



LOVELY
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OPERATING SYSTEM REPORT

Operating Systems (CSE 316)

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Question:

Write a program for multilevel queue scheduling algorithm. There must be three queues generated. There must be specific range of priority associated with every queue. Now prompt the user to enter number of processes along with their priority and burst time. Each process must occupy the respective queue with specific priority range according to its priority. Apply round robin algorithm with quantum time 4 on queue with highest priority range. Apply priority scheduling algorithm on the queue with medium range of priority and first come first serve algorithm on the queue with lowest range of priority. Each and every queue should get a quantum time of 10 seconds. CPU will keep on shifting between queues after every 10 seconds.

Introduction

Multilevel Queue (MLQ) CPU Scheduling

It may happen that processes in the ready queue can be divided into different classes where each class has its own scheduling needs. For example, a common division is a foreground (interactive) process and a background (batch) process. These two classes have different scheduling needs. For this kind of situation, Multilevel Queue Scheduling is used.

- Multiple queues: In MLQ scheduling, processes are divided into multiple queues based on their priority, with each queue having a different priority level. Higher-priority processes are placed in queues with higher priority levels, while lower-priority processes are placed in queues with lower priority levels.
- Priorities assigned: Priorities are assigned to processes based on their type, characteristics, and importance. For example, interactive processes like user input/output may have a higher priority than batch processes like file backups.
- Preemption: Preemption is allowed in MLQ scheduling, which means a higher priority process can preempt a lower priority process, and the CPU is allocated to the higher priority process. This helps ensure that high-priority processes are executed in a timely manner.
- Scheduling algorithm: Different scheduling algorithms can be used for each queue, depending on the requirements of the processes in that queue. For example, Round Robin scheduling may be used for interactive processes, while First Come First Serve scheduling may be used for batch processes.
- Feedback mechanism: A feedback mechanism can be implemented to adjust the priority of a process based on its behavior over time. For example, if an interactive process has been waiting in a lower-priority queue for a long time, its priority may be increased to ensure it is executed in a timely manner.
- Efficient allocation of CPU time: MLQ scheduling ensures that processes with higher priority levels are executed in a timely manner, while still allowing lower priority processes to execute when the CPU is idle.
- Fairness: MLQ scheduling provides a fair allocation of CPU time to different types of processes, based on their priority and requirements.
- Customizable: MLQ scheduling can be customized to meet the specific requirements of different types of processes.

