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Assignment 7

Purpose: The purpose of this program is to implement the Huffman encode and decode. With encode we compress a input file, and using decode it will read the given input file. The user will input a data file and in encoder, and compress a file and the decoder reverses the compressed file back to its original state.

FILES

- Encode.c
  - This file will contain your implementation of the Huffman encoder.
- Decode.c
  - This file will contain your implementation of the Huffman decoder.
- Defines.h
  - This file will contain the macro definitions used throughout the assignment.
- Header.h
  - This will will contain the struct definition for a file header.
- Node.h
  - This file contains the node ADT interface
- Node.c
  - This file will contain your implementation of the node ADT.
- Pq.h
  - This file will contain the priority queue ADT interface.
- Pq.c
  - This file will contain your implementation of the priority queue ADT.
- Code.h
  - This file will contain the code ADT interface.
- Code.c
  - This file will contain your implementation of the code ADT.
- Io.h
  - This file will contain the I/O module interface
- Io.c
  - This file will contain your implementation of the I/O module.
- Stack.h
  - This file will contain the stack ADT interface.
- Stack.c
  - This file will contain your implementation of the stack ADT.
- Huffman.h

    - This file will contain the Huffman coding module interface.
- Huffman.c
    - This file will contain your implementation of the Huffman coding module interface.
- MakeFile
    - Complies the program
- Readme.pdf
    - describes how the program will run
- Design.pdf
    - describes the design of my program
- Encoder
    - Have a function for the print help
    - In the main
        - Have all the variables set to their default values
        - case I
            - Specificies the input file to encode using huffman
        - Case h
            - Print help message
            - Return -1
        - Case v
            - Set stats variable to true
        - Case o
            - Specificies the output file to write the compressed input to
        - Default case that prints the help message
            - Returns -1
        - Initializing histogram, setting each index to 0
        - Read the infile to compress using temporary file
            - Reset position with lseek
        - Build the tree from the histogram
        - Buld the code table from the tree
            - Using build code
            - Count the number of unique characters going from the code table
        - Reset stats variables from io, for final read statistics
        - Set header
        - Write the header out
            - Setting magic to MAGIC
            - File fize to stats st_size
        - Construct a code table to for the symbols
        - Dump the tree to the output file
        - Read data from input

      - Read bytes, and write code to the output file
      - Flush remaining code from buffer
    - If stats is true print out the compressed stats
    - Delete tree close file

- Decoder
  - Have a function for the print help
  - In the main
    - Have all the variables set to their default values
    - case I
      - Specificies the input file to decode using huffman
    - Case h
      - Print help message
      - Return -1
    - Case v
      - Set stats variable to true
    - Case o
      - Specificies the output file to write the decompressed input to
    - Default case that prints the help message
      - Returns -1
    - Creating header
    - Read the infile with header
    - Creating a struct for stat
    - Setting permissions
    - Creating a tree with tree size of header
    - Reading tree from infile
    - Rebuild the tree from the dump tree data
    - Make sure the symbol is less than the file size
    - Read the remaining bits
      - Check if root of left and right are null
        - If we reach a leaf, write the symbol
        - Adding one to symbol counter
        - Resetting the current node
      - If bit is 1, go to right child
      - If bit is 0 go to left child
    - Print stats if it’s true
- Node
  - Node_create
    - Allocating size to create a node
    - If the node is true

            - Set left and right to null
            - Set symbol and frequency to symbol and frequency passed from the parameters
        - Return the node
    - Node_delete
        - Free the node n
        - Set the node n to NULL
    - Node_join
        - Create a parent node, using node_create with the symbol $ and the frequency of left and right
        - Set parent left to left and parent right to right
        - Return the parent node
    - Node _print
        - If the node is true then print the node's left, right and symbol
    - Node_cmp
        - If the frequency of the node n is greater than the frequency of node m
            - Return true
            - If it's not return false
    - Node_print_sym
        - If iscntrl of symbol is false and is print of symbol is true
            - Print the symbol
        - If not then print the symbol with a unprintable symbol as 0x%02"PRIx8

- PriorityQueue
    - Pq_create
        - Allocating size to create a pq, if the pq is true
            - Set size and capacity to 0
                - Allocating size to create node of items
                    - If the items are false then free them
                    - Set them to NULL
        - Return q
    - Pq_delete
        - If the priority queue and items are true
            - Free the items
            - Free the priority queue
        - Return the priority queue
    - Pq_empty
        - If the size of the queue is 0
            - Return true
        - Return false if not

