

Advanced computer programming

Exercise session 6: Data structures and dictionaries

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Exercise 1

In a database, information is usually structure as a table:

id	name	food	confirmed	signup_date
1	John	Pizza	Y	2012-04-11
2	Sandy	Nem	N	2012-04-14
3	Tom	BBQ	Y	2012-04-18
4	Tina	Salad	Y	2012-04-10

Most of the time, accessing a row is done through an *index variable* (*id*). Consequently access time can be greatly decreased with appropriate data structures. What would you recommend ?

Exercise 2

Implement a buffer *B* for a text editor corresponding to the following ADT:

- `insert(B, c)`: insert character *c* at the current position;
- `delete(B)`: delete and return the current character;
- `left(B)`: move the cursor of one position to the left;
- `right(B)`: move the cursor of one position to the right;
- `begin(B)`: move the cursor at the start of the buffer;
- `end(B)`: move the cursor at the end of the buffer;
- `size(B)`: return the size of the buffer;
- `get(B, i)`: return the *i*th character in the buffer.

Exercise 3

We would like to code the following game:

- a background image is hidden by a grid of $H \times W$ black cells;
- every few seconds, one randomly chosen cells disappears, revealing the background image some more;
- the first player to recognize the background image wins.

For responsiveness reasons, the choosing mechanism is subject to being $\Theta(1)$. What data structure would be appropriate for this problem? (A `RandomInt(k)` function, returning an integer uniformly drawn from $0, \dots, k - 1$ is available).

Exercise 4

Let S and T be two sets of integers.

- (a) What data structure would you use to represent a set.
- (b) Give an algorithm which tests whether S is a subset of T . What is the complexity of this algorithm?

Exercise 5

Implement a none-recursive algorithm which computes writes an integer in base 2 (the original integer is given in base 10).

Exercise 6

During a variable definition in a programming language, the compiler needs to store several information in a so-called *Symbol table*. For instance, in a static type language, the compiler must remember the variable type (`int`, `float`, etc.). What data structure(s) is suitable for that purpose? What are the pros and cons of each solution?

Exercise 7

Implement a none-recursive algorithm which evaluates a basic mathematical expression in postfix notation. The postfix notation of " $3 \times (4 + 7)$ " is " $4\ 7\ +\ 3\times$ ".

Bonus

After watching *Windtalkers* (John Woo, 2002), one of your friend decides to play you a joke by sending "encrypted" email: he randomly permuted the letters of every word.

For instance, he may have written

"etyaydres i atwhc jonh ow'os lkiwtaresnd"

for the sentence

"Yesterday I watch John Woo's Windtalkers"

Providing we have a word database at your disposal, what data structure might help you outsmart your friend ?