Factory Method

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Name and Classification:

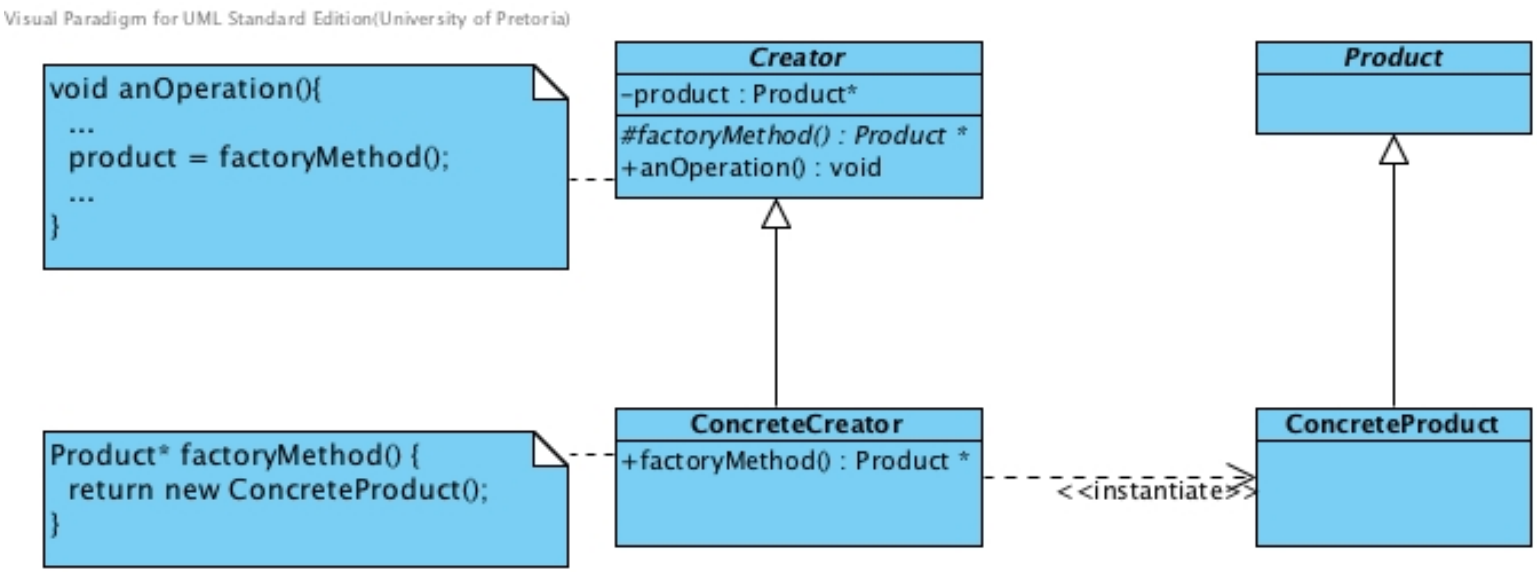
Factory Method

(Class Creational)

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." GoF(107)

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


Visual Paradigm for UML Standard Edition(University of Pretoria)
void anOperation(){
...
product = factoryMethod();
...
}
Creator
-product : Product*
#factoryMethod() : Product *
+anOperation() : void
Product
Product* factoryMethod() {
return new ConcreteProduct();
}
ConcreteCreator
+factoryMethod() : Product *
<<instantiate>>
ConcreteProduct

- A *Creator* creates product which the client uses.
- *Product* is always created by *Creator*.
- *ConcreteCreators* create specific concrete product.
- Makes use of the **Template Method** design pattern.

