Patterns in Software Engineering

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Lecture 2

GoF Design Patterns – Creational

GoF Design Patterns – Principles

- Emphasis on flexibility and reuse through decoupling of classes.

- The underlying principles:
  - program to an interface, not to an implementation.
  - favor composition over class inheritance.
  - find what varies and encapsulate it.

GoF Design Patterns: General Categories

- 23 patterns are divided into three separate categories:
  - **Creational** patterns
    - Deal with initializing and configuring classes and objects.
  - **Structural** patterns
    - Deal with decoupling interface and implementation of classes and objects.
  - **Behavioral** patterns
    - Deal with dynamic interactions among societies of classes and objects.

GoF Design Patterns: Purpose and Scope

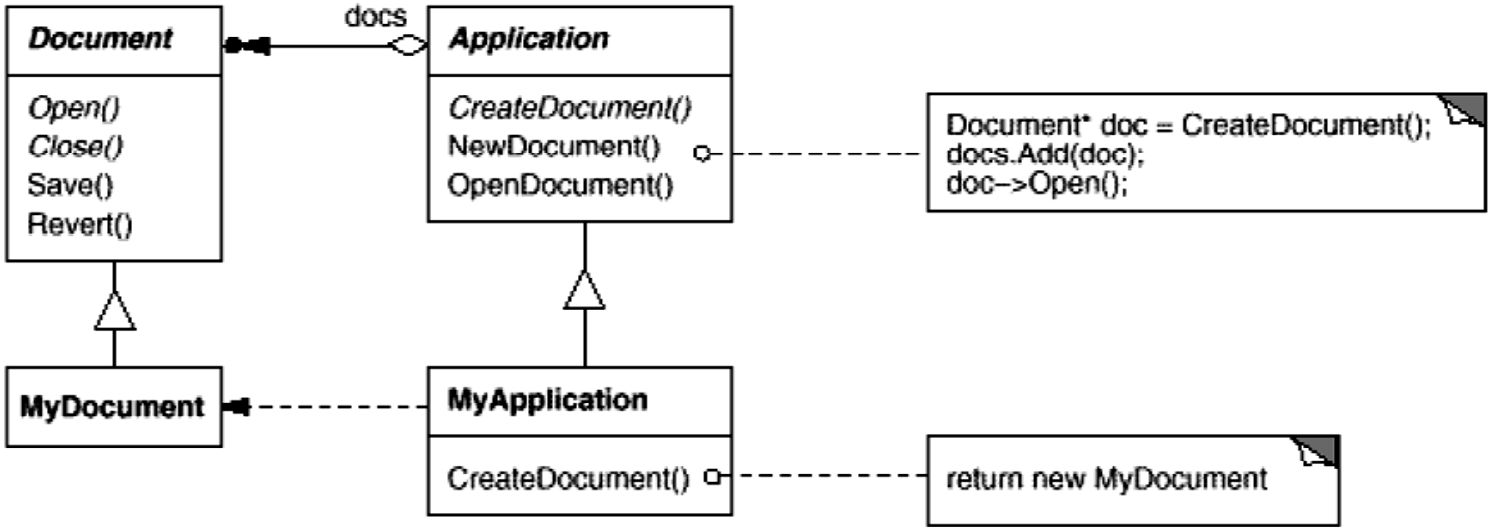
		Purpose		
		Creational	Structural	Behavioral
Scope	Class	Factory Method	Adapter (class)	Interpreter
				Template Method
	Object	Abstract Factory	Adapter (object)	Chain of Responsibility
		Builder	Bridge	Command
		Prototype	Composite	Iterator
		Singleton	Decorator	Mediator
			Facade	Memento
			Flyweight	Observer
			Proxy	State
				Strategy
				Visitor

GoF Creational Patterns

- **Class**
  - ***Factory Method:*** Define an interface for creating an object, but let subclasses decide which class to instantiate. Factory method lets a class defer instantiation to subclasses.
- **Object**
  - ***Abstract Factory:*** Provide an interface for creating families of related or dependent objects without specifying their concrete class.
  - ***Builder:*** Separate the construction of a complex object from its representation so that the same construction process can create different representations.
  - ***Prototype:*** Specify the kinds of objects to create using a prototypical instance, and create new objects by copying this prototype.
  - ***Singleton:*** Ensure a class only has one instance, and provide a global point of access to it.

