Computer Science and Mathematics
Summer term 2013

Exercises 3

1. How much digital storage capacity would be necessary for the content of a library with 100,000 books, if we assume that each book has 200 pages, each page has 50 lines and each line has 80 characters, and if a 1-byte ASCII code is used for the characters?

2. Find the 8-bit two's complement representation of the negative integer –84 .

3. (a) Change the query from the library example in the script so that in addition to the overdue book, the result also contains the name of the person who has borrowed the book.

(b) Write a query which determines all books which have to be given back in the next two weeks. (Assume that from addition of a date and a number, a date results which lies the given number of days after the given date.)

4. Below you find a part of an 8-bit ASCII code table from a web page. What character string is encoded by the bit string given in binary representation as

0100'0011'0100'1000'0100'1001'0100'0101'0100'0110 ?

(The apostrophs are only used for better overview.)

Part of 8-bit ASCII code table:

decimal	hexadecimal	character
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
...	...	...

5. Write Java expressions for the following mathematical expressions:

(a) $\dfrac{a}{b+\dfrac{1}{c}} + 2.5 \cdot 10^6$

(b) $e^{2k} \cdot \sqrt{x^2 - 2xy + 1}$

(c) $z = \begin{cases} 1 & \text{if } n \text{ is even} \\ 0 & \text{otherwise} \end{cases}$

(Remark: $\sqrt{x}$ is `Math.sqrt(x)`, e^x is `Math.exp(x)`,
`a % b` gives the rest when dividing `a` by `b`.)

6.(a) Which errors can possibly occur during runtime of the following Java program fragment?

```
int i;
float list[300];
float x, y;
...
/*  i, x and y are somehow calculated */
...
list[i] = 1.5 / (x + y);
...
```

(b) Which conditions (to be specified in Java syntax) should be checked to capture these errors before they can cause trouble?

7. The following Java method **f** gets an integer array **x** and the length **n** of the array as arguments:

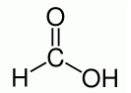
```
public int f(int x[], int n)
   {
   int i, k = 0;
   if (n <= 0) return -1;
   i = 1;
   while (i < n)
      {
      if (x[k] > x[i])
          k = i;
      i = i+1;
      }
   return k;
   }
```

(a) What does the method **f** calculate?

(b) What does it give as result if all fields of the array **x** contain the same number, namely, 1 ?

8. Write an XL (or Java) program which prints all prime numbers between 1 and 1000 on the screen (and no other numbers).

Remark 1: An integer is a prime number if it is larger than 1 and if it is not divisible without rest by any other positive integer except 1 and itself.
Remark 2: **a % b** = rest of the division of integer **a** by integer **b** ($0 \leq$ **a % b** $<$ **b**).

9. Write a turtle command sequence which generates a balls-and-sticks molecule model of formic acid (structural formula: 

).

The atoms shall be represented by spheres with different sizes and colours (depending on the chemical element), and the bonds by cylinders (**F(...)** command of the turtle). The double bond shall be represented by a thicker cylinder.
Hint: The colour of an atom **X** can be specified as in the following example:

```
module X extends Sphere(1.0)
   {{ setShader(BLUE);}};
```

Test your solution with GroIMP.

10. (a) Write an L-system which simulates the primary growth of a plant in annual steps. The *annual shoots* of the vertical main axis (stem) shall all have the same length. The uppermost annual shoot shall bear an *apical bud* (= a red sphere) and a *lateral bud* (= a green sphere). The apical bud is supposed to produce a new annual shoot of the main axis next year, and from the lateral bud shall grow a shorter *lateral shoot* with a branching angle of 45°, which will terminate its growth next year (i.e., there are no buds at the lateral shoots). The positions of the lateral branches are alternating (left-right-left-right-...) along the stem. The simulation shall start with an apical bud.

(b) Modify the model by introducing a trend: Assume that the annual shoots get 10 per cent shorter each year.

(c) Assume additionally that the apical bud produces a flower (= a large blue cone) after 7 years, and that the plant then stops to grow.

Test your solutions with GroIMP.

Remarks: By **`M(-`***s*`)` you can cause the turtle to move back along the main axis by stepsize *s*. **`Cone(`***h*`, `*r*`)` stands for a cone with height *h* and radius *r*.

11. Open the example "Molecules" in GroIMP's built-in example portfolio ("File" / "Show Examples").
Make several model runs by clicking on the buttons "Run run" and "Reset", and observe what happens.
Now modify the model in the following ways:
(a) Increase the number of atoms from 10 to 20.
(b) Switch off the output of text to the console.
(c) Double the distance threshold for formation of a bond between two atoms.