

Please note that the slides published AFTER the lectures and workshops are the official slides and are the ones that should be used for revision.



# COMP2013

## Software Maintenance

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Lectur

OO Analysis/Design with UML

Peer-Olaf Siebers

# Topics



- Lecture

- OO Analysis and Design (OOA/D) with UML
- Lab reflections

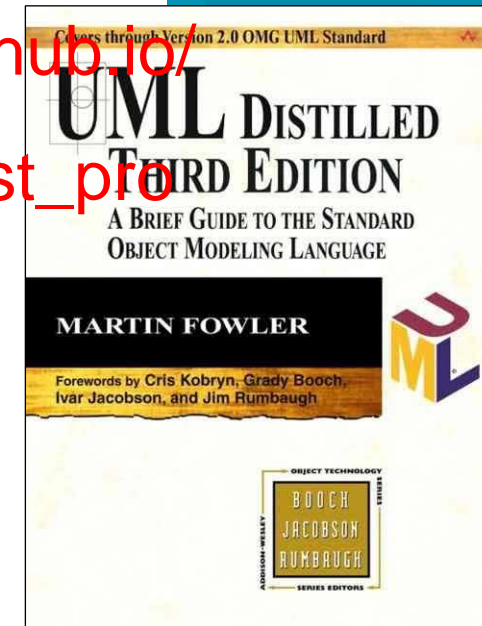
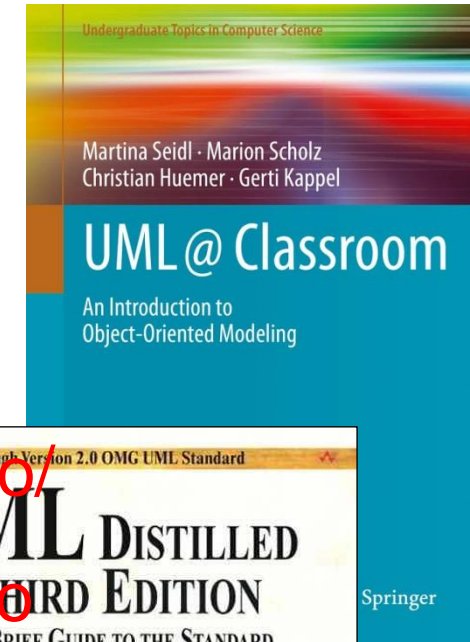
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- Lab:

- Group activity: Designing a software with the

- Workshop:

- Being agile in SWM
- Communication in teams





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# unified modelling language

# UML (Unified Modelling Language)



- UML: "A specification defining a graphical language for visualizing, specifying, constructing, and documenting the artifacts of distributed object systems."

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<https://www.omg.org/spec/UML/About-UML/>

- Latest Version: 2.5.1 (Dec <https://eduassistpro.github.io/>)

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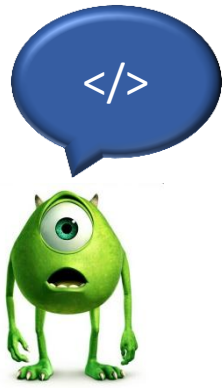


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# Why UML?



- Advantages of using UML:

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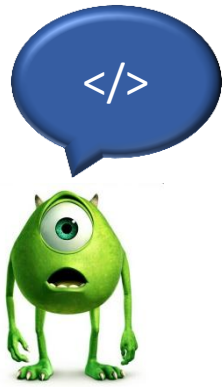


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# Why UML?



