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Written exam in the courses

DD2325 Applied Programming and Computer Science
DA7011 Programming and Computer Science for Physicists

13th of January 2014, 14:00 - 19:00

No means of help allowed.

The grades are: E (7 points needed), D (11 points needed), C (15 points needed), B (19 points needed) and A (22 points needed). Bonus points (maximum 5bp) are converted to points (maximum 5p) on the exam.

1. Newton-Raphson method (3 p)

The following program is written to solve the non-linear equation:
$f(x) = x - \cos(x) = 0$.

```
#include <stdio.h>
#include <math.h>

double f(double x) {
  return (x-cos(x));
}
double fprime(double x) {
  return (1+sin(x));
}
main() {
  float dx=1, x=0.5;
  int   i=0;

  while (fabs(dx) > 1e-12) {
    dx = -f(x) / fprime(x);
    x  = x + dx;
    printf("%3d %17.12f %15e\n", ++i, x, dx);
  }
}
```

When the program is run it does not converge. What is the reason for that?
How can one change the code to achieve convergence?

2. Programming concepts (4 p)

a) Give at least three examples of different datatypes.

b) Why are datatypes used?

c) What is meant by call-by-reference and call-by-value?

d) Give one example of a problem where one can use call-by-reference but NOT call-by-value to solve the problem. Motivate your answer!

3. Sorting (4 p)

a) Describe and write the algorithm for Merge sort.

b) Show how the numbers 3 8 1 9 6 7 are sorted according to the Merge sort algorithm.

4. Lists (7 p)

a) Choose and state the data structures and type definitions in C needed for a *linked list* of integers.

b) Make a sketch of a list with the integers: 1 3 2 3 1 2 using your data structures and type definitions.

c) Mention a couple of advantages of *linked lists* over *arrays*.

5. Huffman coding (7 p)

What is the purpose of Huffman coding?
Now imagine that you would like to represent a message `MISSISSIPPI` in Huffman binary code.

a) Draw a Huffman tree for encoding the symbols in the message.

b) Suggest a code word for each symbol.

c) How many bits are required in total?

d) How does the length in c) compare with ASCII (using a byte)?

EOF