Thinking in Objects

COMSM0086

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Aim of this Session

Our main aim is to provide some guidance on:
"How to Think in Objects"
(and stop thinking in functions ;o)

Whilst at the same time highlighting:
"How to Harness the Power of Object Orientation"

Why this ? Why now ?

You'll be familiar with fundamental programming
(from your previous studies in the C unit from TB1)

Challenge this term is to think in terms of 'Objects'
This is new, unfamiliar and challenging to master

Going from an abstract description of a problem...
to a GOOD *Object Oriented* solution is not easy !

Identifying Classes

First challenge we face is identifying some Classes
In order to partition our code into various class files

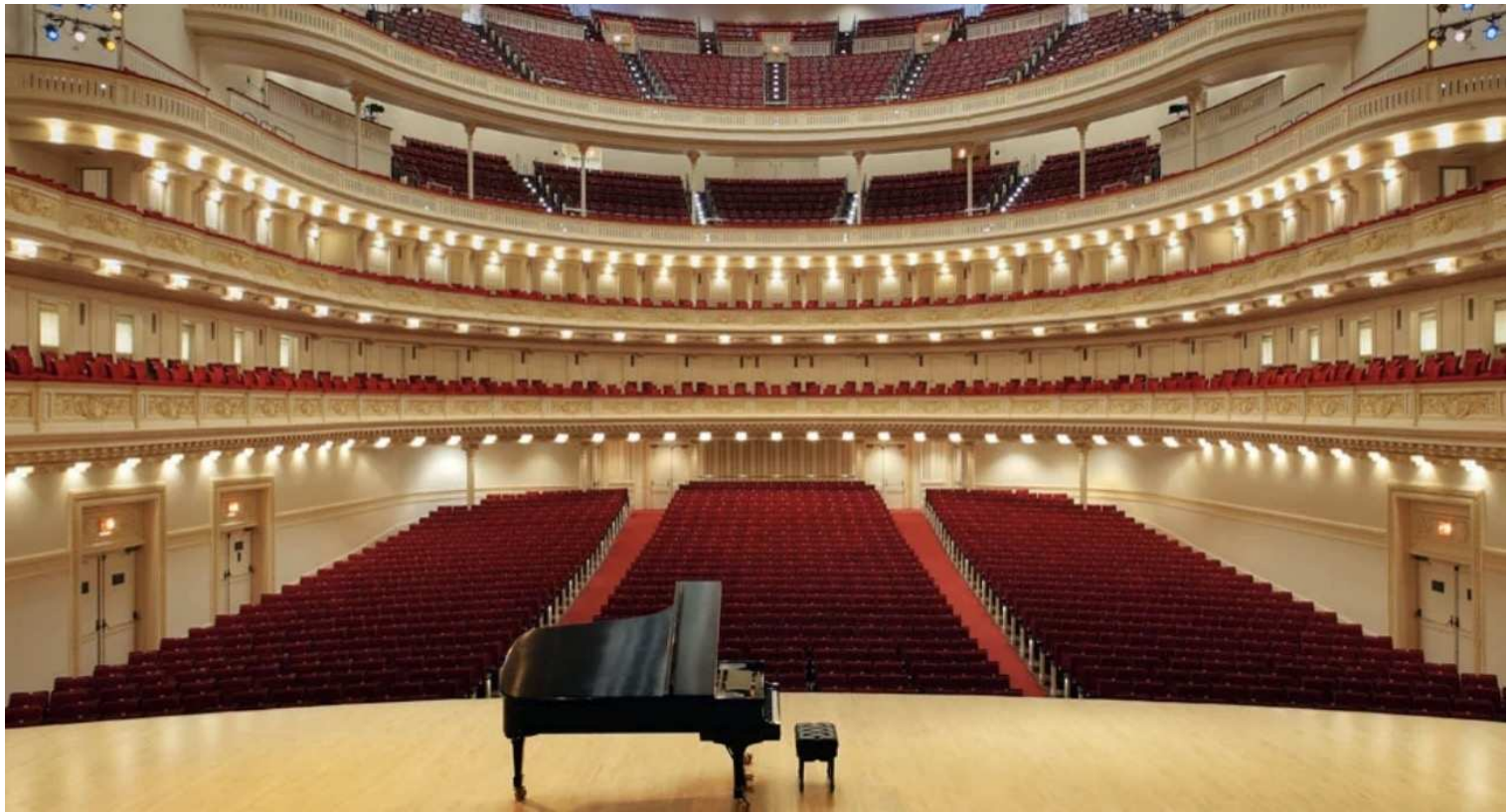
Sometimes students will ask:
"How do I identify GOOD classes ?"

