CS 130 SOFTWARE ENGINEERING

DESIGN PATTERNS

FACTORY, ABSTRACT FACTORY

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AGENDA

- Factory Method
- Abstract Factory

LOGISTICS

- You can download the head first design patterns code examples from the syllabus website.
- I also uploaded design patterns cheat sheet to CCLE (shared by a previous student who went to Yahoo).

THE FACTORY METHOD PATTERN

CALLING THE CONSTRUCTOR

```
Duck duck;
if (picnic) {
  duck = new MallardDuck();
} else if (hunting) {
  duck = new DecoyDuck();
} else if (inBathTub) {
  duck = new RubberDuck();
}
```

This type of code will often lead to problems when new types have to be added.

ANOTHER EXAMPLE IN SIMILAR VEIN

```
Pizza orderPizza(String type){
   if (type.equals( “cheese” )) {
     pizza = new CheesePizza();
   } else if type.equals( “greek” )) {
   pizza = new GreekPizza();
   } else if type.equals( “pepperoni” )) {
   pizza = new PepperoniPizza();
   }
  pizza.prepare();
  pizza.bake();
  pizza.cut();
  pizza.box()
}
```

IDENTIFYING THE ASPECTS THAT VARY

- If the pizza shop decides to change the types of pizza it offers, the orderPizza method has to be changed.

ANOTHER EXAMPLE IN SIMILAR VEIN

```
Pizza orderPizza(String type){
    if (type.equals( “cheese” )) {
      pizza = new CheesePizza();
    } else if type.equals( “greek” )) {
    pizza = new GreekPizza();
    } else if type.equals( “pepperoni” )) {
    pizza = new PepperoniPizza();
    }
   pizza.prepare();
   pizza.bake();
   pizza.cut();
   pizza.box()
}
```

Part that varies.

Part that remains constant

ENCAPSULATING OBJECT CREATION

```
if (type.equals( “cheese” )) {
  pizza = new CheesePizza();
} else if type.equals( “greek” )) {
pizza = new GreekPizza();
} else if type.equals( “pepperoni” )) {
pizza = new PepperoniPizza();
}
```

SimplePizzaFactory

BUILDING A SIMPLE PIZZA FACTORY

```
public class SimplePizzaFactory {
   public Pizza createPizza(String type) {
        Pizza pizza = null;
        if (type.equals("cheese")) {
                pizza = new CheesePizza();
        } else if (type.equals("pepperoni")) {
                pizza = new PepperoniPizza();
        } else if (type.equals("clam")) {
                pizza = new ClamPizza();
        } else if (type.equals("veggie")) {
                pizza = new VeggiePizza();
        }
        return pizza;
   }
}
```

