Process

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and Mainack Mondal (even section)
CS39002

Spring 2019-20

Today's class

- What is a process?
- Structure of a process
- Process states
- Process control block
- Context switch

What is a process?

- A process is a program in execution
  - Recall multitasking
  - Several processes may be in various stages of execution at same time

What is a process?

- A process is a program in execution
  - Recall multitasking
  - Several processes may be in various stages of execution at same time
- CPU switches between several processes
  - We say that processes are executing concurrently
  - CPU multiplexed

Job scheduling and process scheduling

- Job scheduling
  - In batch processing or multiprogramming user programs are called jobs
  - Long term scheduler

- Process scheduling
  - Short term scheduler

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Check the board

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What are parts of a process?

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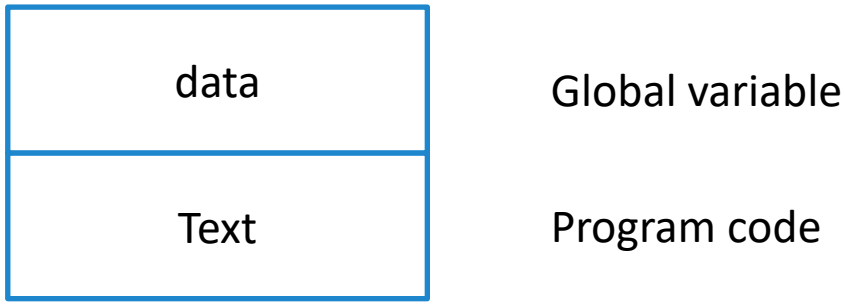

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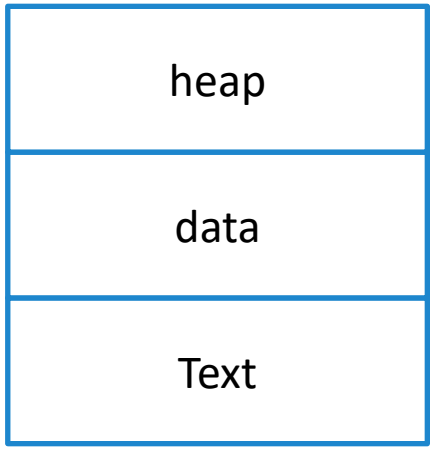

Dynamically allocated memory

Global variable

Program code

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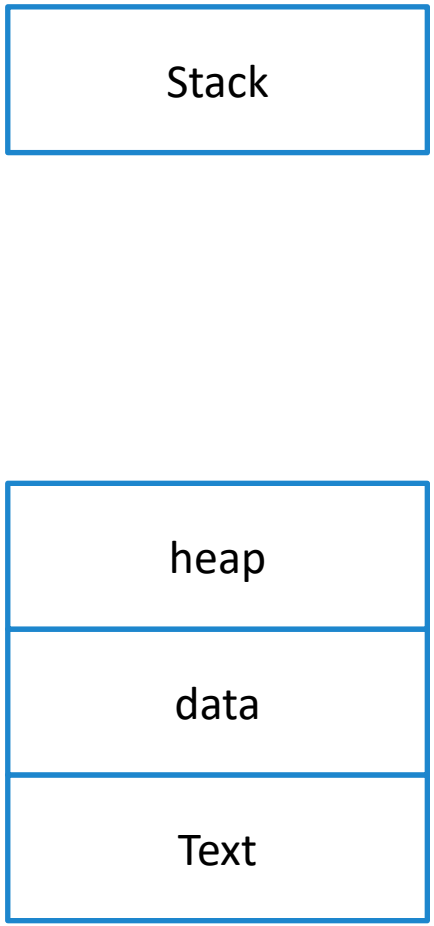