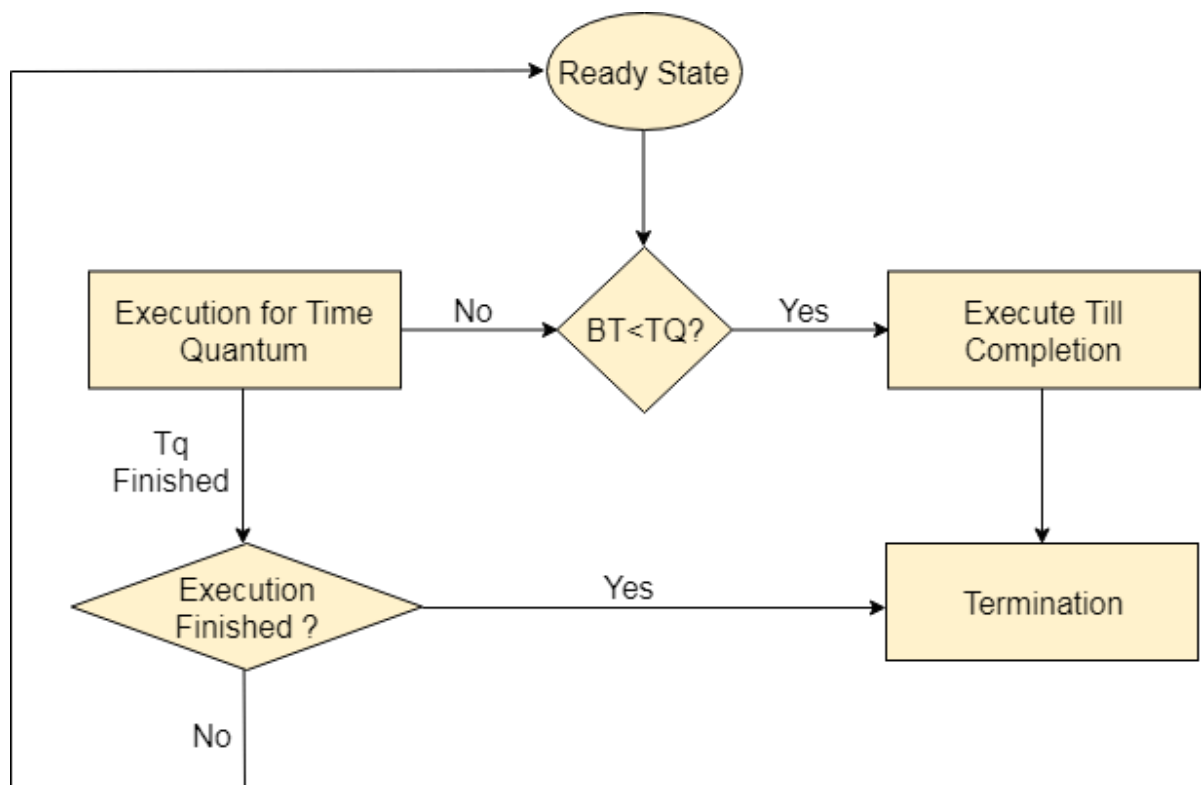
Round Robin CPU Scheduling

Round Robin CPU Scheduling is the most important CPU Scheduling Algorithm which is ever used in the history of CPU Scheduling Algorithms. Round Robin CPU Scheduling uses Time Quantum (TQ). The Time Quantum is something which is removed from the Burst Time and lets the chunk of process to be completed.

First, the processes which are eligible to enter the ready queue enter the ready queue. After entering the first process in Ready Queue is executed for a Time Quantum chunk of time. After execution is complete, the process is removed from the ready queue. Even now the process requires some time to complete its execution, then the process is added to Ready Queue.

The Ready Queue does not hold processes which already present in the Ready Queue. The Ready Queue is designed in such a manner that it does not hold non unique processes. By holding same processes Redundancy of the processes increases.

After, the process execution is complete, the Ready Queue does not take the completed process for holding.



Priority Scheduling Algorithm

In Priority scheduling, there is a priority number assigned to each process. In some systems, the lower the number, the higher the priority. While, in the others, the higher the number, the higher will be the priority. The Process with the higher priority among the available processes is given the CPU. There are two types of priority scheduling algorithm exists. One is Preemptive priority scheduling while the other is Non Preemptive Priority scheduling.

The priority number assigned to each of the process may or may not vary. If the priority number doesn't change itself throughout the process, it is called static priority, while if it keeps changing itself at the regular intervals, it is called dynamic priority.

First Come First Serve

First Come First Serve CPU Scheduling Algorithm shortly known as FCFS is the first algorithm of CPU Process Scheduling Algorithm. In First Come First Serve Algorithm what we do is to allow the process to execute in linear manner.

This means that whichever process enters process enters the ready queue first is executed first. This shows that First Come First Serve Algorithm follows First In First Out (FIFO) principle.

CODE

```
#include <iostream>
using namespace std;

struct process{
    int priority;
    int burst_time;
    int tt_time;
    int total_time=0;
};

struct queues{
    int priority_start;
    int priority_end;
    int total_time=0;
    int length = 0;
    process *p;
    bool executed = false;
};
```

```
bool notComplete(queues q[]){
    bool a=false;
    int countInc=0;
    for(int i=0;i<3;i++){
        countInc=0;
        for(int j=0;j<q[i].length;j++){
            if(q[i].p[j].burst_time != 0){
                a=true;
            }
            else{
                countInc+=1;
            }
        }
        if(countInc==q[i].length){

            q[i].executed = true;
        }
    }
    return a;
}
```

```

void sort_ps(queues q){
    //Queue q has to be sorted according to priority of processes
    for(int i=1;i<q.length;i++){
        for(int j=0;j<q.length-1;j++){
            if(q.p[j].priority<q.p[j+1].priority){
                process temp = q.p[j+1];
                q.p[j+1] = q.p[j];
                q.p[j] = temp;
            }
        }
    }
}

```

```

void checkCompleteTimer(queues q[]){
    bool a = notComplete(q);
    for(int i=0;i<3;i++){
        if(q[i].executed==false){
            for(int j=0;j<q[i].length;j++){
                if(q[i].p[j].burst_time!=0){
                    q[i].p[j].total_time+=1;
                }
            }
            q[i].total_time+=1;
        }
    }
}

```



```

main(){

    //Initializing 3 queues
    queues q[3];
    q[0].priority_start = 7;
    q[0].priority_end = 9;
    q[1].priority_start = 4;
    q[1].priority_end = 6;
    q[2].priority_start = 1;
    q[2].priority_end = 3;

    int no_of_processes,priority_of_process,burst_time_of_process;
    //Prompt User for entering Processes and assigning it to respective
    queues.
    cout<<"Enter the number of processes\n";
    cin>>no_of_processes;
    process p1[no_of_processes];

    for(int i=0;i<no_of_processes;i++){
        cout<<"Enter the priority of the process\n";
        cin>>priority_of_process;
        cout<<"Enter the burst time of the process\n";
        cin>>burst_time_of_process;
        p1[i].priority = priority_of_process;
        p1[i].burst_time = burst_time_of_process;
        p1[i].tt_time = burst_time_of_process;
        for(int j=0;j<3;j++){
            if(q[j].priority_start<=priority_of_process &&
priority_of_process<=q[j].priority_end){
                q[j].length++;
            }
        }
    }
}

