

## About CPU Scheduling and Round Robin Algorithms

The CPU is responsible for performing logical and arithmetic operations, running processes (programs in execution), and fetching information and instructions from memory.

The CPU has a scheduler, which maintains two scheduling queues for processes. The waiting queue contains a set of processes that are waiting for an event (such as I/O) to occur, and the ready queue contains processes residing in main memory that are waiting to execute. Only one process is ran at a time by a processor, so algorithms must be designed for the scheduler to choose which processes are assigned to a processor in which order, and what resources are allocated to them.

There are two types of scheduling algorithms— preemptive and non-preemptive. In a non-preemptive algorithm, processes must run for their entire duration (burst time), and one process must finish executing for another process to start. Preemptive algorithms allow for context switching, in which the system saves the state of one process and loads the saved state of another, allowing for processes to be paused and resumed. These saved states (context) of processes are stored in the process control block (PCB).

Round Robin is a preemptive scheduling algorithm that only allows processes to be ran for a fixed amount of time (time quantum) before a context switch occurs. Once a process has run for its time quantum, it is moved to the end of the ready queue and the CPU moves on to the next process at the front of the queue. This ensures fairness among processes, as the time given to each process is evenly distributed and starvation is eliminated.

## How To Run CPU Round Robin Scheduling Simulator

1. Unzip the folder and open it with a Java IDE (Intellij is recommended).
2. Check the root directory of the project for a file called *processes.csv*.
  - a. If *processes.csv* exists, ignore this step.
  - b. If *processes.csv* does not exist:
    - i. Navigate to the CSVFile class (CSVFile.java).
    - ii. remove the comment symbol (//) from the start of line 62 of the CSVFile class.
    - iii. Run the main method (CSVFile.main()) to create the CSV file. Do not run the main method more than once.
3. Navigate to the Main class and run the main method to start the simulation.

## Interpreting the Output

After all processes have finished executing, the program will print out four metrics describing the system's performance and averages:

1. CPU Utilization: a measure of how busy the CPU is
2. Throughput: the number of processes that complete execution per time unit.
3. Average wait time: The average amount of time processes wait in the ready queue
4. Average turnaround time: the average amount of time it takes to execute a process

## Output With 5 Different Time Quanta

Loaded processes: 4

-----Running Round Robin Simulator with Time Quantum 2-----

Process 1 added to ready queue at time 0

Process 3 added to ready queue at time 0

Time 0 → 2: Process 1 ran for 2 units.

Process 2 added to ready queue at time 2

Process 4 added to ready queue at time 2

Process 3 finished running at time 4

Time 4 → 6: Process 2 ran for 2 units.

Time 6 → 8: Process 4 ran for 2 units.

Time 8 → 10: Process 1 ran for 2 units.

Time 10 → 12: Process 2 ran for 2 units.

Time 12 → 14: Process 4 ran for 2 units.

Process 1 finished running at time 15

Time 15 → 17: Process 2 ran for 2 units.

Process 4 finished running at time 19

Process 2 finished running at time 20

Round Robin Simulator finished execution

CPU Utilization: 0.65

Throughput: 0.2

Average wait time: 8.75 units

Average turnaround time: 13.75 units

-----Running Round Robin Simulator with Time Quantum 4-----

Process 1 added to ready queue at time 0

Process 3 added to ready queue at time 0

Time 0 → 4: Process 1 ran for 4 units.

Process 2 added to ready queue at time 4  
Process 4 added to ready queue at time 4  
Process 3 finished running at time 6  
Time 6 → 10: Process 2 ran for 4 units.  
Time 10 → 14: Process 4 ran for 4 units.  
Process 1 finished running at time 15  
Process 2 finished running at time 18  
Process 4 finished running at time 20  
Round Robin Simulator finished execution

CPU Utilization: 0.85  
Throughput: 0.2  
Average wait time: 9.0 units  
Average turnaround time: 14.0 units

-----Running Round Robin Simulator with Time Quantum 6-----

Process 1 added to ready queue at time 0  
Process 3 added to ready queue at time 0  
Process 1 finished running at time 5  
Process 2 added to ready queue at time 5  
Process 4 added to ready queue at time 5  
Process 3 finished running at time 7  
Time 7 → 13: Process 2 ran for 6 units.  
Process 4 finished running at time 19  
Process 2 finished running at time 20  
Round Robin Simulator finished execution

CPU Utilization: 0.95  
Throughput: 0.2  
Average wait time: 7.0 units  
Average turnaround time: 12.0 units

-----Running Round Robin Simulator with Time Quantum 8-----

Process 1 added to ready queue at time 0  
Process 3 added to ready queue at time 0  
Process 1 finished running at time 5  
Process 2 added to ready queue at time 5  
Process 4 added to ready queue at time 5  
Process 3 finished running at time 7  
Process 2 finished running at time 14  
Process 4 finished running at time 20  
Round Robin Simulator finished execution

CPU Utilization: 1.0  
Throughput: 0.2  
Average wait time: 5.75 units  
Average turnaround time: 10.75 units

-----Running Round Robin Simulator with Time Quantum 10-----

Process 1 added to ready queue at time 0  
Process 3 added to ready queue at time 0  
Process 1 finished running at time 5  
Process 2 added to ready queue at time 5  
Process 4 added to ready queue at time 5  
Process 3 finished running at time 7  
Process 2 finished running at time 14  
Process 4 finished running at time 20  
Round Robin Simulator finished execution

CPU Utilization: 1.0  
Throughput: 0.2  
Average wait time: 5.75 units  
Average turnaround time: 10.75 units

Process finished with exit code 0