# CS 370
# HW4 help session

First Come First Serve, Priority and Round Robin
Fall 2024

# Homework-4 Review

**Write a Python program to demonstrate the following scheduling algorithms**

- First Come First Serve(FCFS)
- Priority with preemption
- Round Robin with time quantum

**Evaluation:**

- Sequence of execution in (Gantt chart)
- Individual and Average turnaround time.
- Individual and Average waiting time.
- Throughput.

# Homework-4 Review

A CSV file is provided which contains all the processes.

processes.csv (We might not use this name when grading so be sure you can account for that)

| | ProcessID | Arrival Time | Burst Time |
|---|---|---|---|
| Header → | ProcessID | Arrival Time | Burst Time |
| Process 1 → | 2 | 0 | 5 |
| Process 2 → | 3 | 0 | 3 |
| ⋮ | 1 | 9 | 8 |
| | 4 | 10 | 6 |

- **You can expect a maximum of 9 processes existing in the test processes.csv file**

# First Come First Serve

- Non preemptive.
- Schedules with respect to arrival time.
- Process that arrived first will get the CPU burst until it completes.
- If multiple processes arrive at the same time, execute lower PID first from the csv.

Let’s work on an example.

# First Come First Serve

| Proc ID | Arrival Time | Burst Time |
|---|---|---|
| 2 | 0 | 5 |
| 1 | 0 | 3 |
| 4 | 3 | 2 |
| 3 | 12 | 6 |

Sort by Arrival time →

| Process ID | Arrival Time | Burst Time |
|---|---|---|
| 1 | 0 | 3 |
| 2 | 0 | 5 |
| 4 | 3 | 2 |
| 3 | 12 | 6 |

# First Come First Serve

| Process ID | Arrival Time | Burst Time |
|---|---|---|
| 1 | 0 | 3 |
| 2 | 0 | 5 |
| 4 | 3 | 2 |
| 3 | 12 | 6 |

**Gantt Chart**

| | | | | | |
|---|---|---|---|---|---|
| | P1 | P2 | P4 | IDLE | P3 |
| 0 | 3 | 8 | 10 | 12 | 18 |

## Pseudo Code to proceed with the Algorithm

```
Sort by PID
Sort by ArrivalTime

#No process to run --> IDLE
        if(cur_time < arr) :
                gantt<-----------((cur_time, arr, 'IDLE'))
                ----------------------------------
#Process arrived and has waited
        if(cur_time > arr) :
                gantt<-------------------------((cur_time, cur_time+burst, pid))
                #Get total wait time (no preemption)
                -----------------------------------------------
                #Advance to end of burst
                -----------------------------------------------
#Process arrived and has not waited
        else :
                gantt<----------------------------(arr, arr+burst, pid))
                #Advance to end of burst
                -------------------------------------
```

# Priority with Preemption

- The process with the highest priority (lowest priority number) will execute first
- Preemption - if a job comes in with a higher priority (lower priority number), it gets to execute right away

Again, let’s work with an example.

# First things First

- Let’s first go over a Priority Scheduling *without* preemption
- It lets us understand the basic idea before moving onto the preemption.

# Priority Scheduling without Preemption

| Process ID | Arrival Time | Burst Time | Priority |
|---|---|---|---|
| 1 | 0 | 2 | 1 |
| 2 | 1 | 5 | 2 |
| 4 | 1 | 2 | 1 |
| 3 | 3 | 6 | 0 |

**Gantt Chart**

P1 P4 P3 P2

0 2 4 10 15

# Priority Scheduling with Preemption

- When Preemption is used, a lower priority running process is preempted when a higher priority process arrives.
- The preempted process joins the ready queue.
- You need to track the processes in the Ready Queue, along with their remaining burst times. A process in the Ready Queue is selected based on priority.