```

```
for(int i =0;i<3;i++){  
    int len = q[i].length;  
    q[i].p = new process[len];  
}
```

```
int a=0;  
int b=0;  
int c=0;
```

```
for(int i =0;i<3;i++){  
    for(int j=0;j<no_of_processes;j++){  
        if((q[i].priority_start<=p1[j].priority) &&  
(p1[j].priority<=q[i].priority_end)){  
            if(i==0){  
                q[i].p[a++] = p1[j];  
  
            }  
            else if(i==1){  
                q[i].p[b++] = p1[j];  
            }  
            else{  
                q[i].p[c++] = p1[j];  
            }  
        }  
    }  
}
```

```

a--;b--;c--;
for(int i=0;i<3;i++){
    cout<<"Queue "<<i+1<<" : \t";
    for(int j=0;j<q[i].length;j++){
        cout<<q[i].p[j].priority<<"->";
    }
    cout<<"NULL\n";
}

```

```

//While RR on multiple queues is not complete, keep on repeating
int timer = 0;
int l =-1;
int rr_timer = 4;
int counter=0;
int counterps=0;
int counterfcfs=0;
while(notComplete(q)){
    if(timer == 10){
        timer = 0;
    }
    l+=1;
    if(l>=3){
        l=l%3;
    }
}

```

```

//Process lth queue if its already not executed
//If its executed change the value of l
if(q[l].executed == true){
    cout<<"Queue "<<l+1<<" completed\n";
    l+=1;
    if(l>=3){
        l=l%3;
    }
    continue;
}

```

//Finally you now have a queue which is not completely executed

//Process the incomplete processes over it

```

if(l==0){
    cout<<"Queue "<<l+1<<" in hand\n";
    //Round Robin Algorithm for q=4
    if(rr_timer == 0){
        rr_timer = 4;
    }
}

```

```

if(l==0){
    cout<<"Queue "<<l+1<<" in hand\n";
    //Round Robin Algorithm for q=4
    if(rr_timer == 0){
        rr_timer = 4;
    }

    for(int i=0;i<q[l].length;i++){
        if(q[l].p[i].burst_time==0){
            counter++;
            continue;
        }
        if(counter == q[l].length){
            break;
        }
        while(rr_timer>0 && q[l].p[i].burst_time!=0 &&
timer!=10){
            cout<<"Executing queue 1 and "<<i+1<<" process for a
unit time. Process has priority of "<<q[l].p[i].priority<<"\n";
            q[l].p[i].burst_time--;
            checkCompleteTimer(q);
            rr_timer--;
            timer++;

        }
    }
}

```

```

    if(timer == 10){
        break;
    }
    if(q[l].p[i].burst_time==0 && rr_timer ==0){
        rr_timer = 4;
        if(i == (q[i].length-1)){
            i=-1;
        }
        continue;
    }
    if(q[l].p[i].burst_time==0 && rr_timer > 0){
        if(i == (q[i].length-1)){
            i=-1;
        }
        continue;
    }
    if(rr_timer <= 0){
        rr_timer = 4;
        if(i == (q[i].length-1)){
            i=-1;
        }
        continue;
    }
}
}

```

```

else if(l==1){
    cout<<"Queue "<<l+1<<" in hand\n";
    sort_ps(q[l]);
    //Priority Scheduling
    for(int i=0;i<q[l].length;i++){
        if(q[l].p[i].burst_time==0){
            counterps++;
            continue;
        }
        if(counterps == q[l].length){
            break;
        }
        while(q[l].p[i].burst_time!=0 && timer!=10){
            cout<<"Executing queue 2 and "<<i+1<<" process for a unit
time. Process has priority of "<<q[l].p[i].priority<<"\n";
            q[l].p[i].burst_time--;
            checkCompleteTimer(q);
            timer++;

        }
        if(timer == 10){
            break;
        }
        if(q[l].p[i].burst_time==0){
            continue;
        }
    }
}
}

```

```

else{
    cout<<"Queue "<<l+1<<" in hand\n";
    //FCFS
    for(int i=0;i<q[l].length;i++){
        if(q[l].p[i].burst_time==0){
            counterfcfs++;
            continue;
        }
        if(counterfcfs == q[l].length){
            break;
        }
        while(q[l].p[i].burst_time!=0 && timer!=10){
            cout<<"Executing queue 3 and "<<i+1<<" process for a unit
time. Process has priority of "<<q[l].p[i].priority<<"\n";
            q[l].p[i].burst_time--;
            checkCompleteTimer(q);

            timer++;
        }
        if(timer == 10){
            break;
        }
        if(q[l].p[i].burst_time==0){
            continue;
        }
    }
}

```



```

    }

}
cout<<"Broke from queue "<<l+1<<"\n";
}

for(int i=0;i<3;i++){
    cout<<"\nTime taken for queue "<<i+1<<" to execute:
"<<q[i].total_time<<"\n";
    for(int j=0;j<q[i].length;j++){
        cout<<"Process "<<j+1<<" of queue "<<i+1<<" took
"<<q[i].p[j].total_time<<"\n";
    }
}

