# Object-Oriented Design

**Lecturer: Raman Ramsin**

**Lecture 20:**

GoF Design Patterns – Creational

# Software Patterns

- Software Patterns support reuse of software architecture and design.
    - Patterns capture the static and dynamic structures and collaborations of successful solutions to problems that arise when building applications in a particular domain.
- Patterns represent solutions to problems that arise when developing software within a particular context.
    - i.e., “Pattern == problem/solution pair in a context”

# GoF Design Patterns – Principles

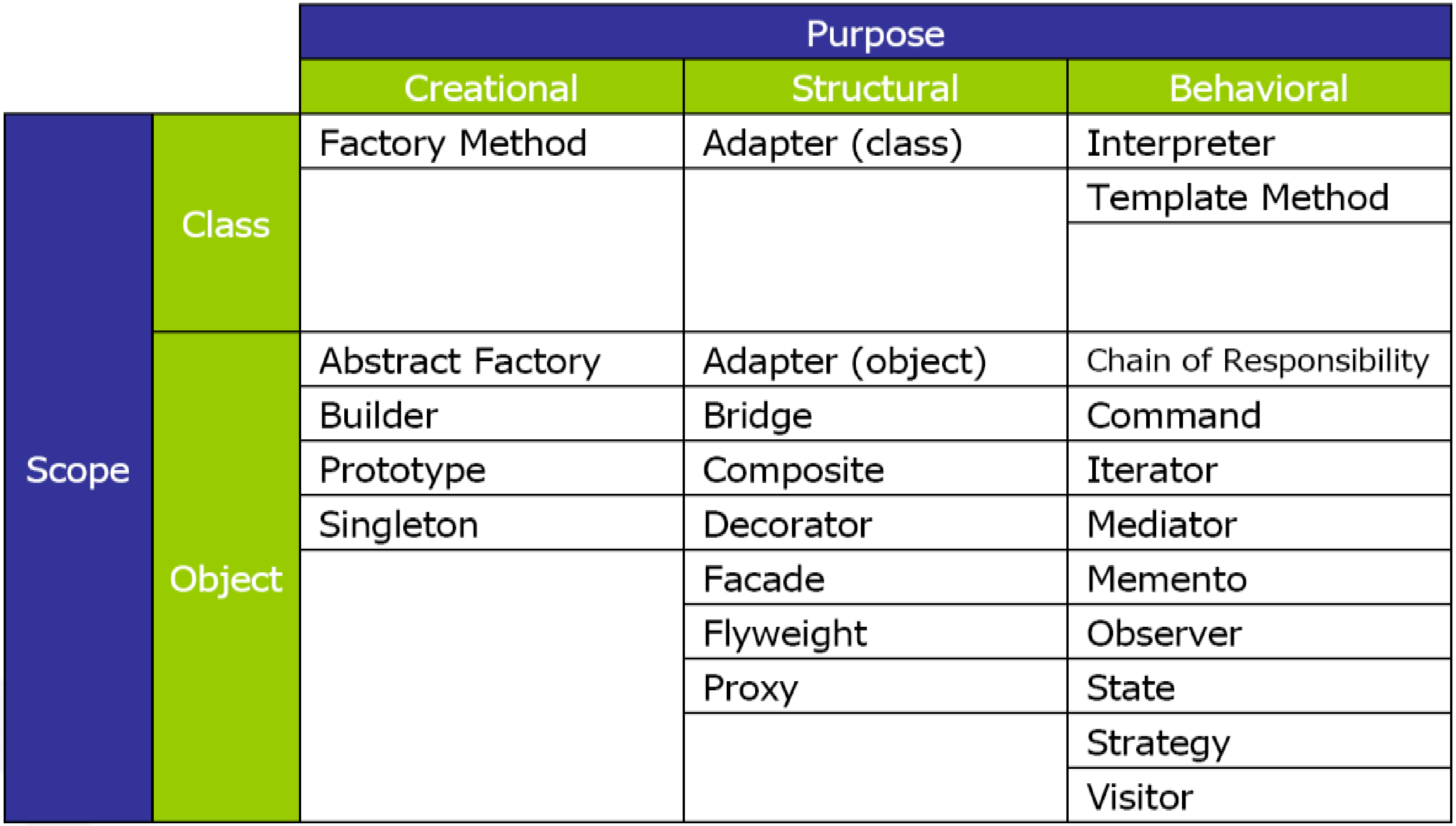
- Emphasis on flexibility and reuse through decoupling of classes.