Temporary data,
function parameters,
local variables, return addresses

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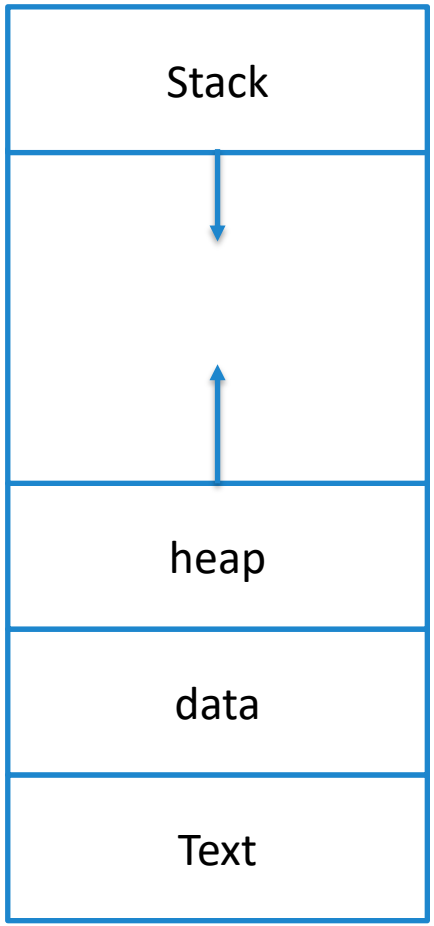

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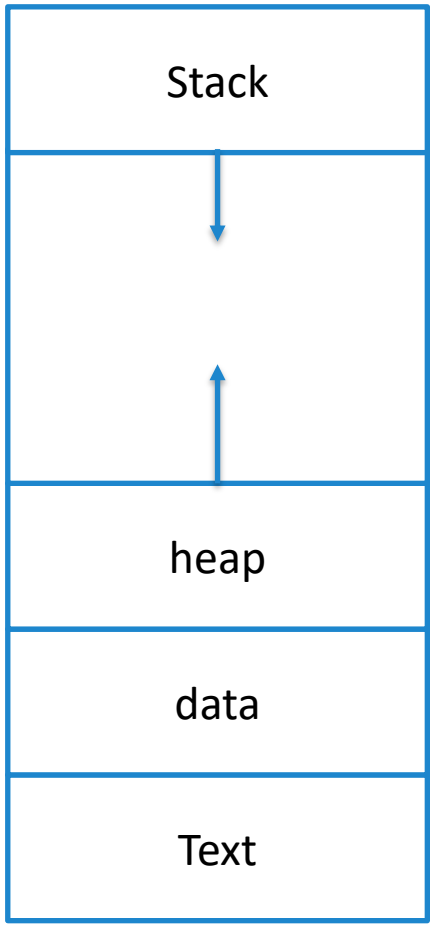

Temporary data,
function parameters,
local variables, return addresses

Also
Program
counter (PC),
CPU registers,
open files

Dynamically allocated memory

Global variable

Program code

Characteristics of a process

- Program is a passive entity
- Process is an active entity
  - Program becomes process when the code is loaded in the memory and ready to execute
- Each execution instance of the same program is a separate process

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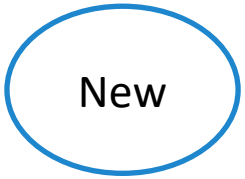
You can think process execution as an automata

- States
  - **new:** The process is being created
  - **running:** Instructions are being executed
  - **waiting:** The process is waiting for some event to occur
  - **ready:** The process is waiting to be assigned to a processor
  - **terminated:** The process has finished execution

- Additionally there is “swap space”
  - Resides in the disk
  - Swap-out and swap-in between main memory and disk

Process state diagram



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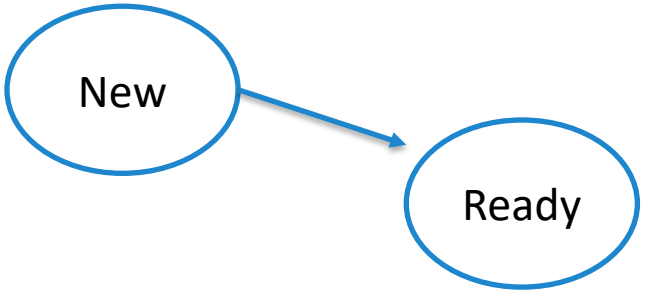

