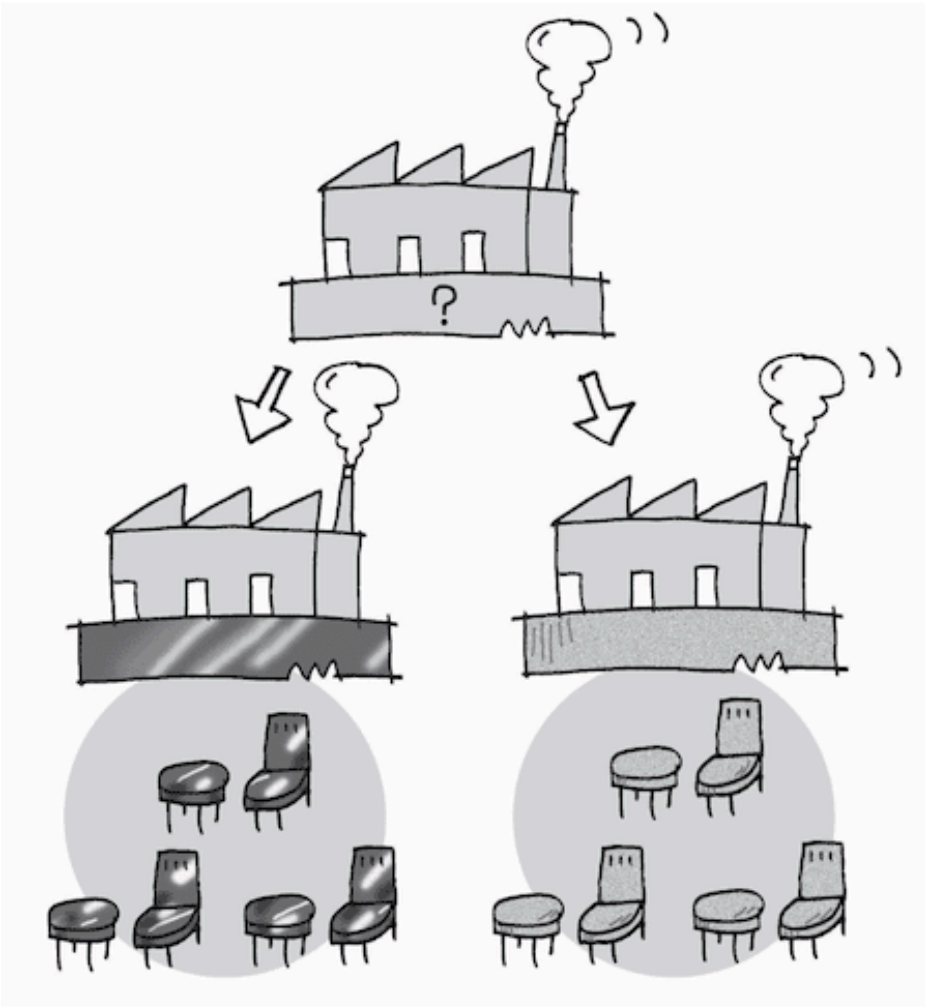
Abstract Factory Pattern

Combine Related Parts to Make a Product



Abstract Factory Pattern

LG and Samsung both follow the same **manufacturing interface** (make TV + controller),
but each produces its own **product family**:

- LG → QLED TV + LG controller
- Samsung → Quantum TV + Samsung controller

The Problem

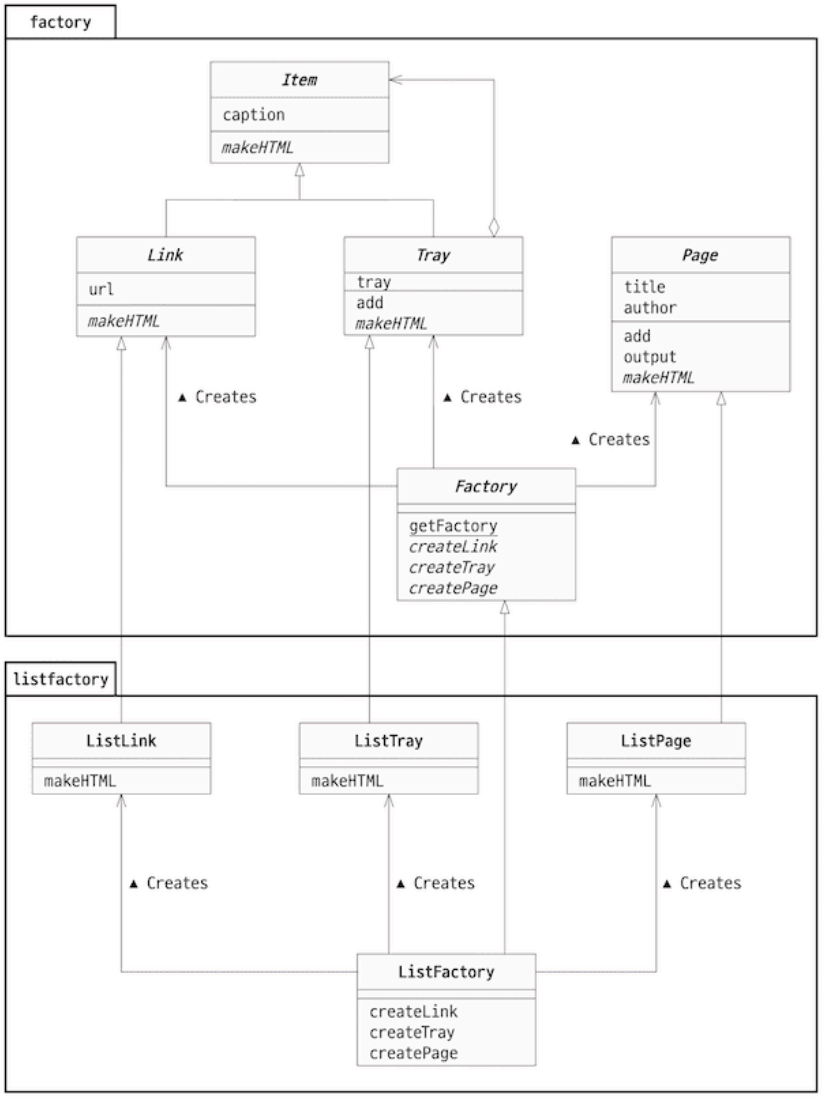
- We need to create **HTML pages** with different styling approaches.
- We want to create related products (**Link**, **Tray**, **Page**) that work together.
- Different **factories** create products in different ways, but the GUI structure should remain the same.

The challenge: how to create **families of related objects** without specifying their **concrete classes** and ensure they work together?

The *Abstract Factory* as the Solution

- We have an abstraction *Abstract Factory* that creates families of related *products*.
- We do not need to `know` about the specific **factory implementation**, we only need to `use` the *abstract interface* to create consistent products.

The Solution (Design)



Step 1: Understand the Players

In this design, we have players:

- *Abstract Factory*
    - **Concrete Factory** (ListFactory, DivFactory)
- *Abstract Product* (Link, Tray, Page)
    - **Concrete Product** (ListLink, DivLink, etc.)

We have the code that uses the factory:

- **Client**

Step 2: Understand abstractions

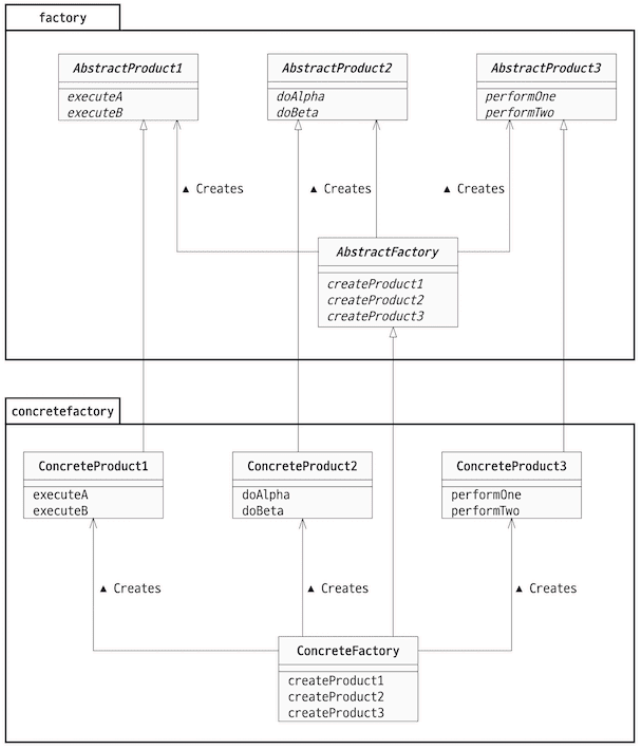
- We have an *Abstract Factory* that `creates` families of related *products*.
    - *Abstract Factory*
    - *Abstract Product* (Link, Tray, Page)
- In short, we use the *factory* to create related products that work together.
    - All products from the same factory are `compatible`.