- 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



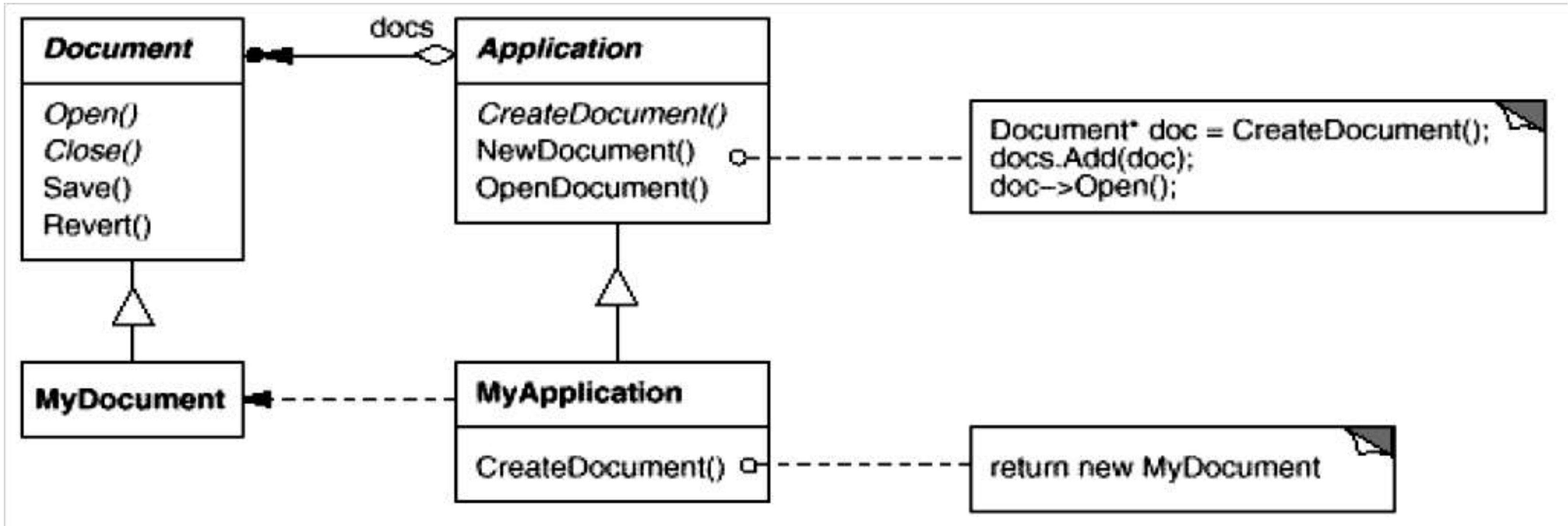
| | | Purpose | | |
|---|---|---|---|---|
| | | Creational | Structural | Behavioral |
| Scope | Class | Factory Method | Adapter (class) | Interpreter |
| | | | | Template Method |
| | Object | Abstract Factory | Adapter (object) | Chain of Responsibility |
| | | Builder | Bridge | Command |
| | | Prototype | 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

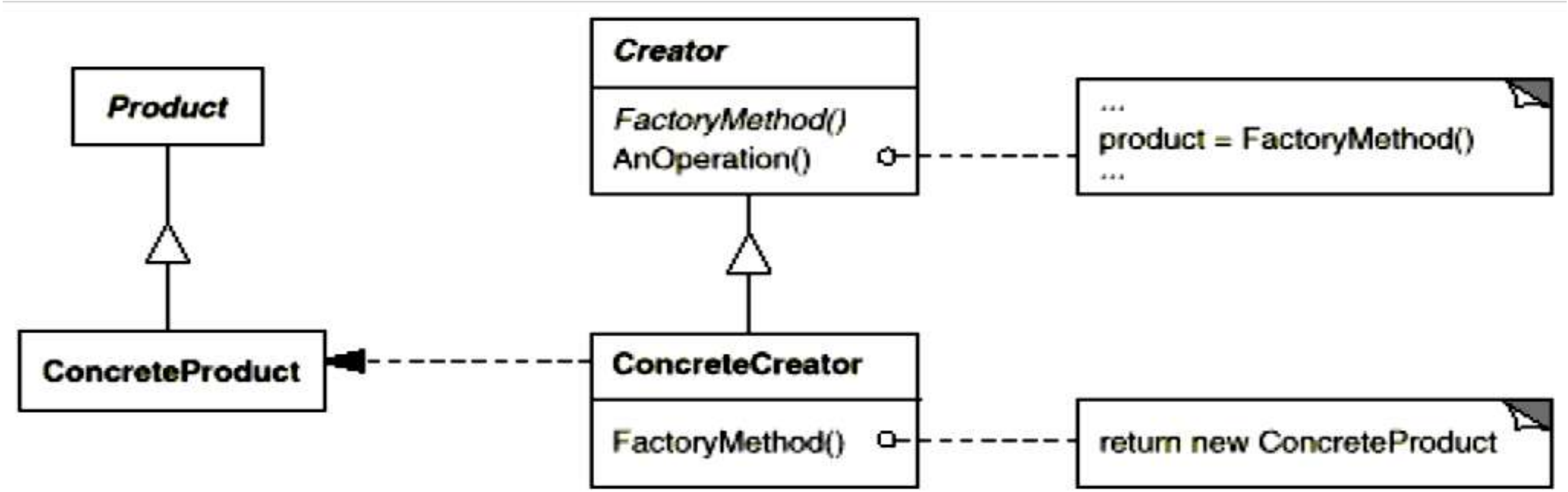
- Intent:
  - Define an interface for creating an object, but let subclasses decide which class to instantiate. Factory Method lets a class defer instantiation to subclasses.



