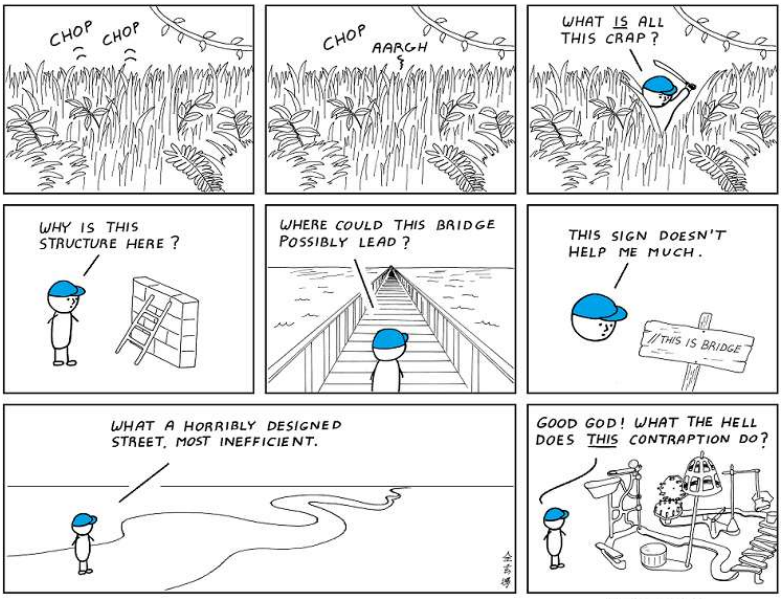

I hate reading other people's code.

OBJECT-ORIENTED PROGRAMMING

Creational Design Patterns

Lecture #10

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Creational design patterns

- Abstract the instantiation process
- Plan for today
  - Factory Method
  - Abstract Factory
  - Singleton
  - Builder
  - Prototype

Creational design patterns

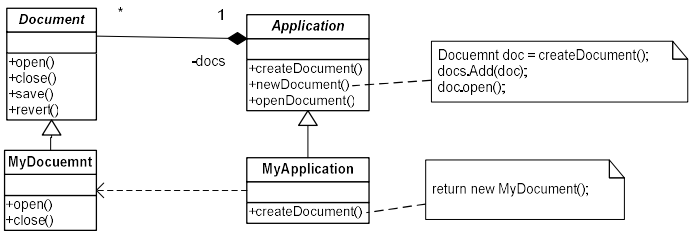
- **Creational patterns** abstract the instantiation process
  - They control (hide) creation of objects and helps build systems independent from creation and building of objects
- **Creational patterns of classes** use inheritance to decide what objects should be created
  - **Factory Method, Prototype**
- **Creational patterns of objects** delegates creation of objects to other objects
  - **Abstract Factory, Builder**

Creational design patterns

- All OO languages include **`new`** command for an object instantiation
- Creational patters allows us to write methods for objects instantiation without direct usage of **`new`**
- Methods can create various objects and can be overridden/overloaded to create other new objects without modification of code

Factory Method

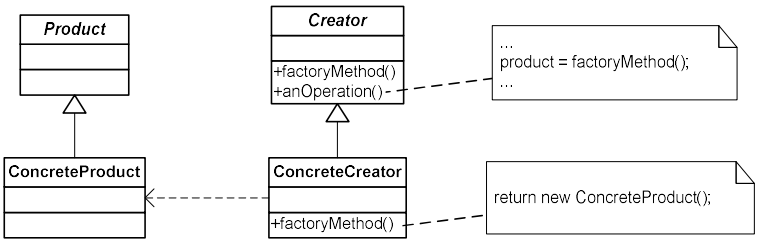
- Purpose
  - Defines interface for creating objects and allows subclasses to control the type of created objects
- Motivation



- Method `createDocument()` represents **Factory Method**

Factory Method

- Usage
  - In case the class cannot assume what type of creating objects is used
  - Subclasses must specify the creation of objects
- Structure



Factory Method

- Participating parts
  - `Product` – defines interface for object types that are created
  - `ConcreteProduct` – implements `Product` interface
  - `Creator` – declares factory method, which returns object of type `Product`
  - `ConcreteCreator` – overrides factory method and returns instance of `ConcretePorduct`
- Collaboration of parts
  - `Creator` depends on its subclasses that implements factory method returning adequate instance of `ConreteProduct`

Factory Method

- Class `Creator` is created without knowledge what `ConcreteProduct` is instantiated. What `ConcreteProduct` is instantiated is given by corresponding `ConcreteCreator` subclass used in application
- It does not mean the subclass decides during runtime what concrete type is used!

