

CS 846: Model-Based Software Engineering

Winter 2012

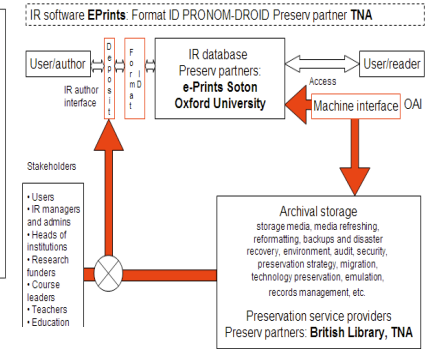
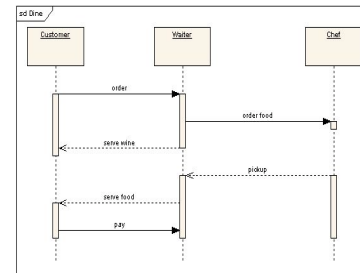
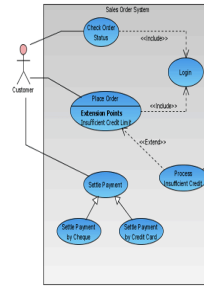
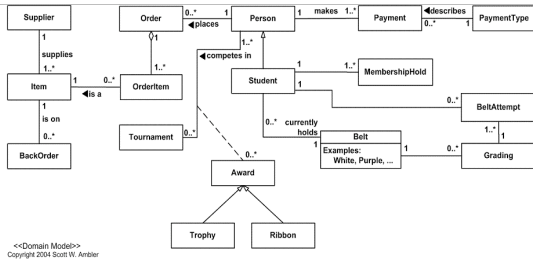
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January 16, 2012

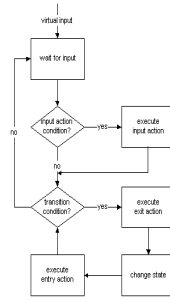
Software Models

<http://se.uwaterloo.ca/~jmatlee/teaching/846>

What is Being Modelled?



`<postal-address> ::= <name-part> <street-address> <zip-part>`
`<name-part> ::= <personal-part> <last-name> <opt-jr-part> <EOL>`
`I <personal-part> <name-part>`



Apply for a car insurance - Explore alternatives

Input: decision point questions

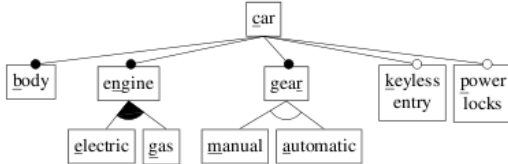
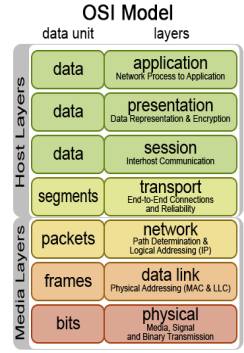
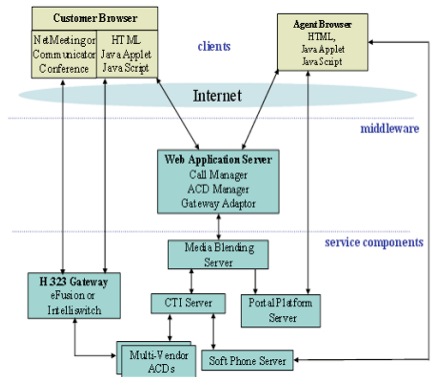
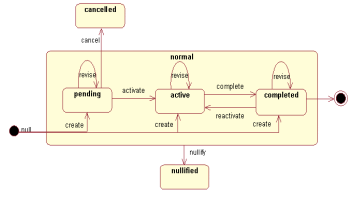
Q1: Number of accidents > N	1	2	3	4	5	6	7	8
Q2: Type of car = (.....)	Y	Y	N	N	N	N	N	..
Q3: Age of the car > M	Y	N	N	N	Y	N	Y	..

Output: test actions

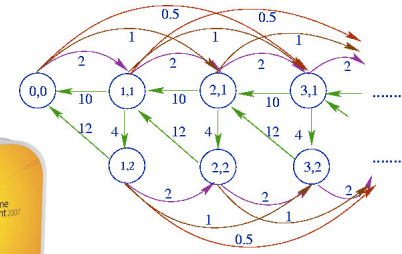
- Check message 'Refuse to insure'
- Return to the main menu
- Accept to insure
- Select standard rate
- Check price
- Display information

Tests to run

- Accept to insure
- Select special rate
- Check price
- Display information

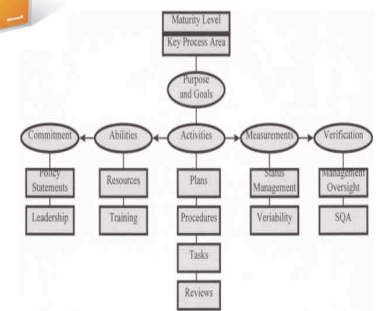
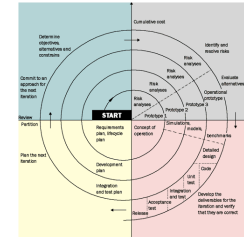
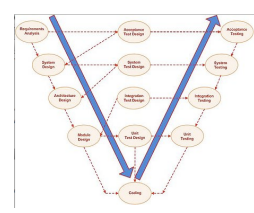
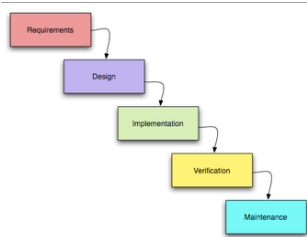


