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CSE 13S Spring 2021
Assignment 7: The Great Firewall of Santa Cruz
Design Document

Assignment Purpose: To Build a Bloom filter which processes messages and returns a modified message that conforms to the specifications set.

Bloom filters test whether an element is in a set:

Return either:

possibly in the set (false positives can occur)

Error rate factor can be specified and in general, the larger the Bloom filter, the lower the false positive rate

definitely not in the set (false negatives cannot occur)

The SPECK Cipher:

Lexical Analysis:

Words spoken by the citizens of GPRSC can include characters:

a-z, A-Z, 0-9, underscore, ‘, -

The Bloom Filter ADT:

Bloom filter stores three salts, each 128 bits in size. **Due to bitwise storage of salts, the bit vector ADT will also be essential.

Bloom filter functions:

bf_create - constructor for new filter

bf_delete - destructor for filter

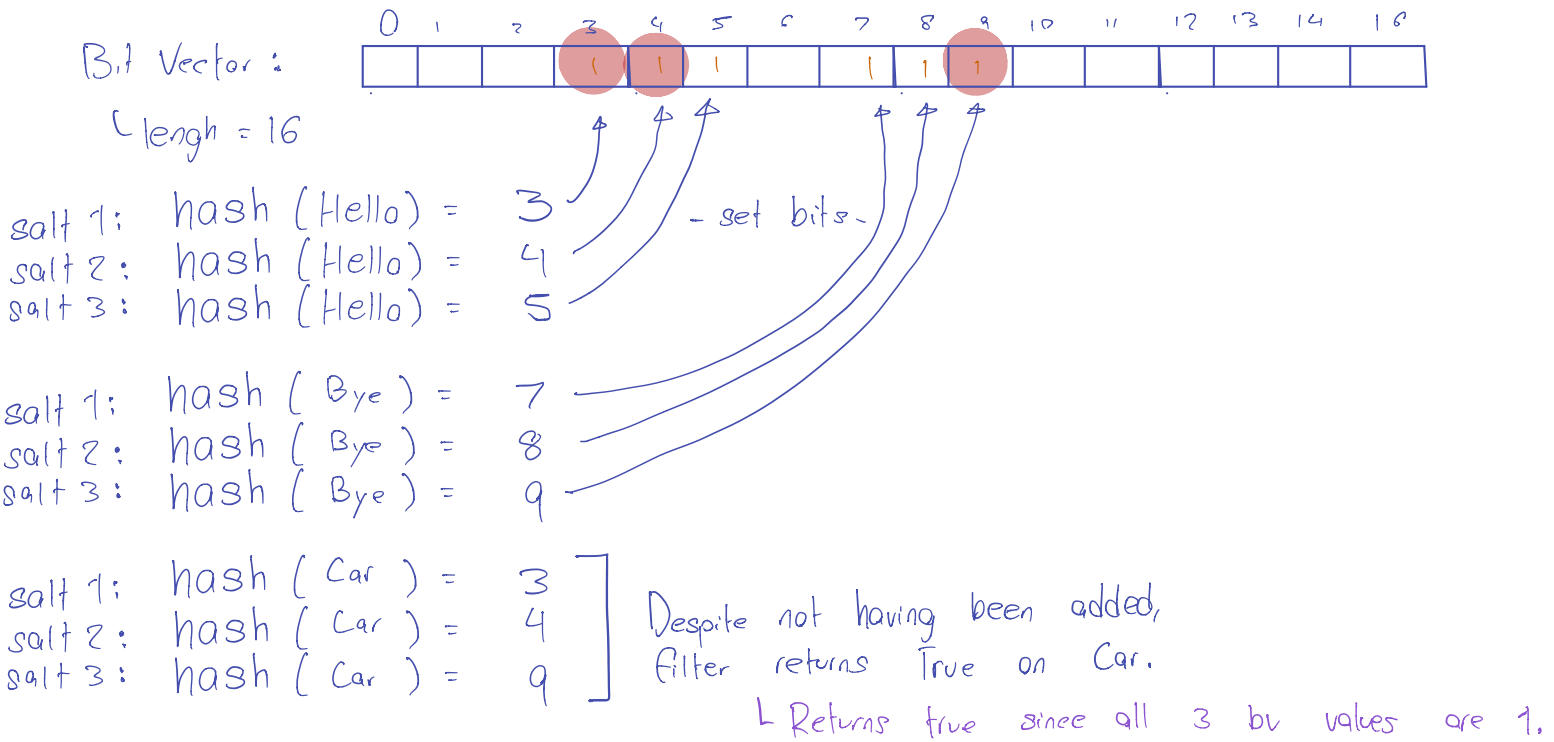
bf_size - return number of bits the filter can access
equal to the length of the bloom's bit vector

