System Modelling

- System modelling helps the analyst to understand the functionality of the system and models are used to communicate with customers.
- Different models present the system from different perspectives
  - External perspective showing the system's context or environment;
  - Behavioural perspective showing the behaviour of the system;
  - Structural perspective showing the system or data architecture.

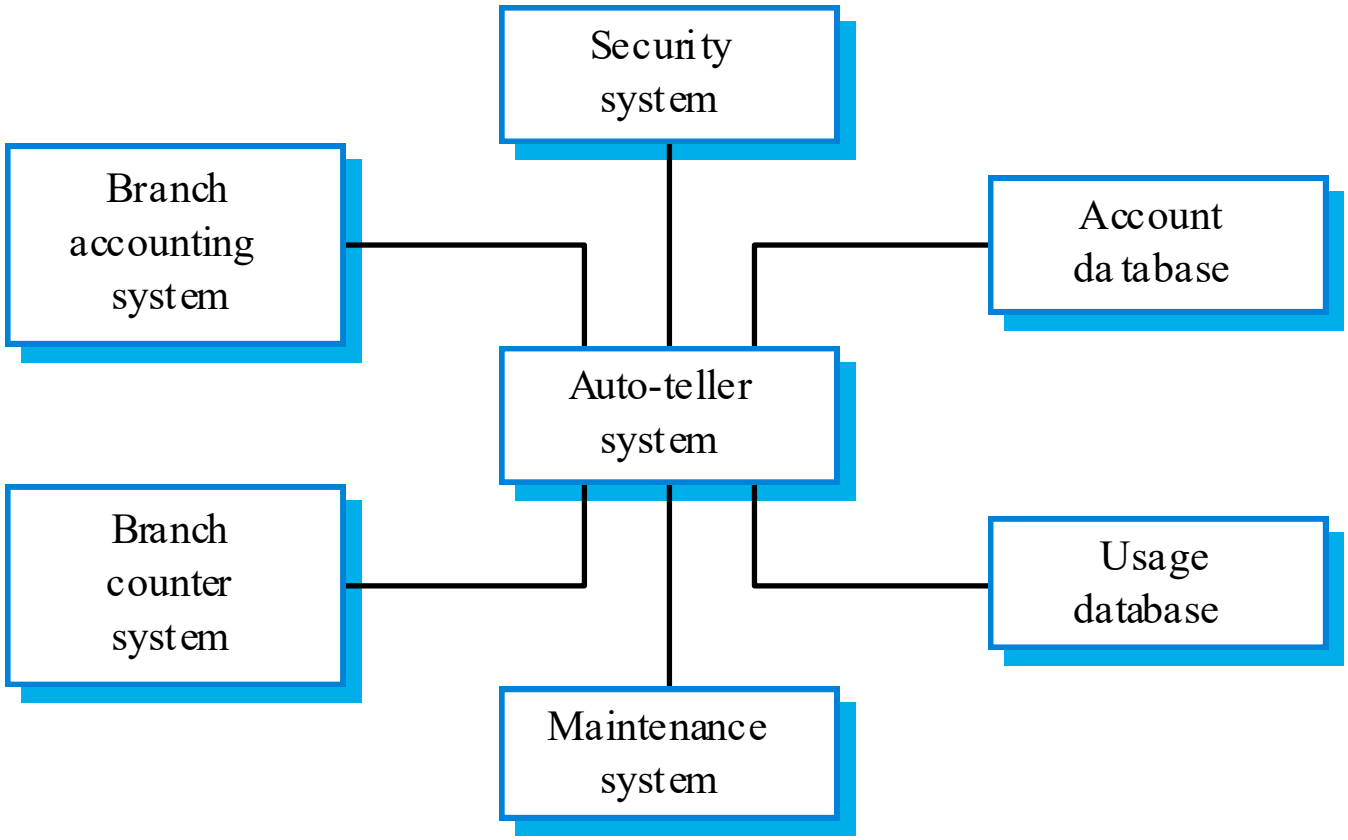
Model types

1. Context Model
   - External View
   - Illustrates Boundaries
   - Component Based
2. Behavioural Models
   - Data Flow Models
   - State Machine Models
3. Semantic Data Models
4. Object Models

Context models

- Context models are used to illustrate the operational context of a system - they show what lies outside the system boundaries.
- Social and organisational concerns may affect the decision on where to position system boundaries.
- Architectural models show the system and its relationship with other systems.