# Factory Method: Applicability

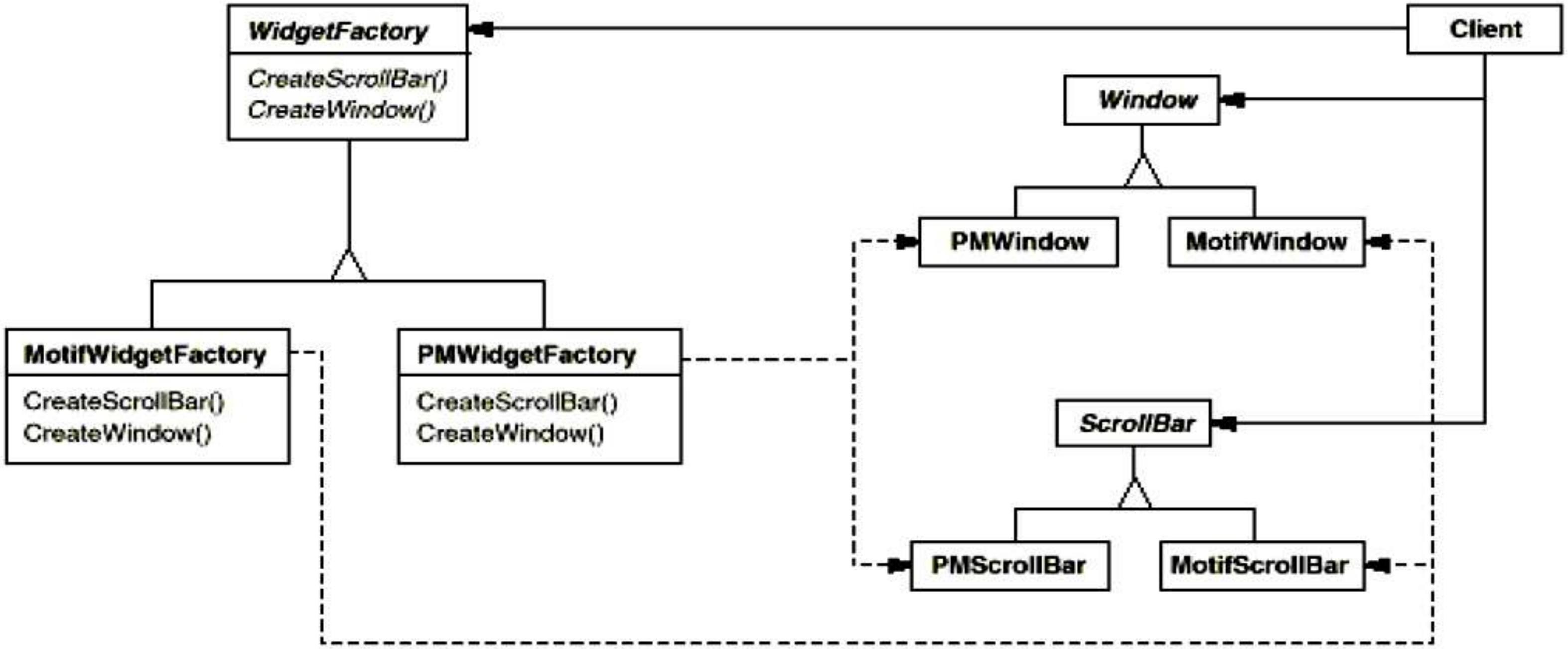
- Use the Factory Method pattern when
  - a class can't anticipate the class of objects it must create.
  - a class wants its subclasses to specify the objects it creates.
  - classes delegate responsibility to one of several helper subclasses, and you want to localize the knowledge of which helper subclass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

