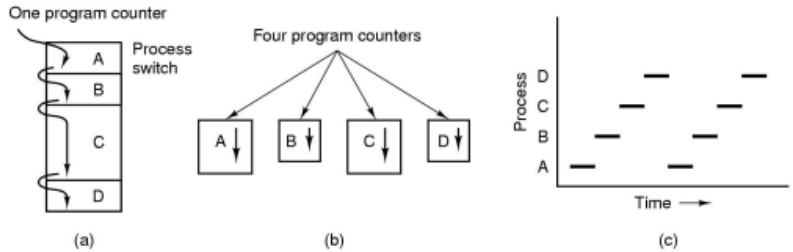
Lecture 25 - Process Scheduling

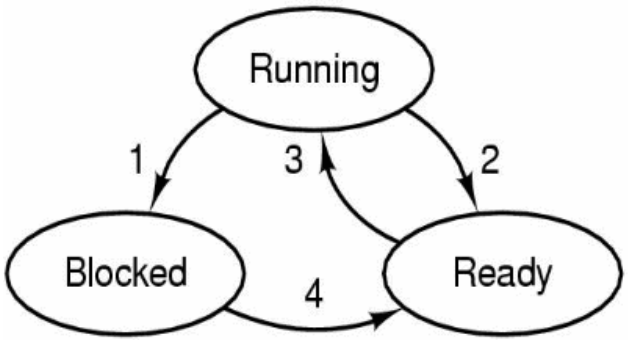
CprE 308

February 10, 2014

Process Scheduling Basics

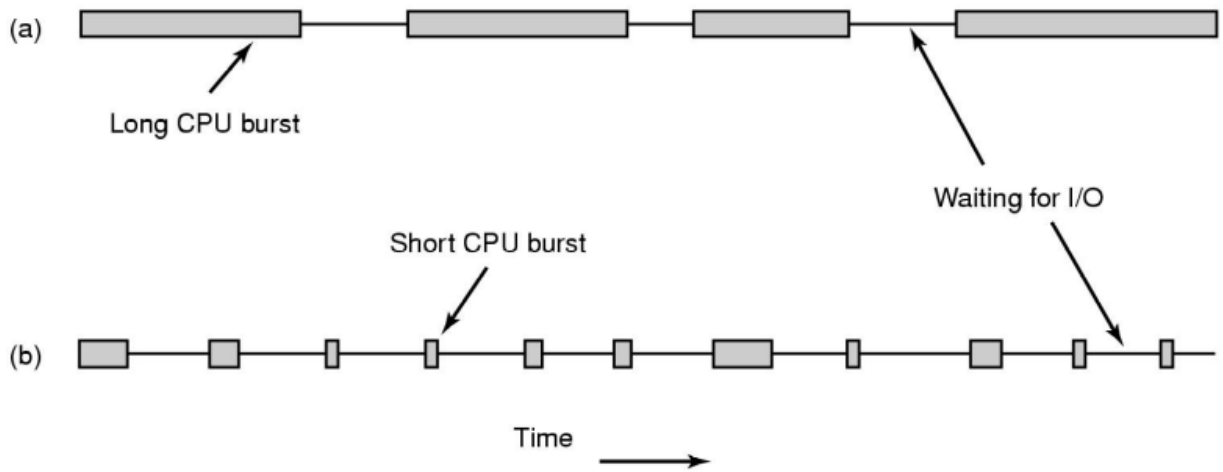
Process/Thread States





1. Process blocks for input
2. Scheduler picks another process
3. Scheduler picks this process
4. Input becomes available

Scheduling



Different Types of jobs have different demands

- A CPU-bound process
- an I/O bound process

Preemption

- Non-preemptive Scheduling: Processes run until they have finished or block for I/O
- Preemptive Scheduling: Can forcibly suspend a process and switch to another
- Clock Interrupt helps in implementing preemption
  - Overhead of preemption

Process Scheduling

Basic Question: Which process goes next?