The context of an ATM system



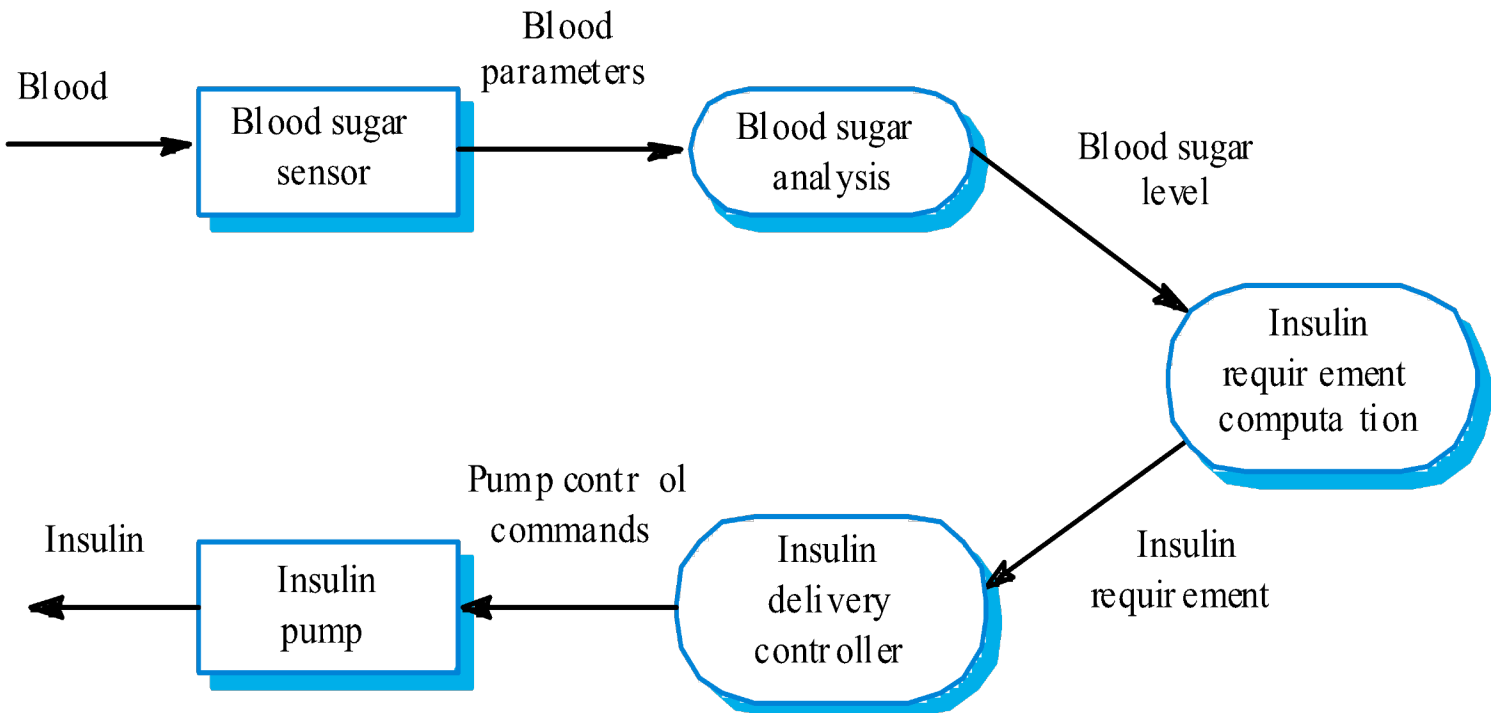
Behavioural models

- Behavioural models are used to describe the overall behaviour of a system.
- Two types of behavioural model are:
  - Data processing models that show how data is processed as it moves through the system;
  - State machine models that show the systems response to events.
- These models show different perspectives so both of them are required to describe the system's behaviour.

Data-processing models

- Data flow diagrams (DFDs) may be used to model the system's data processing.
- These show the processing steps as data flows through a system.
- DFDs are an intrinsic part of many analysis methods.
- Simple and intuitive notation that customers can understand.
- Show end-to-end processing of data.

