Programming in C^{++}

Exercise List 3

Deadline: 24.03.2017

Topic of this task are the *essential methods*.

1. Define (in a file `stack.h`) a class

```
#ifndef _STACK
#define _STACK  1

#include <iostream>
#include <initializer_list>

class stack
{
   size_t current_size;
   size_t current_capacity;
      // size_t is an integer number >= 0. It should be used for
      // sizes of objects, for indexing (because an index lies
      // between 0 and the size of the object) and for hash values
      // (because a hash value will be used for indexing.)
      // size_t is guaranteed to be big enough for the memory
      // of every computer, now and in the future.
      // size_t is an alias. Hence you need to include something
      // from standard library in order to have it.

   double* tab;
      // class invariant is that tab is always
      // allocated with a block with current_capacity.
      // We ignore the fact that normally,
      // elements between current_size and current_capacity
      // are not initialized.
   void ensure_capacity( size_t c );
      // Ensure that stack has capacity of at least c.

public:
   stack( );  // Constructs empty stack. You can use the fact that
          // nullptr is very similar to pointer to zero-length segment.
```

```
    stack( std::initializer_list<double> d );
       // So that you can write s = { 1,2,3 };
       // You need d. size( ) and for( double d : s ) .....

    stack( const stack& s );
    ~stack( );
    void operator = ( const stack& s );
       // These are the essential methods.
       // Later we will also encounter
       // void operator = ( stack&& s ) and
       // stack( stack&& s ).

    void push( double d );  // Use ensure_capacity, so that
                            // pushing is always possible, as
                            // long as memory is not full.

    void pop( );
       // Remove one element from the stack. It's OK to write
       // code that crashes, as long as you write clearly what are
       // your preconditions, so:
       // PRECONDITION:  The stack is not empty.
       // Concerning preconditions, there are two reasonable
       // behaviors: (1) state them, and leave all responsibility to
       //                the caller.
       //            (2) state them, and throw std::runtime_error when
       //                not met. Don't use assert.

    void reset( size_t s );
       // Pops element until stack has size s.
       // PRECONDITION: s <= current_size.

    double& top( );
    double top( ) const;
       // The second one is used when stack was declared const.
       // The first one allows assignment.
       // Both have precondition that the stack is non-empty.

    size_t size( ) const { return current_size; }
    bool empty( ) const { return current_size == 0; }

};
```

Below is a definition of `ensure_capacity()`. Write the other methods by yourself. (in a file with name `stack.cpp`) Small methods (up to three lines) can be written in `stack.h`. Be sure to use field initializers wherever

possible.

```
void stack::ensure_capacity( size_t c )
{
   if( current_capacity < c )
   {
      // New capacity will be the greater of c and
      // 2 * current_capacity.

      if( c < 2 * current_capacity )
         c = 2 * current_capacity;

      double* newtab = new double[ c ];
      for( size_t i = 0; i < current_size; ++ i )
         newtab[i] = tab[i];

      current_capacity = c;
      delete[] tab;
      tab = newtab;
   }
}
```

2. If you wrote the copy constructor, the assignment operator, and the destructor correctly, then your class now has *value semantics*.

```
{
   stack s1 = { 1, 2, 3, 4, 5 };
   stack s2 = s1; // Copy constructor.

   // j is not size_t, because multiplying size_t with itself is
   // unnatural:

   for( unsigned int j = 0; j < 20; ++ j )
      s2. push( j * j );

   s1 = s2;
      // Assignment.
   s1 = s1;
      // Always check for self assignment.

   s1 = { 100,101,102,103 };
      // Works because the compiler inserts constructor and
      // calls assignment with the result.

#if 0
```

```
        // Won't compile. In order to get it compiled, remove const:

        const stack& sconst = s1;
        sconst. top( ) = 20;
        sconst. push(15);
#endif
}
```

3. Check that there are no memory leaks, and that memory is not returned twice. The recommended way to do this is by using **valgrind**. Call **valgrind ./stack** and read the output of **valgrind**.

4. Write

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

   Make it a friend of `class stack`, by adding

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

5. Using `operator <<`, convince yourself (and us) that your implementations of the essential methods have correct behaviour.

6. Check what happens when you change `#if 0` to `#if 1`.