```

```

int sum_tt=0;
int sum_wt=0;

cout<<"\n\nProcess    | Turn Around Time | Waiting Time\n";
for(int i=0;i<3;i++){
    cout<<"Queue "<<i+1<<"\n";
    for(int j=0;j<q[i].length;j++){
        cout<<"Process P"<<j+1<<"\t"<<q[i].p[j].total_time<<"\t\t"
        "<<q[i].p[j].total_time-q[i].p[j].tt_time<<"\n";
        sum_tt+=q[i].p[j].total_time;
        sum_wt+=q[i].p[j].total_time-q[i].p[j].tt_time;
    }
}

cout<<"\n The average turnaround time is :
"<<sum_tt/no_of_processes<<endl;
cout<<"\n The average waiting time is :
"<<sum_wt/no_of_processes<<endl;

}

```

Logic Of the Code

The code is an implementation of a multi-level feedback queue scheduler algorithm using a Round Robin algorithm for the highest priority queue.

The code starts by defining two structs, process and queues. The process struct contains the attributes of a process, including its priority, burst time, turnaround time, and total time. The queues struct contains the priority range for each queue, the total time taken by each queue, the length of each queue, a pointer to an array of processes, and a flag to indicate whether the queue has executed or not.

The notComplete function is used to check if any process is remaining in the queues or not. It iterates through all the queues and their respective processes and checks if any process still has a non-zero burst time. If a process is still remaining in any of the queues, the function returns true, indicating that the scheduler algorithm needs to continue.

The sort_ps function is used to sort the processes in a queue based on their priority. It uses a bubble sort algorithm to swap the processes' positions if their priorities are not in descending order.

The checkCompleteTimer function is used to keep track of the total time taken by each process and queue. It updates the total time for each process that has not yet completed and increases the total time for each queue for every unit of time.

The main function starts by taking user input for the number of processes, their priorities, and burst times. It creates an array of processes p1 and assigns each process to its respective queue based on its priority range.

The code then initializes the Round Robin algorithm by setting the timer to 0 and the time quantum to 4. It uses a while loop to execute the processes in each queue until all processes have completed.

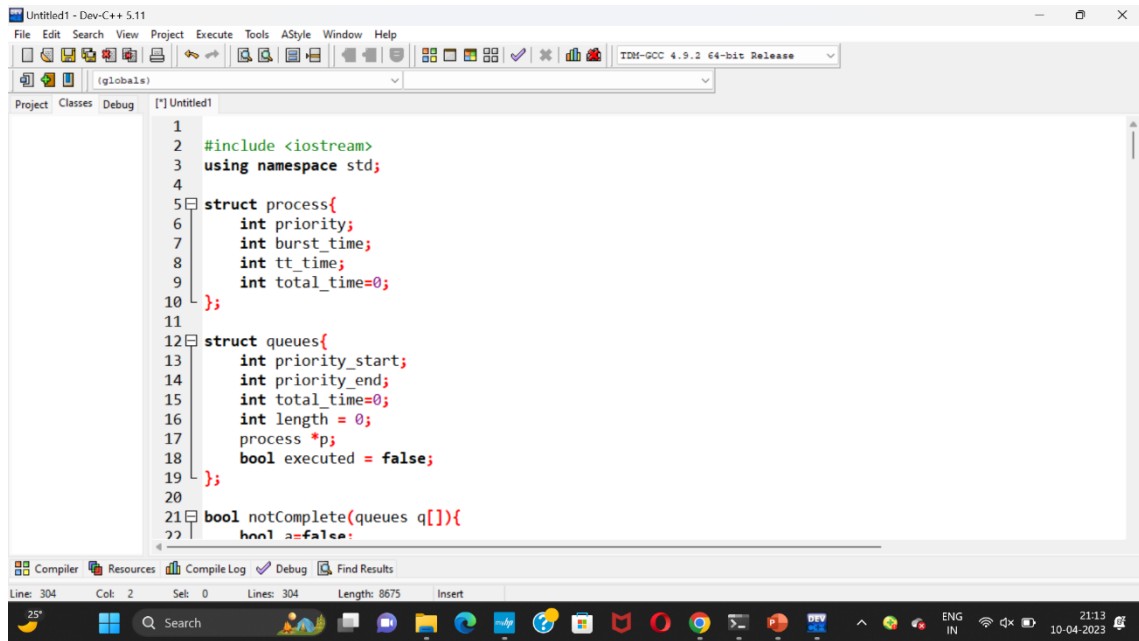
Inside the loop, it checks if the current queue has completed executing all its processes. If yes, it moves to the next queue. If not, it checks if the current queue is the highest priority queue, i.e., queue 1. If yes, it executes the Round Robin algorithm for a time quantum of 4. It executes each process in the queue until the time quantum has expired or the process has completed its burst time. If the time quantum expires, it moves to the next process in the queue. If the process has completed, it moves to the next process in the queue only if all other processes have not completed.

If the current queue is not the highest priority queue, it executes the processes in the queue in a First-Come-First-Serve (FCFS) order until all processes have completed.