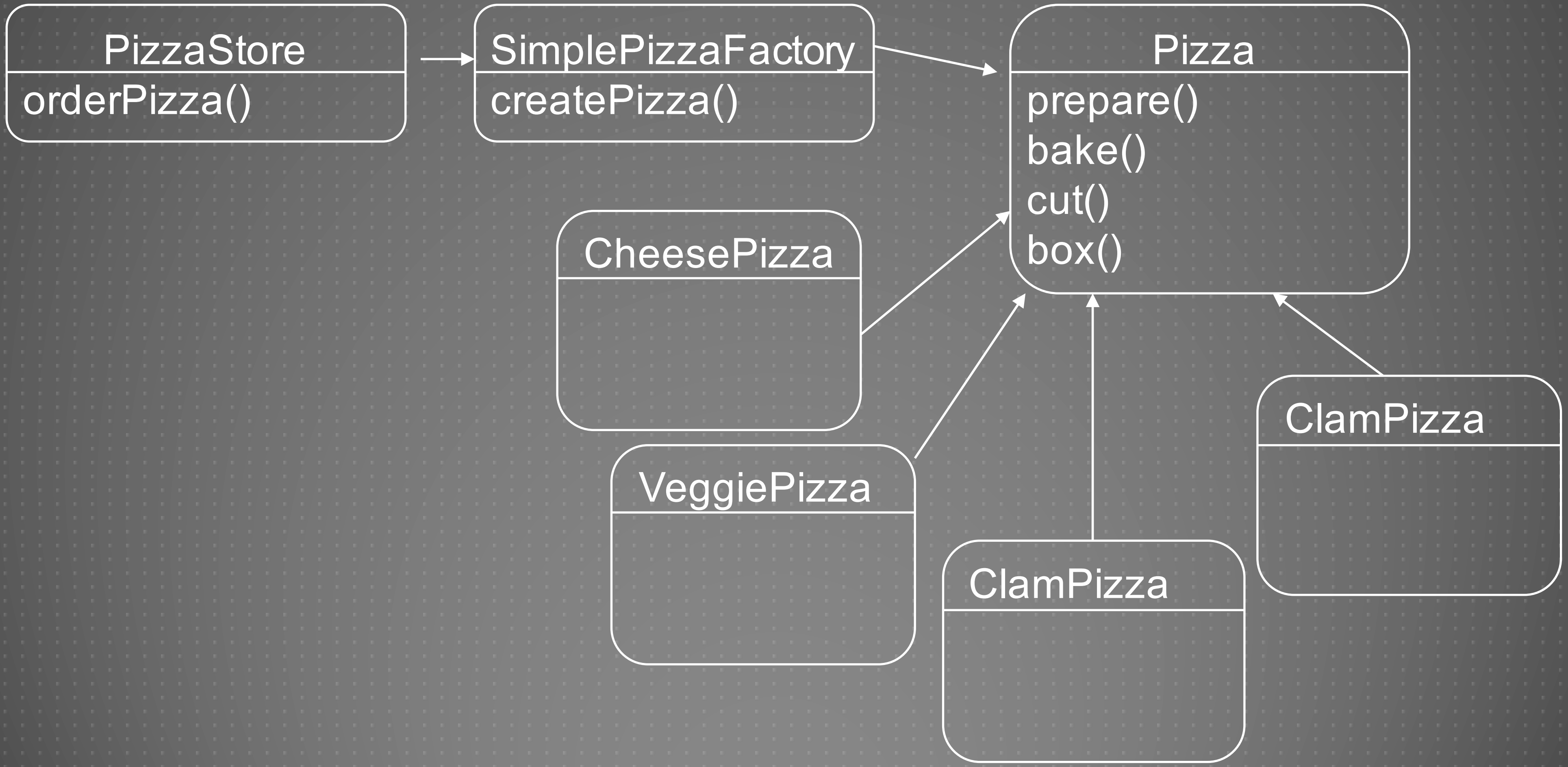
REWORKING THE PIZZASTORE CLASS

```
public class PizzaStore {
    SimplePizzaFactory factory;
    public PizzaStore(SimplePizzaFactory factory) {
        this.factory = factory;
    }
    public Pizza orderPizza(String type) {
        Pizza pizza;
        pizza = factory.createPizza(type);
        pizza.prepare();
        pizza.bake();
        pizza.cut();
        pizza.box();
        return pizza;
    }
}
```

COMPLETE EXAMPLE FOR SIMPLE FACTORY

```
SimplePizzaFactory factory = new SimplePizzaFactory();
 PizzaStore store = new PizzaStore(factory);
 Pizza pizza = store.orderPizza("cheese");
```