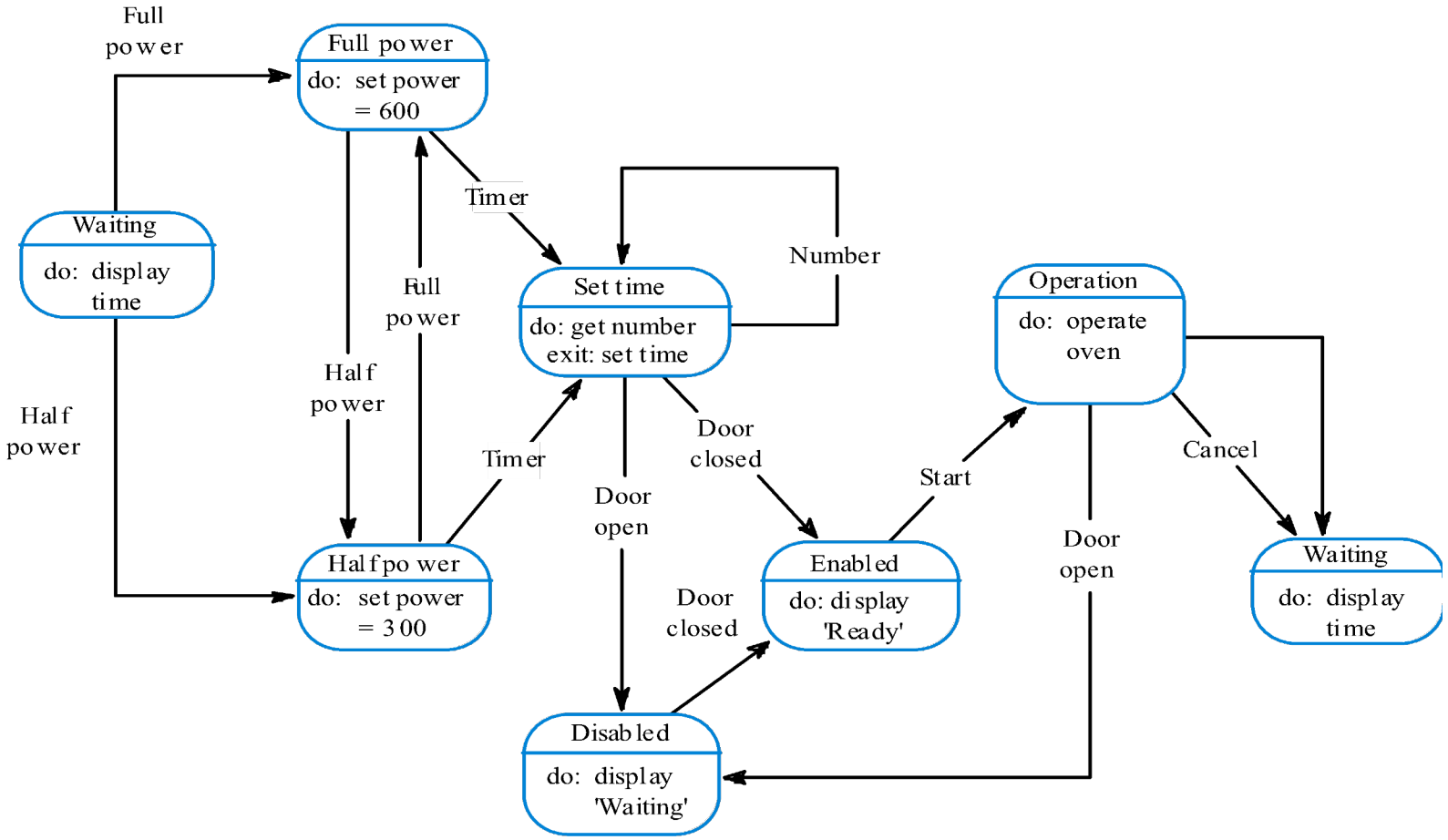
Insulin pump DFD



State machine models

- These model the behaviour of the system in response to external and internal events.
- They show the system's responses to stimuli so are often used for modelling real-time systems.
- State machine models show system states as nodes and events as arcs between these nodes. When an event occurs, the system moves from one state to another.
- Statecharts are an integral part of the UML and are used to represent state machine models.