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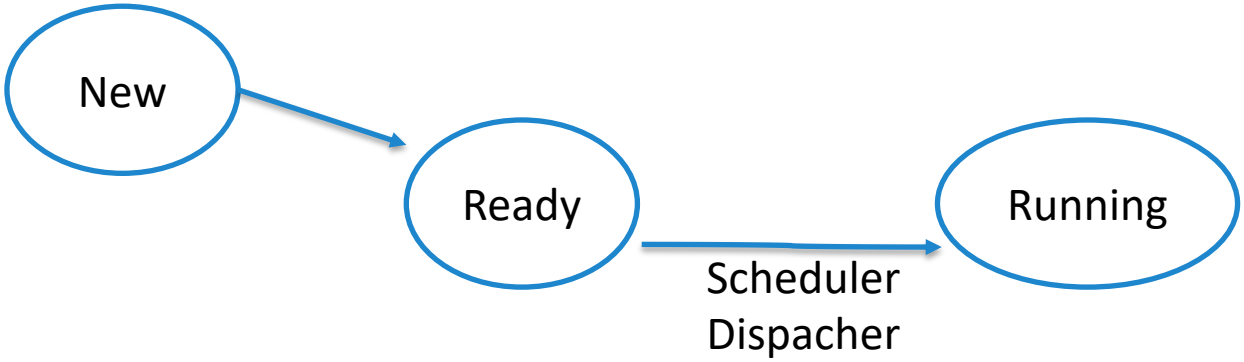

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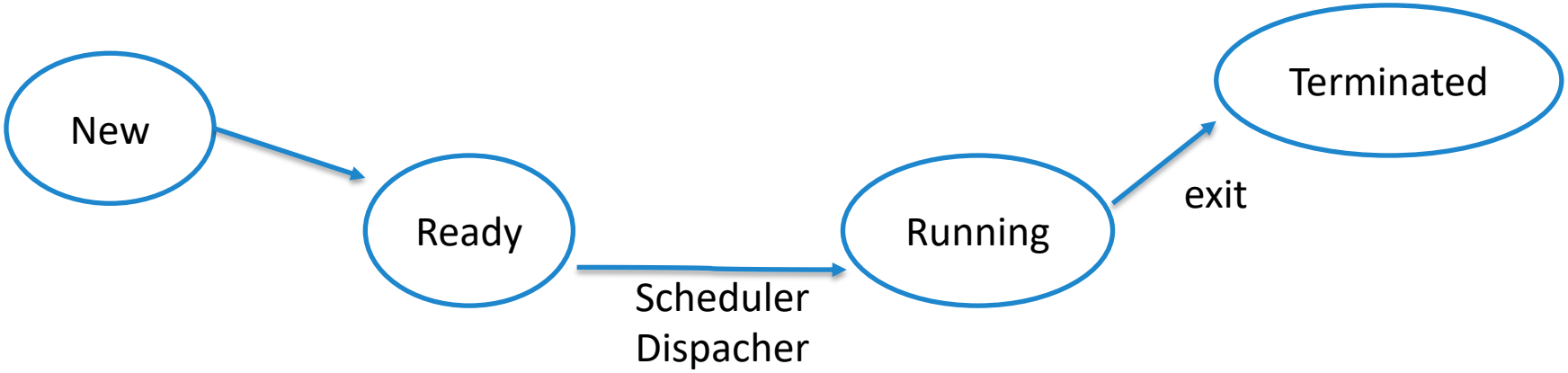

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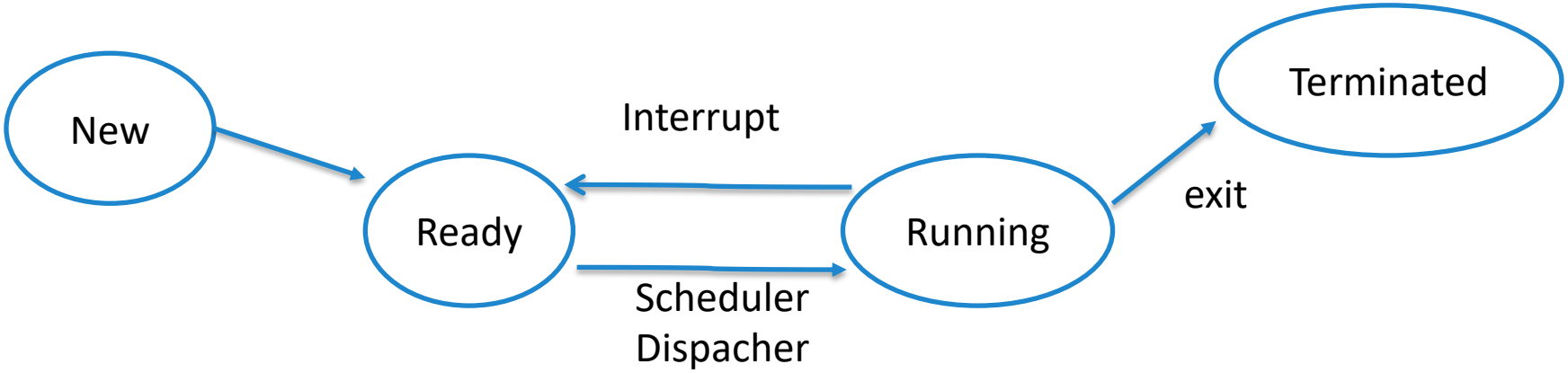

