

Design patterns in videogames

Videogames Technology

Objectives

- Understand the need of design patterns
- Distinguish the main design patterns categories
- Apply the main patterns to problems in videogames

Bibliography

1. Desarrollo de Videojuegos, Arquitectura del Motor de Vieojuegos. Capítulo 4. UCLM.
2. Wikipedia

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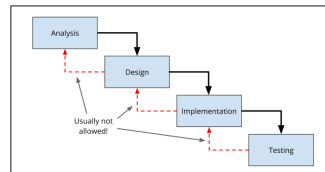
Software Engineering in videogames (I)

Game programming is a complex task

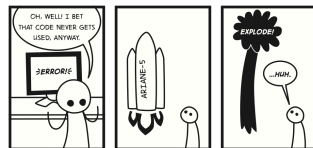
- Rarely done by a single person
- Development team \Rightarrow **Software Engineering**

Classic development process (**software lifecycle**)

1. Analysis: What do I need?
2. Design: How do it?
3. Implementation: Do it
4. Testing: Does it work?



The waterfall process



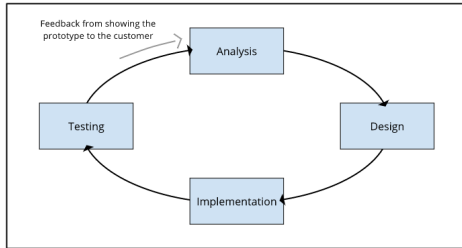
(Source)

More: http://en.wikipedia.org/wiki/Iterative_and_incremental_development

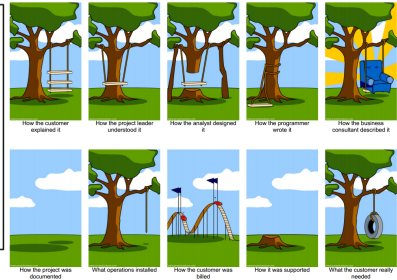
Software Engineering in videogames (II)

Many development processes

- Usually, game development is **iterative**



Iterative software development



Design is critical for the videogame lifecycle: Class hierarchy

Design pattern definition

Concept (I)

Some problems happen frequently

- Experience is a valuable asset, but it is not enough
- A **design pattern** stores knowledge on successful designs

Design pattern

It is the description of the communication among objects and classes customized to solve a generic design problem under a given context

Design Patterns. Elements of Reusable Object-Oriented Software Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides (GoF- Gang of Four), 2008

Design pattern definition

Concept (II)

Informal definition: A design pattern is a solution to a design problem

- Its utility has been verified by experience
- It must be reusable

More: http://en.wikipedia.org/wiki/Software_design_pattern

Design pattern definition

Concept (III)

Design patterns goals

- Provide a portfolio of reusable elements in software design
- Avoid loose time searching solutions to already solved problems
- Formalize a shared vocabulary
- Standarize designs
- Ease learning

Design pattern do not want to

- Impose some design alternatives
- Remove designer creativity

Design pattern definition

Design pattern structure

Four components:

1. **Name.** Short name that identifies the pattern
2. **Problem and context.** Problem that the pattern solves, context where it takes sense and list of preconditions
3. **Solution.** General solution not tied to any programming language. Usually described with UML diagrams.
4. **Advantages/drawbacks.**

Additionally:

- Classification, applicability, structure, roles, collaborators, implementation, example code, related patterns, ...

Design pattern definition

Types of design patterns

Three great groups:

1. **Creational patterns.** Objects and data structures creation
 - Singleton, factory, abstract factory, ...
2. **Structural patterns.** Class hierarchy, relation and composition of objects
 - Model-View-Controller (MVC), adapter, façade, proxy, ...
3. **Behavioral patterns.** Objects message passing (communication)
 - Observer, chain of responsibility, command, iterator, state, strategy, ...

Additional domain patterns

- Web development, GUIs, business, ...

