CISC 3320

C14d Evaluating CPU Scheduling Algorithm

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Acknowledgement

- These slides are a revision of the slides provided by the authors of the textbook via the publisher of the textbook

Outline

- CPU Scheduling Algorithm Evaluation
  - Methodology
  - General approaches
    - Deterministic
    - Probabilistic
    - Simulation

Algorithm Evaluation: Purpose

- Purpose is to answer the question
- How to select CPU-scheduling algorithm for an OS?

Method

- Determine criteria, then evaluate algorithms using one or the combinations of
  - Deterministic modeling
  - Queueing modeling (probabilistic)
  - Simulation

Deterministic Modeling

- **Deterministic modeling**
  - Type of **analytic evaluation**
  - Takes a particular predetermined workload and defines the performance of each algorithm for that workload

Deterministic Modeling: Example

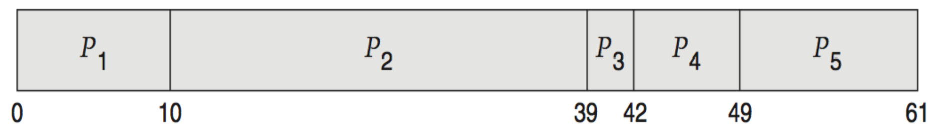
- Determine criterion to be minimum average waiting time
- Consider 5 processes arriving at time 0

Process	Burst Time
P_1	10
P_2	29
P_3	3
P_4	7
P_5	12

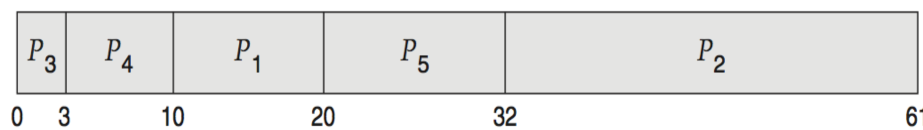
Deterministic Modeling: Example

- For each algorithm, calculate minimum average waiting time
- Simple and fast, but requires exact numbers for input, applies only to those inputs
    - FCS is 28ms:
    - Non-preemptive SFJ is 13ms:
    - RR is 23ms:

- FCS is 28ms:



- Non-preemptive SFJ is 13ms:



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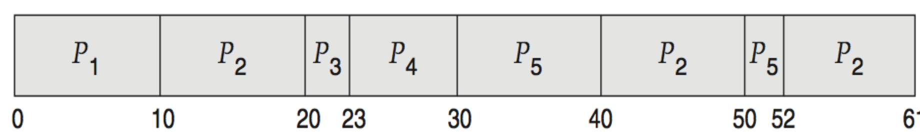


Queueing Models

- Describes the arrival of processes, and CPU and I/O bursts probabilistically
  - Commonly exponential, and described by mean
  - Computes average throughput, utilization, waiting time, etc
- Computer system described as network of servers, each with queue of waiting processes
  - Knowing arrival rates and service rates
  - Computes utilization, average queue length, average wait time, etc

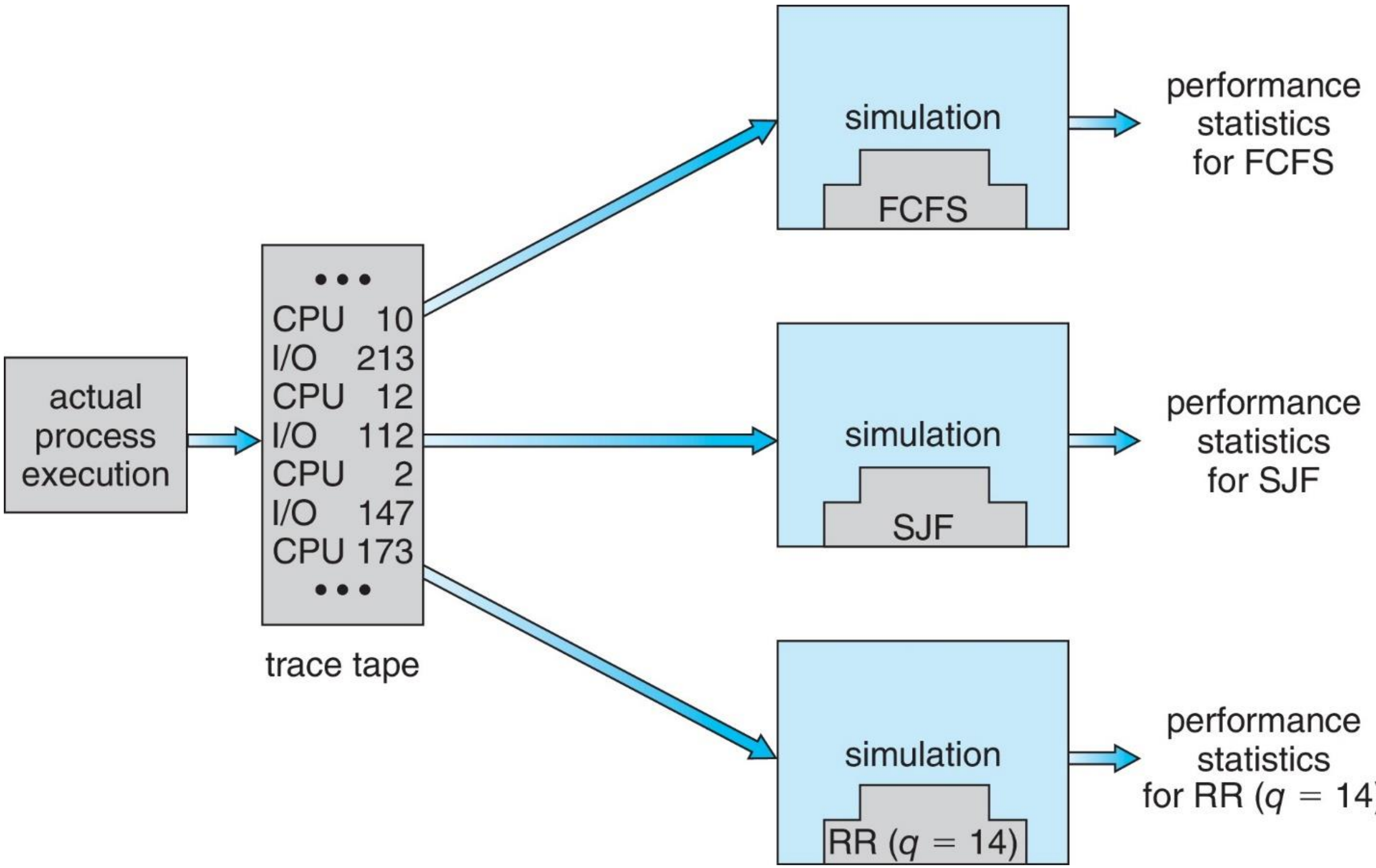
Little's Formula

- n = average queue length
- W = average waiting time in queue
- λ = average arrival rate into queue
- Little's law – in steady state, processes leaving queue must equal processes arriving, thus:
  $$n = \lambda \times W$$
  - Valid for any scheduling algorithm and arrival distribution
- For example, if on average 7 processes arrive per second, and normally 14 processes in queue, then average wait time per process = 2 seconds

Simulations

- Queueing models limited
- **Simulations** more accurate
  - Programmed model of computer system
  - Clock is a variable
  - Gather statistics indicating algorithm performance
  - Data to drive simulation gathered via
    - Random number generator according to probabilities
    - Distributions defined mathematically or empirically
    - Trace tapes record sequences of real events in real systems

Evaluation of CPU Schedulers by Simulation



Implementation

- Even simulations have limited accuracy
- Just implement new scheduler and test in real systems
  - High cost, high risk
  - Environments vary
- Most flexible schedulers can be modified per-site or per-system
- Or APIs to modify priorities
- But again environments vary

Questions?

- Evaluating CPU Scheduling Evaluation
- Methodology
- General approaches
  - Deterministic
  - Probabilistic
  - Simulation