- Forces the creation of an object to occur in a common factory rather than scattered around the code
- A factory can be implemented by using a static factory member, or by making use of polymorphism

Product

- defines the product interface for the factory method to create

ConcreteProduct

- implements the interface for the product

Creator

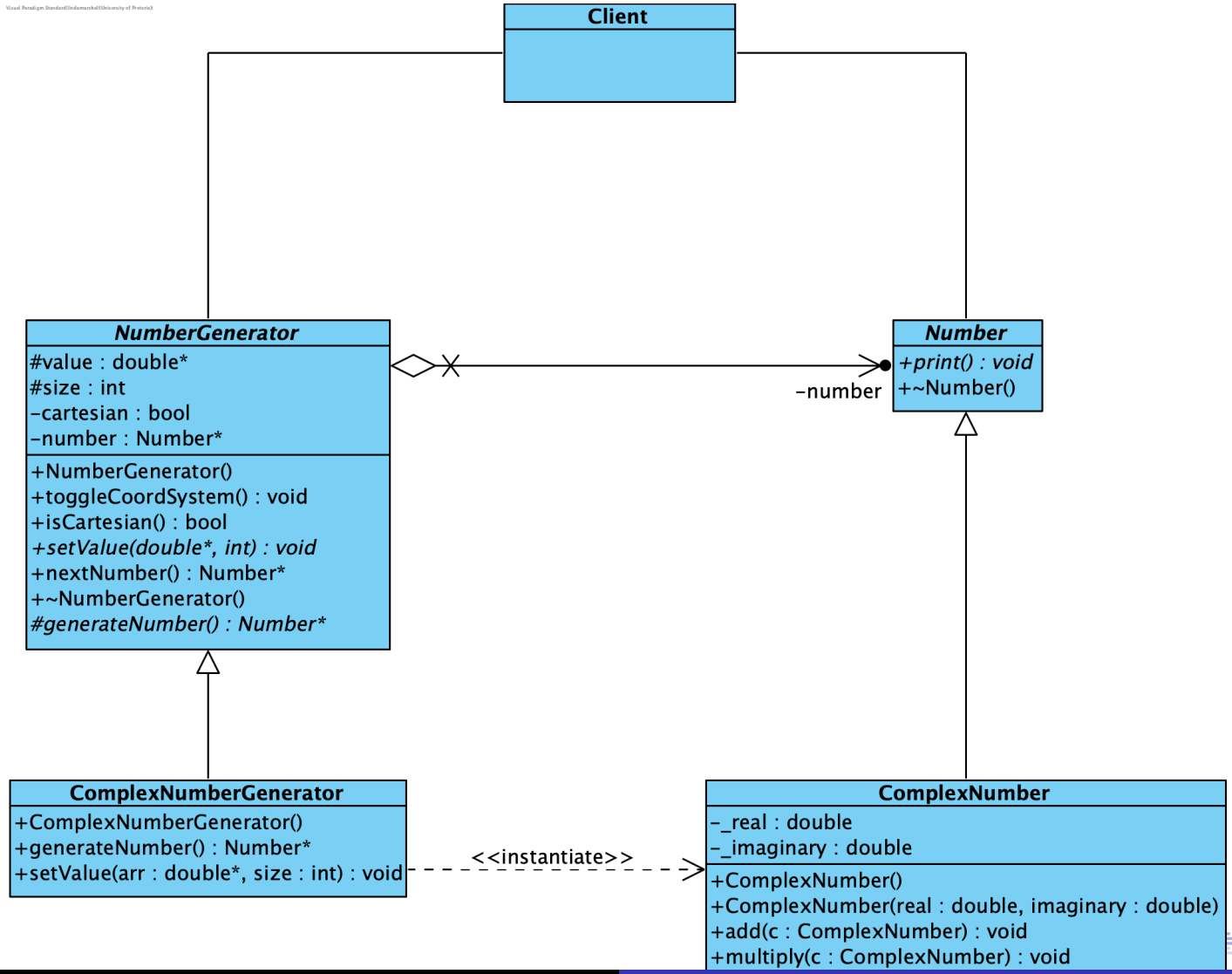
- declares the factory method which returns a product object
- default factory method implementations may return a default concrete product

ConcreteCreator

- overrides the factory method to return an instance of the product

Related Patterns

- **Abstract Factory** (87): Factory Methods used to implement Abstract Factory.
- **Template Method** (325): May be defined in the Creator or Product hierarchies.
- **Prototype** (117): Used to clone objects (Creators or Product).