Step 3: Understand concretion

- We have specific/concrete **ListFactory** and **DivFactory** that create specific/concrete HTML **products** in different styles.
    - **ConcreteFactory** (ListFactory, DivFactory)
    - **ConcreteProduct** (ListLink, DivLink, ListTray, DivTray, etc.)

The Design

We have an abstract factory/product, and a matching concrete factory/product.



Code

- Main Method
- Factory Classes
- Product Classes

Main Method

```
def main():
    # Demo with ListFactory
    print("\n1. Creating page with ListFactory...")
    list_factory = ListFactory()
    list_page = create_content(list_factory)
    list_page.printit()

    # Demo with DivFactory
    print("\n2. Creating page with DivFactory...")
    div_factory = DivFactory()
    div_page = create_content(div_factory)
    div_page.printit()
```

Step 1: Get the appropriate factory

```
list_factory = ListFactory()
```

Step 2: Create related products using the factory

In the create_content() method:

```
    blog1 = factory.create_link("Python Tutorial", "https://python.org")
    blog_tray = factory.create_tray("Learning Resources")
    page = factory.create_page("My Bookmarks", "Student")
```

- All products created by the same factory are `compatible` and work together.
- The **client** doesn't know which concrete factory is being used.

Step 3: Compose products into a complete structure

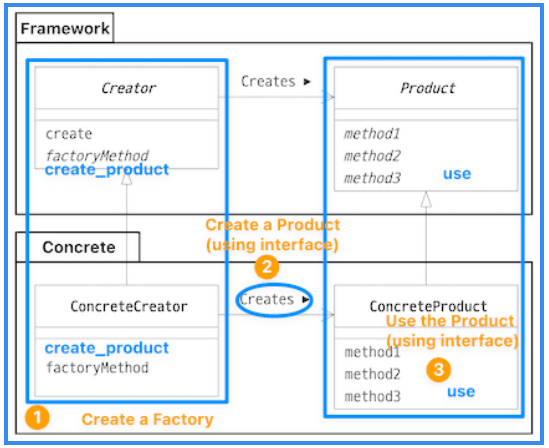
```
    blog_tray.add(blog1)
    blog_tray.add(blog2)

    page.add(blog_tray)
```

- Products from the same factory family can be `composed` together.
- The final result is a consistent HTML page with unified styling.

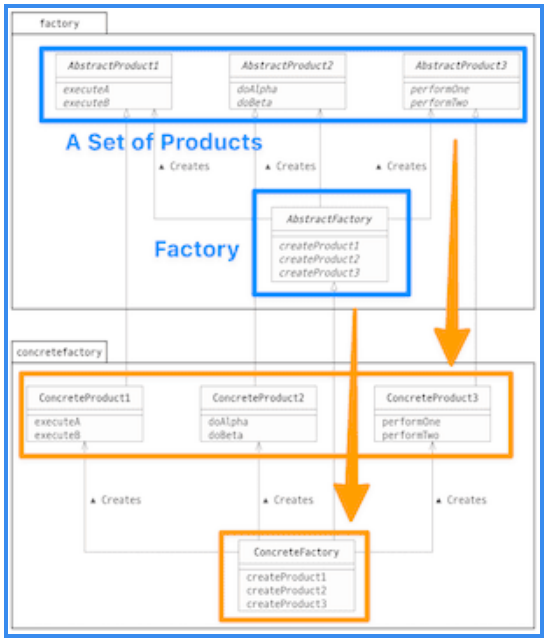
Discussion

What's the difference between the FactoryMethod pattern and the AbstractFactory pattern?