SIMPLE FACTORY DEFINED

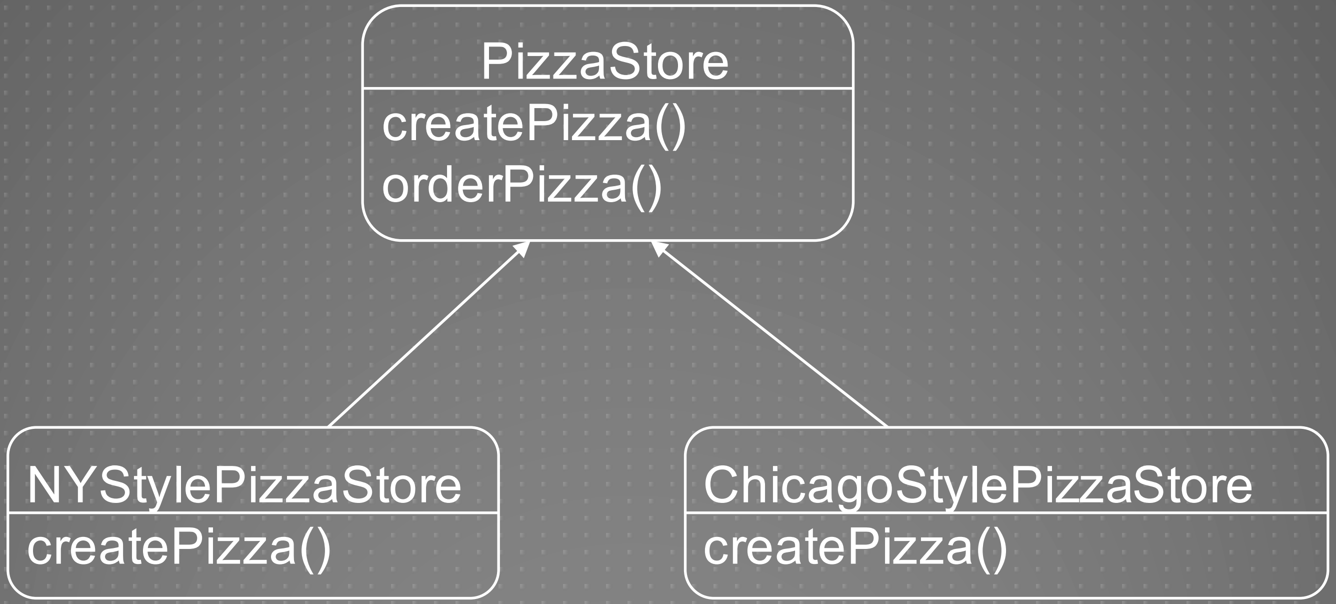


ABSTRACT METHOD – A FRAMEWORK FOR THE PIZZA STORE

```
public abstract class PizzaStore {
  abstract Pizza createPizza(String item);

  public Pizza orderPizza(String type) {
     Pizza pizza = createPizza(type);
     pizza.prepare();
     pizza.bake();
     pizza.cut();
     pizza.box();
     return pizza;
  }
}
```

ALLOWING THE SUBCLASSES TO DECIDE



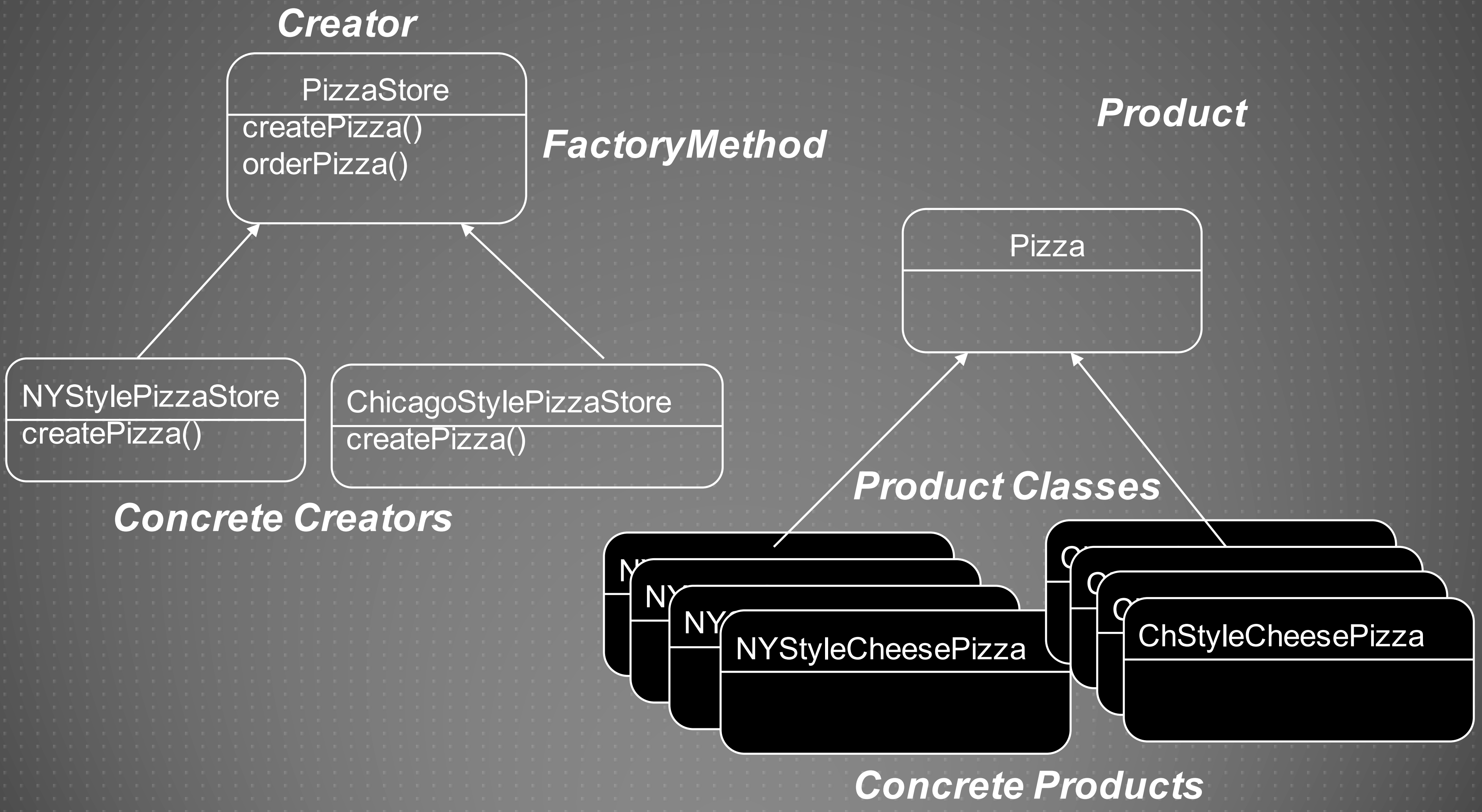
A factory method handles object creation and encapsulates it in the subclass. This decouples the client code in the super class from the object creation that happens in the subclass.