# Priority Scheduling with Preemption

| Process ID | Arrival Time | Burst Time | Priority |
|---|---|---|---|
| 1 | 0 | 5 | 2 |
| 2 | 1 | 8 | 1 |
| 4 | 2 | 4 | 3 |
| 3 | 3 | 6 | 2 |

## Gantt Chart

P1 P2 P1 P3 P4

0 1 9 13 19 23

# Priority Scheduling with Preemption

| Process ID | Arrival Time | Burst Time | Priority | Remaining Burst time |
|---|---|---|---|---|
| 1 | 0 | 5 | 2 | 5 |
| 2 | 1 | 8 | 1 | 8 |
| 4 | 2 | 4 | 3 | 4 |
| 3 | 3 | 6 | 2 | 6 |

Time elapsed = 0

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|

P1

0

# Priority Scheduling with Preemption

| Process ID | Arrival Time | Burst Time | Priority | Remaining Burst time |
|---|---|---|---|---|
| 1 | 0 | 5 | 2 | 4 |
| 2 | 1 | 8 | 1 | 8 |
| 4 | 2 | 4 | 3 | 4 |
| 3 | 3 | 6 | 2 | 6 |

Time elapsed = 1

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P1 | | | | | | | | | |

P1 P2

0 1

# Priority Scheduling with Preemption

| Process ID | Arrival Time | Burst Time | Priority | Remaining Burst time |
|---|---|---|---|---|
| 1 | 0 | 5 | 2 | 4 |
| 2 | 1 | 8 | 1 | 8 |
| 4 | 2 | 4 | 3 | 4 |
| 3 | 3 | 6 | 2 | 6 |

Time elapsed = 2

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P4 | P1 | | | | | | | | |

P1 P2

0 1

# Priority Scheduling with Preemption

| Process ID | Arrival Time | Burst Time | Priority | Remaining Burst time |
|---|---|---|---|---|
| 1 | 0 | 5 | 2 | 4 |
| 2 | 1 | 8 | 1 | **6** |
| 4 | 2 | 4 | 3 | 4 |
| 3 | 3 | 6 | 2 | 6 |

Time elapsed = 3

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P3 | P4 | P1 | | | | | | | |

P1 P2

0 1

# Priority Scheduling with Preemption

| Process ID | Arrival Time | Burst Time | Priority | Remaining Burst time |
|---|---|---|---|---|
| 1 | 0 | 5 | 2 | 4 |
| 2 | 1 | 8 | 1 | **0** |
| 4 | 2 | 4 | 3 | 4 |
| 3 | 3 | 6 | 2 | 6 |

Time elapsed = 9

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P3 | P4 | | | | | | | | |

P1 P2 P1

0 1 9

# Gantt chart for Priority with Preemption

- At T0 P1 arrives and begins execution.
- At T1 P2 arrives with a higher priority than P1 so preemption occurs. P1 joins the Ready Queue.
- At T2 P4 arrives. This has lower priority than P2 so P2 continues. P4 joins the Ready Queue.
- At T3 P3 arrives with equal priority to P1 but P2 still has highest priority. P3 joins the Ready Queue.
- Once P2 finishes P1 (priority = 2) resumes at T9, followed by P3 (priority = 2) at T13 and then lastly P4 (priority = 3) at T19. All done at T23.

# Round Robin

- Round robin – Everyone gets a chance.
- The quantum (integer) is used to determine the time quantum for round robin. (Command line argument)
- Ready Queue is First come First served.
- For this assignment, if a new process arrives the same instant when a process is switched out, the new process gets in the ready queue first.

# Round Robin (quantum 2) – (1)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | 3 |
| 2 | 1 | 5 | 5 |
| 4 | 3 | 2 | 2 |
| 3 | 12 | 6 | 6 |

Time elapsed = 0

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P1 | | | | | | | | | |

0

# Round Robin (quantum 2) – (2)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | 1 |
| 2 | 1 | 5 | 5 |
| 4 | 3 | 2 | 2 |
| 3 | 12 | 6 | 6 |

Time elapsed = 2

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P2 | P1 | | | | | | | | |

**P1**

0 2

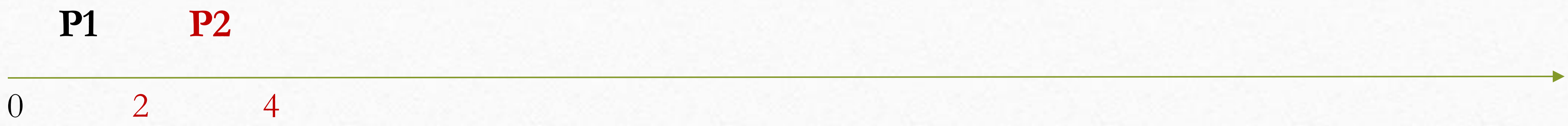
# Round Robin (quantum 2) – (3)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | **1** |
| 2 | 1 | 5 | **3** |
| 4 | 3 | 2 | **2** |
| 3 | 12 | 6 | **6** |