- Advantages of using UML:
  - Enhances communication and ensures the right communication
  - Captures the logical software architecture independent of the implementation language
  - Helps to manage the compl
  - Enables reuse of design

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# case studies

# Example: Library Booking System



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# Example: Library Booking System



- Library Rules

- The library contains books and journals; it may have several copies of a given book; some are for short term loan only, the others can be borrowed by any library member for three weeks
- Normal members can borrow 5 books at a time, staff members up to 12
- Only staff members can borrow books

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- System Requirement

- The system must keep track of when books and journals are borrowed and returned, enforcing the rules described above

# Example: Library Booking System



- Our Job: Development of a Library Booking System

- After discussing priorities with the university we decided that the first iteration of the system should consider the followi

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- As a university member I want to be able to b a book
- As a university member I want to be able to re book
- As a university staff member I want to be able to borrow a journal
- As a university staff member I want to be able to return a journal

# Activity: Fleet Logistics Management



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# Activity: Fleet Logistics Management



- User stories

- As a client I want to be able to check availability of lorries
- As a client I want to be able to track cargo

- As a manager I want to be

- As an admin I want to be a

- As an admin I want to be able to organise route

- As an admin I want to be able to track lorries

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# ooa/d process

# "Use Case Driven" OOA/D Process



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# object oriented a is

# Use Case Diagrams



- Use case diagrams
  - Behaviour diagrams used to describe a **set of actions** (use cases) that some system or systems (subject) should or can perform in collaboration with one or more **external users** of the system (actors)
  - They do **not** make any attempt to describe the **number of times** that the systems actions and sub-actions should be performed
- Use case diagram components:
  - Actors
  - Use cases
  - System boundary
  - Relationships

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# Use Case Diagrams



- Actors

- Entities that interface with the system
- Can be people or other systems
- Think of actors by consider

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- Use cases

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- Based on user stories (derived from discussions with stakeholders)
- Represent what the actor wants your system to do for them
- In the use case diagram only the use case name is represented; in a use case specification each use case is formally described
  - Formal description must be a complete flow of activity (from the actors point of view) that provides observable and valuable result to the actor(s)

# Use Case Diagrams



- Relationship between use case and actor:
  - Associations indicate which actors **initiate** which use cases
- Relationship between two use cases
  - Specifying common functionality and simplifyi
  - Using `<<include>>` or `<<extend>>`

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# Use Case Diagrams



- <<include>>

- Multiple use cases share a piece of same functionality which is placed in a separate use case rather than documented in every use case that needs it
- One use case is a functional requirement
- The dependent use case ultimately uses the use case

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- <<extends>>

- Use when activities might be performed as part of another activity but are not mandatory for a use case to run successfully
- We are adding more capability

# Example: Library Booking System



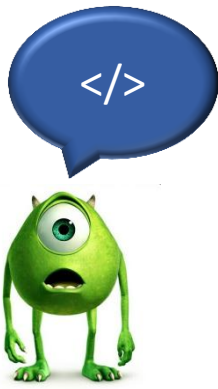
- Reminder
  - The library contains books and journals; it may have several copies of a given book; only staff members can borrow journals

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# Activity: Fleet Logistics Management



- Use Case Diagram?

- Reminder

- Client wants to check availability
    - Admin wants to search for

Manager wants to see the finances.  
of track lorries and cargo

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# Use Case Specification



- Use case specification elements

- Use case name
- Use case purpose
- Pre-condition(s)
- Base Path (optimistic flow)
- Alternative Paths (pragmatic flows)
- Post-condition(s)

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# Use Case Specification



- Base and alternative path:

- Base Path (optimistic flow)
  - "happy day" scenario

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- Alternative Paths (pragmatic flows)
  - Every other possible way the system can be used
  - Includes perfectly normal alternative use, but also errors and failures

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# Example: Library Booking System



- Use Case: Borrow copy of books

- Purpose:
  - The Book Borrower borrows a copy of the book from the Library Booking System
- Pre-condition(s):
  - The book must exist
  - The book must be available

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# Example: Library Booking System



- Use Case: **Borrow copy of books**

- Base Path (optimistic flow)

1. LBS requests membersh
2. BB provides membershi
3. BB is logged in by LBS
4. LBS checks permissions /-eobcs
5. LBS asks for presenting a book
6. BB presents a book
7. LBS scans RFID tag inside book
8. LBS updates records accordingly
9. LBS disables anti-theft device
10. BB is logged out by LBS
11. LBS confirms that process has been completed successfully