CREATING MULTIPLE INSTANCES

```
NYPizzaFactory nyFactory = new NYPizzaFactory();
PizzaStore nyStore = new PizzaStore(nyFactory);
Pizza pizza = nyStore.orderPizza("cheese");

ChicagoPizzaFactory chicagoFactory = new ChicagoPizzaFactory();
PizzaStore chicagoStore = new PizzaStore(chicagoFactory);
Pizza pizza = chicagoStore.orderPizza("cheese");
```

FACTORY METHOD PATTERN



THE FACTORY METHOD PATTERN

The Factory Method Pattern defines an interface for creating an object but lets subclasses decide which class to instantiate. Factory Method lets a class defer instantiation to subclasses

THE ABSTRACT FACTORY

CONTROLLING PIZZA QUALITY

- Some of your franchises have gone rogue and are substituting inferior ingredients to increase their per-pizza profit
- Time to enter the pizza ingredient business
  - You'll make all the ingredients yourself and ship them to your franchises
  - But this is not so easy…
- You have the same product families (e.g., dough, sauce, cheese, veggies, meats, etc.) but different implementations (e.g., thin vs. thick or mozzarella vs. reggiano) based on region

THE INGREDIENT FACTORY INTERFACE

```
public interface PizzaIngredientFactory
{
  public Dough createDough();
  public Sauce createSuace();
  public Cheese createCheese();
  public Veggies[] createVeggies();
  public Pepperoni createPepperoni();
  public Clams createClams();
}
```

THEN WHAT?

1. For each region, create a subclass of the `PizzaIngredientFactory` that implements the concrete methods
2. Implement a set of ingredients to be used with the factory (e.g., `ReggianoCheese`, `RedPeppers`, `ThickCrustDough`)
   - These can be shared among regions if appropriate
3. Integrate these new ingredient factories into the `PizzaStore` code

THE NEW YORK INGREDIENT FACTORY

```
public class NYPizzaIngredientFactory implements
PizzaIngredientFactory {
  public Dough createDough() {
    return new ThinCrustDough();
  }
  public Sauce createSauce() {
    return new MarinaraSauce();
  }
  public Cheese createCheese() {
    return new ReggianoCheese();
  }
  public Veggies[] createVeggies() {
    Veggies veggies[] = {new Garlic(), new Onion(), new
Mushroom(), new RedPepper()};
```

CONNECTING TO THE PIZZAS

- Now, we need to force our franchise owners to only use factory produced ingredients
- Before, the abstract `Pizza` class just had `Strings` to name its ingredients
    - It implemented the `prepare()` method (and `bake()`, `cut()`, and `box()`)
    - The concrete `Pizza` classes just defined the constructor which, in some cases, specialized the ingredients (and sometimes cut corners) and maybe overwrote other methods
- Now, the abstract `Pizza` class has actual ingredient objects
    - And the `prepare()` method is abstract
    - The concrete pizza classes will collect the ingredients from the factories to prepare the pizza

CONCRETE PIZZAS

- Now, we only need one CheesePizza class (before we had a ChicagoCheesePizza and a NYCheesePizza)
- When we create a CheesePizza, we pass it an IngredientFactory, which will provide the (regional) ingredients

AN EXAMPLE PIZZA

```
public class CheesePizza extends Pizza {
  PizzaIngredientFactory ingredientFactory;
  public CheesePizza(PizzaIngredientFactory
ingredientFactory){
    this.ingredientFactory = ingredientFactory;
  }
  void prepare() {
    System.out.println("Preparing " + name);
    dough = ingredientFactory.createDough();
    sauce = ingredientFactory.createSauce();
    cheese = ingredientFactory.createCheese();
  }
}
```

Which cheese is created is determined at run time by the factory passed at object creation time

