W4156

Design I: Communicating Designs & UML

Lecture Arc

1: Communicating Designs	2: Object Oriented Analysis and Design	3: Patterns
How do I communicate the design of a software design/architecture?	What is OOAD and how does it help translate a problem domain into a technology solution?	Are there recurring problems and a ‘library’ of customizable ‘good’ solutions? Can I avoid solving every solution from scratch?

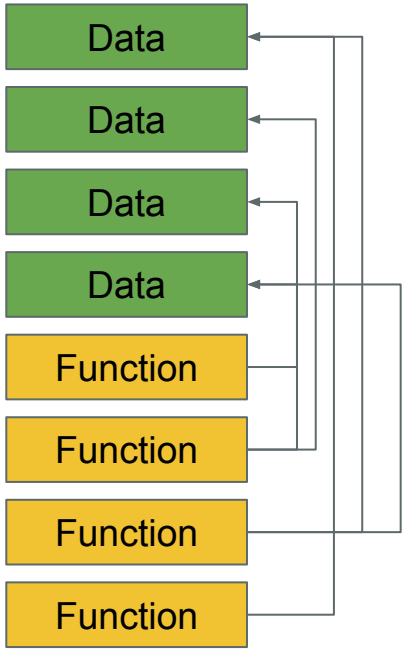
Agenda

Dig deeper into understanding OOAD

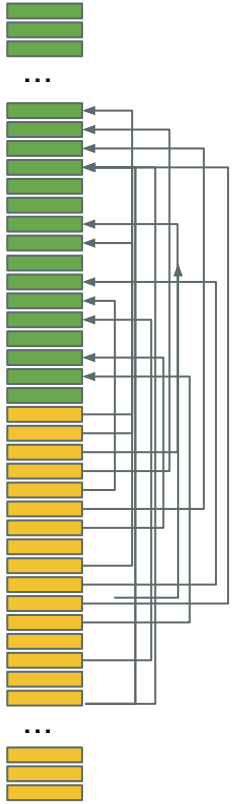
- ❑ What problem creates need for OOAD?
- ❑ What is OOAD?
- ❑ Key Principles
  - ❑ Classes
  - ❑ Relationships

Problem: Code Soup

What is going on?



- Is this coding paradigm easy to:
  - Read,
  - Test
  - Change/Extend
  - Reuse
- Does it scale with complexity?



Complexity (yet again)

Yet again we are in a fight to master complexity

As computer scientists we have a small set of trusty tools ……

- **Abstraction:** we build abstraction on abstraction to hide complexity
- **Encapsulation:** we hide complexity within abstractions to build higher order primitives

Ok - what is OOAD?

Enter OOAD

A ***paradigm*** (way of thinking and designing)

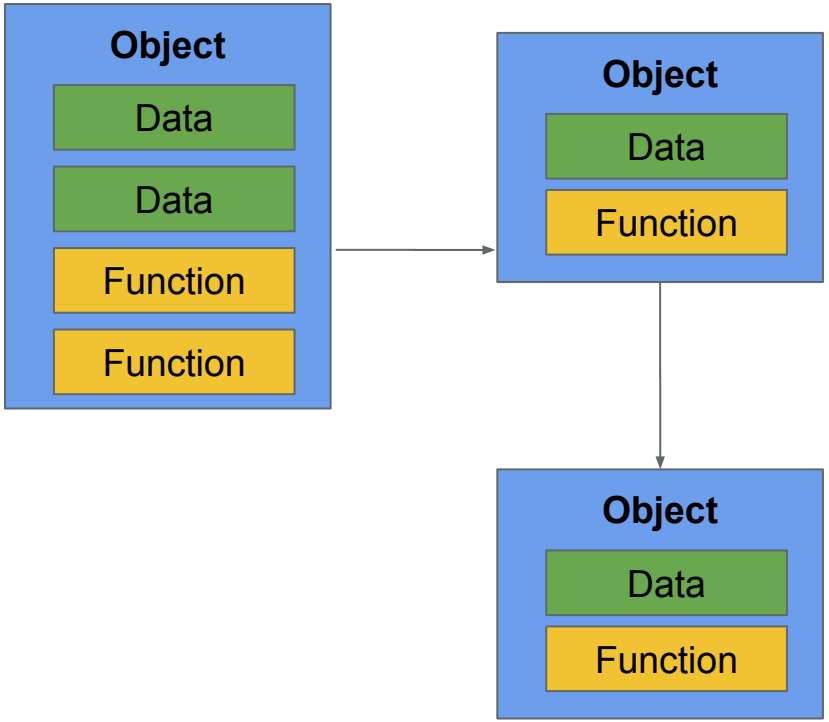
1. ***Analyze*** our *problem domains* in terms of object interacting with objects
2. ***Design*** our program as series of interacting objects
3. Use programming languages/features supporting **'objects'**

Paradigm yields[1] **benefits** of:

- Encapsulation
- Abstraction / Controlling Complexity
- Testability, Readability, Modifiability

[1] I will present opposing points of view later

Object Oriented Version (over simplified)



Why is it called Object Oriented?