The *real* answer to this question is probably:
"Practice and Experience"

This answer feels a bit like the old joke...

Carnegie Concert Hall - New York

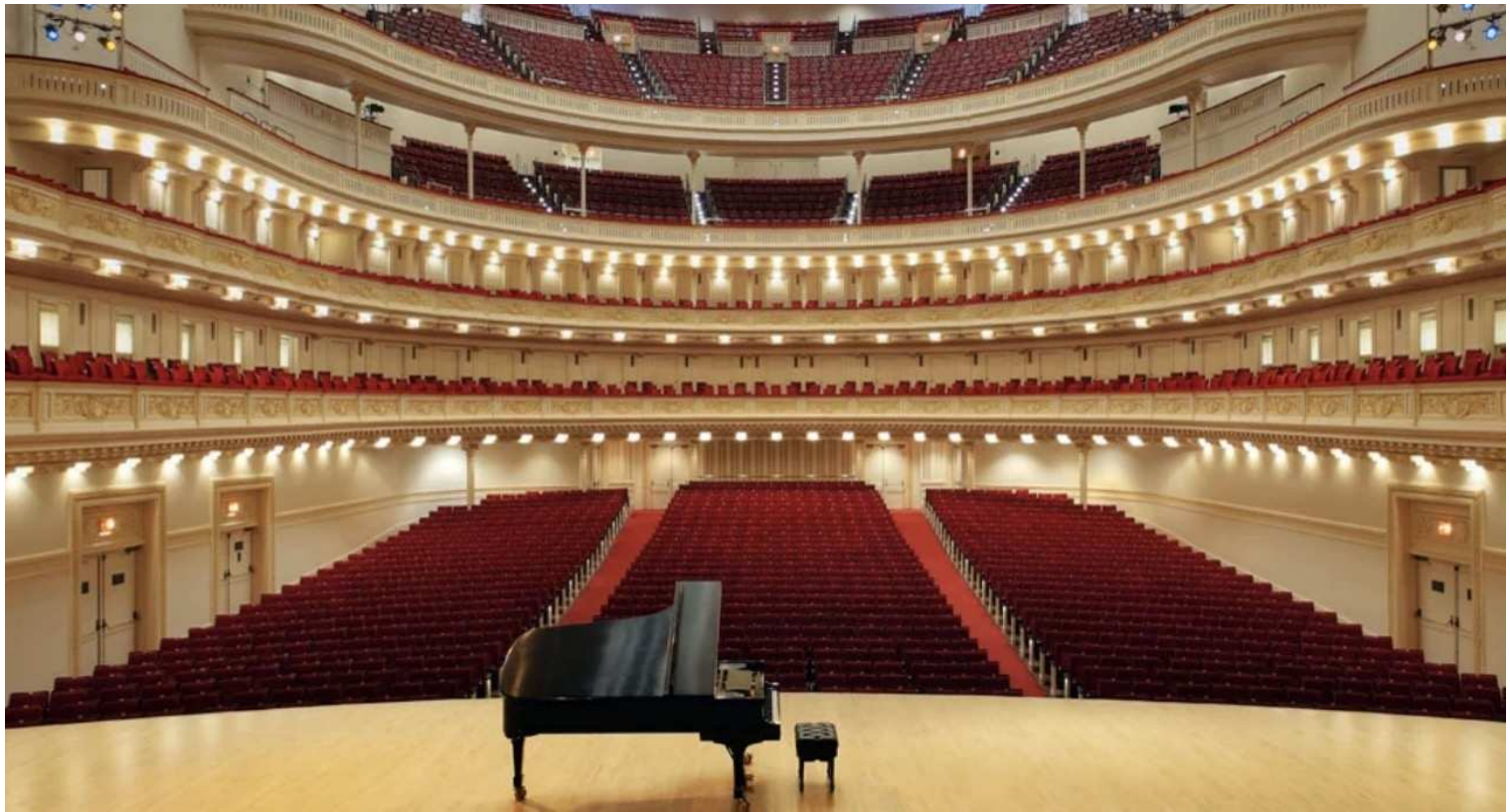
Lost Tourist: How do I get to Carnegie Hall ?



