Tutorial No. 3

Q.1 extend basic calculator with scientific calculations

Contains following operations

Geometric :

Sin ,cos,tan

Statistics:

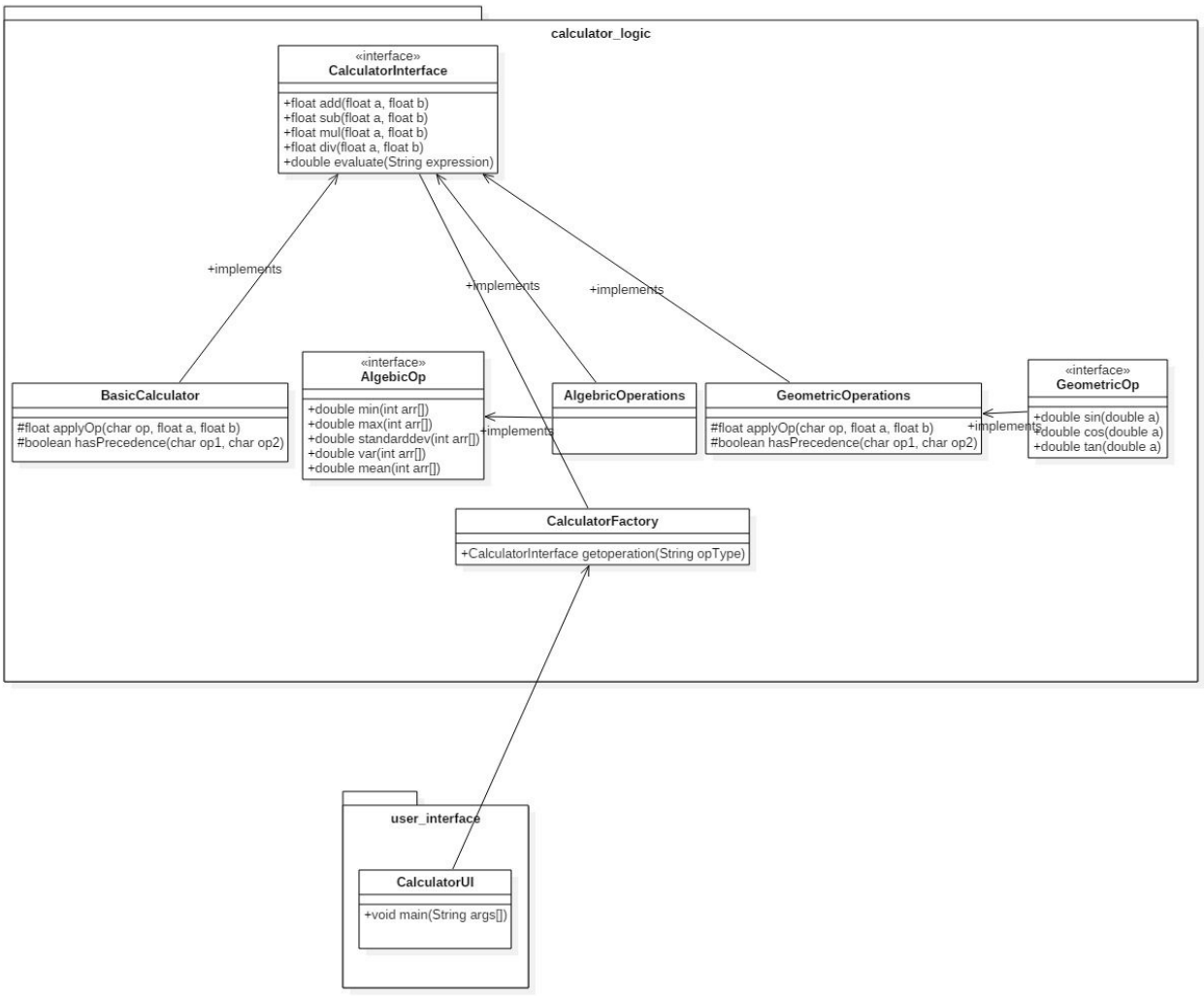
Min,max,mean,standard deviation,variance