Creational patterns

Singleton

Singleton

Problem: Guarantee only one instance of a class

Solution: Private constructor, instantiate the class through a public method

Example: We need only one game instance

Singleton	
-	<u>singleton : Singleton</u>
-	Singleton()
+	<u>getInstance() : Singleton</u>

Code example

```
public class Singleton {  
    private static Singleton INSTANCE = new Singleton();  
  
    private Singleton() {}  
  
    public static Singleton getInstance() { return INSTANCE; }  
}
```

Creational

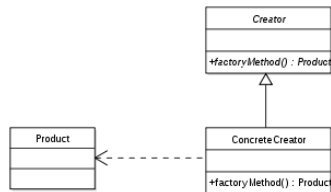
Factory

Factory

Problem: Create new object

Solution: Group object creation logic in a factory class

Example: Create warriors and rogues in a RPG game



Factory code example

```
public class CarFactory {
    public static Car buildCar(String model) {
        switch (model) {
            case "small":
                return new SmallCar();
            case "sedan":
                return new SedanCar();
            case "luxury":
                return new LuxuryCar();
        }
    }
}
```

Creational patterns

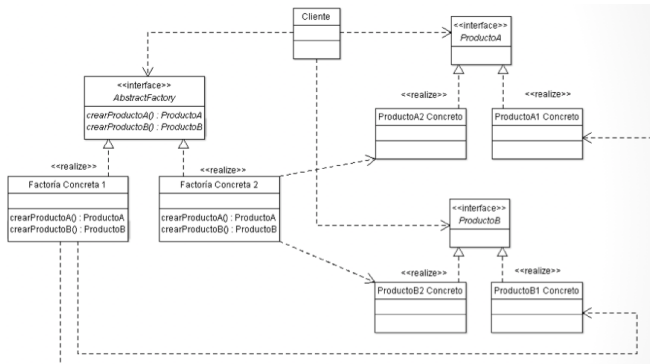
Abstract Factory (I)

Abstract Factory

Problem: Create families of new objects

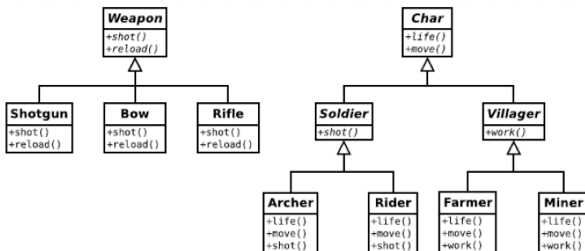
Solution: Create a hierarchy of factories

Example: Create human or orc warriors in a RPG game



Creational patterns

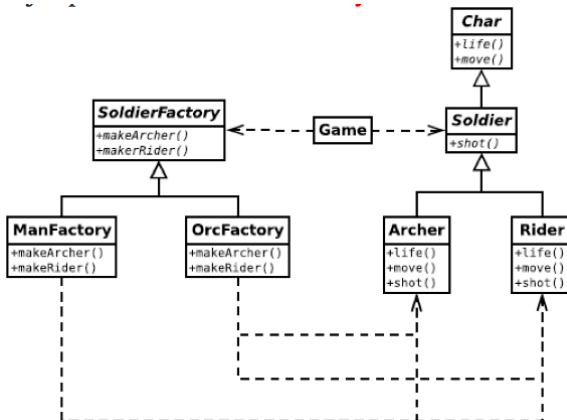
Abstract Factory (II)



RTS game class hierarchy

Creational patterns

Abstract Factory (III)



Example of abstract factory applied to a RTS game

Creational patterns

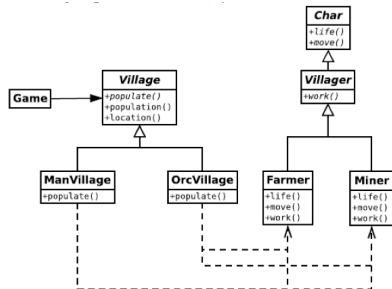
Factory Method

Factory Method

Problem: Create new objects

Solution: Method that instantiates objects

Example: Populate a village with characters



Design patterns

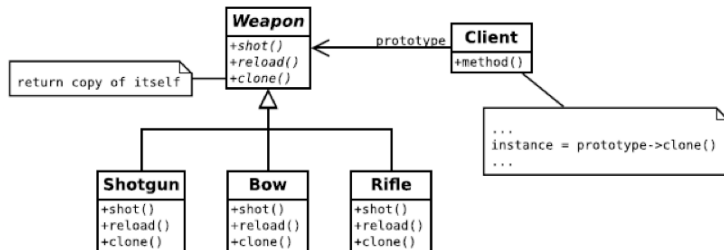
Creational patterns: Prototype

Prototype

Problem: Create a large number of objects whose instantiation is heavy

Solution: Clone objects

Example: Instantiate a large number of weapon objects



Structural patterns

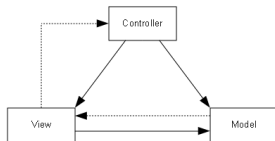
MVC (I)