The FactoryMethod pattern is about creating a product with different configurations.



The AbstractFactory pattern is about creating a set of related products.



DIP

The client depends on abstractions (AbstractFactory and AbstractProduct) rather than concrete implementations - **Dependency Inversion Principle**

Key Benefits

1. **Consistency**: All products from the same factory work together
2. **Flexibility**: Easy to switch between different product families
3. **Isolation**: Client code is isolated from concrete classes
4. **Extensibility**: Easy to add new product families

Key Drawback

Abstract Factory pattern is **Difficult to extend**:

Adding a new type of product requires changing the AbstractFactory interface and all concrete factories.

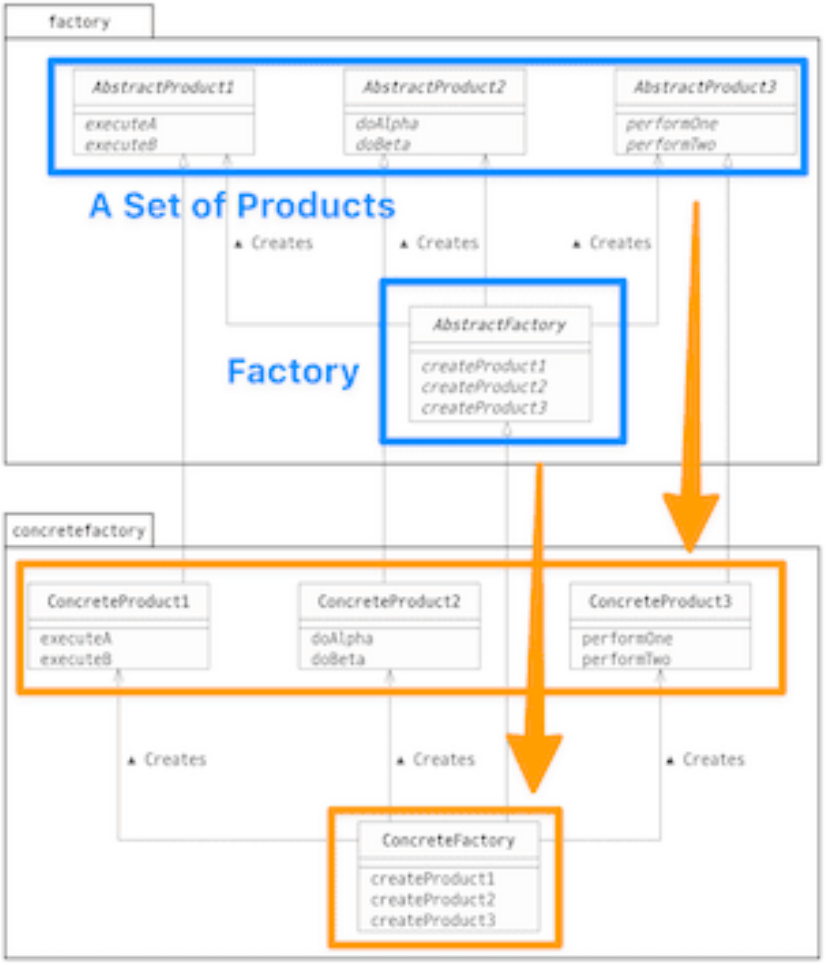
When to Use Abstract Factory

- When you need to create families of related products
- When you want to ensure products work together
- When you need to support multiple product lines
- When you want to hide concrete classes from clients

Related Patterns

- **Factory Method**: Abstract Factory uses Factory Method to create products
- **Singleton**: Factory instances are often Singletons
- **Prototype**: Products can be created by cloning prototypes