- Personal Computer
  - Few processes, interactive, low response time
- Batch Systems (Compute Servers)
  - Many processes, not interactive, throughput is important
- Real Time Systems
  - Guaranteed response times, meet deadlines

Scheduling Algorithm Goals

- Minimize Response time
- Maximize throughput i.e. number of jobs/hour
- Fairness among jobs, users(?)
- Maximize CPU utilization
- Minimize Context Switch Overhead

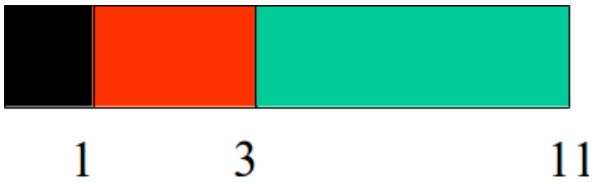
Batch Scheduling

First Come First Serve (FCFS)

- Maintain queue of processes
- Schedule first in queue
- Scheduled job executes until it finishes or blocks for I/O
- Simple, easy to implement
- Not good for mix of short and long jobs
  - Example: a short job arriving soon after a long one

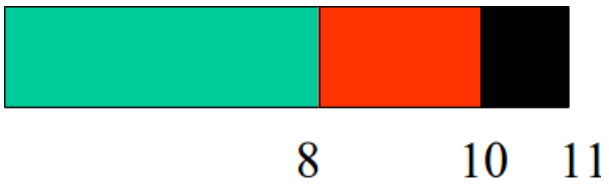
Shortest Job First (batch systems, non-preemptive)

- Suppose 3 jobs arrive: length 8,2,1
- Shortest Job First:



Sum of response times=15

- Scheduler X:



Sum of response times=29

Shortest Remaining Time Next (preemptive)

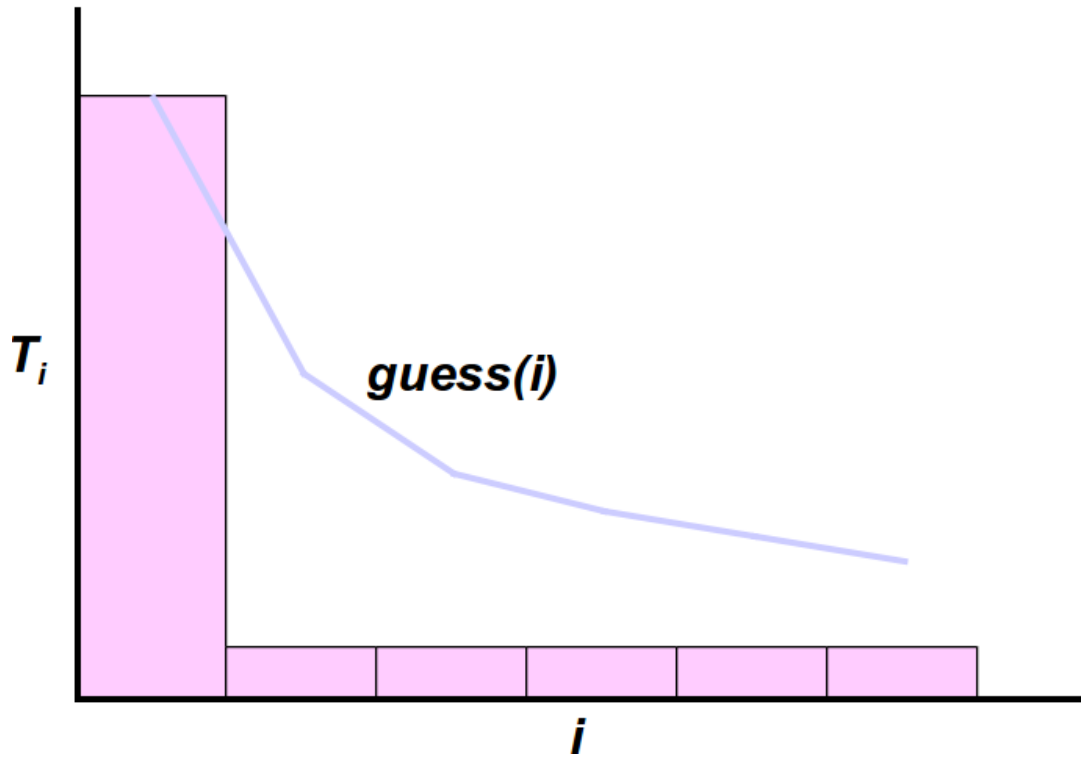
- Next schedule the job with the shortest time to completion
- Fairness problems: A long job might be continually pre-empted by many short jobs

Interactive Scheduling

Realistically . . .