# Factory Method: Structure



# Abstract Factory

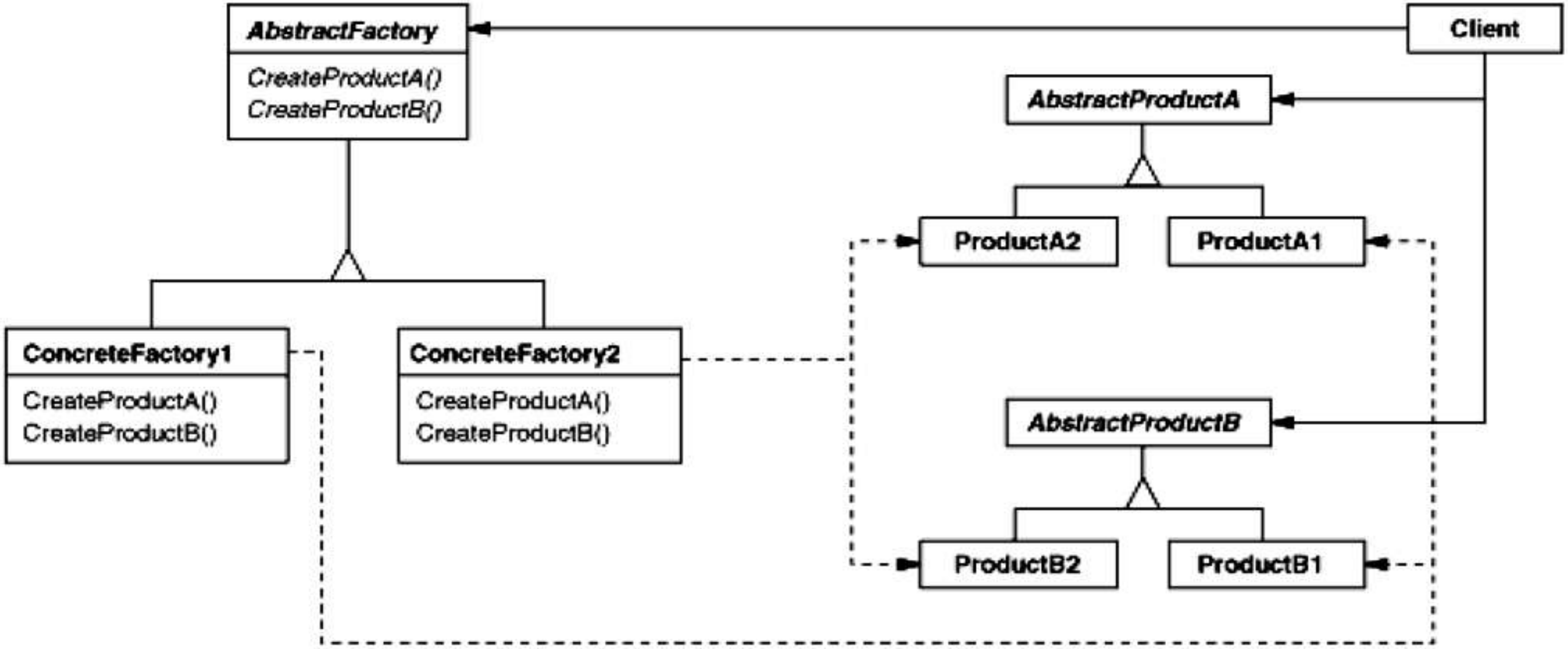
- Intent:
  - □ Provide an interface for creating families of related or dependent objects without specifying their concrete classes.