Model-View-Controller (MVC)

Problem: Decouple logic, data and visualization

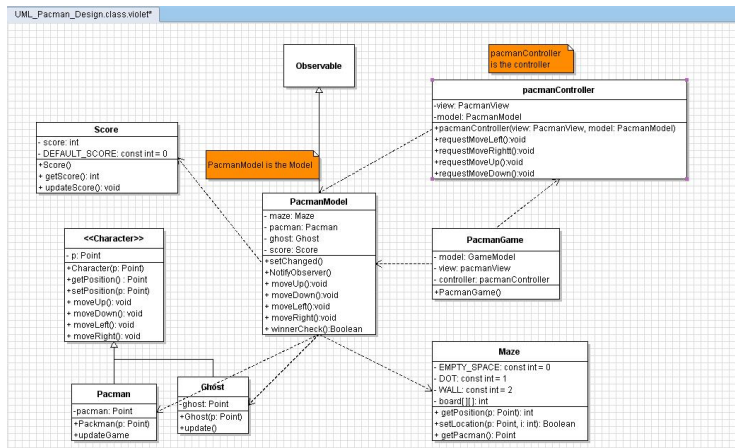
Solution: Use different classes to contain data, its visualization and the game control

Example: Any game or graphical application



Design patterns

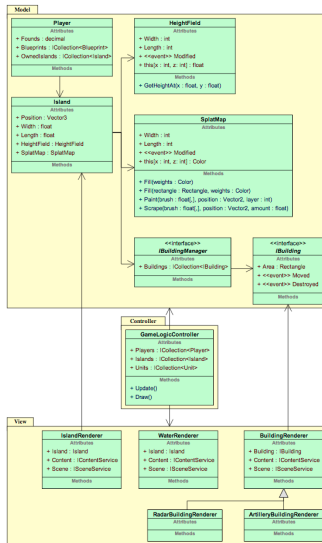
Structural patterns: MVC (II)



Source: <https://code.google.com/p/pacpounder/downloads/list>

Design patterns

Structural patterns: MVC (III)



Structural patterns

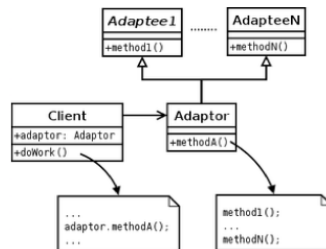
Adapter

Adapter

Problem: One class needs to invoke a method in another class, but it cannot

Solution: Use an intermediate class with a new interface

Example: Incompatible third-party library



Structural patterns

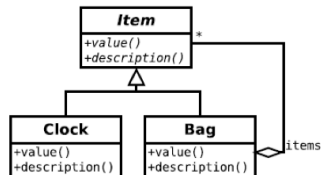
Composite

Composite

Problem: Store objects that might contain other objects

Solution: Objects composition

Example: Game whose player keeps an inventory whose items might contain other items



Structural patterns

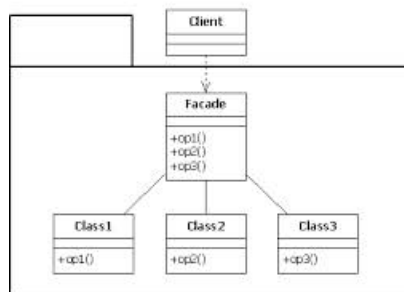
Façade

Façade

Problem: Complex interface to a set of classes

Solution: Create an intermediate class that simplifies the interface

Example: Graphical library with several operation modes



Behavioral patterns

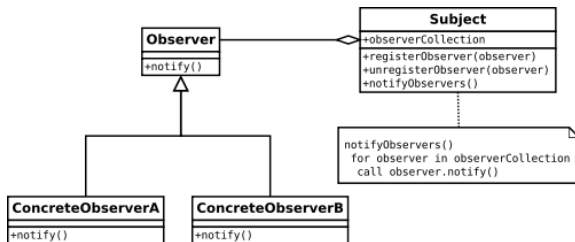
Observer (I)

