CSEN 383 – Assignment 2
Winter 2024

Group 2

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Objective

The objective of this project is to gain hands-on experience with diverse Process Scheduling Algorithms. Our C program is designed to operate using the following scheduling algorithms:

- First come first-served (FCFS) [non-preemptive]
- Shortest job first (SJF) [non-preemptive]
- Shortest remaining time (SRT) [preemptive]
- Round robin (RR) [preemptive]
- Highest priority first (HPF) [non-preemptive]
- Highest priority first (HPF) [preemptive]

Constraints

- Processes are constrained to have an Arrival Time less than 100 quanta.
- Arrival Time, Expected Run Time, and Priority are randomly generated for each process.
- Only one process queue is present.
- There is no I/O time involved in the execution.
- Time Slice for Round Robin is set to 1 quantum.
- For Highest Priority First (HPF), four distinct queues are employed.

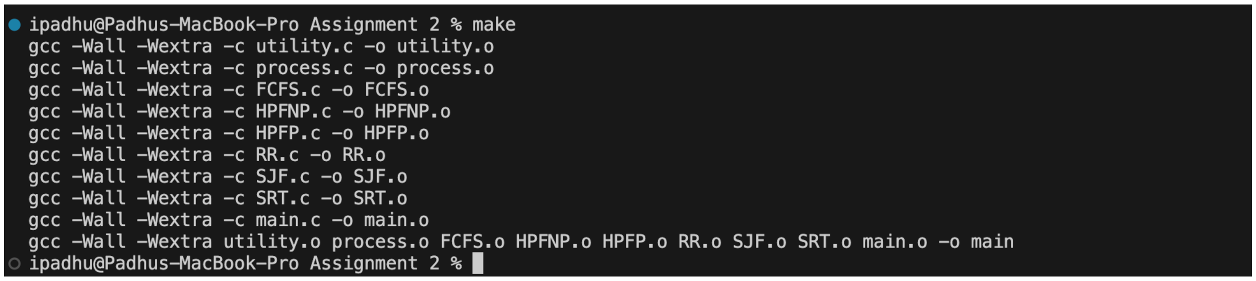
Code Execution

A Makefile has been crafted to compile all the files and showcase the output. To execute the code, use the following command:

```
make run
```

To remove the object files and clean up the project directory, employ the command:

```
make clean
```



