Institut for Matematik og Datalogi
Syddansk Universitet

November 21, 2011
JFB

Introduction to Computer Science
E11 – Lecture 14

Lecture, November 10, 12:15–14, U26

We continued with chapter 12 in the textbook, covering section 12.5 and then concentrating on security (also from sections 3.5 and 4.5) and cryptography.

Lecture, November 15, 8:15–10, U26

We will introduce the symbolic computation programming language Maple. We will also continue with cryptography, concentrating on RSA.

Lecture, November 22, 8:15–10, U26

We will finish with cryptography and security and introduce different paradigms for programming languages.

Laboratory: November 23 - Terminal Room

Discuss the following problems in groups of two (or possibly three).

1. You can start Maple by typing `xmaple`. The `restart` command is useful when you want to change your worksheet a little and execute it again; it clears all the variables and assignments. (When you want to execute the entire worksheet again, you can do it through the **Edit** menu button and **Execute**.)

   In the **Help** menu, click on **Take a Tour of Maple**. Then go through the **Ten Minute Tour**. Try doing the things suggested in the Tour, including right clicking and using the Slider on the animation toolbar. When you differentiate and then integrate, do you get back the original function?

2. Plotting data: Start up the statistical package in Maple by typing `with(Statistics);`. Define two lists, the first being [100, 200, 300, 400, 500], and the second being the number of comparisons by Insertion Sort from a previous lab. (If you don't have them with you, you can use the values: [2315, 9962, 23197, 41943, 64028].) Try plotting the points with `ScatterPlot(X,Y);` (assuming that is what you called your lists), or add a second argument `color=''Red''` to change to a different color. You can change the shape of the symbols marking the points or add a legend by right clicking on the plot.

   Now try fitting a curve to these points. You can try a quadratic curve with `ScatterPlot(X,Y,fit=[a*x^2 + b*x + c,x])`. To find the constants, you can use `Fit(a*x^2 + b*x + c,X,Y,x)`. Try at least one other type of curve, maybe linear.

   Repeat this with your data from Quicksort or Mergesort. Use $ax \log_2 x + bx + c$ as one of the curves you try. (If you don't have your data with you, you can use the values: [545, 1280, 2089, 2979, 3852].)

3. Under the **Help** menu, click on Manuals, Resources, and more, then on Manuals, and then on Introductory Programming Guide. In Section 1, you can find out how to enter a procedure into your worksheet. Try writing a procedure to take the majority of three Boolean values (it should output 1 if at least 2 of the inputs are 1, and output 0 if at least 2 of the inputs are 0).

4. Write a procedure for finding a value in an unordered list, i.e., implement the sequential search algorithm from page 241 (or 223) in the textbook (except do not assume the list is sorted, so the "greater than" test needs to be "not equal"). Test it on some random data. You may pass the length of the array as a parameter to your procedure.

5. Write a procedure for Insertion sort in Maple. Test it on some random data created with the **Matrix** palette on the left, using integers. You may pass the length of the array as a parameter to your procedure.

6. Under **Take a Tour of Maple** in the **Help** menu, there is a section on the right entitled **Programming, Code Generation, and OpenMaple**. It shows a Maple procedure translated into some other programming languages. Note the similarity in the languages. Can you understand them?

Assignment due 8:15, November 29

Late assignments will not be accepted. Working together is not allowed. (You may write this either in English or Danish.) Explain your answers. Write your solution to this assignment in LaTeX. Submit a PDF file through the Blackboard system and turn in an identical paper copy. Write your full name and your section number clearly on the first page of your assignment.

1. Write a Bare Bones program to compute the function $2X + 3Y$, where X is the value in the variable X and Y the value in Y. (Note it will help to think about how to get the value 3 in a variable.)

2. Do one of the two following problems:

   (a) Suppose that between two asterisks on the Turing machine's tape, there is a binary number in twos complement notation, i.e., each cell contains a bit $b_i \in \{0, 1\}$. Design a Turing machine which starts on the asterisk to the right of this number and changes this number to its negative. (Do not assume in advance any particular length for the binary number; just assume that there is an asterisk immediately to the left of it.)

   (b) Design a Turing machine that considers a string of zeros and ones between two asterisks as a non-negative integer in binary form and multiplies it by 9.