Time elapsed = 4

Ready Queue

| P1 | P4 | P2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|



# Round Robin (quantum 2) – (4)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | **0** |
| 2 | 1 | 5 | **3** |
| 4 | 3 | 2 | **2** |
| 3 | 12 | 6 | **6** |

Time elapsed = 5

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P4 | P2 | | | | | | | | |

| **P1** | **P2** | **P1** | |
|---|---|---|---|

0 2 4 5

# Round Robin (quantum 2) – (5)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | **0** |
| 2 | 1 | 5 | **3** |
| 4 | 3 | 2 | **0** |
| 3 | 12 | 6 | **6** |

Time elapsed = 7

Ready Queue

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P2 | | | | | | | | | |

**P1** **P2** **P1** **P4**

0 2 4 5 7

# Round Robin (quantum 2) – (6)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | **0** |
| 2 | 1 | 5 | **0** |
| 4 | 3 | 2 | **0** |
| 3 | 12 | 6 | **6** |

Time elapsed = 10

Ready Queue

**P1** **P2** **P1** **P4** **P2**

0 2 4 5 7 10

# Round Robin (quantum 2) – (7)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | **0** |
| 2 | 1 | 5 | **0** |
| 4 | 3 | 2 | **0** |
| 3 | 12 | 6 | **6** |

Time elapsed = 12

Ready Queue

**P1** **P2** **P1** **P4** **P2** **IDLE**

0 2 4 5 7 10 12

# Round Robin (quantum 2) – (8)

| Process ID | Arrival Time | Burst Time | Remaining Burst time |
|---|---|---|---|
| 1 | 0 | 3 | 0 |
| 2 | 1 | 5 | 0 |
| 4 | 3 | 2 | 0 |
| 3 | 12 | 6 | 0 |

Time elapsed = 18

Ready Queue

**P1** **P2** **P1** **P4** **P2** **IDLE** **P3**

0 2 4 5 7 10 12 18

## Method accepts (data, Time Quantum)

create Ready Queue
Sort by pid
Sort by arrival time

Add all processes arriving at time 0 to ready queue
Remove them from unarrived queue

Hold objects once finished in finished_queue while **ready_queue is !empty** or **not all process arrived** or **prev_run_process** is not None :

Now in this while Loop implement the following

Check if every process has arrived to prevent early termination upon IDLE.
Add new arrivals to ready queue and remove from unarrived queue
Add most recently run process to ready queue after new arrivals
Checks if IDLE and sets process to correct time while updating Gantt Chart
Get next process in ready queue
Add waiting time

If process has more than time quantum remaining.  Burst and store to put back on ready queue.
Else burst remaining amount and set to finished.  Do not add back on queue

# Notes:

- The maximum length of the Gantt chart will not exceed 100 intervals.
- Processes may not appear in the file in order
- The processID is not related to arrival time, priority, or anything else

The processID’s may not always be consecutive numbers e.x. {1,3,6}

- There may be multiple processes with the same arrival time.
    - Break ties by processID
    - processID’s are always unique

# Other Requirements

- Language: Python.
- Must run on department machines.
- Use Canvas to submit a single .zip file named HW4.zip that contains:
  - All files related to the assignment. (Please document your code)
  - A README.txt file containing a description of each file and any information you feel the grader may need.
  - If your code exists in multiple files then there must exist one driver program which runs all the three scheduling algorithms. We execute only one file.

# Term Project

- Two Options:
    - (1) Research Project
    - (2) embedded/IoT project with raspberry pi
- Research Project – Two column IEEE/ACM style paper regarding a modern issue in Operating Systems and/or computing(The list is provided in the project description)
- Development Project – Raspberry Pi computer must communicate with one other computer and a sensor. Other than that, it's pretty much up to you.

# Thank you - Questions?

# Acknowledgements

- These slides are based on contributions of current and past CS370 instructors and TAs, including Phil.Sharp ,J. Applin, S. R. Chowdhury,  K. Bruhwiler, Y. K. Malaiya, S. Pallickara, K. Drago