keyless_entry → power_locks

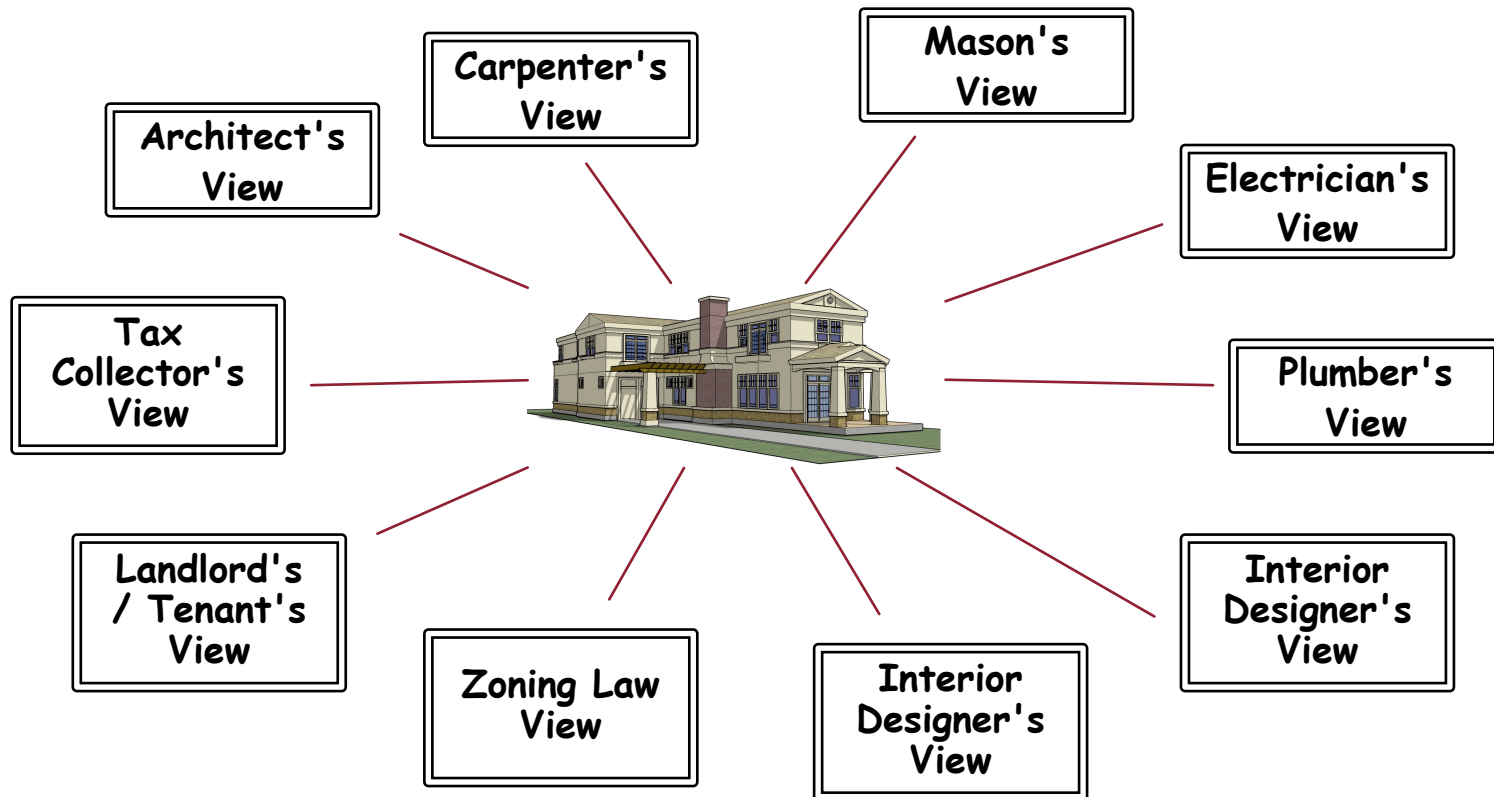


	Risks (Failure Modes)					
	Participant does not read emails	Participant does not reply to requests	Room with required equipment is not available	System response is too close to meeting	Important participant has last minute change	Overall single effect of countermeasure
Countermeasures						
Criticality (risk)	0.264	0.468	0.01	0.287	0.375	
Email reminder sent	0.7	0.7	0	0.1	0	0.542
Change the meeting, increase time range	0.2	0.2	0	0.1	0	0.176
System has access to personal e-agendas	0.3	0.2	0.1	0.2	0.3	0.346
Change the meeting, fewer constraints (equipment)	0	0	0.9	0	0	.009
Cancel a meeting and send email confirmation	0.8	0.8	1	0.7	0.9	1.141
Combined risk reduction	0.966	0.982	1	0.806	0.93	

$$E = a KLOC^b$$



Models as Views



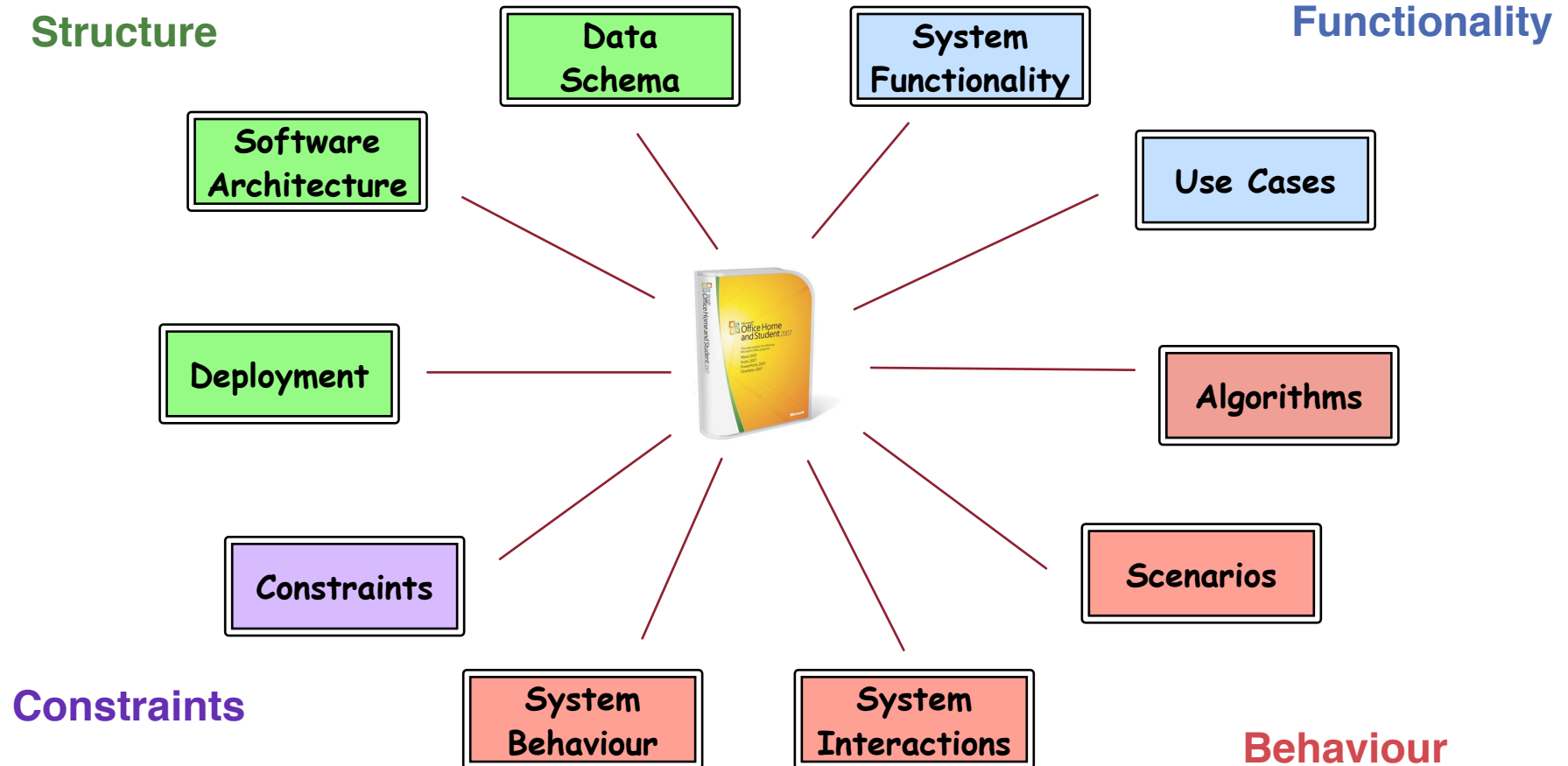
Every view

- obtained by a different **projection, abstraction, translation**
- may be expressed in a different notation (modelling language)
- reflects a different intent

[Example from J. Bezivin, J. Dingel]

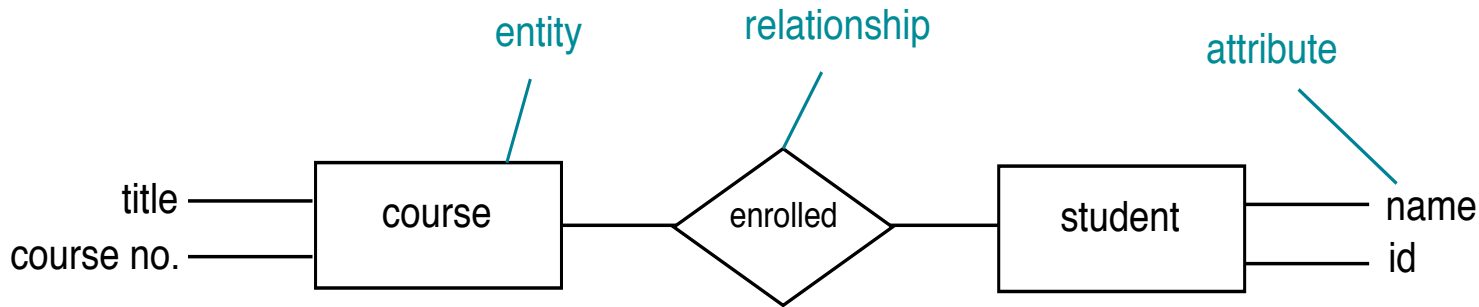
Modelling Paradigms

Fundamental **modelling paradigms**, each emphasizing some basic view of the software to be developed.