Factory Method

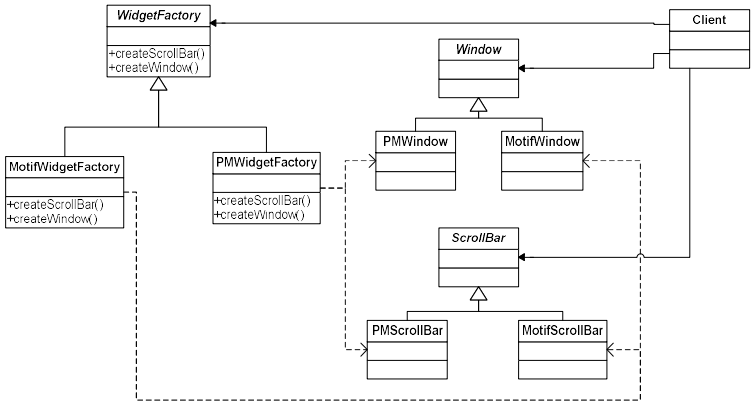
- Advantages
  - Code is much more flexible and reusable thanks to avoidance of direct instantiating of application specific objects
  - Code works only with `Product` interface and can use any classes `ConcreteProduct`, which implement this interface
- Implementation
  - `Creator` can be either abstract or concrete class
  - When factory method creates more types of objects, for example input parameter distinct among them by `if-else` construction

Abstract Factory

- Purpose
  - An interface of creating a group of related of dependent objects without specifying they concrete classes
  - Creation of objects is delegated to other objects using composition and Factory Method is used for creation of concrete objects

Abstract Factory

- Motivation

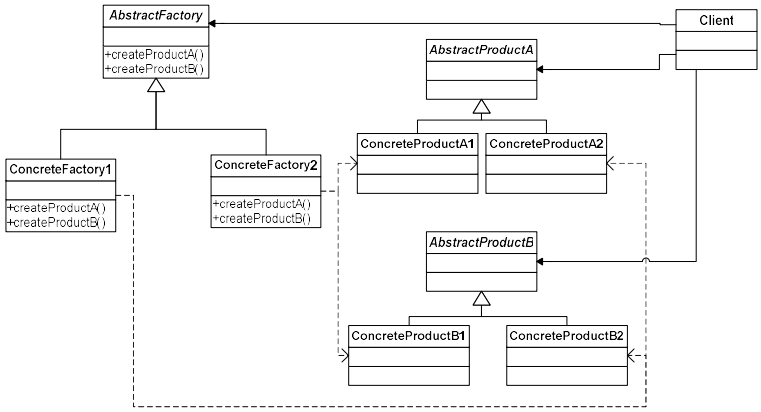


Abstract Factory

- Usage
  - System should be independent of the way how its objects are created
  - Class cannot assume what classes are used for creating objects
  - System must use only one group of related objects
  - Objects of one group must be used together

Abstract Factory

- Structure



Abstract Factory

- Participating parts
  - `AbstractFactory` – interface declaring operations for creating objects of abstract products
  - `ConcreteFactory` – implements operations for creating concrete objects
  - `AbstractProduct` – interface of a product
  - `ConreteProduct` – defines concrete product that is created by concrete factory method; implements interface `AbstractProduct`
  - `Client` – uses only interfaces declared as abstcract (`AbstractFactory`, `AbstractProduct`)

Abstract Factory

- Collaboration of parts
  - Only single instance of `ConcreteFactory` is created (see pattern Singleton) and it creates objects according concrete implementation. For creting other types of products there must be another instance of other `ConcreteFactory`
  - Class `AbstractFactory` depends on implementation of factory methods by its subclasses

Abstract Factory

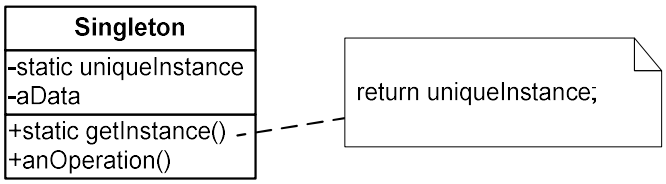
- Advantages
  - Isolates client from concrete implementation of classes
  - Allows simple switch of product groups, because concrete factory class implements creation of whole product group
  - Enforces usage of one product group
- Implementation
  - Typical implementation needs only single instance of factory class
  - In this case pattern Singleton is used
  - In case concrete factory class must create new types of products (not included in abstract declaration), only one factory method (with parameter) is implemented