Q.2 enlist the design principle it follows

1)

Class diagram:

fig.class diagram:calculator_monolithic_scientific



Implementation

```
//user interfaces
package user_interface;
import calculator_logic.*;
import java.util.Scanner;
public class CalculatorUI {
        public static void main(String[] args) {
           Scanner scan=new Scanner(System.in);
                String c="Y";
                while(c.equals("Y"))
                {
                System.out.println("Enter the expression : ");
```

```
                String exp;
                exp=scan.nextLine();
                CalculatorFactory calFactory=new CalculatorFactory();
                CalculatorInterface cal=calFactory.getOperation(exp);
                double res=cal.evaluate(exp);
                System.out.println("Answer is "+res);
                System.out.print("Do You not continue(Y/N):");
                c=scan.nextLine();
                }
                scan.close();
        }
}


//interfaces
package calculator_logic;

public interface CalculatorInterface {
        public float add(float a,float b);
        public float sub(float a,float b);
        public float mult(float a,float b);
        public float div(float a,float b);
        public double evaluate(String expression);
}

public interface GeometricOp {
        public double sin(double a);
        public double cos(double a);
        public double tan(double a);

}
public interface AlgebricOp {
                public  double min(int arr[]);
                public  double max(int arr[]);
                public  double standarddev(int arr[]);
                public  double var(int arr[]);
                public  double mean(int arr[]);

}

//Concrete  implementation
//arithmetic
package calculator_logic;
```

```
import java.util.*;
public class AlgebricOperations implements AlgebricOp,CalculatorInterface {

	@Override
	public double min(int[] arr) {
		// TODO Auto-generated method stub
		int min=arr[0];
		for(int k=1;k<arr.length;k++)
		{
			if(arr[k]<min)
				min=arr[k];
		}
		return min;
	}

	@Override
	public double max(int[] arr) {
		// TODO Auto-generated method stub
		int max=arr[0];
		for(int k=1;k<arr.length;k++)
		{
			if(arr[k]>max)
				max=arr[k];
		}
		return max;
	}

	@Override
	public double standarddev(int[] arr) {
		// TODO Auto-generated method stub
	    double sum = 0.0, standardDeviation = 0.0;

	    for(double num : arr) {
	        sum += num;
	    }

	    double mean = sum/10;

	    for(double num: arr) {
	        standardDeviation += Math.pow(num - mean, 2);
	    }
	    return Math.sqrt(standardDeviation/10);
	}
```

```
@Override
public double var(int[] arr) {
	// TODO Auto-generated method stub
	double sd=standarddev(arr);
	return Math.pow(sd,2);
}

@Override
public double mean(int[] arr) {
	// TODO Auto-generated method stub
	double sum=0.0;
	for(double num : arr) {
      sum += num;
   }
	int length=arr.length;
	double mean=sum/length;
	return mean;
}
public double evaluate(String expression){
	StringTokenizer token;
	ArrayList<Integer> arrlist;
	token=new StringTokenizer(expression,"(");
	String tempt=token.nextToken();
	String temp=token.nextToken();
	token=new StringTokenizer(temp,")");
	temp=token.nextToken();
	token=new StringTokenizer(temp,",");
	arrlist=new ArrayList<>();
	while(token.hasMoreTokens()){
		arrlist.add(Integer.parseInt(token.nextToken()));
	}
	int arr[]=new int[arrlist.size()];
	for(int i=0;i<arrlist.size();i++){
		arr[i]=(int)arrlist.get(i);
	}
	if(tempt.equals("min")){
		return min(arr);
	}
	else if(tempt.equals("max")){
		return max(arr);
	}
	else if(tempt.equals("mean")){
```

```
                return mean(arr);
            }
            else if(tempt.equals("sd")){
                return standarddev(arr);
            }
            else if(tempt.equals("var")){
                return var(arr);
            }
            return 0.0;
        }

        @Override
        public float add(float a, float b) {
            // TODO Auto-generated method stub
            return 0;
        }

        @Override
        public float sub(float a, float b) {
            // TODO Auto-generated method stub
            return 0;
        }

        @Override
        public float mult(float a, float b) {
            // TODO Auto-generated method stub