Entity-Relationship Diagrams

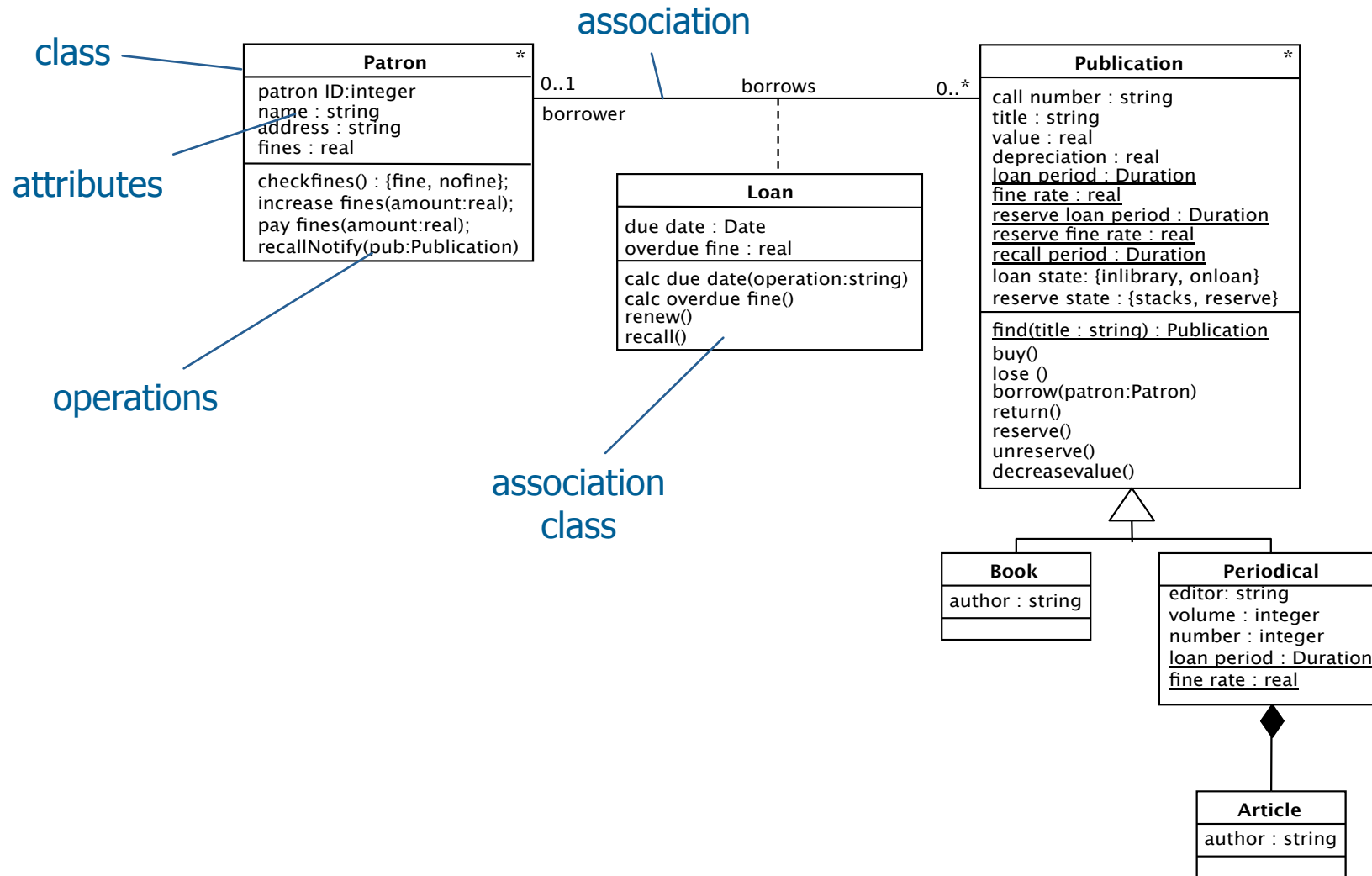
An **ER diagram** is a *structural model* representing a software system's data elements and relationships among them.



- originally invented for model database design (Chen, 1976)
- emphasizes concepts/data
- relationships can represent associations, navigability, containment, dependencies, etc.

UML Class Diagrams

UML Class Diagrams are an elaborate form of ER diagram.

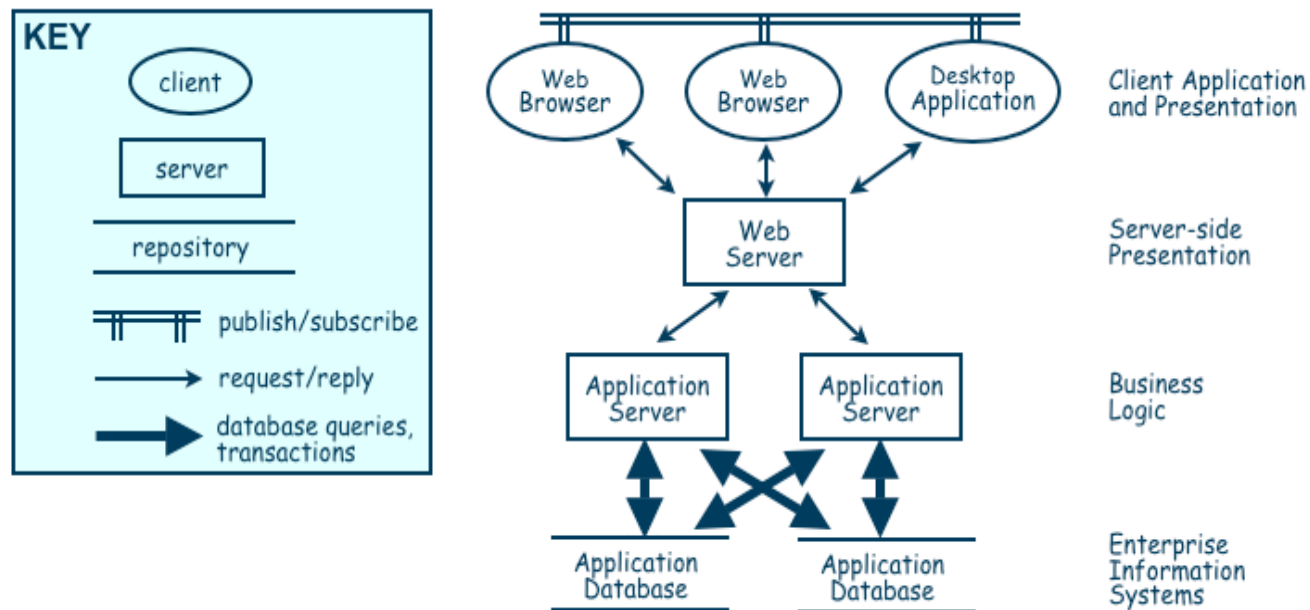


[Figure from Pfleeger, Atlee, 2009]

Software Architecture

A **software architecture** is high-level model of code *structure*.

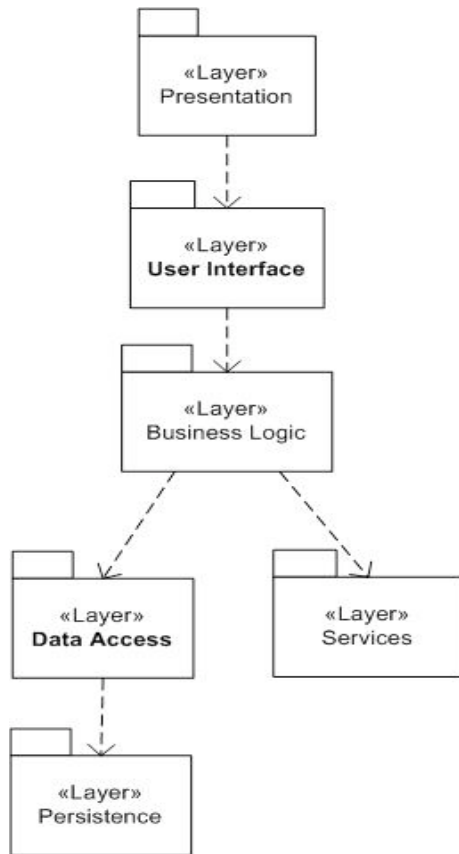
Typically modelled as a "box and arrow" diagram, with a key explaining the types of **components** (boxes) and **connectors** (arrows).



