CS343 - Operating Systems

Module-2C

CPU Scheduling Algorithms - 1

Dr. John Jose

Assistant Professor

Department of Computer Science & Engineering

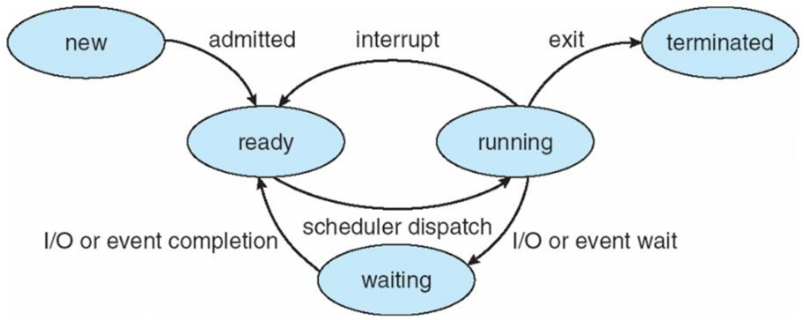
Indian Institute of Technology Guwahati, Assam.

http://www.iitg.ac.in/johnjose/

Session Outline

- CPU scheduling
- Categories of scheduling algorithms
- FCFS scheduling algorithm
- SJF scheduling algorithm
- SRTF scheduling algorithm
- Round Robin scheduling algorithm
- Priority scheduling algorithm

Preemptive vs Non-preemptive Scheduling



1. When a process switches from the running state to the waiting state
2. When a process switches from the running state to the ready state
3. When a process switches from the waiting state to the ready state
4. When a process terminates

❖ 1 & 4, the scheduling is **non-preemptive** (cooperative)

❖ 2 & 3, the scheduling is **preemptive**

Scheduling Criteria

- Different CPU-scheduling algorithms have different properties.
- Certain characteristics/criteria are used for comparing various CPU scheduling algorithms.
  - CPU Utilization
  - Throughput
  - Turnaround time
  - Waiting Time
  - Response Time

Categories of Scheduling Algorithms & Goals

- **Batch System**
  - Complete maximum number of jobs per unit time.
  - Minimize time between submission and termination
  - Keep CPU busy all time
- **Interactive System**
  - Response to requests quickly
  - Reduce waiting time
  - Meet user expectations
- **Real time System**
  - Meeting deadlines
  - Ensure quality constraints

CPU Scheduling Algorithms

Batch Systems

- First-come first-served
- Shortest job first
- Shortest remaining Time next

Interactive Systems

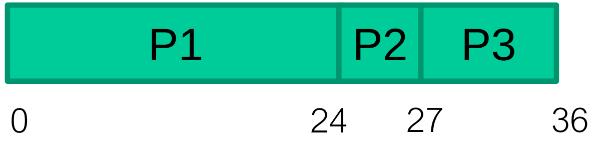
- Round-robin scheduling
- Priority scheduling
- Multiple queues
- Shortest process next
- Guaranteed scheduling
- Lottery scheduling
- Fair-share scheduling

FCFS Scheduling

- ❖ Simplest CPU-scheduling algorithm
- ❖ First-come, first-served - process that requests the CPU first is allocated the CPU first
- ❖ FCFS policy is managed with a FIFO queue
- ❖ When a process enters the ready queue, its PCB is linked onto the tail of the FIFO queue
- ❖ When the CPU is free, it is allocated to process at the head of the queue
- ❖ The running process is then removed from the queue
- ❖ It is non-preemptive, once scheduled it will complete
- ❖ Short jobs wait for long

FCFS Scheduling

- Example: Three processes arrive in order P1, P2, P3 all at time 0.
  - P1 burst time: 24
  - P2 burst time: 3
  - P3 burst time: 9



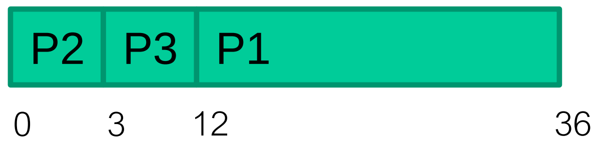
- Waiting Time
  - P1: 0,   P2: 24,   P3: 27
- Completion Time:
  - P1: 24,   2: 27,   P3: 36
- Average Waiting Time: (0+24+27)/3 = 17
- Average Completion Time: (24+27+36)/3 = 29

