Operating System 112 Fall
Homework 2 - CPU Scheduling

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Objective

In this homework, we are going to learn how CPU schedules processes and implement some classic scheduling algorithm by yourselves.

1. Learn how to evaluate performance of different scheduling algorithm.
2. Having an better recognition of what context switch is.

Input

The first line of input contains ***N***, ***M***, the amount of level in multilevel feedback queue and the number of process.

The next ***N*** lines(from highest priority queue to lowest priority queue) each contain ***mode***$_i$, ***time_quantum***$_i$, the algorithm of the ith-queue.

mode	time quantum	algorithm
0	-1	First-Come, First-Served
1	-1	Shortest Remaining Time First
2	***time_quantum***$_i$	Round Robin with time quantum is ***time_quantum***$_i$

Input

The next $\boldsymbol{M}$ lines each contain $\boldsymbol{arrival\_time_j}$, $\boldsymbol{bust\_time_j}$, the arrival time, bust time of the jth-process p_j. $\boldsymbol{arrival\_time_j} < \boldsymbol{arrival\_time_k}$ when $j < k$.

Constraints:

$1 <= \boldsymbol{N} <= 5$

$1 <= \boldsymbol{M} <= 100$

$0 <= \boldsymbol{arrival\_time_j} <= 10000$

$1 <= \boldsymbol{bust\_time_j} <= 1000$

If $\boldsymbol{mode}$!= 2, $\boldsymbol{time\_quantum_i} = -1$

Else $1 <= \boldsymbol{time\_quantum_i} <= 100$

Output

The output will begin with ***M*** lines, each containing two nonnegative integer, the wait time, turnaround time of the ith-process p_i.

The next line will contain a nonnegative integer, total wait time.

The final line will contain a nonnegative integer, total turnaround time.

Process Priority

queue_time :The time when process push into queue (e.g. new arrive process, preempted process)
remaining_time :The remain time of process.

[1]: In RR, when two process have same ***queue_time***, select the process with larger ***arrival_time***.

[2]: In SRTF, when two process have same ***remaining_time***, select the process with smaller ***arrival_time.***

[3]: In multi-level queue, the process in higher priority queue can preempt the running process in lower priority queue.

Part 1: First Come, First Serve (25%)

Amount of test cases: 5 (5% for each)

Test case 1:

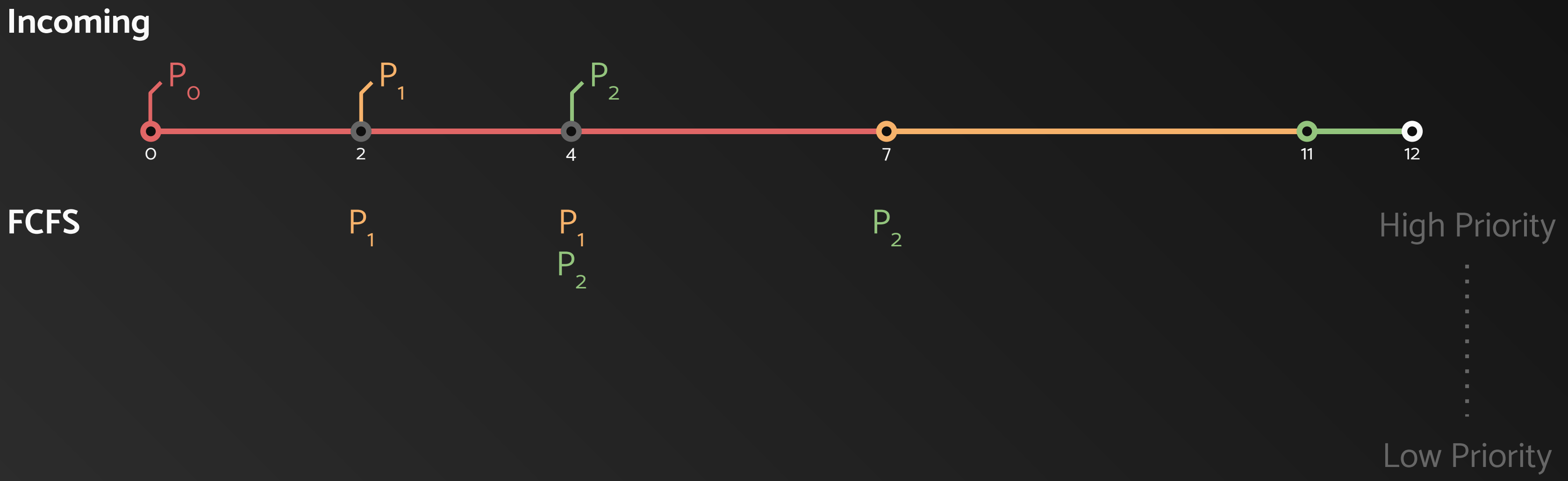
Input:

```
1 3         # 1 queue, 3 processes
0 -1        # queue 0: FCFS
0 7         # process 0: arr=0, bust=7
2 4         # process 1: arr=2, bust=4
4 1         # process 2: arr=4, bust=1
```