Factory Method

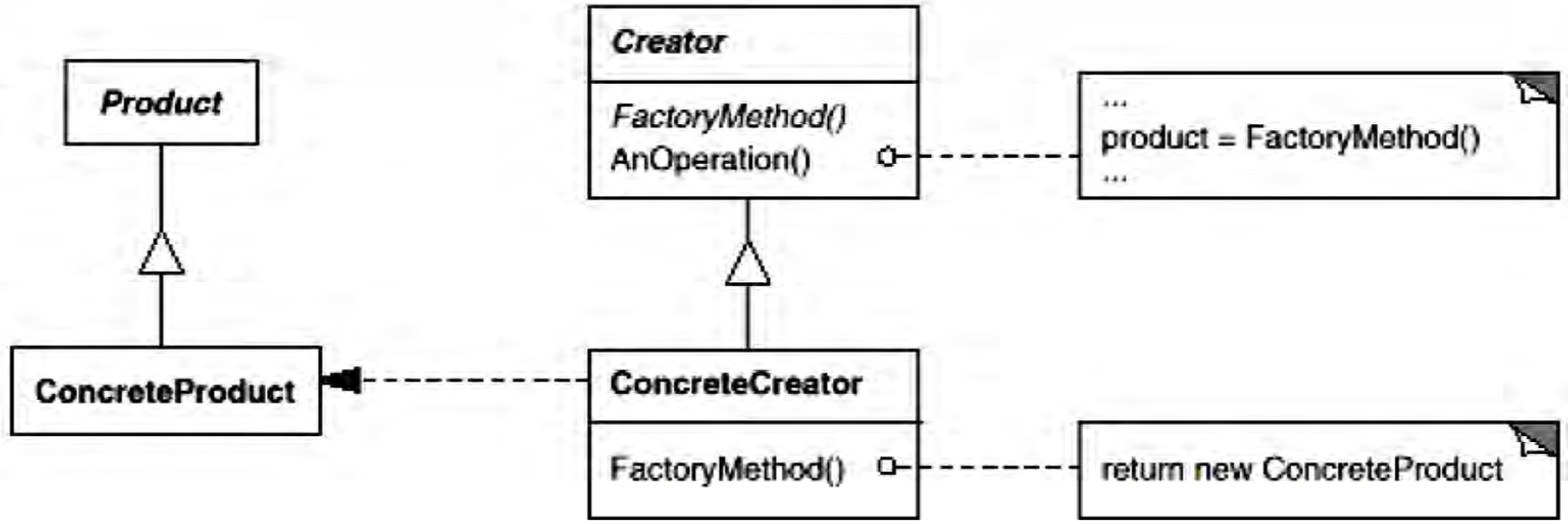
- Intent:
  - Define an interface for creating an object, but let subclasses decide which class to instantiate. Factory Method lets a class defer instantiation to subclasses.



Factory Method: Applicability

- Use the Factory Method pattern when
  - a class can't anticipate the class of objects it must create.
  - a class wants its subclasses to specify the objects it creates.
  - classes delegate responsibility to one of several helper subclasses, and you want to localize the knowledge of which helper subclass is the delegate.

