Project4 实验报告

余北辰 519030910245

1 实验概述

1.1 实验名称

Scheduling Algorithms

1.2 实验内容

1. 模拟FCFS, SJF, Priority, RR, Priority_rr五种不同的调度方案
2. 计算每种方案的平均周转时间，平均等待时间和平均响应时间。

2 实验环境

- Ubuntu 18.04.5 LTS
- Linux version 5.4.0-72-generic
- VirtualBox 6.1.18

3 实验过程与结果展示

在提供的源代码中，其他的部分已经为我们写好，我们所需要做的就是补充好五个schedule.h文件，完成其中的`add()`函数和`schedule()`函数，分别实现添加进程到就绪队列以及实现对应的进程调度的功能。

为了进行平均周转时间，平均等待时间和平均响应时间的计算，在task.h中添加变量：

```
extern int task_tid;
extern int total_turnaround_time;
extern int total_waiting_time;
extern int total_response_time;
```

在driver.c中添加输出：

```
    printf("Average turnaround time = %lf units.\n", 1.0 * total_turnaround_time / task_tid);
    printf("Average waiting time = %lf units.\n", 1.0 * total_waiting_time / task_tid);
    printf("Average response time = %lf units.\n", 1.0 * total_response_time / task_tid);
```

3.1 FCFS

FCFS的实现最为简单。

对于add函数，只要简单地将新进程添加到就绪队列的末尾即可。这里根据课本的提示，使用 `__sync_fetch_and_add()` 函数，原子地实现tid的自加1。

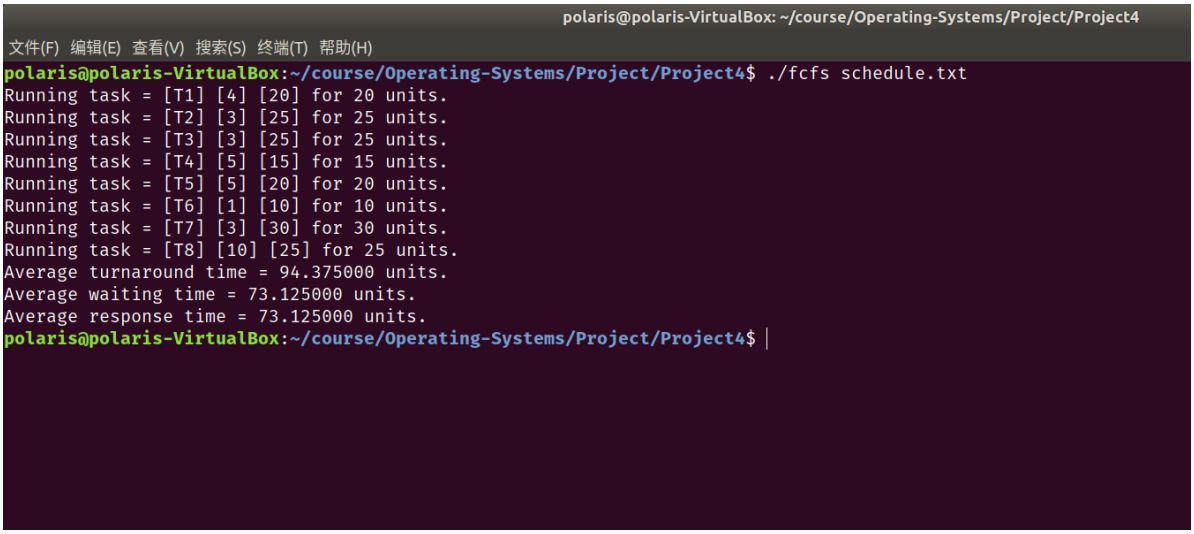
```
void add(char *name, int priority, int burst)
{
    Task *new_task = malloc(sizeof(Task));
    new_task->burst = burst;
    new_task->name = name;
    new_task->priority = priority;
    new_task->response_time = new_task->turnaround_time = new_task->waiting_time = 0;
    new_task->tid = __sync_fetch_and_add(&task_tid, 1);
    insert(&task_list, new_task);
}
```

