

Introduction to Mathematical Software Exercise 4



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Problem 1 Important

Before you start solving this exercise, ensure that you have solved all previous 1 to 2 star exercises!

Problem 2 Strings



Find out what the following inputs do:

- a) `i := 3+4;`
- b) `a := "The value of i is ";`
- c) `b := ".";`
- d) `cat(a,i,b);`

Problem 3 Decimal Expansion of Rational Numbers

Let two integers a , b be given with $b \neq 0$. Write a Maple procedure that returns the rational number $\frac{a}{b}$ in *decimal expansion*.

The output might be finite or periodic and should be of the form "`1.0`" for $a = 1$, $b = 1$ and "`-0.75`" for $a = -3$, $b = 4$ in the finite case and "`0.p3`" for $a = 1$, $b = 3$, "`0.1p6`" for $a = 1$, $b = 6$ and "`-0.00p142857`" for $a = -1$, $b = 700$, where p denotes the beginning of the period.

Browse the internet for a suitable algorithm to accomplish this task. Search engines should lead you to pages like <http://en.wikipedia.org/wiki/Decimal>.

Hint: Helpful Maple-commands may include `Array(1..n)` (where n is fixed), `cat`, and `irem`.

Problem 4 An Application: Image Processing (Part 3)

- k) Open the Maple document that you saved last week. Press the “!!!”-button in order to make Maple aware of all your former inputs.
- l) Now we want to detect edges in your filtered image (if you are interested in details and further information, have a look at http://en.wikipedia.org/wiki/Edge_detection). For this purpose, we will use 3×3 -filters. They tell us how to calculate the value of the new pixel from the old pixel and the 8 pixels around it by weighting them. Fortunately, this is already implemented in Maple (Convolution-command). Apply the following *Sobel-filters* (they are kind of an approximation of the derivative) separately to the image and save the results into different variables:

$$\text{SobelX} = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix} \qquad \text{SobelY} = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

They detect vertical and horizontal edges. (cf. http://en.wikipedia.org/wiki/Sobel_operator)

- m) Unfortunately, the values of some pixels might become less than 0. These will become black, if you write the image directly, although they represent edges. Also, we only get one image with vertical edges and one with horizontal edges. We can avoid both problems by “defining” the *Sobel-Operator* as follows: If GX is the result of the Convolution-command when applying the SobelX-filter and GY is the result of the Convolution-command when applying the SobelY-filter, the result of the Sobel-operator is the result of the following Maple-Command:

$$GS := \text{sqrt} \sim (GX^2 + GY^2);$$

Take a look at GS . The Edges should be white while the rest should be dark.