Factory Method: Structure

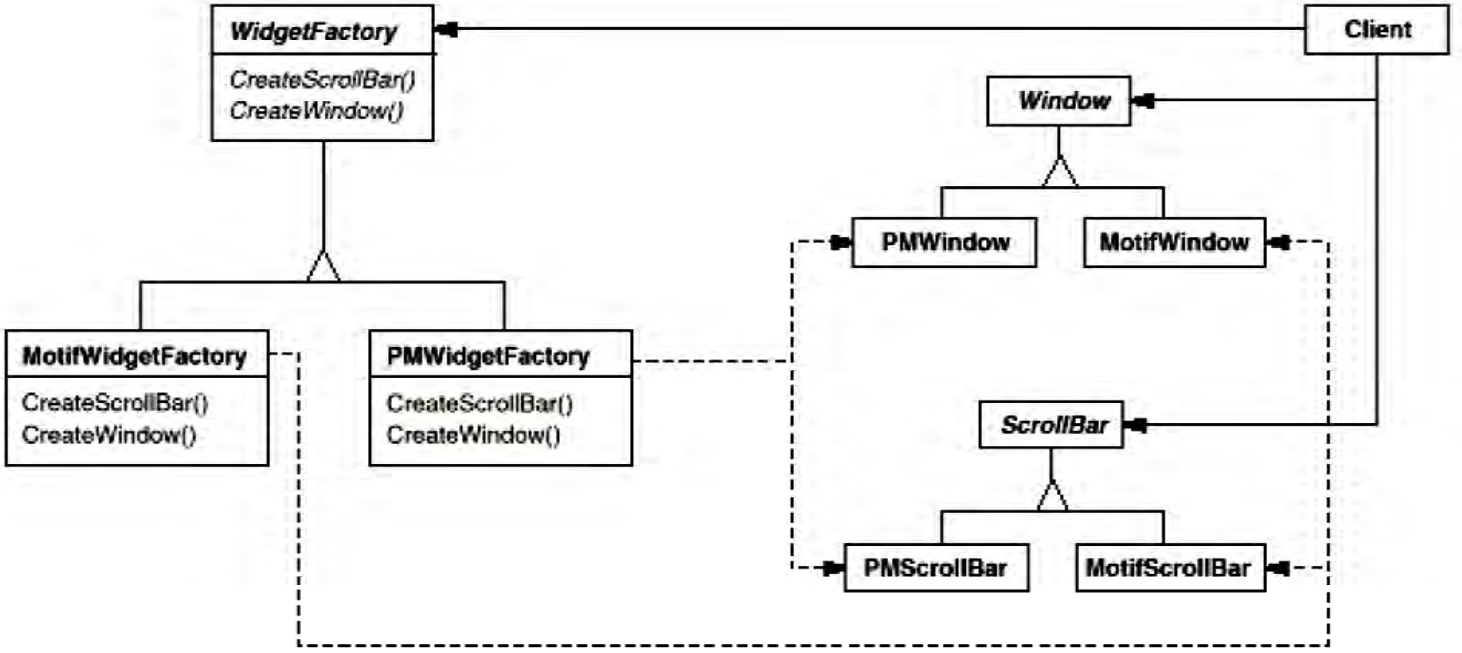


Factory Method: Consequences

- ✓ *It provides hooks for the subclasses.*
- ✓ *It connects parallel class hierarchies.*

Abstract Factory

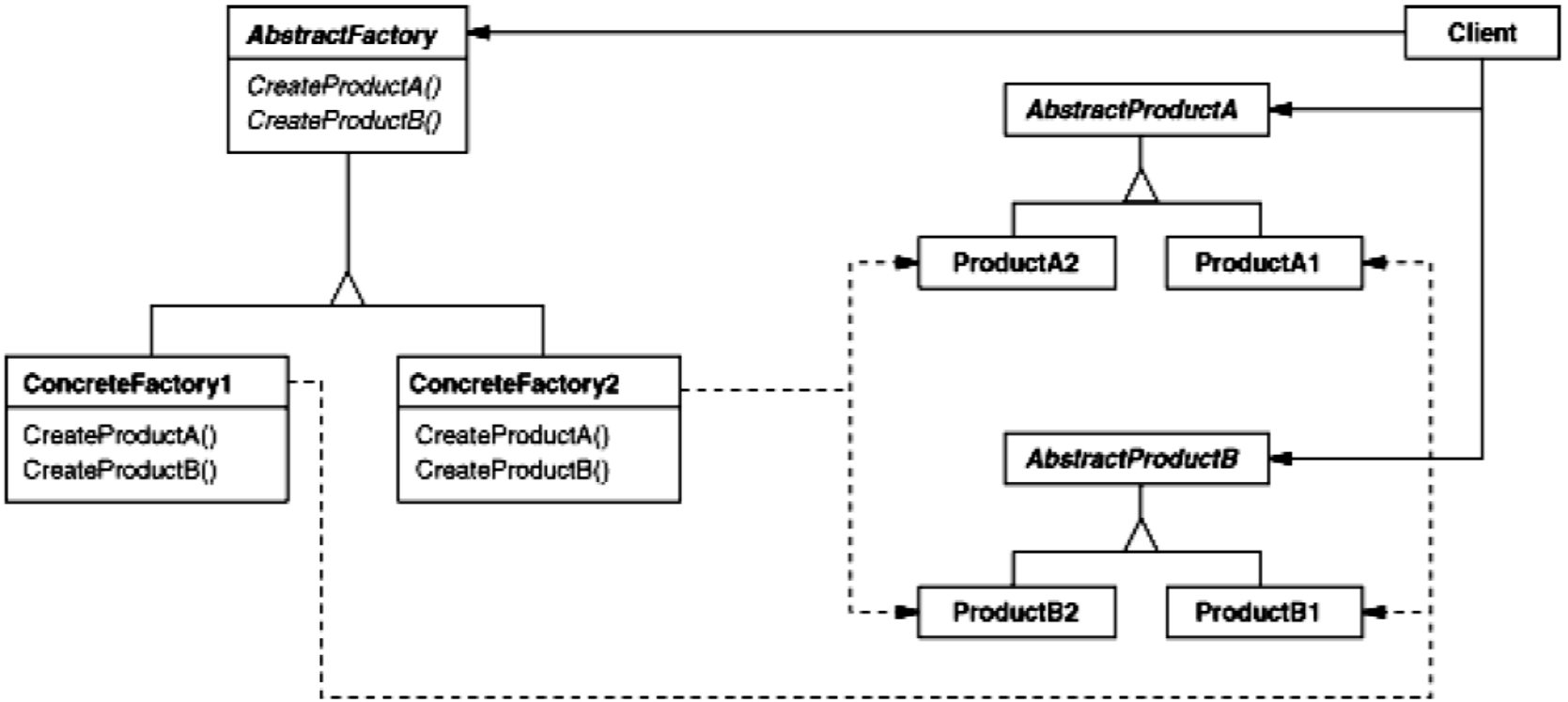
- Intent:
  - Provide an interface for creating families of related or dependent objects without specifying their concrete classes.



