Introduction to UML

Team Emertxe

What is UML?

Non è un processo, ma è standard per documentazione

potresti modellare qualsiasi cosa

- Unified Modeling Language
  - OMG Standard, Object Management Group
  - Based on work from Booch, Rumbaugh, Jacobson
- UML is a modeling language to express and design documents, software
  - Particularly useful for OO design
  - Not a process, but some have been proposed using UML
  - Independent of implementation language

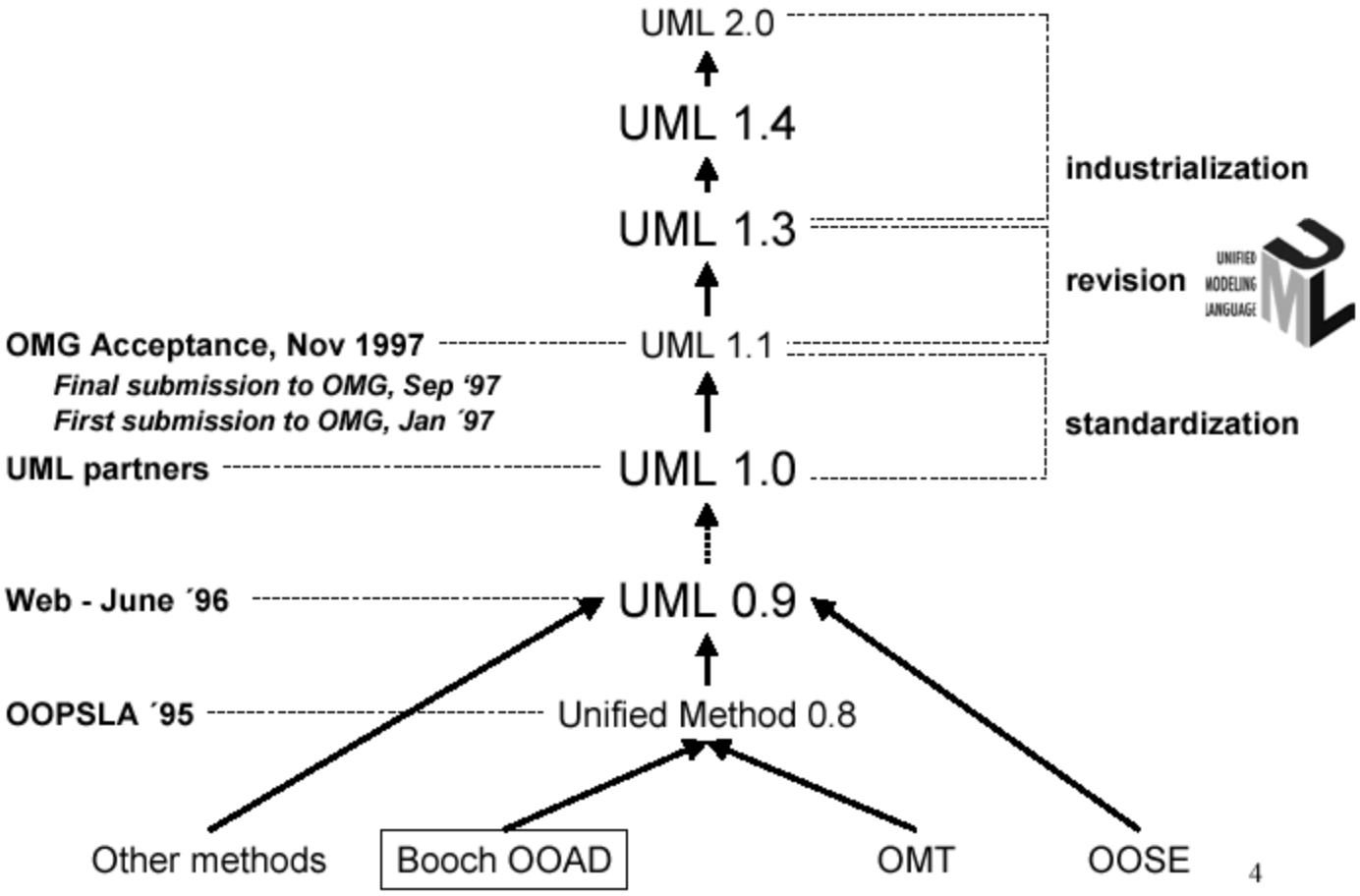
Why use UML

- Open Standard, Graphical notation for
  - Specifying, visualizing, constructing, and documenting software systems
- Language can be used from general initial design to very specific detailed design across the entire software development lifecycle
- Increase understanding/communication of product to customers and developers
- Support for diverse application areas
- Support for UML in many software packages today (e.g. Rational, plugins for popular IDE's like NetBeans, Eclipse)
- Based upon experience and needs of the user community

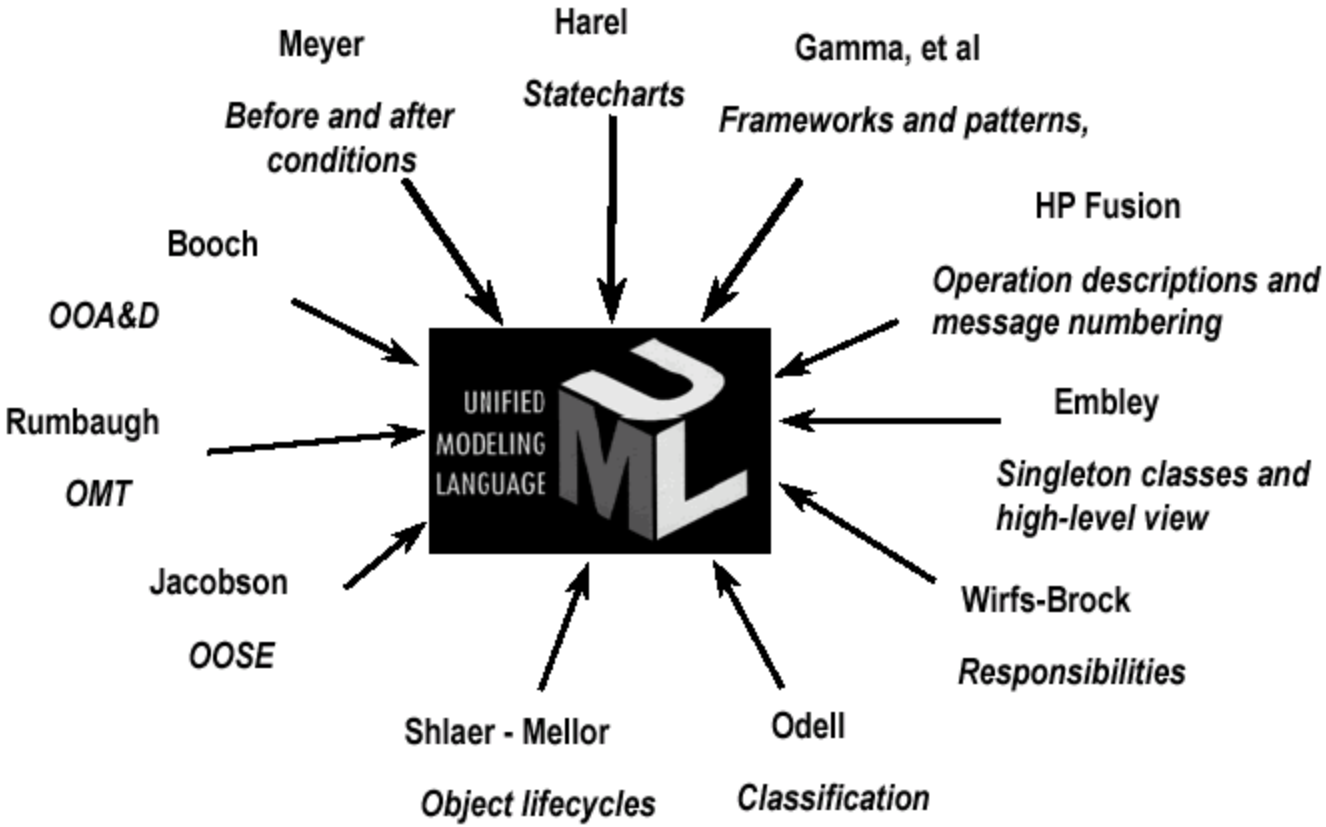
Brief History

- Inundated with methodologies in early 90's
  - Booch, Jacobson, Yourden, Rumbaugh
- Booch, Jacobson merged methods 1994
- Rumbaugh joined 1995
- 1997 UML 1.1 from OMG includes input from others, e.g. Yourden
- UML v2.0 current version

History of UML



Contributions to UML



Systems, Models and Views

Modello non sarà esattamente uguale alla realtà

Modello descrivono il sistema

- A ***model*** is an abstraction describing a subset of a system
- A ***view*** depicts selected aspects of a model
- A ***notation*** is a set of graphical or textual rules for depicting views
- Views and models of a single system may overlap each other

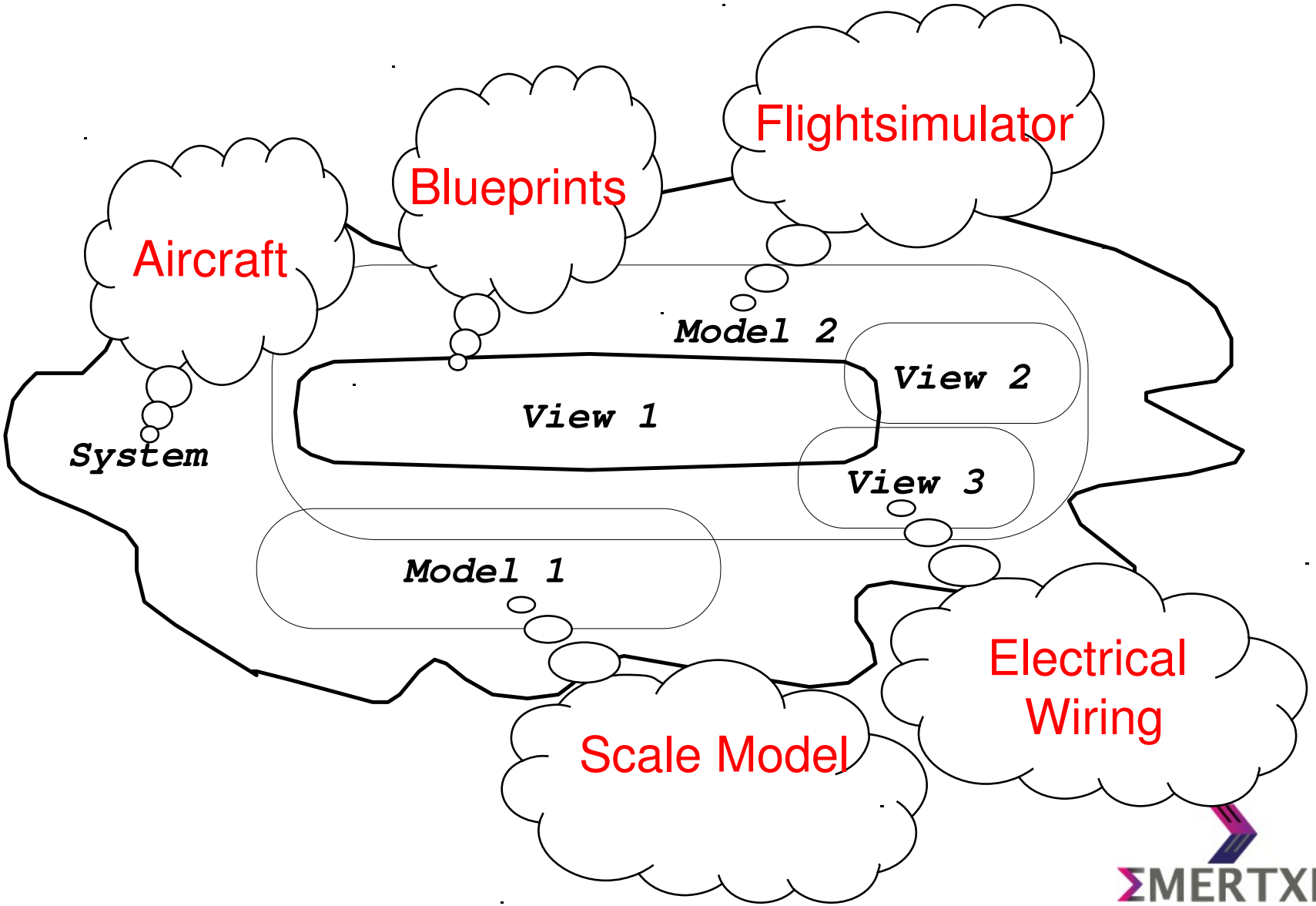
Vista: qualcosa di specifico che vedo di un modello

↳ descrive le viste che costituiscono il modello.

Examples:

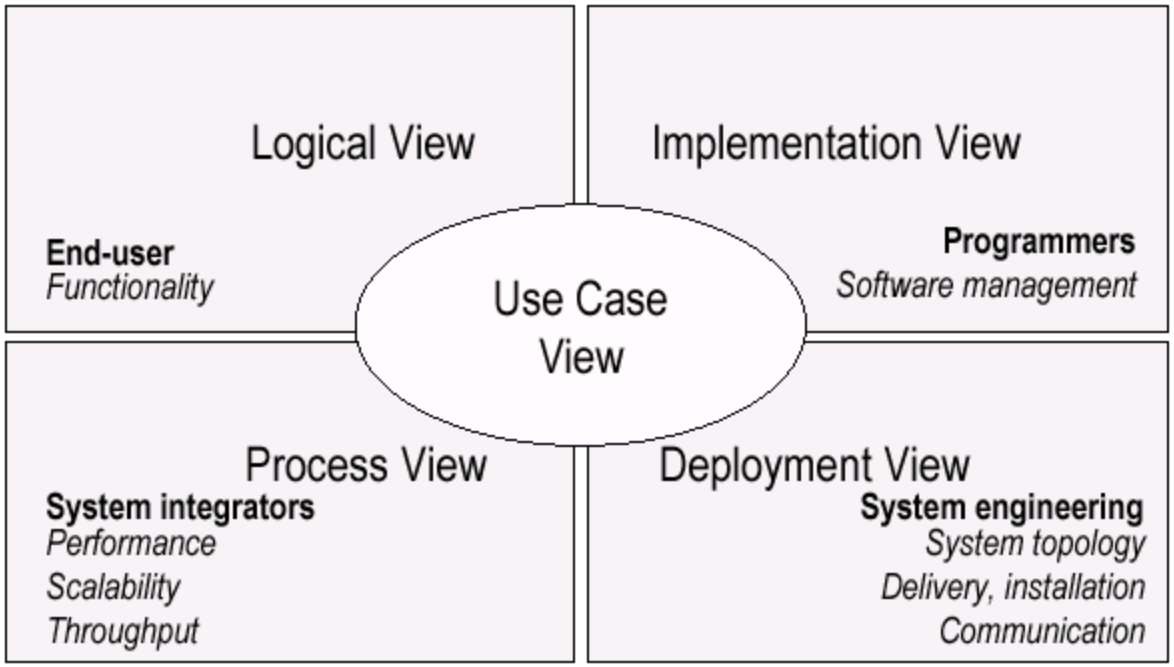
- System: Aircraft
- Models: Flight simulator, scale model
- Views: All blueprints, electrical wiring, fuel system

