Course C^{++}, Exercise Number 5

15.03.2012 + one week

This exercise is about inheritance. The most important thing that you must understand about inheritance is that it is used too often. Meaningful examples of inheritance are hierarchies of graphical objects, and file hierarchies. Inheritance should only be used when the following conditions are met:

1. some group of types have something (important) in common,
2. you want to able to mix these types at run time, e.g. by putting them in the same container,
3. you don't know in advance how many types there will be. (You want to be able to add more types later.) Put differently: Adding another type would not mess up all your algorithms.

It is probably a good idea to have a look at
`http://www.ii.uni.wroc.pl/~nivelle/teaching/object2011/inheritance.pdf`
first.

1. Consider the following hierarchy:

```
class surf
{
   virtual double area( ) const = 0;
   virtual double circumference( ) const = 0;
   virtual surf* clone( ) const = 0;
   virtual print( std::ostream& ) const = 0;
   ~surf( );
}

class rectangle : public surf
{
   double x1, y1;
   double x2, y2;

   double area( ) const;
   double circumference( ) const;
```

```
   rectangle* clone( ) const;
   void print( std::ostream& ) const;
};

class triangle : public surf
{
   double x1, y1; // Positions of corners.
   double x2, y2;
   double x3, y3;

   double area( ) const;
   double circumference( ) const;
   triangle* clone( ) const;
   void print( std::ostream& ) const;
};

class circle : public surf
{
   double x; // Position of center.
   double y;
   double radius;

   double area( ) const;
   double circumference( ) const;
   circle* clone( ) const;
   void print( std::ostream& ) const;
}
```

Write suitable constructors for each of the subclasses, and implement the `area( ) const`, `circumference( ) const`, `clone( ) const`, and `print( std::ostream& ) const` methods.

2. We want to be able to put a mixture of rectangles, triangles, and circles in an `std::vector` in a robust way, without memory leakeage.

   In order to do this, we must define a class

```
struct surface
{
   surf* ref;

   surface( const surface& s )
      : ref( s. ref -> clone( ))
   { }

   surface( const surf& s )
```

```
      : ref( s. clone( ))
   { }

   void operator = ( const surface& s )
   {
      if( ref != s. ref )
      {
         delete ref;
         ref = s. ref -> clone( );
      }
      // I am not in favour of making assignment
      // return something.
   }

   ~surface( )
   {
      delete ref;
   }

   const surf& getsurf( ) const { return *ref; }
      // There is no non-const method, because
      // changing would be dangerous.
};
```

Define a print function

```
std::ostream& operator << ( std::ostream& stream, const surface& s );
```

according to the pattern on the slides.

3. Fill an `std::vector< surface >` with a couple of surfaces, and make sure that the following functions work correctly

```
std::ostream& operator << ( std::ostream& stream,
                            const std::vector< surface > & table )
{
   for( unsigned int i = 0; i < table. size( ); ++ i )
   {
      stream << i << "-th element = " << table [i] << "\n";
   }
   return stream;
}
```

```
void print_statistics( const std::vector< surface > & table )
{
   double total_area = 0.0;
   double total_circumference = 0.0;
   for( std::vector< surface > :: const_iterator
           p = table. begin( );
           p != table. end( );
           ++ p )
   {
      total_area += p -> getsurf( ). area( );
      total_circumference += p -> getsurf( ). circumference( );
      std::cout << "adding info about " << *p << "\n";
   }

   std::cout << "total area is " << total_area << "\n";
   std::cout << "total circumference is " << total_circumference << "\n";
```

4. Convince yourself, by writing a `for` loop, that there are no memory leaks.