Abstract Factory: Applicability

- Use the Abstract Factory pattern when
  - a system should be independent of how its products are created, composed, and represented.
  - a system should be configured with one of multiple families of products.
  - a family of related product objects is designed to be used together, and you need to enforce this constraint.
  - you want to provide a class library of products, and you want to reveal just their interfaces, not their implementations.

Abstract Factory: Structure



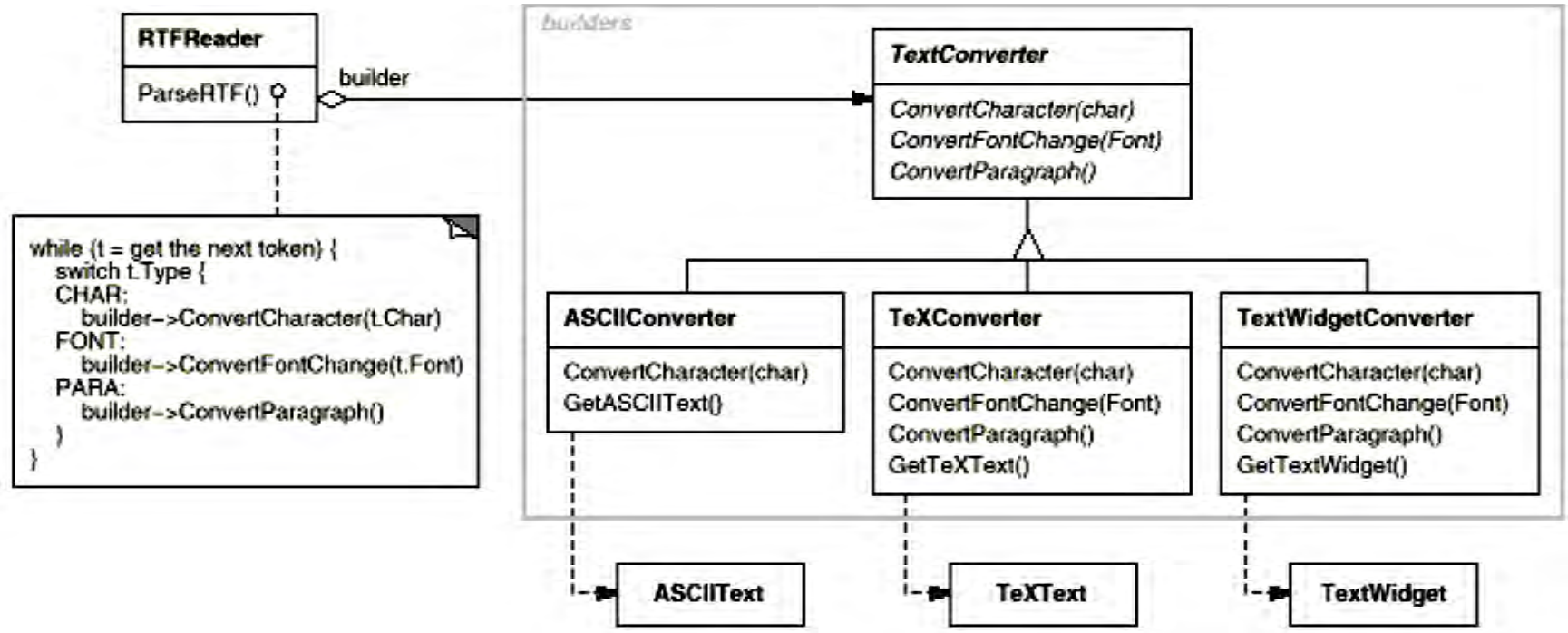
Abstract Factory: Consequences

- ✓ *Concrete classes are isolated.* Clients manipulate instances through their abstract interfaces.
- ✓ *Exchanging product families is easy.* Different product configurations can be used simply by changing the concrete factory.
- ✓ *Consistency among products is promoted.*

- ✗ *Supporting new kinds of products is difficult.* The AbstractFactory interface fixes the set of products that can be created.

Builder

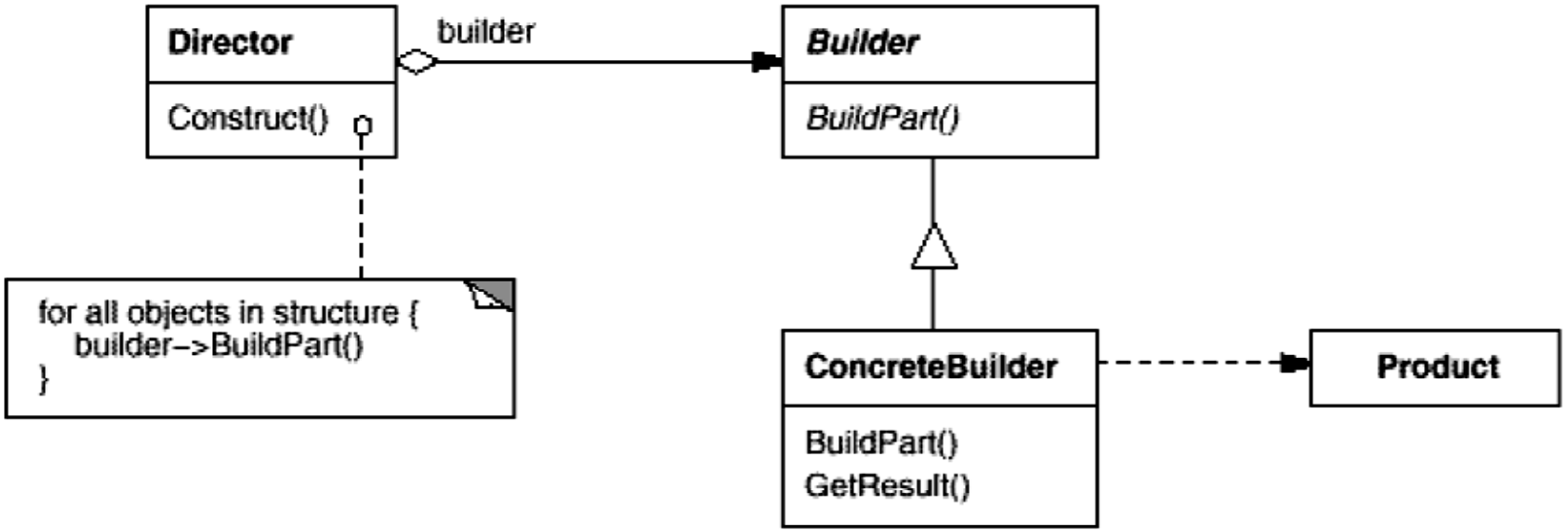
- Intent:
  - Separate the construction of a complex object from its representation so that the same construction process can create different representations.



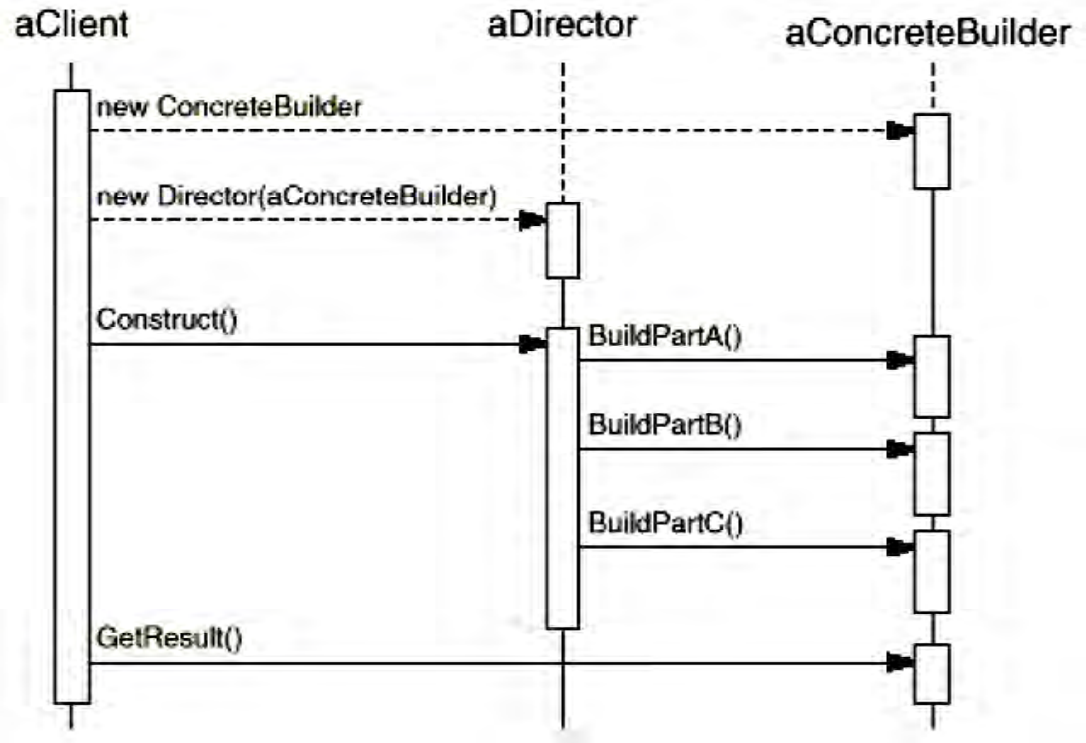
Builder: Applicability

- Use the Builder pattern when
  - the algorithm for creating a complex object should be independent of the parts that make up the object and how they're assembled.
  - the construction process must allow different representations for the object that's constructed.