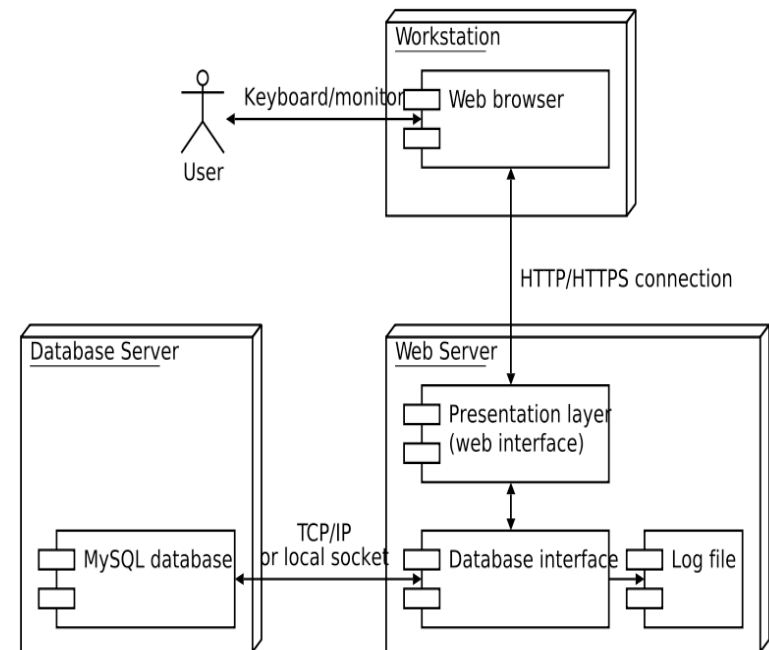
[Figure from Pfleeger, Atlee, 2009]

UML "Software Architecture" Models

The closest that UML comes to a software architecture model are **UML Package Diagrams** and **UML Deployment Diagrams**.



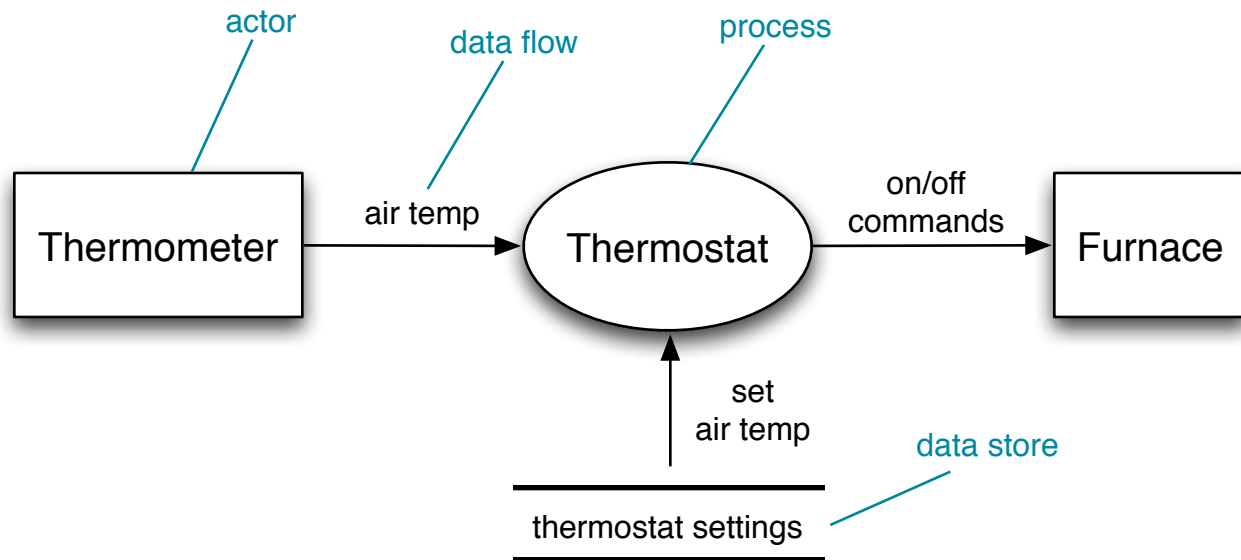
UML Package Diagram



UML Deployment Diagram

Data Flow Diagrams (DFDs)

Descriptive model of **functional decomposition** of the system, and the data dependencies between functions.

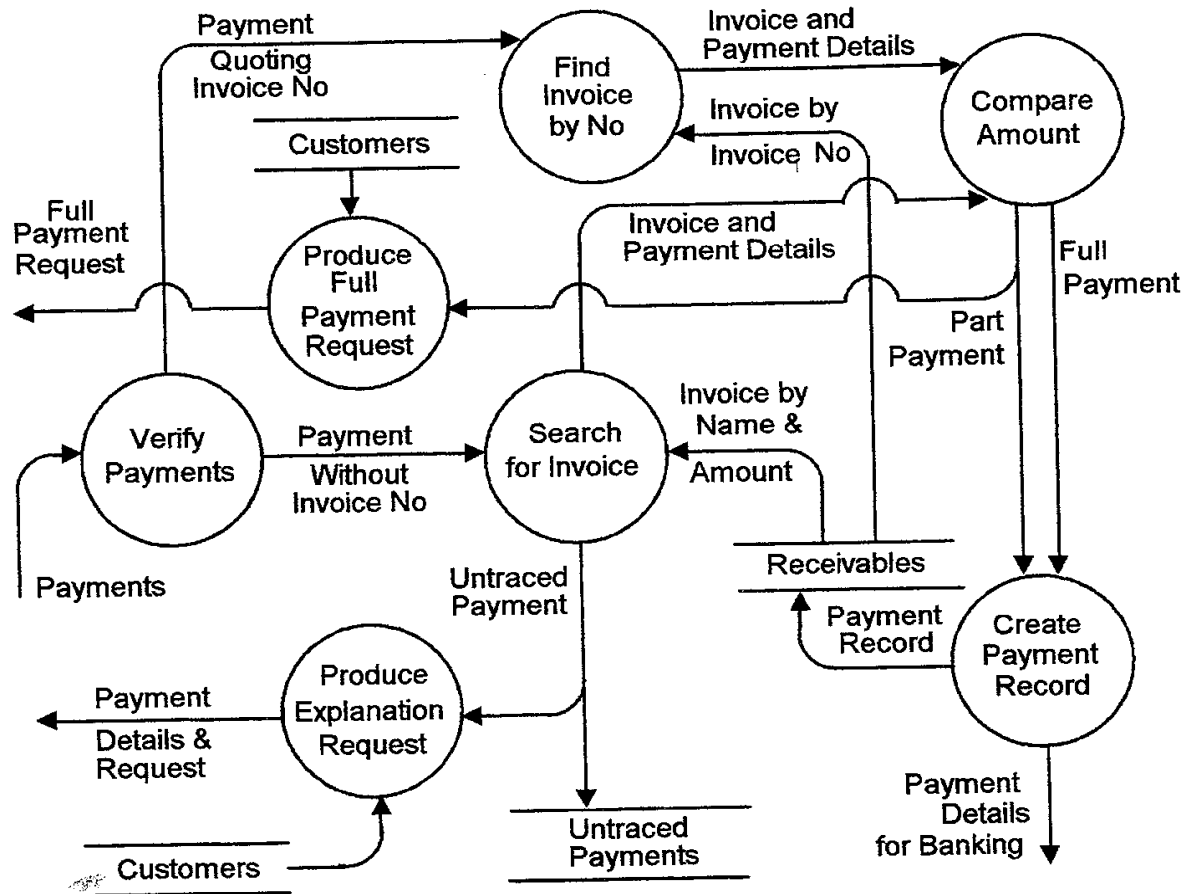


DFDs model

- collection of functions
- sources and sinks of data
- data dependencies

Data Flow Diagrams (DFDs)