调度算法的实现也较为简单，只要将就绪队列链表从头结点开始遍历即可：

```
void schedule()
{
    int time = 0;
    Node *p = task_list;
    while (p != NULL)
    {
        while (p->next != NULL)
        {
            p = p->next;
        }
        int slice = p->task->burst;
        run(p->task, slice);
        p->task->waiting_time = p->task->response_time = time;
        time += slice;
```

```
        p->task->turnaround_time = time;
        __sync_fetch_and_add(&total_response_time, p->task->response_time);
        __sync_fetch_and_add(&total_turnaround_time, p->task->turnaround_time);
        __sync_fetch_and_add(&total_waiting_time, p->task->waiting_time);
        delete (&task_list,p->task);
        free(p->task);
        p = task_list;
    }
}
```

测试结果：



3.2 SJF

SJF的 `add()` 函数和FCFS相同，都只需要将新进程添加到就绪队列的末尾即可。

`schedule()` 如下，每次都寻找就绪队列中最短运行时间的进程：

```
void schedule()
{
    int time = 0;
    Node *p = task_list;
    while (p != NULL)
    {
        int shortest_burst = p->task->burst;
        Node *q = p;
        while (p->next != NULL)
        {
            p = p->next;
            if (p->task->burst <= shortest_burst)
            {
                shortest_burst = p->task->burst;
```

```
            q = p;
        }
    }
    int slice = q->task->burst;
    run(q->task, slice);
    q->task->waiting_time = q->task->response_time = time;
    time += slice;
    q->task->turnaround_time = time;
    __sync_fetch_and_add(&total_response_time, q->task->response_time);
    __sync_fetch_and_add(&total_turnaround_time, q->task->turnaround_time);
    __sync_fetch_and_add(&total_waiting_time, q->task->waiting_time);
    delete (&task_list, q->task);
    free(q->task);
    p = task_list;
  }
}
```

测试结果：

```
polaris@polaris-VirtualBox: ~/course/Operating-Systems/Proj
文件(F)  编辑(E)  查看(V)  搜索(S)  终端(T)  帮助(H)
polaris@polaris-VirtualBox:~/course/Operating-Systems/Project/Project4$ ./sjf schedule.txt
Running task = [T6] [1] [10] for 10 units.
Running task = [T4] [5] [15] for 15 units.
Running task = [T1] [4] [20] for 20 units.
Running task = [T5] [5] [20] for 20 units.
Running task = [T2] [3] [25] for 25 units.
Running task = [T3] [3] [25] for 25 units.
Running task = [T8] [10] [25] for 25 units.
Running task = [T7] [3] [30] for 30 units.
Average turnaround time = 82.500000 units.
Average waiting time = 61.250000 units.
Average response time = 61.250000 units.
polaris@polaris-VirtualBox:~/course/Operating-Systems/Project/Project4$
```

3.3 RR

RR的`add()`函数和FCFS相同，都只需要将新进程添加到就绪队列的末尾即可。

`schedule()`函数如下，类似于FCFS，而每次进程只允许最多slice的时间后就被中止并重新插入就绪队列的末尾：

```
void schedule()
{
  int time = 0;
  Node *p = task_list;
  while (p != NULL)
  {
    while (p->next != NULL)
    {
      p = p->next;
```

```
        }
        int slice = p->task->burst;
        run(p->task, slice);
        p->task->waiting_time = p->task->response_time = time;
        time += slice;
        p->task->turnaround_time = time;
        __sync_fetch_and_add(&total_response_time, p->task->response_time);
        __sync_fetch_and_add(&total_turnaround_time, p->task->turnaround_time);
        __sync_fetch_and_add(&total_waiting_time, p->task->waiting_time);
        delete (&task_list,p->task);
        free(p->task);
        p = task_list;
    }
}
```