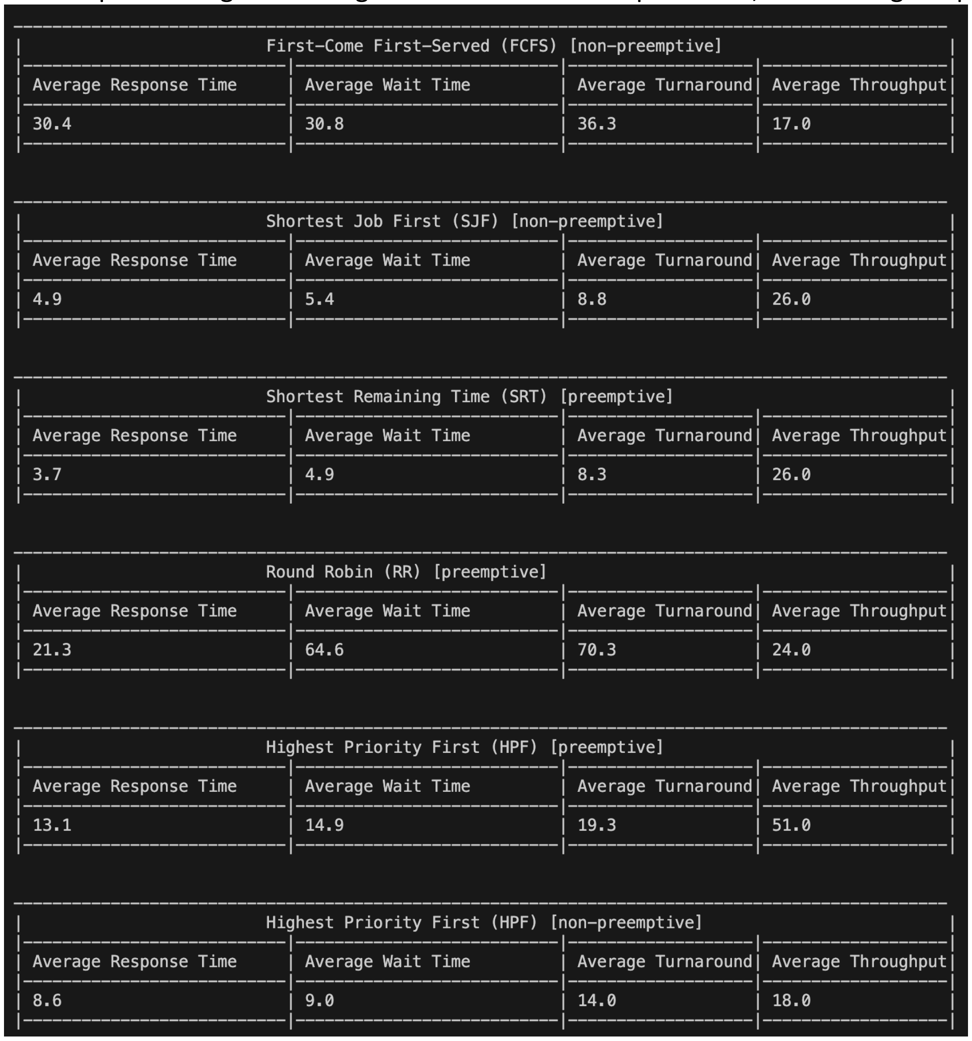
```
ipadhu@Padhus-MacBook-Pro Assignment 2 % make
  gcc -Wall -Wextra -c utility.c -o utility.o
  gcc -Wall -Wextra -c process.c -o process.o
  gcc -Wall -Wextra -c FCFS.c -o FCFS.o
  gcc -Wall -Wextra -c HPFNP.c -o HPFNP.o
  gcc -Wall -Wextra -c HPFP.c -o HPFP.o
  gcc -Wall -Wextra -c RR.c -o RR.o
  gcc -Wall -Wextra -c SJF.c -o SJF.o
  gcc -Wall -Wextra -c SRT.c -o SRT.o
  gcc -Wall -Wextra -c main.c -o main.o
  gcc -Wall -Wextra utility.o process.o FCFS.o HPFNP.o HPFP.o RR.o SJF.o SRT.o main.o -o main
ipadhu@Padhus-MacBook-Pro Assignment 2 %
```

The default time slice for Round Robin is set to 5. To customize the time slice for Round Robin, use the following command:

```
make run RR_TIME_SLICE="10"
```

