Data Structures and Algorithms

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1 Radix rendezés

Rendezd számjegypozíciós (RADIX) listarendezéssel a

$$(132, 203, 133, 011, 232, 201)$$

listát. Mutasd be a fenti példán az algoritmus működését! Adj az algoritmus futási idejére aszimptotikus korlátot a tömb méretének, a rendezendő számok méretének és a számjegyhalmaz számosságának függvényében. Milyen elkerülhetetlen kompromisszumot látsz a futási időre és a tárhelyre vonatkozóan?

2 Zárójelek

Írj algoritmust, amely verem segítségével megkeresi egy $A[1 \dots n]$ szövegben a zárójelpárok helyét. Például a 'M(in)ta (s(z)öv)eg' esetén a kimenet $((2, 5), (11, 13), (9, 16))$.

3 Optimization

Consider the following algorithm that takes an array A of length n:

```
begin
  for i := 3 to n step 1 do
    for j := 2 to i − 1 step 1 do
      for k := 1 to j − 1 step 1 do
        if | A[i] − A[j] |==| A[j] − A[k] | ∨ | A[i] − A[k] |==| A[j] − A[k] |
          return true
        fi
      od
    od
  od
  return false
```

Write an algorithm equivalent to the previous one such that for all A it yields a strictly better asymptotic complexity!

4 Radix trees

A radix tree is used to represent a dictionary of words defined over the alphabet of the 26 letters of the English language. Assume that letters from A to Z are represented as numbers from 1 to 26. For each node x of the tree, $x.links$ is the array of links to other nodes, and $x.value$ is a Boolean value that is true when x represents a word in the dictionary. Write an algorithm Print-Radix-Tree(T) that outputs all the words in the dictionary rooted at T.

5 Huffman codes: Project Euler Problem 219

Let A and B be bit strings (sequences of 0's and 1's). If A is equal to the leftmost $length(A)$ bits of B, then A is said to be a prefix of B. For example, 00110 is a prefix of 001101001, but not of 00111 or 100110.

A prefix-free code of size n is a collection of n distinct bit strings such that no string is a prefix of any other. For example, this is a prefix-free code of size 6:

$$0000, 0001, 001, 01, 10, 11$$

Now suppose that it costs one penny to transmit a '0' bit, but four pence to transmit a '1'. Then the total cost of the prefix-free code shown above is 35 pence, which happens to be the cheapest possible for the skewed pricing scheme in question. In short, we write $Cost(6) = 35$.

What is $Cost(10^9)$?

6 Merkle trees

In cryptography and computer science, a hash tree or Merkle tree is a tree in which every leaf node is labelled with the hash of a data block, and every non-leaf node is labelled with the cryptographic hash of the labels of its child nodes. Hash trees allow efficient and secure verification of the contents of large data structures. Hash trees are a generalization of hash lists and hash chains.

How to prove something is not on the tree? Hint: items can be sorted and indexed on the tree.