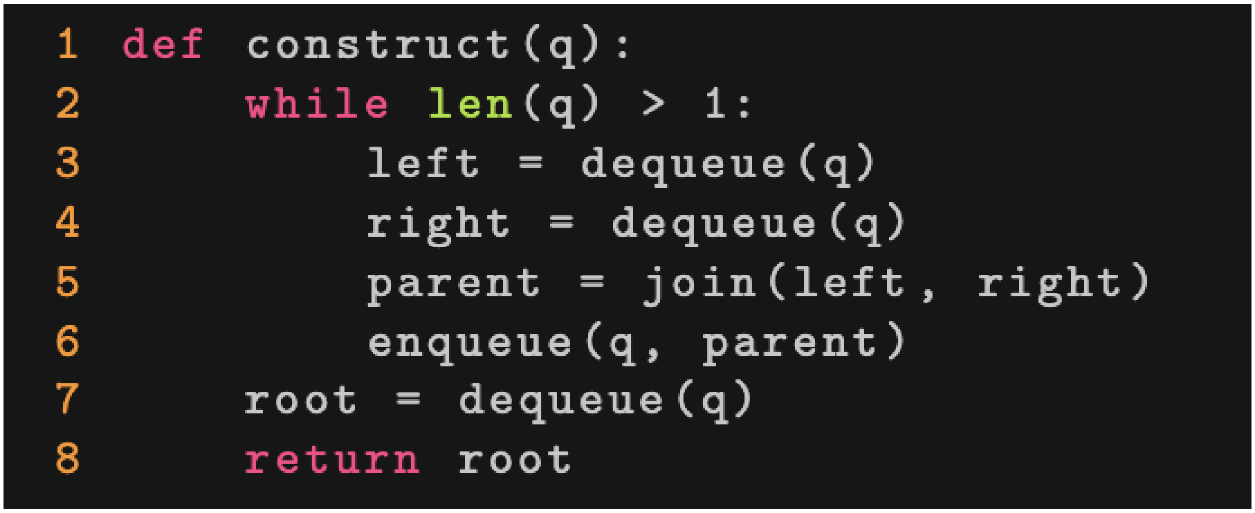
    - Pq_full
        - If the priority queue size and capacity are the same
            - Return true
            - If not return false
    - Pq_size
        - Return the size of the priority queue
    - Enqueue
        - Check if the pq is full
            - If it is return false
        - Have a while loop until the parentsis smaller than the node or index is 0
            - Swap added node to parents
    - Dequeue
        - Check if the pq is full
            - If it is return false
        - Using a helper function
            - To maintain heap
            - Pop the element
            - Decrease pointer
    - Pq_print
        - Have a loop that goes through the queue and prints each of the items
- Code
    - Code_init
        - Create code c
        - Set the top to 0
        - Have a for loop that goes to the max size
            - Set the bits to 0x0
        - Return c
    - Code_size
        - Return the top of code c
    - Code_empty
        - If the code c top is 0
            - Return true
        - Return false
    - Code_full
        - If the top od code c equals to ALPHABET
            - Return true
        - If not return false
    - Code_get_bit
        - If the bit of the index i is out of range
            - Return false

    - If the bit of the index i is equal to 0
      - Return false
    - If the bit of the index i is 1
      - Return true
  - Code_set_bit
    - Set the bit of the index i in code
    - Set it to 1 if i is out of range
      - Return false
  - Code_clr_bit
    - Bit at index i in code, clear it to 0
    - If i is not in the range
      - Return false
    - Else return true
  - Code_push_bit
    - If the code is full
      - Return false
    - If the bit is 1
      - Set the bit c and c top
    - If not clear the bit
    - Add one to node pointer
    - Return true
  - Code_pop_bit
    - If the code was empty
      - Then return false
    - Subtract 1 from top pointer
    - Return the popped bit
    - Clear the bit position
    - Return true
  - Code_print
    - For loop that goes till max_code_size
      - Print each of the bits
- I/O
  - Read_bytes
    - Set current read to read of infile, buf, and nbytes
    - Set total read to current read
    - Have a while loop that checks if current read isn't 0 and total read is less than n bytes
      - Set current read to read of fil, buf and total read, nbytes minus total read
      - Add current read to total read for statistics