Output:

```
0 7         # process 0: wait=0, turnaround=7
5 9         # process 1: wait=5, turnaround=9
7 8         # process 2: wait=7, turnaround=8
12          # total waiting time
24          # total turnaround time
```

Part 1: First Come, First Serve (25%)



Part 2: Shortest Remaining Time First (25%)

Amount of test cases: 5 (5% for each)

※ Preempted by process with **smaller** bust time.

Test case 1:

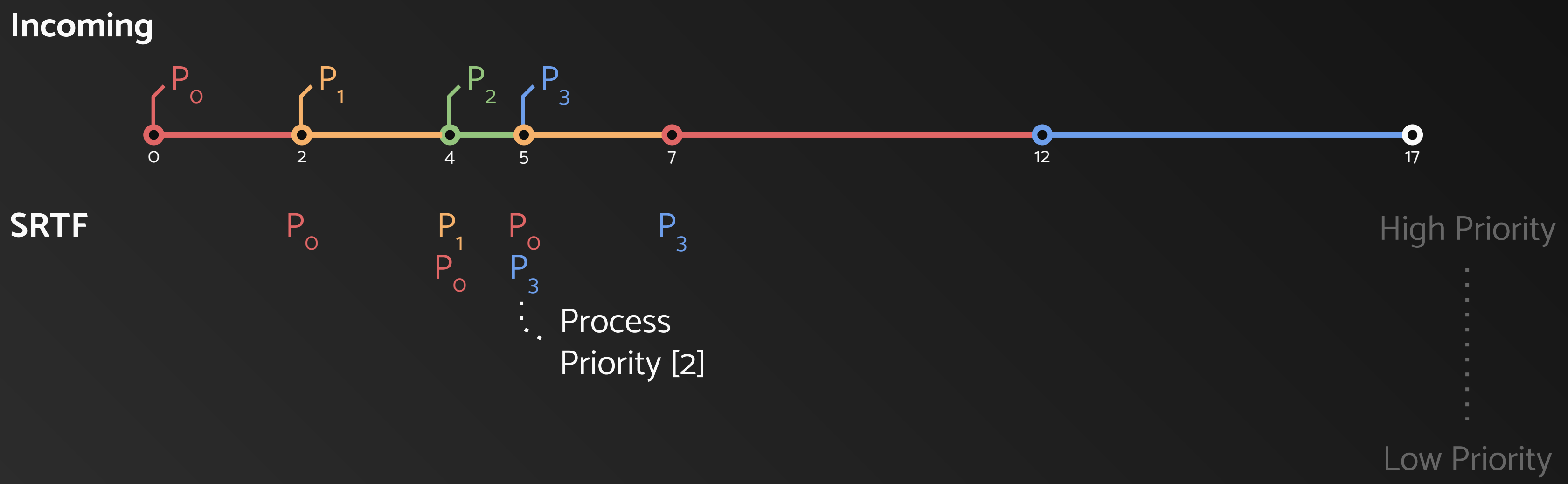
Input:

```
1 4          # 1 queue, 4 processes
1 -1         # queue 0: SRTF
0 7          # process 0: arr=0, bust=7
2 4          # process 1: arr=2, bust=4
4 1          # process 2: arr=4, bust=1
5 5          # process 3: arr=5, bust=5
```

