Functional Programming

Examination 2000-01-15

(5 Hours)

The Rules.

1. Any documents allowed
2. Please give your solutions in English and SML
3. Write structured and commented programs, give concise explanations to the most sophisticated parts of your code. More importantly, give the key ideas of your solutions
4. Unless otherwise stated, you should provide complete programs, including (data)type definitions
5. If in doubt, make all your assumptions explicit, do not hesitate to ask questions
6. Write your name (and personal number) on every page
7. The exercises are quite close to what we did in classes and assignments
8. There are 50 points you can score during this exam. To pass you should score 24. To get VG, you must score 39.
9. Good luck!

1 Occurrences (10 points)

Declare the SML functions:

1. `cOccInString(`*`str`*`,`*`ch`*`)` = the number of occurrences of character *ch* in string *str*. (3 points)
2. `sOccInString(`*`str`*`,`*`sbstr`*`)` = the number of occurrences of substring *sbstr* in string *str*. (7 points)

   For example, `sOccInString("abcdabcdabcd", "bc") = 3`

2 British Currency (10 points)

The former British currency had 12 pence to a shilling and 20 shillings to a pound. Declare SML functions to add and subtract two amounts in this currency. For example,

(7 pounds 12 shillings 7 pence) ± (6 pounds 14 shillings 8 pence)

3 Palindromes (5 points)

A string is called a *palindrome* if it is identical with the reversed string. For example, "deed" and "level" are palindromes. Write an SML function that determines whether a sting is a palindrome. Short definition is a bonus.

4 Polynomial Arithmetic (10 points)

Find an appropriate representation (type or datatype) for polynomials

$$a_n \cdot x^n + a_{n-1} \cdot x^{n-1} + \ldots + a_2 \cdot x^2 + a_1 \cdot x + a_0$$

and declare SML functions for:

1. multiplying a polynomial by a constant,
2. multiplying a polynomial by x^k, for $k \geq 0$,
3. multiplying a polynomial by $c \cdot x^k$, for $k \geq 0$, where c is a constant,
4. adding two polynomials,
5. subtracting two polynomials,
6. multiplying two polynomials.

5 Sets as Intervals (10 points)

Sets of integers, like

$$\{1, 4, 5, 6, 7, 8, 9, 12, 14\}$$

may be represented as intervals, like

$$1, 4 - 9, 12, 14$$

Select an appropriate representation (type or datatype) for such intervals and define the SML functions for

1. inclusion of an element in a set (represented by interval),
2. deletion of an element from a set (represented by interval),
3. union of two sets (represented by intervals),
4. set difference,
5. subset predicate.

6 Subtrees (5 points)

Consider binary trees containing integers in nodes. Define an appropriate (data)type and an SML function that determines whether one tree is a subtree of another.