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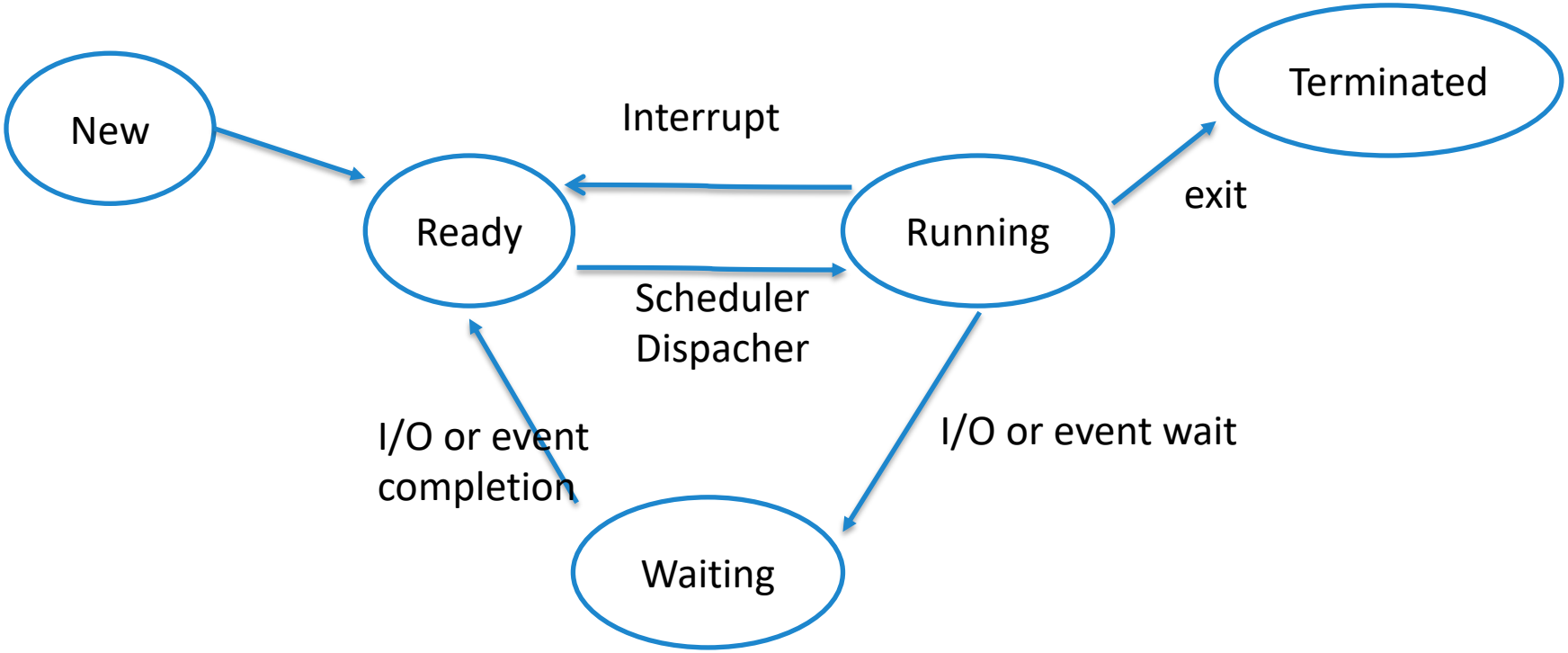