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BB = Book Borrower

LBS = Library Booking System

# Example: Library Booking System



- Use Case: **Borrow copy of books**

- Alternative Paths (pragmatic flows)
  - BB's card has expired: Step 3a: LB that card has expired; LBS must exit the use case
  - LBS cannot read membership card: Step 3a: LB a message that card could not be read correctly; LBS must go back to Step 1
  - ...
- Post-condition(s):
  - The member has successfully borrowed the book
  - The system is up to date

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# Activity: Fleet Logistics Management



- Use Case: **Search for Information**

- Use case: **Assignment Project Exam Help**

- Search for Information

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- Purpose:

- Admin can search the DB for any kind of information, including courses and jobs

- Pre-condition(s):

- Admin has to be logged in

# Activity: Fleet Logistics Management



- Use Case: Search for Information

- Base Path (optimistic flow)
  1. Admin opens search window
  2. Admin defines query using <https://eduassistpro.github.io/>
  3. Admin sends query to DB
  4. DB deals with query: finding results
  5. DB deals with query: organising them by relevance
  6. DB sends results back
  7. DB requests confirmation that result is sufficient
  8. Admin confirms that result is sufficient
  9. DB closes search window

# Activity: Fleet Logistics Management



- Use Case: Search for Information

- Alternative Paths (pragmatic flows)
  - Admin has not received t  
Admin must go back to St
  - DB is not accessible: Step 3a: DB returns warni  
needs to be left
- Post-condition(s):
  - The admin has retrieved the required information

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# Activity Diagrams



- Activity diagram
  - Graphical representations of workflows of stepwise activities and actions related to an individual use case or across many use cases
  - Supports parallel behaviour

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# Activity Diagrams



- Activity diagram components
  - Activities: A state that is left once the activity is finished
  - Activity edge: Transition that fires when previous activity completes
  - Synchronisation bar: Describes ties
  - Decision diamond: Used to
  - Start and stop markers: Used to define entry
  - Swim lane: A way to group activities performed by an actor on an activity diagram or to group activities in a single thread

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# Example: Library Booking System

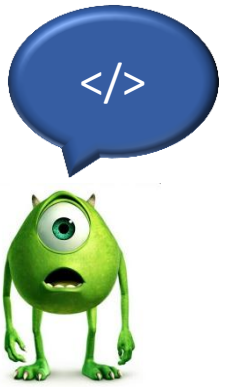


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# Activity: Fleet Logistics Management



- Activity Diagram for use case "Search for Information"?

- Reminder: Base Path (optimistic flow) for this use case
  1. Admin opens search window
  2. Admin defines query using <https://eduassistpro.github.io/>
  3. Admin sends query to DB
  4. DB deals with query: finding results
  5. DB deals with query: organising them by relevance
  6. DB sends results back
  7. DB requests confirmation that result is sufficient
  8. Admin confirms that result is sufficient
  9. DB closes search window

# Activity: Fleet Logistics Management



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# Sequence Diagrams



- Sequence diagrams are a **temporal representation** of objects and their interactions; they show the **objects** and **actors** taking part in a collaboration at the top of dashed lines.

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- Sequence diagrams components
  - Participants are **objects** or **actors** that interact in the diagram
  - **Lines** represent **time** as seen by the object (lifeline)
  - **Arrows** from lifeline of sender to lifeline of receiver are **messages** (denoting events or the invocation of operations)
  - A **narrow rectangle** covering an object's life line shows a **live activation** of the object

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# Sequence Diagrams



- The axes in a sequence diagram
  - **Horizontal**: which object/participant is **acting**
  - **Vertical**: time (down -> forward in time)
- Creation: arrow with 'ne'
  - Notice that an **object created after the start to** **appears lower** than the others
- Deletion: an X at bottom of object's lifeline
  - In some OOP languages this is handled automatically

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# Example: Library Booking System



- Reminder
  - The library contains books and journals; it may have several copies of a given book; only staff members can borrow journals

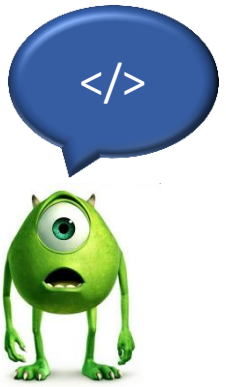
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This is the record that  
keeps track of the books

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# Activity: Fleet Logistics Management



- Sequence Diagram for use case "Search for Information"?