            return 0;
        }

        @Override
        public float div(float a, float b) {
            // TODO Auto-generated method stub
            return 0;
        }
}

//geometric
package calculator_logic;
import java.util.Stack;
public class GeometricOperations implements CalculatorInterface,GeometricOp {

        @Override
        public float add(float a, float b) {
```

```
		// TODO Auto-generated method stub
		return a+b;
	}

	@Override
	public float sub(float a, float b) {
		// TODO Auto-generated method stub
		return a-b;
	}

	@Override
	public float mult(float a, float b) {
		// TODO Auto-generated method stub
		return a*b;
	}

	@Override
	public float div(float a, float b) {
		// TODO Auto-generated method stub
		return b/a;
	}

	@Override
	public double sin(double a) {
		// TODO Auto-generated method stub
		return Math.sin(a);
	}

	@Override
	public double cos(double a) {
		// TODO Auto-generated method stub
		return Math.cos(a);
	}

	@Override
	public double tan(double a) {
		// TODO Auto-generated method stub
		return Math.tan(a);
	}

	public double evaluate(String expression)
	{
		char[] tokens;
```

```
Stack<Double> values;
Stack<Character> ops;
tokens = expression.toCharArray();
values = new Stack<>();
ops = new Stack<Character>();
for (int i = 0; i < tokens.length; i++)
{
	if (tokens[i] == ' ')
		continue;
	if (tokens[i] >= '0' && tokens[i] <= '9')
	{
		StringBuffer sbuf = new StringBuffer();
		while (i < tokens.length && tokens[i] >= '0' && tokens[i] <= '9')
			sbuf.append(tokens[i++]);
		values.push(Double.parseDouble(sbuf.toString()));
	}
	else if(tokens[i] == 's'){
		i=i+3;				//sin45 + cos45
		StringBuffer temp = new StringBuffer();
		while(i<tokens.length && tokens[i] >= '0' && tokens[i]<='9'){
			temp.append(tokens[i++]);
		}

values.push(Double.parseDouble(""+sin(Double.parseDouble(temp.toString()))));
	}
	else if(tokens[i] == 'c'){
		i=i+3;				//sin45 + cos45
		StringBuffer temp = new StringBuffer();
		while(i<tokens.length && tokens[i] >= '0' && tokens[i]<='9'){
			temp.append(tokens[i++]);
		}

values.push(Double.parseDouble(""+cos(Double.parseDouble(temp.toString()))));
	}
	else if(tokens[i] == 't'){
		i=i+3;				//sin45 + cos45
		StringBuffer temp = new StringBuffer();
		while(i<tokens.length && tokens[i] >= '0' && tokens[i]<='9'){
			temp.append(tokens[i++]);
		}

values.push(Double.parseDouble(""+tan(Double.parseDouble(temp.toString()))));
	}
```

```
                else if (tokens[i] == '('
                        ops.push(tokens[i]);
                else if (tokens[i] == ')')
                {
                        while (ops.peek() != '('
                        values.push(applyOp(ops.pop(), values.pop(), values.pop()));
                        ops.pop();
                }
                else if (tokens[i] == '+' || tokens[i] == '-' ||
                                tokens[i] == '*' || tokens[i] == '/')
                {
                        while (!ops.empty() && hasPrecedence(tokens[i], ops.peek()))
                        values.push(applyOp(ops.pop(), values.pop(), values.pop()));
                        ops.push(tokens[i]);
                }
        }
        while (!ops.empty())
                values.push(applyOp(ops.pop(), values.pop(), values.pop()));
        return values.pop();
}
protected boolean hasPrecedence(char op1, char op2)
{
        if (op2 == '(' || op2 == ')')
                return false;
        if ((op1 == '*' || op1 == '/') && (op2 == '+' || op2 == '-'))
                return false;
        else
                return true;
}
protected double applyOp(char op, double b, double a)
{
        float a1=Float.parseFloat(a+"");
        float b1=Float.parseFloat(b+"");
        switch (op)
        {
        case '+':
                return add(a1,b1);
        case '-':
                return sub(a1,b1);
        case '*':
                return mult(a1,b1);
        case '/':
                if (b1 != 0)
```

```
                                return div(a1,b1);
                        }
                        return 0;
                }
}

//basic calculator
package calculator_logic;
import java.util.Stack;
public class BasicCalculator implements CalculatorInterface {

        @Override
        public float add(float a, float b) {
