

Operating Systems (coe628) Lab 1

Week of January 18, 2016

Duration 1 week

Objectives

- Review the C programming language.
- Learn how to use the Netbeans Integrated Development Environment (IDE) for C programs
- Implement a Priority Queue using a linked list.

Problem description

You need to implement a Priority Queue using a linked list.

A Priority Queue is used in Operating Systems kernel as part of the scheduling algorithm. Briefly, when a process cannot continue running (perhaps because it is waiting for some event such as input/output), the OS has to choose which waiting process that is ready to run gets control of the CPU. Part of this algorithm involves a priority queue where the ready processes are ordered by their priority. All things being equal, the highest priority task will be allowed to run.

Template code is given to you. You need to implement the functions `PQ_insert` and `PQ_delete` functions.

You are given the header file `pri_queue.h`:

```
#ifndef PRI_QUEUE_H
#define PRI_QUEUE_H
typedef struct node {
    int priority;
    char * data;
    struct node * next;
} Node_t, * Node_ptr_t;
extern void PQ_insert( int, char * );
extern Node_ptr_t PQ_delete();
extern Node_ptr_t PQ_get_head();
extern int PQ_get_size();
#endif /* PRI_QUEUE_H */
```

This header file defines new data types:

- `Node_t`: A data structure for the nodes in the Priority Queue linked list. Each node contains its priority, data (a string) and a pointer to the next node in the list. (If a node is the last one on the list its “next” is NULL.)

- `Node_ptr_t`: A pointer to a `Node_t` structure.

The header file also contains the signatures for some functions:

- `void PQ_insert(int, char *)`: **You have to implement this function.** It inserts a new Node in the Priority Queue with the specified priority and data.
- `Node_ptr_t PQ_delete()`: **You have to implement this function.** It deletes and returns the highest priority Node.

You are also given the file `main.c`:

```
#include <stdio.h>
#include <stdlib.h>
#include <assert.h>
#include "pri_queue.h"
/* DO NOT MODIFY THIS FILE */
int main(int argc, char** argv) {
    Node_ptr_t head;
    assert(PQ_get_size() == 0);
    fprintf(stderr, "First assert worked!\n");
    PQ_insert(0, "first node");
    assert(PQ_get_size() == 1);
    fprintf(stderr, "Second assert worked!\n");
    head = PQ_get_head();
    assert(head != NULL);
    fprintf(stderr, "Third assert worked!\n");
    assert(head->data == "first node");
    fprintf(stderr, "Fourth assert worked!\n");
    assert(head->priority == 0);
    fprintf(stderr, "Fifth assert worked!\n");
    PQ_insert(5, "abc");
    head = PQ_get_head();
    assert(head->priority == 5);
    fprintf(stderr, "Sixth assert worked!\n");
    assert(head->next->priority == 0);
    fprintf(stderr, "Seventh assert worked!\n");
    PQ_insert(3, "def");
    head = PQ_get_head();
    assert(head->priority == 5);
    fprintf(stderr, "Eighth assert worked!\n");
    assert(head->next->priority == 3);
    fprintf(stderr, "Ninth assert worked!\n");
    assert(head->next->next->priority == 0);
    fprintf(stderr, "Tenth assert worked!\n");
    PQ_insert(7, "hij");
    head = PQ_get_head();
    assert(head->priority == 7);
    fprintf(stderr, "11th assert worked!\n");
    assert(head->next->priority == 5);
    fprintf(stderr, "12th assert worked!\n");
```

```

    assert(head->next->next->priority == 3);
    fprintf(stderr, "13th assert worked!\n");
    assert(head->next->next->next->priority == 0);
    fprintf(stderr, "14th assert worked!\n");
    PQ_insert(2, "pqr");
    head = PQ_get_head();
    assert(head->priority == 7);
    fprintf(stderr, "15th assert worked!\n");
    assert(head->next->priority == 5);
    fprintf(stderr, "16th assert worked!\n");
    assert(head->next->next->priority == 3);
    fprintf(stderr, "17th assert worked!\n");
    assert(head->next->next->next->priority == 2);
    fprintf(stderr, "18th assert worked!\n");
    assert(head->next->next->next->next->priority == 0);
    fprintf(stderr, "19th assert worked!\n");

    return (EXIT_SUCCESS);
}

```

Finally, there is the file `pri_queue.c`:

```

#include <stdlib.h>
#include <stdio.h>
#include "pri_queue.h"
/** @file pri_queue.c */
static Node_ptr_t head = NULL;
/**
 * Insert a Node into a priority queue.
 * @param priority
 * @param data
 * @author YOUR NAME
 */
void PQ_insert(int priority, char * data) {
    //FIX THIS
}
/**
 * Delete and return the node with the highest priority.
 * @return The highest priority Node.
 */
Node_ptr_t PQ_delete() {
    //FIX THIS
    return NULL;
}
/**
 * Do NOT modify this function.
 * @return A pointer to the head of the list. (NULL if
list is empty.)

```

```
*/
Node_ptr_t PQ_get_head() {
    return head;
}

/**
 * Do NOT modify this function.
 * @return the number of items in the queue
 */
int PQ_get_size() {
    int size = 0;
    for(Node_ptr_t tmp = head; tmp != NULL;
        tmp = tmp->next, size++)
        ;
    return size;
}
```

Getting started

- Create a directory called `coe628` with the command `mkdir coe628`
- Change to that directory with the command: `cd coe628`
- Download [this zip file](#) and save it in the `coe628` directory.
- Unzip the `lab1.zip` file with the command `unzip lab1.zip`
- This creates a Netbeans project.
- Start Netbeans and open the project “lab1” in your `coe628` directory.
- Compile and run the project. It should compile and the first assertion should work.
- You now have to implement the insert and delete functions so that all of the assertions work.

And Finally: Submit your lab

To submit your lab:

1. Submit the project as follows:
 - This must be done on a Departmental computer. (You can ssh into a computer remotely.)
 - Make the `lab1` directory your current directory.
 - Run the command `submit628`.

That's all folks....

Copyright © 2016 Ken Clowes. This work is licensed under the Creative Commons Attribution 3.0 Unported License. To view a copy of this license, visit <http://creativecommons.org/licenses/by/3.0/> or send a letter to Creative Commons, 171 Second Street, Suite 300, San Francisco, California, 94105, USA.