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- Reminder: Activity Diagram

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# Activity: Fleet Logistics Management



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# Class Diagrams



- Class diagrams shows the existence of **classes** and their **structures** and **relationships** in the logical view of a system
- Class diagram components:
  - Classes (their structure and
  - Class relationships
    - Dependency
    - Association
    - Aggregation
    - Composition
    - Realisation
    - Generalisation
  - Multiplicity and navigation indicators

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- What makes a class model good?
  - If you can build a system quickly and cheaply to the satisfaction of the client
  - If you can build a system that is easy to maintain and easy to extend

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- Identifying classes
  - A class describes a set of objects with an equal
  - Identify candidate classes by picking all nouns and noun phrases out of a requirement specification of a system
  - Discard candidates which appear to be inappropriate (redundant, vague, an event or operation, meta-language, outside the scope of the system, an attribute)

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# Class Diagrams



- What kind of things are classes?

- Tangible (real world things)
- Roles
- Events
- Interactions

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- First two are much more common sources for classes – the other two might help to find and name associations between them

# Class Diagrams



- Associations between classes

- Correspond to **verbs**
- Real world association that can be described by a **short sentence** (reader borrows a book)
- Classes are associated if so **w about some object of class B** or vice versa

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- Multiplicity

- Number of **links** between each instance of the **source class** and instances of the **target class**
  - 1 = exactly 1; \* = unlimited number (zero or more); 0..\* = zero or more; 1..\* = one or more; 0..1 = zero or 1; 3..7 = specified range (from 3 to 7)

# Class Diagrams



- Class representation

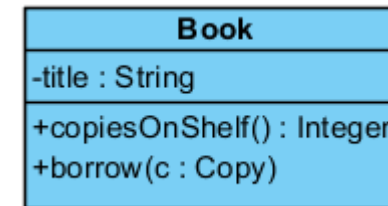
- In UML classes are depicted as rectangles with three compartments

- Class name **Assignment Project Exam Help**
    - Attributes: Describe the d class
    - Operations: Define the w <https://eduassistpro.github.io/>

- Additional symbols

- + public
    - # protected
    - private
    - / derived
    - \$ static

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This is the record that keeps track of the books



# Class Diagrams



- Relationship: Association

- These are the most general types of relationships
- It shows **bi-directional** **Association** between two classes
- It is a **weak coupling** as ass at independent of each other

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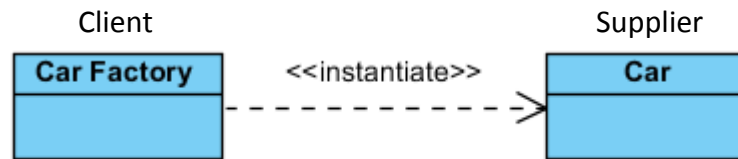


Every Copy is associated only with one Book; every Book is associated with one or more Copies



- Relationship: Dependency

- A **directed relationship** which shows that an element or a set of elements **require(s)**, **need(s)** or **depend(s)** on other elements for implementation
- It is a **supplier-client relationship** something to the client, and thus the client is in some sense **structurally dependent** on the supplier element(s)
- Modification of the supplier **may impact** the client



CarFactory class depends on the Car class



- Relationship: Aggregation ("is part of" relationship)
  - This is a special type of association
  - It is used when one object logically or physically contains another; the container is called "aggregate"
  - The components of aggreg <https://eduassistpro.github.io/>

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Each Honours Course consists of 6 or more Modules; each Module could be part of one or more Honours Courses