# Abstract Factory: Applicability

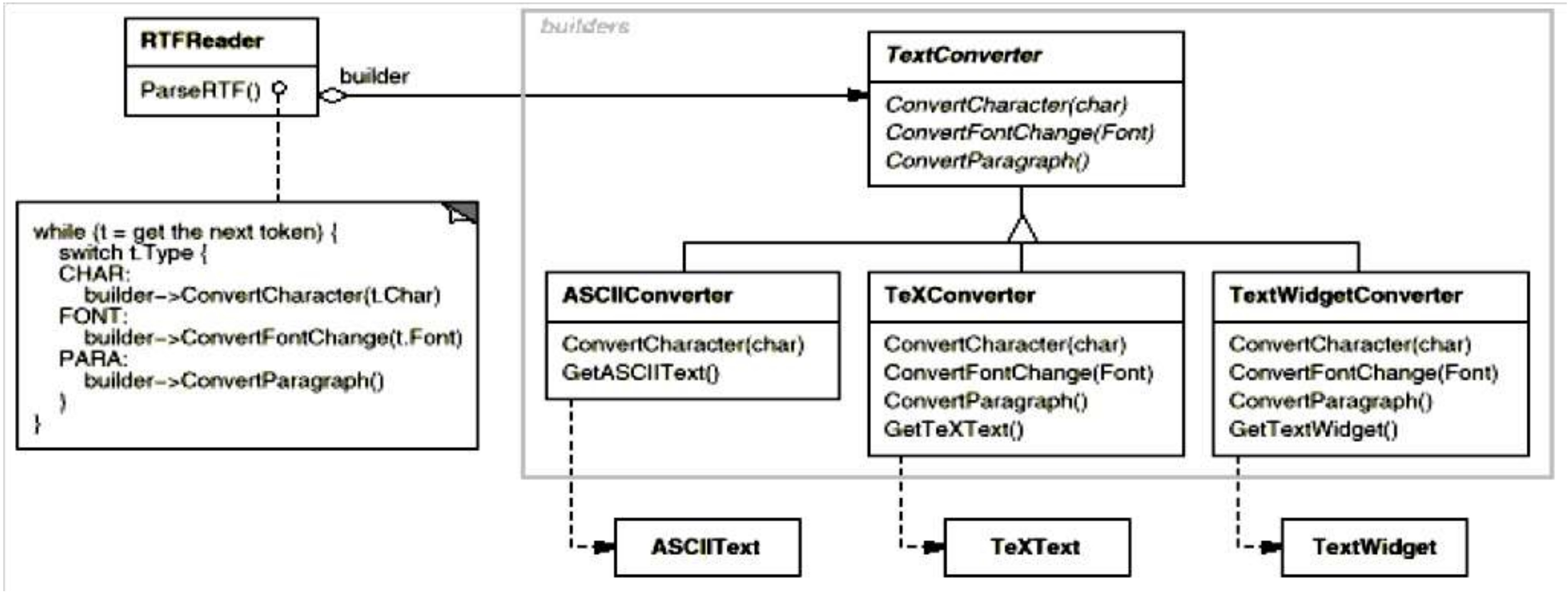
- Use the Abstract Factory pattern when
  - □ a system should be independent of how its products are created, composed, and represented.
  - □ a system should be configured with one of multiple families of products.
  - □ a family of related product objects is designed to be used together, and you need 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



# Builder

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

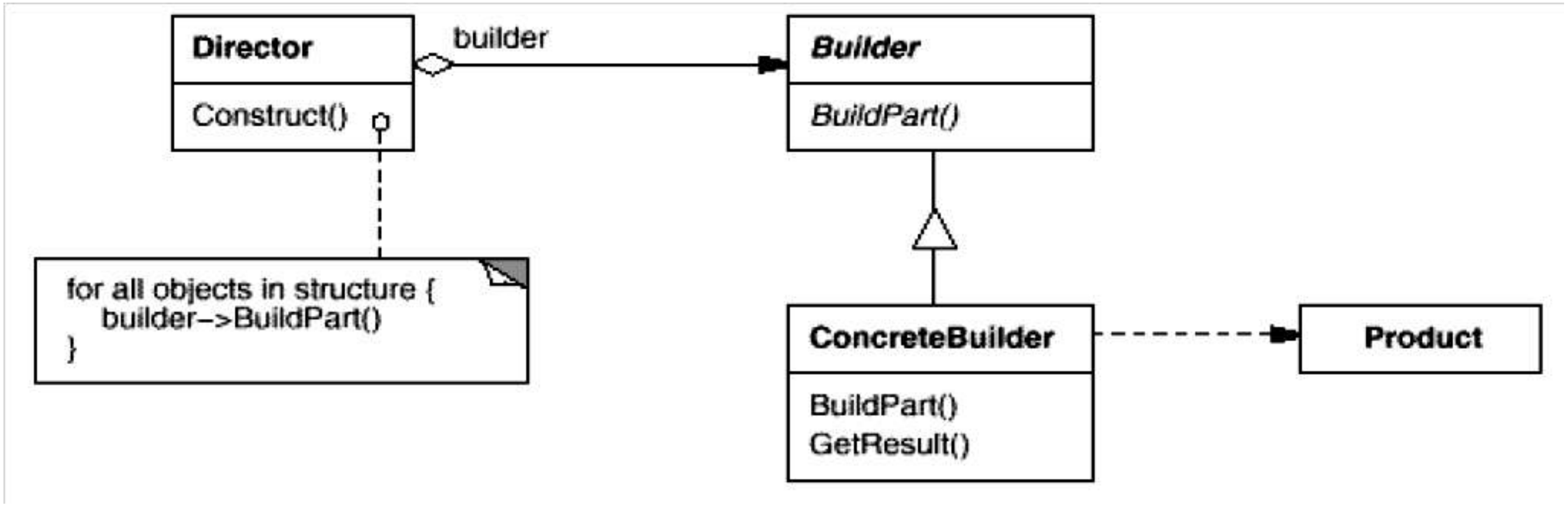


```
while (t = get the next token) {
    switch t.Type {
    CHAR:
        builder->ConvertCharacter(t.Char)
    FONT:
        builder->ConvertFontChange(t.Font)
    PARA:
        builder->ConvertParagraph()
    }
}
```

