Winterterm 2012/2013

Otto-von-Guericke-University Magdeburg
Max Planck Institute for Dynamics of Complex Technical Systems
Computational Methods for Systems and Control Theory

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Website: http://www.mpi-magdeburg.mpg.de/mpcsc/lehre/2012_WS_SC/

Scientific Computing 1
5th Homework

Handout: 11/01/2012 **Return:** 11/08/2012

Exercise 1: (3 Points)

a.) Convert $(1011.101)_2$ and $(0.011111\ldots)_2$ to the decimal system.

b.) Convert $(1CBA)_{16}$ and $(C2D2.E3)_{16}$ into the dual and the decimal system.

c.) Convert $(131)_{10}$ and $(0.3)_{10}$ into the hexadecimal system.

Exercise 2: (5 Points)

Proof that the grouping of 4 digits in the dual-system to one digit in the hexadecimal-system is correct.

Exercise 3: (4 Points)

Write a C program which reads a decimal floating point number from the standard input and converts it to another number system. The basis p and the maximum number of digits in the mantissa should be read from the standard input, too. The basis should be limited to $2 \leq p \leq 16$.

Exercise 4: (2 Points)

Indicate all positive numbers that can be expressed using $\mathbb{M}(2, 3, -1, 3)$.

Exercise 5: (5 Points)

Write a C program which prints all numbers that are contained in a given $\mathbb{M}(p, t, e_{min}, e_{max})$. Use the output to plot the members of $\mathbb{M}(2, 4, -2, 4)$ and $\mathbb{M}(3, 2, -1, 2)$ on the number ray. (This can be done with an arbitrary tool, e.g., MATLAB®, gnuplot, TikZ, or by hand.)

Exercise 6: (4 Points)

Write a C function which determines the machine epsilon in double precision. Compile the program using the following compiler options:

- without any extra option (`gcc -o outfile -i input.c`),
- using *SSE2* optimizations (`gcc -mfpmath=sse -msse2 -o output input.c`),
- using the “fast-math” option (`gcc -ffast-math -o output input.c`),
- using the “float-store” option (`gcc -ffloat-store -o output input.c`),

- and second level optimizations (`gcc -O2 -o output input.c`).

What do you recognize? What are possible reasons for this behavior? If you do not use the virtual machine for this exercise please denote some details about your machine (32/64bit, Operating System, Compiler).
Extra: Think about an algorithm which is invariant under such compiler optimizations.

Exercise 7: **(2 Points)**

You will get a C program from the previous exercise via e-mail. Take a look at it and comment it. Think about:

- Is the code readable or well formed?
- Is the purpose obvious?
- Are unclear statements documented?
- Are function and variable names meaningful?
- Are there parts which can be implemented better or more efficient?
- ...

Overall Points: 25

In the Tutorial

The following exercises are not part of the homework and will be solved in the tutorial. However, if you solve them successfully during the homework, you can earn some extra points.

Exercise 8:

Determine the absolute and the relative error of 0.5403023059 and π in

a.) $\mathbb{M}(10, 3, -2, 2)$

b.) $\mathbb{M}(2, 3, -2, 3)$

c.) $\mathbb{M}(2, 5, -2, 2)$

Exercise 9:

Compute the smaller one of the two solutions to the quadratic equation

$$x^2 - 1.8x + 0.0001, \quad (a = 0.9,\ b = 0.0001)$$

using

a.) $x_1 = a - \sqrt{a^2 - b}$,

b.) $x_2 = a + \sqrt{a^2 - b}, \quad x_1 = \frac{b}{x_2}$.

Solve the equation in $\mathbb{M}(10, 3, -\infty, \infty)$ and $\mathbb{M}(10, 4, -\infty, \infty)$ and determine the relative error.