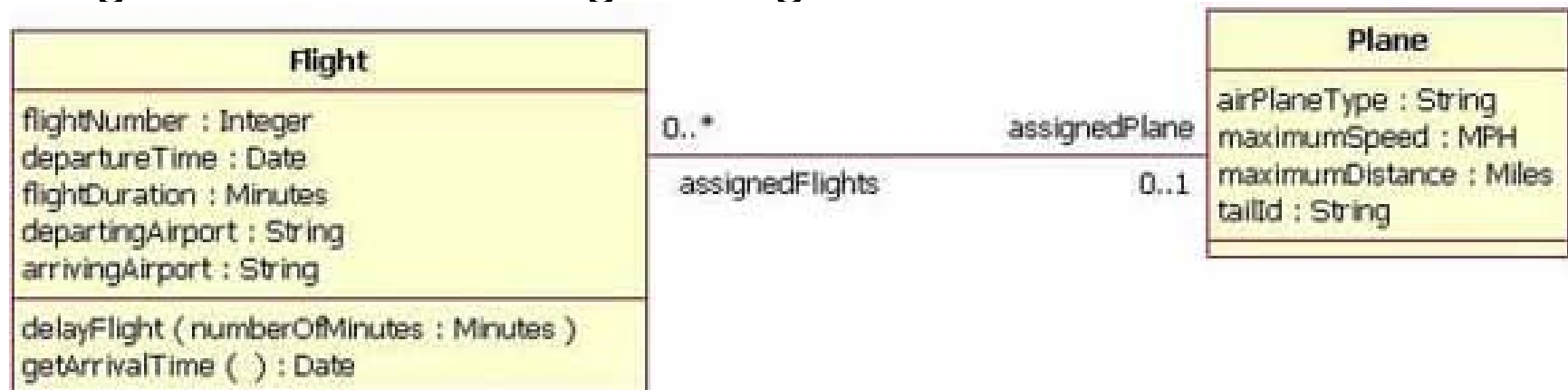
Uni-directional Association

- In a uni-directional association, two classes are related, but only one class "knows" that the relationship exists.

- A uni-directional association is drawn as a solid line with an open arrowhead pointing to the known class. Uni-directional association includes a role name and a multiplicity value, but only for the known class.
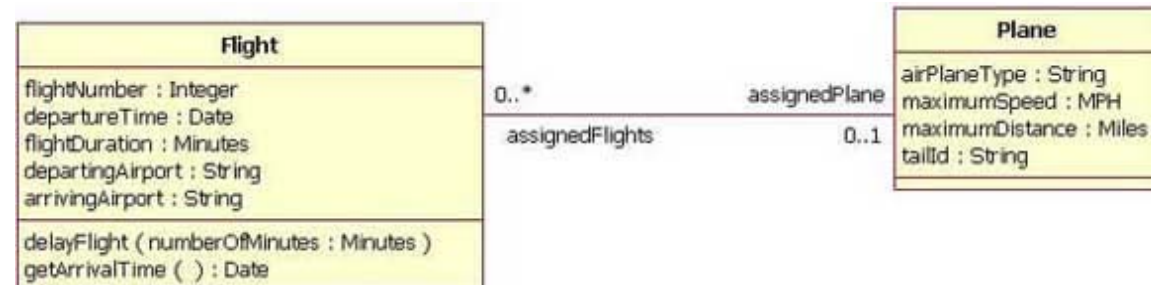
Associations vs. Attributes

■ Attributes and Associations differ by the type of their value

  ♦ Attributes have literals as values (number, string, date, …)

  ♦ Associations have objects as their values

■ Example:
  ♦ The flight number of a Flight is an Integer
  ♦ The plane assigned to a flight is an instance of class Plane

■ Furthermore, an attribute has exactly one value, an association can have multiple values (or: there can be multiple associations)
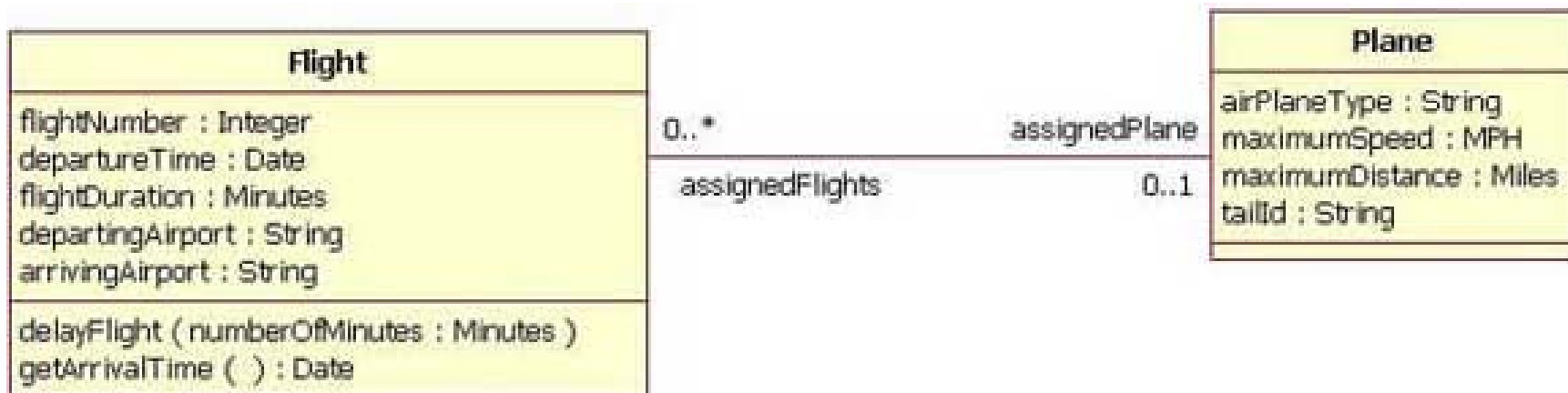
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UML Class Diagrams

19

Multiplicity

- The **multiplicity** of an association end is the number of possible instances of the class associated with a single instance of the other end.

- Multiplicities are single numbers or ranges of numbers.

- This table gives the most common multiplicities.

Multiplicities	Meaning
0..1	zero or one instance.
0..* *or* *****	no limit on the number of instances (including none).
1	exactly one instance
1..*	at least one instance
n..m	*n* to *m* instances (n and m stand for numbers, e.g. **0..4**, **3..15**)
n	exactly n instance (where n stands for a number, e.g. **3**)

Multiplicity - Example

■ The multiplicity value next to the Plane class of 0..1 means that when an instance of a Flight exists, it can either have one instance of a Plane associated with it or no Planes associated with it (i.e., maybe a plane has not yet been assigned).

■ The Plane instance can be associated either with no flights or with up to an infinite number of flights.

Flight		Plane
flightNumber : Integer departureTime : Date flightDuration : Minutes departingAirport : String arrivingAirport : String	0..* assignedPlane assignedFlights 0..1	airPlaneType : String maximumSpeed : MPH maximumDistance : Miles tailId : String
delayFlight (numberOfMinutes : Minutes) getArrivalTime ( ) : Date		

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UML Class Diagrams

21

Association Classes

- *Association class* are tied to a primary association. It includes valuable information about the relationship.

