Section, Name and ID#: [redacted]

AMERICAN UNIVERSITY OF ARMENIA
College of Science and Engineering
CS 120 Introduction to Object-Oriented Programming
MIDTERM EXAM

10

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 Double_fuct(int n){
  if(n%2==1){
  for(int i=1; i<=n; i+=2){
    n_fuct*=i;}
  }
  else if(n%2==0){
  for(int i=2; i<=n; i+=2){
    n_fuct*=i;}
  }
  else if(n<=0){
    n_fuct=1;}
  return n_fuct;}
```

```
float pi(int n){
  float result1,result2,result3;
  for(int i=0; i<=n; i++){
    result3=(Double(2*i-1))/(Double_fuct(2*i)*
      ((1+2*i+1)));
    result1=result3;
    result2=result3;
  result=kahan(result1,result2,0.0);}
  return result;}
```

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Use the backside, if needed

Problem 1 of 4

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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

$$y = \hat{k}x + \hat{b},$$

where the slope k and the intercept b are computed as

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

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 static double [] lin (double [] data) {
double[] result = new double [2];
int [] x = new x[data.length]; int [] x_2 = new int [data.length];
double [] y = new y[data.length];
double [] xy = new xy[data.length];
for (int i = 0; i < data.length; i++){
    x[i] = i;
    y[i] = data[i];
}
for (int j = 0; j < data.length; j++) {
    for (int k = 0; k < data.length; k++) {
    xy[j] += x[j] * y[k]; }
    }
}
result[0] = (mean(xy) - (mean(x) * mean(y))) / (mean(x_2) -
- (mean(x) * mean(x)));
result[1] = mean(y) - (result[0] * mean(x)); }
return result; }
```

for (int i = 0; i < data.length; i++)
x_2[i] = i * i;

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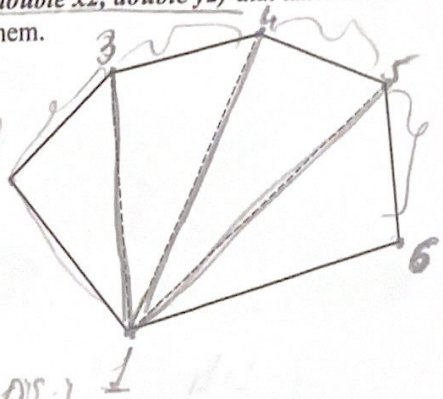
Problem 3: Write a Java function ***public static double area(double[][] vertex)*** that takes as its argument a *2-by-n* array of a convex polygon's vertex coordinates ***double[][] vertex*** – the *x* coordinates in the first row and *y* coordinates in the second row. It returns polygon's area as follows:

1. Divides the polygon into triangles by connecting the ***first*** vertex with the n^{th} and $(n+1)^{st}$ 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)
    double area=0, a, b, c, p;
    for (int i=0; i< vertex.length-1; i++){
a=dist(vertex[0][0], vertex[1][0], vertex[0][i],
    vertex[1][i]); b=dist(vertex[0][i], vertex[1][i],
    vertex[0][i+1], vertex[1][i+1]);
c= dist(vertex[0][0], vertex[1][0], vertex[0][i+1],
    vertex[1][i+1]);
    p=(a+b+c)/2;
    area+=Math.sqrt(p*(p-a)(p-b)(p-c));}

    return area;
```

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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
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

		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 static void magic4N(int[][] square){
int arr_1 = new int[square.length][square[0].length];
int arr_2 = new int[square.length][square[0].length];
for(int i = 0; i<square.length; i++){
  for(int j=0; j<square[i].length; j++){
    arr_1[i][j]=j+1; }
for(int i=0; i<square.length; i++)
  for(int j=0; j<square[i].length; j++){
    arr_2[i][j]= square[i].length-1-j; }
for(int i=0; i<arr.length/4; i++)
  for(int j=0; j<arr[i].length/4; j++){
    arr[i][j]=arr_1[i][j];
    arr[arr.length-arr.length/4][j]=arr_1[i][j];
    arr[i][arr[i].length-arr.length/4]=arr_1[i][j];
    arr[arr.length-arr.length/4][arr.length-arr.length/4]=arr_1[i][j];
for(int i=arr.length/4; i<arr.length-arr.length/4; i++)
  for(int j=arr[i].length/4; j<arr.length-arr.length/4; j++)
    arr[i][j]=arr_2[i][j];
return arr; }
```

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