# Builder: Applicability

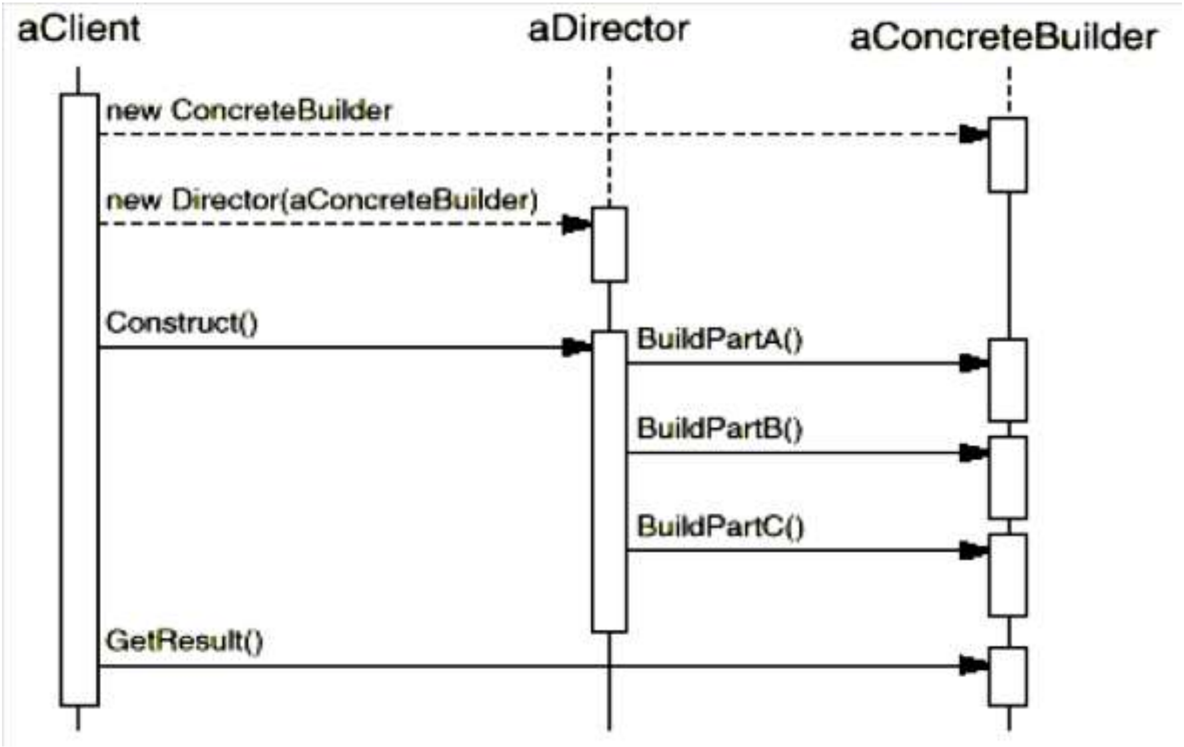
- Use the Builder pattern when
  - the algorithm for creating a complex object should be independent of the parts that make up the object and how they're assembled.
  - the construction process must allow different representations for the object that's constructed.