- An association class is represented like a normal class, but it is linked to an association line with a dotted line.
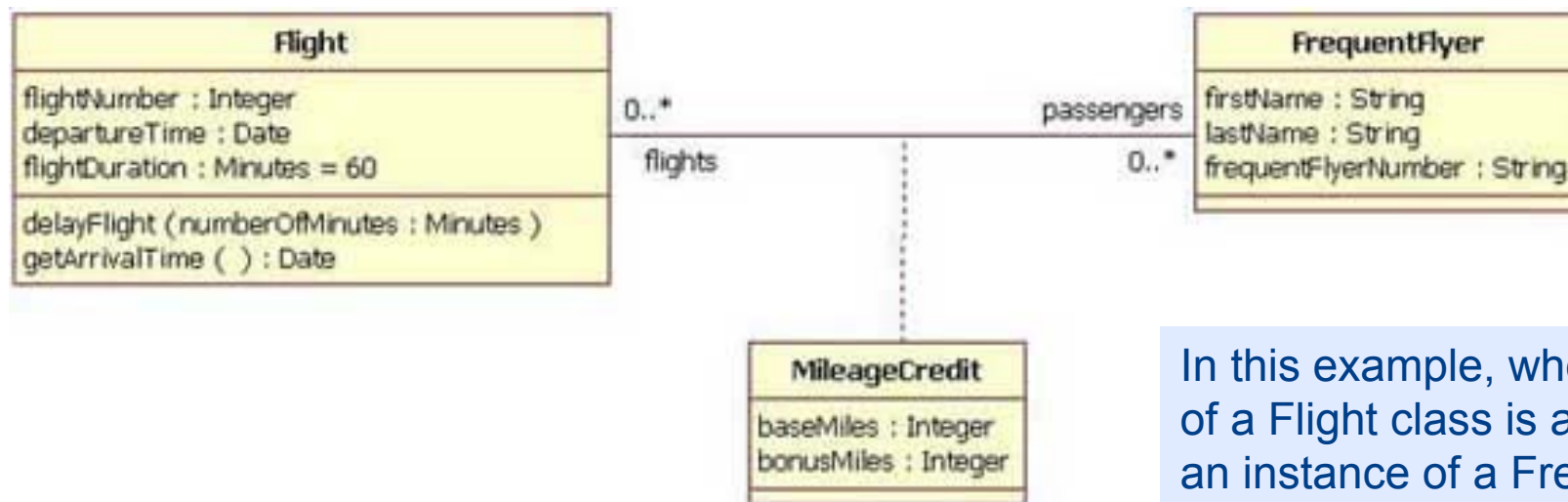
In this example, when an instance of a Flight class is associated with an instance of a FrequentFlyer class, there will also be an instance of a MileageCredit class

Aggregation and Compostion

■ Aggregation is a special type of association used to model a "whole to its parts" relationship.

♦ **In basic aggregation** relationships, the lifecycle of a *part* class is independent from the *whole* class's lifecycle.

● Aggregation is denoted by a empty diamond at the whole end

♦ For a **composition**, the child class's instance lifecycle is dependent on the parent class's instance lifecycle.

● Composition is denoted by a filled diamond at the whole end

Examples of Aggregation

- **Aggregation**
  - ♦ The Wheel class's instance lives independently of the Car class's instance.
  - ♦ The wheel can be created before being placed on a car during assembly.
  - ♦ If the Car instance is destroyed the Wheels instance can exist further.

- **Composition**
  - ♦ Company class instance will always have at least one Department class instance.
  - ♦ A department cannot exist before a company exists.
  - ♦ When the Company instance is removed, the Department instance is automatically removed as well.

Dependencies and Constraints

■ A **dependency** is a relation between two classes in which a change in one may force changes in the other. Dependencies are drawn as dotted lines.