FIXING THE PIZZA STORES

```
public class NYPizzaStore extends PizzaStore {
  protected Pizza createPizza(String item) {
    Pizza pizza = null;
    PizzaIngredientFactory ingredientFactory = new
NYPizzaIngredientFactory();
    if (item.equals("cheese")) {
      pizza = new CheesePizza(ingredientFactory);
      pizza.setName("New York Style Cheese Pizza");
    } else if (item.equals("veggie")) {
      pizza = new VeggiePizza(ingredientFactory);
      pizza.setName("New York Style Veggie Pizza");
    } // more of the same...
    return pizza;
  }
```

For each type of pizza, we instantiate a new pizza and give it the factory it needs to get its ingredients

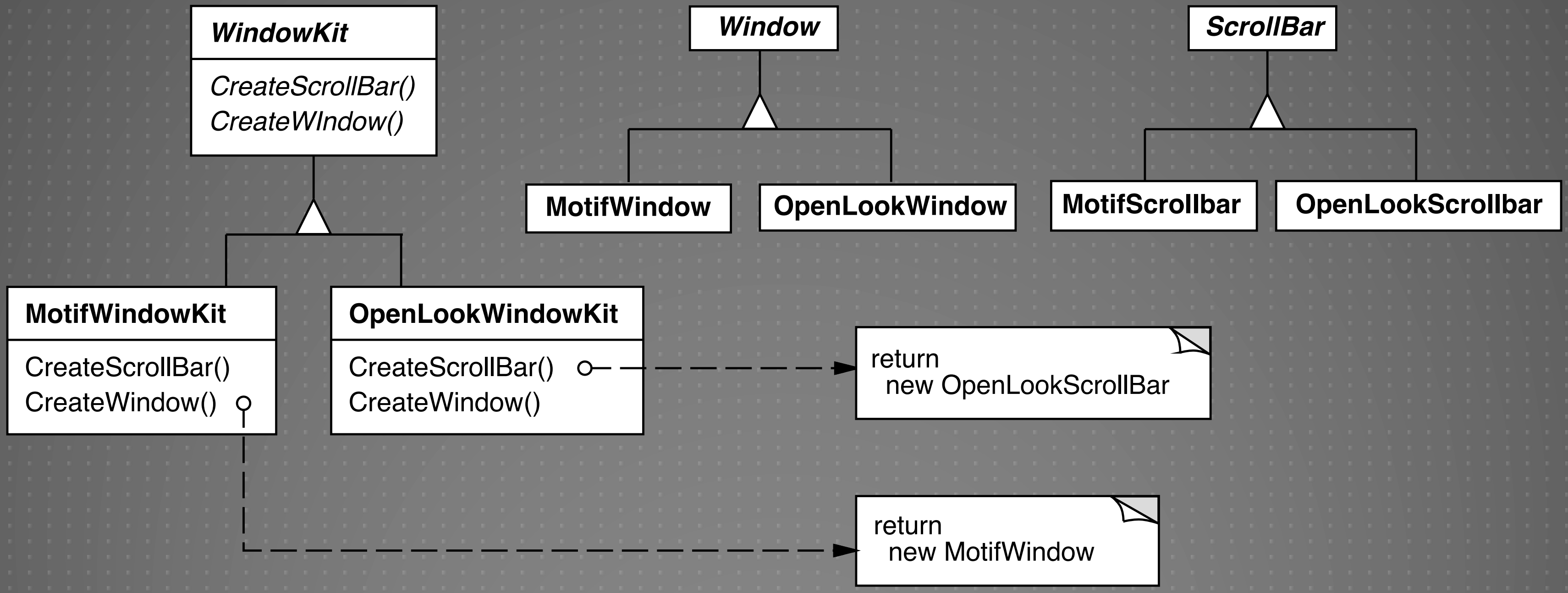
WHEW. RECAP.

- We provided a means of creating a family of ingredients for pizzas by introducing a new type of factory: the **abstract factory**
- An abstract factory provides an interface for creating a family of products
  - Decouples code from the actual factory that creates the products
  - Makes it easy to implement a variety of factories that produce products for different contexts (we used regions, but it could just as easily be different operating systems, or different "look and feels")
- We can substitute different factories to get different behaviors

THE ABSTRACT FACTORY PATTERN

The Abstract Factory Pattern provides an interface for creating families of related or dependent objects without specifying their concrete classes.

THINK-PAIR-SHARE



Which class is an abstract factory?
Which classes are concrete factories?

THINK-PAIR-SHARE

- Which classes must be modified if you want to add a different look and feel called MacWindowKit?
- Which classes must be modified if you want to add a new type of object such as a button as a part of WindowKit?

THINK-PAIR-SHARE

- What happens if we have multiple types of windows?
- What happens if we need different types of windows that take different arguments?
- What happens if we want to define a window as combination of window, scroll bar and button?

QUESTIONS?