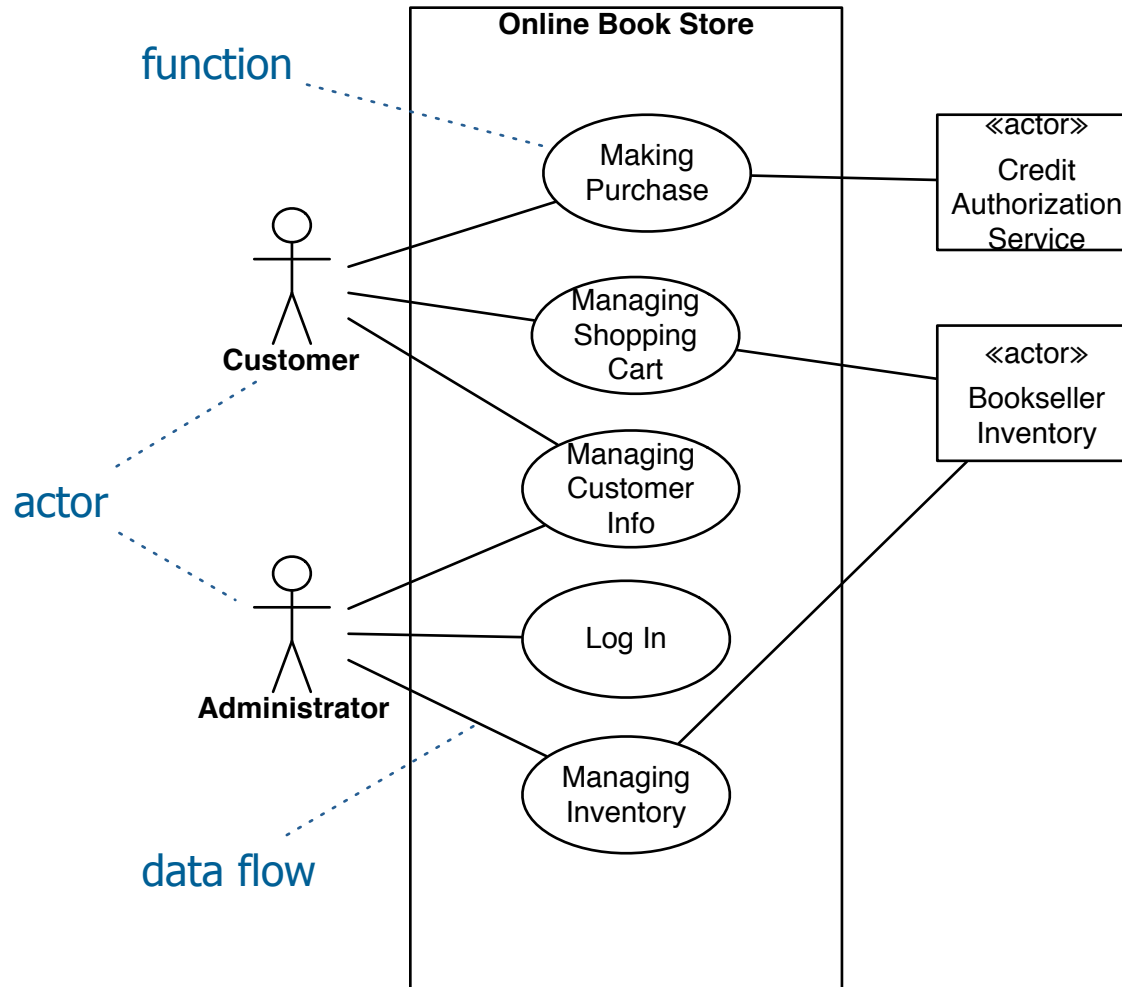
Although DFDs are good for communicating the big picture, they are inherently incomplete, undetailed, and ambiguous.



[Figure from M. Jackson, 1995]

UML Use Case Diagrams

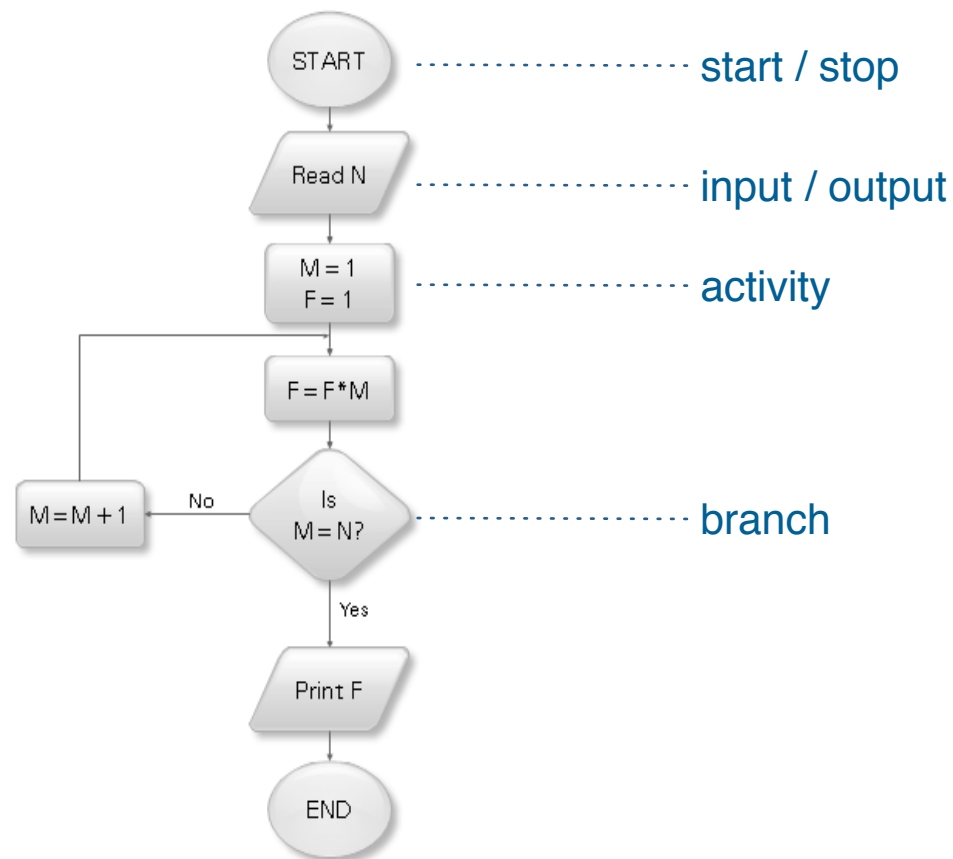
Use Case Diagrams are a very high-level data-flow diagram.



Flowcharts

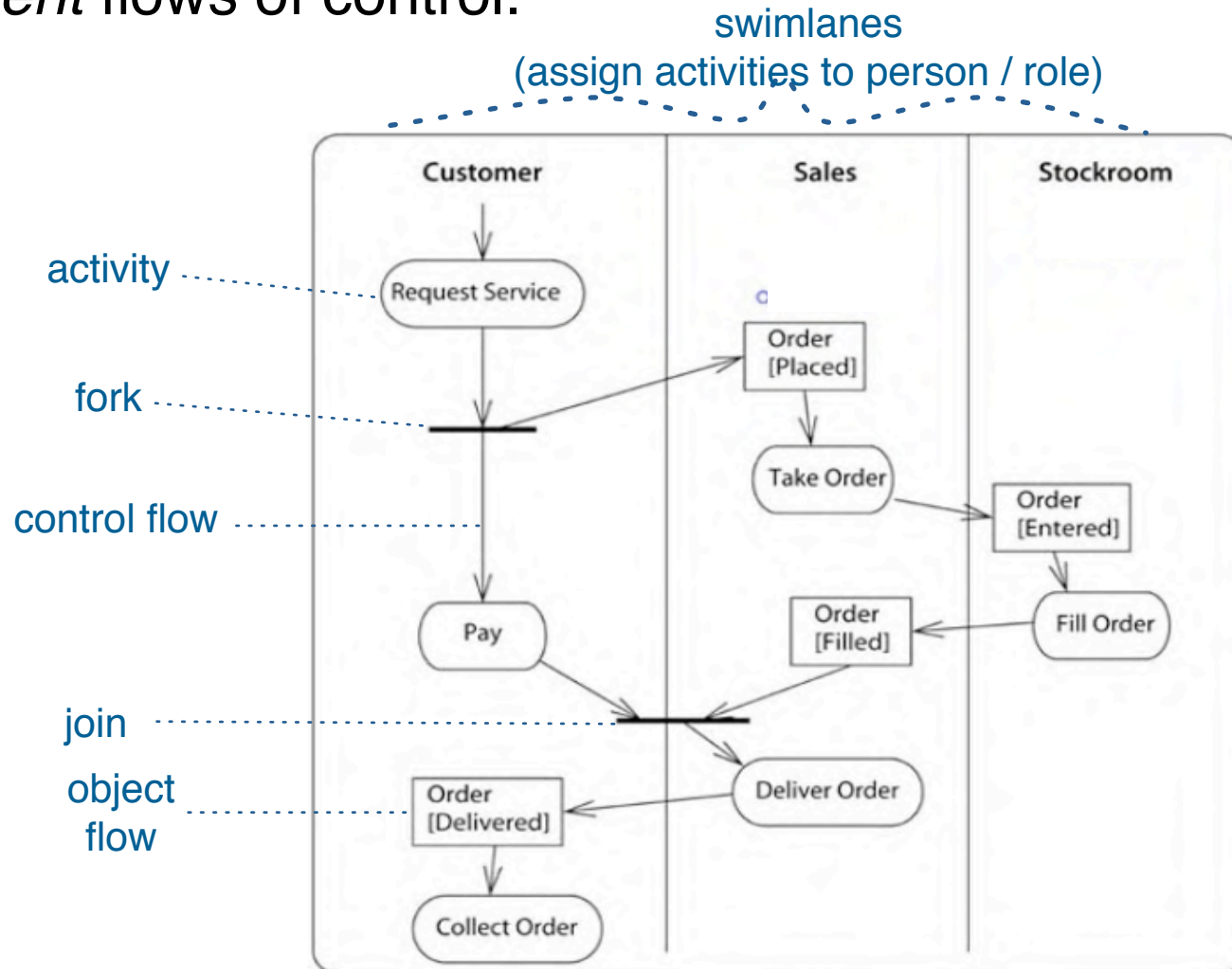
Flowcharts are an ancient modelling notation, for representing *behaviour* in terms of steps of an algorithm.

