COMP140: Individual Creative Computing Project

7: Design Patterns

Learning outcomes

- **Describe** the concept of Design Patterns
- **Understand** some of the classic 'Gang of Four' Design Patterns
- **Implement** some of the most commmon design patterns

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OO Design Basics

Role of Design Patterns

Object orientated systems tend to exhibit recurring structures that promote:

- Abstraction
- Flexibility
- Modularity
- Elegance

Role of Design Patterns

- Therein lies valuable design knowledge.
- The challenge, of course, is to...
  - capture
  - communicate
  - and apply
- ...this knowledge.

Role of Design Patterns

A design pattern...

- Abstracts a recurring design structure
- Comprises class and/or object
  - dependencies
  - structures
  - interactions
  - conventions
- names and specifies the design structure explicitly
- and thereby distils design experience

Components of a Design Pattern

A design pattern is comprised of:

- A name
- Common aliases — *also known as*...
- Real-world examples
- Contexts
- Common problems solved
- Solution
- Structure
- Diagrams
- Consequences

Components of a Design Pattern

- Design patterns are often tacit knowledge made explicit.
- You will develop tacit knowledge of patterns through regular design practice.
- You are expected to engage in constant research and reflection when designing software to learn all of these different patterns.
- They will help you communicate and design in the future.
- Additional research will be required as the number of patterns greatly exceeds those that can be covered in workshops.

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Design Patterns

Types of Design Pattern

Design patterns come in three main flavours:

- **creational**: concerned with the process of creating and managing the creation of objects.
- **structural**: dealing with the composition of objects.
- **behavioural**: characterizing the different means by which objects can interact with others.

Types of Design Pattern

- **Creational**
- Singleton
- Typesafe Enum
- Factory
- Prototype
- Builder

- **Structural**
- Adapter
- Bridge
- Proxy
- Facade
- Decorator

- **Behavioural**
- Template
- State
- Observer
- Visitor
- Strategy

Design Patterns

We will now briefly examine these patterns. Throughout this section...

- **Please** make notes
- **Link** to on-line resources
- **Ask** questions
- **Think** about how the patterns may apply to your own projects
- **Conduct** further research

Singleton

- Guarantees that there is only one instance of a class and can be accessed globally
- Usually 'lazily' initialised via a static function that satisfy the statement above
- Used for manager classes which track some sort of Global State
- **Warning!** Some consider Singletons to be an anti-pattern
- Singleton: an anti-pattern? - `https://stackoverflow.com/questions/12755539/why-is-singleton-considered-an-anti-pattern`

Abstract Factory

- Centralises the creation of similar objects
- Decouples the creation of the object from actual object
- This pattern requires several class
  - Abstract Product - Base class for all things created by the Factory
  - Abstract Factory - Base class for all factories, creates Abstract Products
  - Many Concrete Products - Implement Abstract Product
  - Many Concrete Factories - Implements Abstract Factory and creates Concrete Products
- The caller then creates instances of Product through the concrete factory
- Used for spawning objects or the creation of other similar objects

Observer

- When one object is updated, all observers of this object are notified
- A list of observers are maintained by the subject
- When the state of the subject changes then the list of the observers is processed
- Each observer is then notified of the change
- Each observer should register/unregistered itself with a subject
- Very useful for UI, Input or Network systems in games

State

- Do you have large amount of if..else or switch statements in your code?
- Have you ever had to change such a system?
- Then the State pattern is here to help
- You define a Base State class which all other States implement
- This Base State will have a method for updating the state, for entering and exiting
- Each Concrete State will then implement these methods and handle its own logic
- Transitions can be handled by a Manager class
- This is generally used to deal with Game State or AI (see Finite State Machines)

Further Reading

- Design Patterns Unity - https://www.habrador.com/tutorials/programming-patterns/
- Game Programming Patterns - http://gameprogrammingpatterns.com/contents.html
- What Design Patterns are useful for games - https://gamedev.stackexchange.com/questions/4157/what-are-some-programming-design-patterns-that-a
- Singleton - http://wiki.unity3d.com/index.php/Singleton
- State Pattern - https://www.raywenderlich.com/6034380-state-pattern-using-unity
- Observer Pattern - https://www.habrador.com/tutorials/programming-patterns/3-observer-pattern/