Systems, Models and Views

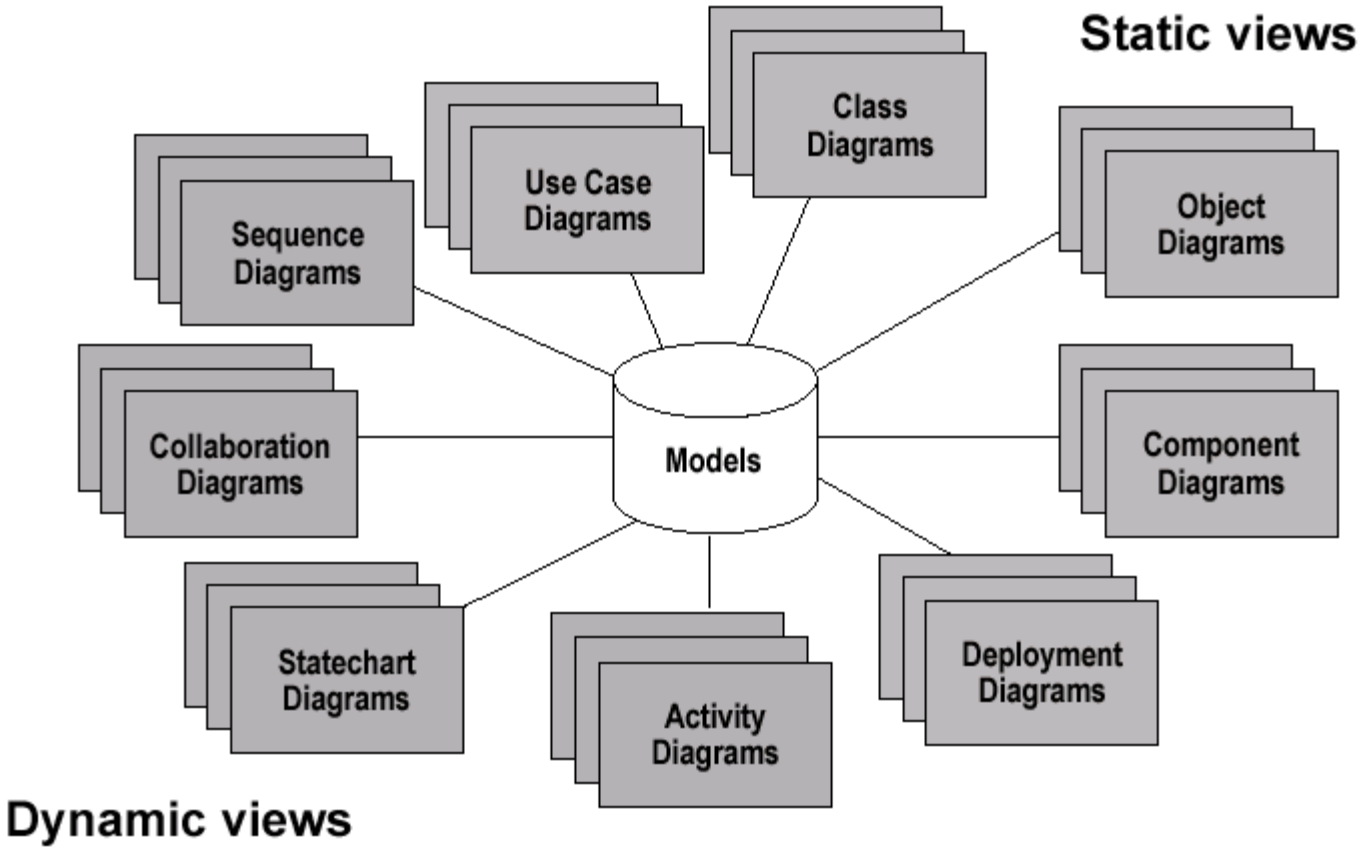


Models, Views, Diagrams

- UML is a multi-diagrammatic language
  - Each diagram is a view into a model
    - Diagram presented from the aspect of a particular stakeholder
    - Provides a partial representation of the system
    - Is semantically consistent with other views
  - Example views



Models, Views, Diagrams



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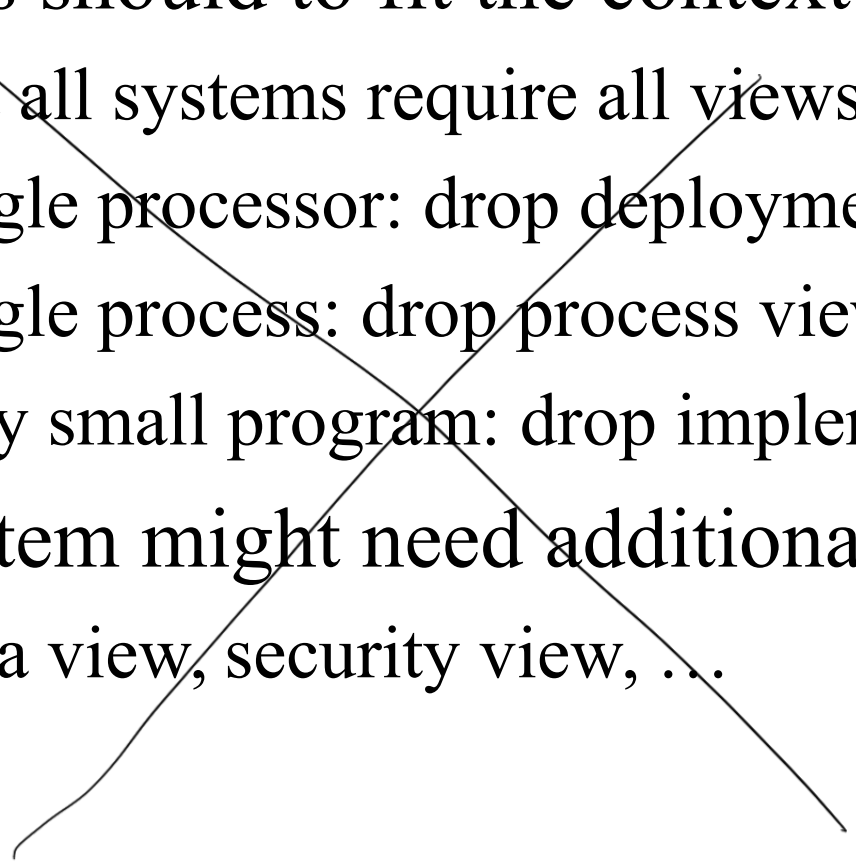
How Many Views?

- Views should to fit the context
  - Not all systems require all views
  - Single processor: drop deployment view
  - Single process: drop process view
  - Very small program: drop implementation view
- A system might need additional views
  - Data view, security view, …



UML: First Pass

- You can model 80% of most problems by using about 20 % UML
- We only cover the 20% here

Es, usiamo 4 tipologie di diagrammi

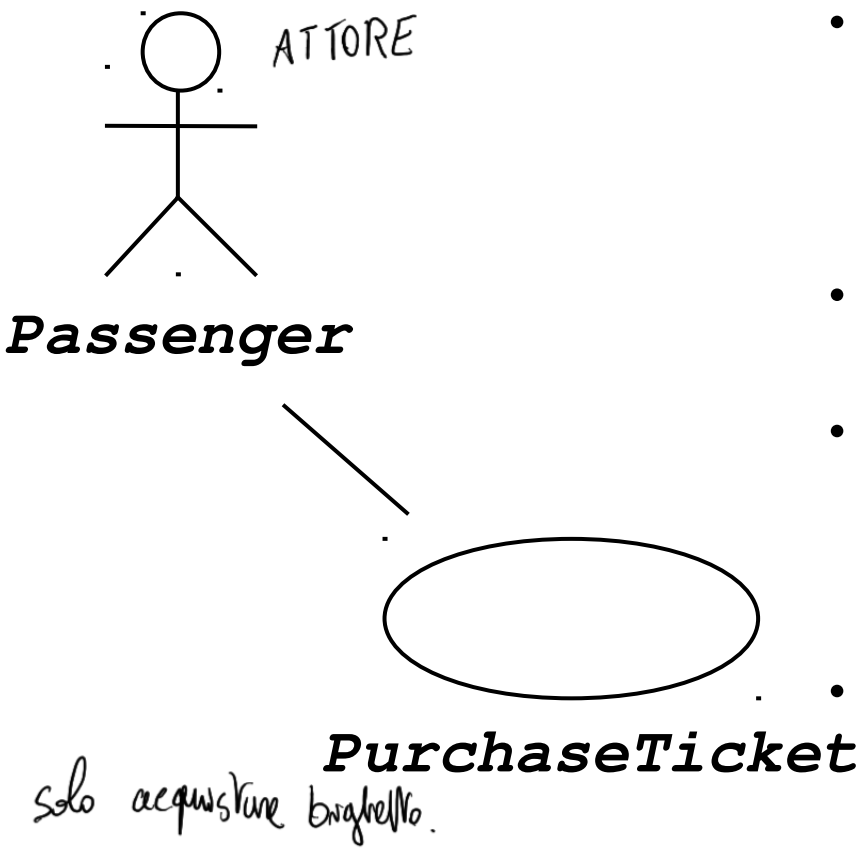
Basic Modeling Steps

- Use Cases
  - Capture requirements
- Domain Model
  - Capture process, key classes
- Design Model
  - Capture details and behaviors of use cases and domain objects
  - Add classes that do the work and define the architecture

UML Baseline

- Use Case Diagrams
- Class Diagrams
- Package Diagrams
- Interaction Diagrams
  - Sequence
  - Collaboration
- Activity Diagrams
- State Transition Diagrams
- Deployment Diagrams

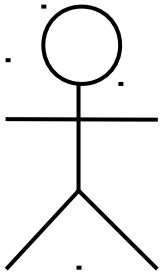
Use Case Diagrams



- Used during requirements elicitation to represent external behavior
- ***Actors*** represent roles, that is, a type of user of the system
- ***Use cases*** represent a sequence of interaction for a type of functionality; summary of scenarios
- The use case model is the set of all use cases. It is a complete description of the functionality of the system and its environment

Actors

Qualsiasi entità esterna



Passenger

- An actor models an external entity which communicates with the system:
  - User
  - External system
  - Physical environment
- An actor has a unique name and an optional description.
- Examples:
  - Passenger: A person in the train
  - GPS satellite: Provides the system with GPS coordinates

Qualcosa di esterno che non devo programmare

NOTA: anche ambiente fisico esterno può essere attore.
Es: palazzo con drone

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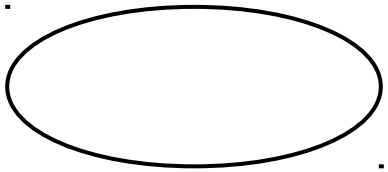
Use Case

Rappresenta funzione specifica

A use case represents a class of functionality provided by the system as an event flow.



PurchaseTicket

A use case consists of:

- Unique name
- Participating actors
- Entry conditions
- Flow of events
- Exit conditions
- Special requirements

Condiz. per cui riesco a eseguire queste cose: es. ho accesso alla rete.

che succede quando ho completato Ticket? Es. gli do' il QR

Non descrivo come vanno, ma espresse nello scenario del caso d'uso.

gli chiedo conness. cuffia

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Use Case Diagram: Template Example

Name: **`Purchase ticket`**

Participating actor: **`Passenger`**

Entry condition:

- **`Passenger`** standing in front of ticket distributor.
- **`Passenger`** has sufficient money to purchase ticket.

Exit condition:

- **`Passenger`** has ticket.

Event flow:

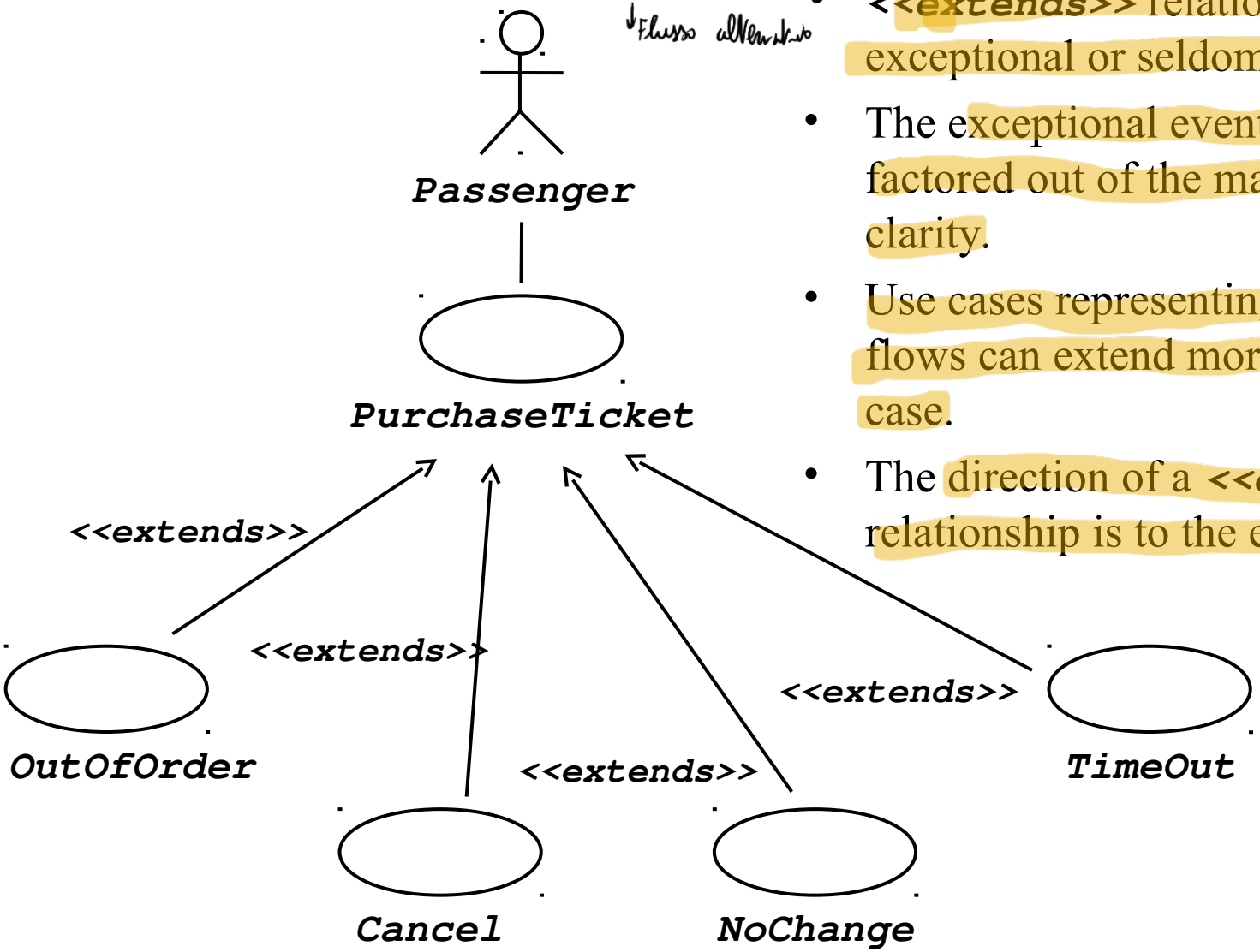
1. **`Passenger`** selects the number of zones to be traveled.
2. Distributor displays the amount due.
3. **`Passenger`** inserts money, of at least the amount due.
4. Distributor returns change.
5. Distributor issues ticket.

Anything missing?

Exceptional cases!

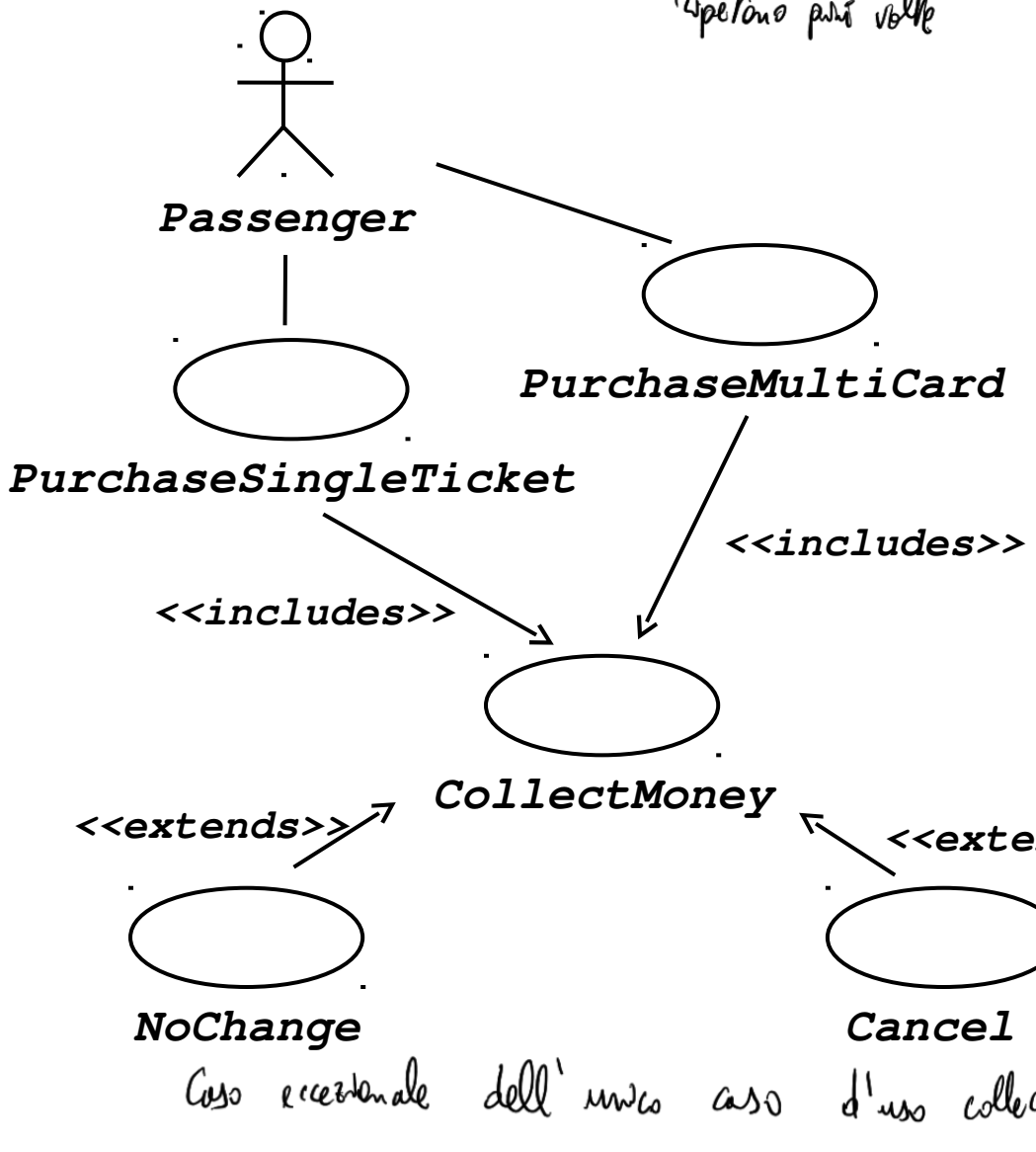
↳ es. perdo connessione, annullo l'acquisto, cosa succede.