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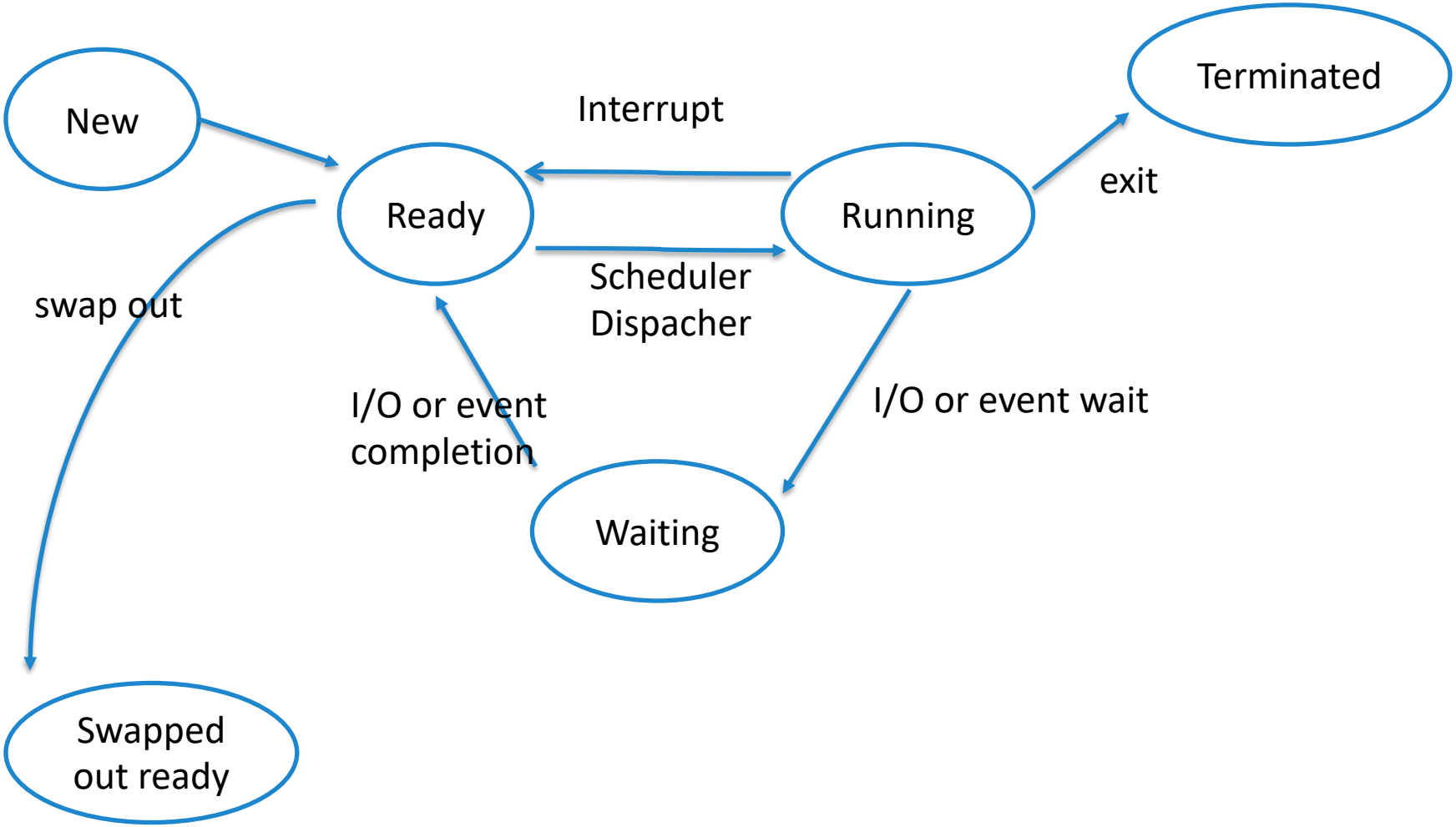

