GAM250: Advanced Games Programming

2: 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 mainted 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
- Some of this function is already built into C#(delegates & Events) and Unity(Unity Events)

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)

Unity Implementations

- Singleton - `https://unity3d.com/learn/tutorials/projects/2d-roguelike-tutorial/writing-game-manager`
- Better Singleton? - `https://riptutorial.com/unity3d/example/9564/implementation-using-runtimeinitializeonloadmeth`
- Factory - `http://brightreasongames.com/object-construction-factory-method/`
- State - `http://www.habrador.com/tutorials/programming-patterns/6-state-pattern/`
- Observer - `http://www.habrador.com/tutorials/programming-patterns/3-observer-pattern/`

Live Coding

Singleton & Observer

Exercise 1

- Implement Singleton and Observer in the following project
- Download or fork - `https://github.com/Falmouth-Games-Academy/GAM250-Example-Game`
- The Player score and lives could be tracked using the Observer Pattern
- The Player and Wave Manager could be implemented as Singleton

Exercise 2

- Research Object Pools
- Implement Object Pools for Bullets and Asteroids
- For bonus points, create Factories for these objects

Further Reading

- Game Programming Patterns - `http://gameprogrammingpatterns.com/contents.html`
- Game Programming Patterns in Unity - `http://www.habrador.com/tutorials/programming-patterns/`
- Unity Design Patterns - `https://github.com/Naphier/unity-design-patterns`