Builder: Structure



Builder: Collaborations

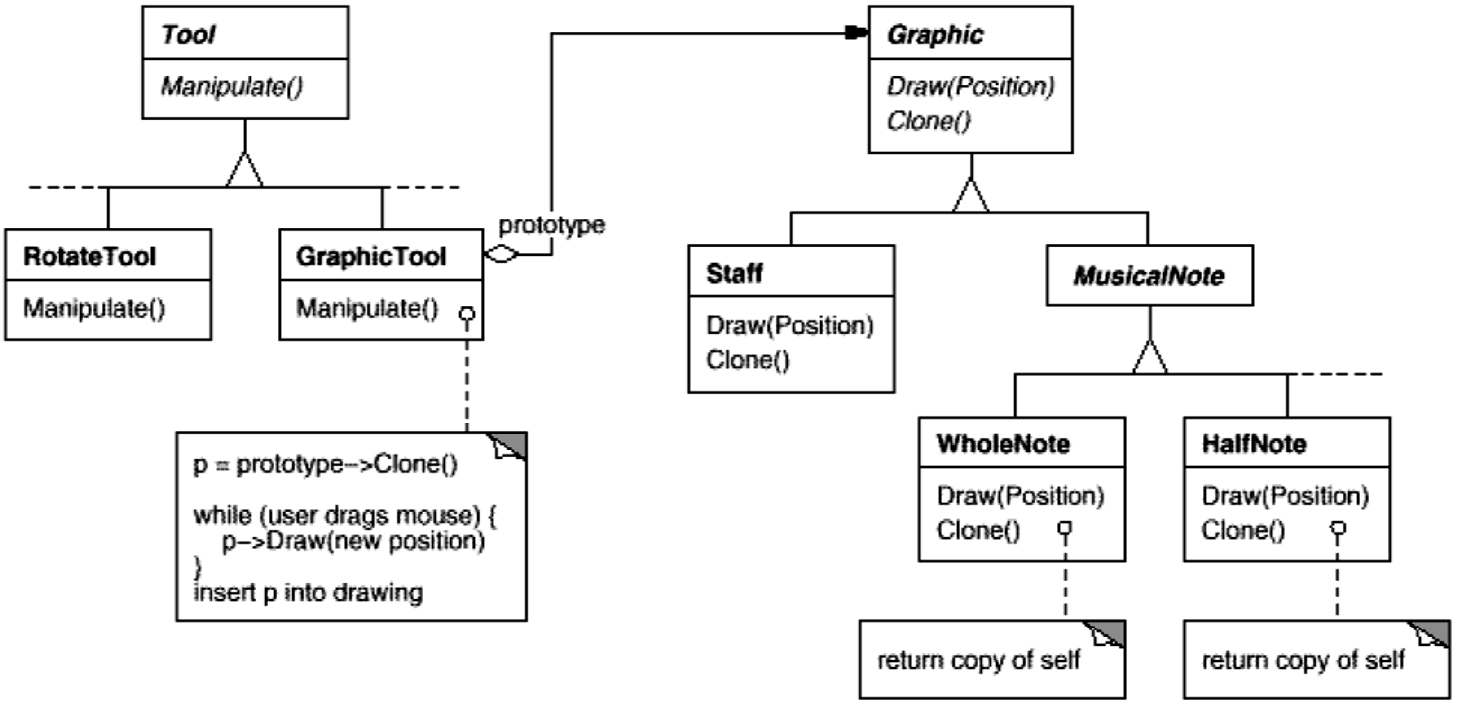


Builder: Consequences

- ✓ *It lets you vary a product's internal representation.*
- ✓ *It isolates code for construction and representation.*
- ✓ *It gives you finer control over the construction