Carnegie Concert Hall - New York

Lost Tourist: How do I get to Carnegie Hall ?

Passing Pianist: Practice !



Some Real Help ?

But that answer isn't much help in learning OOP !

Identifying a set of suitable classes is not easy
A difficult task, involving knowledge and creativity

There is no "right answer"...
But there are "good choices" & "not so good choices"

Here are a few simple tips for identifying classes...

Identifying Suitable Classes

Collect key entities ('nouns') from 'problem domain'

`Student, Triangle, Colour, Board, Player, Location`

Collect key entities ('nouns') from 'solution domain'

`LookupTable, NameValuePair, AddressServer, LinkedList`

Collect key tasks/roles from the 'solution domain'
Include these as "doer" classes (my word ;o)
(they "do" things & their name often ends in "er")

`FileParser, DataLoader, CommandHandler, ReportGenerator`

Incremental Identification

Don't expect to identify ALL classes in advance
Some classes "emerge" during iterative development

Be prepared to refactor project as code expands:

- Splitting classes when they get complex/incoherent
- Creating additional class when new feature won't fit
- Merging classes when commonalities arise
- Wholesale restructuring when things turn ugly !!!

Design patterns can help provide a good structure
(but we haven't really covered these yet ;o)

Inheritance

Look out for opportunities to use inheritance !
(But don't try overuse it !!!)

Unit assignments are designed to involve inheritance
Real world opportunity for use are much less common

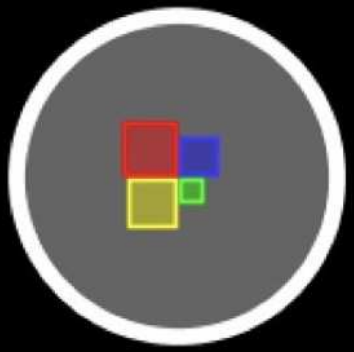
You'll often need to extend existing class hierarchies
The need to create your own hierarchy is less common

Illustrative Example

Let us consider a simple example application...
A graphical visualisation of GitHub groupwork

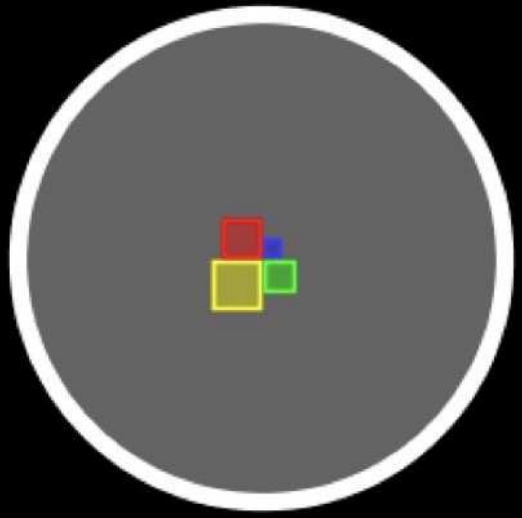
Each project involves 3-5 student contributors
We can generate reports on contributor activity
(code commits, pull requests, change reviews etc.)