# Builder: Structure



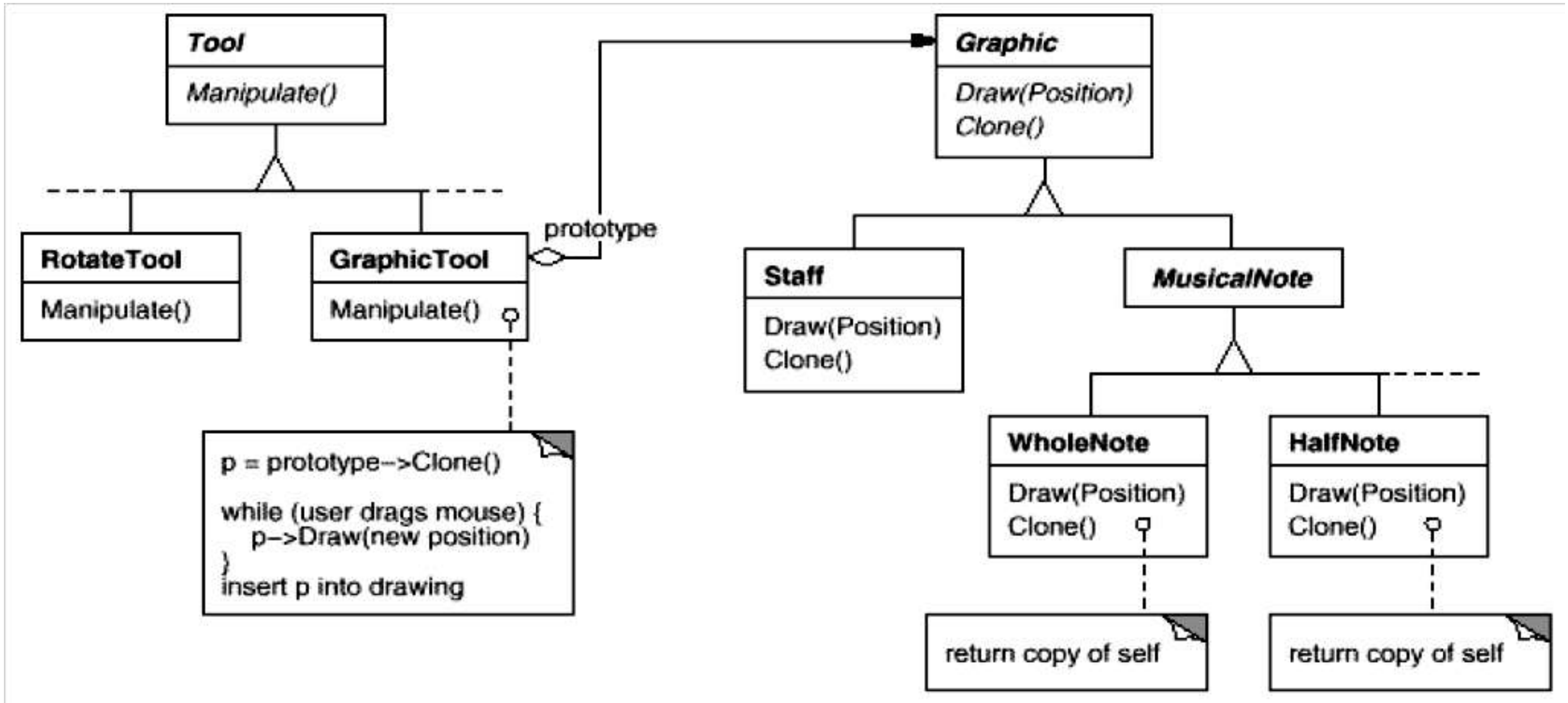
```
for all objects in structure {
    builder->BuildPart()
}
```

