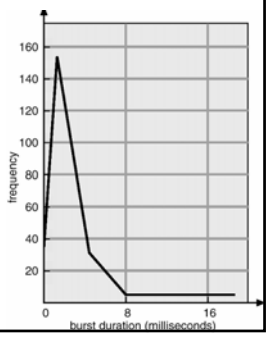
Process Scheduling

- Reading: OS Concepts pp.151-177
- Multiprogramming
  - means switching between processes
  - in order to maximize CPU utilization

Multiprogramming

- Processes cycle between CPU execution and waiting for I/O.
- _____
- _____



Process Types

- Processes are typically either CPU bound or I/O bound
- Alternatively we can classify them as
  - Interactive: _____
  - Batch: _____
  - Real-time: _____

Nonpreemptive scheduling

- Nonpreemptive scheduling means only scheduling a new process when the current process gives up the CPU. This can occur if the current process
  - _____
  - _____
- _____
- _____

Preemptive scheduling

- Preemptive scheduling means switching at will…
  - _____
  - _____
  - _____
- If we preempt a process we must worry about what it is doing at the time
  - _____
    _____
- Overhead caused by preemption is called the **dispatch latency** which is made up of
  - _____
  - _____
  - _____

Scheduling Criteria

- CPU utilization: _____
- Throughput: _____
- Turnaround time: _____
- Waiting time: _____
- Response time: _____
- _____
  _____
- _____
  _____

FCFS Scheduling

Process	Burst Time	Waiting Time?
P_1	24	
P_2	3	
P_3	6	

- What is the Average Waiting Time?
- If the arrival Order: P_1 , P_2 , P_3
- Gantt Chart:
- If the arrival Order: P_3 , P_2 , P_1

FCFS Scheduling

- Algorithm: First Come First Served
- Problems:
  - _____
  - _____
  - _____
- Linux usage:

_____

_____

_____

SJF Scheduling

Process	ArrivalTime	CPU Burst
P_1	0.0	7
P_2	2.0	4
P_3	4.0	1
P_4	5.0	4

- _____
  _____
- _____
- Two schemes
  - Nonpreemptive: _____
  - Preemptive: (SRTF)_____
    _____

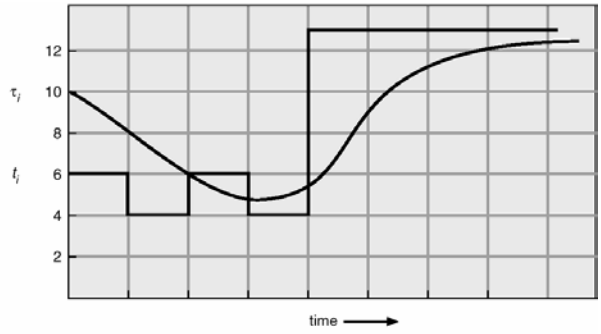
SJF Scheduling

- Optimal solution: _____
  _____
- Problem: _____
  _____

Basics
Algorithms
Advanced

Exponential Averaging

1. t_n = actual length of n^{th} CPU burst
2. τ_{n+1} = predicted value for the next CPU burst
3. $\alpha, 0 \le \alpha \le 1$
4. Define : $\tau_{n+1} = \alpha\, t_n + (1-\alpha)\tau_n.$

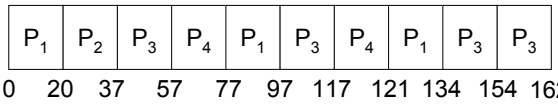


CPU burst (t_i)	6	4	6	4	13	13	13	...
"guess" (τ_i)	10	8	6	6	5	9	11	12	...

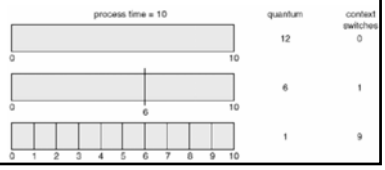
Basics
Algorithms
Advanced

Round Robin Scheduling

Process	Burst Time
P_1	53
P_2	17
P_3	68
P_4	24



- _____
  _____
  _____
- _____
  _____
- _____



Selecting a Time Quantum

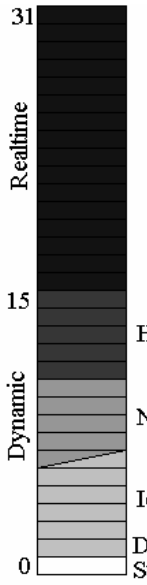
- Using a large time quantum: _____
- Using a small time quantum: _____
- Rule of thumb: _____

Priority Scheduling

Process	Priority	CPU Burst
P_1	3	7
P_2	5	4
P_3	2	1
P_4	8	4

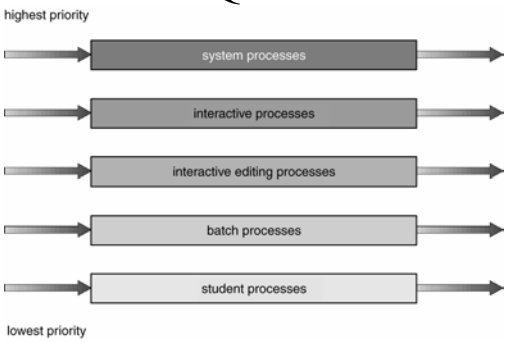
- Algorithm: _____
- Problem: _____
  - _____

Priority Scheduling in NT



- Windows NT
  - Classes of thread priority:
    - _____
    - _____
    - _____
    - _____
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____

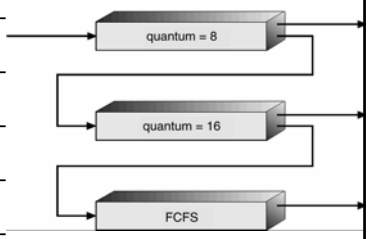
Multilevel Queue Scheduling



- Absolute priorities can result in starvation
- This can be solved by
  - _____
    _____
    _____

Multilevel feedback queues

- Changing priorities means that processes move between queues
-



Multiple Processors

- Multiple CPUs increases the complexity of scheduling and the associated concurrency problems. There are two main models:
- Symmetric multiprocessing where all processors do the same thing (i.e. homogeneous processors).

Multiple Processors (cont'd)

- Asymmetric multiprocessing
  - _____
  - _____

Real Time Scheduling

- Hard real-time systems
  - _____
  - _____
  - _____
- Soft real-time computing
  - _____
  - _____
    - _____
    - _____

Algorithm Evaluation

- Deterministic modeling
  - _____
  - _____
  - _____
- Queuing models based on
  - _____
  - _____
  - _____
- Simulation
  - _____
- Implementation
  - _____
  - _____

Summary

- Basics
- Scheduling Algorithms
  - FCFS
  - SJF
  - Priority Scheduling
  - RR
  - Multilevel Queues
- Advanced Topics
  - Multiple processor scheduling
  - Real-time scheduling
  - Algorithm Evaluation