UML


factory
AbstractProduct1
executeA
executeB
AbstractProduct2
doAlpha
doBeta
AbstractProduct3
performOne
performTwo
A Set of Products
Creates
Creates
Creates
AbstractFactory
createProduct1
createProduct2
createProduct3
Factory
concretefactory
ConcreteProduct1
executeA
executeB
ConcreteProduct2
doAlpha
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ConcreteProduct3
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Creates
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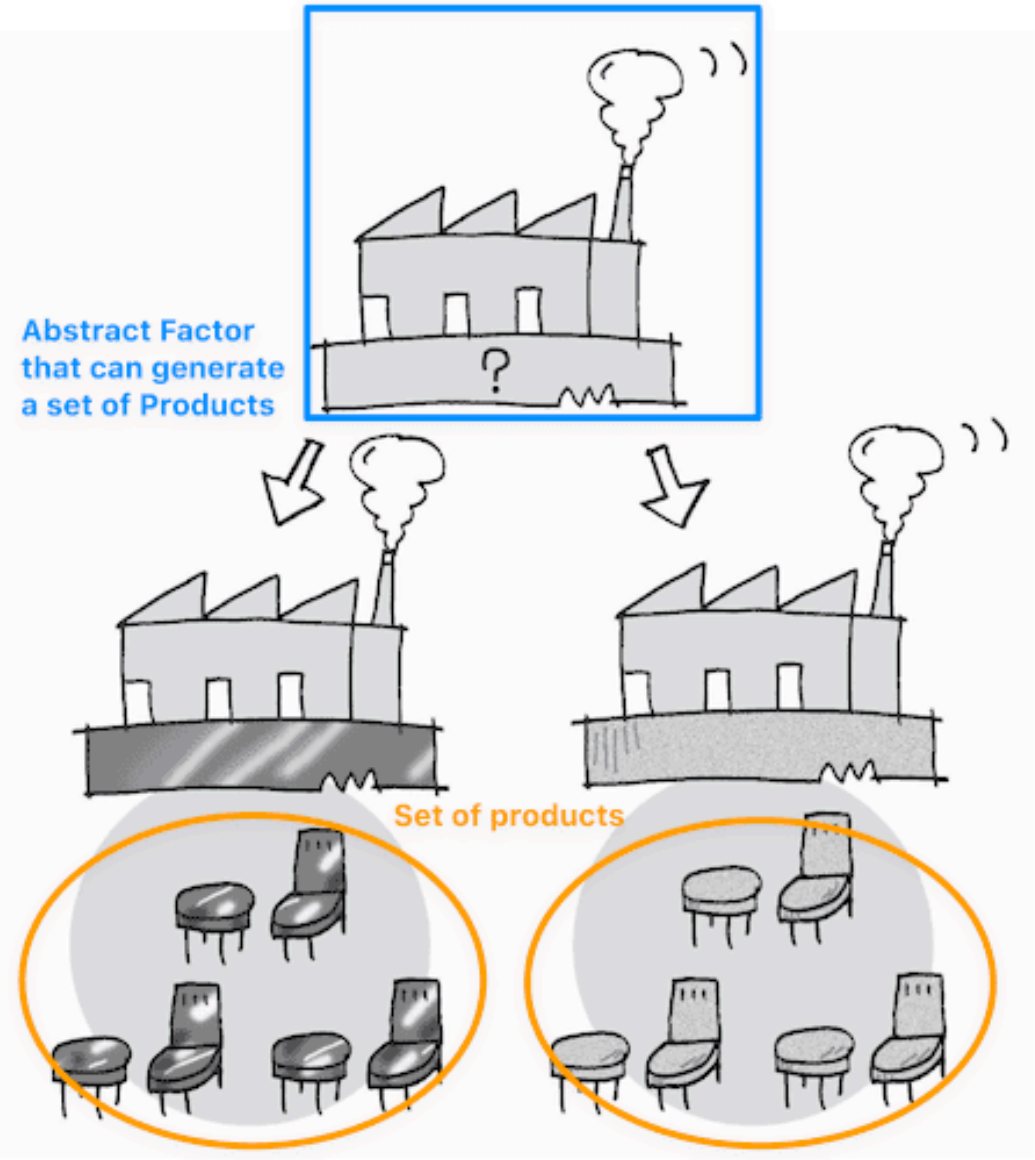
Abstract Factor
that can generate
a set of Products
?
Set of products