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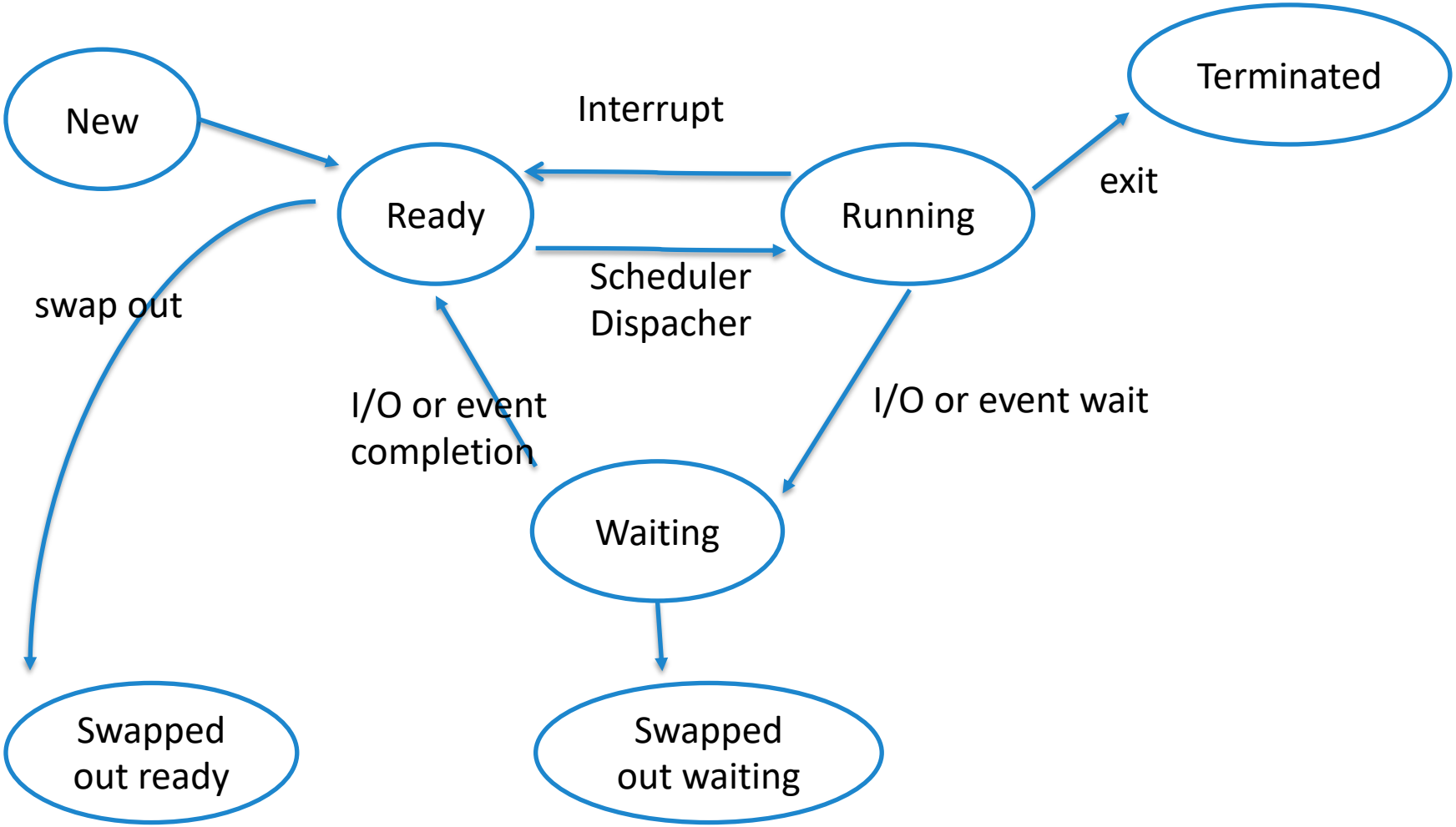