    - Write_bytes
        - Set current read to write of outfile, buf, and nbytes
        - Set total read to current read
        - Have a while loop that checks if current read isn’t 0 and total read is less than n bytes
            - Set current read to write of file, buf and total read, nbytes minus total read
            - Add current read to total read for statistics
    - Read_bit
        - Have a variable for buffer, index, end
        - Read the bytes and put them in a buffer
            - If it’s 0 then return false
        - Check if all the bites are read
        - Find byte position in buffer
        - Find bit position in byte
        - Get the state of the byte
        - Increment offset
    - Write_code
        - Iterate through code c
            - Get the top bit
            - If code get bit is 1, true
                - Add bit of one to current spot of the buffer
            - If code get bit is 0, false
                - Add 0 to the current spot in the buffer
            - If buffer equals the size of the block, write it
    - Flush_codes
        - Find the last position where there are bytes to flush
        - Flush the bytes using write bytes

- Stacks
    - Stack_create
        - Allocate memory for stack
        - If the stack is true
            - Set the top to 0
            - Set capacity to the capacity passed
            - Set the items to allocated memory
        - Return the stack
    - Stack_delete
        - If that stack is true
            - Free the items

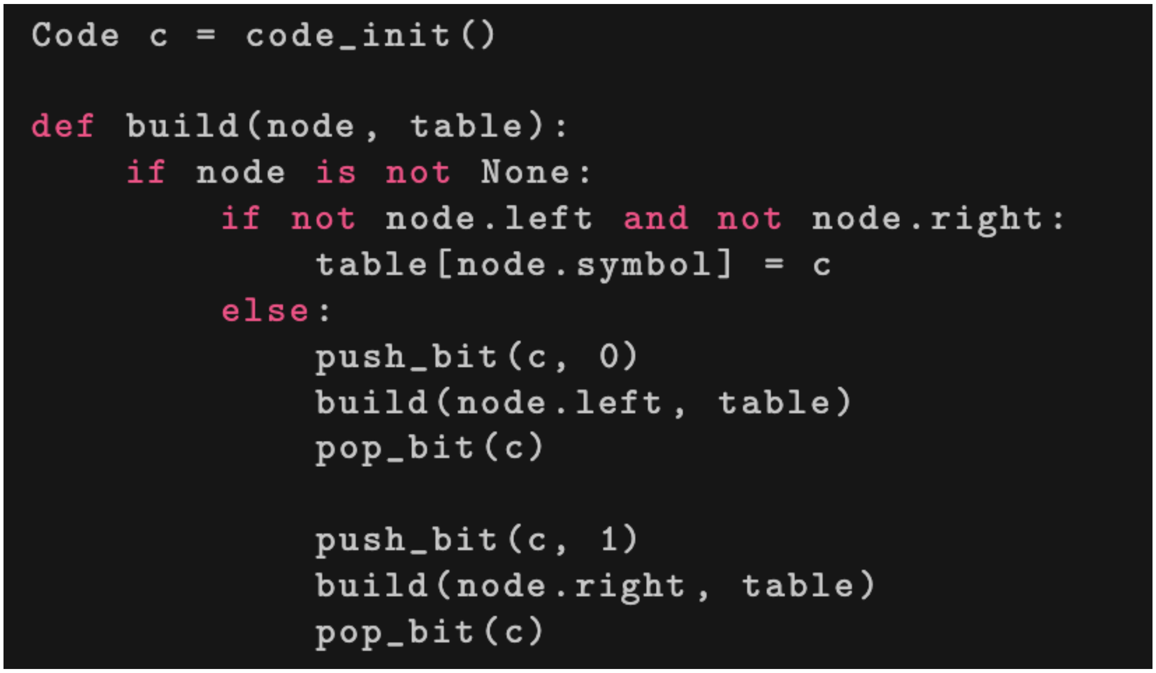
            - Free the stack
            - Set the stack to null
    - Stack_empty
        - Set top to 0
    - Stack_full
        - If the top and capacity are the same
            - Return true
    - Stack_size
        - Return top
    - Stack_push
        - If the stack is full return false
        - inccrease top pointer
        - Set the top node to the push node
        - Return true
    - Stack_pop
        - If the stack is empty
            - Return false
        - Decrease the top pointer
        - Set node n stack s' items with the idex of the top
        - Return true
    - Stack_print
        - Have a loop that goes to the capacity
            - Using node print to print out every item
- Huffman



```
def construct(q):
    while len(q) > 1:
        left = dequeue(q)
        right = dequeue(q)
        parent = join(left, right)
        enqueue(q, parent)
    root = dequeue(q)
    return root
```