Reports are exported as separate JSON documents
Which are then be imported into our application
This then generates graphical representations...



Viv (vv12345)

Una (uu12345)



Tom (tt12345)

Implementation

First let's see a function-oriented implementation
Structure is most important (algorithms less so)

This was written using the Processing platform
Makes good use of Processing graphics libraries !

YES !

It IS perfectly possible to write valid Java code,
that totally avoids any Object Oriented constructs

MondrianFunctional

Summary of Function Calling Patterns

```
setup >> scanForProjectReports
setup >> loadNextReport

draw >> drawAllStudentsInGroup...
                  >> drawSingleStudent...
                                >> getValueOfMetric

keyPressed >> loadPreviousReport >> loadJSONObject
keyPressed >> loadNextReport >> loadJSONObject
```

Reflection on the code

This code works fine and does the job...
But it is not Object Oriented in structure:

- Centralised control
- Use of globals and much flow of data
- Tight linkages between functions

Let's refactor it so that it is more Object Oriented
(which, in the end, is what we are here to learn)

Also an opportunity to explore some OO concepts
Make use of powerful Java features along the way

Analysis: Proposed Classes

There are two key entities from application domain:

- Project: Encapsulates details of a specific repository
- Student: Encapsulates details of an individual student

A data structure for ALL projects would be useful:

- ProjectList: Implemented by extending `ArrayList`

Also a "doer" class to scan for available reports:

- ProjectScanner: returns all reports in specified folder

MondrianObjectOriented

Main Class

Main class is relatively simple, it just deals with:

- Setting up key parameters (window size, font etc.)
- Kicking off the scanner to look for project reports
- Filling the `ProjectList` data structure with reports
- Drawing of graphics (delegated to other classes)
- Handling of key presses from user (next/previous)

OO Concepts: Student and Project Classes

Delegated Responsibility

Both classes are responsible for drawing themselves

Both load JSON and populate their internal variables

Abstraction and Encapsulation

Advanced features "hidden away" inside classes

For example: just-in-time loading and caching of data

OO Concepts: ProjectList Class

Abstraction and Encapsulation

Internally deals with creating & managing iterators
Internally handles checking existence of next/prev

Inheritance and Reuse

Extends ArrayList, adding project specific features
Reuses methods from ArrayList and Java Iterators
Adds "getCurrent" method (not provided by ArrayList)

Extension and Method Augmentation

Augments existing methods with safety features
Methods with more descriptive domain-specific names
(e.g. "next" becomes "moveToNextProject")

OO Concepts: ProjectScanner Class

A "doer" utility class to scan for project reports
Returns a list of projects loaded in from filesystem

Abstraction and Encapsulation

Messy details of File IO "hidden away" inside class

Cohesion

ProjectScanner class focuses only on Low-level File IO
Could be expanded with other File IO features later

A Few Additional Notes

Function-style methods are still useful in OO code
(e.g. `loadStudentData` and `getValueOfMetric`)

We have combined "key entities" with "doers":
The Student class represents the Student entity...
...but also implements drawing & JSON data parsing

In a more complex application, we might choose
to split these out into a number of separate classes

Complexity

You could argue that we've increased complexity of the code by creating multiple additional class files (some classes are small and contain little code)

On the positive side, code is logically organised...
It is clear where various features should be located

The whole application is currently quite simplistic (we removed some features from the *real* code)

After a few more iterations it could become complex
We'd soon be grateful for a well-organised structure

Evolution

Carpenters often say: "Measure twice, cut once"
Why can't we plan and design code in advance ?

That's a very 'waterfall' way of thinking
Producing an entire design is time consuming
It assumes certainty and perfect prior knowledge

Agile is more fluid and attempts to be flexible
Encompasses exploration and "emerging features"

Better to embrace (and plan for) evolution
Rather than enforce a rigid structure "set in stone"

Questions ?