# Class Diagrams



- Relationship: Composition

- This is a strong form of aggregation (physical containment)
- The multiplicity at the composition end is always 1 as the parts have no meaning outside the whole
- If the whole is copied or deleted together with it; the owner is explicitly responsible for creation and deletion

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A board has 64 squares, and each square belongs to exactly one board



- Relationship: Realisation

- A "Realisation" is a specialised abstraction relationship between two sets of model elements, one representing a specification (the supplier) and the other representing an implementation of the latter (the client)

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Interface SiteSearch is realised (implemented) by SearchService



- Relationship: Generalisation ("is a" relationship) > Inheritance
  - A **directed relationship** between a more general classifier (**superclass**) and a more specific classifier (**subclass**)

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LecturerInformation and StudentInformation are generalised by UserInformation

# Example: Library Booking System



- Reminder
  - The library contains books and journals; it may have several copies of a given book; only staff members can borrow journals

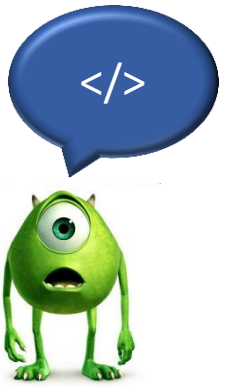
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Note: This is the record that keeps track of the books

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# Activity: Fleet Logistics Management



- Class Diagram?

- Reminder

- Client wants to check ava
    - Admin wants to search fo

Manager wants to see the finances.  
of track lorries and cargo

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# Activity: Fleet Logistics Management



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# State Machine Diagrams



- State machine diagrams

- In order to implement a class we need to understand what the dependencies are between the state of an object and its events
- State machine diagrams show the events or the messages that cause a transition from one state to another and that result from a state change.
- You do not have to create a state machine diagram class!

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# State Machine Diagrams

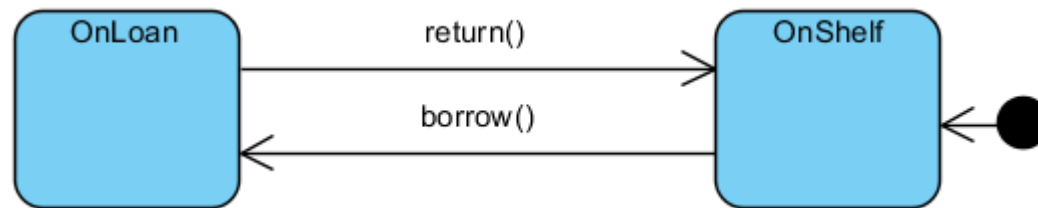


- State: A **condition during the life of an object** when it satisfies some condition, performs some action, or waits for an event

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- There are two special states:
  - Start state: Each state diagram must have one
  - Stop State: An object can have multiple stop states

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State machine diagram for "Copy"

# State Machine Diagrams



- Guard

- Sometimes a change of state of the object depends on the exact values of an object's attributes
- Guard conditions affect the transition by enabling actions or transitions only when they evaluate to TRUE, and disabling them when they evaluate to FALSE.

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State machine diagram for "Book"

# Activity: Fleet Logistics Management



- State Machine Diagram for "Lorry Class"?

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# Activity: Fleet Logistics Management



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# "Use Case Driven" OOA/D Process



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lab reflections





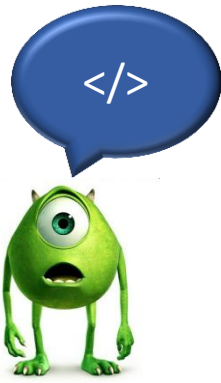
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## Lab 02: Part 2



- Adding "Employable" branch

- ZooCorp + Employable: Aggregation
- Employable: Interface
  - Does not define any field
- Employee: Abstract
  - Why do we want employee to be abstract?
- Zookeeper/Admin: Concrete
  - Make sure you choose the correct superclass
  - Need to implement all unimplemented methods from the interface

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And finally ...



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# References



- Barclay and Savage (2004) Object-Oriented Design with UML and Java

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