测试结果如下：

```
polaris@polaris-VirtualBox: ~/course/Operating-Systems/Project/Project4
文件(F)  编辑(E)  查看(V)  搜索(S)  终端(T)  帮助(H)
polaris@polaris-VirtualBox:~/course/Operating-Systems/Project/Project4$ ./rr schedule.txt
Running task = [T1] [4] [20] for 10 units.
Running task = [T2] [3] [25] for 10 units.
Running task = [T3] [3] [25] for 10 units.
Running task = [T4] [5] [15] for 10 units.
Running task = [T5] [5] [20] for 10 units.
Running task = [T6] [1] [10] for 10 units.
Running task = [T7] [3] [30] for 10 units.
Running task = [T8] [10] [25] for 10 units.
Running task = [T1] [4] [10] for 10 units.
Running task = [T2] [3] [15] for 10 units.
Running task = [T3] [3] [15] for 10 units.
Running task = [T4] [5] [5] for 5 units.
Running task = [T5] [5] [10] for 10 units.
Running task = [T7] [3] [20] for 10 units.
Running task = [T8] [10] [15] for 10 units.
Running task = [T2] [3] [5] for 5 units.
Running task = [T3] [3] [5] for 5 units.
Running task = [T7] [3] [10] for 10 units.
Running task = [T8] [10] [5] for 5 units.
Average turnaround time = 128.750000 units.
Average waiting time = 107.500000 units.
Average response time = 35.000000 units.
polaris@polaris-VirtualBox:~/course/Operating-Systems/Project/Project4$
```

3.4 priority

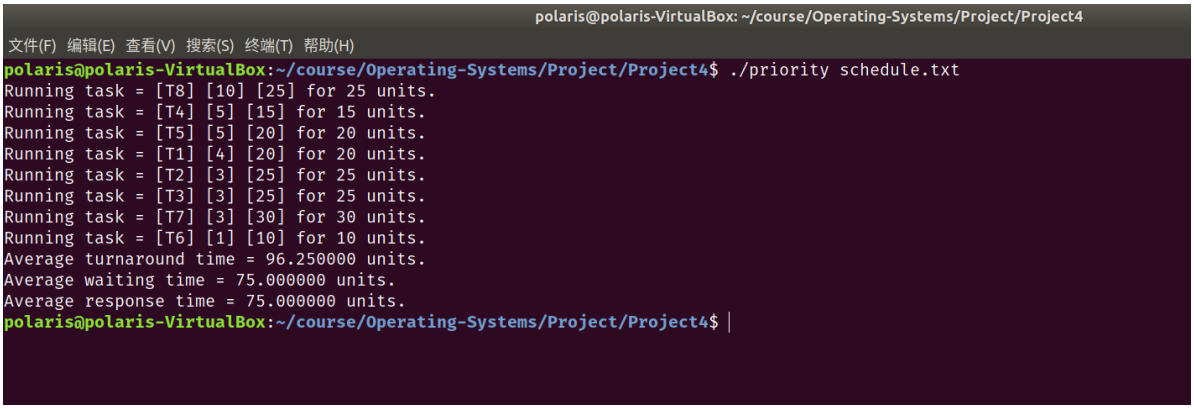
priority调度的`add()`函数和FCFS相同，都只需要将新进程添加到就绪队列的末尾即可。

`schedule()`函数与SJF类似，每次都寻找就绪队列中最高优先级的进程：

```
void schedule()
{
    int time = 0;
    Node *p = task_list;
    while (p != NULL)
    {
        int biggest_priority = p->task->priority;
```

```
        Node *q = p;
        while (p->next != NULL)
        {
            p = p->next;
            if (p->task->priority >= biggest_priority)
            {
                biggest_priority = p->task->priority;
                q = p;
            }
        }
        int slice = q->task->burst;
        run(q->task, slice);
        q->task->waiting_time = q->task->response_time = time;
        time += slice;
        q->task->turnaround_time = time;
        __sync_fetch_and_add(&total_response_time, q->task->response_time);
        __sync_fetch_and_add(&total_turnaround_time, q->task->turnaround_time);
        __sync_fetch_and_add(&total_waiting_time, q->task->waiting_time);
        delete (&task_list, q->task);
        free(q->task);
        p = task_list;
    }
}
```

