

## The Portfolio Class

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- ▶ We will achieve the milestone of pricing a Portfolio of derivatives of many different forms.
- ▶ This will be easy because of polymorphism.
- ▶ No new C++ language features.
- ▶ The factory design pattern.

## The Priceable interface

```
class Priceable {  
public:  
    /* Compute the price of the security in the  
       Black--Scholes world */  
    virtual double price(  
        const BlackScholesModel& model ) const = 0;  
};
```

Make ContinuousTimeOption extend Priceable.

## The Portfolio interface

A Portfolio class must have the following key functions:

- (i) a function to add a Priceable instance together with an associated quantity;
- (ii) a function to change the quantity held of a given security;
- (iii) a function price to compute the value of the Portfolio.

A Portfolio should itself implement the interface Priceable

## The Portfolio implementation

- (i) Our Portfolio implementation will hold a vector of `shared_ptr` objects that point to `Priceable` instances.
- (ii) It will also have a vector of quantities.
- (iii) Because we need to store `shared_ptr` objects, the method to add securities will take a `shared_ptr` to a security, instead of a reference to the security.

```
class Portfolio : public Priceable {
public:
    /* Virtual destructor */
    virtual ~Portfolio() {};
    /* Returns the number of items in the portfolio*/
    virtual int size() const = 0;
    /* Add a new security to the portfolio,
       returns the index at which it was added */
    virtual int add( double quantity,
                   std::shared_ptr<Priceable> security ) = 0;
    /* Update the quantity at a given index */
    virtual void setQuantity( int index,
                              double quantity ) = 0;
    /* Compute the current price */
    virtual double price(
        const BlackScholesModel& model ) const = 0;
    /* Creates a Portfolio */
    static std::shared_ptr<Portfolio> newInstance();
};
```

## Factory method

- ▶ Portfolio is abstract.
- ▶ To obtain an instance you call the *factory method* `newInstance`.
- ▶ The user doesn't even know the implementation class, so we return a `shared_ptr`.
- ▶ All the implementation details are hidden from the user.
- ▶ Decreases *coupling* of code.
  - ▶ Makes code compile faster.
  - ▶ Makes header files easier for the user to read.

# PortfolioImpl

```
class PortfolioImpl : public Portfolio {
public:
    /* Returns the number of items in the portfolio*/
    int size() const;
    /* Add a new security to the portfolio,
       returns the index at which it was added */
    int add( double quantity,
            shared_ptr<Priceable> security );
    /* Update the quantity at a given index */
    void setQuantity( int index, double quantity );
    /* Compute the current price */
    double price(
        const BlackScholesModel& model ) const;

    vector<double> quantities;
    vector< shared_ptr<Priceable> > securities;
};
```



Implement newInstance:

```
shared_ptr<Portfolio> Portfolio::newInstance() {
    shared_ptr<Portfolio> ret=
        make_shared<PortfolioImpl>();
    return ret;
}
```

Implement add:

```
int PortfolioImpl::add( double quantity,
    shared_ptr<Priceable> security ) {
    quantities.push_back( quantity );
    securities.push_back( security );
    return quantities.size();
}
```

## The most interesting method

```
double PortfolioImpl::price(  
    const BlackScholesModel& model ) const {  
    double ret = 0;  
    int n = size();  
    for (int i=0; i<n; i++) {  
        ret += quantities[i]  
            * securities[i]->price( model );  
    }  
    return ret;  
}
```

The exciting point is that we can price any Priceable object and we will automatically call the best available pricing function.

# Test put-call parity

```
static void testPutCallParity() {
    shared_ptr<Portfolio> portfolio
        = Portfolio::newInstance();

    shared_ptr<CallOption> c
        =make_shared<CallOption>();
    c->setStrike(110);
    c->setMaturity(1.0);

    shared_ptr<PutOption> p=make_shared<PutOption>();
    p->setStrike(110);
    p->setMaturity(1.0);

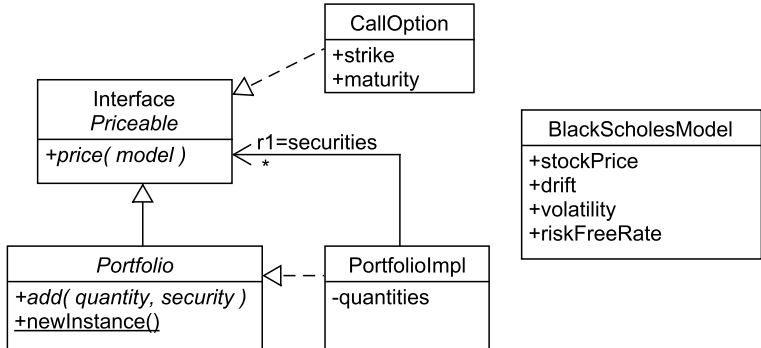
    portfolio->add( 100, c );
    portfolio->add( -100, p );

    BlackScholesModel bsm;
    bsm.volatility = 0.1;
    bsm.stockPrice = 100;
    bsm.riskFreeRate = 0;

    double expected = bsm.stockPrice - c->getStrike();
    double portfolioPrice = portfolio->price( bsm );

    ASSERT_APPROX_EQUAL(100*expected,
        portfolioPrice,0.0001);
}
```

# UML



## Summary

- ▶ Use `shared_ptr` to build sophisticated data structures that store objects long-term.
- ▶ Use the *static factory method* design pattern to maximise information hiding and reduce dependencies between files.
- ▶ Use object orientation to achieve pluggable code that will not need to be changed even when new requirements come in.