Output:

```
5 12         # process 0: wait=9, turnaround=16
1 5          # process 1: wait=1, turnaround=5
0 1          # process 2: wait=0, turnaround=1
7 12         # process 3: wait=2, turnaround=6
13           # total waiting time
30           # total turnaround time
```

Part 2: Shortest Remaining Time First (25%)



Incoming

SRTF

Process
Priority [2]

High Priority

Low Priority

Part 3: Round Robin (25%)

Amount of test cases: 5 (5% for each)

Test case 1:

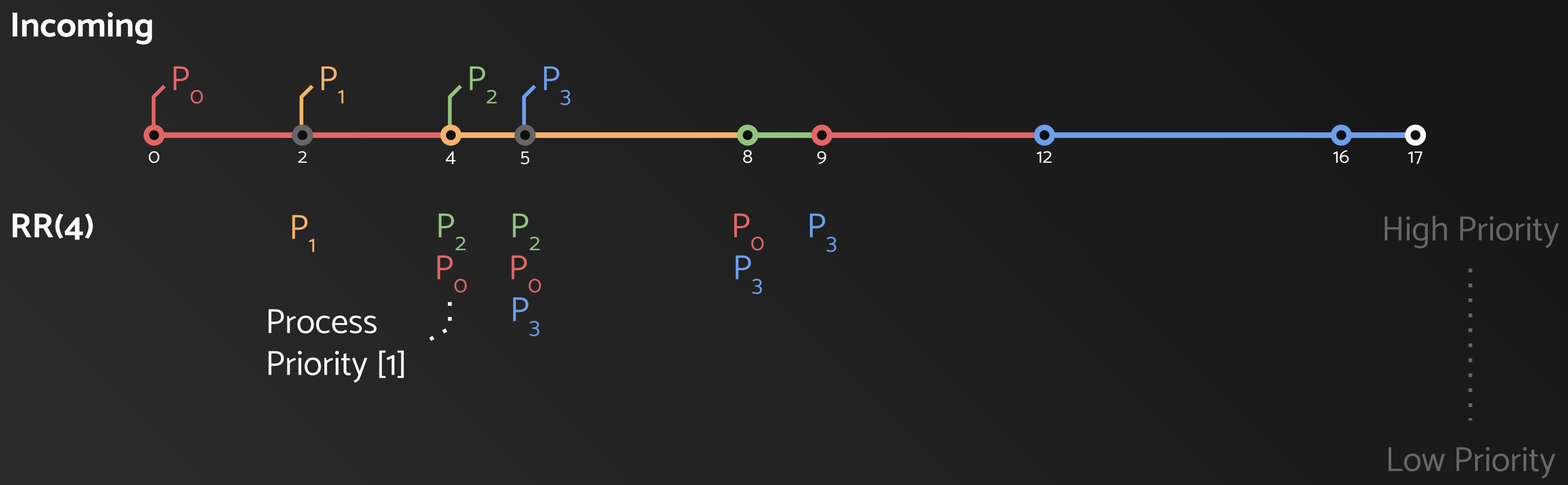
Input:

```
1 4     # 1 queue, 4 processes
2 4     # queue 0: RR(4)
0 7     # process 0: arr=0, bust=7
2 4     # process 1: arr=2, bust=4
4 1     # process 2: arr=4, bust=1
5 5     # process 3: arr=5, bust=4
```

Output:

```
5 12    # process 0: wait=5, turnaround=12
2 6     # process 1: wait=2, turnaround=6
4 5     # process 2: wait=4, turnaround=5
7 12    # process 3: wait=7, turnaround=11
18      # total waiting time
35      # total turnaround time
```

Part 3: Round Robin (25%)



Incoming

RR(4)

Process Priority [1]

High Priority

Low Priority

Part 4: RR + SRTF (10%)

Amount of test cases: 5 (2% for each)

※ If the process is not finish (preempted or time quantum exceeded), push it to the next level priority queue (if available).