# Builder: Collaborations



# Prototype

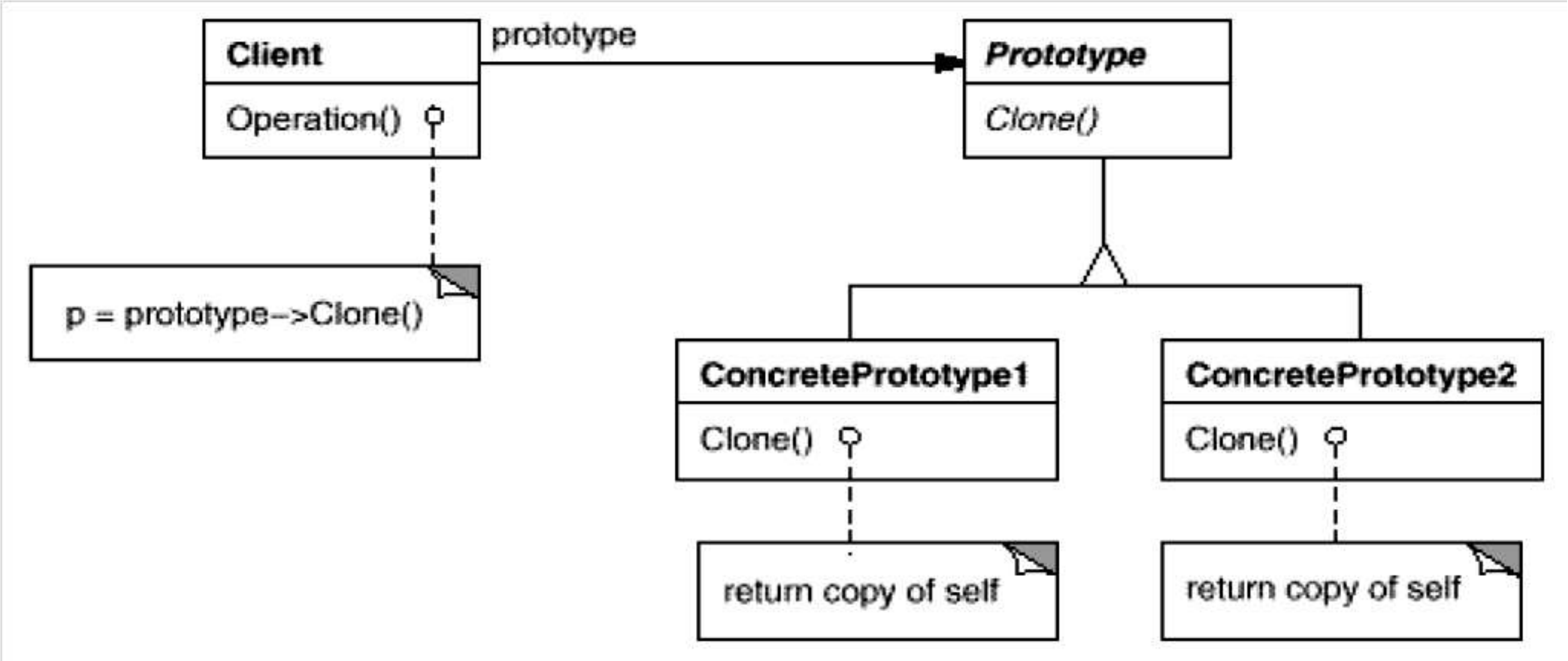
- Intent:
  - Specify the kinds of objects to create using a prototypical instance, and create new objects by copying this prototype.



# Prototype: Applicability

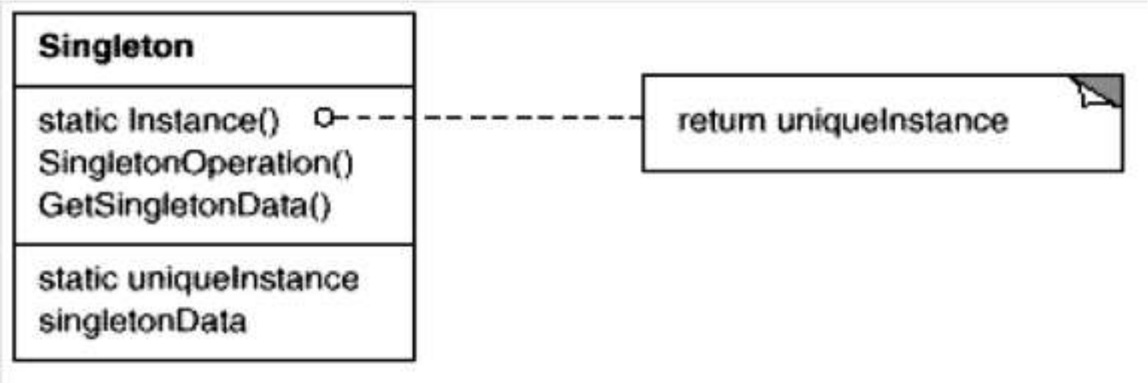
- Use the Prototype pattern when
  - the classes to instantiate are specified at run-time, for example, by dynamic loading.
  - building a class hierarchy of factories that parallels the class hierarchy of products should be avoided.
  - instances of a class can have one of only a few different combinations 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



# 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.

# Reference

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