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AMERICAN UNIVERSITY OF ARMENIA
College of Science and Engineering
COMP120 Introduction to Object-Oriented Programming
MIDTERM 2 EXAM

Date: Tuesday, March 24 2015

Starting time: 10:30

Duration: 1 hour 20 minutes

Attention: **ANY COMMUNICATION IS STRICTLY PROHIBITED**

Please write down your name at the top of all used pages

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Problem 1

The easiest way to implement rotation by 90° of a square array is to transpose it and then reverse all its rows separately. Transposing once more after the rotation will result in vertical flip – the top row will appear at the bottom, the second row will become the last but one, etc. Write a C++ function `void flip(int *a2D, int size)` that takes as its argument a pointer to the first element of a square array `int *a2D` of the specified `int size` and flips it vertically. Use already implemented functions `void reverse(int a1D[], int length)` and `void transpose(int *a2D, int size)`:

```
void reverse(int a1D[], int length)
{
    for (int i = 0; i < length / 2; i++)
        swap(a1D[i], a1D[length - 1 - i]);
}
```

```
void transpose(int *a2D, int size)
{
    for (int row = 0; row < size; row++)
        for (int col = row + 1; col < size; col++)
            swap(a2D[row * size + col], a2D[col * size + row]);
}
```

```
void flip(int *a2D, int size)
{
    transpose(a2D, size);
    for (int i = 0; i < size; i++)
        reverse(a2D + size * i, (a2D + size * i)[], size);
    transpose(a2D, size);
}
```

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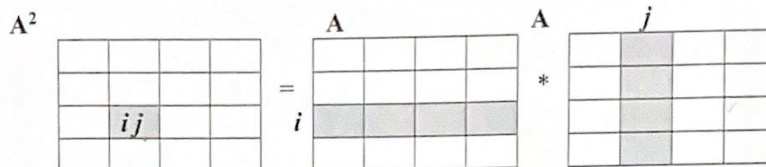
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Problem 2

Using functions *transpose()* from Problem 1 and *scalar()* from below, write a C++ function *void square(int *a2D, int *product, int size)* that takes as its argument a pointer to the first element of a square array *int *a2D* of the specified *int size*, computes its square (multiplies it by itself) and saves it in another square array of the same size, the pointer to the first element of which is given by *int *product*. Each element p_{ij} in the i^{th} row and j^{th} column of the array **product* is the scalar product of the i^{th} row and j^{th} column of the array **a2D* and is calculated by the

$$\text{expression: } p_{ij} = \sum_{k=0}^{\text{size}-1} a_{ik} a_{kj}$$

```
int scalar(int a[], int b[], int length)
{
    int result = 0;
    for (int i = 0; i < length; i++)
        result += a[i] * b[i];
    return result;
}
```



*void square(int *a2D, int *product, int size)*

```
{
    int *a2Dtrans;
    for (int row = 0; row < size; row++)
    {
        for (int col = 0; col < size; col++)
            a2Dtrans[row * size + col] = a2D[row * size + col];
        // created copy of a2D
    }
    transpose(a2Dtrans, size); // we have the transpose of a2D;
    for (row = 0; row < size; row++)
    {
        for (col = 0; col < size; col++)
            product[row * size + column] =
                = scalar(a2D + size * i)[col], (a2Dtrans + size * j)[col], size);
        // see Problem 1
    }
    delete [] a2Dtrans;
}
```

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Problem 3

Using functions `segment()` from below and `rotate()` from Problem 1, write a C++ function `void spiral2(int *a2D, int even_size)` that takes as its argument a pointer to the first element of a square array `int *a2D` of the specified even size `int even_size` and fills it with two spirals of `zeros` and `ones`. The entire first row starting from the first element is filled with `zeros` and, symmetrically, entire last row starting from the last element is filled with `ones`. Then, the entire last column, except the last element, is filled with `zeros` and, symmetrically, the entire first column, except the first element – with `ones`. And so on, until the central elements are reached. A shaded example is shown below:

```
int* segment(int *start, int length, int direction, int increment)
```

```
{
    for (; length > 0; length--)
    {
        *(start + direction) = *start + increment;
        start += direction;
    }
    return start;
}
```

0	0	0	0	0	0
1	1	1	1	1	0
1	0	0	0	1	0
1	0	1	1	1	0
0	0	0	0	0	0
1	1	1	1	1	1

```
void spiral2(int *a2D, int even_size)
```

```
{
    int along[4] = {-1, -even_size, 1, even_size};
    *a2D = 0;
    for (int length = even_size + 1; length > 3; length -= 2)
    {
        a2D = segment(a2D, length, along[direction], 0);
        length -= 2;
        a2D = segment(a2D, length, along[direction], 0);
        direction = 2 - direction;
    }
```

```
    rotate(a2D, even_size);
```

```
    *a2D = 1;
```

```
    for (int length = even_size + 1; length > 3; length -= 2)
    {
        a2D = segment(a2D, length, along[direction], 0);
        length -= 2;
        a2D = segment(a2D, length, along[direction], 0);
        direction = 2 - direction;
    }
```