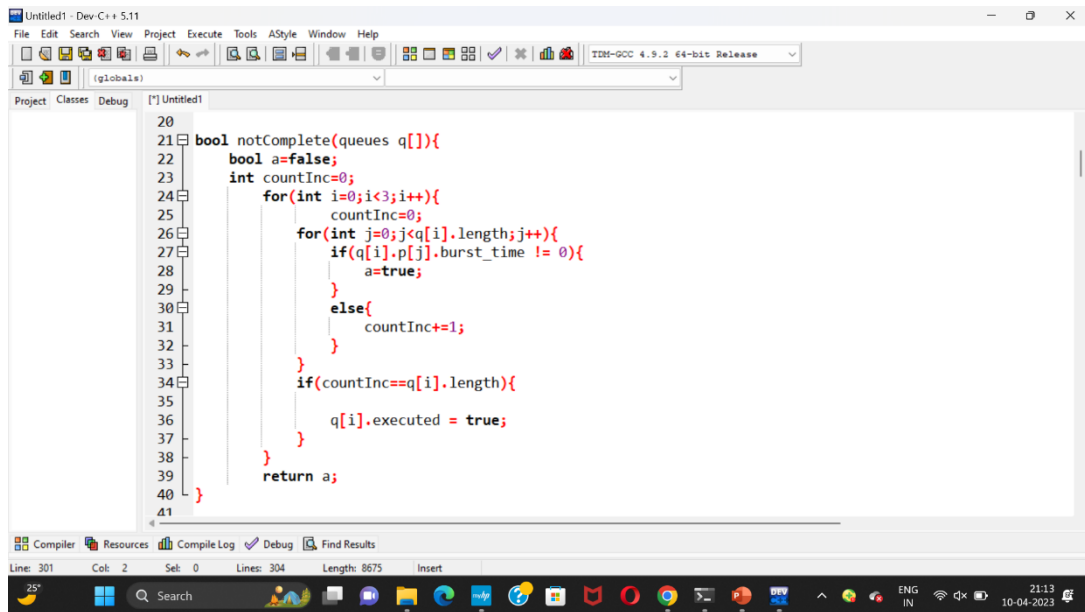
The code keeps track of the total time taken by each process and queue using the `checkCompleteTimer` function after each unit of time, and it prints the status of each process and queue after every execution. The code stops when all processes have completed executing.

In summary, the given code implements a multi-level feedback queue scheduler algorithm using a Round Robin algorithm for the highest priority queue and an FCFS algorithm for lower priority queues.