1. ***Everything*** is an object

2. Objects communicate by sending and receiving messages
   [messages are also objects. See #1]

3. Objects have their own memory
   [memory is made of objects. See #1]

4. Every object is an instance of a class
   [classes are also objects! See #1]

5. The class holds the shared behavior for its instances
   [classes are also objects! See #1]

6. To run a program pass control to the first object
   [Everything is then messages between objects. See #1]

Adapted from http://wiki.c2.com/?AlanKaysDefinitionOfObjectOriented

Ah ....

In all seriousness - for repetition. OO is:

1. a *mindset* to view/'see' the world as objects interacting with objects
2. to model software solutions in this paradigm
3. to code in language constructs in the paradigm

(I didn't even need to make these ones!)

Example 1: What is the OO model of Ewans journey to deliver this lecture and deliver the lecture itself[1]?

1. What are the objects?
2. For each object:
   - What data do they hold?
   - What can each object *do/functions*?
3. What are the interaction between objects (what messages/objects are exchanged)
4. Can we describe the relationship between objects in terms of
   a. "X is a Y"
   b. "X has a Y"
   c. "X uses a Y"
5. Do we need to model atoms/oxygen? When do we stop?

[1](I am prepared to be the butt of as many jokes as required for you to grasp OO)

Example 2:
Can we refactor the previous example in OO paradigm?

(We will do this crudely/intuitively today. In the next lecture we will discuss the *analysis and design process/techniques*)

Key Principles

Deriving OO Constructs from Needs

How do I ...	Concept
manage complexity / what is my primary paradigm construct?	Object
store the ‘data’/’state’ of objects?	Attributes (encapsulation)
represent the ‘behavior’ of objects?	Methods (encapsulation)
provide encapsulation / limit exposure of methods/attributes	Visibility (second link)
recognize/represent objects may be same ‘entity’ share similar data/behavior	Class (and instance)
represent more complex relationships between classes	Relationship between classes
represent classes that should not be able to be ‘instantiated’	Abstract
represent methods or data that should be *shared* across all instances	Static Method and Scope Variable
establish initial state/behavior of objects?	Constructors and here
work out if two of my objects ‘the same’	Equality, Hash
test if an object supports a specific behavior	Instanceof

Relationships Between Classes

Type	Description	Example
Association	Uses	Car uses road
Inheritance	Is a	Professor is a human being
Aggregation	Weak containment	Grouping. Child can exist independent. Delete class and students still exist!
Composition	Strong containment	Real world whole part. Child not independent. Delete house deletes rooms!

Breathe

Remember:

1. all of these language features are to help us create a representation of our problem domain/the real world in code

2. If we lacked ***these constructs*** we would find it ***hard to represent*** the ***inherent structure*** of our domain in code

- "Faculty and Students are both people but:
    - Who can grade?"
    - Who has a payroll ID?
- "A store can change the price of an product. But if an individual can is bashed then that instance gets discounted"
- "Convert mph to kph is a method but not part of an instance of car?"

Second OO Example / Building it Up ...

Warning:

- OO is often taught using ‘physical’ examples (Cat, Dog, Chicken)
- This is great to relate to *initially*
- However, they miss other abstractions/concepts

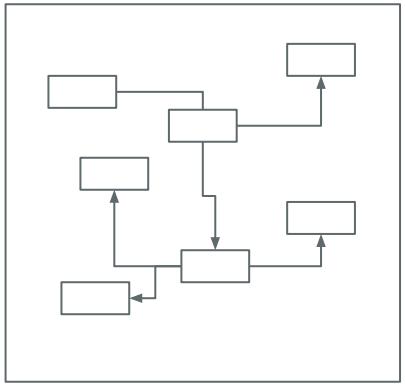
Example:

- AirBnB: people, admins, renter, lister -> (all physical)
- Perhaps we identify a ‘booking’ -> (tangible but not physical)
- How do we validate an entry? -> (abstract activity - ‘Validator’)
- Are we able to cancel a booking? -> (more abstract ‘CancellationPolicy’)
- *Process/workflow* to verify a host? -> (more abstract ‘VerificationWorkflow’)

Okay .....

Real World / Problem Domain

Analysis & Design



Pop Quiz

Question	Answer
What is the motivation for object oriented design?	
What are the key tenets of the paradigm?	
In OO everything I try to model my problem domain as <X> and the <Y> between <X>	
What is the ‘AD’ in ‘OOAD?’	
Ewan is an <> which is an instance of <>	
When we say Python supports object orientation what do we mean?	

Reading

Reading	Optionality
Springer OOAD (chapters 1,2,3 & + 4)	Required (spread over design lectures) [I gave 1-3 before midterm but am relisting as a reminder!]
Python Support for OO	Required