AMERICAN UNIVERSITY OF ARMENIA

College of Science and Engineering

CS 120 Introduction to Object-Oriented Programming

MIDTERM EXAM

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Date / Time: Friday, March 17 2017 at 17:30

Duration: 2 hours

Attention: **ANY TYPE OF COMMUNICATION IS STRICTLY PROHIBITED**

Write down your section, name and ID# at the top of all used pages

Participation:

Problem 1: Consider below a C++ function ***float kahan(float num1, float num2, float& compensation)*** that implements the ***Kahan Summation Algorithm*** for high-precision compensated summation of two float arguments ***float num1*** and ***float num2***:

```
float kahan(float num1, float num2, float &compensation)
{
      float result;
      num2 -= compensation;
      result = num1 + num2;
      compensation = (result - num1) - num2;
      return result;
}
```

Using this function, write a C++ function ***float pi(int n)*** that computes the value π by the following formula:

$$\pi = 2\sum_{k=0}^{n}\frac{(2k-1)!!}{(2k)!!(2k+1)} = \frac{2}{1*1} + \frac{1}{2}*\frac{2}{3} + \frac{1*3}{2*4}*\frac{2}{5} + \frac{1*3*5}{2*4*6}*\frac{2}{7} + \cdots$$

Recall that **n!!** is the product of odd numbers from *1* to ***n***, if ***n*** is odd; and is the product of even numbers from *2* to ***n***, if ***n*** is even. The double factorial of non-positive numbers equals to *1* by definition.

The initial value of ***float compensation*** is ***0.0***.

```
int n;
cin << n ~~compensation~~
float pi(int n) {
 float result; float[] element;
 for (k=0; k <= n; k++) {
  ~~if (k % 2 = 0) {~~
  ~~element = 2*~~ while
       fact
  element[]=(2 * (d-fact(2k-1)))/
(d-fact(2k) * (2k+1))
  result = kahan(element, 0.0)
```

```
int d-fact(int l)
~~if~~ while(l>0; l = l-2) {
  ~~if (l%2 = 0) {~~
  result *= l }
  else {
 return result;
```

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Problem 2: Write a Java method ***public static double[] lin(double[] data)*** that takes as its argument an array of data points ***double[] data***, and returns a two-element array – the first element being the slope of the linear regression and the second element being the intercept. The linear regression approximates the data points by the linear formula

$$y = k\,x + b,$$

where the slope k and the intercept b are computed as

$$k = \frac{\overline{xy} - \bar{x}\,\bar{y}}{\overline{x^2} - \bar{x}^2}, b = \bar{y} - k\,\bar{x}$$

x+= i
x_mean = ~~mean~~ i / data length
y= data[i]
y_mean = data[i] / data length

Here $\bar{x}$ is the mean of the x coordinates, $\bar{y}$ is the mean of the y coordinates, $\overline{x^2}$ is the mean of the squares of the x coordinates, and $\overline{xy}$ is the mean of the products of the x and y coordinates. Use the element indices of the array ***double[] data*** as x coordinates and the element values as y coordinates. You may assume and use the method double ***mean(double[] a)***.

```
public statsc double[] lin(double[] data) {
double k,b; x,y; xy-mean, x_sq2;
for (i=0; i<=data.length; i++) {
 x+=i; y += data[i];
 k=~~x~~
 xy-mean+= ~~xy~~; ~~xymean~~(i* data[i])/data.length; x_sq2 ~~mean~~ i*i;
 k = (xy-mean - (x/data.length)*(y/data.length))/
       ( x_sq2/data.length - ((x/data.length)*(x/data.length);
 b = y/data.length - k * (x/data.length);
}
 double[] result = {k, b};
 return result;

}
```

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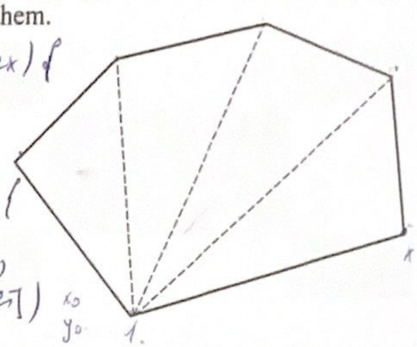
Use the backside, if needed

x= 1, 2, 3   1·5 + 2·6 + 3·7
y= 5 6 7

Problem 3: Write a Java function ***public static double area(double[][] vertex)*** that takes as its argument a ***2-by-n*** array of a convex polygon's vertex coordinates ***double[][] vertex*** – the ***x*** coordinates in the first row and ***y*** coordinates in the second row. It returns polygon's area as follows:

1. Divides the polygon into triangles by connecting the ***first*** vertex with the $\cancel{n}k^{th}$ and $(\cancel{n}k+1)^{st}$ vertices;
2. Adds the areas of the constructed triangles using the formula $area = \sqrt{p(p-a)(p-b)(p-c)}$, where ***a, b*** and ***c*** are the sides and $p = (a + b + c) / 2$.

You may assume and use a method ***double dist(double x1, double y1, double x2, double y2)*** that takes as its arguments coordinates of two points and returns the distance between them.




```
public static double area (double[][] vertex){
  for(row=0; row<2; row++) {
    for(col=0; col<vertex[row].length; col++){
      dist1 = dist(vertex[0][col], vertex[1][col],
          vertex[0][col+1], vertex[1][col+1])
      dist2 = dist(vertex[0][col+1], vertex[1][col+1],
          vertex[0][col+2], vertex[1][col+2])
```

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Problem 4: Write a Java method ***public static void magic4N(int[][] square)*** that creates a magic square of a ***4N-by-4N*** size using the following algorithm:

1. Creates an array of the same size as ***int[][] square*** and fills it forward with successive integers assigning ***1*** to the top-left element;
2. Creates anther array of the same size as ***int[][] square*** and fills it backward with successive integers assigning ***1*** to the bottom-right element;
3. Divides the original ***int[][] square*** into 16 blocks of the same size – 4 blocks per row and column. In the on-diagonal (shaded) blocks copies the elements from the first array, and in the off-diagonal blocks copies the elements from second array.

1	2					7	8	8
9	10					15	16	
		19	20	21	22			
		27	28	29	30			
		35	36	37	38			
		43	44	45	46			
49	50					55	56	
57	58					63	64	8

		62	61	60	59		
		54	53	52	51		
48	47					42	41
40	39					34	33
32	31					26	25
24	23					18	17
		14	13	12	11		
		6	5	4	3		

```
public statse void magsc4N( int[][] spuere ) {
  int[][] forward ; backward =?
  for ( row = 0; row ≤ square.length ; row++) {
    for( col = 0; col ≤ spuere[row].length ; col++) {
          forward [?] [?] = col ; } }
  for ( row = spuere.length ; row ≥ 0 ; row --) {
    for( col = spuere[row].length; col ≥ 0 ; col--) {
          backward [?] [?] = col ; } }
```

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Use the backside, if needed