Observer

Problem: Notify a set of objects when another object changes

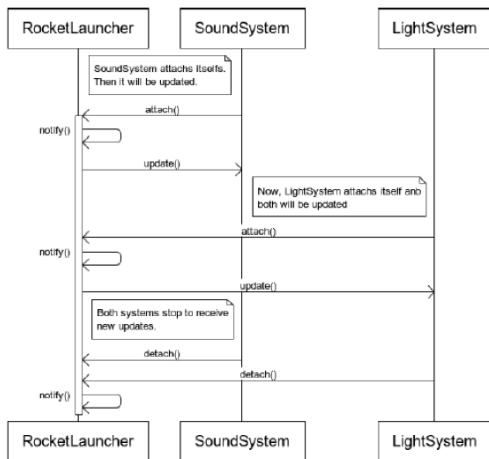
Solution: Link a set of observers to an observed object

Example: A view that has to know when the model changes



Behavioral patterns

Observer (II)



Behavioral patterns

Observer (III)

DataStore.java

```
public class DataStore extends Observable {
    private String data;

    public String getData() { return data; }

    public void setData(String data) {
        this.data = data;
        setChanged();
        notifyObservers();
    }
}
```

Screen.java

```
public class Screen implements Observer {
    @Override
    public void update(Observable ob, Object arg) {
        // Do something
    }

    public static void main(String args[]) {
        Screen screen = new Screen();
        DataStore datastore = new DataStore();
    }
}
```

Behavioral patterns

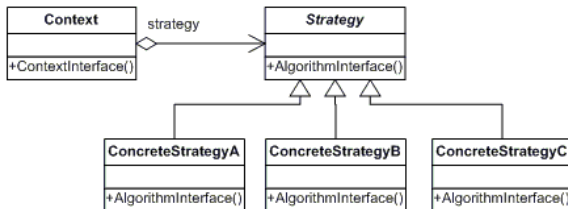
Strategy (I)

Observer

Problem: Choose in execution time which method use from several ones

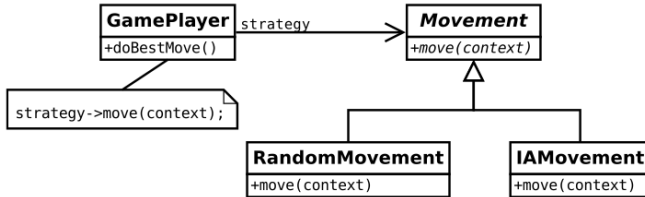
Solution: Encapsulate the method in a class

Example: A fighter with several fighting styles



Design patterns

Behavioral patterns: Strategy (II)



Behavioral patterns

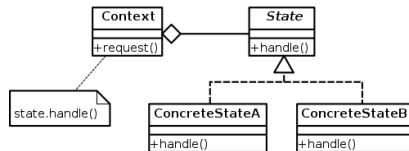
State (I)

State

Problem: Implement a state machine

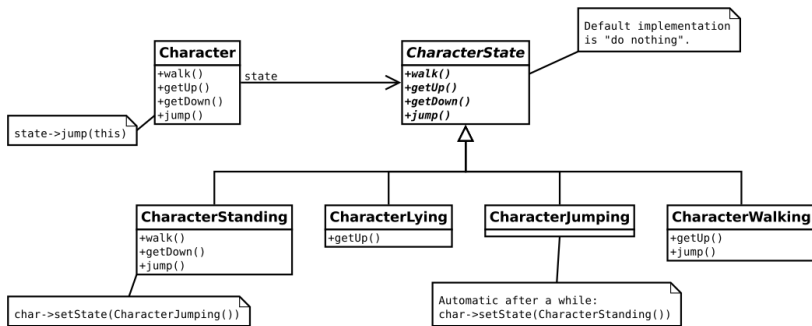
Solution: Encapsulate state transitions

Example: NPC behavior



Design patterns

Behavioral patterns: State (II)



Behavioral patterns

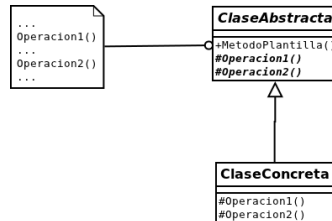
Template Method (I)

Template Method

Problem: Customize an algorithm

Solution: Divide the algorithm in methods that can be overridden

Example: Chess and checkers games



Behavioral patterns

Template method (II)