process:* Since the Builder pattern constructs the product step by step under the director's control.

Prototype

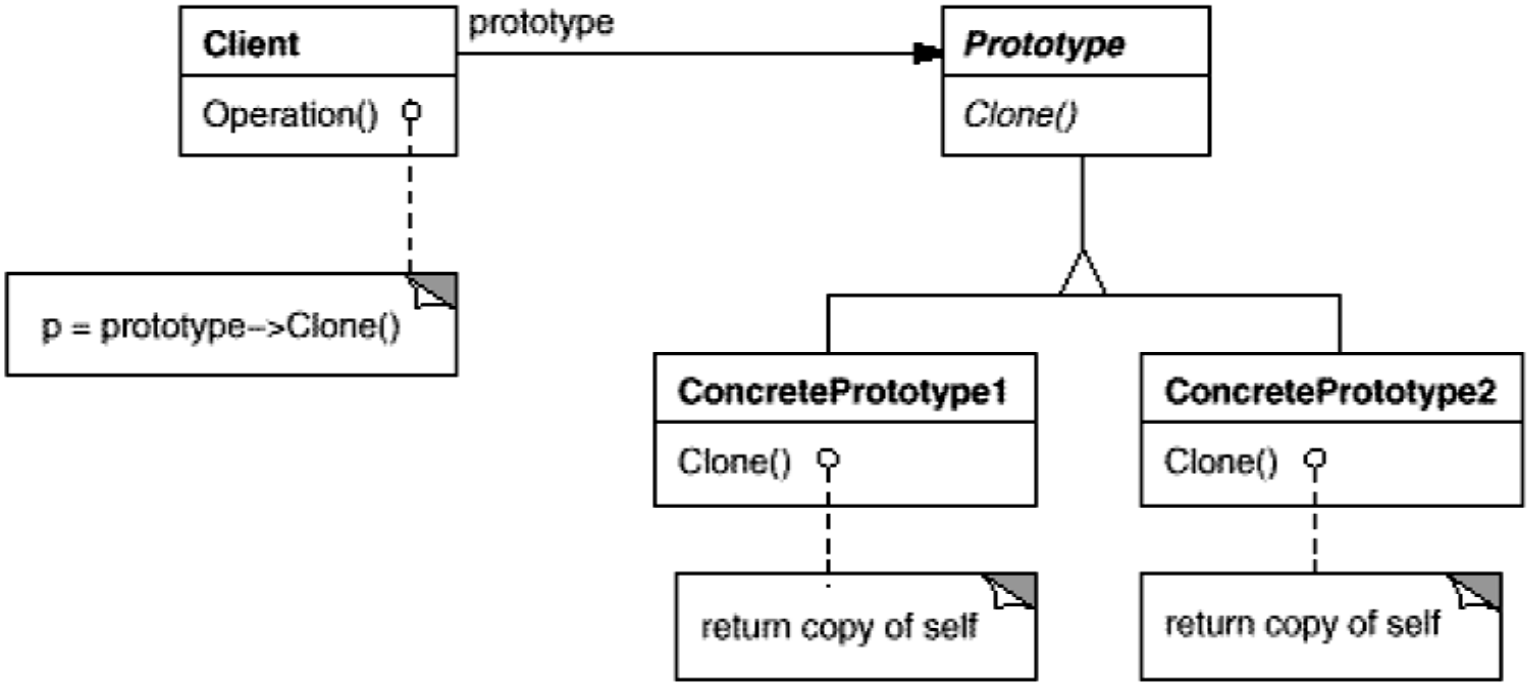
- Intent:
  - Specify the kinds of objects to create using a prototypical instance, and create new objects by copying this prototype.