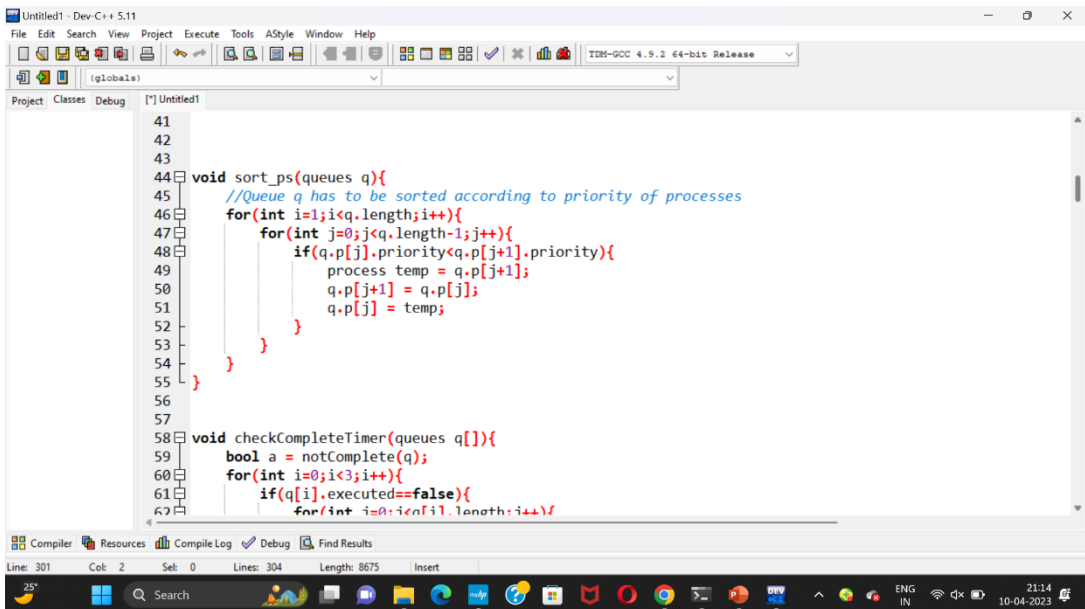
Screenshots



```
1
2 #include <iostream>
3 using namespace std;
4
5 struct process{
6     int priority;
7     int burst_time;
8     int tt_time;
9     int total_time=0;
10 };
11
12 struct queues{
13     int priority_start;
14     int priority_end;
15     int total_time=0;
16     int length = 0;
17     process *p;
18     bool executed = false;
19 };
20
21 bool notComplete(queues q[]){
22     bool a=false;
```



```
20
21 bool notComplete(queues q[]){
22     bool a=false;
23     int countInc=0;
24     for(int i=0;i<3;i++){
25         countInc=0;
26         for(int j=0;j<q[i].length;j++){
27             if(q[i].p[j].burst_time != 0){
28                 a=true;
29             }
30             else{
31                 countInc++;
32             }
33         }
34         if(countInc==q[i].length){
35             q[i].executed = true;
36         }
37     }
38     return a;
39 }
40
41
```



```
41
42
43
44 void sort_ps(queues q){
45     //Queue q has to be sorted according to priority of processes
46     for(int i=1;i<q.length;i++){
47         for(int j=0;j<q.length-i;j++){
48             if(q.p[j].priority<q.p[j+1].priority){
49                 process temp = q.p[j+1];
50                 q.p[j+1] = q.p[j];
51                 q.p[j] = temp;
52             }
53         }
54     }
55 }
56
57
58 void checkCompleteTimer(queues q[]){
59     bool a = notComplete(q);
60     for(int i=0;i<3;i++){
61         if(q[i].executed==false){
62             for(int j=0;j<q[i].length;j++){
```

```
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(globals)
Project Classes Debug [*] Untitled1
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    if(q[i].executed==false){
        for(int j=0;j<q[i].length;j++){
            if(q[i].p[j].burst_time!=0){
                q[i].p[j].total_time+=1;
            }
        }
        q[i].total_time+=1;
    }
}

main(){
    //Initializing 3 queues
    queues q[3];
    q[0].priority_start = 7;
    q[0].priority_end = 9;
    q[1].priority_start = 4;
    q[1].priority_end = 6;
    q[2].priority_start = 1;
    q[2].priority_end = 3;
}
```

```
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int no_of_processes,priority_of_process,burst_time_of_process;
//Prompt User for entering Processes and assigning it to respective queues.
cout<<"Enter the number of processes\n";
cin>>no_of_processes;
process p1[no_of_processes];

for(int i=0;i<no_of_processes;i++){
    cout<<"Enter the priority of the process\n";
    cin>>priority_of_process;
    cout<<"Enter the burst time of the process\n";
    cin>>burst_time_of_process;
    p1[i].priority = priority_of_process;
    p1[i].burst_time = burst_time_of_process;
    p1[i].tt time = burst_time_of_process;
    for(int j=0;j<3;j++){
        if(q[j].priority_start<=priority_of_process && priority_of_process<=q[j].priority_end){
            q[j].length++;
        }
    }
}
```

```
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122
123

    }
    }

    for(int i =0;i<3;i++){
        int len = q[i].length;
        q[i].p = new process[len];
    }

    int a=0;
    int b=0;
    int c=0;

    for(int i =0;i<3;i++){
        for(int j=0;j<no_of_processes;j++){
            if((q[i].priority_start<=p1[j].priority) && (p1[j].priority<=q[i].priority_end)){
                if(i==0){
                    q[i].p[a++] = p1[j];
                }
                else if(i==1){
                    q[i].p[b++] = p1[j];
                }
            }
        }
    }
}
```

```
Untitled1 - Dev-C++ 5.11
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(globals)
Project Classes Debug [*] Untitled1
122         q[i].p[b++] = p1[j];
123     }
124     else{
125         q[i].p[c++] = p1[j];
126     }
127 }
128 }
129 }
130
131 a--;b--;c--;
132 for(int i=0;i<3;i++){
133     cout<<"Queue "<<i+1<<" : \t";
134     for(int j=0;j<q[i].length;j++){
135         cout<<q[i].p[j].priority<<"->";
136     }
137     cout<<"NULL\n";
138 }
139
140
141 //While RR on multiple queues is not complete, keep on repeating
142 int timer = 0;
143 int l = -1;
```

```
Untitled1 - Dev-C++ 5.11
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(globals)
Project Classes Debug [*] Untitled1
142     int timer = 0;
143     int l = -1;
144     int rr_timer = 4;
145     int counter=0;
146     int counterps=0;
147     int counterfcfs=0;
148     while(notComplete(q)){
149         if(timer == 10){
150             timer = 0;
151         }
152         l+=1;
153         if(l>=3){
154             l=l%3;
155         }
156
157         //Process lth queue if its already not executed
158         //If its executed change the value of l
159         if(q[l].executed == true){
160             cout<<"Queue "<<l+1<<" completed\n";
161             l+=1;
162             if(l>=3){
163                 l=l%3;
164             }
165         }
166     }
167
168     //Finally you now have a queue which is not completely executed
169     //Process the incomplete processes over it
170
171     if(l==0){
172         cout<<"Queue "<<l+1<<" in hand\n";
173         //Round Robin Algorithm for q=4
174         if(rr_timer == 0){
175             rr_timer = 4;
176         }
177
178         for(int i=0;i<q[l].length;i++){
179             if(q[l].p[i].burst_time==0){
180                 counter++;
181                 continue;
182             }
183         }
184     }
185 }
```

```
Untitled1 - Dev-C++ 5.11
File Edit Search View Project Execute Tools AStyle Window Help
(globals)
Project Classes Debug [*] Untitled1
161     l+=1;
162     if(l>=3){
163         l=l%3;
164     }
165     continue;
166 }
167
168 //Finally you now have a queue which is not completely executed
169 //Process the incomplete processes over it
170
171 if(l==0){
172     cout<<"Queue "<<l+1<<" in hand\n";
173     //Round Robin Algorithm for q=4
174     if(rr_timer == 0){
175         rr_timer = 4;
176     }
177
178     for(int i=0;i<q[l].length;i++){
179         if(q[l].p[i].burst_time==0){
180             counter++;
181             continue;
182         }
183     }
184 }
```

```

182 |
183 |         if(counter == q[l].length){
184 |             break;
185 |         }
186 |         while(rr_timer>0 && q[l].p[i].burst_time!=0 && timer!=10){
187 |             cout<<"Executing queue 1 and "<<i+1<<" process for a unit time. Process has priority
188 |             q[l].p[i].burst_time--;
189 |             checkCompleteTimer(q);
190 |             rr_timer--;
191 |             timer++;
192 |         }
193 |
194 |         if(timer == 10){
195 |             break;
196 |         }
197 |         if(q[l].p[i].burst_time==0 && rr_timer ==0){
198 |             rr_timer = 4;
199 |             if(i == (q[i].length-1)){
200 |                 i=-1;
201 |             }
202 |             continue;
203 |         }