Microwave oven model



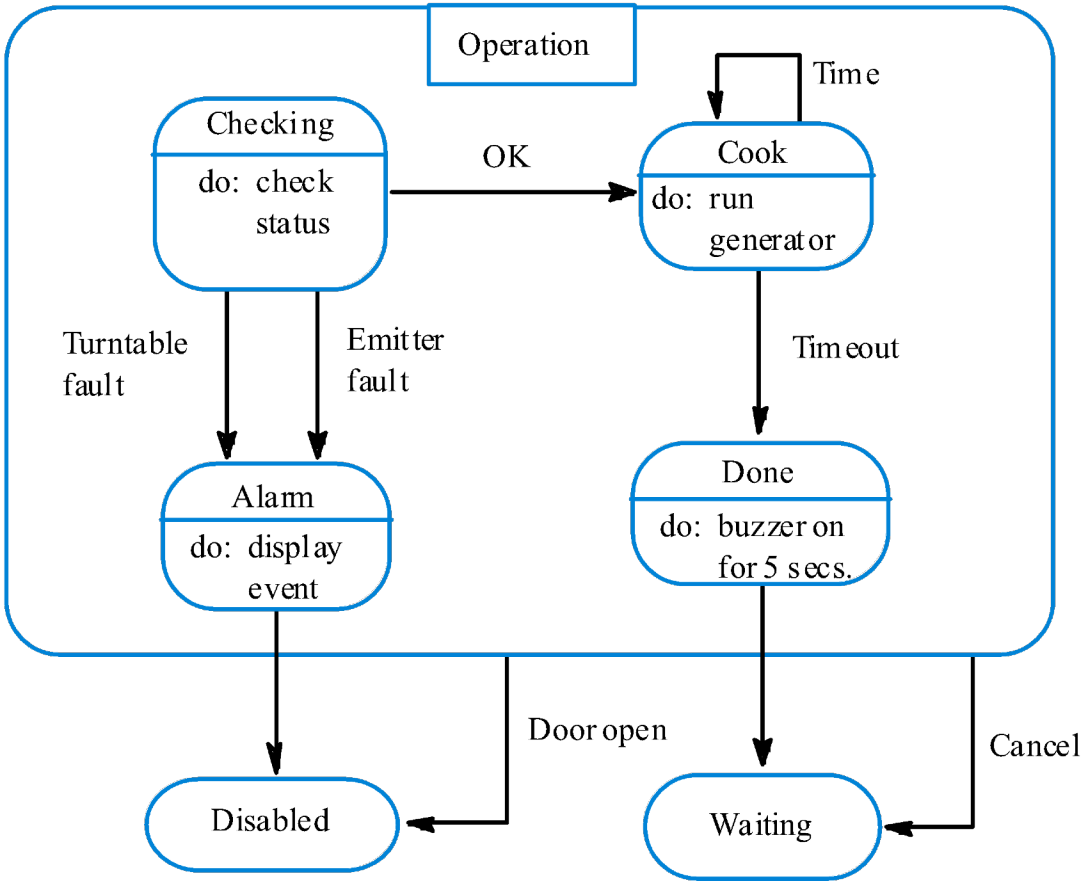
Microwave oven state description

State	Description
Waiting	The oven is waiting for input. The display shows the current time.
Half power	The oven power is set to 300 watts. The display shows ÔHalf powerÕ
Full power	The oven power is set to 600 watts. The display shows ÔFull powerÕ
Set time	The cooking time is set to the userÕs input value. The display shows the cooking time selected and is updated as the time is set.
Disabled	Oven operation is disabled for safety. Interior oven light is on. Display shows ÔNot readyÕ
Enabled	Oven operation is enabled. Interior oven light is off. Display shows ÔReady to cookÕ
Operation	Oven in operation. Interior oven light is on. Display shows the timer countdown. On completion of cooking, the buzzer is sounded for 5 seconds. Oven light is on. Display shows ÔCooking completeÕ while buzzer is sounding.

Microwave oven stimuli

Stimulus	Description
Half power	The user has pressed the half power button
Full power	The user has pressed the full power button
Timer	The user has pressed one of the timer buttons
Number	The user has pressed a numeric key
Door open	The oven door switch is not closed
Door closed	The oven door switch is closed
Start	The user has pressed the start button
Cancel	The user has pressed the cancel button

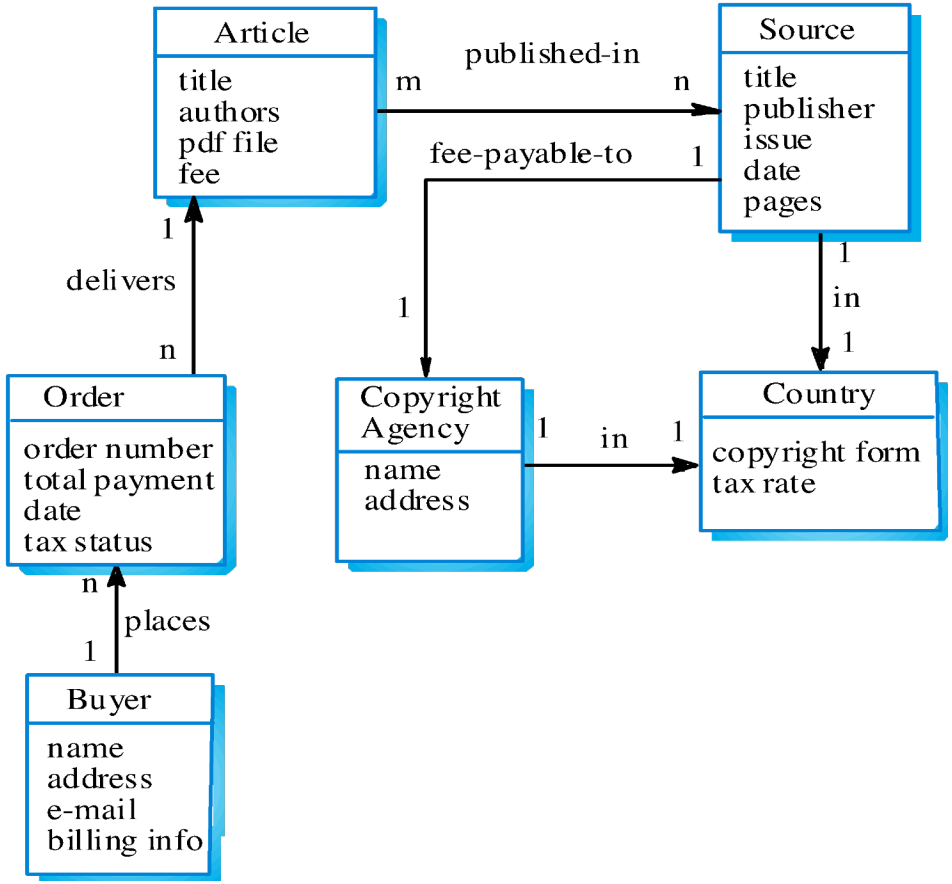
Microwave oven operation



Semantic data models

- Used to describe the logical structure of data processed by the system.
- An entity-relation-attribute model sets out the entities in the system, the relationships between these entities and the entity attributes
- Widely used in database design. Can readily be implemented using relational databases.
- No specific notation provided in the UML but objects and associations can be used.