- Jobs don't run to completion
  - run till they block for user input
- Don't know the length of "jobs"
- How long is that?
  - Predict using past behavior
  - $guess = \sum(T_i)/n$

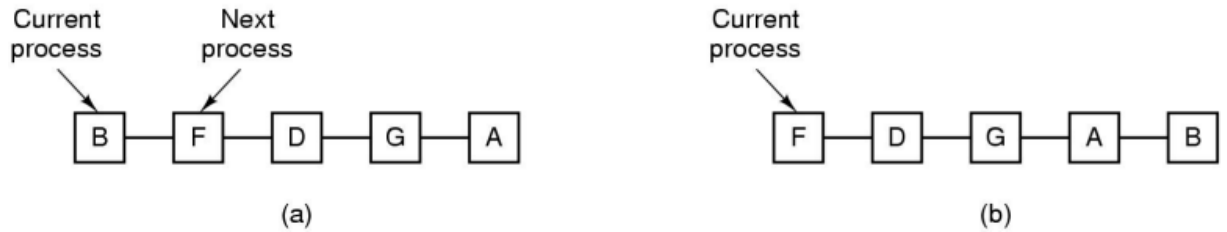
Mean Guessing



Exponential Averaging

- $guess_i = a(new\_data) + (1 - a)(guess_{i-1})$
  - a: weight given to new data
  - $(1 - a)$: weight given to previous guess

Round Robin (Interactive Systems)



- Give CPU time to each process by turn
- Quantum = CPU time alloted every turn
- How is this better than shortest remaining time next for long jobs?
- How to choose the value of the quantum?
  - Too small might mean high context switch overhead
  - Too large might mean bad response times

Priority Scheduling

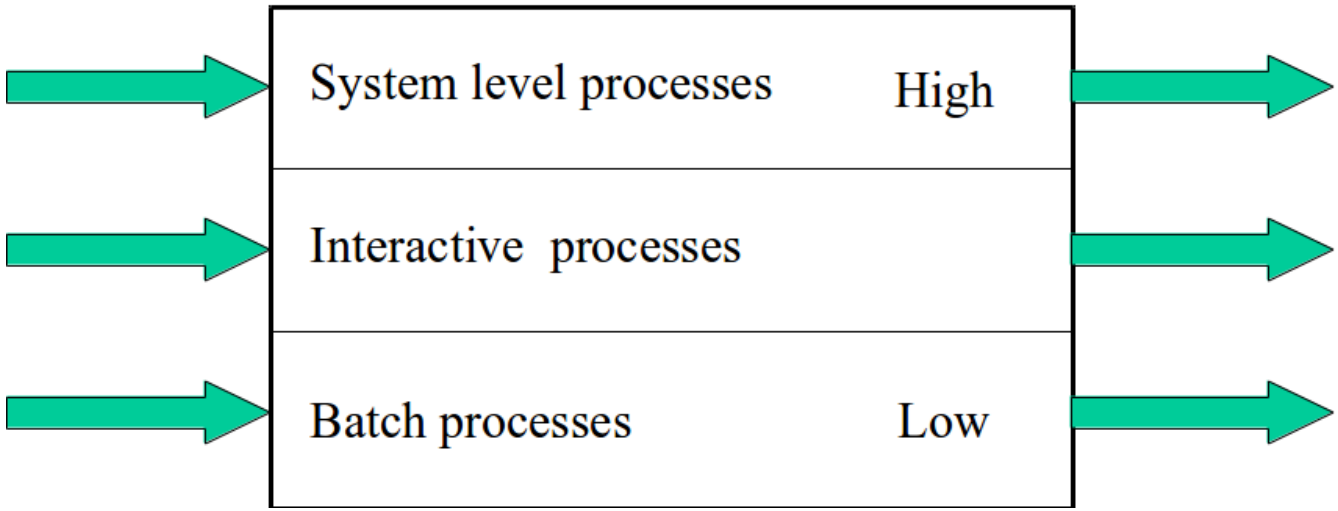
Different Priorities

- Background process sending mail vs:
- Shell process accepting input

Requirement:

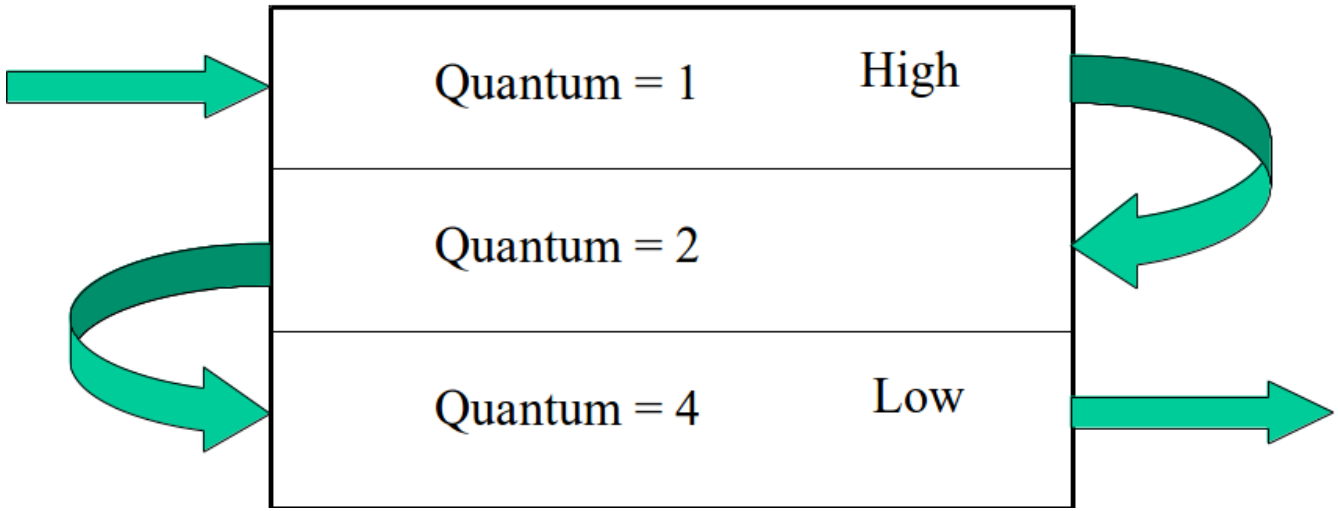
- Schedule jobs with highest priority first
- Issues: high priority jobs should not overwhelm the others
  - Might decrease priority with time

Multiple Queues - static version



- Lower priority queues don't run if higher priority queues non-empty
- Could time slice between queues

Multiple Queues - dynamic version



- Process enters high priority level
- If takes more than 1 quantum, move to second highest priority, . . .

Multiple Queues - dynamic version

- Higher priority = faster service, but short service times
- Reduce number of context switches for long processes
- What about a process which became interactive after a long bout of computation
  - Increase priority?

Lottery Scheduling: Another implementation priorities

- Example: 3 processes, priorities 2,3,5
- Distribute 20,30,50 tickets respectively
- System holds "lottery" 50 times per second
  - Winner gets 20 ms of CPU time
- Gives probabilistic guarantees

Real-time Scheduling

Real-time scheduling

- Provide time guarantees
- Upper bound on response times
  - Programmer's job
  - Every level of the system
- Soft versus hard real-time
  - Streaming mp3 player versus air-traffic controller

CPU Scheduling: Summary

- FCFS
- Shortest job first, shortest remaining job next
- Round robin - context switch overhead
- Priority scheduling
  - Multi-level queues
  - Lottery Scheduling
- Real-time schedule - schedulability