

# CSL 301

## OPERATING SYSTEMS



### Lecture 4

#### Scheduling

Instructor  
Dr. Dhiman Saha

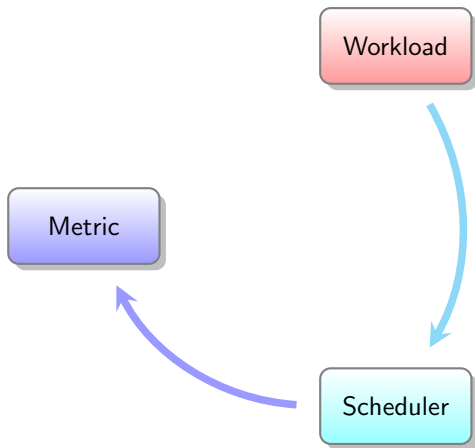
# Processes running in the system

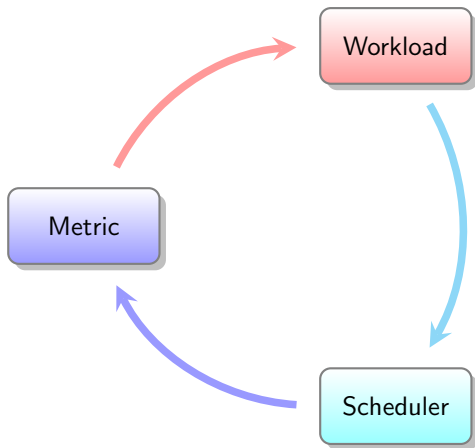


Workload

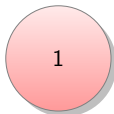


# Measuring the scheduling “**quality**”

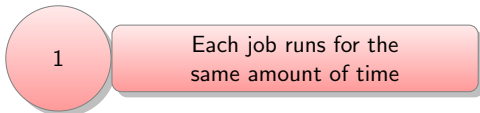




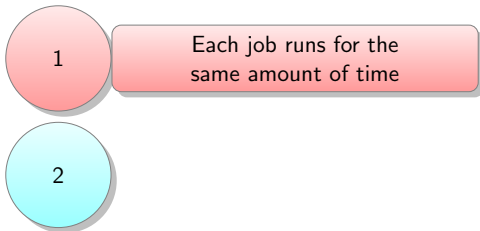
# Workload Assumptions



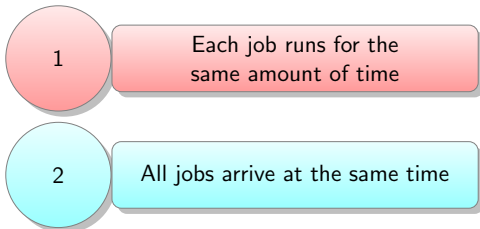
# Workload Assumptions



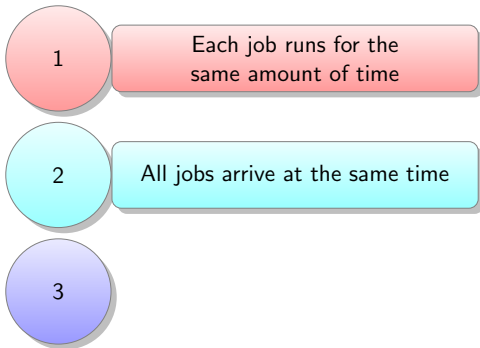
# Workload Assumptions



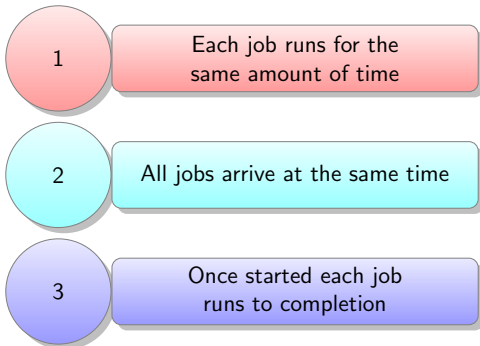