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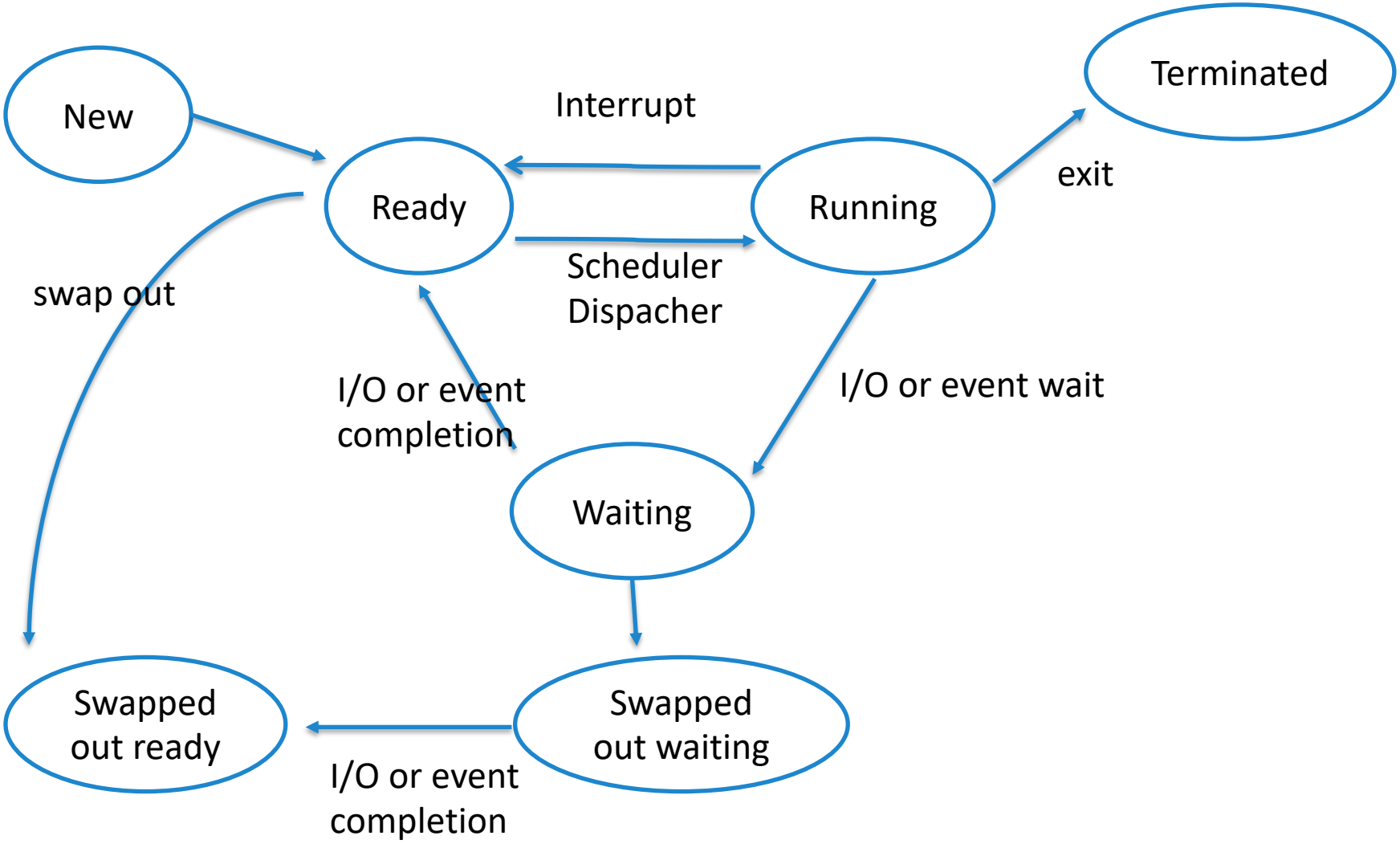