Library semantic model



Data dictionaries

- Data dictionaries are lists of all of the names used in the system models. Descriptions of the entities, relationships and attributes are also included.
- Advantages
  - Support name management and avoid duplication;
  - Store of organisational knowledge linking analysis, design and implementation;
- Many CASE workbenches support data dictionaries.

Data dictionary entries

Name	Description	Type	Date
Article	Details of the published article that may be ordered by people using LIBSYS.	Entity	30.12.2002
authors	The names of the authors of the article who may be due a share of the fee.	Attribute	30.12.2002
Buyer	The person or organisation that orders a co py of the article.	Entity	30.12.2002
fee-payable-to	A 1:1 relationship between Article and the Copyright Agency who should be paid the copyright fee.	Relation	29.12.2002
Address (Buyer)	The address of the buyer. This is used to any paper billing information that is required.	Attribute	31.12.2002

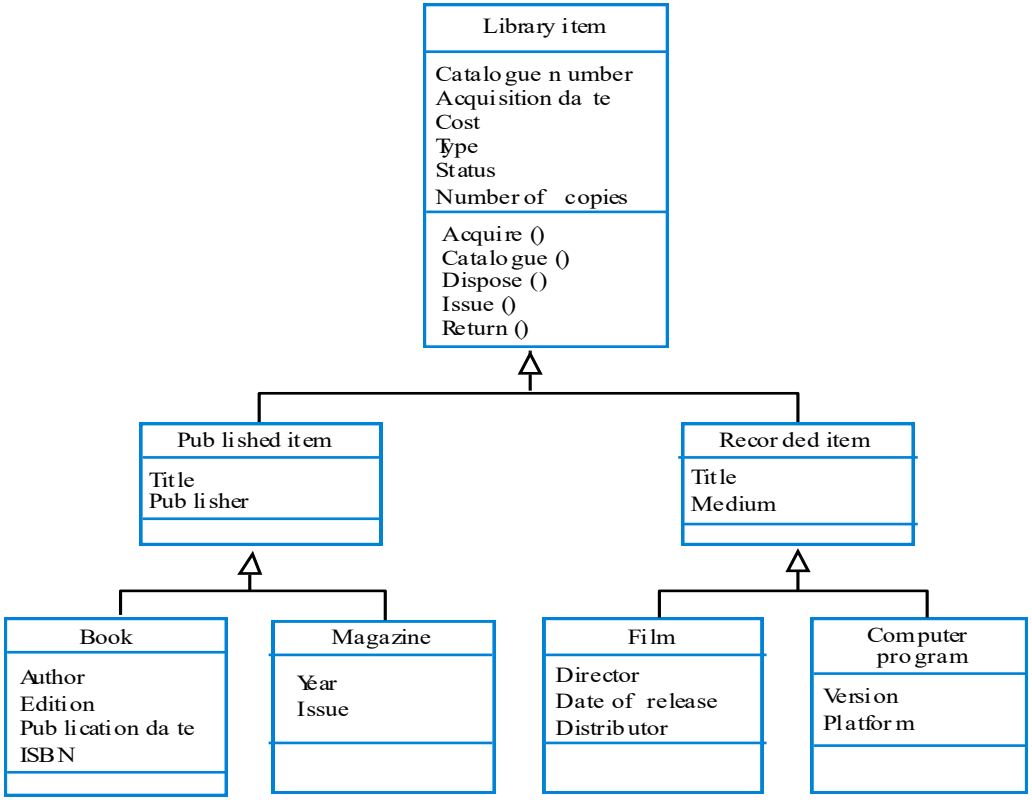
Object models

- Natural ways of reflecting the real-world entities manipulated by the system
- More abstract entities are more difficult to model using this approach
- Object class identification is recognised as a difficult process requiring a deep understanding of the application domain
- Object classes reflecting domain entities are reusable across systems