Client
NumberGenerator
#value : double*
#size : int
-cartesian : bool
-number : Number*
+NumberGenerator()
+toggleCoordSystem() : void
+isCartesian() : bool
+setValue(double*, int) : void
+nextNumber() : Number*
+~NumberGenerator()
#generateNumber() : Number*
Number
+print() : void
+~Number()
-number
ComplexNumberGenerator
+ComplexNumberGenerator()
+generateNumber() : Number*
+setValue(arr : double*, size : int) : void
<<instantiate>>
ComplexNumber
-_real : double
-_imaginary : double
+ComplexNumber()
+ComplexNumber(real : double, imaginary : double)
+add(c : ComplexNumber) : void
+multiply(c : ComplexNumber) : void

```
class NumberGenerator {
  public:
    NumberGenerator();
    void toggleCoordSystem();
    bool isCartesian();
    virtual Number* generateNumber() = 0;
    virtual void setValue(double*,int) = 0;
    Number* nextNumber();
    virtual ~NumberGenerator();
  protected:
    double* value;
    int size;
  private:
    bool    cartesian;
    Number* number;
};
```

```
NumberGenerator::NumberGenerator()  {
        number = 0;  cartesian = true;
        value = 0; size = 0;
}
void NumberGenerator::toggleCoordSystem() {
        cartesian = !cartesian;
}
bool NumberGenerator::isCartesian() {
        return cartesian;
}
Number* NumberGenerator::nextNumber() {
        number = generateNumber();
        return number;
}
NumberGenerator::~NumberGenerator()  {
        if (number != 0) {  number = 0;  }
        if (size != 0)   { delete [] value;  value = 0;  }
}
```

```
class ComplexNumberGenerator : public NumberGenerator {
  public:
    ComplexNumberGenerator() : NumberGenerator() { };
    virtual Number* generateNumber() {
      if (size == 0) {
        value = new double[2];
        value[0] = 0;  value[1] = 0;  size = 2;       }
      if (isCartesian())
        return new ComplexNumber(value[0],value[1]);
      else
        return new ComplexNumber(value[0]*cos(value[1]),
                                 value[0]*sin(value[1]));
    };
    virtual void setValue(double* arr,int size) {
      if (this->size != 0) {
        delete [] value;
        this->size = 0;  }
      value = new double[size];
      value[0] = arr[0];  value[1] = arr[1];
      this->size = size;
    };
};
```