■ A **constraint** is a condition that every implementation of the design must satisfy. Constraints are written in curly braces { }.
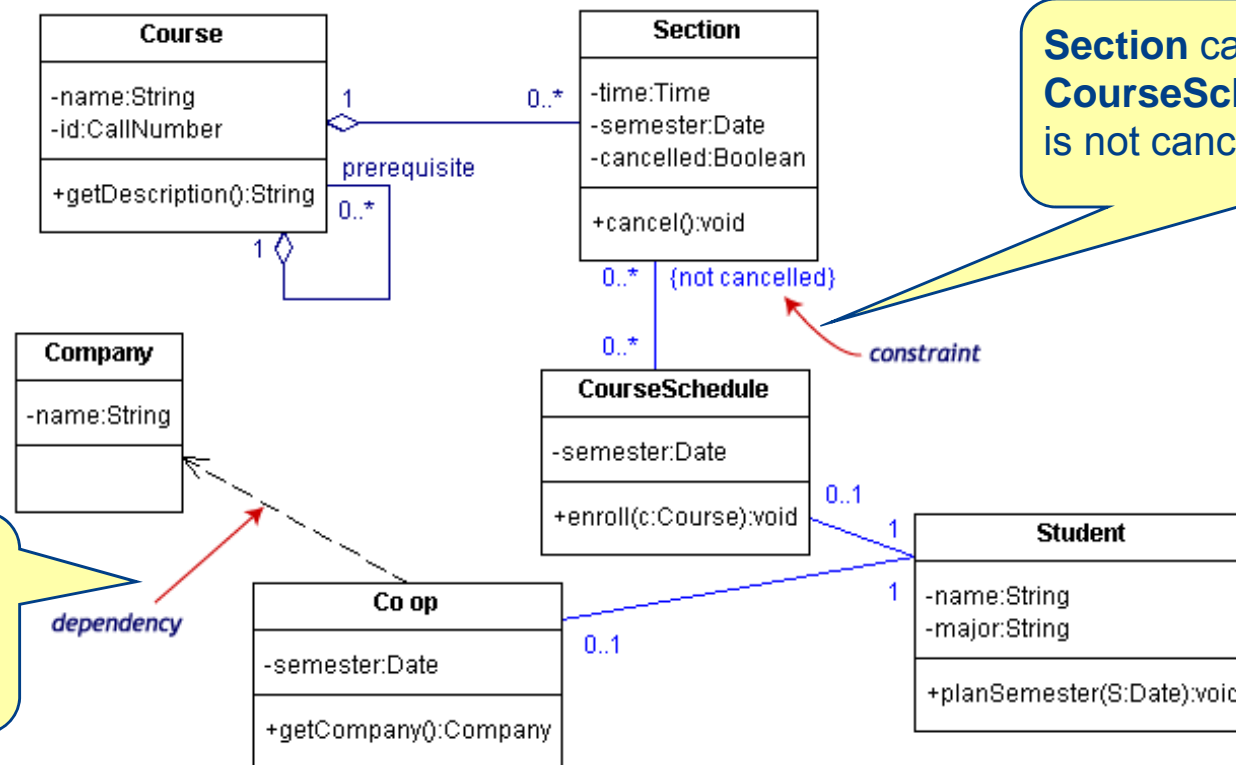
Section can be part of a **CourseSchedule** only if it is not canceled.

Co_op depends on **Company**. If you decide to modify **Company**, you may have to change **Co_op** too.

Instances - UML Objects

■ Sometimes it is useful to show example instances of the classes

■ The notation of an instance consists of two parts

   ♦ The top compartment having an underlined concatenation of Instance Name and Class Name separated by a colon

   ♦ The lower compartment having some of the attribute names and their values
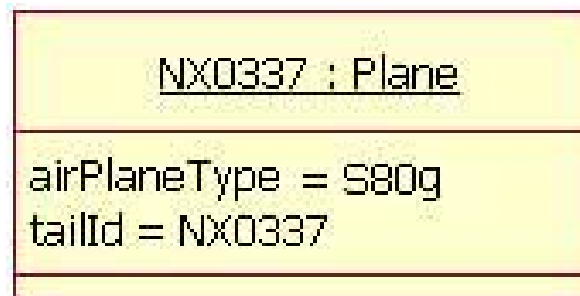
Instances

■ Example: Object diagram with class instances and their associations.