bf_insert - hashes an input word with the three salts, then sets the bits in the bloom filter's bit vector to reflect the inserted word

bf_probe - hashes an input word with the three salts, if the same vector bits are already set, the word was *most likely* added to the Bloom filter

bf_count - returns number of set bits in the bf

bf_print - prints out the filter



Note, this illustrates the advantage of three salts, to trigger the above false positive, all three of the hashed values must coincidentally fall into indexes that are already set to one, not just only one.

To correct for these remaining values, a hash table containing linked lists is used.

The HashTable ADT:

The hash table stores values to keys. Using a key, finding the value is possible in constant time. To generate a hash value from a key, K, a hashing function H(x) must be used where K is inserted as the input x.

HashTable functions:

ht_create - constructor for a hash table, sets the salt (hashing function) and initializes the tabble's linked list.

ht_delete - destructor for hash table

ht_size - return table size = the number of indices = the number of linked lists

ht_lookup

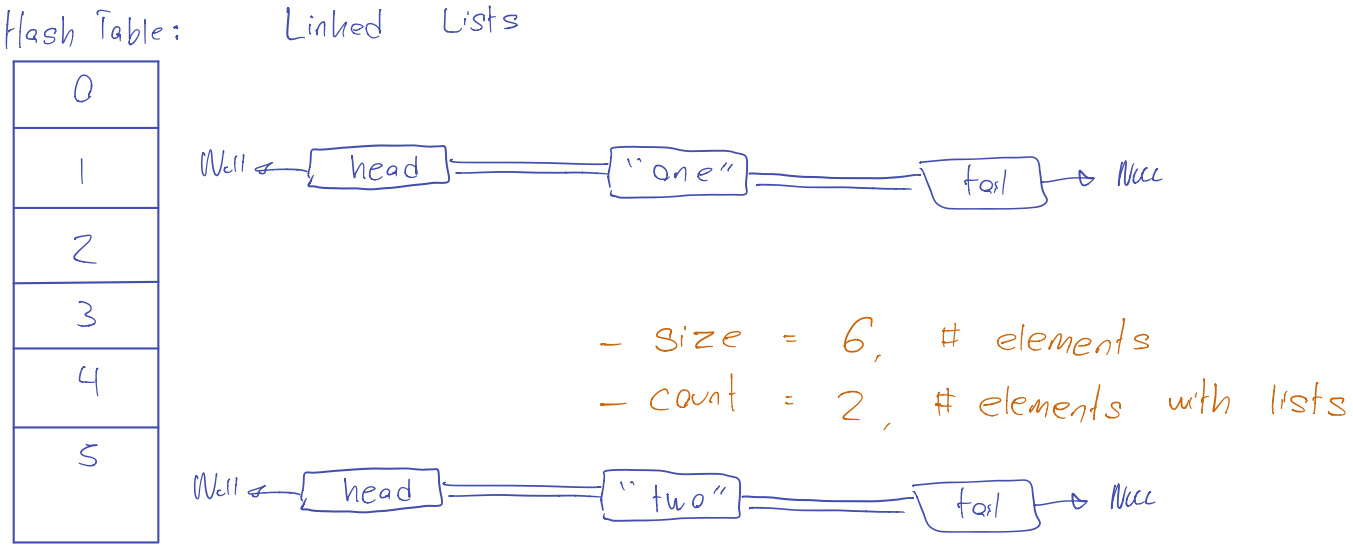
hash an input word *oldspeak*

the result of this hashing is the index of the linked list to perform lookup on

if a corresponding **node is found return true, else false

ht_insert - inserts a word *oldspeak* and it's translation *newspeak*
index of the linked list to insert is the hashing of oldspeak
if no linked list at index, create one, then add to it

ht_count - returns number of non NULL linked lists
ht_print - print out contents of hash table