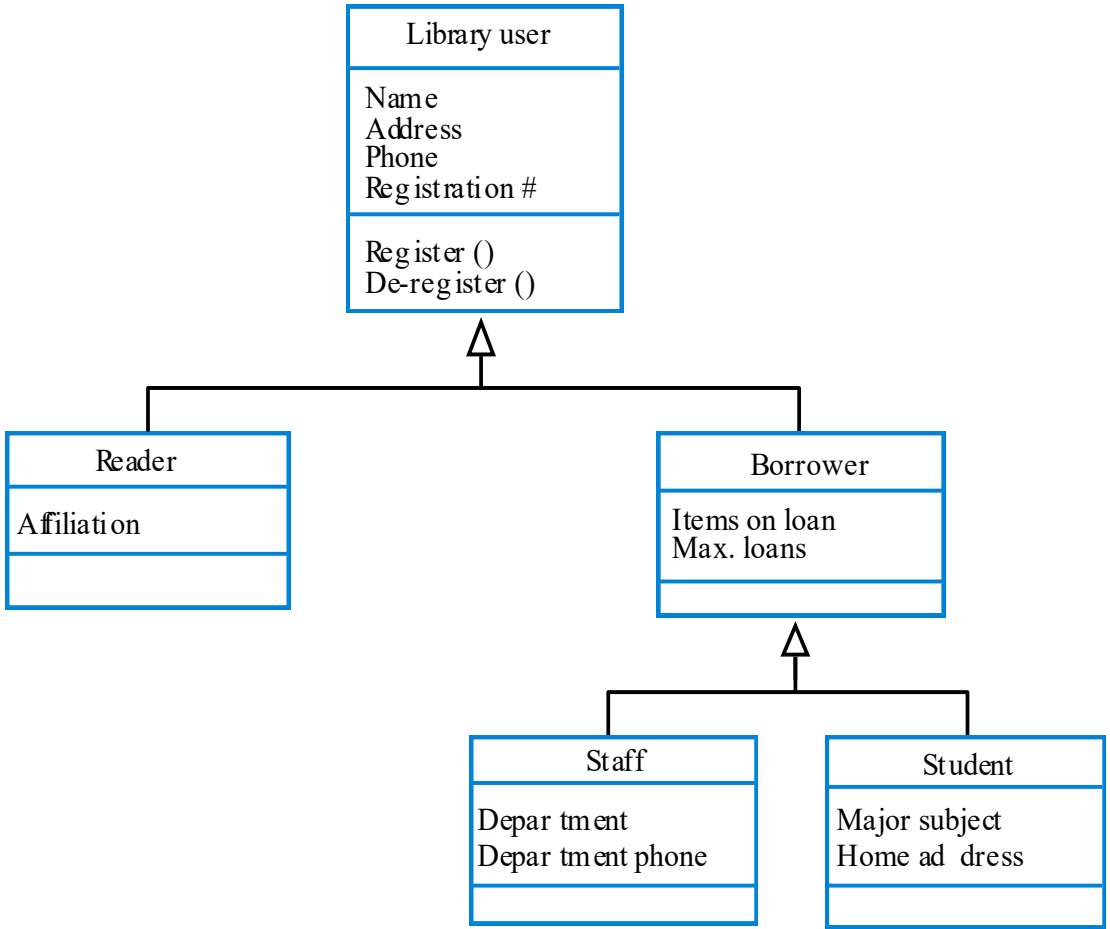
Object models and the UML

- The UML is a standard representation devised by the developers of widely used object-oriented analysis and design methods.
- It has become an effective standard for object-oriented modelling.
- Notation
  - Object classes are rectangles with the name at the top, attributes in the middle section and operations in the bottom section;
  - Relationships between object classes (known as associations) are shown as lines linking objects;
  - Inheritance is referred to as generalisation and is shown ‘upwards’ rather than ‘downwards’ in a hierarchy.