The <<extends>> Relationship



- **<<extends>>** relationships represent exceptional or seldom invoked cases.
- The exceptional event flows are factored out of the main event flow for clarity.
- Use cases representing exceptional flows can extend more than one use case.
- The direction of a **<<extends>>** relationship is to the extended use case

The <<includes>> Relationship



- **<<includes>>** relationship represents behavior that is factored out of the use case.
- **<<includes>>** behavior is factored out for reuse, not because it is an exception.
- The direction of a **<<includes>>** relationship is to the using use case (unlike **<<extends>>** relationships).

Use Cases are useful to…

Ogni caso d'uso rappresenta 1 requisito

- Determining requirements
  - New use cases often generate new requirements as the system is analyzed and the design takes shape.
- Communicating with clients
  - Their notational simplicity makes use case diagrams a good way for developers to communicate with clients.
- Generating test cases
  - The collection of scenarios for a use case may suggest a suite of test cases for those scenarios.

Use Case Diagrams: Summary

- Use case diagrams represent external behavior
- Use case diagrams are useful as an index into the use cases
- Use case descriptions provide meat of model, not the use case diagrams.
- All use cases need to be described for the model to be useful.

Class Diagrams

↳ usati sia nell'analisi dei requisiti, ma soprattutto nel design. Per analisi dei requisiti è espresso in modo molto sommario

- Gives an overview of a system by showing its classes and the relationships among them.
  - Class diagrams are static → in UML ho diagrammi statici o dinamici. → Una volta disegnato non dice come le classi vengono usate. Indica un oggetto fisso che non sta facendo niente. No azioni in corso
  - they display what interacts but not what happens when they do interact
- Also shows attributes and operations of each class

  metodi
- Good way to describe the overall architecture of system components

  ↓ Comunicaz. non stiamo avvenendo statico

Class Diagram: Perspectives

- We draw Class Diagrams under three perspectives
  - Conceptual = Biglietto, passeggero, macchinetta ecc. Altissimo livello
    - Software independent
    - Language independent
  - Specification = Specificano le interfacce: es. i metodi e le interfacce
    Più importanti => quelli visibili all'utente, ad esempio
    - Focus on the interfaces of the software
  - Implementation
    - Focus on the implementation of the software

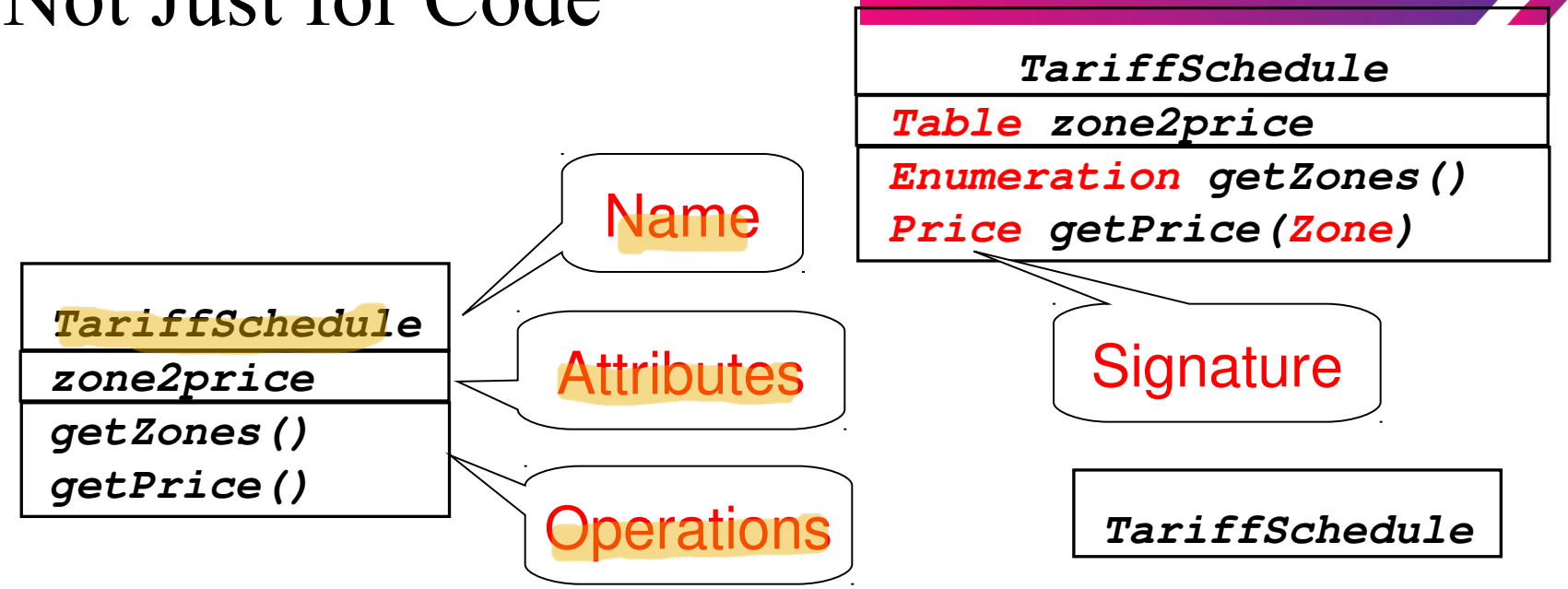
↳ etichetta con possibili implementazioni

NON PER FORZA COSÍ SEPARATE

Requisiti funzionali = rappresentano delle funzioni esposte all'utente

Requisiti non funzionali = " " nascoste.

Classes:
Not Just for Code



- A ***class*** represent a concept
- A class encapsulates state ***(attributes)*** and behavior ***(operations).***
- Each attribute has a ***type***.
- Each operation has a ***signature***.
- The class name is the only mandatory information.

→ non ci sono valori associati
Posso definire il valore e definire lo stato → Cristallizzato lo stato e
altrimenti diagramma degli oggetti.

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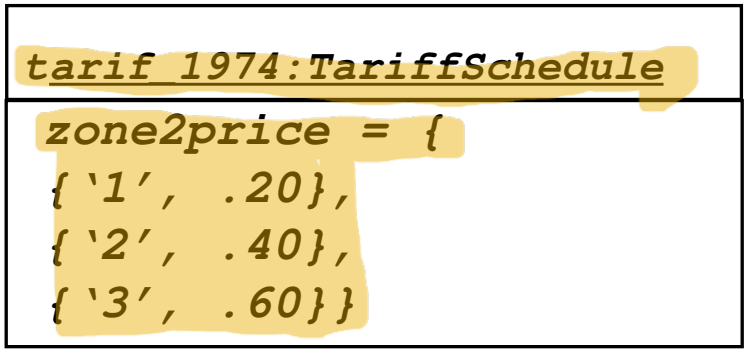
Instances



- An ***instance*** represents a phenomenon.
- The name of an instance is underlined and can contain the class of the instance.
- The attributes are represented with their ***values***.

UML Class Notation

- A class is a rectangle divided into three parts
  - Class name
  - Class attributes (i.e. data members, variables)
  - Class operations (i.e. methods)
- Modifiers
  - Private: -
  - Public: +
  - Protected: # Possono accedervi solo classi dello stesso pacco.
  - Static: Underlined (i.e. shared among all members of the class)
- Abstract class: Name in italics

NOTA: in fase di analisi non specifico molte informazioni perché ancora so poco.

Employee
-Name : string +ID : long #Salary : double
+getName() : string → tipo di ritorno +setName() ↑ tipo -calcInternalStuff(in x : byte, in y : decimal)

in pur

in, out → variabile sarà cambiata

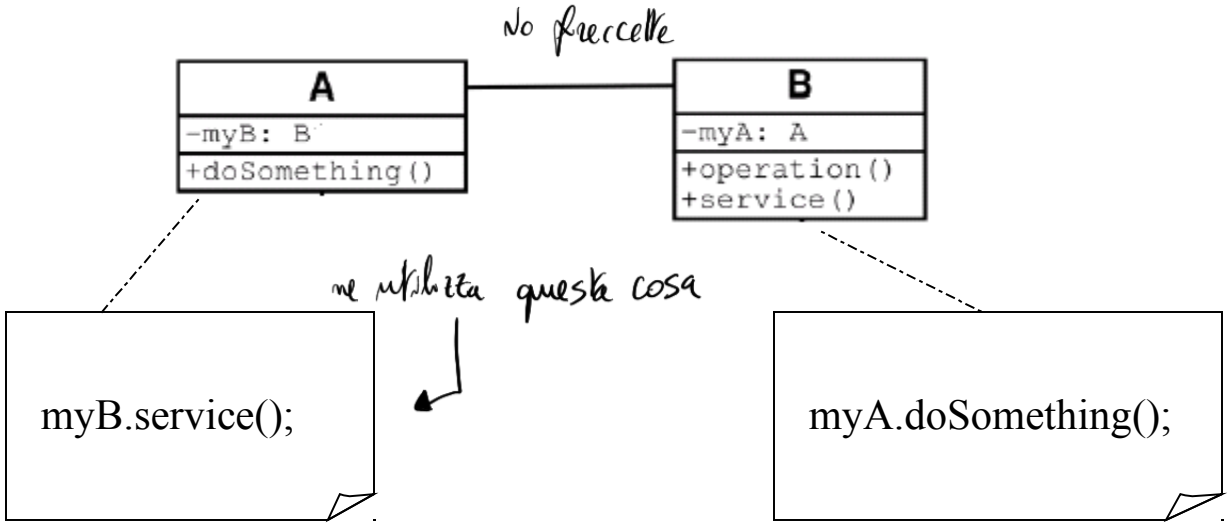
↑ Poco usato perché dipende dal linguaggio

UML Class Notation

- Lines or arrows between classes indicate relationships
  - Association ⇒ A conosce B, per esempio c'è un riferimento di B in A. C'è una comunicazione
    - A relationship between instances of two classes, where one class must know about the other to do its work, e.g. client communicates to server
    - indicated by a straight line or arrow
  - Aggregation È un'associazione in cui una classe è parte di una collez. di ogg. posseduta da un'altra classe.
    - An association where one class belongs to a collection, e.g. instructor part of Faculty Es: ruota è aggregata a auto.
    - Indicated by an empty diamond on the side of the collection ⇒ oggetto che aggrega: diamante.
  - Composition
    - Strong form of Aggregation Non solo oggetti della composta appartengono a quella classe, ma la loro esistenza dipende dall'aggregante.
    - Lifetime control; components cannot exist without the aggregate
    - Indicated by a solid diamond on the side of the collection ⇒ Es. Non può esistere la ruota senza macchina e viceversa.
  - Inheritance
    - An inheritance link indicating one class a superclass relationship, e.g. bird is part of mammal
    - Indicated by triangle pointing to superclass

Binary Association

Binary Association: Both entities "Know About" each other



Optionally, may create an Associate Class

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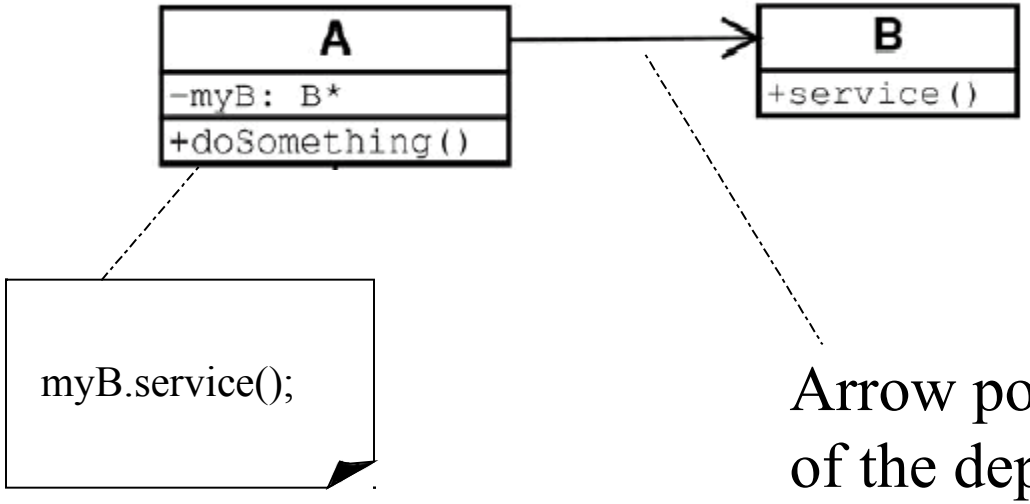
Unary Association

A knows about B, but B knows nothing about A

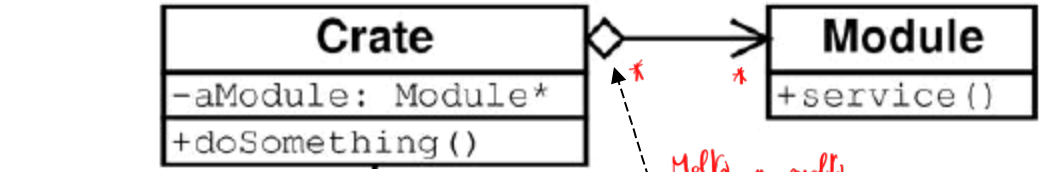


Arrow points in direction of the dependency

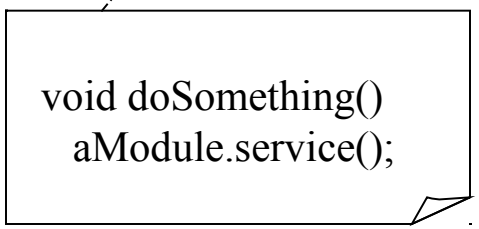
Aggregation

Posso avere più moduli contemp.

Aggregation is an association with a “collection-member” relationship



Es: Farmacoteca e quadri



Hollow diamond on the Collection side

No sole ownership implied

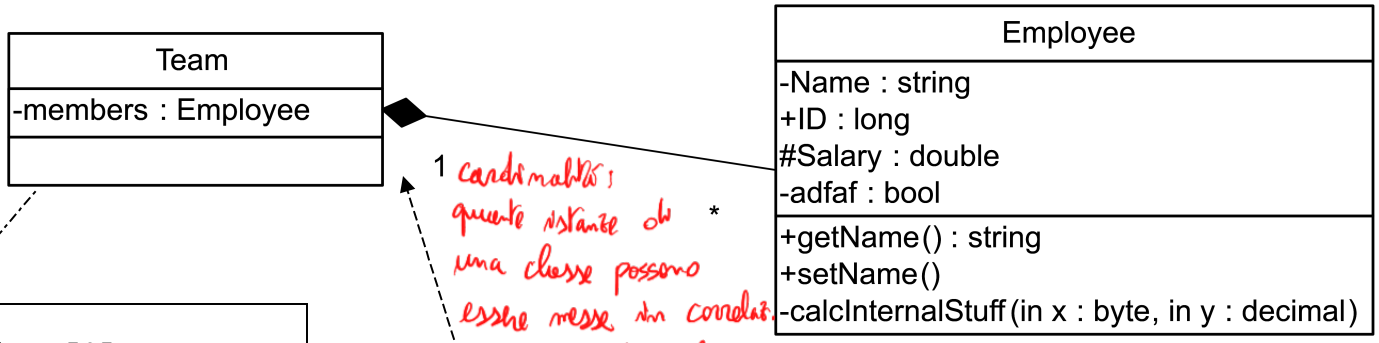
Non vuol dire che solo crate può contenerli.

Composition

Composition is Aggregation with:

- Lifetime Control (owner controls construction, destruction)
- Part object may belong to only one whole object

↳ Oggetto può appartenere a una sola collezione (una sola istanza, cosa diversa dalla prima)
1 cuore può appartenere a una sola persona



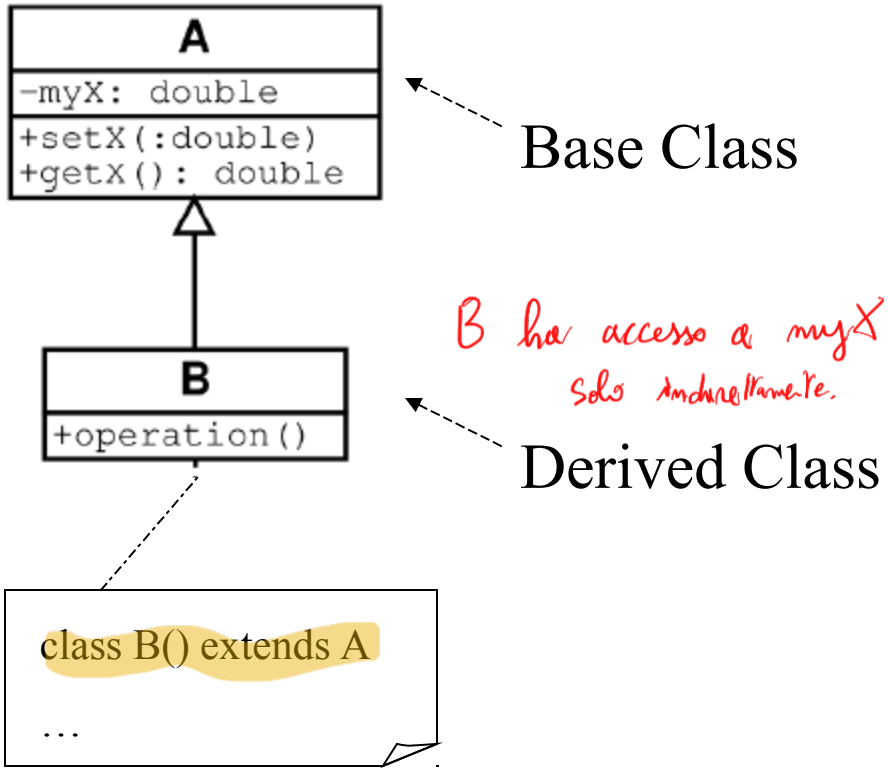

```
members[0] =
 new Employee();

…

delete members[0];
```

Filled diamond on side of the Collection

corpo umano → organs
=> new Heart(), new Brain() ... → delete Brain();

Inheritance

Standard concept of inheritance



UML Multiplicities

Tot istanze che partecipano alle associazioni

Links on associations to specify more details about the relationship

Multiplicities	Meaning
0..1	zero or one instance. The notation ***n . . m*** indicates ***n*** to ***m*** instances.
0..* *or* *	no limit on the number of instances (including none).
1	exactly one instance
1..*	at least one instance

es: ruota - macchina => 4

ruota - magazzino => 0...*

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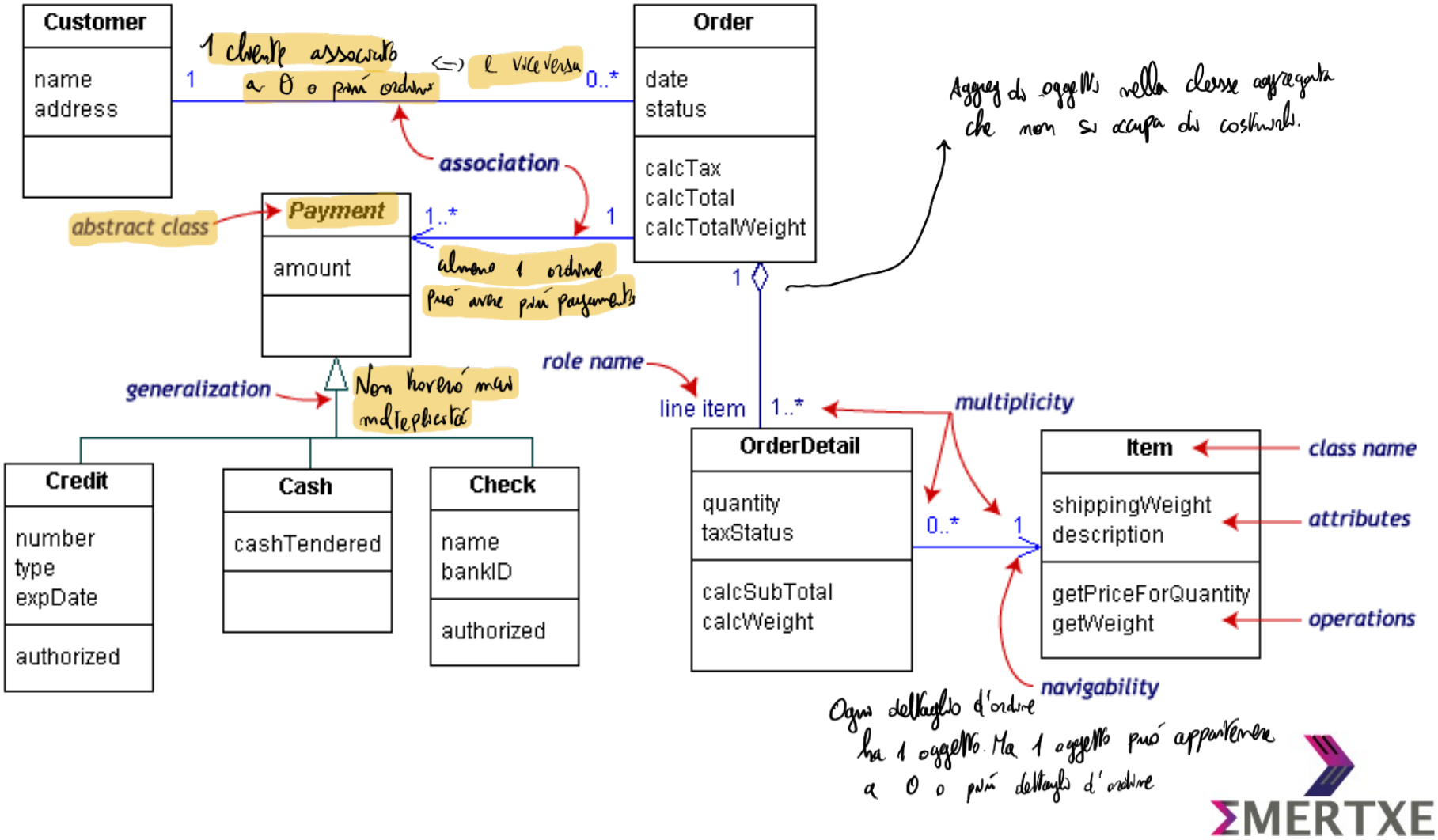
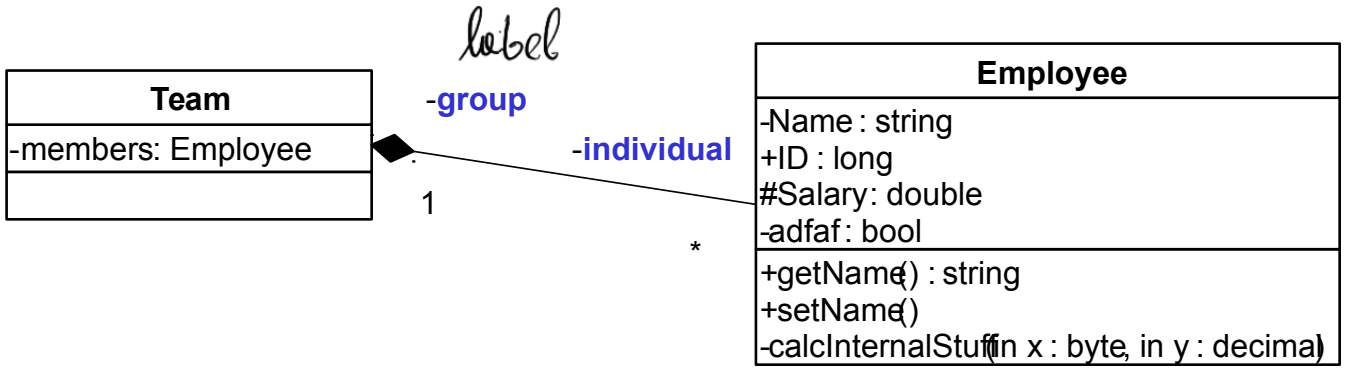
UML Class Example



Association Details

- Can assign names to the ends of the association to give further information



Static vs. Dynamic Design

- Static design describes code structure and object relations
  - Class relations
  - Objects at design time
  - Doesn't change
- Dynamic design shows communication between objects
  - Similarity to class relations
  - Can follow sequences of events
  - May change depending upon execution scenario
  - Called Object Diagrams

Comunicazioni esclusive tra classi collegate tra loro

Rappresenta degli scenari per ciò che può succedere

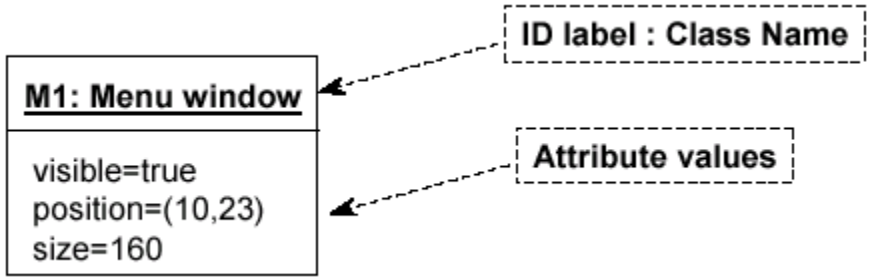
Object Diagrams

- Shows instances of Class Diagrams and links among them
  - An object diagram is a snapshot of the objects in a system
    - At a point in time : diagramma statico
    - With a selected focus
      - Interactions – Sequence diagram → generale: vedi come evolve il deployment nel tempo
      - Message passing – Collaboration diagram ↑ 2 oggetti stanno comunicando in quell'istante
      - Operation – Deployment diagram focus sulla comunicazione
      focus su dove gira cosa, chi fa funzionare
      ↑ statico
      ↳ es. server, database...

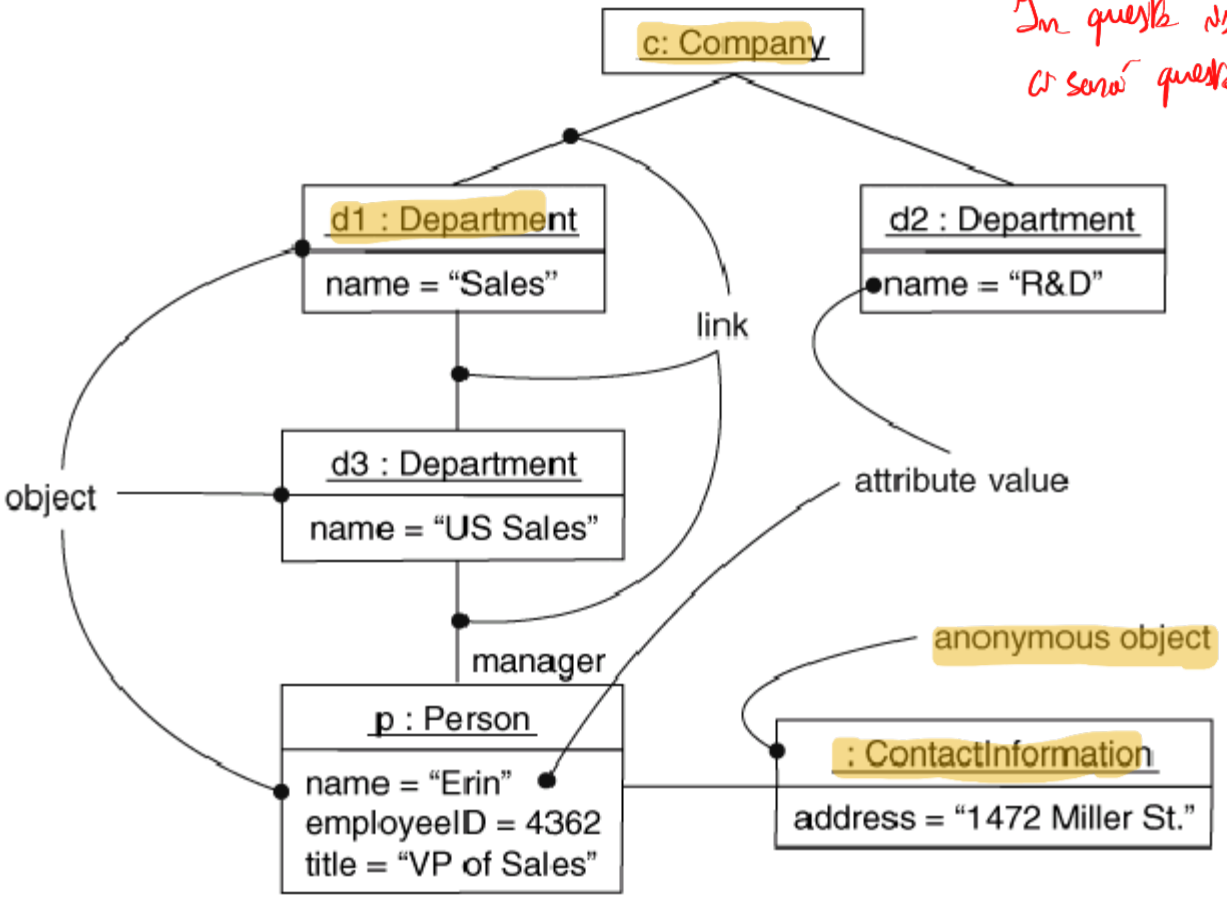
Object Diagrams

- Format is
  - Instance name : Class name
  - Attributes and Values

  - Example:



Objects and Links



In questa istanza ci sarà questo legame. x Es. perché sta mandando un messaggio

Si fa per sottolineare qualcosa di comune o importante. Es. capita spesso che ci sia questo collegamento

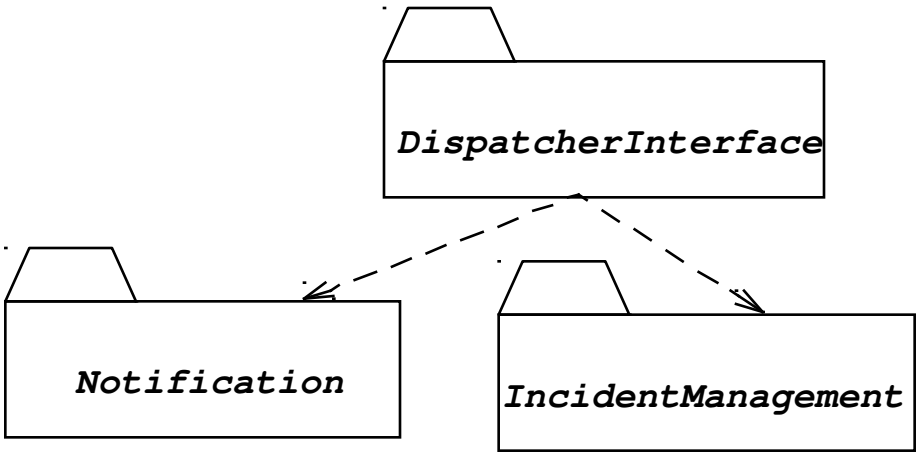
Can add association type and also message type

Package Diagrams

- To organize complex class diagrams, you can group classes into packages. A package is a collection of logically related UML elements
- Notation
  - Packages appear as rectangles with small tabs at the top.
  - The package name is on the tab or inside the rectangle.
  - The dotted arrows are dependencies. One package depends on another if changes in the other could possibly force changes in the first.
  - Packages are the basic grouping construct with which you may organize UML models to increase their readability

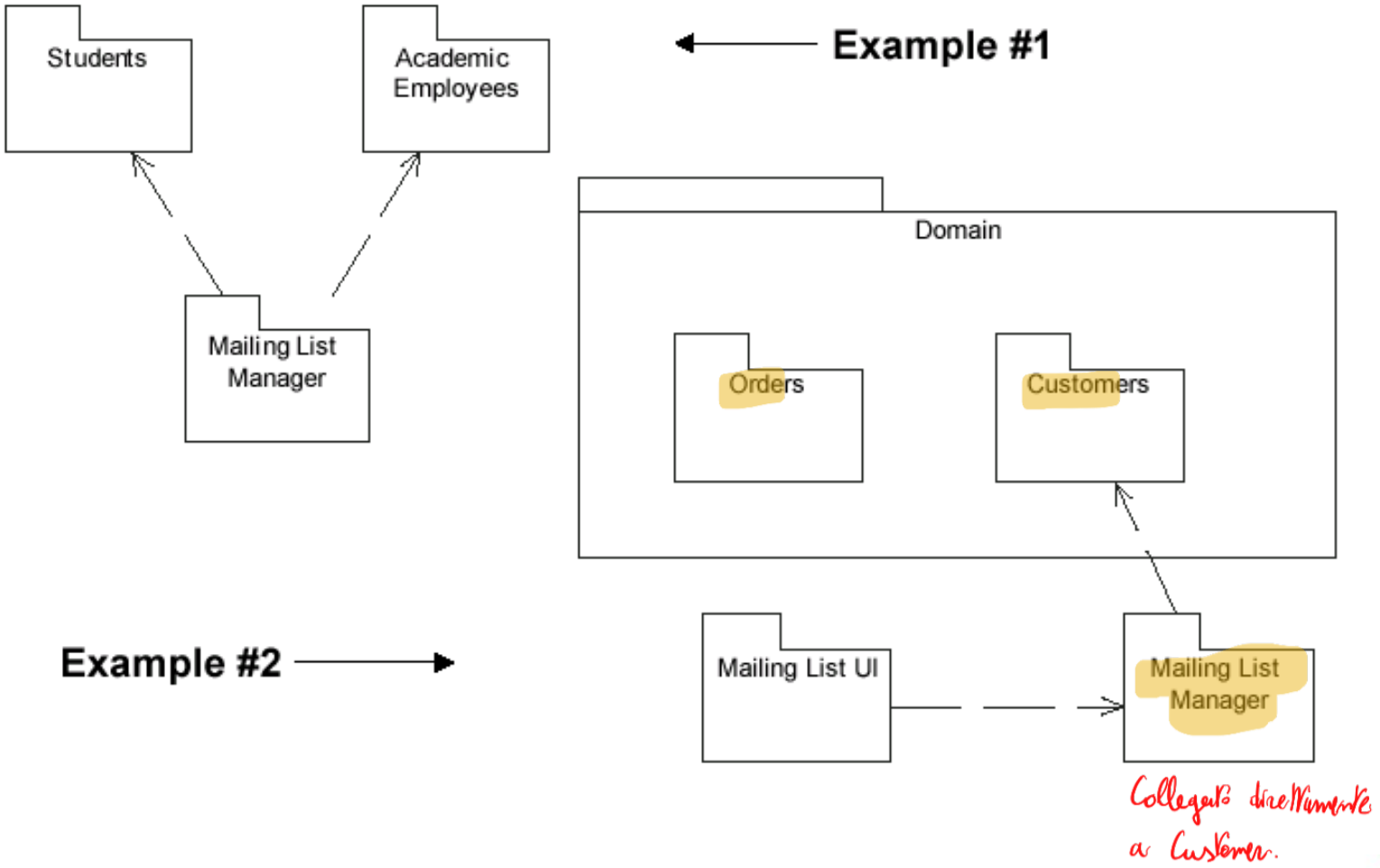
Non le esplicito nel diagramma di Package le dipendenze.

Package Example



Qui non creo un diagramma per Notification e IncidentManager

More Package Examples



Interaction Diagrams

- Interaction diagrams are dynamic -- they describe how objects collaborate.
- A Sequence Diagram:
  - Indicates what messages are sent and when
  - Time progresses from top to bottom
  - Objects involved are listed left to right
  - Messages are sent left to right between objects in sequence

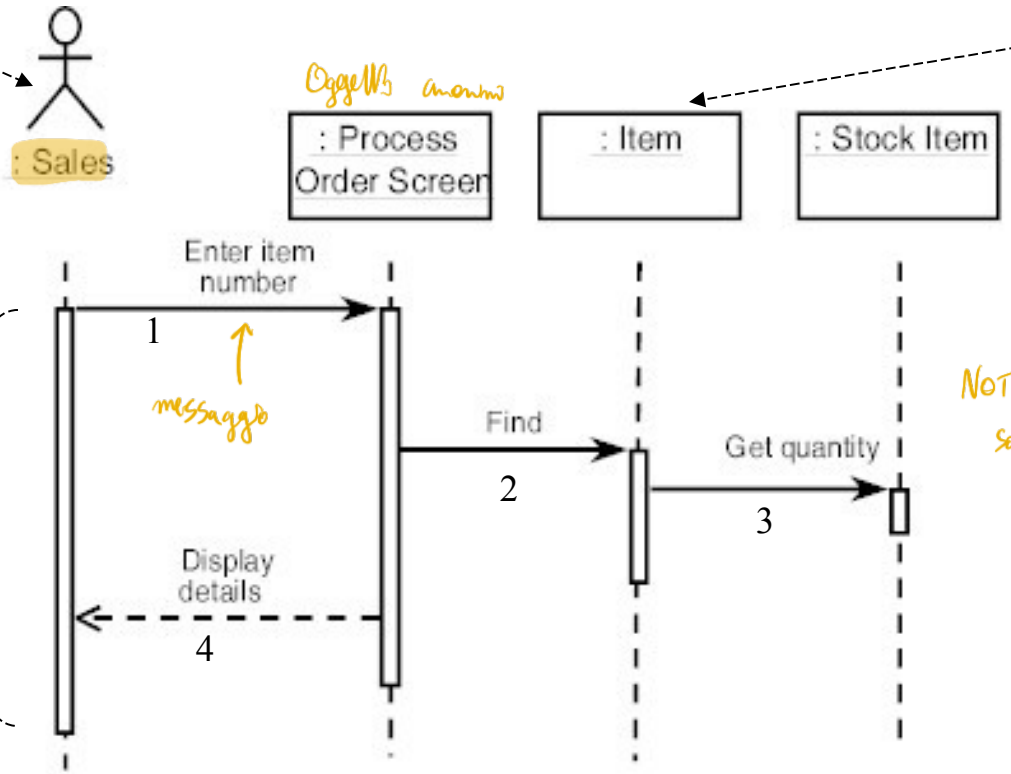
Sequence Diagram Format

Sopra ho attori e oggetti

Actor from Use Case

→ Indica che c'è un'interaz. col mondo esterno
→ Messaggio può partire da attore o da altro

Objects



Oggetti anonimi

Rettangolo: attivaz. di quell'oggetto. Sta facendo qualcosa di particolare

NOTA: Posso avere 2 rettangoli sovrapposti (es. Thread, processore...)

Activation

Lifeline

Da quando inizia la lifeline l'oggetto è creato

Calls = Solid Lines

Returns = Dashed Lines

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——→ MESSAGGIO SINCRONO: richiede sempre che ci sia una risposta.

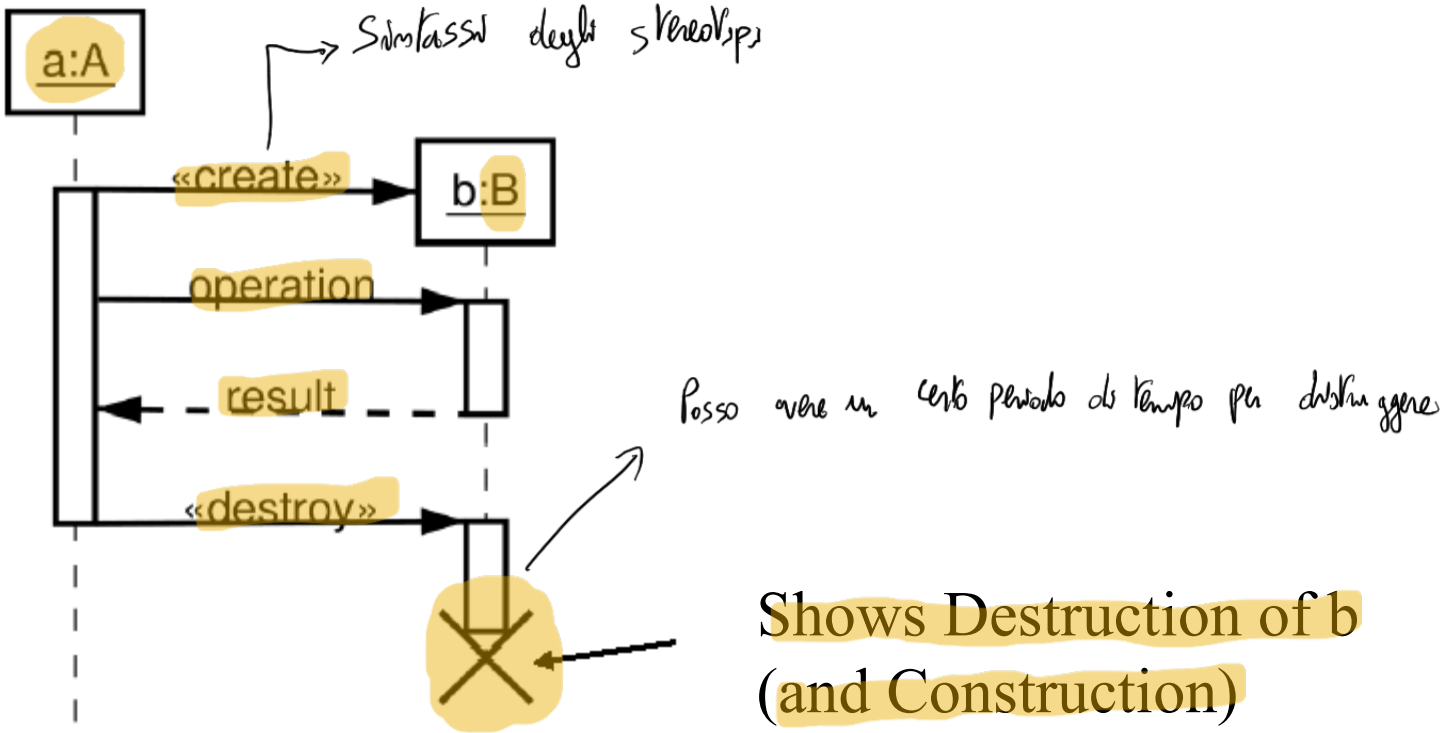
- - - - - → MESSAGGIO DI RISPOSTA

MESSAGGI ESTERNI: Non si sa chi li manda e a chi sono diretti:
esistono nel diagramma di analisi di base.

NOTA: nei diagrammi semplici e non nei dettagliati posso evitare la diff. tra sincrono e asincrono.

NOTA 2: nomi dei messaggi devono essere presenti nella classe corrispondente all'oggetto ricevente.
Uno chiama un metodo di un altro.
Eccez: altro può chiamare azioni non presenti nell'oggetto.

Sequence Diagram: Destruction

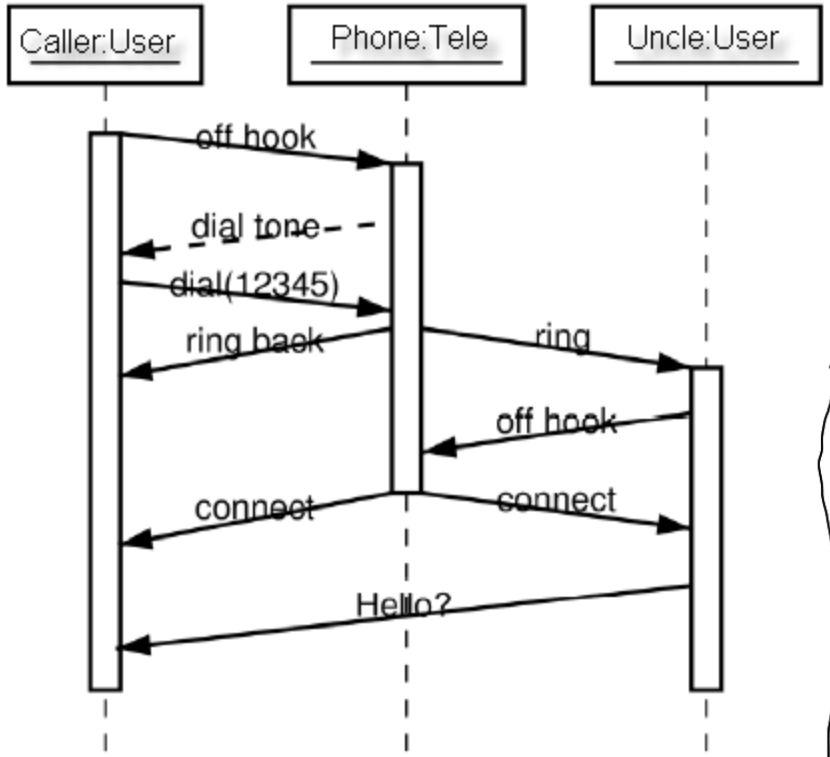


Shows Destruction of b (and Construction)

Sequence Diagram: Timing

Slanted Lines show propagation delay of messages

Good for modeling real-time systems



Attore gestito con classe

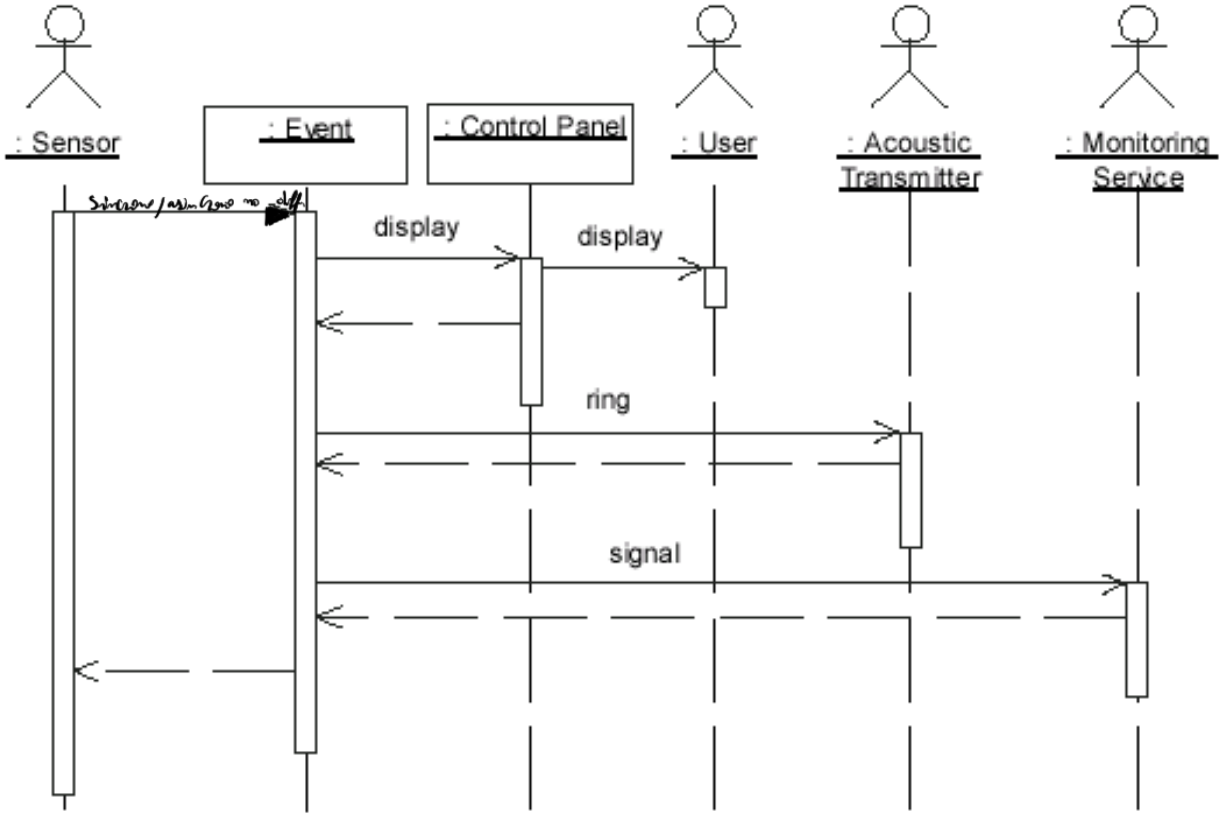
Se ho se 2 oggetti devono accedere alla stessa risorsa per fare elaborazione. A chi do' precedenza? E se il primo cambia qualcosa per il secondo che so fa?