Test case 1:

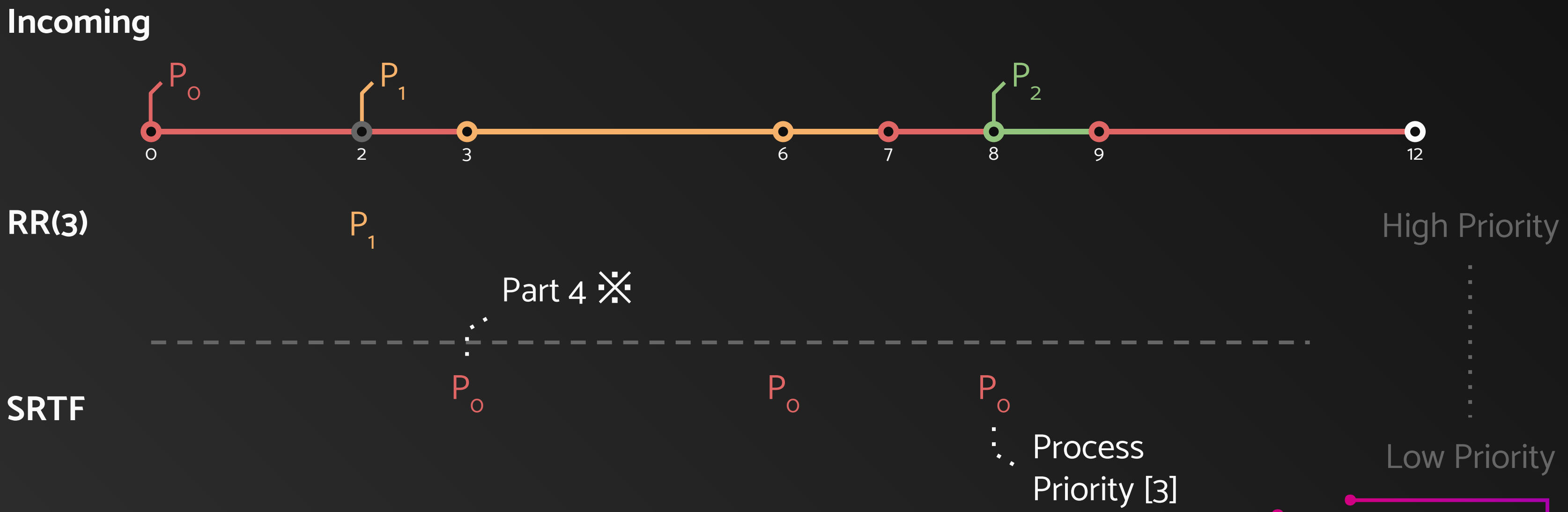
Input:

```
2 4         # 2 queue, 4 processes
2 3         # queue 0: RR(3)
1 -1        # queue 1: SRTF
0 7         # process 0: arr=0, bust=7
2 4         # process 1: arr=2, bust=4
8 1         # process 2: arr=8, bust=1
```

Output:

```
5 12        # process 0: wait=5, turnaround=12
1 5         # process 1: wait=1, turnaround=5
0 1         # process 2: wait=0, turnaround=1
6           # total waiting time
18          # total turnaround time
```

Part 4: RR + SRTF (10%)



Part 5: Multilevel Queue (25%)

Amount of test cases: 5 (5% for each)

※ Same as Part 4.