Depict **control flow** rather than data flow



UML Activity Charts

UML Activity Charts are a variation on flowcharts that support *concurrent* flows of control.

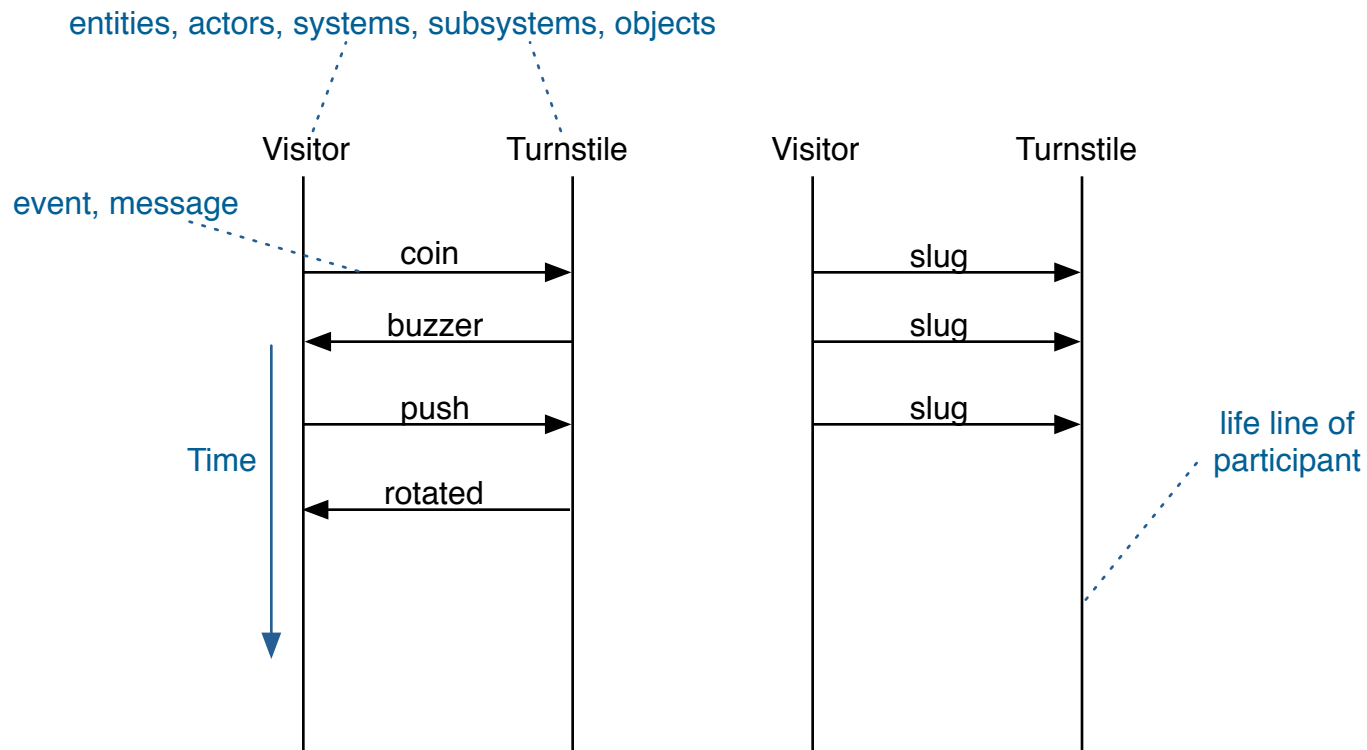


[Figure from M. Blaha, J. Rumbaugh, 2005]

Event Traces

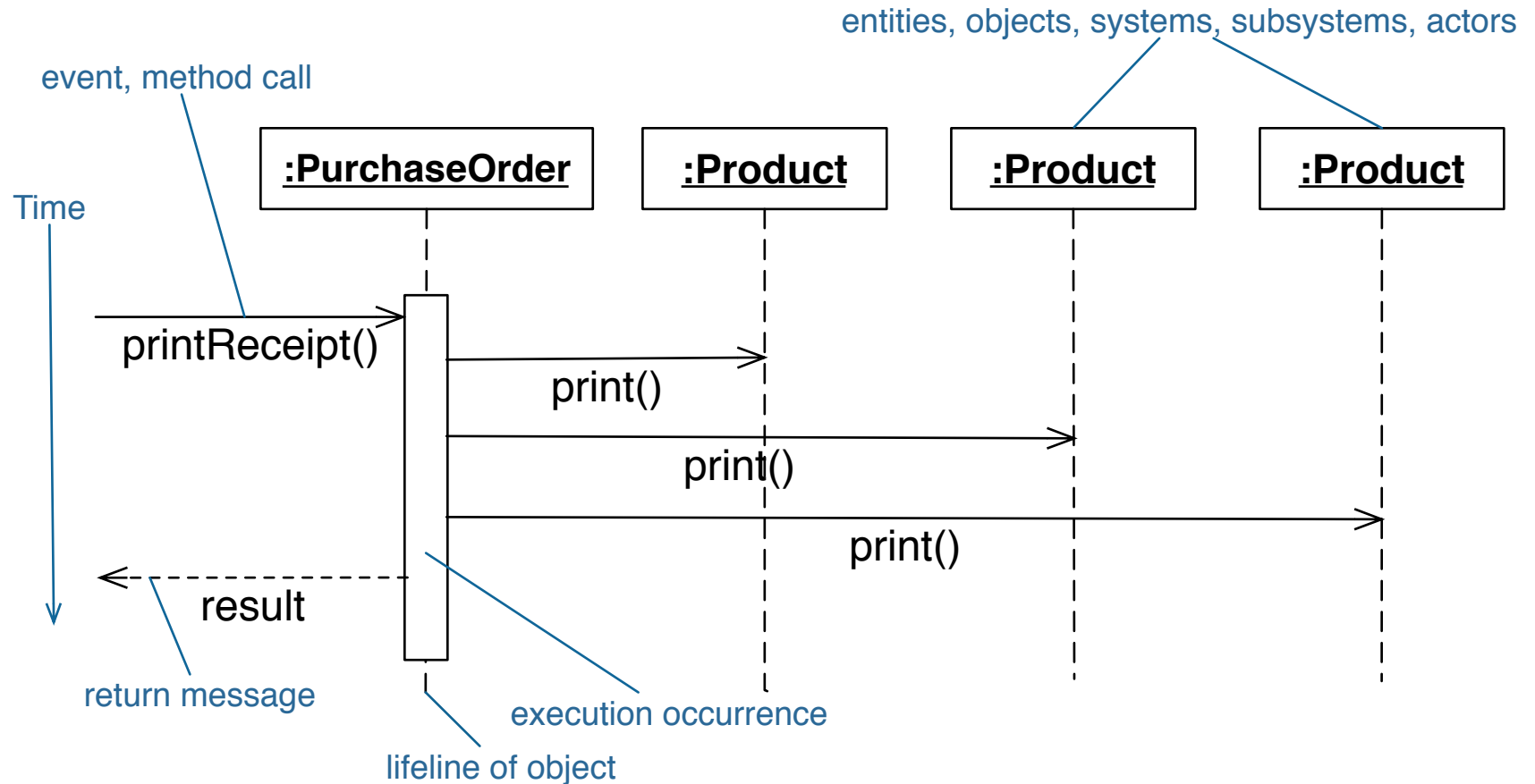
Dynamic model of *behaviour* showing communication among entities in one scenario (execution trace).