È rischioso perché devo impedire il fright della race condition

If messages cross this is usually problematic – race conditions

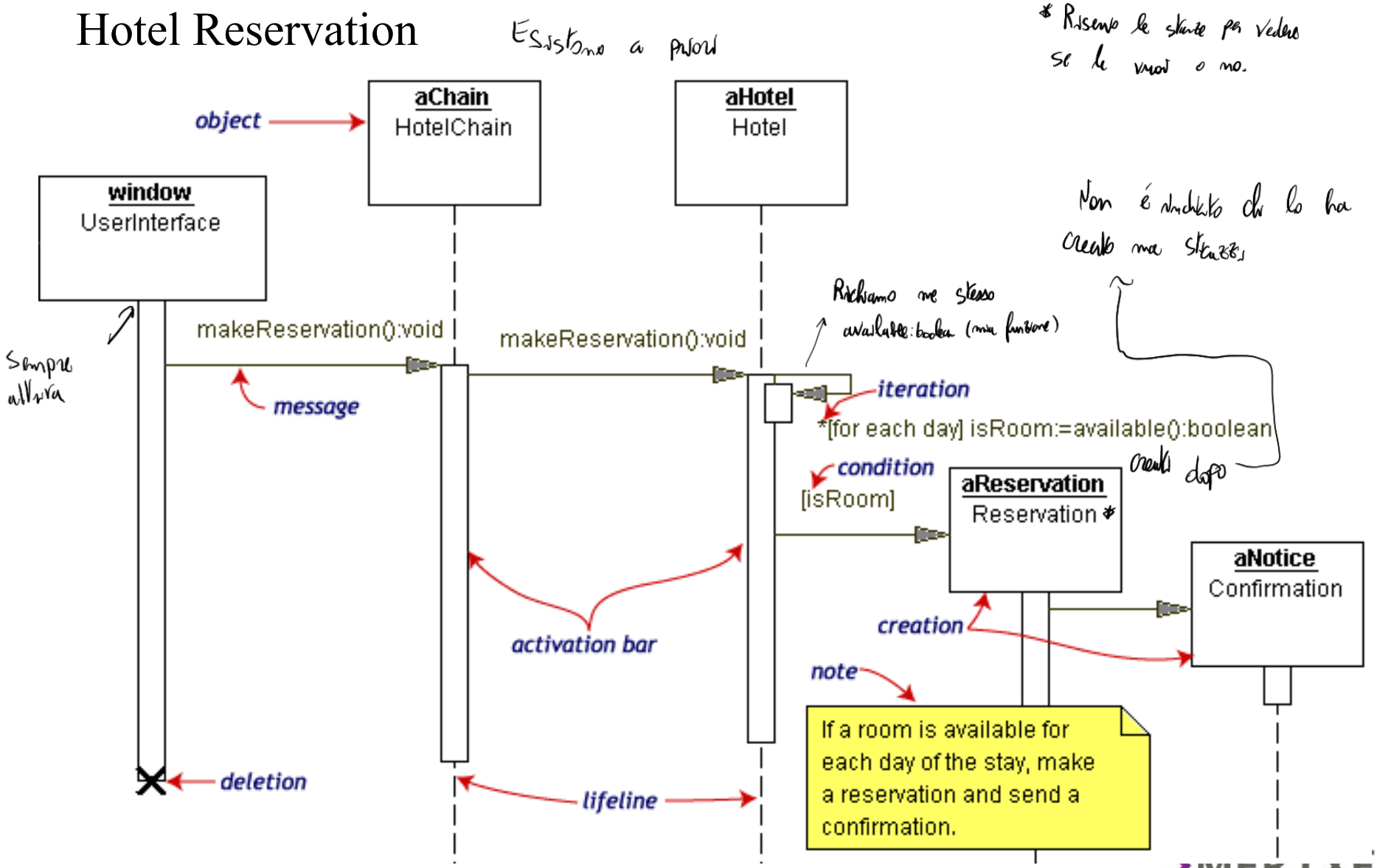
Sequence Example: Alarm System

- When the alarm goes off, it rings the alarm, puts a message on the display, notifies the monitoring service



Sequence Diagram: Example

Hotel Reservation



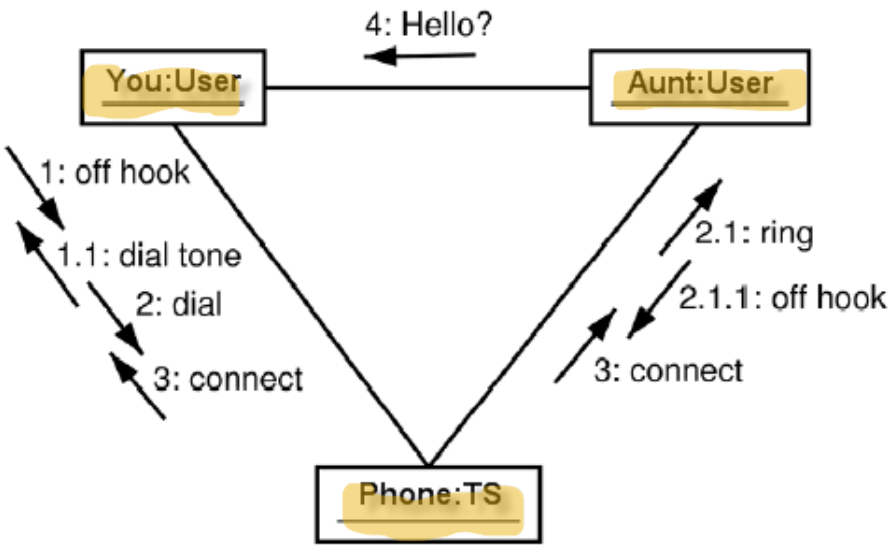
Collaboration Diagram

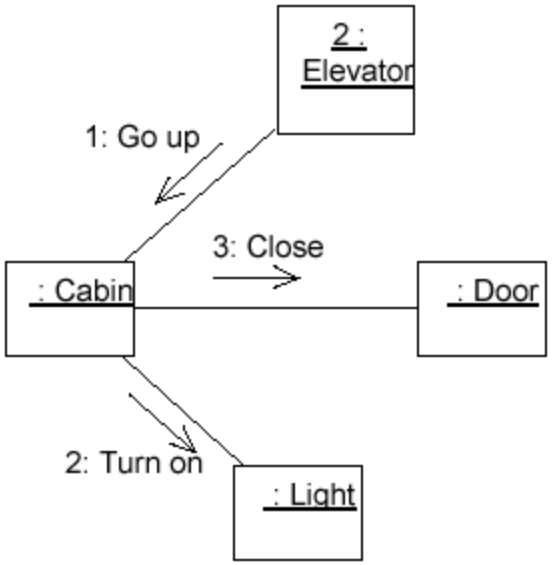
- Collaboration Diagrams show similar information to sequence diagrams, except that the vertical sequence is missing. In its place are:
  - Object Links - solid lines between the objects that interact
  - On the links are Messages - arrows with one or more message name that show the direction and names of the messages sent between objects
- Emphasis on static links as opposed to sequence in the sequence diagram

Sequence si focalizza sulla sequenza temporale, qui ci concentriamo sul messaggio stesso. Interessa più quello.

Collaboration Diagram

Perde il focus sulla sequenza temporale; più difficile da leggere: interessa il collegamento





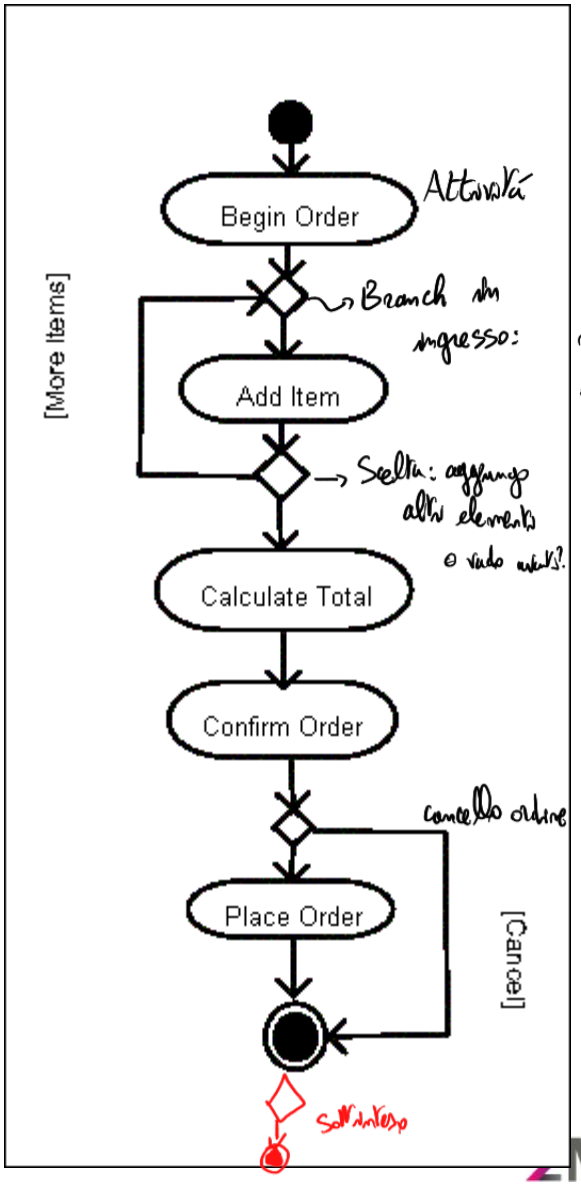
Un po' meno riferibile

Activity Diagrams

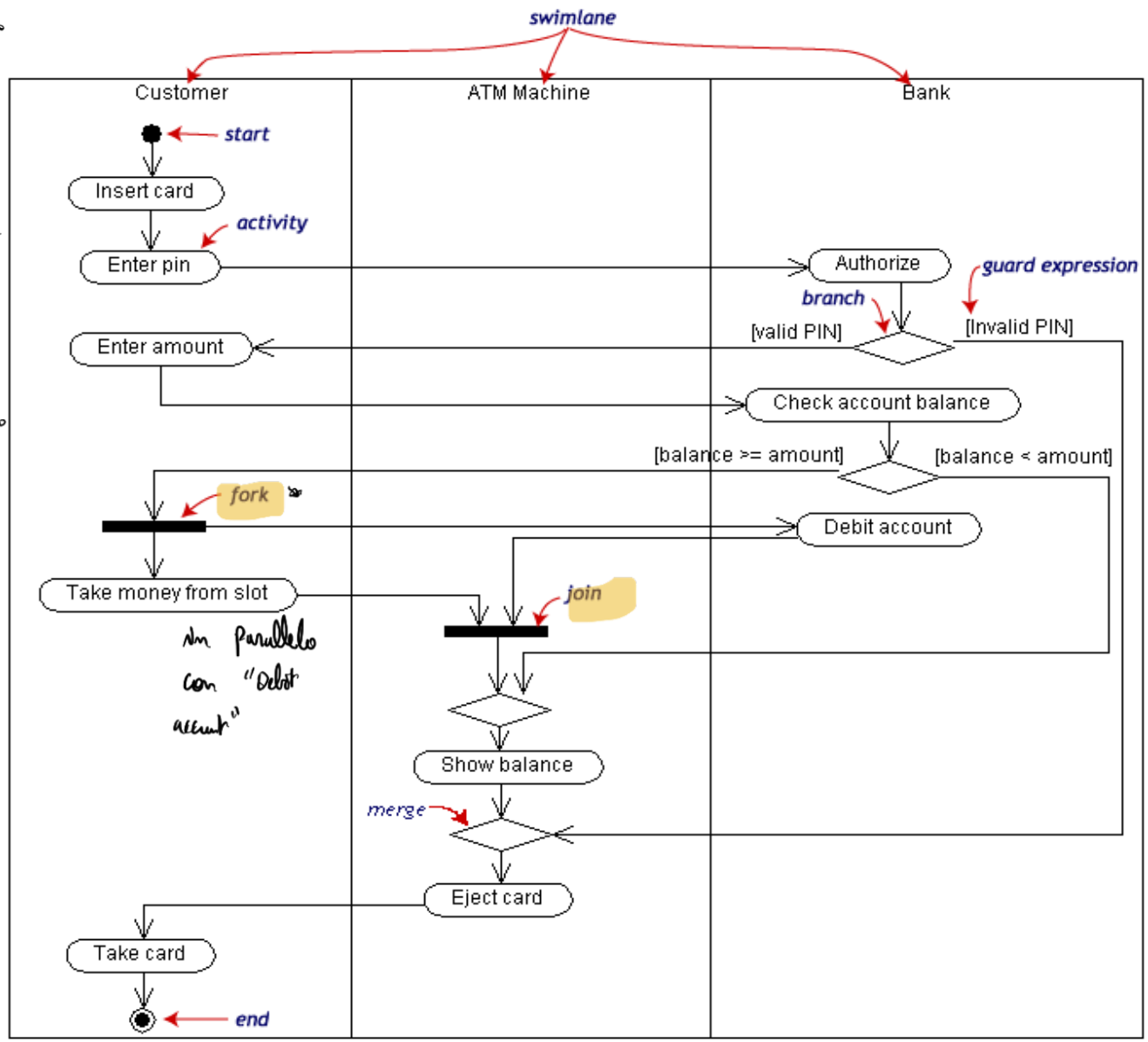
- Fancy flowchart
  - Displays the flow of activities involved in a single process
  - States
    - Describe what is being processed
    - Indicated by boxes with rounded corners
  - Swim lanes
    - Indicates which object is responsible for what activity
  - Branch
    - Transition that branch
    - Indicated by a diamond
  - Fork
    - Transition forking into parallel activities
    - Indicated by solid bars
  - Start and End

Sample Activity Diagram

- Ordering System
- May need multiple diagrams from other points of view



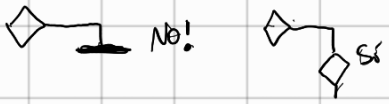
Activity Diagram: Example



Regola: Se c'è una fork ci deve essere una join.

Se c'è un diamante che apre deve quello che chiude.

(Branch) (Merge)



State Transition Diagrams

Concetto di automa a stati finiti è lo stesso

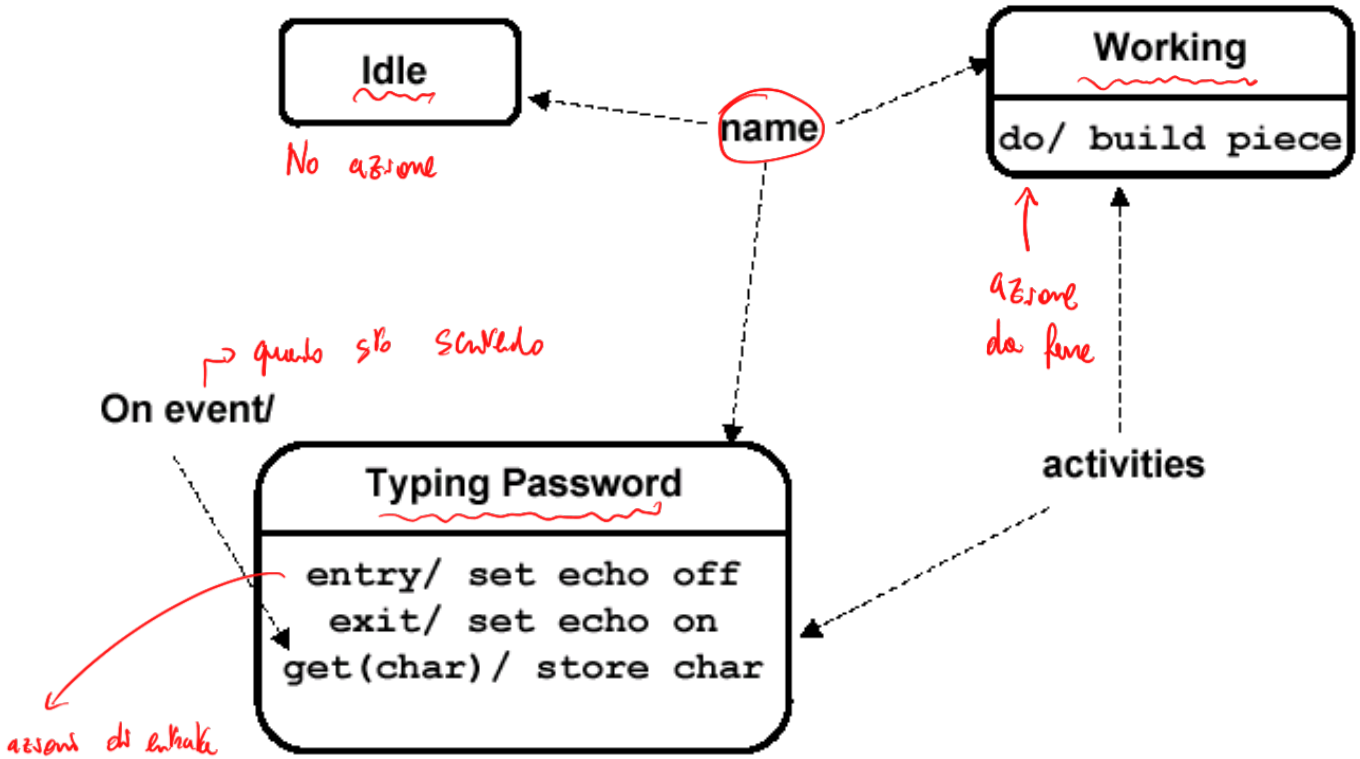
- Fancy version of a DFA
- Shows the possible states of the object and the transitions that cause a change in state
  - i.e. how incoming calls change the state
- Notation
  - States are rounded rectangles
  - Transitions are arrows from one state to another. Events or conditions that trigger transitions are written beside the arrows.
  - Initial and Final States indicated by circles as in the Activity Diagram
    - Final state terminates the action; may have multiple final states