SJF Scheduling

- Shortest (in terms of CPU time) job available is scheduled first
- Shorter processes makes progress
- SJF policy is managed with a priority queue with burst time as input
- When a process enters the ready queue, its PCB is linked onto the priority queue at the appropriate entry
- When the CPU is free, it is allocated to the process at the head of the priority queue
- If too many short jobs, long processes will starve
- SJF is non-preemptive; once allotted the process will complete
- Lowest turnaround time

SJF Scheduling

- Consider 3 process P2, P3, P1 all arriving at time T0.
  - P1 burst time: 24
  - P2 burst time: 3
  - P3 burst time: 9



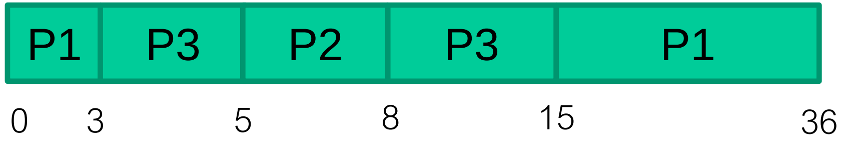
- Waiting Time
  - P1: 12, P2: 0, P3: 3
- Completion Time:
  - P1: 36, P2: 3, P3: 12
- Average Waiting Time: (12+0+3)/3 = 5 (compared to 17)
- Average Completion Time: (36+3+12)/3 = 17 (compared to 29)

SRTF Scheduling

- Shortest Remining Time First (SRTF) job is scheduled first
- Preemptive scheduling algorithm
- A priority queue with remaining time is used as input
- When a process enters/re-enters the ready queue, its PCB is linked onto the priority queue at the appropriate entry
- When the CPU is free, it is allocated to the process at the head of the priority queue
- Newly arriving short process may forcefully preempt currently running process.
- Longer process may have multiple context switch before completion

SRTF Scheduling

- Consider the following process arriving at different time slots
  - P1 burst time: 24 arrives at 0
  - P2 burst time: 3 arrives at 5
  - P3 burst time: 9 arrives at 3



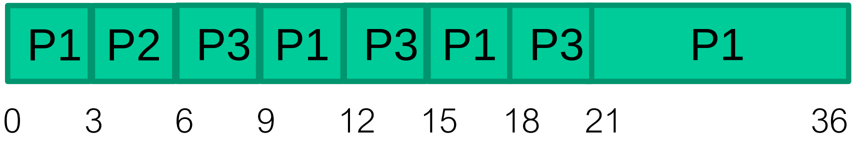
- Waiting Time
  - P1: (15-3) =12,   P2: 0,   P3: (8-5) = 3
- Completion Time:
  - P1: 36,   P2: 8,   P3: 15
- Average Waiting Time: (0+3+12)/3 = 5
- Average Completion Time: (8+15+36)/3 = 19.6

Round Robin Scheduling

- ❖ Modified version of preemptive FCFS
- ❖ Each process gets a small unit of CPU time (time quantum)
- ❖ FIFO queue is used as input
- ❖ When a process enters/re-enters the ready queue, its PCB is linked the tail of the queue
- ❖ After quantum expires, the process is preempted and added to the tail of the ready queue (Hence, preemptive scheduling algorithm)
- ❖ CPU is allocated to the process at the head of the queue
- ❖ Longer process may have multiple context switch before completion

Round Robin Scheduling

- Consider the following process arriving at T0, time quantum of 3 units
  - P1 burst time: 24
  - P2 burst time: 3
  - P3 burst time: 9



- Waiting Time
  - P1: (6+3+3) =12, P2: 0, P3: (6+3+3)= 12
- Completion Time:
  - P1: 36, P2: 3, P3: 21
- Average Waiting Time: (0+12+12)/3 = 8
- Average Completion Time: (3+21+36)/3 = 20

Round Robin Scheduling

- ❖ RR scheduling is better for short jobs and fair
- ❖ Shorter response time, good for interactive jobs
- ❖ Context-switching time adds up for long jobs
- ❖ Context switching takes additional time and overhead
- ❖ If the chosen quantum is
    - ❖ too large, response time suffers
    - ❖ infinite, performance is the same as FIFO
    - ❖ too small, throughput suffers and percentage overhead grows

Priority Scheduling

- Each process has a priority number
- Highest priority process is scheduled first; if equal priorities, then FCFS
- Managed with a priority queue with priority value as input
- When a process enters the ready queue, its PCB is linked onto the priority queue at the appropriate entry
- CPU is allocated to the process at the head of the queue
- It can have 2 variants; non-preemptive and preemptive
- Arrival of a new process with a higher priority can preempt the currently running process.

Thank you

johnjose@iitg.ac.in

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