Shows a slice of behaviour, not complete behaviour.



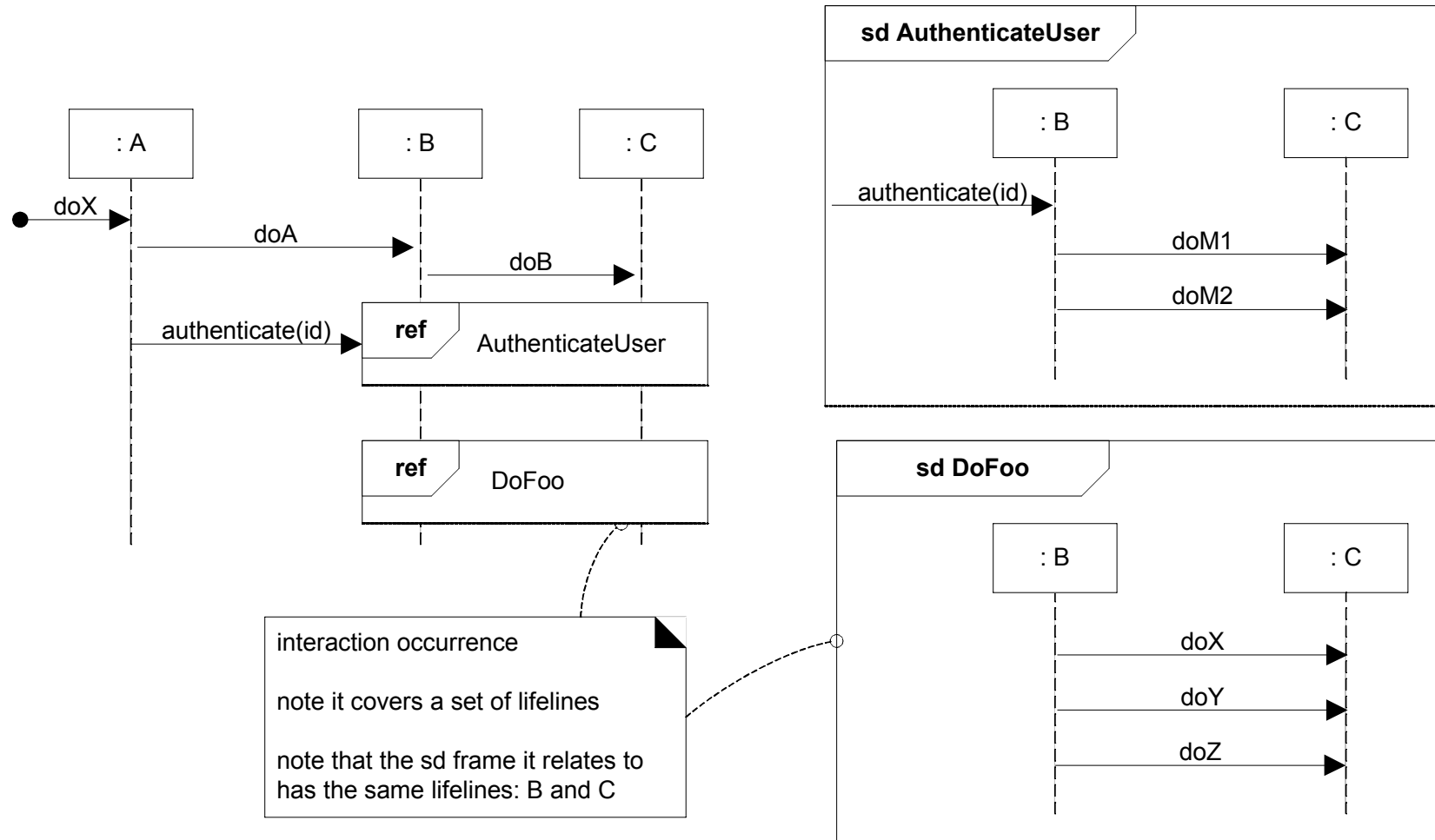
UML Sequence Diagrams

UML Sequence Diagrams are elaborate event traces....



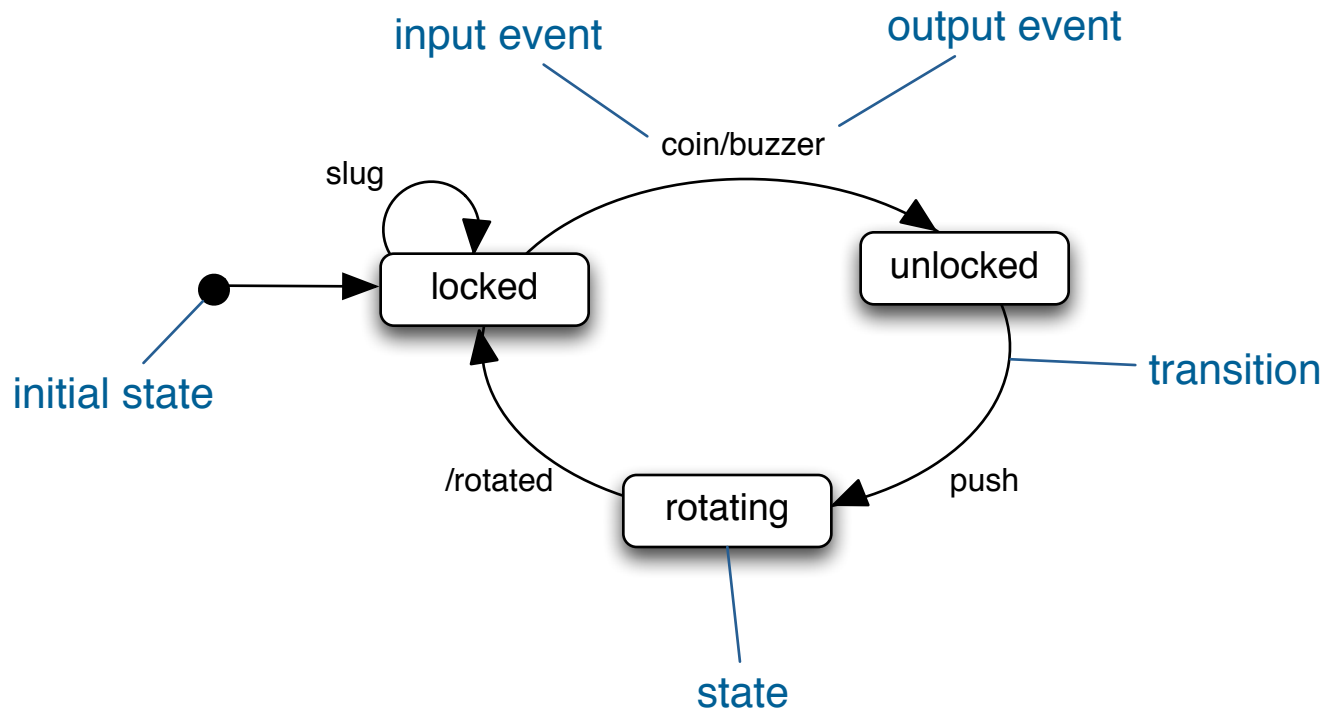
UML Sequence Diagrams

... including branches, loops, concurrency, optional subsequences, **references to other sequence diagrams.**



State Machines

Compact representation of all event traces.