```

```

203 |
204 |         if(q[l].p[i].burst_time==0 && rr_timer > 0){
205 |             if(i == (q[i].length-1)){
206 |                 i=-1;
207 |             }
208 |             continue;
209 |         }
210 |         if(rr_timer <= 0){
211 |             rr_timer = 4;
212 |             if(i == (q[i].length-1)){
213 |                 i=-1;
214 |             }
215 |             continue;
216 |         }
217 |     }
218 |
219 | }
220 |
221 |
222 | else if(l==1){
223 |     cout<<"Queue "<<l+1<<" in hand\n";
224 |     sort ns(n,l);

```

```

223 |     cout<<"Queue "<<l+1<<" in hand\n";
224 |     sort ps(q[l]);
225 |     //Priority Scheduling
226 |     for(int i=0;i<q[l].length;i++){
227 |         if(q[l].p[i].burst_time==0){
228 |             counterps++;
229 |             continue;
230 |         }
231 |         if(counterps == q[l].length){
232 |             break;
233 |         }
234 |         while(q[l].p[i].burst_time!=0 && timer!=10){
235 |             cout<<"Executing queue 2 and "<<i+1<<" process for a unit time. Process has priority
236 |             q[l].p[i].burst_time--;
237 |             checkCompleteTimer(q);
238 |             timer++;
239 |         }
240 |
241 |         if(timer == 10){
242 |             break;
243 |         }
244 |         if(n[l].n!=1 && n[l].burst_time==0){

```



```

Untitled1 - Dev-C++ 5.11
File Edit Search View Project Execute Tools AStyle Window Help
(globals)
Project Classes Debug
245         continue;
246     }
247 }
248 }
249 }
250 else{
251     cout<<"Queue "<<l+1<<" in hand\n";
252     //FCFS
253     for(int i=0;i<q[l].length;i++){
254         if(q[l].p[i].burst_time==0){
255             counterfcfs++;
256             continue;
257         }
258         if(counterfcfs == q[l].length){
259             break;
260         }
261         while(q[l].p[i].burst_time!=0 && timer!=10){
262             cout<<"Executing queue 3 and "<<i+1<<" process for a unit time. Process has priority
263             q[l].p[i].burst_time--;
264             checkCompleteTimer(q);
265         }
266         timer++;

```

```

Untitled1 - Dev-C++ 5.11
File Edit Search View Project Execute Tools AStyle Window Help
(globals)
Project Classes Debug
267     }
268     if(timer == 10){
269         break;
270     }
271     if(q[l].p[i].burst_time==0){
272         continue;
273     }
274 }
275 }
276 }
277 }
278 cout<<"Broke from queue "<<l+1<<"\n";
279 }
280 }
281 for(int i=0;i<3;i++){
282     cout<<"\nTime taken for queue "<<i+1<<" to execute: "<<q[i].total_time<<"\n";
283     for(int j=0;j<q[i].length;j++){
284         cout<<"Process "<<j+1<<" of queue "<<i+1<<" took "<<q[i].p[j].total_time<<"\n";
285     }
286 }
287 }
288 int sum<im ++=0;