Library class hierarchy



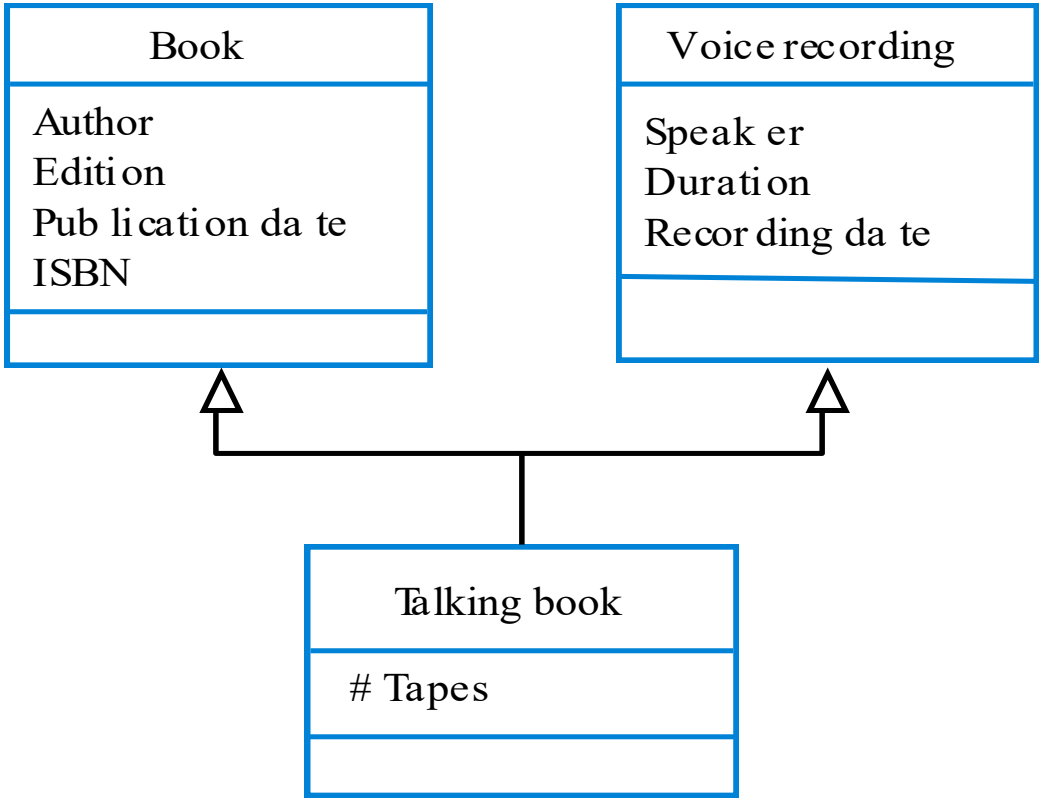
User class hierarchy



Multiple inheritance

- Rather than inheriting the attributes and services from a single parent class, a system which supports multiple inheritance allows object classes to inherit from several super-classes.
- This can lead to semantic conflicts where attributes/services with the same name in different super-classes have different semantics.
- Multiple inheritance makes class hierarchy reorganisation more complex.