Result

The observations from running the six algorithms reveal insights into the performance metrics obtained from implementing distinct algorithms on a set of 52 processes, considering all specified constraints.



```
-------------------------------------------------------------------------------------------------
|                             First-Come First-Served (FCFS) [non-preemptive]                   |
|----------------------------|----------------------------|--------------------|-------------------|
| Average Response Time      | Average Wait Time          | Average Turnaround| Average Throughput|
|----------------------------|----------------------------|--------------------|-------------------|
| 30.4                       | 30.8                       | 36.3               | 17.0              |
|----------------------------|----------------------------|--------------------|-------------------|


-------------------------------------------------------------------------------------------------
|                             Shortest Job First (SJF) [non-preemptive]                         |
|----------------------------|----------------------------|--------------------|-------------------|
| Average Response Time      | Average Wait Time          | Average Turnaround| Average Throughput|
|----------------------------|----------------------------|--------------------|-------------------|
| 4.9                        | 5.4                        | 8.8                | 26.0              |
|----------------------------|----------------------------|--------------------|-------------------|


-------------------------------------------------------------------------------------------------
|                             Shortest Remaining Time (SRT) [preemptive]                        |
|----------------------------|----------------------------|--------------------|-------------------|
| Average Response Time      | Average Wait Time          | Average Turnaround| Average Throughput|
|----------------------------|----------------------------|--------------------|-------------------|
| 3.7                        | 4.9                        | 8.3                | 26.0              |
|----------------------------|----------------------------|--------------------|-------------------|


-------------------------------------------------------------------------------------------------
|                             Round Robin (RR) [preemptive]                                     |
|----------------------------|----------------------------|--------------------|-------------------|
| Average Response Time      | Average Wait Time          | Average Turnaround| Average Throughput|
|----------------------------|----------------------------|--------------------|-------------------|
| 21.3                       | 64.6                       | 70.3               | 24.0              |
|----------------------------|----------------------------|--------------------|-------------------|


-------------------------------------------------------------------------------------------------
|                             Highest Priority First (HPF) [preemptive]                         |
|----------------------------|----------------------------|--------------------|-------------------|
| Average Response Time      | Average Wait Time          | Average Turnaround| Average Throughput|
|----------------------------|----------------------------|--------------------|-------------------|
| 13.1                       | 14.9                       | 19.3               | 51.0              |
|----------------------------|----------------------------|--------------------|-------------------|


-------------------------------------------------------------------------------------------------
|                             Highest Priority First (HPF) [non-preemptive]                     |
|----------------------------|----------------------------|--------------------|-------------------|
| Average Response Time      | Average Wait Time          | Average Turnaround| Average Throughput|
|----------------------------|----------------------------|--------------------|-------------------|
| 8.6                        | 9.0                        | 14.0               | 18.0              |
|----------------------------|----------------------------|--------------------|-------------------|
```

1. First Come First Serve (Non-Preemptive):

- ♦ High response time, wait time, and turnaround time characterize this algorithm, leading to a lower throughput compared to other algorithms.
- ♦ The inherent issue lies in the fact that new processes must wait until the preceding process completes execution, creating potential scenarios of starvation. Despite these drawbacks, First Come First Serve (FCFS) is known for its simplicity in implementation.

2. Shortest Job First (Non-Preemptive):

- ♦ Exhibits lower response time, wait time, and turnaround time in comparison to alternative algorithms. However, it is noteworthy that processes with high burst time may experience instances of starvation.

3. Shortest Remaining Time First (Preemptive):

- ♦ Demonstrates low response time, wait time, and turnaround time, similar to Shortest Job First.
- ♦ Prioritizes the execution of jobs with the least remaining time to complete.

4. Round Robin (Preemptive):

- ♦ Each process is allocated an equal time slice for execution. Consequently, all processes in the queue receive CPU time for a limited duration, and the completion of lengthy processes does not occur in a single turn after CPU allocation. This significantly amplifies the turnaround time, as well as increases the response time and wait time for all processes, resulting in lower throughput compared to other algorithms.
- ♦ A key challenge lies in determining the optimal duration of the time slice. A large time slice tends to yield results similar to First Come First Serve (FCFS), while a small time slice introduces high context-switching overhead.

5. Highest Priority First:

i. Preemptive:

- ♦ Possesses the best throughput among the observed algorithms.
- ♦ Preemptive nature allows newer processes with high priority to run quickly, resulting in minimal response time, wait time, and turnaround time.
- ♦ Risk of processes with lower priority facing starvation.

ii. Non-Preemptive:

- ♦ Shows the lowest throughput among observed algorithms.
- ♦ Highest Priority First Preemptive yields better results, reducing starvation among long processes.

Conclusion

The algorithm with the highest throughput among those considered is the Highest Priority First (Preemptive). For both Shortest Remaining Time First (SRTF) Preemptive and Highest Priority First (HPF) Preemptive, the response time, wait times, and turnaround time are the lowest. Conversely, Highest Priority First (Non-Preemptive) exhibits the lowest throughput, while Round Robin records the highest wait time for process execution.