# Workload Assumptions



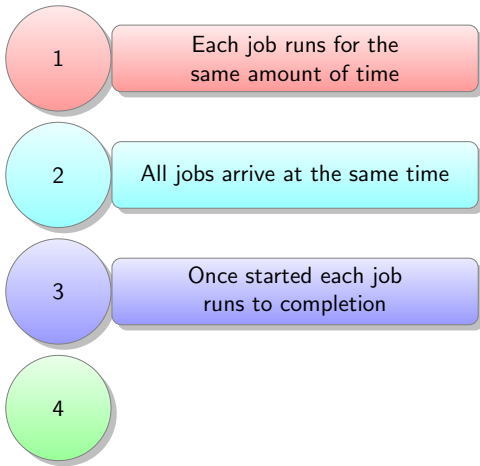
# Workload Assumptions



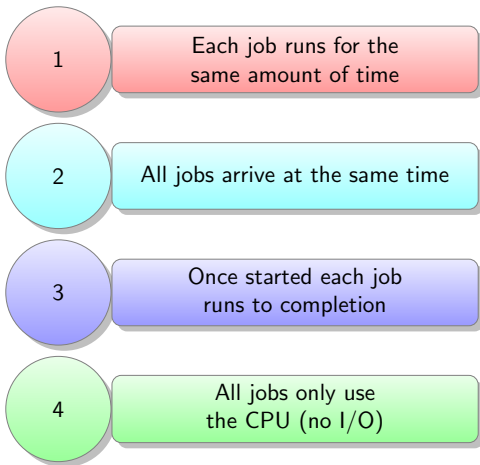
# Workload Assumptions



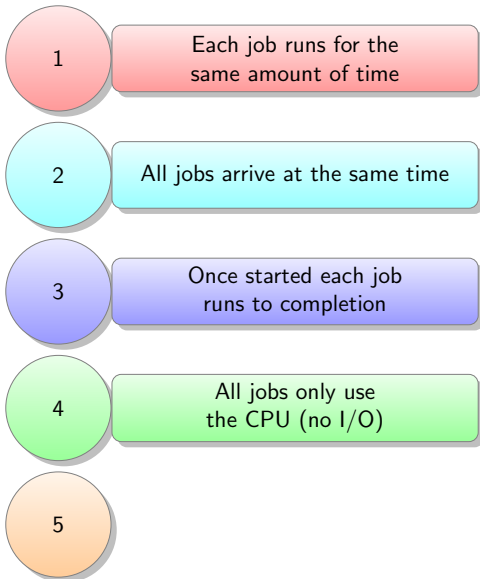
# Workload Assumptions



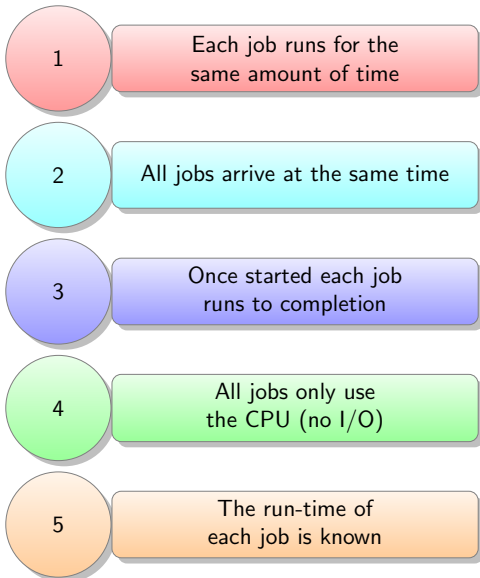
# Workload Assumptions



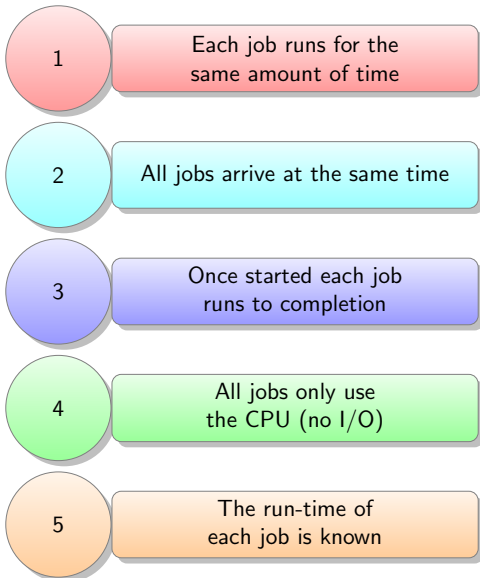
# Workload Assumptions



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## turnaround time

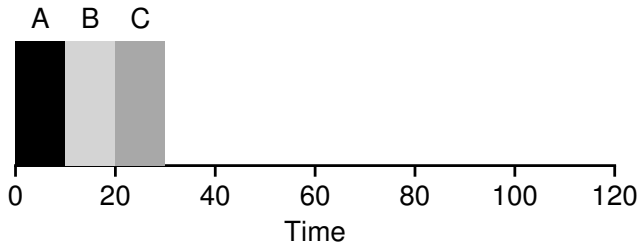
The turnaround time of a job is defined as the **time at which the job completes** minus **the time at which the job arrived** in the system.

$$T_{turnaround} = T_{completion} - T_{arrival}$$

# First In, First Out First Come, First Served

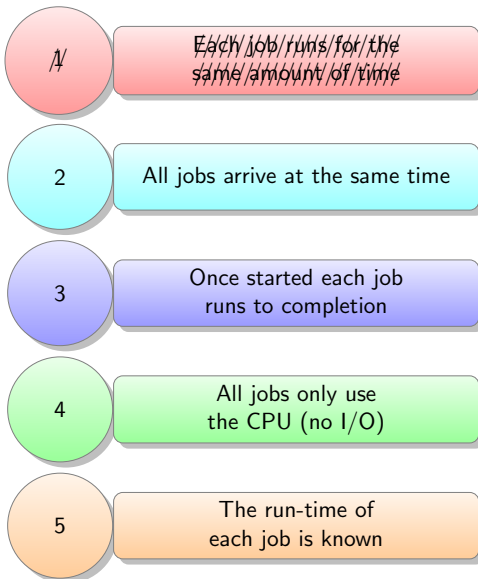
FIFO / FCFS

- ▶ A, B, and C, arrive at roughly the same time
- ▶  $T_{arrival} = 0$



Classwork

What will the **average turnaround time** be for these jobs?

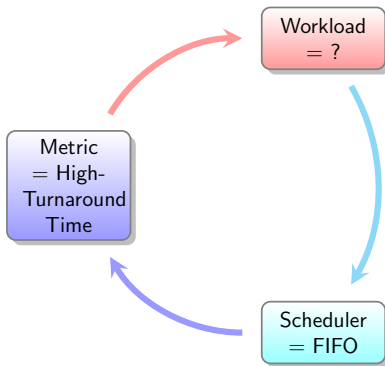


# How does FIFO perform now?

CW-1

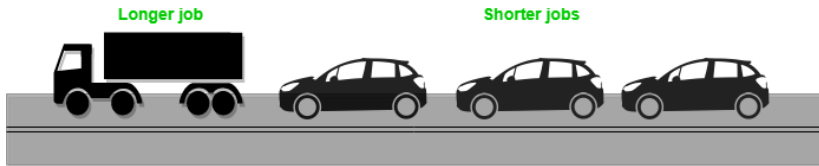
Classwork

Construct a **workload** to make FIFO perform poorly



average turnaround time?

# The Convoy Effect



## New Scheduler

How can we develop a better algorithm to deal with our new reality of jobs that run for different amounts of time?

# Shortest Job First

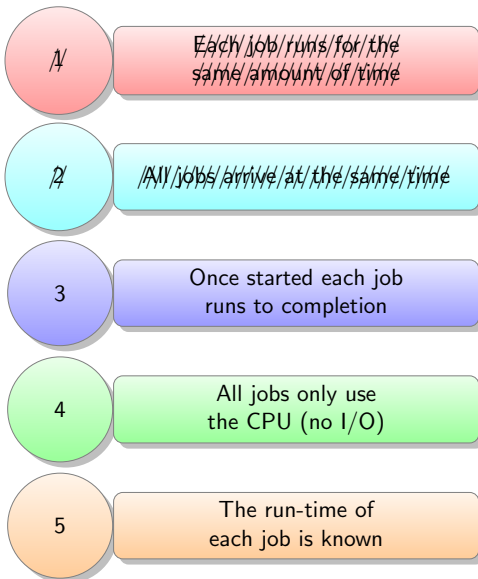
SJF

## Simple Approach

- ▶ Run the shortest job first, then the next shortest, and so on.
- ▶ Idea borrowed from operations research
- ▶ Redo the last FIFO workload with SJF
- ▶ What is the turn around time now?
- ▶ What is the improvement?

## Point-to-Ponder

Is SJF an **optimal** scheduling algorithm? How?



# How does SJF perform now?

CW-2

Classwork

Construct a **workload** to make SJF perform poorly

Need for a new scheduler

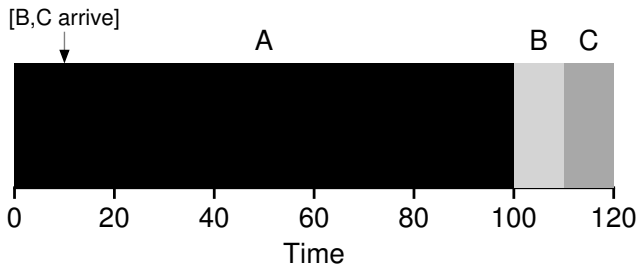
- ▶ Again what is the average turnaround time now?

# How does SJF perform now?

CW-2

Classwork

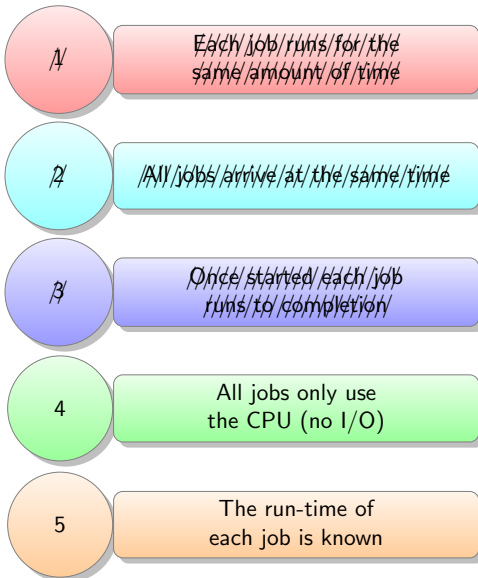
Construct a **workload** to make SJF perform poorly



The Convoy Effect

Need for a new scheduler

- Again what is the average turnaround time now?



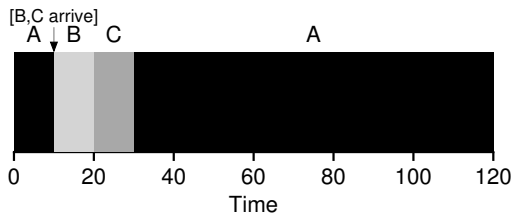
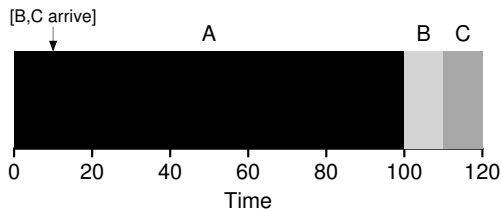
# Preemptive Scheduling

The scheduler can perform a **context switch**, stopping one running process temporarily and resuming (or starting) another.

- ▶ Using the mechanisms we discussed earlier
- ▶ The timer interrupt
- ▶ And context switching

Shortest Time-to-Completion First  
Preemptive Shortest Job First  
Shortest Remaining Time First

STCF/PSJF/SRTF



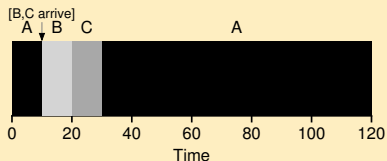
Compare avg. turnaround time

- ▶ Sometimes we care about when a job starts
- ▶ Instead of when it finishes

$$T_{response} = T_{firstrun} - T_{arrival}$$

- ▶ What does  $T_{response}$  capture?

CW-3

Compute Avg.  $T_{response}$  for Preemptive SJF

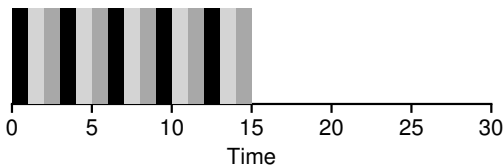
- ▶ How can we build a scheduler that is sensitive to response time?

# Round Robin

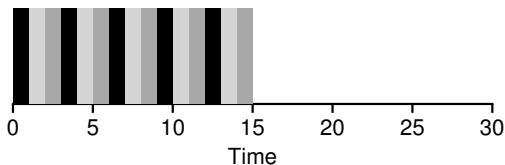
Time-slicing

RR

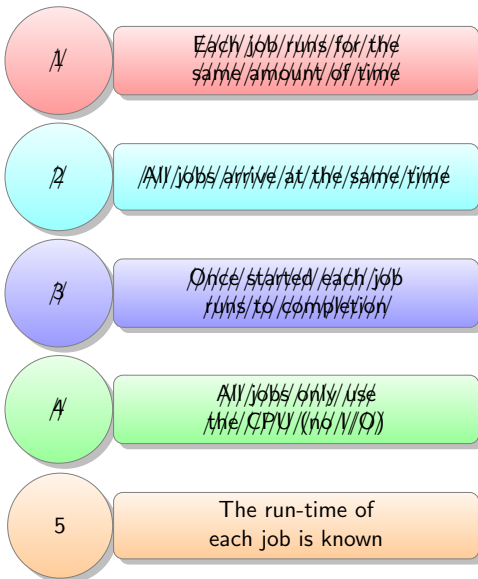
- ▶ Instead of running jobs to completion, RR runs a job for a time slice (sometimes called a **scheduling quantum**) and
- ▶ Then switches to the next job in the run queue.
- ▶ It repeatedly does so until the jobs are finished.

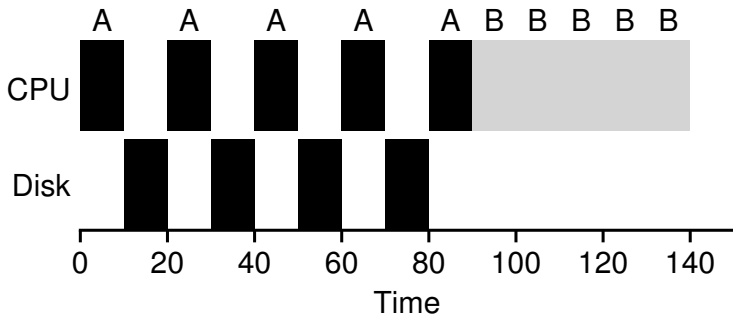


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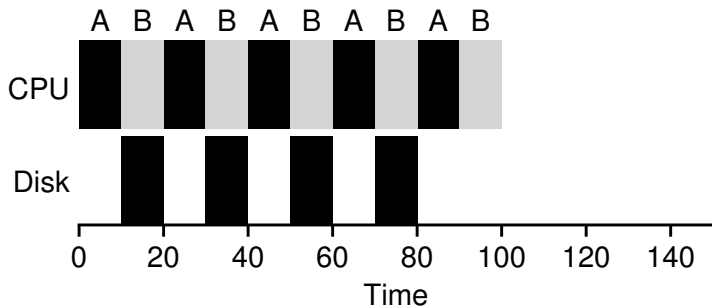


- ▶ Avg. Response Time?
- ▶ Compare with FIFO
- ▶ What about avg. turn-around time?
- ▶ How to choose the time-slice?





# I/O Aware (Overlap)





- ▶ Smarter Scheduling
- ▶ Multi-level feedback queue