测试结果如下：



3.5 priority-RR

priority-RR调度的 `add()` 函数和FCFS相同，都只需要将新进程添加到就绪队列的末尾即可。

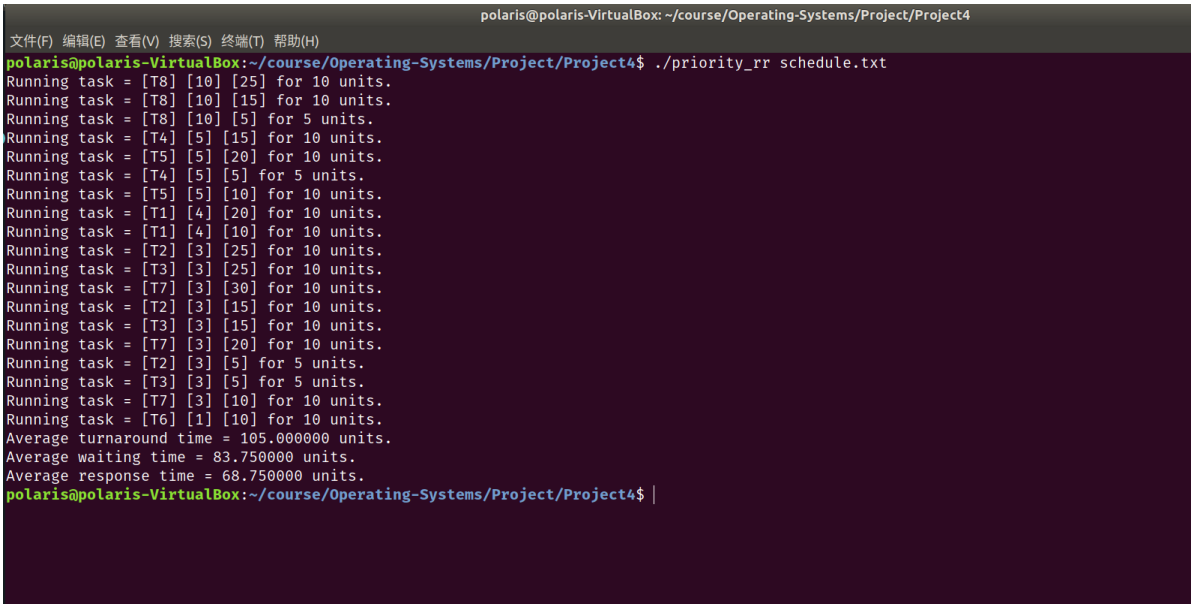
而 `schedule()` 函数则复杂一些，属于priority和RR的结合，每次都寻找就绪队列中最高优先级的进程，且只允许运行最多slice的时间后就被中止并重新插入就绪队列的末尾：

```
```

```
void schedule()
{
    int slice = QUANTUM;
    int time = 0;
    Node *p = task_list;
    while (p != NULL)
    {
        int biggest_priority = p->task->priority;
        Node *q = p;
        while (p->next != NULL)
        {
            p = p->next;
            if (p->task->priority >= biggest_priority)
            {
                biggest_priority = p->task->priority;
                q = p;
            }
        }
        if (q->task->burst > slice)
        {
            run(q->task, slice);
            if (q->task->response_time == -1)
                q->task->response_time = time;
            q->task->burst -= slice;
            time += slice;
            delete (&task_list, q->task);
            insert(&task_list, q->task);
        }
        else if (q->task->burst <= slice)
        {
            run(q->task, q->task->burst);
            if (q->task->response_time == -1)
                q->task->response_time = time;
            time += q->task->burst;
            q->task->turnaround_time = time;
            q->task->waiting_time = time - q->task->origin_burst;
            __sync_fetch_and_add(&total_response_time, q->task->response_time);
            __sync_fetch_and_add(&total_turnaround_time, q->task->turnaround_time);
            __sync_fetch_and_add(&total_waiting_time, q->task->waiting_time);
            delete (&task_list, q->task);
            free(q->task);
```

```
42          }
43          p = task_list;
44      }
45  }
```

测试结果如下：



4 实验总结

1. 由于本实验的大体框架已经搭好，所要做的只是修改代码而已，因此整体难度不太大
2. RR和priority-RR调度算法在打印时，一开始没有减去已经运行过的时间，后来已改正

5 实验参考资料

- 实验参考书籍：Operating System Concept， 10^{th} edition
- 实验源代码网址： https://github.com/greggagne/osc10e