In genere 1 stato iniziale, ma anche più stati finali

State Representation

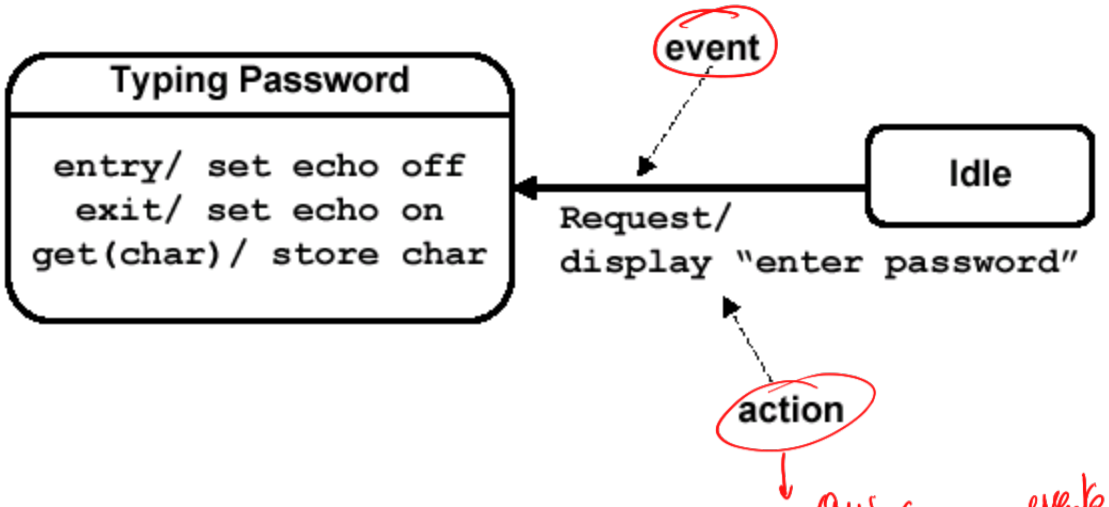
- The set of properties and values describing the object in a well defined instant are characterized by
  - Name
  - Activities (executed inside the state)
    - Do/ activity
  - Actions (executed at state entry or exit)
    - Entry/ action
    - Exit/ action
  - Actions executed due to an event
    - Event [Condition] / Action ^Send Event

Notation for States



Attività: si ripete continuamente, azione di ingresso, uscita o durante un evento.

Simple Transition Example



qui con evento di richiesta si passa da idle a typing pw.

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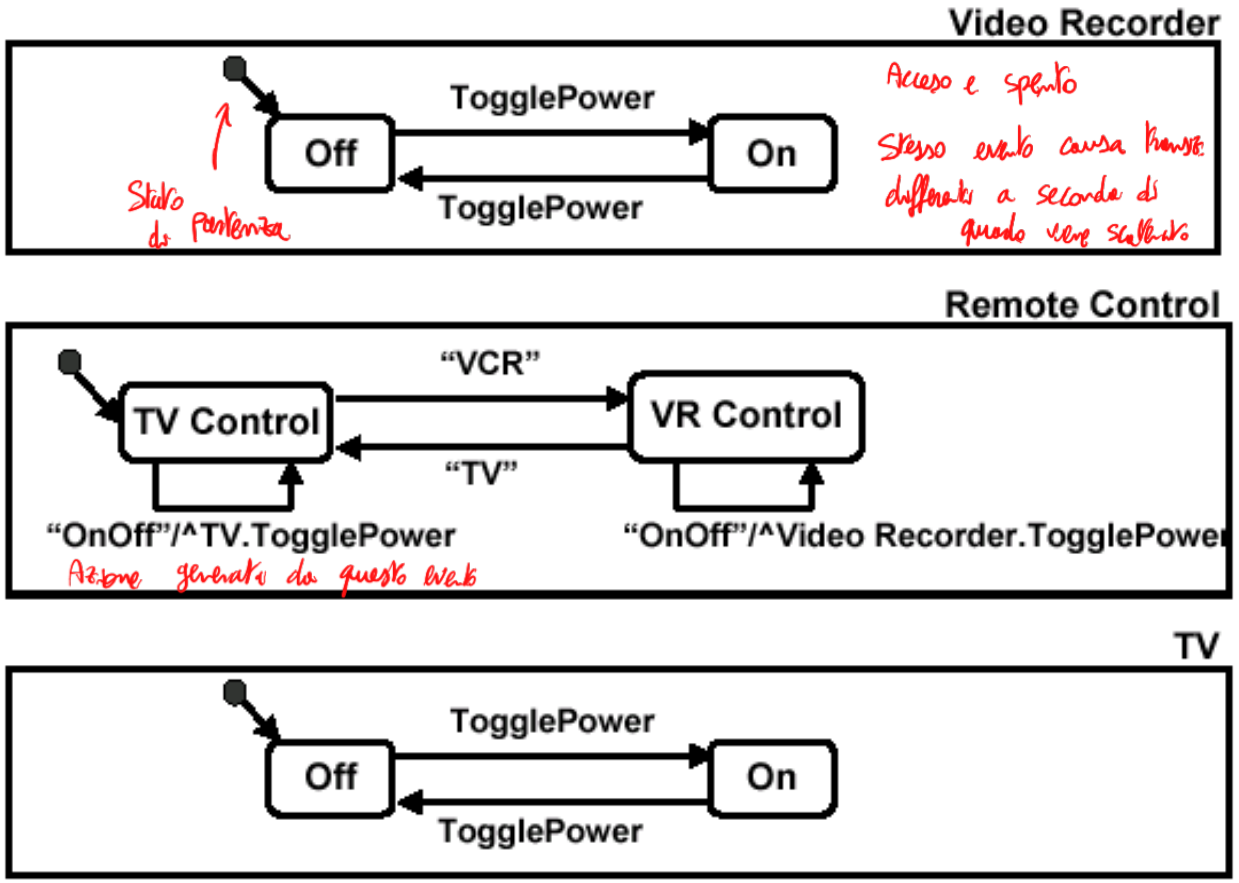
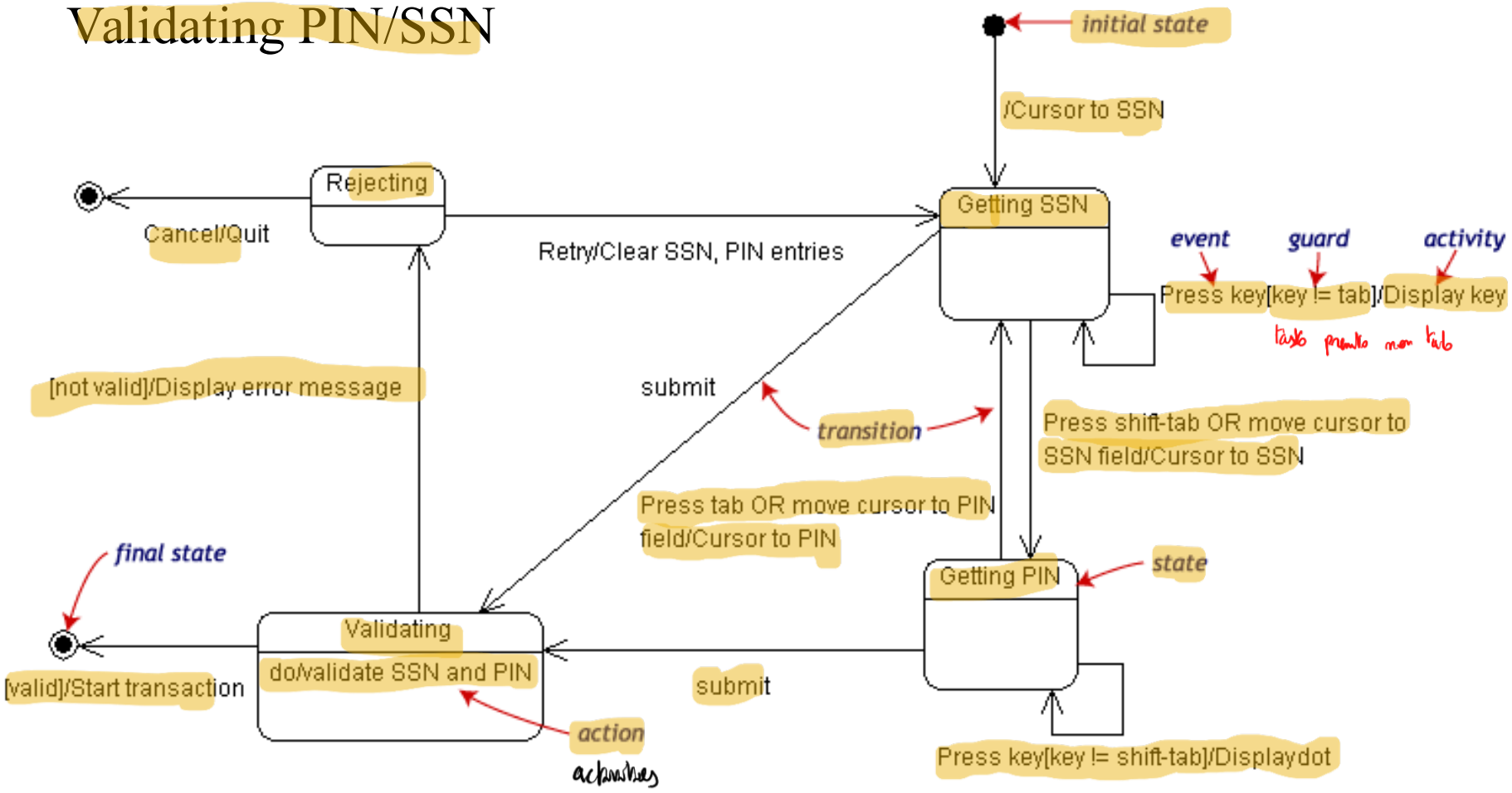
Simple State Examples...



Utile la freccia quando voglio re-triggerare entry-exit.

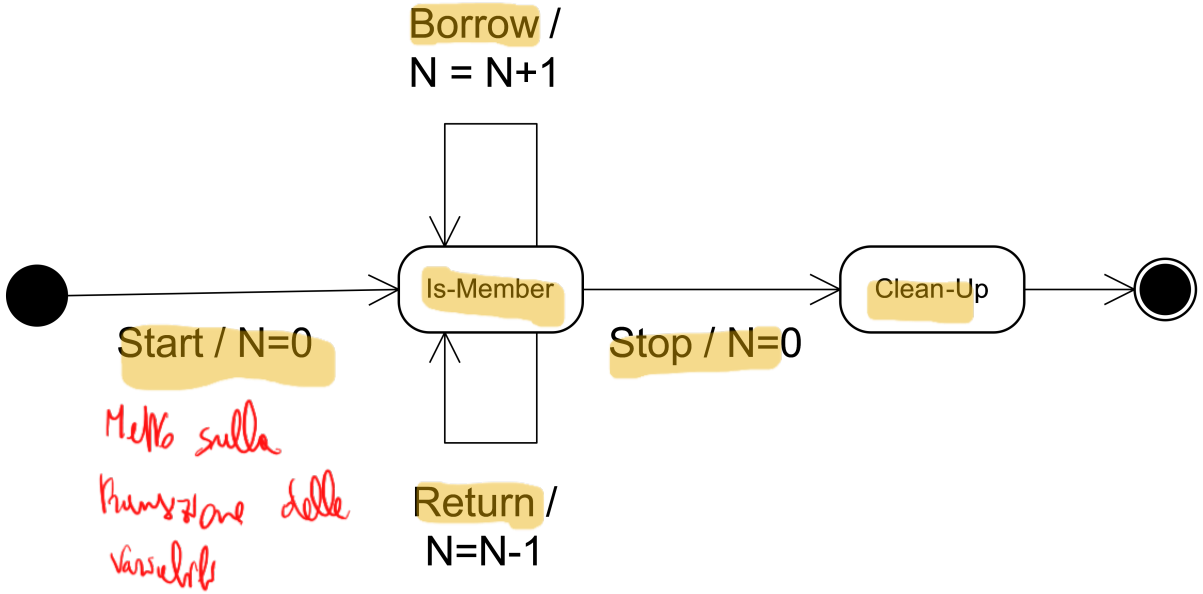
State Transition Example

Validating PIN/SSN



State Charts: Local Variables

- State Diagrams can also store their own local variables, do processing on them
- Library example counting books checked out and returned

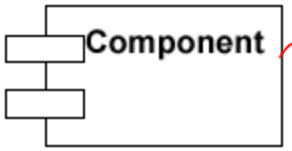


Component Diagrams

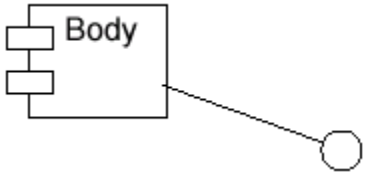
- Shows various components in a system and their dependencies, interfaces
- Explains the structure of a system
- Usually a physical collection of classes
  - Similar to a Package Diagram in that both are used to group elements into logical structures
  - With Component Diagrams all of the model elements are private with a public interface whereas Package diagrams only display public items.

Component Diagram Notation

- Components are shown as rectangles with two tabs at the upper left



- Dashed arrows indicate dependencies
- Circle and solid line indicates an interface to the component