Singleton

- Purpose
  - Allows creation single instance of a given class and allows global access to it
- Motivation
  - Sometimes we need just one single instance of the class
  - For example, I want a single object to control and manage objects of windows in the system
  - We need an easy access to the object
  - To ensure it cannot be created more than one objects of the class

Singleton

- Structure



- Advantages
  - Controlled access to an explicit object
  - Does not allow to create other instances

Builder

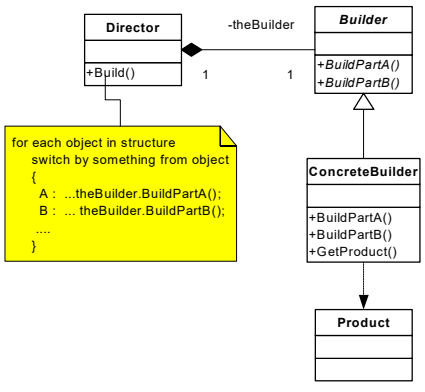
- Purpose
  - Separates construction (composition) process of a complex object from its representation (structure)
- Motivation
  - Situations in which we need to compose object from other objects
  - We want to hide before client the implementation of object composition
  - We wand to support client by variability of composition of object structure

Builder

- Usage
  - Separate problem of object composition (from what to build) from its construction (how to build) and from object representation (what to build)
  - Client accesses object construction by interface that is implemented by various concrete objects

Builder

- Structure

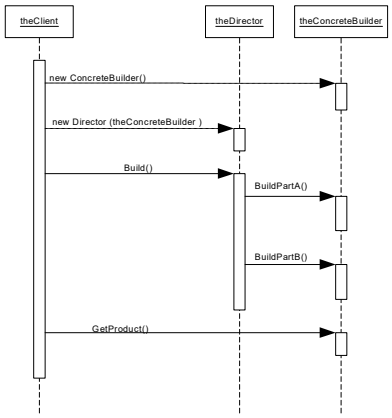


Builder

- Participating parts
  - `Builder` – abstract interface for creating parts of an object
  - `ConcreteBuilder` – implements `Builder` and constructs concrete type of `Product` (executes whole construction)
  - `Director` – directs construction of structured object by builder object implementing `Builder` (i.e. `ConcreteBuilder`); it does not know the structure
  - `Product` – represents building structured objects

Builder

- Collaboration of parts



Prototype

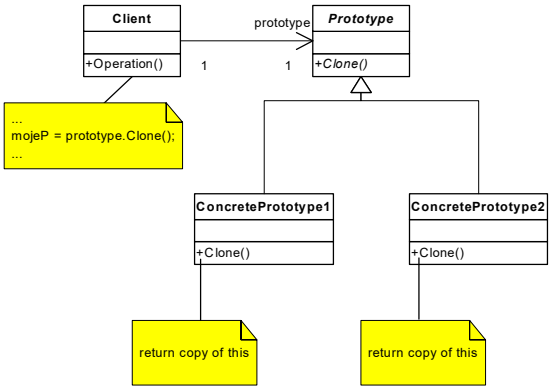
- Purpose
  - Objects are created by cloning prototype instances defining a single interface
- Motivation
  - When creating objects, we often cannot choose the type of the instance
  - Usage of Factory patterns requires rewriting whole factory mothod after inheritance
  - Creation of objects as copies of other objects without knowing their actual classes

Prototype

- Usage
  - Structure of products has common interface that supports cloning objects
  - Client contains list of prototype objects used for cloning new objects
  - Client access objects (to clone them) only using common interface without knowing actual classes of them

Prototype

- Structure



Prototype

- Participating parts
  - `Prototype` – abstract interface for creating objects, declares abstract method `Clone()` of object cloning
  - `ConcretePrototype` – implements `Prototype` and creates copy of this concrete instance by rewriting `Clone()`
  - `Client` – uses `Prototype` for creating new objects by method `Clone()`, it does not need to know what `ConcretePrototype` is used (sometimes called Prototype Manager and often implemented by various Factory patterns)