MODELING DOCUMENTS

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28
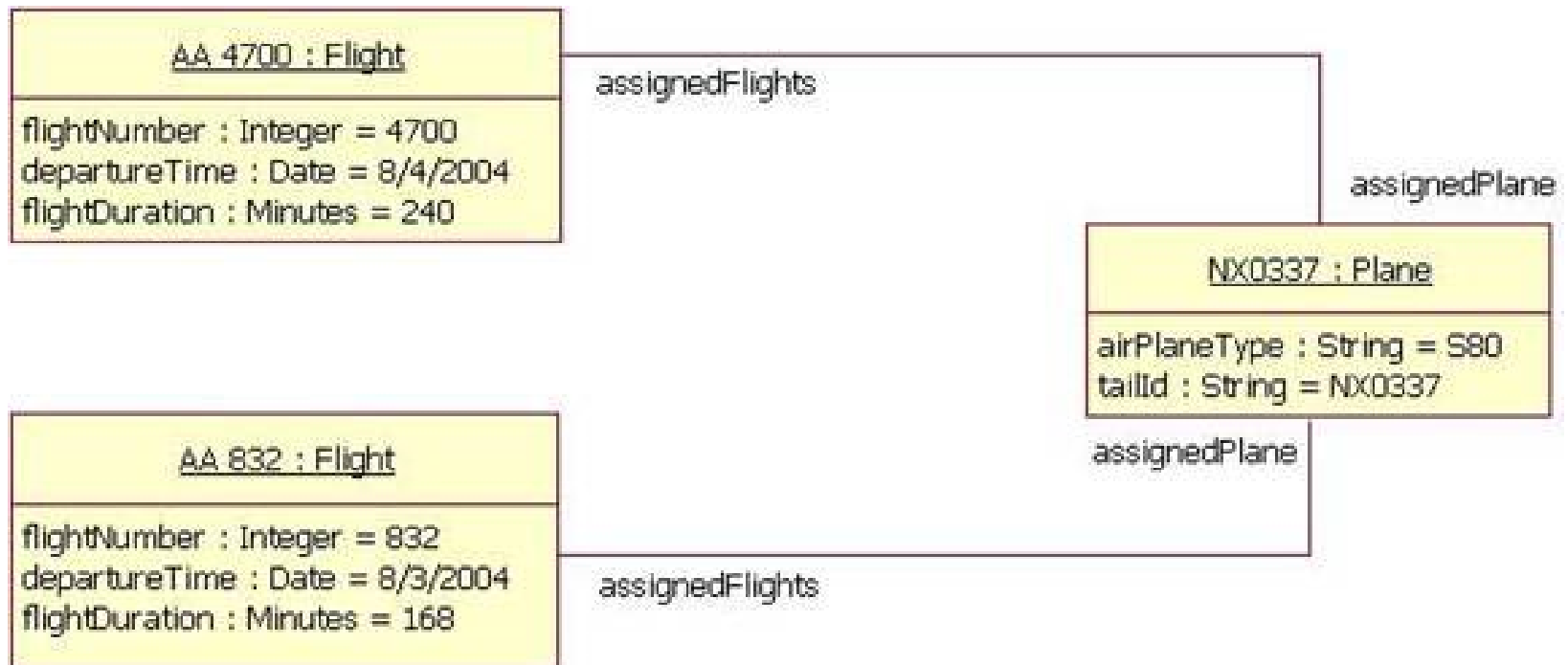
Document Models

- Documents can be grouped into **document classes** (also called document types) according to their usage:
  - ♦ Examples: invoice, application, menu, report

- There can be specialisations of document classes.
  - ♦ Example: There can be special kinds of reports like project report, expert opinions, or reviews.

- **Metadata** are attribute values which describe documents.
  - ♦ Example: a report might have an creator, a creation date and a subject.

- There are standards for metadata like the Dublin Core Metadata Initiative (http://dublincore.org)

Structured Meta-data − Examples

user data (document)
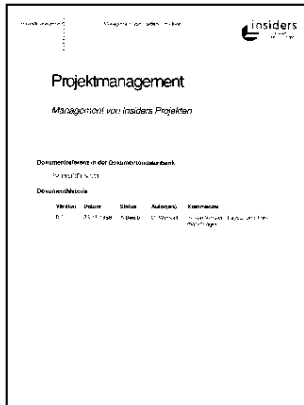
meta-data

name:	ELENA-Ber
creation:	18.3.2001
modification:	25.6.2001
format:	Word
document type:	project report
recipient:	All Life Insurance Inc.
author:	Smith

■ Each document consists of the
- ♦ usage data (document itself, content)
- ♦ meta-data

■ Kinds of meta-data
- ♦ General metadata
  - ● can be used for any kind of information
  - ● Examples: author, date of creation, subject
- ♦ Application-specific metadata
  - ● Examples:
    - – For a letter: sender and recipient
    - – For a report: project name