```

```

Untitled1 - Dev-C++ 5.11
File Edit Search View Project Execute Tools AStyle Window Help
(globals)
Project Classes Debug
284     cout<<"Process "<<j+1<<" of queue "<<i+1<<" took "<<q[i].p[j].total_time<<"\n";
285 }
286 }
287 }
288 int sum_tt=0;
289 int sum_wt=0;
290 }
291 cout<<"\n\nProcess | Turn Around Time | Waiting Time\n";
292 for(int i=0;i<3;i++){
293     cout<<"Queue "<<i+1<<"\n";
294     for(int j=0;j<q[i].length;j++){
295         cout<<"Process P"<<j+1<<"\t"<<q[i].p[j].total_time<<"\t\t" <<q[i].p[j].total_time-q[i].p[
296         sum_tt+=q[i].p[j].total_time;
297         sum_wt+=q[i].p[j].total_time-q[i].p[j].tt_time;
298     }
299 }
300 }
301 cout<<"\n The average turnaround time is : "<<sum_tt/no_of_processes<<endl;
302 cout<<"\n The average waiting time is : "<<sum_wt/no_of_processes<<endl;
303 }
304 }

```

```
C:\Users\hp\OneDrive\Docum x + v
Enter the number of processes
6
Enter the priority of the process
4
Enter the burst time of the process
2
Enter the priority of the process
4
Enter the burst time of the process
1
Enter the priority of the process
5
Enter the burst time of the process
7
Enter the priority of the process
3
Enter the burst time of the process
5
Enter the priority of the process
2
Enter the burst time of the process
4
Enter the priority of the process
1
Enter the burst time of the process
3
Queue 1 : NULL
Queue 2 : 4->4->5->NULL
Queue 3 : 3->2->1->NULL
Queue 1 completed
Queue 3 in hand
Executing queue 3 and 1 process for a unit time. Process has priority of 3
```

```
C:\Users\hp\OneDrive\Docum x + v
Queue 3 in hand
Executing queue 3 and 1 process for a unit time. Process has priority of 3
Executing queue 3 and 1 process for a unit time. Process has priority of 3
Executing queue 3 and 1 process for a unit time. Process has priority of 3
Executing queue 3 and 1 process for a unit time. Process has priority of 3
Executing queue 3 and 1 process for a unit time. Process has priority of 3
Executing queue 3 and 2 process for a unit time. Process has priority of 2
Executing queue 3 and 2 process for a unit time. Process has priority of 2
Executing queue 3 and 2 process for a unit time. Process has priority of 2
Executing queue 3 and 2 process for a unit time. Process has priority of 2
Executing queue 3 and 3 process for a unit time. Process has priority of 1
Broke from queue 3
Queue 1 completed
Queue 3 in hand
Executing queue 3 and 3 process for a unit time. Process has priority of 1
Executing queue 3 and 3 process for a unit time. Process has priority of 1
Broke from queue 3
Queue 1 completed
Queue 3 completed
Queue 2 in hand
Executing queue 2 and 1 process for a unit time. Process has priority of 5
Executing queue 2 and 1 process for a unit time. Process has priority of 5
Executing queue 2 and 1 process for a unit time. Process has priority of 5
Executing queue 2 and 1 process for a unit time. Process has priority of 5
Executing queue 2 and 1 process for a unit time. Process has priority of 5
Executing queue 2 and 1 process for a unit time. Process has priority of 5
Executing queue 2 and 2 process for a unit time. Process has priority of 4
Broke from queue 2
Queue 3 completed
Queue 2 in hand
Executing queue 2 and 2 process for a unit time. Process has priority of 4
```

```
C:\Users\hp\OneDrive\Docum x + v
Queue 2 in hand
Executing queue 2 and 2 process for a unit time. Process has priority of 4
Executing queue 2 and 3 process for a unit time. Process has priority of 4
Broke from queue 2

Time taken for queue 1 to execute: 0

Time taken for queue 2 to execute: 21
Process 1 of queue 2 took 18
Process 2 of queue 2 took 20
Process 3 of queue 2 took 21

Time taken for queue 3 to execute: 11
Process 1 of queue 3 took 4
Process 2 of queue 3 took 8
Process 3 of queue 3 took 11

Process      | Turn Around Time | Waiting Time
Queue 1
Queue 2
Process P1    18                11
Process P2    20                18
Process P3    21                20
Queue 3
Process P1     4                 -1
Process P2     8                 4
Process P3    11                 8

The average turnaround time is : 13

The average waiting time is : 10

23° Search 10-04-2023 21:39
```

```
C:\Users\hp\OneDrive\Docum x + v
Time taken for queue 2 to execute: 21
Process 1 of queue 2 took 18
Process 2 of queue 2 took 20
Process 3 of queue 2 took 21

Time taken for queue 3 to execute: 11
Process 1 of queue 3 took 4
Process 2 of queue 3 took 8
Process 3 of queue 3 took 11

Process      | Turn Around Time | Waiting Time
Queue 1
Queue 2
Process P1    18                11
Process P2    20                18
Process P3    21                20
Queue 3
Process P1     4                 -1
Process P2     8                 4
Process P3    11                 8

The average turnaround time is : 13

The average waiting time is : 10

-----
Process exited after 27.65 seconds with return value 0
Press any key to continue . . .

23° Search 10-04-2023 21:39
```