-
    - Build_tree
        - Create a priority queue
        - In a for loop
            - Create a node for every

- Insert the node into the priority queue
- Enqueue the priority queue and the node
- dequeue 2 nodes from priority queue
- Enqueue with new node
- Get the last node of the priority queue

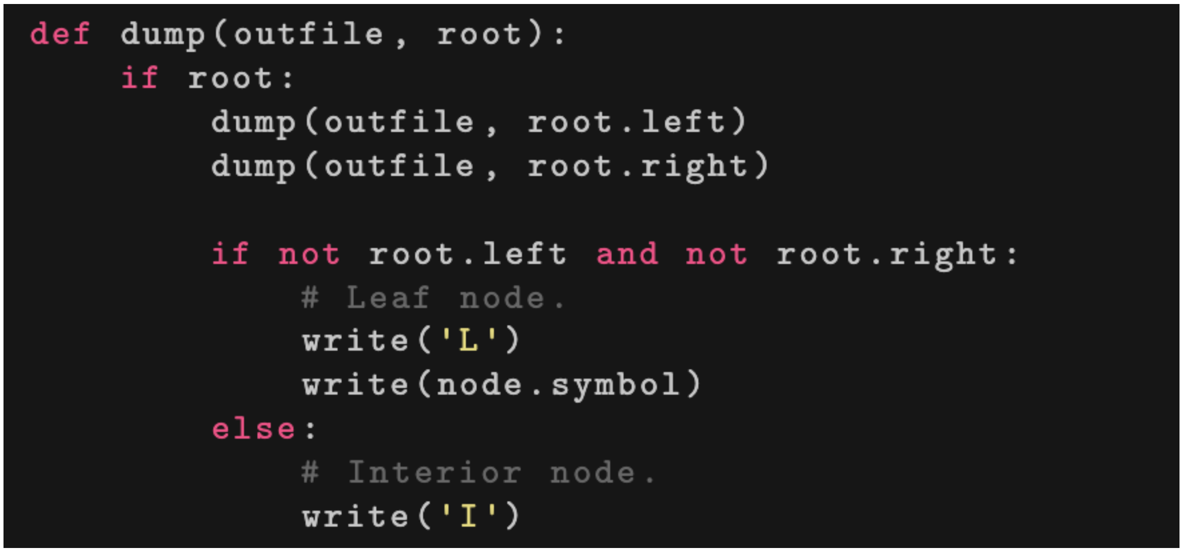
- 

```
Code c = code_init()

def build(node, table):
    if node is not None:
        if not node.left and not node.right:
            table[node.symbol] = c
        else:
            push_bit(c, 0)
            build(node.left, table)
            pop_bit(c)

            push_bit(c, 1)
            build(node.right, table)
            pop_bit(c)
```

  Build_code
    - Takes the node
    - Checks if the node is not null
    - Iterate through the tree
    - If the node, is the interior node then push 0, go to the left child
        - Pop one off the code
        - Push one to the code
        - Recursive down to right child
        - Pop one off again
        - If its the leaf node
            - Put current code into table at the index of the current symbol



```
def dump(outfile, root):
    if root:
        dump(outfile, root.left)
        dump(outfile, root.right)

        if not root.left and not root.right:
            # Leaf node.
            write('L')
            write(node.symbol)
        else:
            # Interior node.
            write('I')
```

- Dump_tree
    - Check if node pointer is not null
    - Call left and right children recursivly
    - If nodes if a leaf
        - Print L and the symbol
    - If node is interior
        - Print I
- Rebuild_tree
    - Rebuild huffman tree
    - Create node for right left and root
        - Using sequence of characters
        - Using stack to rebuild tree
    - Check if symbol in the tree if either a leaf or interior node
    - Push leaf node to stack
    - Pop two nodes if its a interior node
    - Push the combined popped nodes
    - Get the rebuilt huffman tree
- Delete_tree
    - If root is null
        - Stop
    - Else call itself on the tree left child and right child of the current node
    - Else delete the node