                // TODO Auto-generated method stub
                return a+b;
        }

        @Override
        public float sub(float a, float b) {
                // TODO Auto-generated method stub
                return a-b;
        }

        @Override
        public float mult(float a, float b) {
                // TODO Auto-generated method stub
                return a*b;
        }

        @Override
        public float div(float a, float b) {
                // TODO Auto-generated method stub
                return b/a;
        }

        public double evaluate(String expression)
        {
                Stack<Float> values;
                Stack<Character> ops;
                char[] tokens;
                tokens = expression.toCharArray();
                values = new Stack<>();
                ops = new Stack<Character>();
```

```
        for (int i = 0; i < tokens.length; i++)
        {
                if (tokens[i] == ' ')
                        continue;
                if (tokens[i] >= '0' && tokens[i] <= '9')
                {
                        StringBuffer sbuf = new StringBuffer();
                        while (i < tokens.length && tokens[i] >= '0' && tokens[i] <= '9')
                                sbuf.append(tokens[i++]);
                        values.push(Float.parseFloat(sbuf.toString()));
                }
                else if (tokens[i] == '(')
                        ops.push(tokens[i]);
                else if (tokens[i] == ')')
                {
                        while (ops.peek() != '(')
                        values.push(applyOp(ops.pop(), values.pop(), values.pop()));
                        ops.pop();
                }
                else if (tokens[i] == '+' || tokens[i] == '-' ||
                                tokens[i] == '*' || tokens[i] == '/')
                {
                        while (!ops.empty() && hasPrecedence(tokens[i], ops.peek()))
                        values.push(applyOp(ops.pop(), values.pop(), values.pop()));
                        ops.push(tokens[i]);
                }
        }
        while (!ops.empty())
                values.push(applyOp(ops.pop(), values.pop(), values.pop()));
        return values.pop();
}
protected static boolean hasPrecedence(char op1, char op2)
{
        if (op2 == '(' || op2 == ')')
                return false;
        if ((op1 == '*' || op1 == '/') && (op2 == '+' || op2 == '-'))
                return false;
        else
                return true;
}
protected float applyOp(char op, float b, float a)
{
        switch (op)
```

```
                {
                case '+':
                        return add(a,b);
                case '-':
                        return sub(a,b);
                case '*':
                        return mult(a,b);
                case '/':
                        if (b != 0)
                                return div(a,b);
                }
                return 0;
        }

}

//factory class
package calculator_logic;

public class CalculatorFactory {
        public CalculatorInterface getOperation(String opType){
            if(opType == null){
              return null;
            }
            if(opType.contains("sin")|| opType.contains("cos")||opType.contains("tan")){
              return new GeometricOperations();
            }
            else if(opType.contains("min")||opType.contains("max")||
opType.contains("min")||opType.contains("mean")||opType.contains("sd")||opType.contains("var
"))
            {
              return new AlgebricOperations();
            }
            else{
                  return new BasicCalculator();
            }
          }
}
```

2)

i) firstly it follows OCP principle - nothing change in prior code only extension of scientific operations are added via different classes

ii)it follows direct inversion principle - there are separate classes for different class of operation
For e.g Basiccalculator class only dependent on interface
Not any low level concrete class

iii)single responsibility principle:- All operations are not dependent on any particular class
For e.g GeometricOperation class is only responsible for geometric calculations.

iv) interface segregation:- in this scientific calculator there a 3 separate interfaces , which conatins relevant signatures.