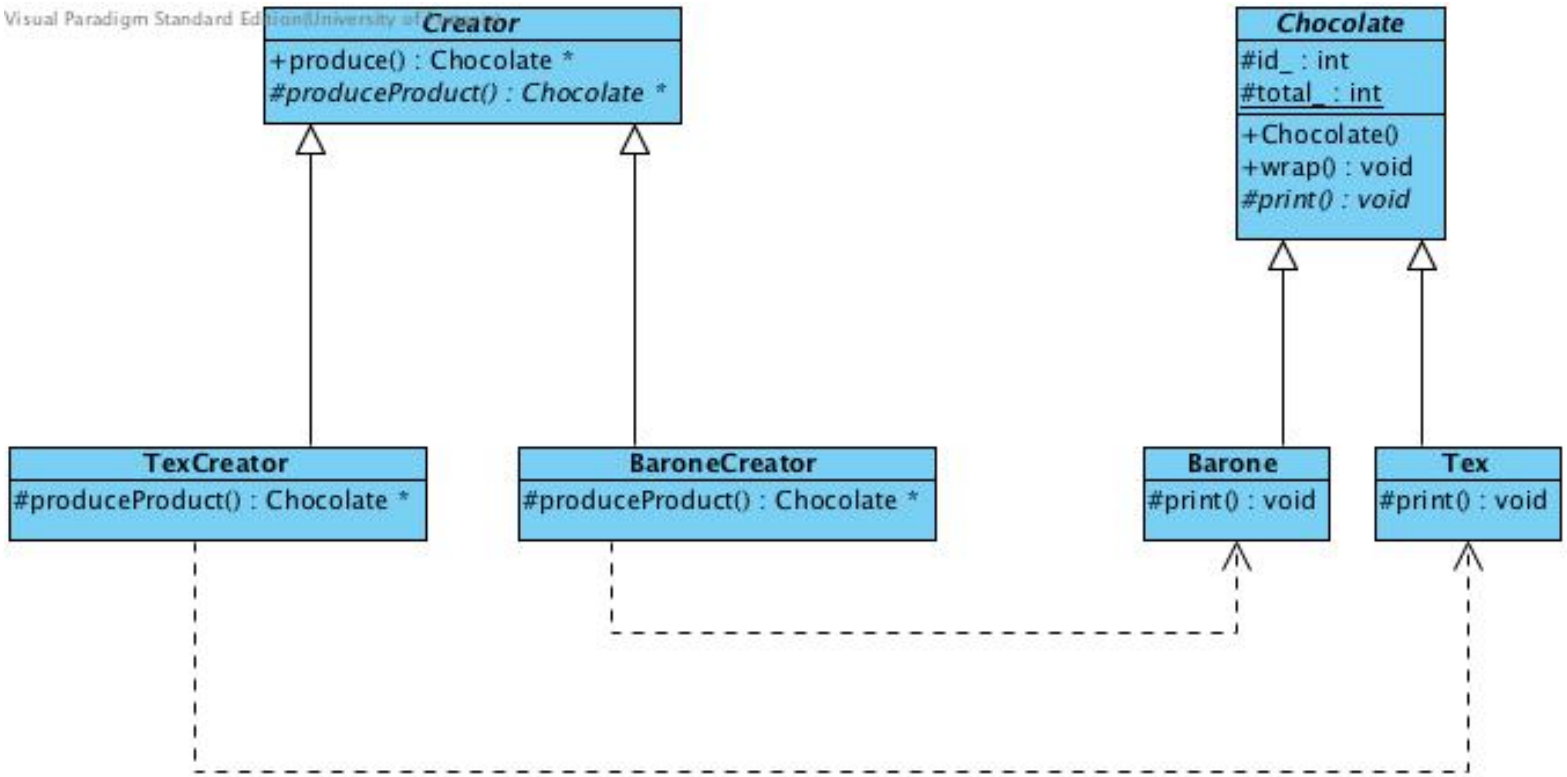
```
class Number {
  public:
    virtual void print() = 0;
    virtual ~Number();
};

class ComplexNumber : public Number  {
public:
        ComplexNumber();
        ComplexNumber(double real, double imaginary);
        void add(ComplexNumber c);
        void multiply(ComplexNumber c);
        double getReal();
        double getImaginary();
        void print();
private:
        double _real;
        double _imaginary;
};
```

```
ComplexNumber::ComplexNumber() : Number() {
        _real = 0;
        _imaginary = 0;
}
ComplexNumber::ComplexNumber(double real, double imaginary) {
        _real = real;
        _imaginary = imaginary;
}
void ComplexNumber::add(ComplexNumber c) {
        _real = _real + c._real;
        _imaginary = _imaginary + c._imaginary;
}
void ComplexNumber::multiply(ComplexNumber c) {
        _real = (_real * c._real) - (_imaginary * c._imaginary);
        _imaginary = (_real * c._imaginary) + (_imaginary * c._rea
}
double ComplexNumber::getReal() { return _real; }
double ComplexNumber::getImaginary() { return _imaginary; }
void ComplexNumber::print() {
        std::cout<<_real<<" + "<<_imaginary<<"i"<<std::endl;
}
```

Exercise

- Add a `Rational` Number class that inherits from `Number`.
  - Is it possible to abstract some operations out of the concrete products?
  - Challenge: Write the mathematical operations as C++ operators.
- Add a concrete factory class to create Rational numbers.


Visual Paradigm Standard Edition(University
Creator
+produce() : Chocolate *
#produceProduct() : Chocolate *
Chocolate
#id_ : int
#total_ : int
+Chocolate()
+wrap() : void
#print() : void
TexCreator
#produceProduct() : Chocolate *
BaroneCreator
#produceProduct() : Chocolate *
Barone
#print() : void
Tex
#print() : void