UML StateMachine Diagrams

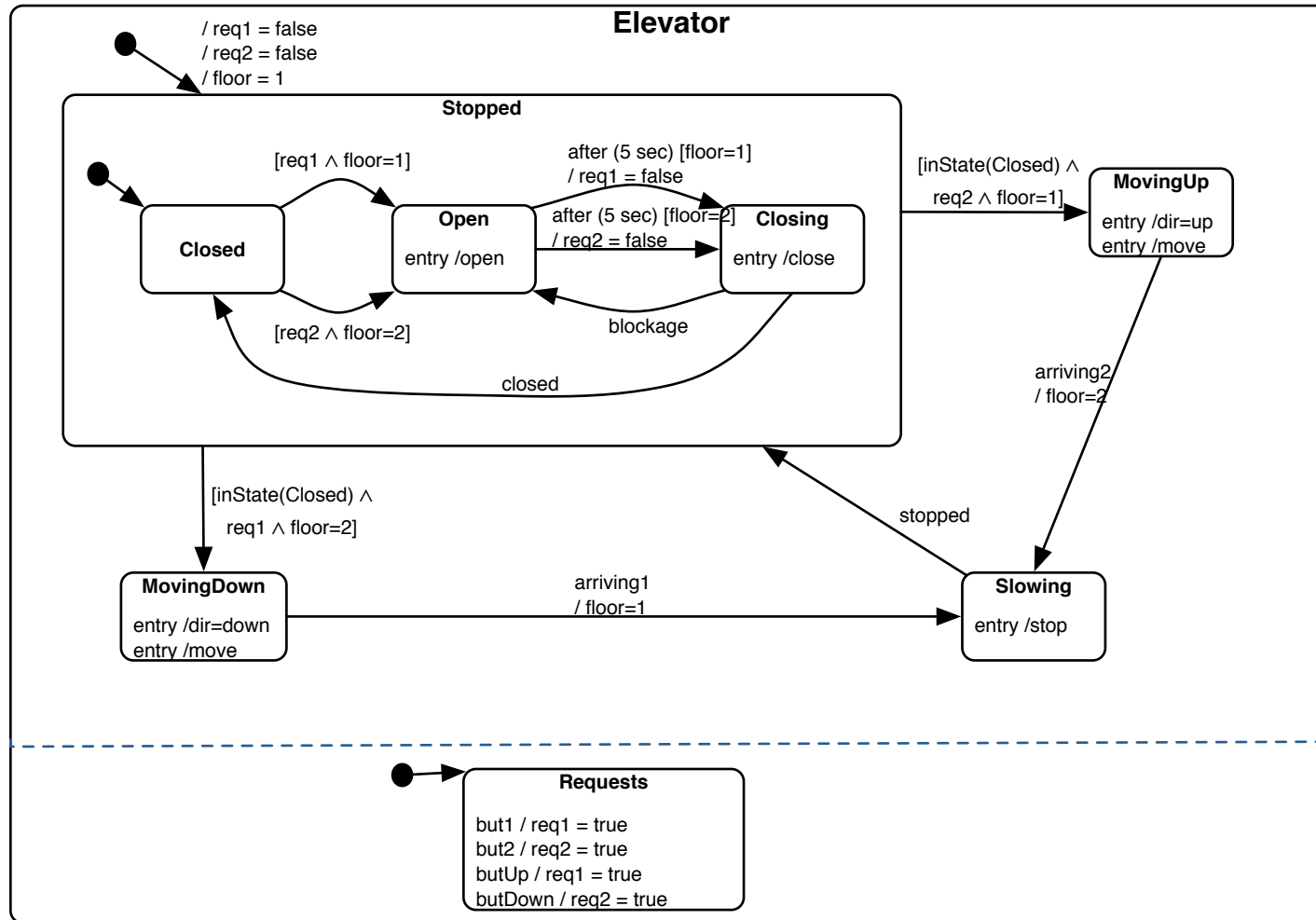
UML StateMachine Diagrams borrow heavily from David Harel's statecharts.

VARIABLES

req1 : boolean := false (* outstanding request for floor1 *)

req2 : boolean := false (* outstanding request for floor2 *)

floor : {1, 2} (* current location of elevator *)



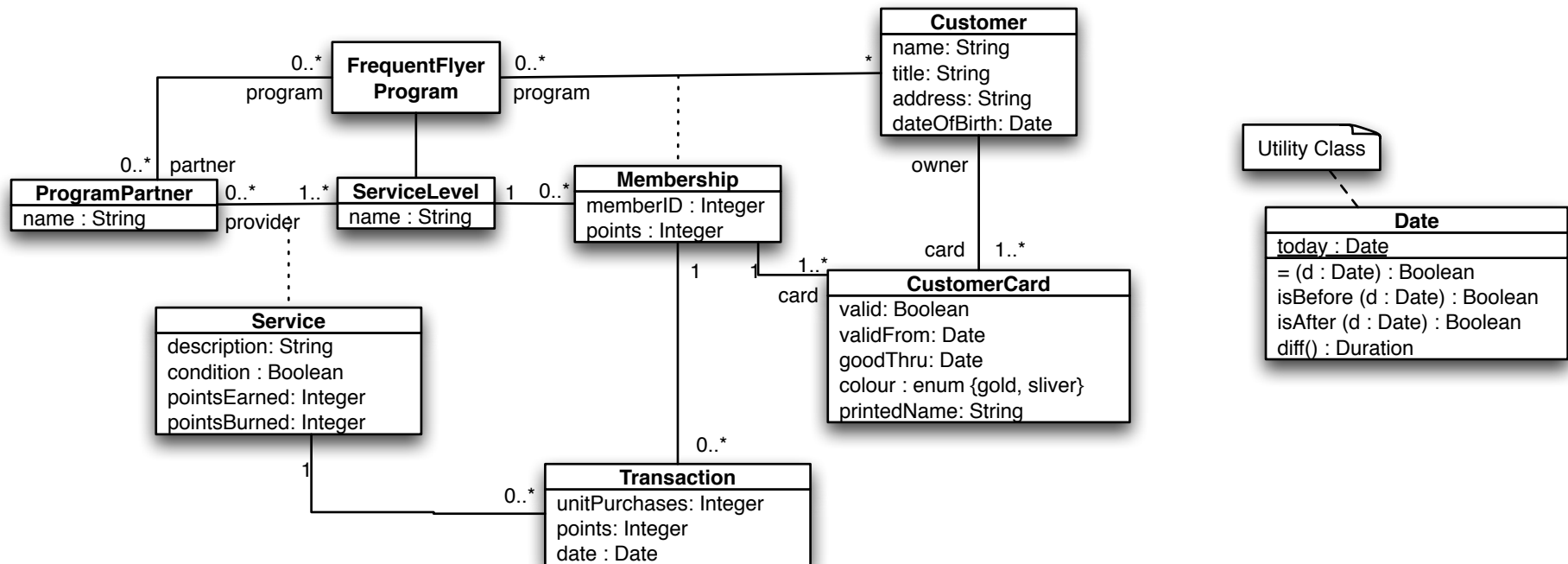
Logic

Logic is the basis for a number of languages that express constraints on allowable interpretations of other models.

- allowable instantiations of data models
- invariants among attribute values in data models
- pre/post conditions of functions
- event conditions in event traces
- guard conditions in state machines

Object Constraint Language

OCL was designed for expressing constraints on UML diagrams.



context CustomerCard inv

`self.printedName = (self.owner.title.concat(self.ownername))`

context CustomerCard inv

`(self.valid and self.colour=gold) implied self.membership.serviceLevel = "gold"`

UML: 13 Different Diagram Types

Structural

- Class Diagrams
- Object Diagrams
- Composite Structure Diagrams
- Component Diagrams
- Package Diagrams
- Deployment Diagrams

Behavioural

- Interaction Overview Diagrams
- Activity Diagrams
- Sequence Diagrams
- Communication Diagrams
- State Machine Diagrams
- Timing Diagrams

Functional

- Use Case Diagrams

OCL is a separate language that was invented for writing constraints on UML models

Next Week

3 Prominent Modelling Languages

- Alloy
- Statecharts
- Scala

References

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