Test case 1:

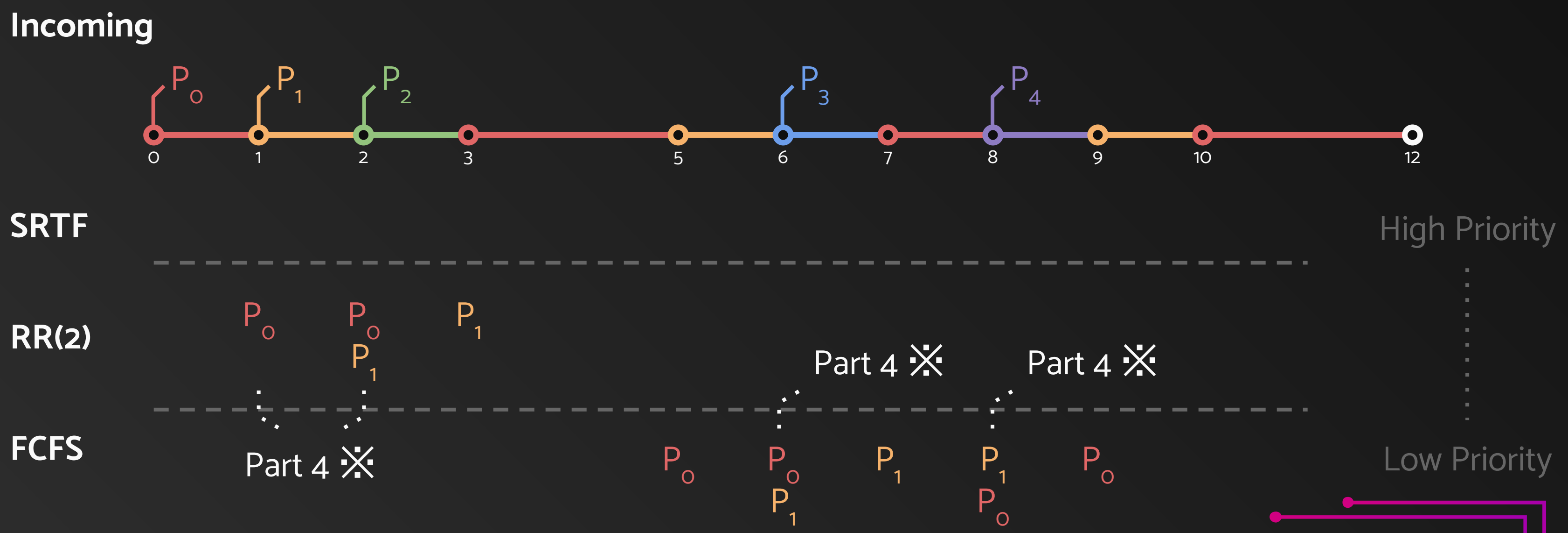
Input:

```
3 5         # 3 queue, 4 processes
1 -1        # queue 0: SRTF
2 2         # queue 1: RR(2)
0 -1        # queue 2: FCFS
0 5         # process 0: arr=0, bust=5
1 3         # process 1: arr=1, bust=3
2 1         # process 2: arr=2, bust=1
6 1         # process 3: arr=6, bust=1
8 1         # process 4: arr=8, bust=1
```

Output:

```
6 11        # process 0: wait=6, turnaround=12
6 9         # process 1: wait=6, turnaround=9
0 1         # process 2: wait=0, turnaround=1
0 1         # process 3: wait=0, turnaround=1
0 1         # process 4: wait=0, turnaround=1
12          # total waiting time
23          # total turnaround time
```

Part 5: Multilevel Queue (25%)



Submission and Rules

Submission:

1. You should write your code in C/C++
2. Please upload your homework in such format:
   - hw2_studentID.cpp (e.g. hw2_312551014.cpp)

Rule:

- No **plagiarism** is allowed, since the grade of this course is critical for **graduate program application in CS related field**, we will not pardon such behavior at all, so please be responsible to yourself. You can discuss with your classmates, but don't copy and paste.
- Incorrect filename / file format will get -10% point.
- Delayed submission will get -20% point per day.