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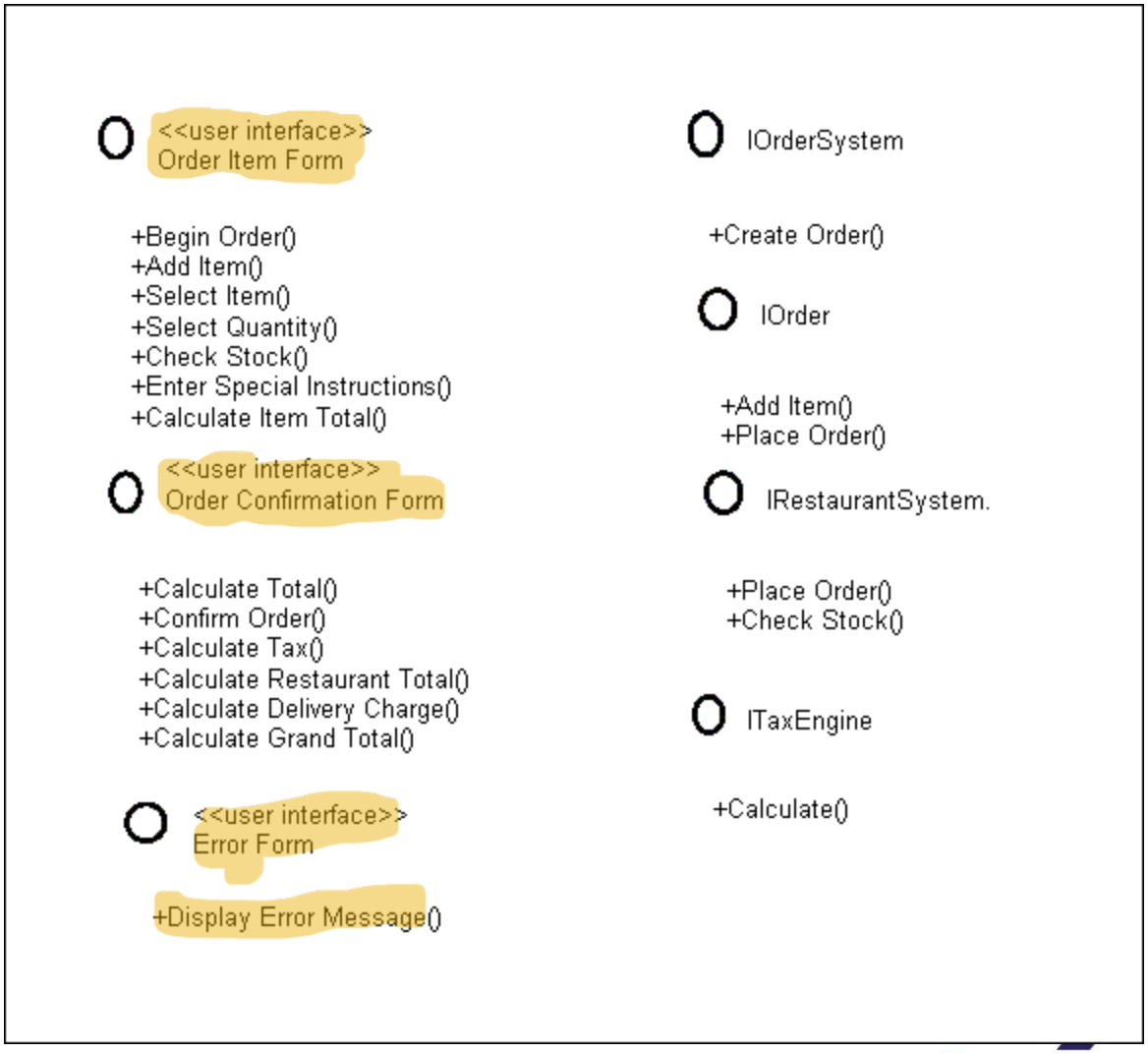
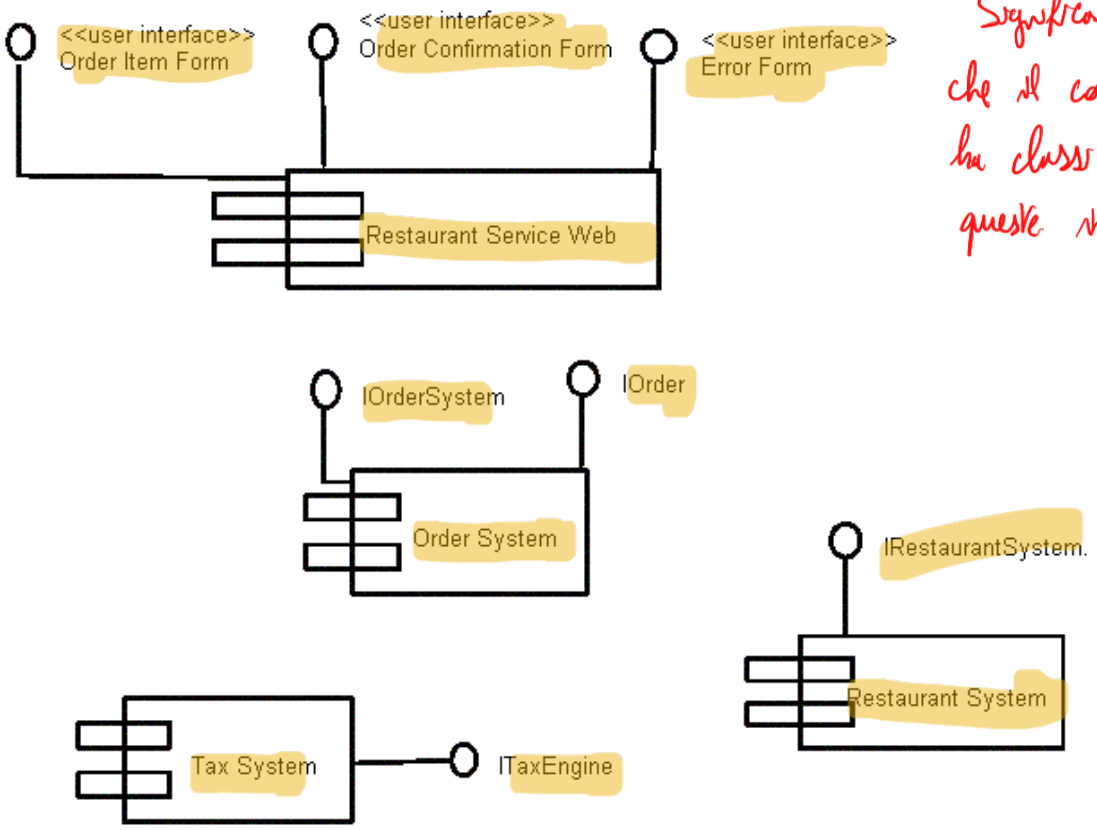
Component Example: Interfaces

- Restaurant ordering system
- Define interfaces first – comes from Class Diagrams



Component Example: Components

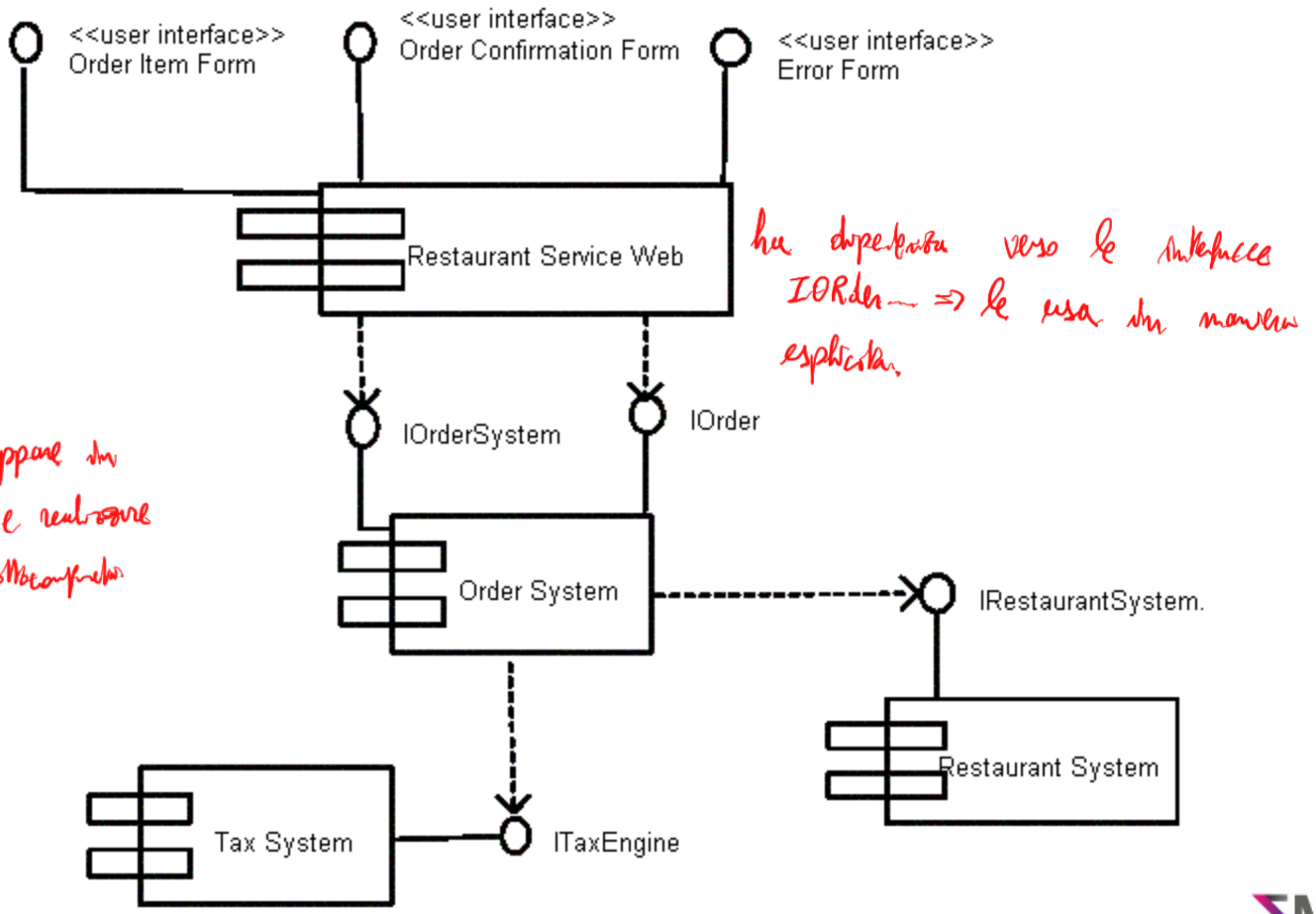
- Graphical depiction of components



Significa che il componente ha classi che implementano queste interfacce

Component Example: Linking

- Linking components with dependencies



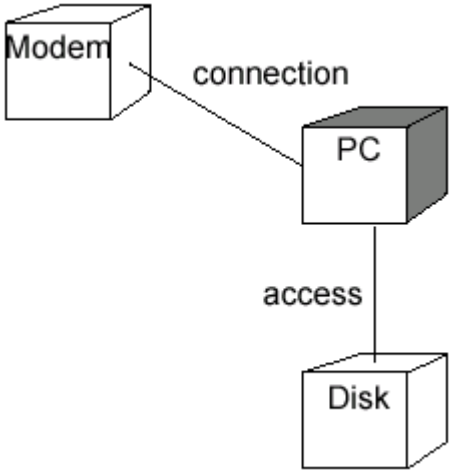
ha dipendenza verso le interfacce IOrder... => le usa in maniera esplicita.

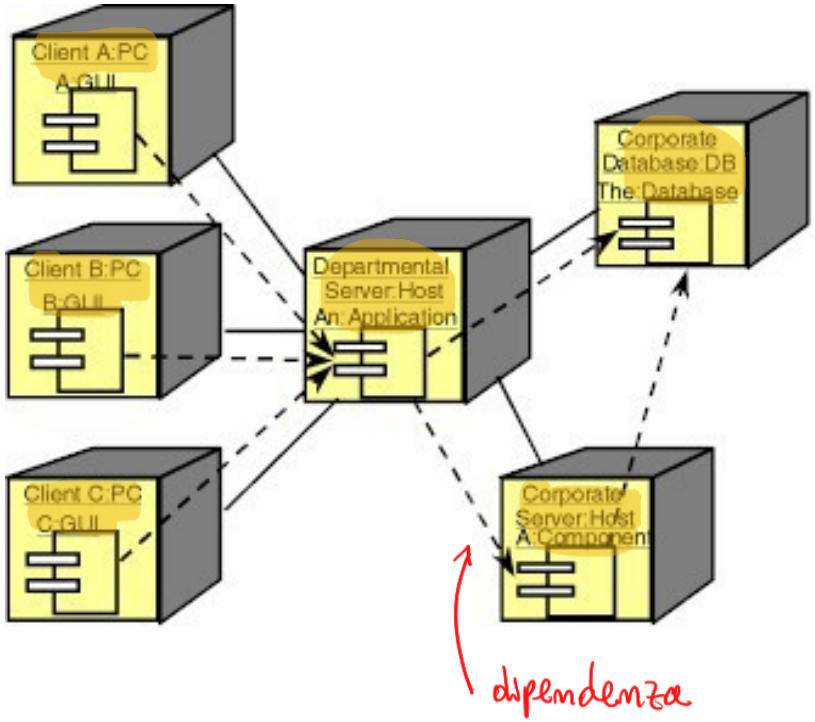
Posso anche raggruppare in grande componente e realizzare dipendenze con sottocomponenti

Deployment Diagrams

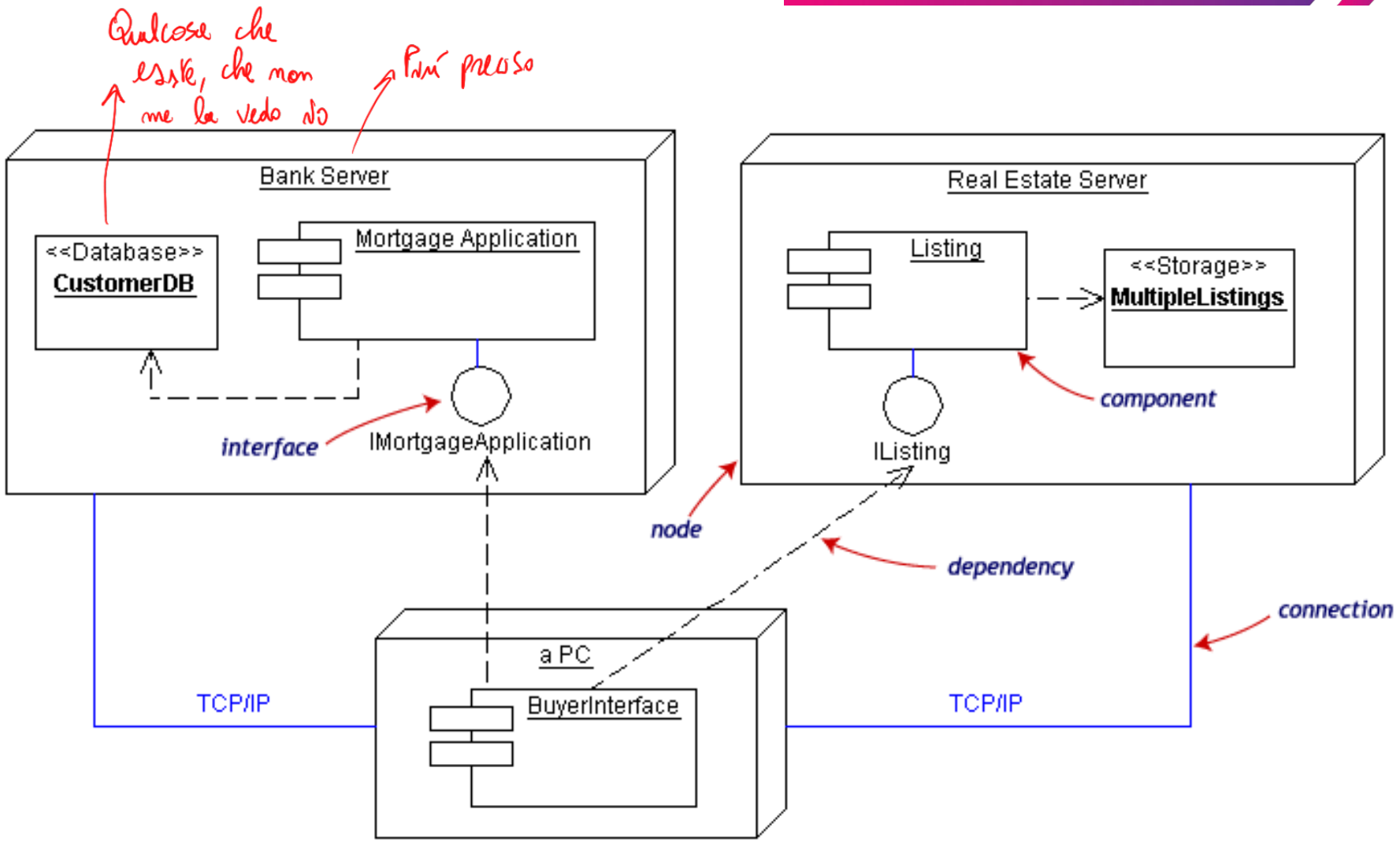
- Shows the physical architecture of the hardware and software of the deployed system
- Nodes
  - Typically contain components or packages
  - Usually some kind of computational unit; e.g. machine or device (physical or logical)
- Physical relationships among software and hardware in a delivered systems
  - Explains how a system interacts with the external environment

Deployment Examples





Deployment Example



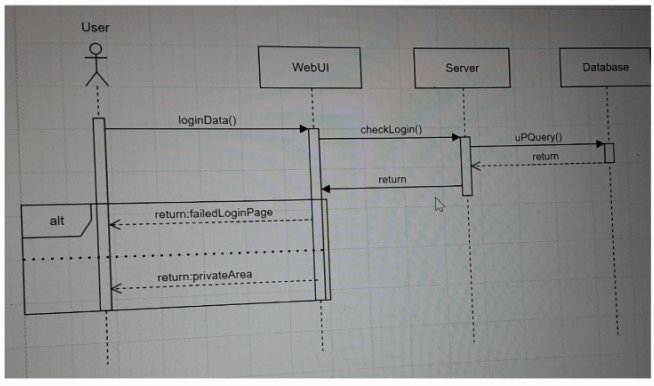
Often the Component Diagram is combined with the Deployment

Summary and Tools

- UML is a modeling language that can be used independent of development
- Adopted by OMG and notation of choice for visual modeling
  - http://www.omg.org/uml/
- Creating and modifying UML diagrams can be labor and time intensive.
- Lots of tools exist to help
  - Tools help keep diagrams, code in sync
  - Repository for a complete software development project
  - Examples tools Microsoft Visio, Dia

Thank You

- Messaggio sincrono aspetta sempre una RETURN
- Esiste REF che chiama altri diagrammi delle sequenze
- NOTA:



Questo è un chiaro esempio di Responsibility!

- Nei diagrammi di design bisogna sostituire il più possibile gli attori con oggetti.
  Attori possono ricevere solo return di MESSAGGI CHIARI (es: "login effettuato con successo")