Practical Programming in C-language

Pelle Garbus, 20092716

March 22, 2017

Abstract

A) The built-in data types for numbers in C-language are discussed for a 16-bit system. B) The solution to exam problem 13 is seen in Figure 1 that has been computed from the ordinary differential equation 1. The numerical solution matches the plot of the tangent function from the math.h library in the same range.

1 Data types in C

The website 'http://www.studytonight.com/c/datatype-in-c.php' offers an excellent overview of the different data types. There are characters (is not considered to be a data representing a number, but the character itself is represented by a number), integer, float and void (the latter is an empty-type). The first three data types can be altered by so-called modifiers (signed/unsigned/short/long). For the float-type there are additional double and long double.

Seen below are tables of int (Table 1), float (Table 2) and char (Table 3) that include their modifiers. The numbers of bytes used (for a 16-bit system) is listed directly next to the variable type. Again note that char is not a type used for numbers, but included here for a complete picture of the amount of data used for the different types and their modifiers. All data have been copied from the above link.

Type, bytes	Range
int, 2	-32,768 to 32767
unsigned int, 2	0 to 65535
short int, 1	-128 to 127
long int, 4	-2,147,483,648 to 2,147,483,647
unsigned long int, 4	0 to 4,294,967,295

Table 1: 'int'-properties for a 16-bit computer.

Type, bytes	Range
Float, 4	3.4E-38 to 3.4E+38
double, 8	1.7E-308 to 1.7E+308
long double, 10	3.4E-4932 to 1.1E+4932

Table 2: 'float'-properties for a 16-bit computer.

Type, bytes	Range
char, 1	-128 to 127
unsigned char, 1	0 to 255

Table 3: 'char'-properties for a 16-bit computer.

2 Exam problem 13

The solution has been found by following the GNU manual chapter 27 on ordinary differential equations. Given is the ordinary differential equation (ODE) of the tangent function

$$y' = 1 + y(0)^2 \tag{1}$$

with the starting condition y(0) = 0. The implementation of the ODE is given in a helper function that specifies the next y-value for a current y-position. The GSL rutine gsl_odeiv.h provides a system for which the user-defined differential equation, the jacobian (not used), the dimension (single dimensional) and additional parameters (none) are given as input. A driver is allocated that takes in the newly defined system, a step-algorithm (rk8pd choosen) a starting step size, absolute allowed error (and relative error). The differential equation can now be solved numerically by running the defined driver from a user-defined start and end values by a desired number of steps. The number of steps is not important since the step-algorithmn moves through the gradient space of the differential equation, and only continues if below a certain error level. Otherwise the internal step-size is reduced.

3 Solution to Problem 13

The tangens function has a asymtote for every x fulfilling $\frac{\pi}{2}$ - nπ. As the tangens function is a periodic function, it is only necessary to consider the solution within two adjacent asymtotes, i.e.]-$\frac{\pi}{2}$, $\frac{\pi}{2}$[. The solution to the exercise has only been carried out from [0,$\frac{\pi}{2}$[due to symmetry arguments. Tangens is an odd function, i.e. f(-x) = -f(x), why the y values found in the positive range can directly be used in the range below x = 0 with a negative sign.

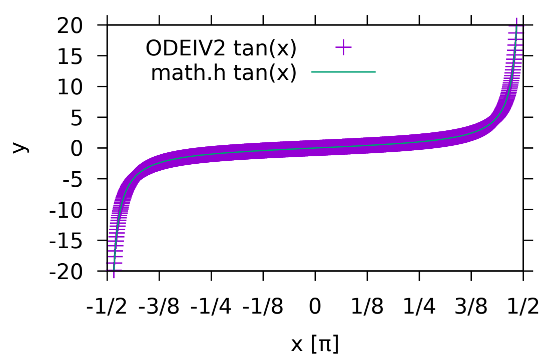

Figure 1: The tangential function found by the differential equation 1 and compared with the tangential function provided by the math.h library in the range [0,$\frac{\pi}{2}$[.