Information as product
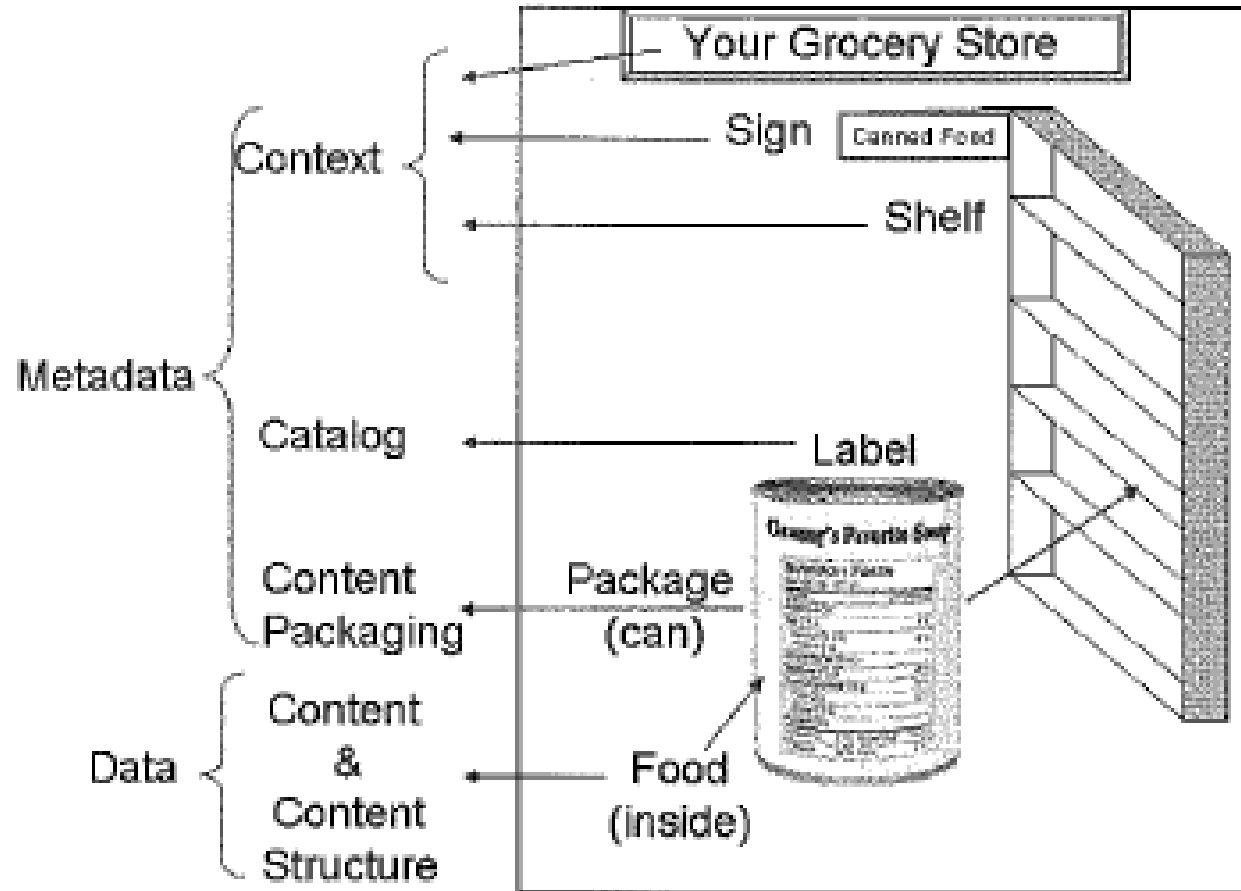
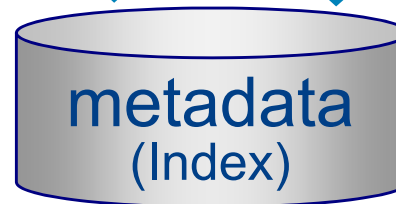Michael C. Daconta: Information as Product, 2007
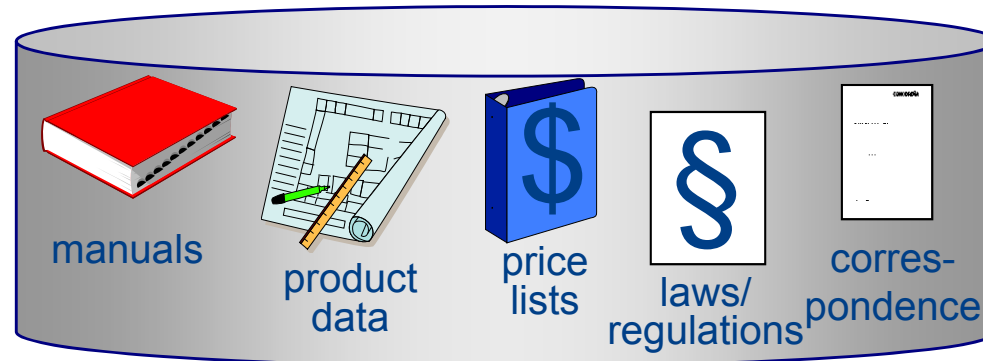
Meta-data

user
(producer/ consumer)

services

store　　**search**
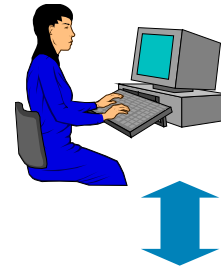
description
(catalog)

metadata
(Index)

resources
(information
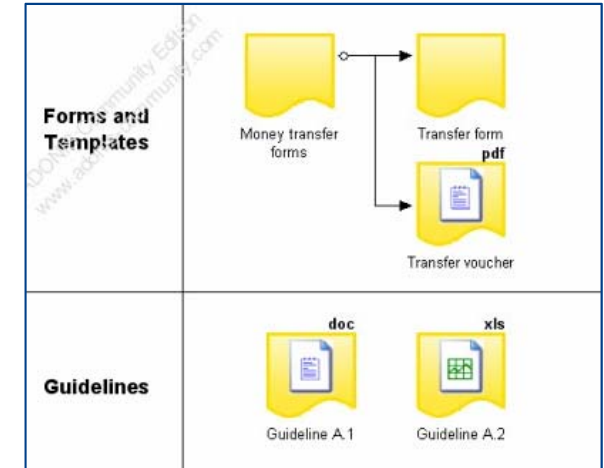products)

manuals

product
data
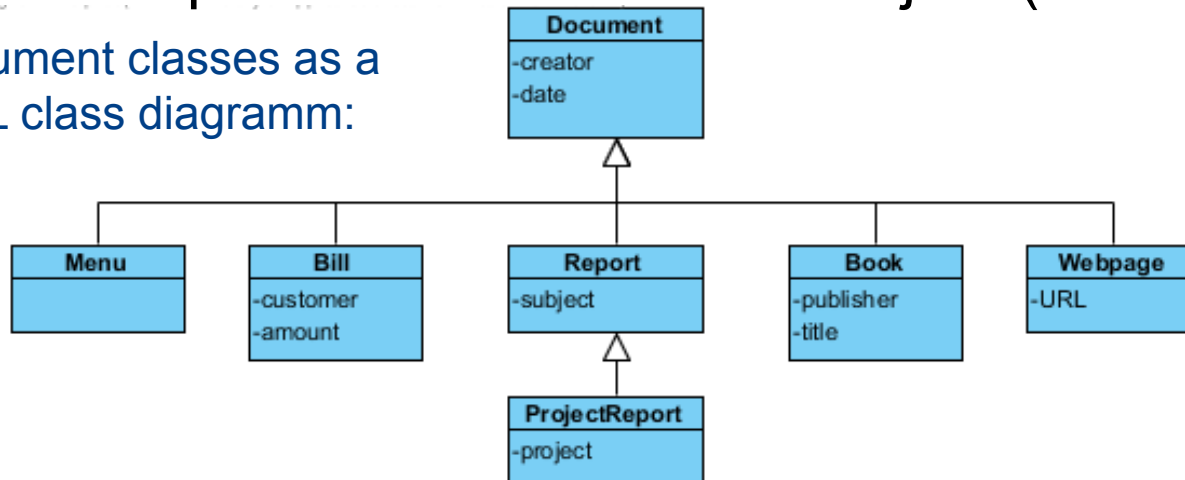
price
lists

laws/
regulations

corres-
pondence

Document model

- ■ Although some tools like ADONIS have a model type for documents, there is no standard for modeling documents

- ■ However, we can use UML class diagrams and object diagrams to model documents [1]

  - ♦ A document class is represented as a class object with attributes describing the meta-data

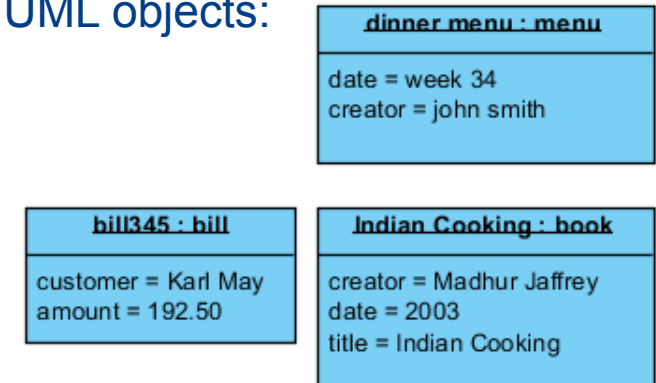 - ♦ A specific document is an object (i.e. an instance of a class)

document classes as a
UML class diagramm:

specific documents
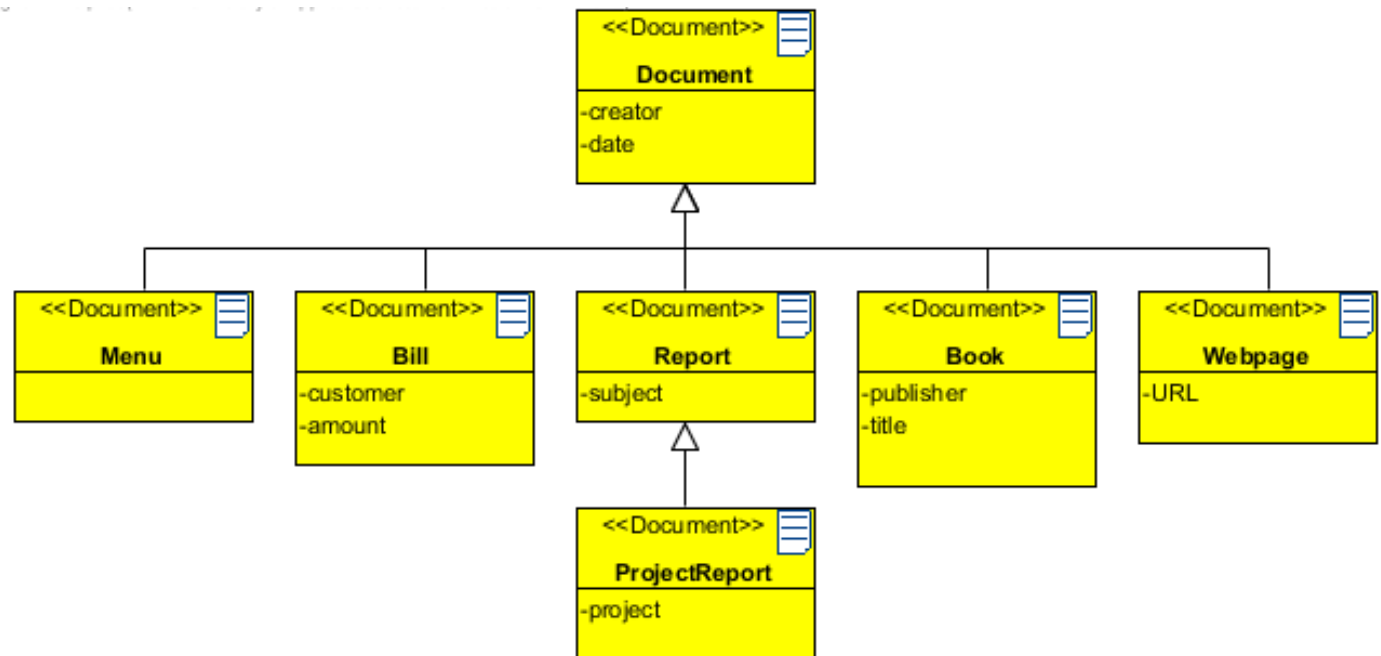as UML objects:

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33

Modeling Documents in Agilian

■ In the Agilian Enterprise tool we can use stereotypes to specialize UML class diagrams for modeling documents.

■ We can define a new stereotype "Document" and

♦ change color

♦ add an icon

A Data Model in Agilian

■ A Data Model can combine

- ♦ Document classes
- ♦ Objects
- ♦ Structured Data
- ♦ Associations