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AMERICAN UNIVERSITY OF ARMENIA

College of Science and Engineering

COMP120 Introduction to Object-Oriented Programming

FINAL EXAM

14/15

Date: Monday, May 18 2015
Starting time: 09:20
Duration: 1 hour 40 minutes
Attention: **ANY TYPE OF COMMUNICATION IS PROHIBITED**

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

Problem 1

Consider below a ***public interface Valuable*** that includes the only method ***public double value(double x)***:

```
public interface Valuable {

      public double value(double x);
}
```

1.1 Implement a ***public class Function*** that encapsulates a member variable of type ***Valuable*** and computes its derivative at the specified point ***x*** using the approximation:

$$f'(x) \approx \frac{f(x+dx) - f(x-dx)}{(2 * dx)}$$

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```
public class Function {

      private Valuable f;
      private double dx;

      public Function(Valuable newValuable, double newDX) {
            //TO BE IMPLEMENTED
      }

      public double derivative(double x) {
           //TO BE IMPLEMENTED
      }
```

1.2 Implement an expression

$$exp(-a * (x - c)^2)$$

as a ***public class Gauss*** that implements the interface ***Valuable*** and encapsulates double parameters ***a*** and ***c***. The parameters are initialized by the two-argument constructor ***public Gauss(double newA, double newC)***;

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1.3 In a separate ***public static void main(String args[])*** write a code that inputs two double values, creates an object of type ***Gauss*** and, using the class ***Function***, prints the value of its derivative at the ***x = 1.0*** point:

```
public static void main(String args[]) {
      Scanner input = new Scanner(System.in);
      double a = input.nextDouble(), c = input.nextDouble();

      //TO BE COMPLETED

}
```

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Ex. 1, 3 see on the 3,5 page →

Use the backside, if needed

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```
public class Gauss implements Valuable{
    private double a, c;
    public Gauss(double newA, double newC) {
        this.a = newA;
        this.c = newC;
    }

    @Override
    public double value(double x){
        return Math.exp(-a * Math.pow(x-c));
    }
}
```

Ex. 1.1:

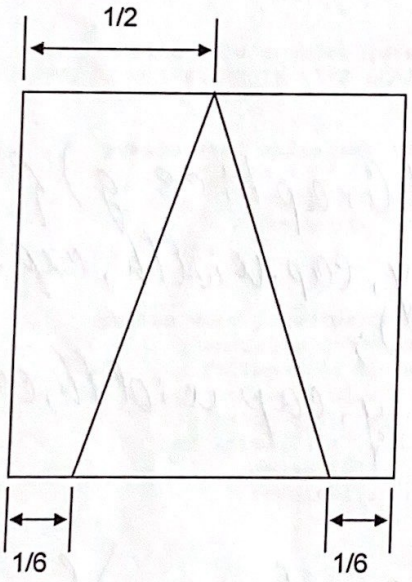
```
public class Function {
    private Valuable f;
    private double dx;
    public Function(Valuable newValuable, double newDX)
        f = newValuable;
        dx = newDX;
    }
    public double derivative(double x) {
        return (f.value(x+dx) - f.value(x-dx))/(2*dx);
    }
}
```

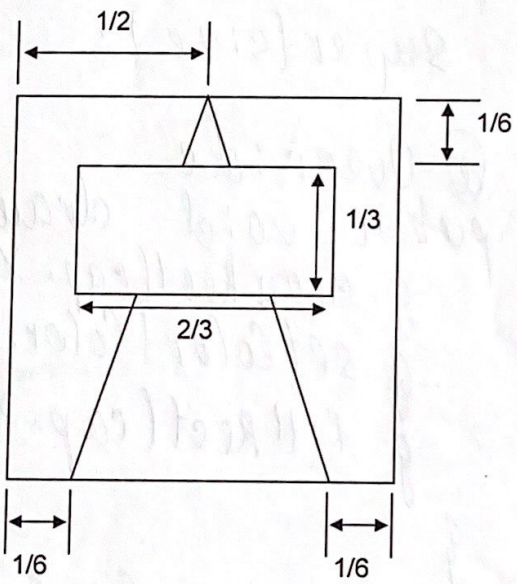
Problem 2

All 6 types of chess pieces can be drawn based on simple sketches consisting of a triangular base and rectangular cap. Consider below a ***public class ChessPiece*** that implements the triangular base only. Its geometry relative to the unit size of the square field is also sown:

```
public class ChessPiece {

	private Rectangle field;
	private Polygon base;

	public ChessPiece(int size) {
		field = new Rectangle(size, size);
		base = new Polygon(); //initially empty polygon
		base.addPoint(size / 6, size); //left vertex of the base
		base.addPoint(5 * size / 6, size); //right vertex of the base
		base.addPoint(size / 2, 0); //top vertex of the base
	}

	public void drawBase(Graphics g) {
		g.drawRect(field.x, field.y, field.width, field.height);
		g.drawPolygon(base);
	}

	public void drawCap(Graphics g) {
	}

	public void draw(Graphics g) {
		g.drawBase(g);
		g.drawCap(g);
	}
}
```

Extend a ***public class Rook extends ChessPiece*** that encapsulates ***Rectangle cap*** member variable. Implement the constructor and override ***public void drawCap(Graphics g)***. The geometries of the general chess piece and the rook are shown below:





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```
                                        :sPiece {
public
    private Rectangle cap;
    private static final int size = 10;

    public Rook(){
        super(size);
        int width = (size * 2)/3;
        int height = size/3;
        int x = size/6;
        int y = size/6;
        cap = new Rectangle(x, y, width, height);
    public Rook(int size){
        super(size);
}
    @Override
    public void drawCap(Graphics g){
        g.drawRect(cap.x, cap.y, cap.width, cap.height);
        g.setColor(Color.WHITE);
        g.fillRect(cap.x, cap.y, cap.width, cap.height);
    }
}   public void draw(Graphics g){
    drawBase(g);                          not needed
    drawCap(g);
}
```

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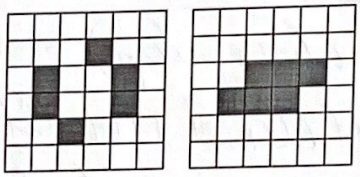
Problem 3

Consider the famous **Game of Life** cellular automaton – a two-dimensional square grid of cells, each of which can appear in one of two possible states: **alive** – ***true***, or **dead** – ***false***. At each time step called **tick** all cells are updated depending on *8* neighbors adjacent horizontally, vertically or diagonally, as follows:

- An alive (***true***) cell dies (becomes ***false***), if it has less than *2* or more than *3* live neighbors;
- An alive (***true***) cell remains alive, if it has *2* or *3* alive neighbors;
- A dead (***false***) cell becomes alive (***true***), if it has exactly *3* alive neighbors.

Complete a Java ***public class Life*** that extends ***public class Animator*** and animates the **Game of Life**. It encapsulates a ***100-by-100 private boolean grid[][]*** and initializes it randomly. Your task is to implement the methods ***public boolean tick()*** and ***public void snapshot(Graphics g)***. Draw squares for dead cells and fill squares – for alive ones. Use the methods ***g.drawRect(int topLeftX, int topLeftY, int width, int height)*** and ***g.fillRect(int topLeftX, int topLeftY, int width, int height)***. Use the default cell size = *4*. You may also use a method ***private int sum9(int row, int col)*** that returns the number of alive neighbors of a cell at the specified ***int row*** and ***int col***.

An example of an initial state is shown in the left figure. The right figure depicts the state after one tick.



```
public class Animator extends JApplet {

      public boolean tick() {
//TO BE OVERRIDEN IN LIFE CLASS
            return true;
      }

      public void snapshot(Graphics g) {
//TO BE OVERRIDEN IN LIFE CLASS
      }

      public void delay(int lag) {
            if (lag > 0) {
                  delay(lag - 1);
                  delay(lag - 1);
            }
      }

      public void paint(Graphics g) {
            g.setColor(Color.WHITE);
            g.fillRect(0, 0, getWidth(), getHeight());
            g.setColor(Color.BLACK);
            snapshot(g);
            if (tick()) {
                  delay(25);
                  repaint();
            }
      }
}
```

(public class Life is shown on the next page)

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Use the backside, if needed

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```
public static void main(String[] args){
    Scanner input = new Scanner(System.in);
    double a = input.nextDouble(), c = input.nextDouble();
    Gauss gauss = new Gauss(a, c);
    double dx = 1e-6; // 0.000001
    Function function = new Function(gauss.dx);
    double derivative = function.derivative(1.0);
    System.out.println(derivative);
}
```

Ex. 3: (Conway Game of Life)

```
public void updateGridItemsStates() {
    for(int row = 0; row < grid.length; row++){
        for(int col = 0; col < grid[0].length; col++){
            if(itemsCount<2 || itemsCount>3) {
                grid[row][col] = false;
            }
        }else{
            if(itemsCount = 3){
                grid[row][col] = true;
            }
        }
    }
```

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```
public class Life extends Animator {

      private boolean grid[][] = new boolean[100][100];
      private int cellSize = 4;

      public void init() {
            for (int row = 0; row < grid.length; row++)
                  for (int col = 0; col < grid[0].length; col++)
                        grid[row][col] = Math.random() < 0.5;
      }

      private int sum9(int row, int col) {
            int result = grid[row][col] ? -1 : 0;

            for (int i = Math.max(0, row - 1);
                        i < Math.min(grid.length - 1, row + 1); i++)
                  for (int j = Math.max(0, col - 1);
                              j < Math.min(grid[0].length - 1, col+ 1); j++)
                        result += grid[i][j] ? 1 : 0;

            return result;
      }

      public boolean tick() {
            //TO BE IMPLEMENTED
      }

      public void snapshot(Graphics g) {
            //TO BE IMPLEMENTED
      }
}
```

Ex. 3:

```
@Override
public boolean tick() {
    try {
        // wait for 1 second
        Thread.sleep(1000);
    } catch (Exception e) {
    }
    return true;
}
```

← why?

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```
public void paintComponent(Graphics g) {
    updateGridItemsStates();
    drawGrid(g);
}

public void drawGrid(Graphics g) {
    int x = 0, y = 0;
    for (int row = 0; row < grid.length; row++) {
        for (int col = 0; col < grid[0].length; col++) {
            g.setColor(Color.BLACK);
            g.drawRect(x, y, cellSize, cellSize);
            if (grid[row][col]) {
                g.setColor(Color.WHITE);
            }
            g.fillRect(x, y, cellSize, cellSize)
            x += cellSize;
        }
        x = 0
        y += cellSize)
    }
}
```

← Conway's Game of Life' page 3, 5: