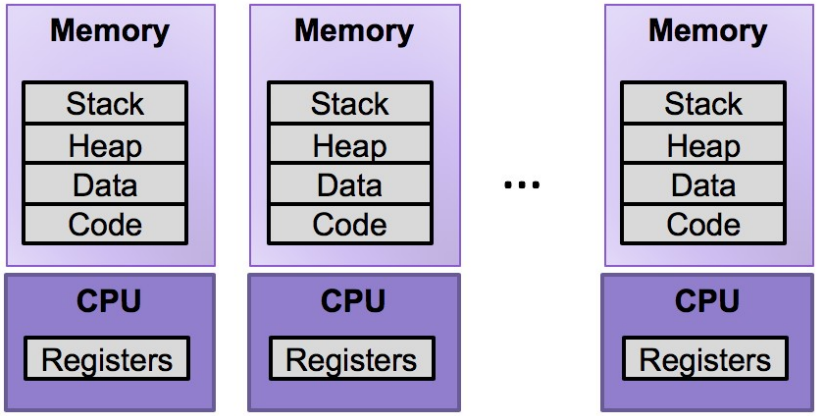
Lecture 18: CPU Scheduling

CS 105 Spring 2025

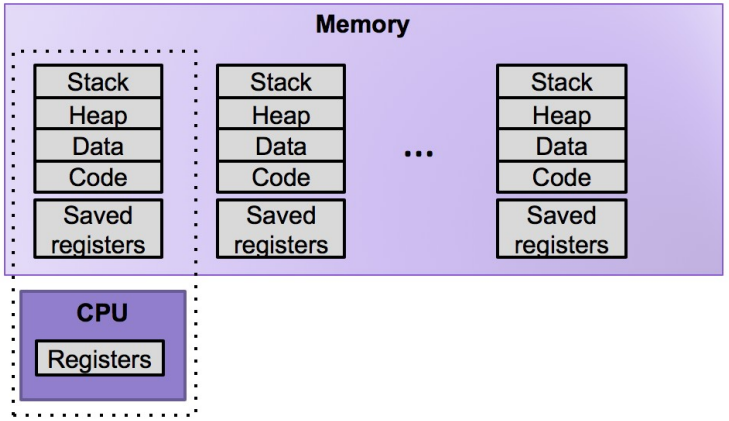
Review: Multiprocessing

The Illusion



- Abstraction: logical control flow within a process

The Reality



- Context switching b/n processes
- User cannot predict how instructions will interleave

Real-world Examples

- Restaurants handling orders
- DMV handling customers
- Students handling assignments
- Hospitals handling patients

Possible Metrics

- **Latency:** how much time between when a job is requested and when a job is completed
- **Response time:** how much time between when a job is requested and when you start processing the job
- **Throughput:** the rate at which jobs are completed

Simplifying Assumptions (for now)

1) Once you start a job, you complete that job before beginning the next job
2) The run-time of each job is known in advance
3) All jobs only use the CPU

First In, First Out (FIFO)

- Jobs are scheduled in the order they arrive

- Example:
  - Job A arrives at time 0, takes time 10 to complete
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- Average Latency = $\frac{10+15+20}{3} = 15$
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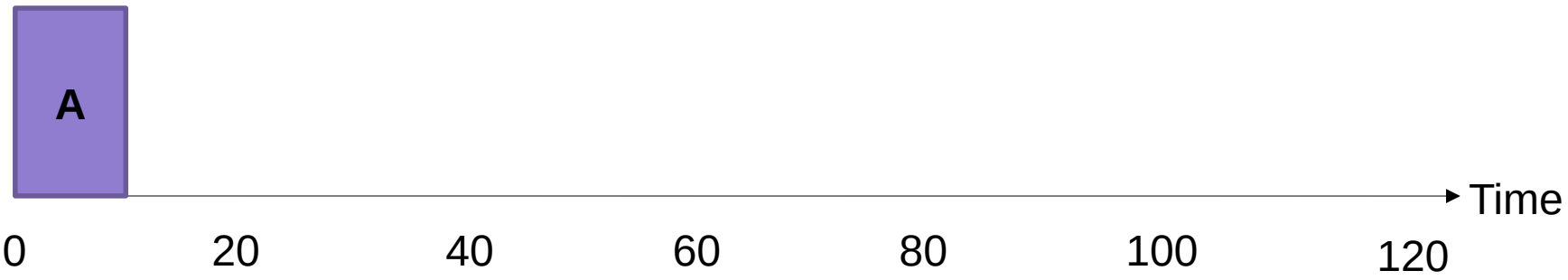

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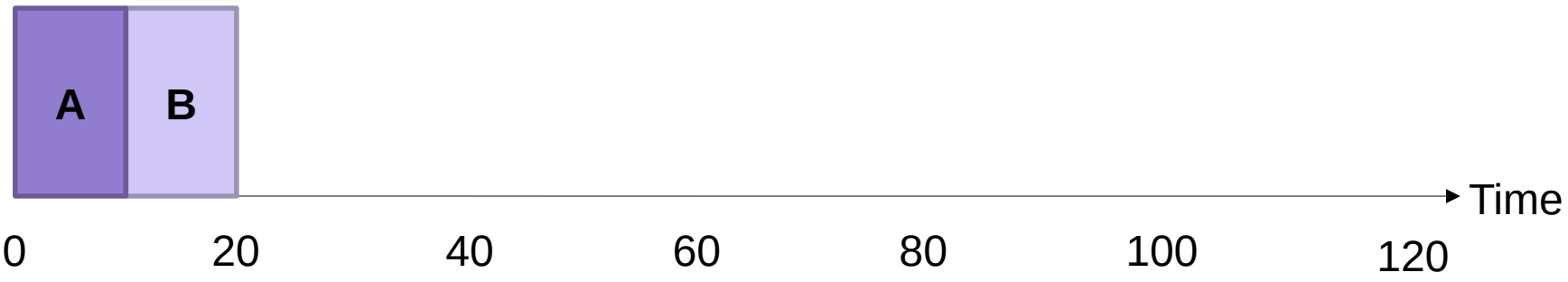

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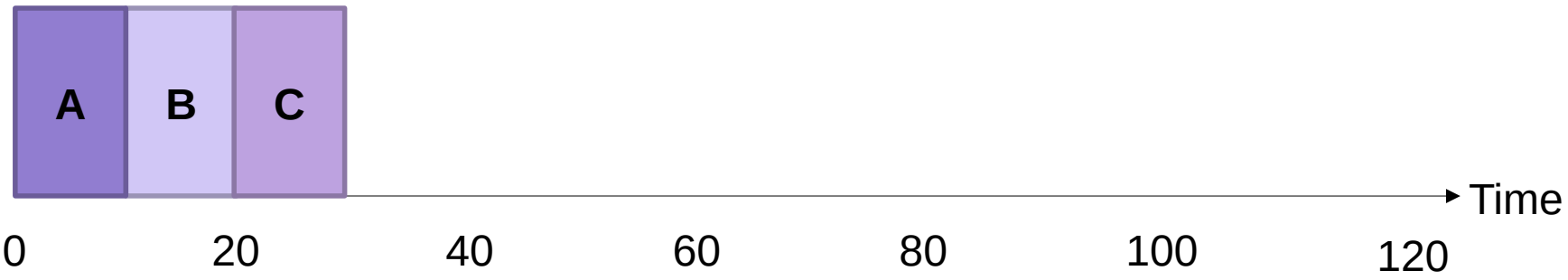

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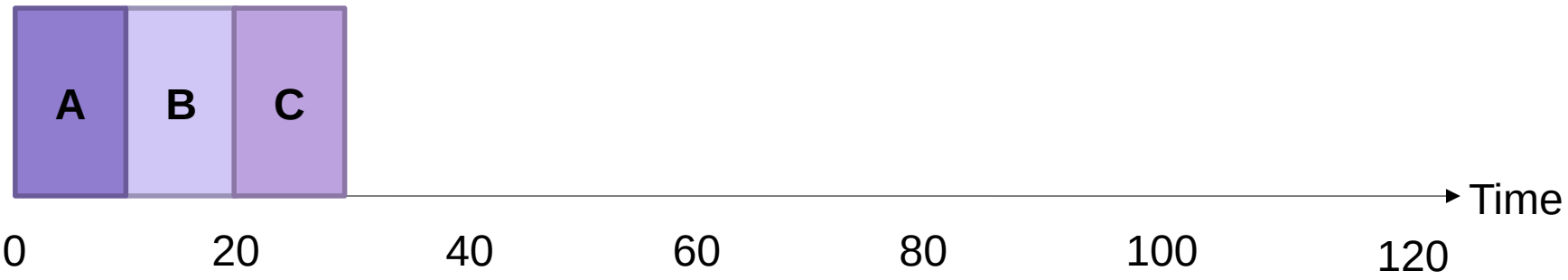

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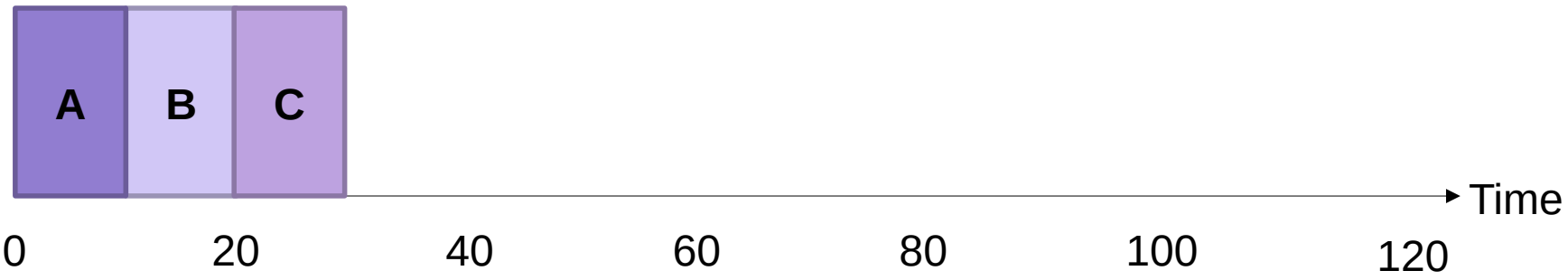

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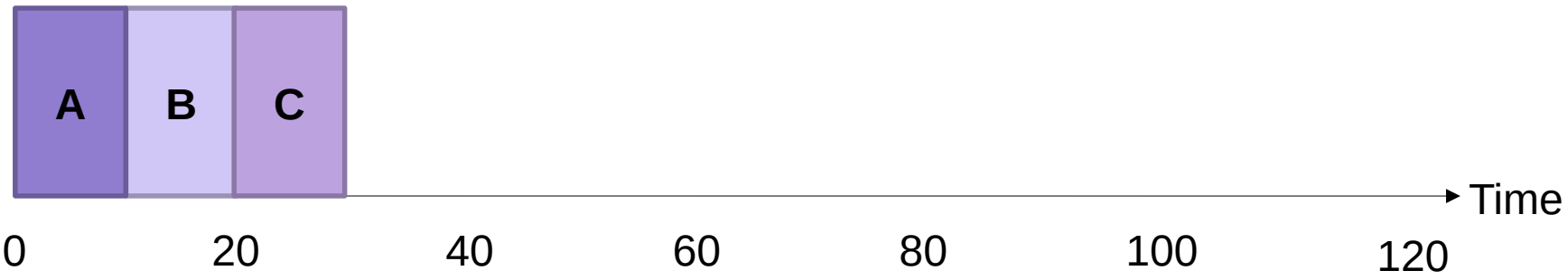

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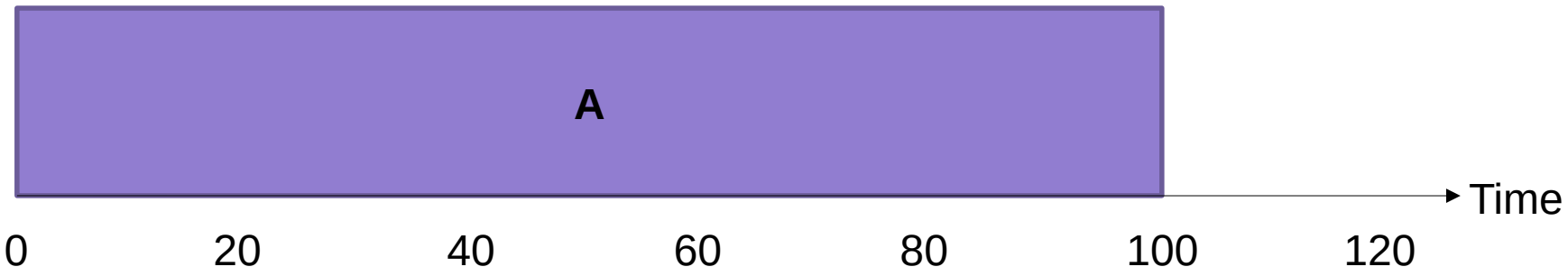

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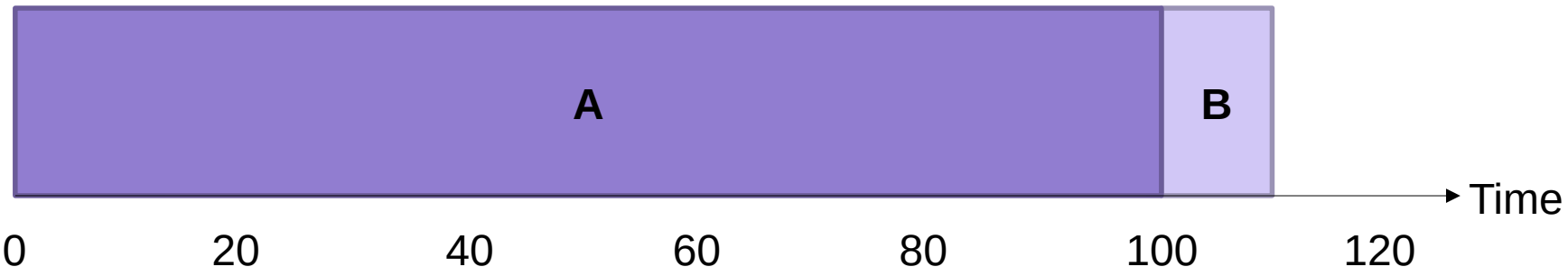

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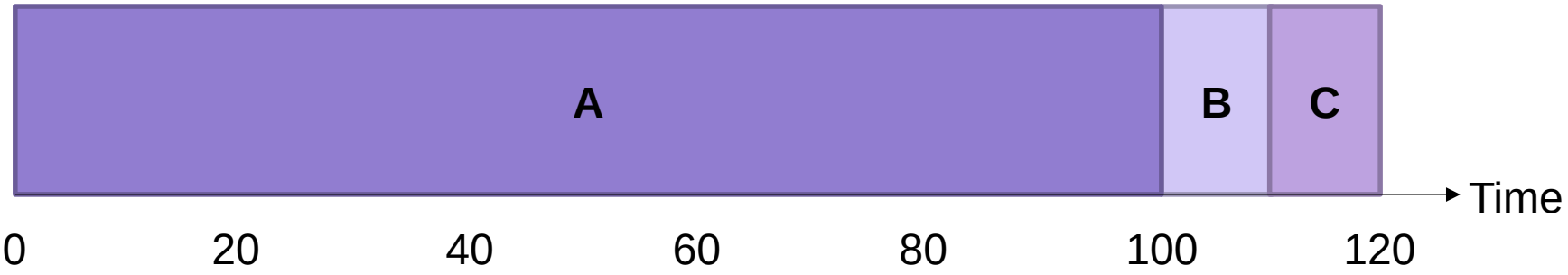

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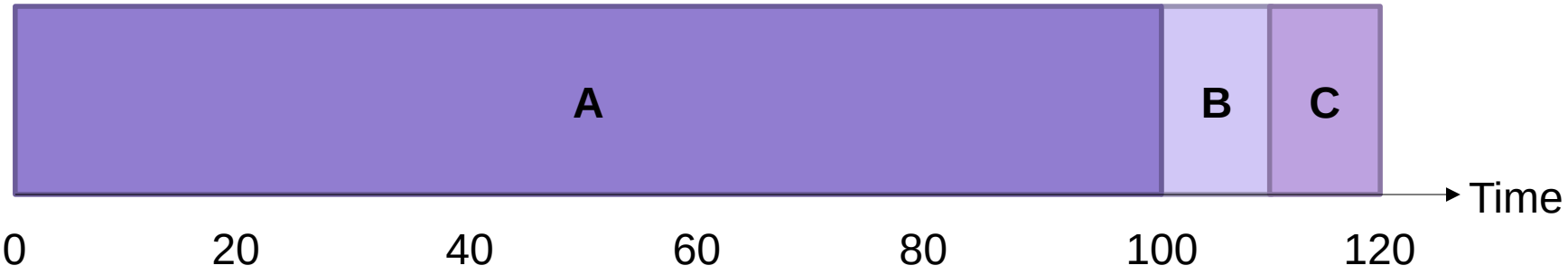

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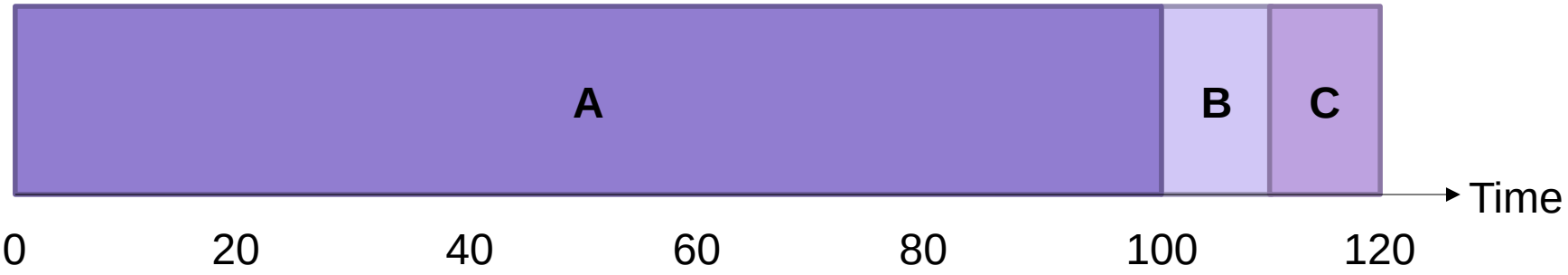

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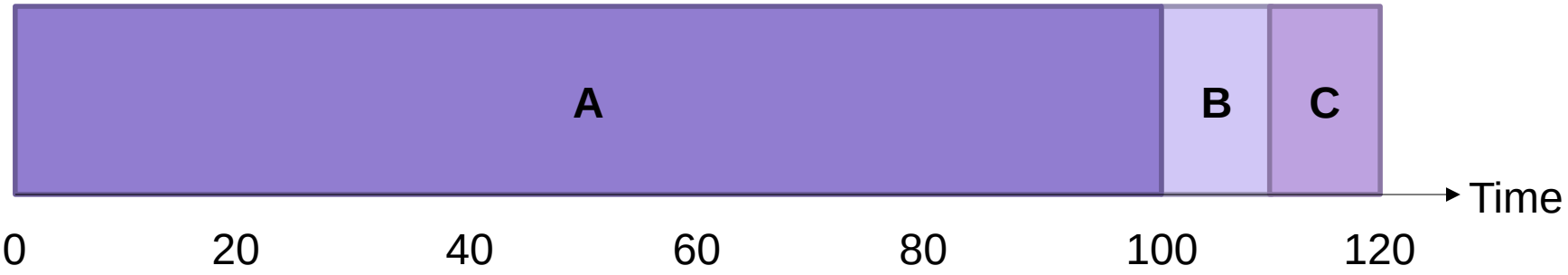

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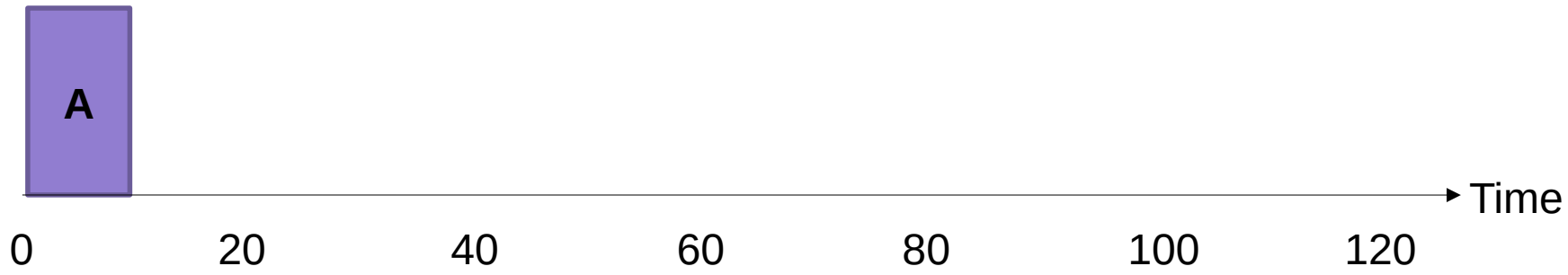

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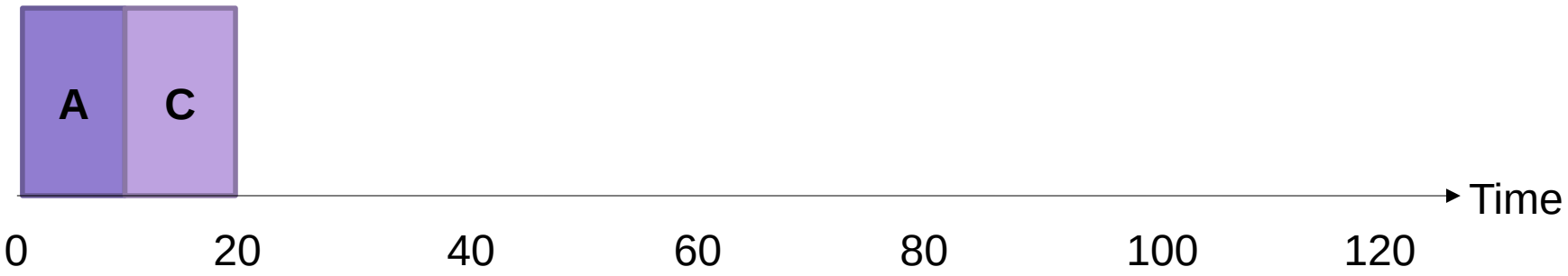

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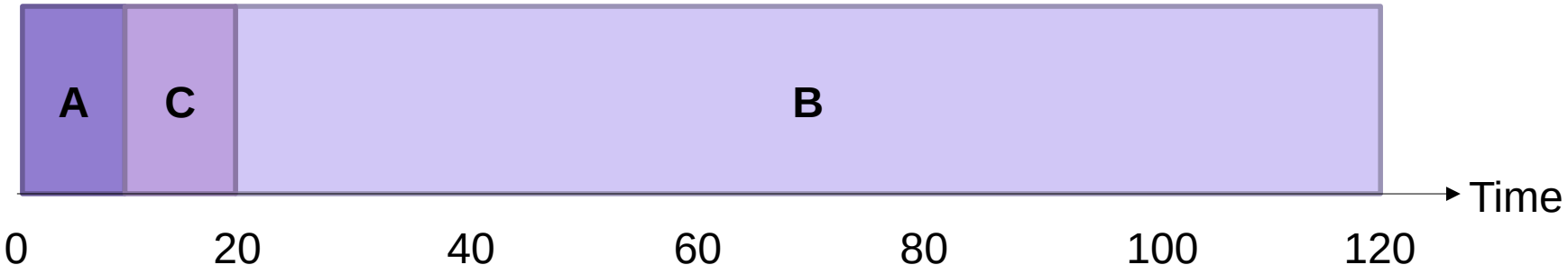

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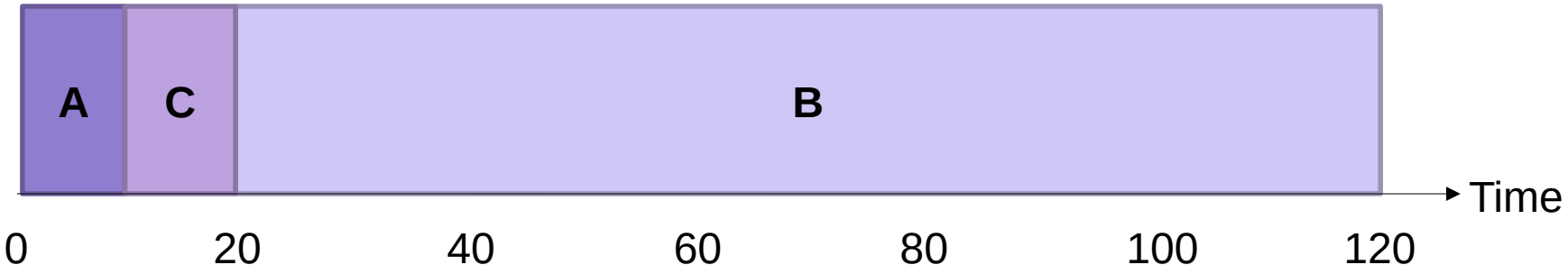

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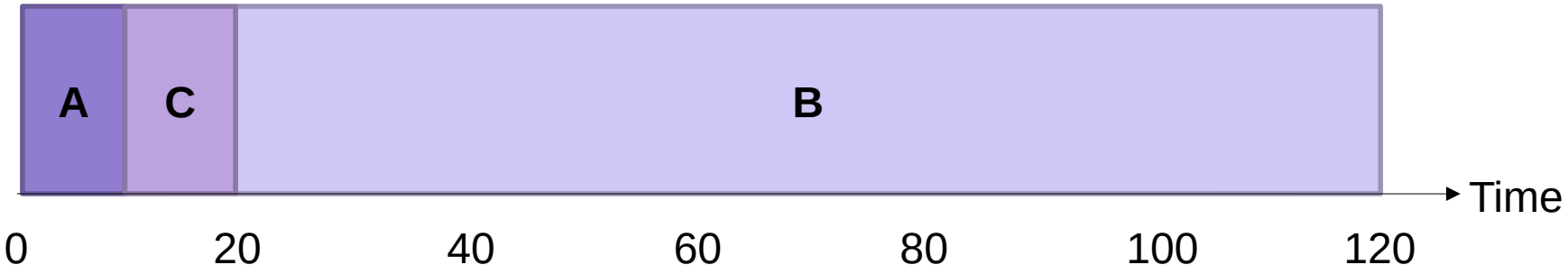

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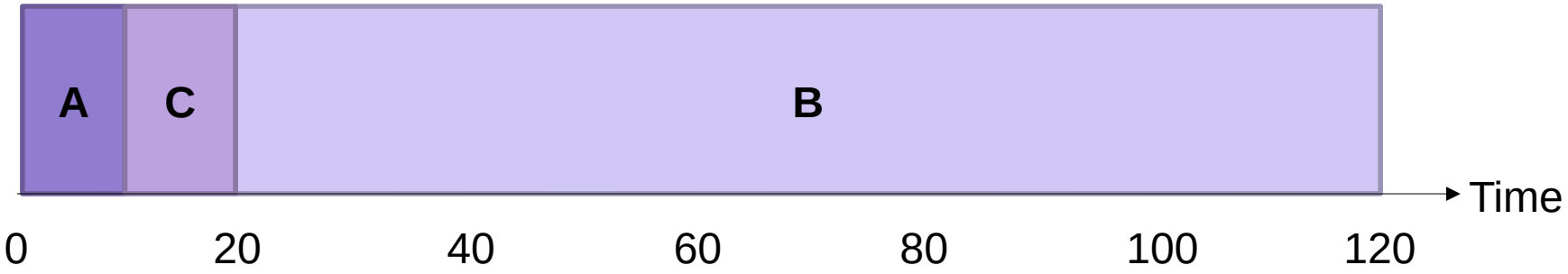

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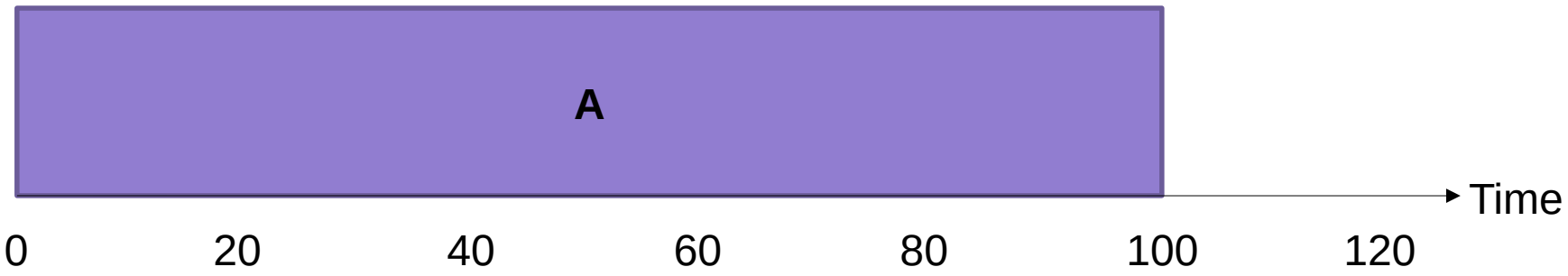

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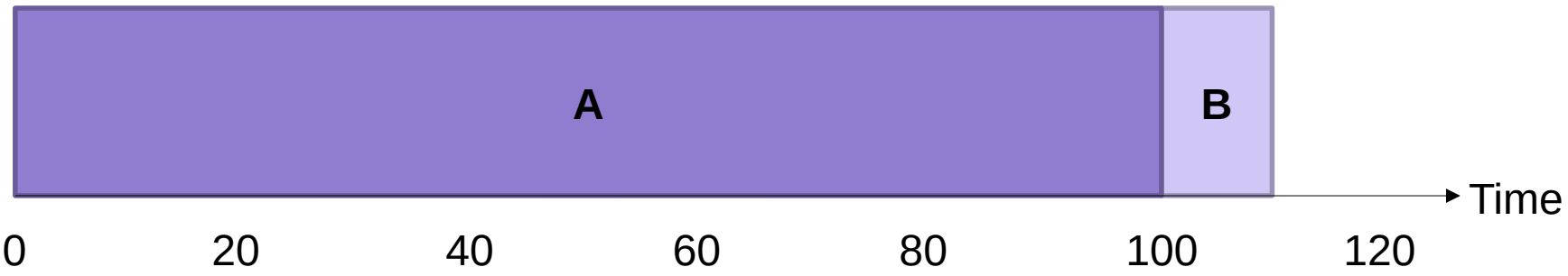

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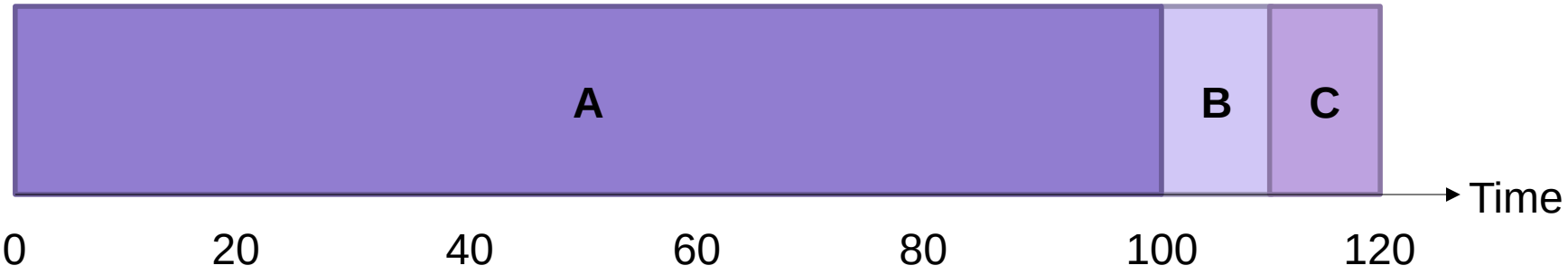

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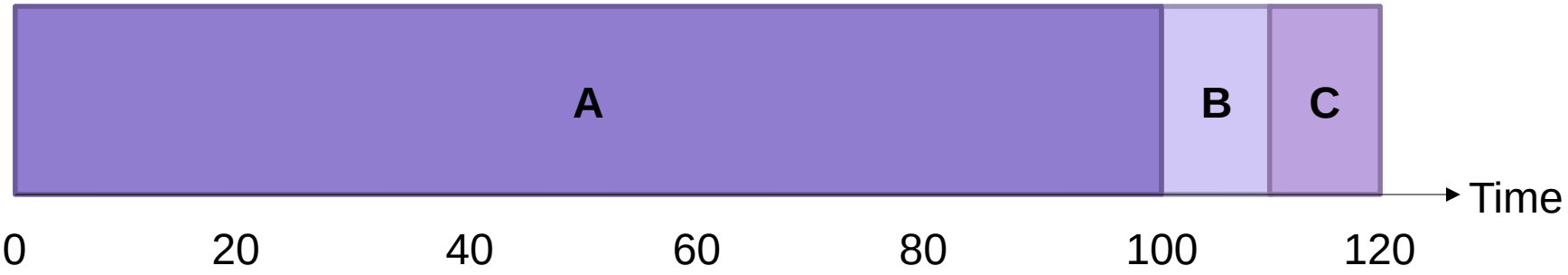

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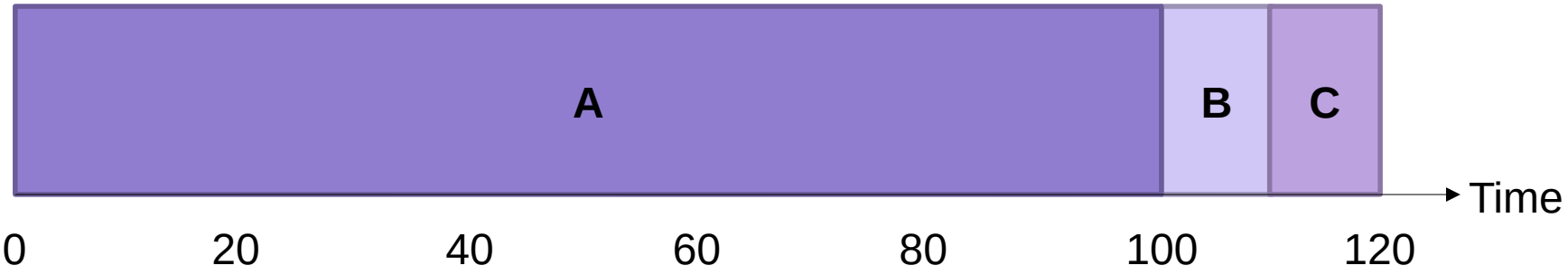

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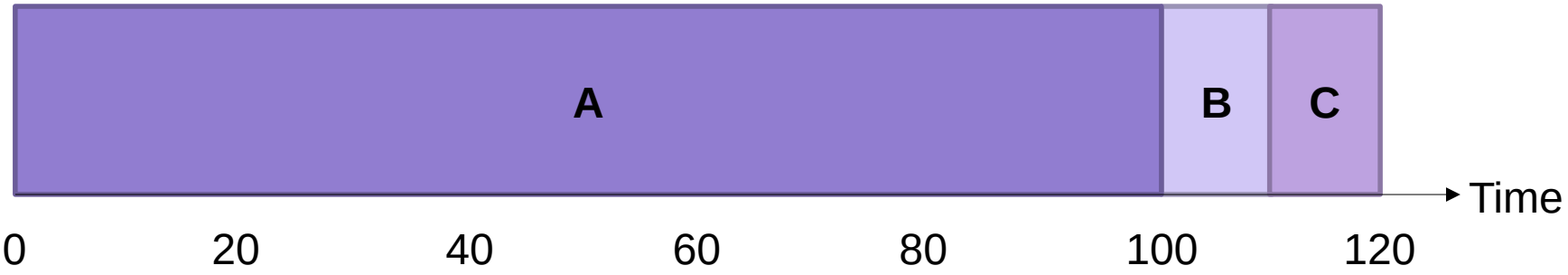

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Shortest Time-to-Completion First (STCF)

- The job with the shortest time-to-completion is scheduled next
- If a job arrives with a shorter time-to-completion then the current job, it preempts the current job
- Example:
  - Job A arrives at time 0, takes time 100 to complete
  - Job B arrives at time 5, takes time 10 to complete
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- Average Latency = $\frac{120+10+15}{3} = 48.3$
- Average Response = $\frac{0+0+5}{3} = 1.6$
- Throughput = $\frac{3}{120} = .025$

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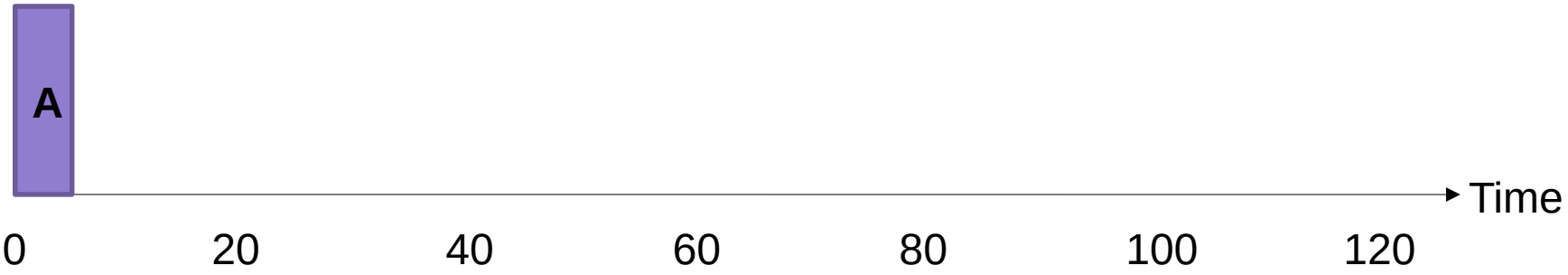

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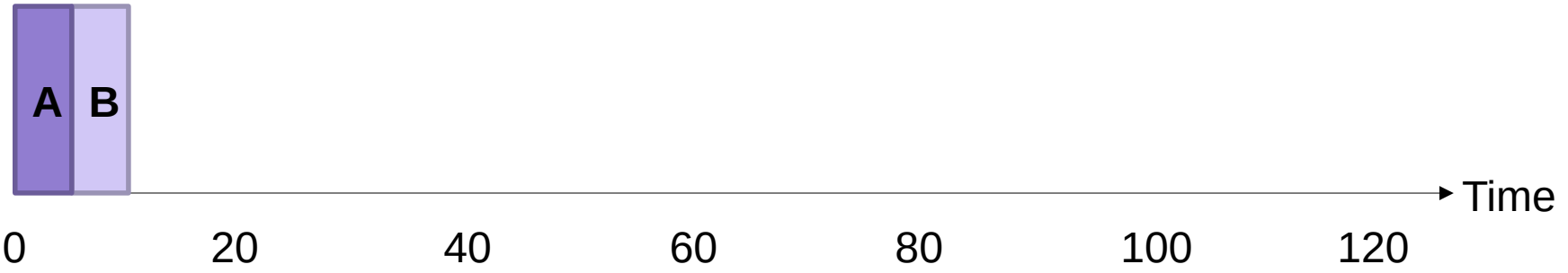

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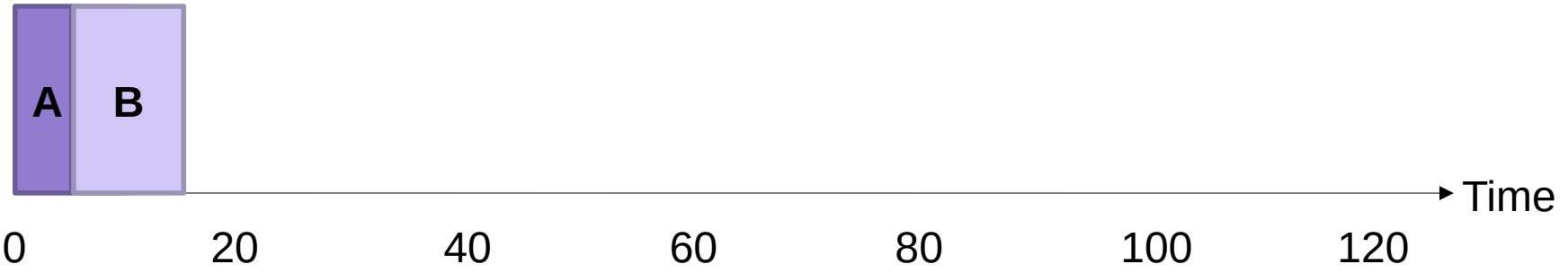

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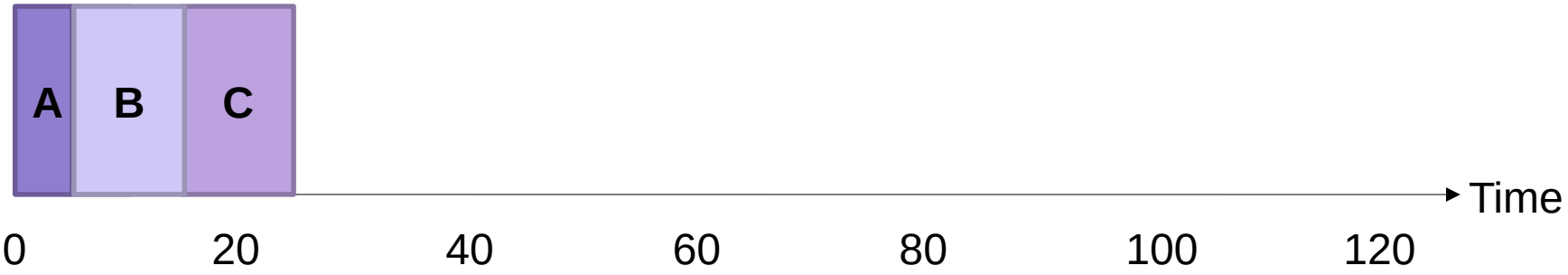

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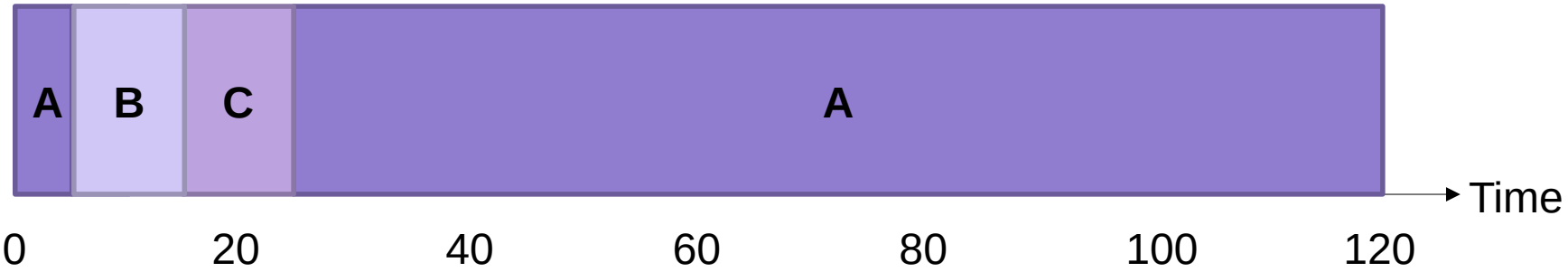

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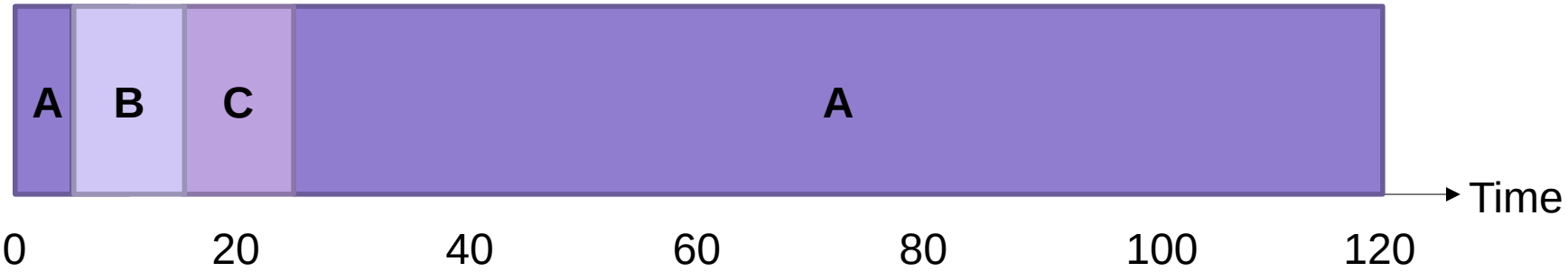

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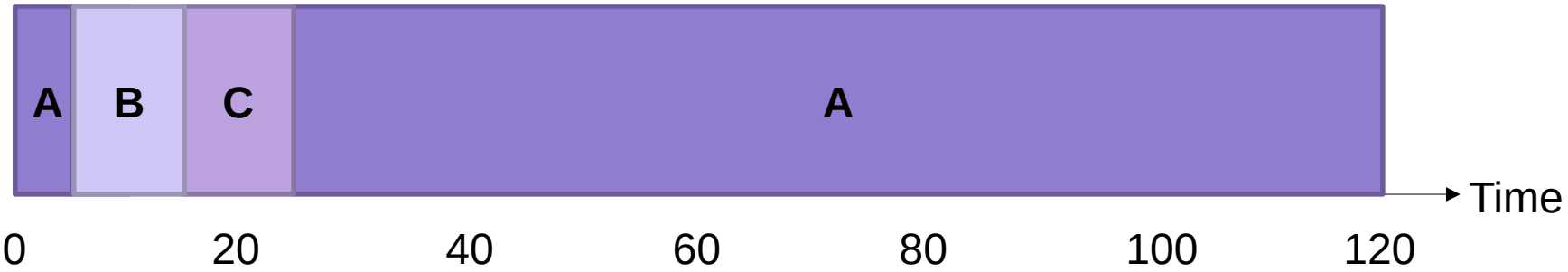

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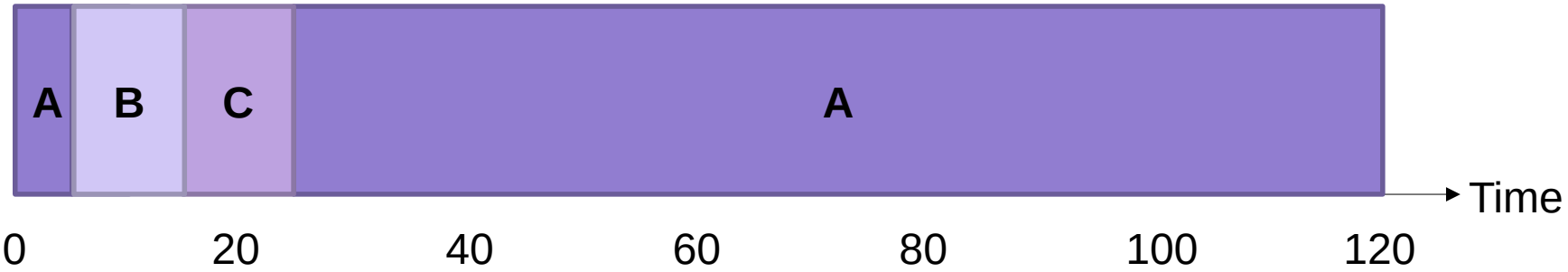

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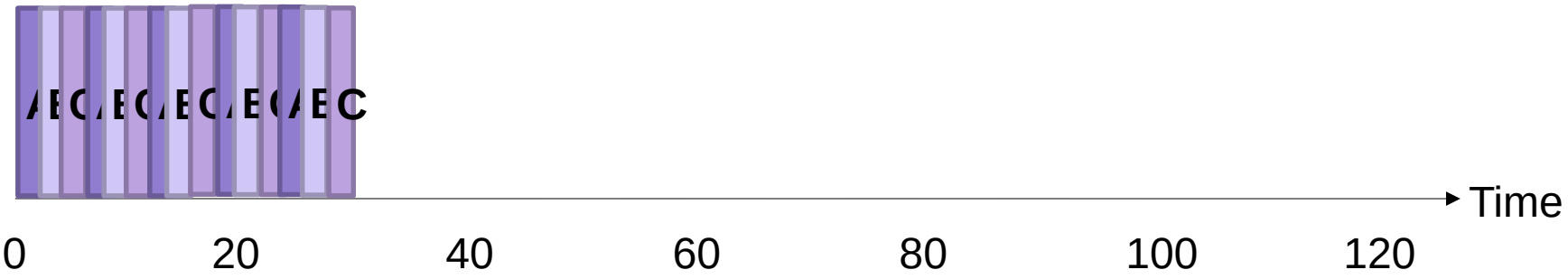

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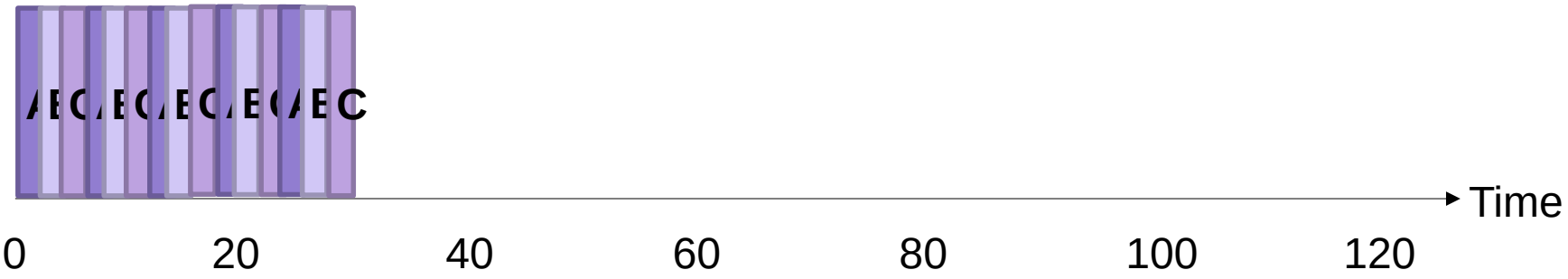

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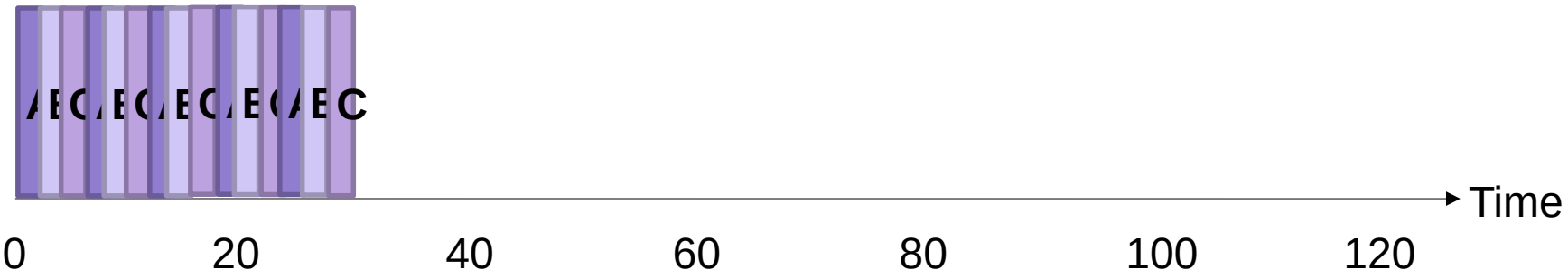

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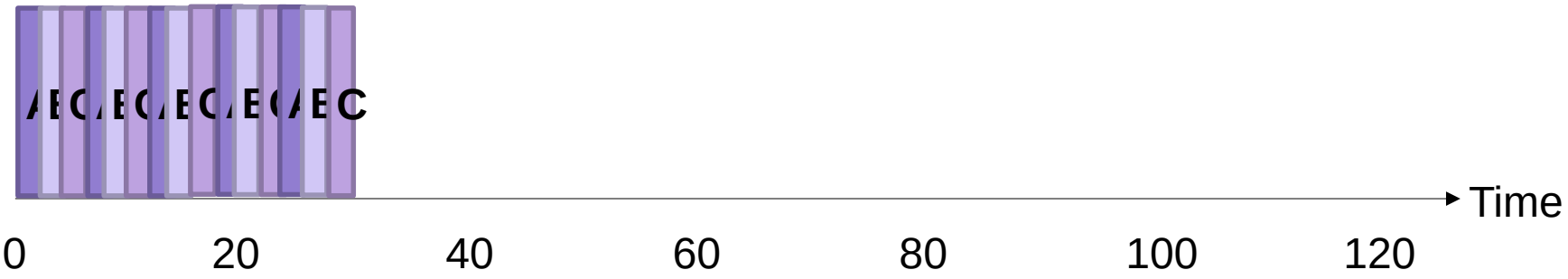

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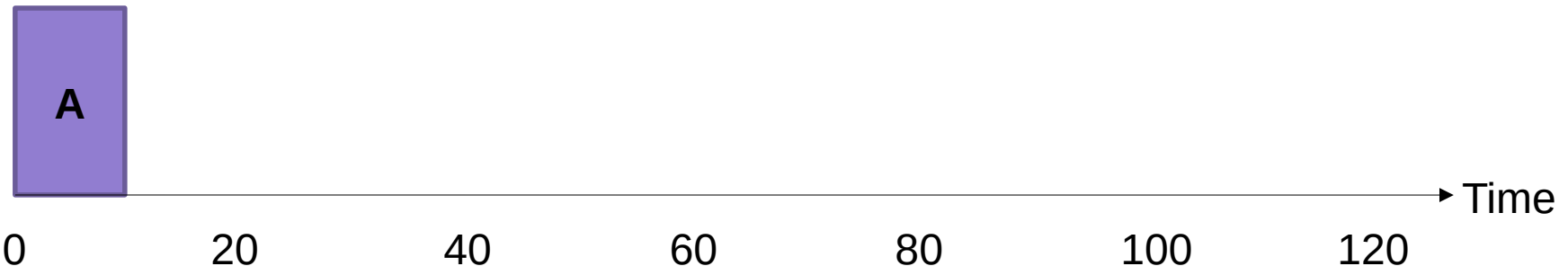

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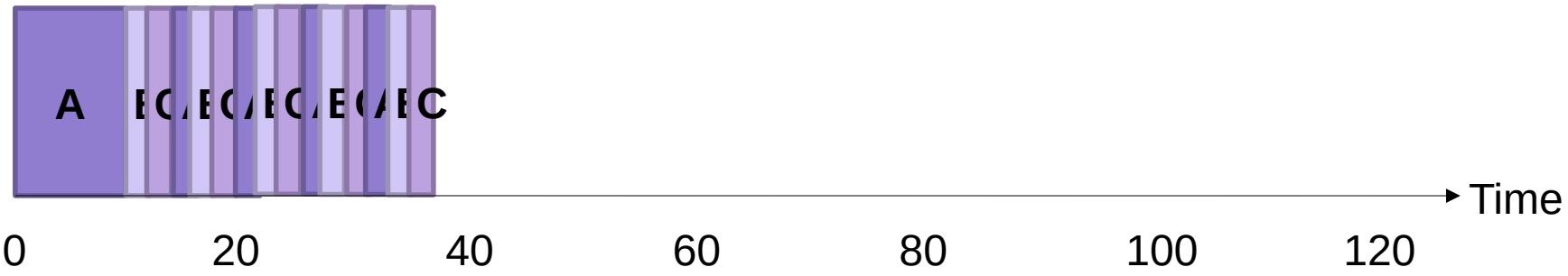

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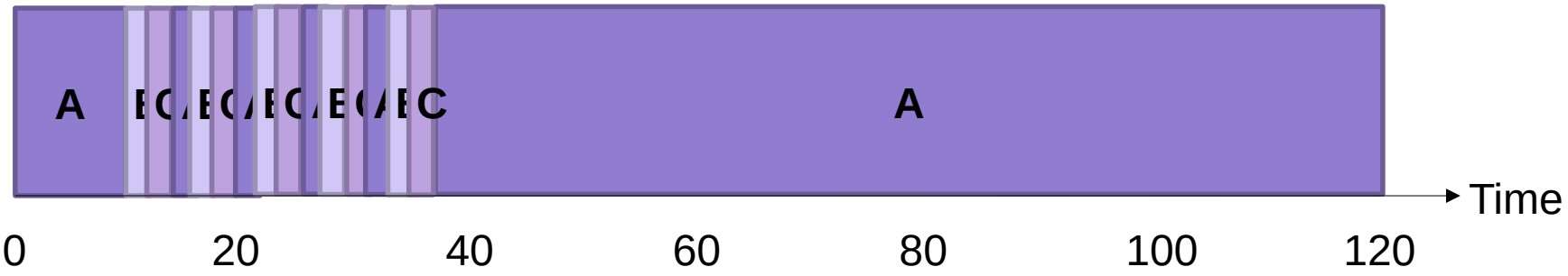

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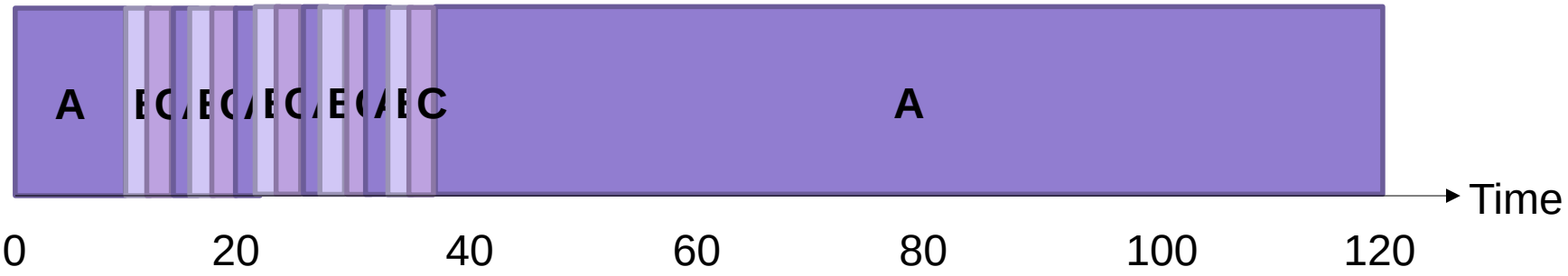

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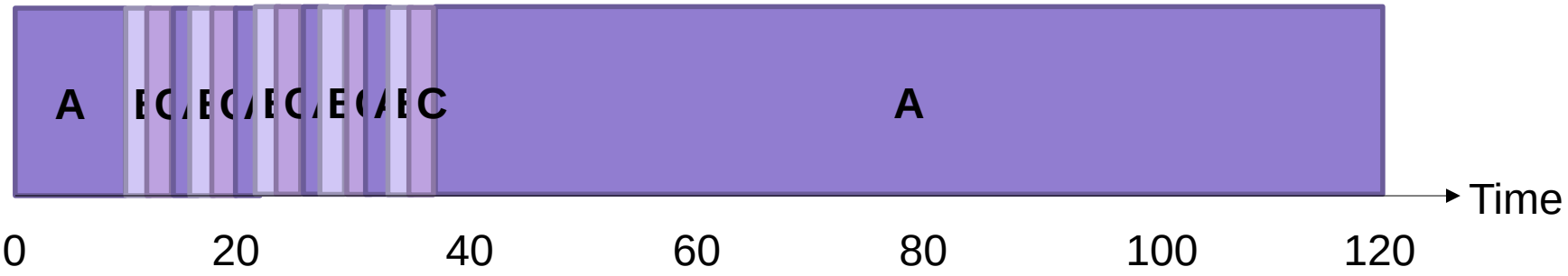

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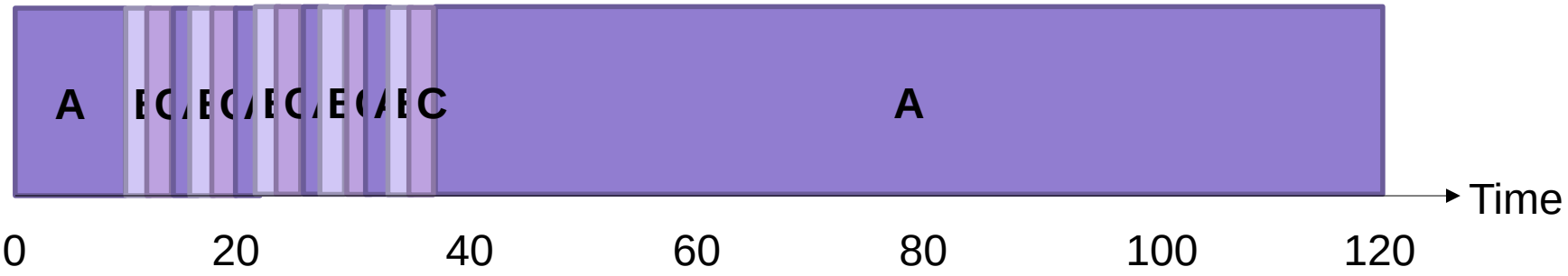

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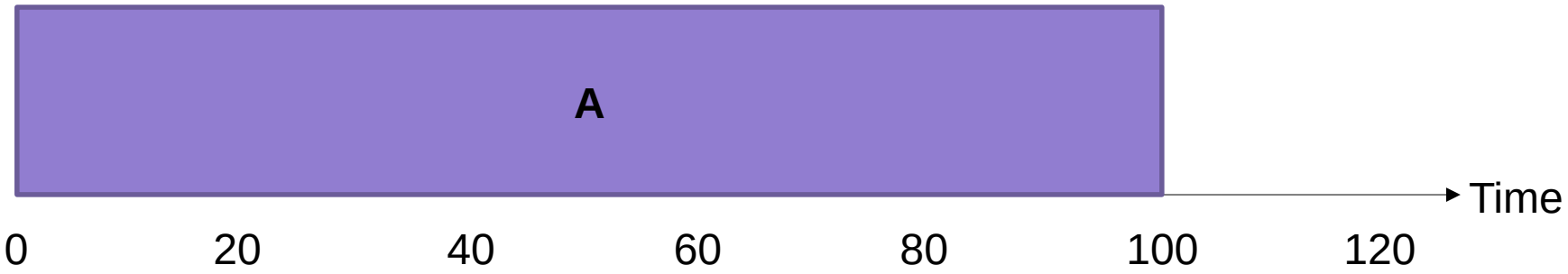
Processes are not all the same

- CPU-bound processes use a lot of CPU
  - e.g., compiling, scientific computing applications, mp3 encoding



- I/O-bound processes use CPU in short bursts
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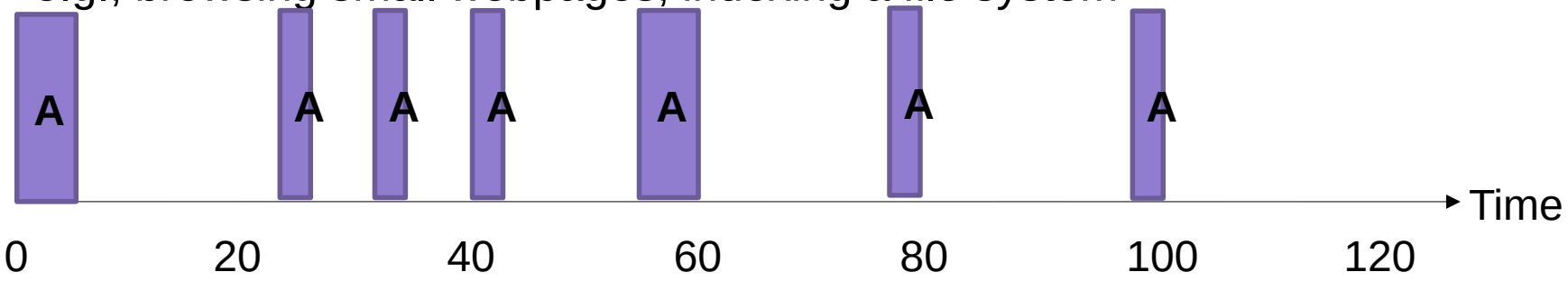

- Balanced processes are somewhere in between
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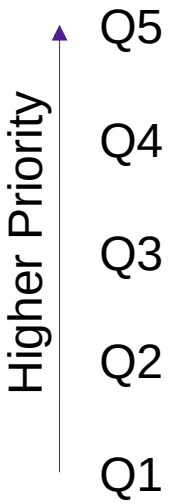

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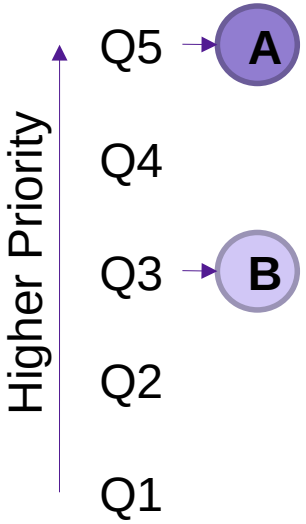

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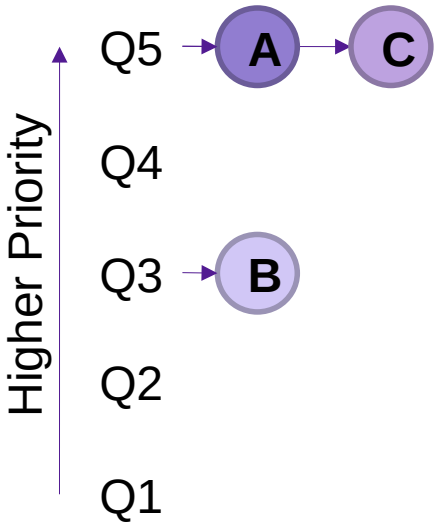

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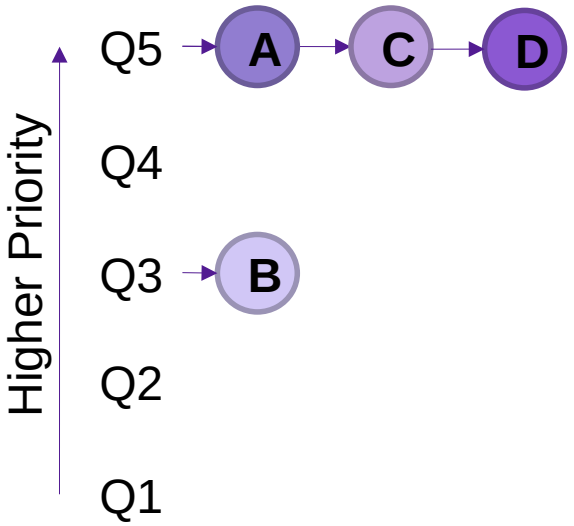

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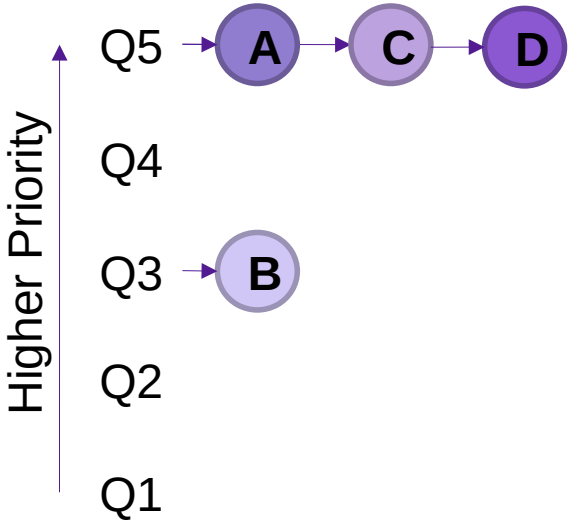

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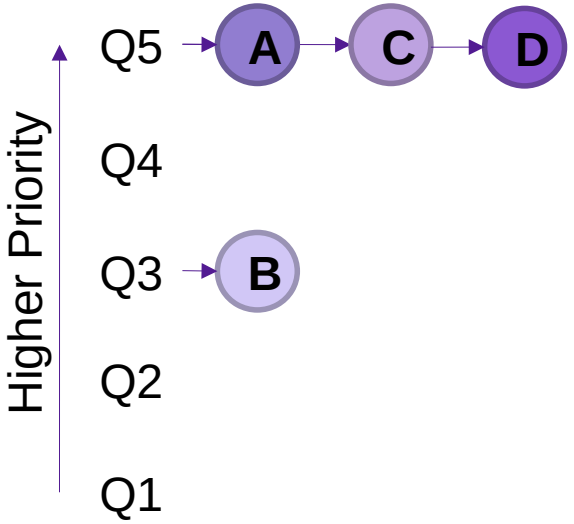
5) After some time period, move all jobs in the system to the highest priority queue



Example: Multi-level Feedback Queue

- Multilevel feedback queue with four levels with a time slice of 10 in the highest priority queue, 20 in the next, 40 in the next, and 80 in the lowest priority queue. Priorities reset every 200ms.
- Example:
  - Job A arrives first at time 0 and uses the CPU for 50ms before finishing.
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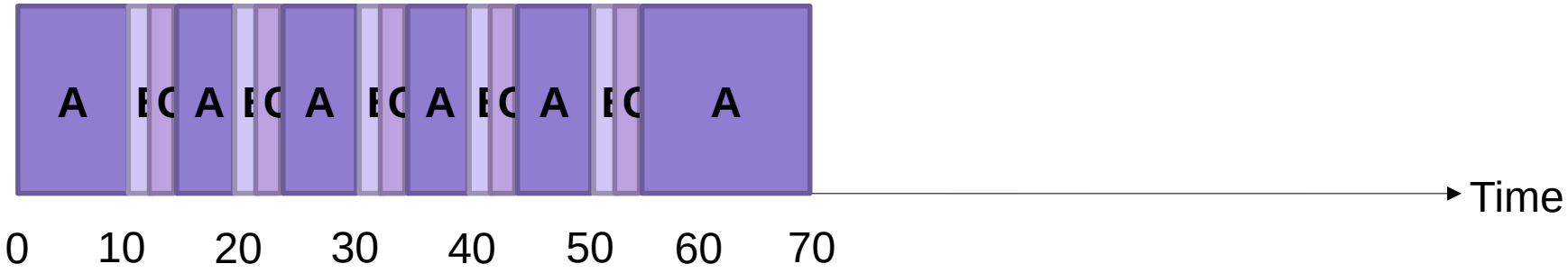

Schedulers in Operating Systems

- **CPU Scheduler** selects next process to run from the runnable pool
- **Page Replacement Scheduler** selects page to evict
- **Disk Scheduler** selects next read/write operation to perform
- **Network Scheduler** selects next packet to send/process