Assignment 8

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TA lecture, Informatics II D-BAUG
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Concerning the Exam

Assignments Relevance

- The topics from the assignments contribute for **at least 50%** of the exam.
- Using just the mandatory part of the assignments, you can already reach a mark of 4.0 or higher. So even, if you only do the mandatory exercises, you can pass this part of the exam.
- The not mandatory parts of the assignments rather cover the marks above 4.0 up to 6.0. Thus the more not mandatory questions you solve, the better your grade gets.

Concerning the Exam

Not mandatory Questions

- For the rest of the semester there will be less not mandatory questions.
- The aim of the not mandatory parts was to account for differences among the students. Such that if you're not so much into programming yet, you can ommit them until your skills have improved. They are clearly meant as an offer not as a burden.
- Personally I like not mandatory stuff because it's usually fun. Stuff "I really have to do" is much more difficult to enjoy.

Concerning the Exam

Summaries

We will provide the summaries Oskar has written on the website after the easter break.

Exam Questions

As soon as possible, long before the exam we will provide you with a set of example questions which could be part of the final exam.

"Präsenzstunden" Today

In the **standard** room

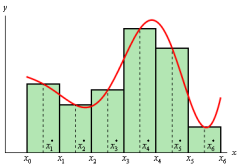
- **HIL E15.2**
- **15:00 - 18:00**
- **Timon Gehr** *(arriving 15:45)*
- **Lei Zhong** *(arriving 15:00)*

Lei joins **Timon**

Of course Lei keeps on correcting the hand-ins of his group but he won't hold his own TA lecture in future. Instead he joins Timon for the presence hours.

Outline

Rectangle Rule



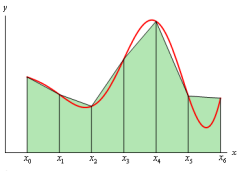
Source: http://tutorial.math.lamar.edu

We divide the interval into a given number of slices. Of each slice we take the function value at the center as the height of the according **rectangle**. The sum of the areas of all rectangles is our **approximation** of the integral.

Explanations and the code are in the lecture slides. You can look at the code, when you're stuck while programming. **Otherwise** try to implement it from the top of your head.

Outline

Trapezoidal Rule



Source: http://tutorial.math.lamar.edu

Same as before, we divide the interval into a given number of slices. But now we take the function values at the beginning and at the end of the interval. Using the two heights we calculate the area of the according **trapezoid**.

The sum of the areas of all trapezoids is our approximation of the integral. Again try to implement this method from the top of your head.

Outline

Function in Matlab

The Code for the function:

$$f(x) = \frac{\sqrt{x^6 - x^3 + 12}}{ln((x^2 + 4) \cdot (x^2 - 2) + 10)} \quad (1)$$

... looks like this in Matlab:

```
function res = f(x)
  res = sqrt(x^6-x^3+12) / log((x^2+4)*(x^2-2)+10);
end
```


Matlab Function Definitions

```
function res = f(x)
  res = sqrt(x^6-x^3+12) / log((x^2+4)*(x^2-2)+10);
end
```

Names:

- "`res`" is ... the name we gave to the return value.
- "`f`" is ... the function name.
  This means we **have to save the file** as "`f.m`".
- "`x`" is ... the parameter name.
  It's the input value we pass to the function.

Matlab Function Usage

```
function res = f(x)
  res = sqrt(x^6-x^3+12) / log((x^2+4)*(x^2-2)+10);
end
```

We call this method in the **Command Window** like this:

```
>> f(100)
ans =
   5.4286e+04
```

With a **semicolon** after the call, the result isn't printed:

```
>> f(100);
>>
```


Outline

Matlab Vectors

A vector in Matlab is like an array in Java. Nevertheless the brackets differ a bit.

Creating a vector:

```
>> test = [1 2 42 7]
test =
     1     2    42     7
```

Using a vector:

```
>> test(3)
ans =
    42
>>
```


Matlab Vectors

Using a vector:

```
>> test(3)
ans =
    42
>>
```

Indexing

Be aware that arrays in Matlab are indexed starting with `1` and not `0`, as in Java. So the first element of vector `vec` in Matlab is element `vec(1)`sin(!

Outline

Measuring Execution Time

It's quite simple:

```
tic
f(42);
toc
```

Example on one line:

```
>> tic; f(42); toc
Elapsed time is 0.000079 seconds.
```


Measuring Execution Time

Example on one line:

```
>> tic; f(42); toc
Elapsed time is 0.000079 seconds.
```

And don't forget: **Output is slow!**

```
>> tic; f(42), toc
ans =
   4.9551e+03
Elapsed time is 0.000635 seconds.
```

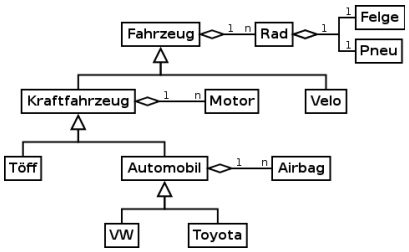

Measuring Execution Time

As we know from exercise 4.3 g) the **execution time in Java** is measured this way:

```
long time = System.currentTimeMillis();
double res = test.f(42);
long duration = System.currentTimeMillis() - time;
```


Outline

Solution, Vehicles Diagram



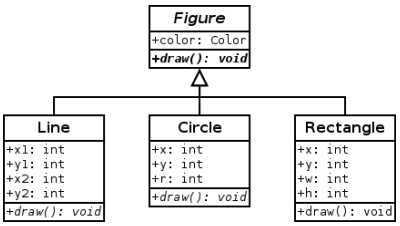
Airbag for Motorcycles



It can be argued, that some of todays motorcycles actually have an airbag. Or an airbag is even contained in the hightech suit for motorcyclists.

Outline

Given Class Diagram



Superclass Figure

```
1 class Figure {
2     Color color;
3     public Figure(Color c) {
4         color = c;
5     }
6     public void draw() {
7         System.out.println("Figure␣"+color);
8     }
9 }
```


Subclass Line

```
1 class Line extends Figure {
2     int x1, x2, y1, y2;
3     public Line(Color c,
4                 int x1,int y1,int x2,int y2) {
5         super(c); // reuse Figure-constructor
6         this.x1 = x1;
7         this.y1 = y1;
8         this.x2 = x2;
9         this.y2 = y2;
10    }
11    public void draw() {
12        System.out.println("Line␣"+color+"␣("
13            +x1+"/"+y1+")␣to␣("+x2+"/"+y2+")");
14 }  } // saving space
```


Subclass Circle

```
1 class Circle extends Figure {
2     int x, y, r;
3     public Circle(Color c,int x,int y,int r) {
4         super(c); // reuse Figure-constructor
5         this.x = x;
6         this.y = y;
7         this.r = r;
8     }
9     public void draw() {
10        System.out.println("Circle␣"+color+
11            "␣at␣("+x+"/"+y+")␣radius␣"+r);
12    }
13 }
```


Subclass Rectangle

```
1 class Rectangle extends Figure {
2     int x, y, w, h;
3     public Rectangle(Color c,
4             int x,int y,int w,int h) {
5         super(c); // reuse Figure-constructor
6         this.x = x;
7         this.y = y;
8         this.w = w;
9         this.h = h;
10    }
11    public void draw() {
12        System.out.println("Rectangle␣"+color
13        +"␣at␣("+x+"/"+y+")␣size␣"+w+"x"+h+"");
14 }  }
```


Usage in main

```
1 public static void main(String[] args) {
2     LinkedList<Figure> figures =
3         new LinkedList<Figure>();
4     figures.add(new Figure(Color.PINK));
5     figures.add(new Line(Color.BLUE,10,10,20,20));
6     figures.add(new Line(Color.RED,20,10,10,20));
7     figures.add(new Circle(Color.GREEN,30,30,10));
8     figures.add(
9         new Rectangle(Color.YELLOW,20,20,20,10));
10    for (Figure f : figures) {
11        f.draw();
12    }
13 }
```


Output of main

```
1 Figure [r=255,g=175,b=175]
2 Line [r=0,g=0,b=255] from (10/10) to (20/20)
3 Line [r=255,g=0,b=0] from (20/10) to (10/20)
4 Circle [r=0,g=255,b=0] at (30/30) with radius 10
5 Rectangle [r=255,g=255,b=0] at (20/20) size 20x10
```

Text shrinked: "`java.awt.Color`" ommitted.

Outline

class Line extends Figure

```
1 private int x1, x2, y1, y2;
2 public Line(Color c, int x1,int y1,int x2,int y2) {
3     super(c); // reuse constructor of Figure
4     this.x1 = x1;
5     this.x2 = x2;
6     this.y1 = y1;
7     this.y2 = y2;
8 }
```

We have to call the `super`-constructor explicitly (line 3), since Figure has no default-constructor (without parameters).

class Line extends Figure

```
1 public void draw(EasyGraphics graph) {
2     if ((x2-x1) > (y2-y1)) {
3         for (int i=x1; i<x2; ++i) {
4             graph.set(i, (i-x1)*(y2-y1)/(x2-x1)+y1,
5                     color.getRGB());
6         }
7     } else {
8         for (int i=y1; i<y2; ++i) {
9             graph.set((i-y1)*(x2-x1)/(y2-y1)+x1, i,
10                    color.getRGB());
11        }
12    }
13    graph.repaint();
14 }
```


class Circle extends Figure

Class structure ommitted, you can find the full solution on the website. The basic concept is to use a *sin*-function for the x-value and a *cos*-function for the y-value.

```
1 public void draw(EasyGraphics graph) {
2     for (int i=0; i<r*Math.PI*2; ++i) {
3         graph.set(x+(int)(Math.cos((double)i/r)*r),
4                   y+(int)(Math.sin((double)i/r)*r),
5                   color.getRGB());
6     }
7     graph.repaint();
8 }
```


class Circle extends Figure

```
1 graph.set(x+(int)(Math.sin((double)i/r)*r),
2           y+(int)(Math.cos((double)i/r)*r),
3           color.getRGB());
```

Common pitfalls are problems with Java's **integer computations** and **type casts**. If something doesn't work as expected, always make sure to consistently work with `double`-values only. If you need an `int` in the end, cast it just before passing back the value. Only when your algorithm works as you wish, you can finally optimize the use of `double`.

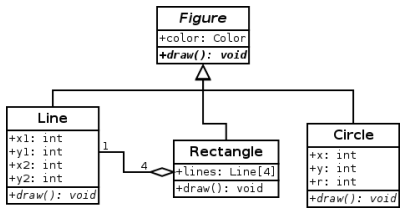
class Rectangle extends Figure

```
1 private Line[] lines; // Rectangle has 4 lines!
2
3 public Rectangle(Color c,
4                  int x,int y,int w,int h) {
5     super(c);
6     lines = new Line[4];
7     lines[0] = new Line(c,x,y,x+w,y);
8     lines[1] = new Line(c,x+w,y,x+w,y+h);
9     lines[2] = new Line(c,x,y+h,x+w,y+h);
10    lines[3] = new Line(c,x,y,x,y+h);
11 }
```

Being lazy, I use four `Line` objects to form a `Rectangle`.

Rectangle has Lines

Being lazy, I use four `Line`-objects to form a `Rectangle`. Therefore the class diagram now looks like this:



class Rectangle extends Figure

```
1 public void draw(EasyGraphics graph) {
2     for (Line l : lines) {
3         l.draw(graph);
4     }
5     graph.repaint();
6 }
```

Drawing the `Rectangle` is easy, since we just have to call the `draw`-methods of the four aggregated `Line`s.

main-Method

I decided to keep my `Figure`s in a `LinkedList`.
At first I add 20 `Line`s, all starting from the same origin.

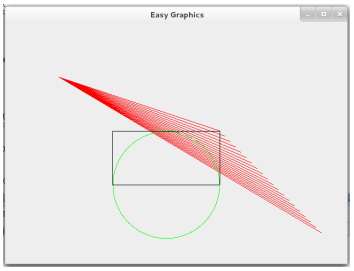
```
1 public static void main(String[] args) {
2     LinkedList<Figure> figures;
3     figures = new LinkedList<Figure>();
4     for (int i=0; i<20; ++i) {
5         figures.add(new Line(Color.RED,
6               100,100,400+i*10,200+i*10));
7     }
8     ...
```

`main` Method

Further I add a `Circle` and a `Rectangle`.
Finally we call the `draw`-Methods in a loop.

```
1       ...
2       figures.add(new Circle(Color.GREEN,
3               300,300,100));
4       figures.add(new Rectangle(Color.BLACK,
5               200,200,200,100));
6       EasyGraphics graph = new EasyGraphics();
7       for (Figure f : figures) {
8           f.draw(graph);
9       }
10  }
```


And thats how this example looks like



Questions, please

Please

- Feedback?
- Additions?
- Remarks?
- Wishes?
- ...

All the Best!