The Linked List ADT:
This will be a doubly linked list (each node has a pointer to a previous and a next node).

Each node contains an oldspeak word and, if there is one, its newspeak translation.
Oldspeak without a newspeak translation is known as *badspeak*

Upon construction, a linked list begins with 2 sentinel nodes.

Linked list external variables:
Seeks - tracks number of lookups performed
Links - tracks number of links traversed

Linked list functions:
ll_create
if Boolean mtf is true, found nodes are moved to front

ll_delete - destructor for the linked list, delete every node with node delete
ll_length - return length of linked list, the 2 sentinel nodes are not counted as a part of this length
ll_lookup
if a linked list contains the node with asset oldspeak, return the node, else return NULL
Additionally if MTF is specified, move the found node to the front of the LL.
ll_insert
Check if a duplicate node already exists, if so break
else calls to create a new node, inserts the node in the LL
Always insert new nodes at the *head*, right after the first sentinel node

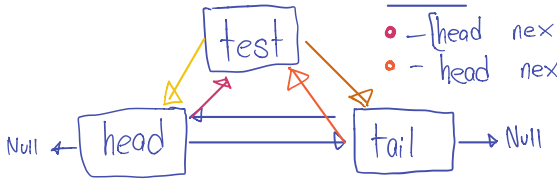
ll_insert :

ll_lookup first - return if node exists

Empty Linked List:

insert (test)

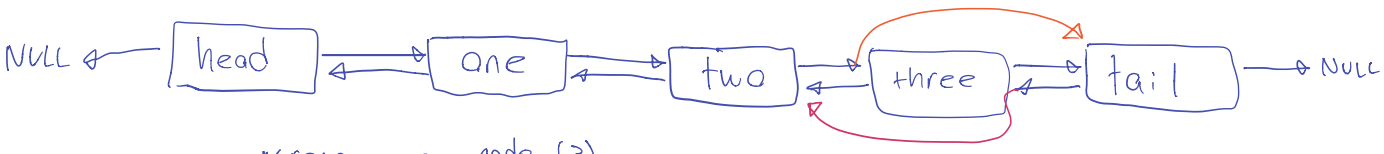
- inserted prev → head, always
- inserted next → head → next, always
- [head next] → tail now becomes inserted
- head next now becomes inserted



index the list length

move to front: search for "3" then move it to front

lookup (3) - using std lookup
- remove (3)*
- insert (3) - using std insert

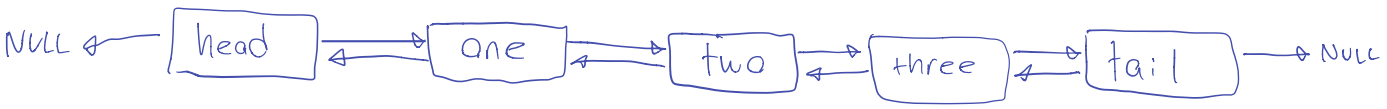


*remove a node (3)

- three → prev → three → next
- three → next → three prev
  - now nothing points to three

node_detet (three)

ll_delete:



To allow for for loop to work, delete previous, not current

Using the hash function:
The hash function returns the index of the bloom filter and hash table that are to be written to. However, this return value, by the nature of the hash function is a 10 digit number which far exceeds the reasonable size for either the bloom filter of hash table.

Indexes to HashTable and bloom filter are actually given by:

index = Hash(<hashing salt>, oldspeak) % HashTable|Bf→vector.length