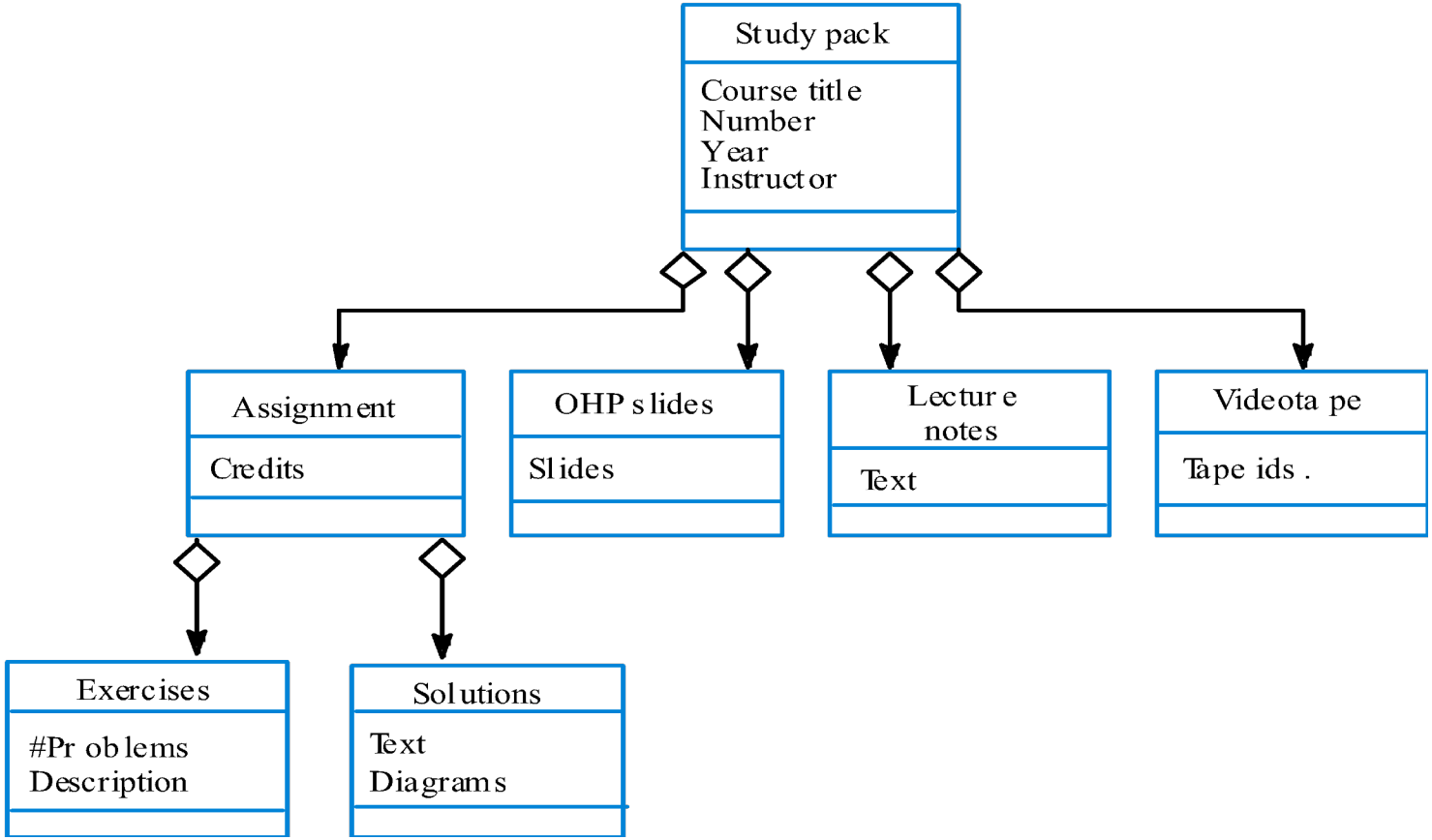
Multiple inheritance



Object aggregation

- An aggregation model shows how classes that are collections are composed of other classes.
- Aggregation models are similar to the part-of relationship in semantic data models.

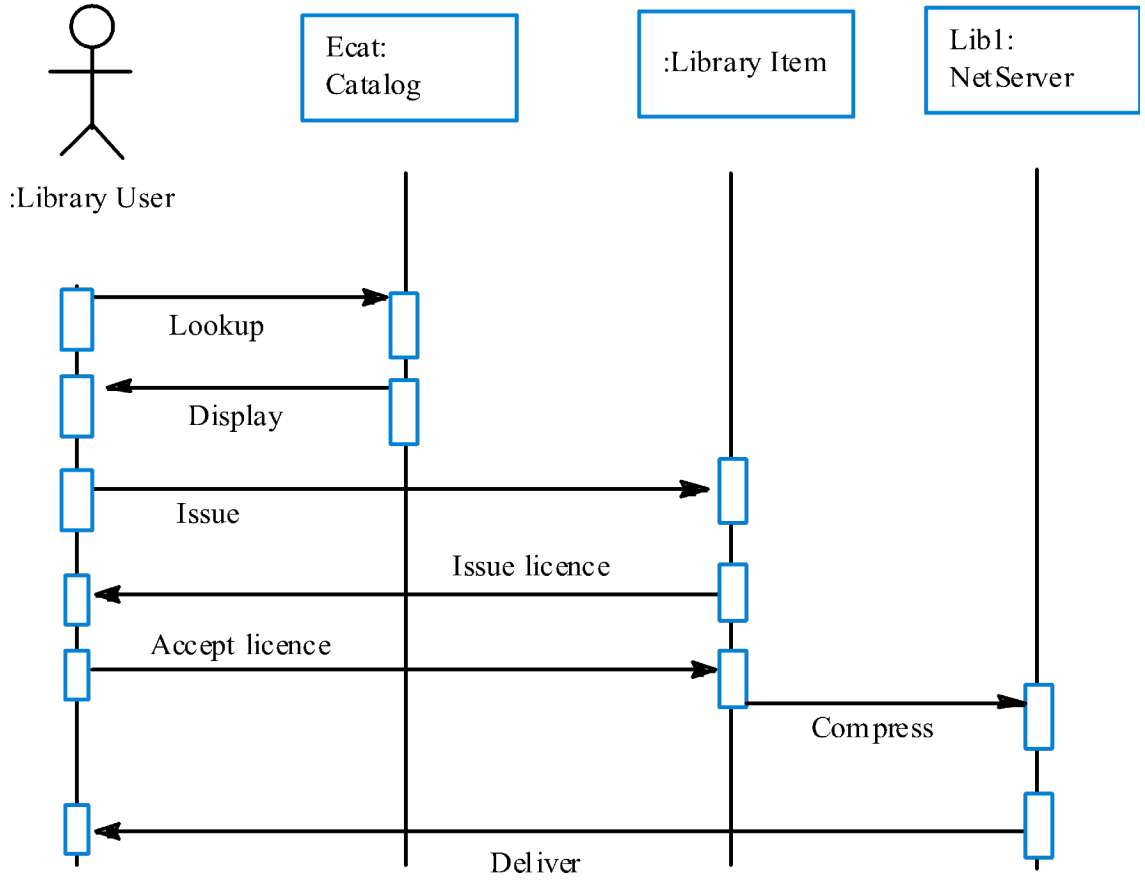
Object aggregation



Object behaviour modelling

- A behavioural model shows the interactions between objects to produce some particular system behaviour that is specified as a use-case.
- Sequence diagrams (or collaboration diagrams) in the UML are used to model interaction between objects.

Issue of electronic items



CASE workbenches

- A coherent set of tools that is designed to support related software process activities such as analysis, design or testing.
- Analysis and design workbenches support system modelling during both requirements engineering and system design.
- These workbenches may support a specific design method or may provide support for a creating several different types of system model.

An analysis and design workbench