Prototype: Applicability

- Use the Prototype pattern when
  - the classes to instantiate are specified at run-time, for example, by dynamic loading.
  - building a class hierarchy of factories that parallels the class hierarchy of products should be avoided.
  - instances of a class can have one of only a few different combinations of state.
    - It may be more convenient to install a corresponding number of prototypes and clone them rather than instantiating the class manually.

Prototype: Structure

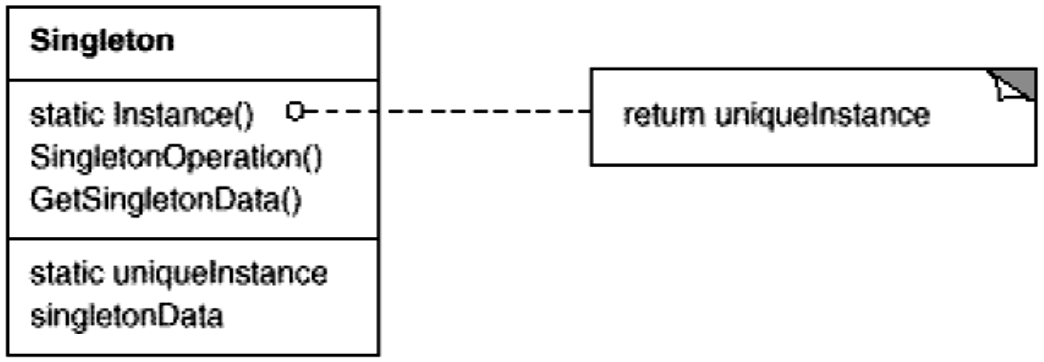


Prototype: Consequences

- ✓ *It hides the concrete product classes from the clients, thereby reducing the number of names clients know about.*
- ✓ *It lets a client work with application-specific classes without modification.*
- ✓ *It lets you add and remove products at run-time.*
- ✓ *It lets you specify new objects by varying values.*

Singleton

- Intent:
  - Ensure a class only has one instance, and provide a global point of access to it.



Singleton: Applicability

- Use the Singleton pattern when
  - there must be exactly one instance of a class, and it must be accessible to clients from a well known access point.
  - when the sole instance should be extensible by subclassing, and clients should be able to use an extended instance without modifying their code.

Singleton: Consequences

- ✓ *It provides Controlled access to sole instance.*
- ✓ *It reduces the name space by avoiding global variables.*
- ✓ *It permits refinement of operations and representation through subclassing.*
- ✓ *It permits a variable number of instances.*
- ✓ *It is more flexible than class operations.*

Reference

- Gamma, E., Helm, R., Johnson, R., and Vlissides, J., *Design Patterns: Elements of Reusable Object-oriented Software.* Addison-Wesley, 1995.