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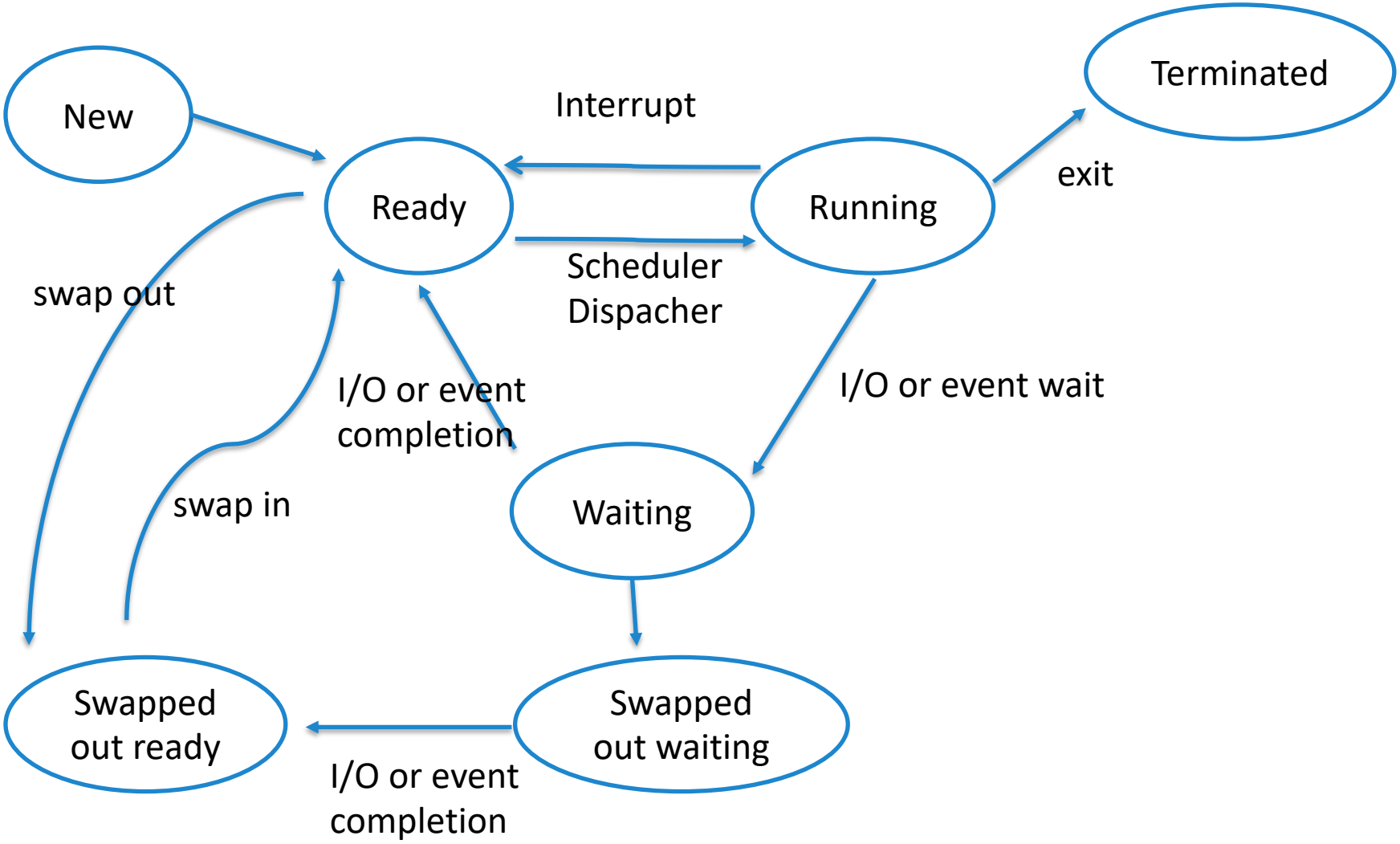

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Process control block (PCB)

- Each process is represented in the kernel as a PCB
  - Also called task control block
  - Contains many pieces of information associated with a specific process

Structure of a PCB

- Process state – running, waiting, etc
- Program counter (PC) – location of instruction to next execute
- Content of CPU registers
- CPU scheduling information- priorities, scheduling queue pointers
- Memory-management information –Base and limit registers, page tables
- Accounting information – CPU used, clock time elapsed since start, time limits, pid
- I/O status information – I/O devices, allocated to process, list of open files

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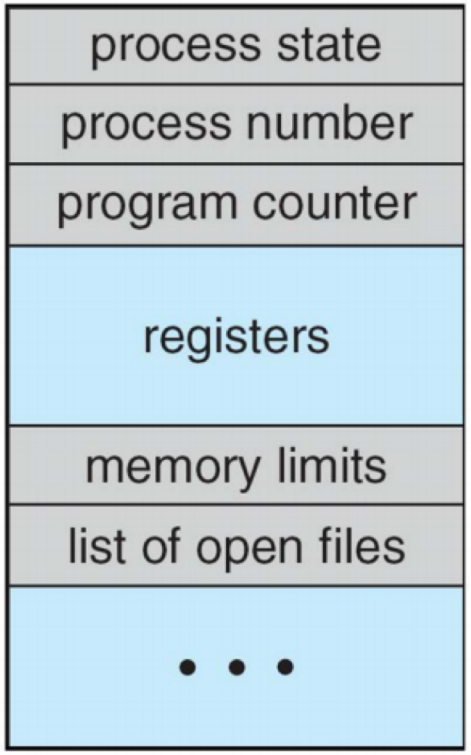

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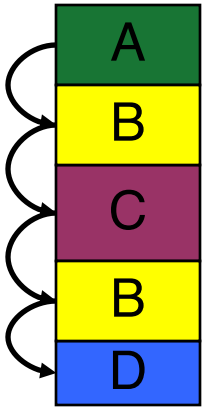
CPU runs multiple processes

CPU's point of view



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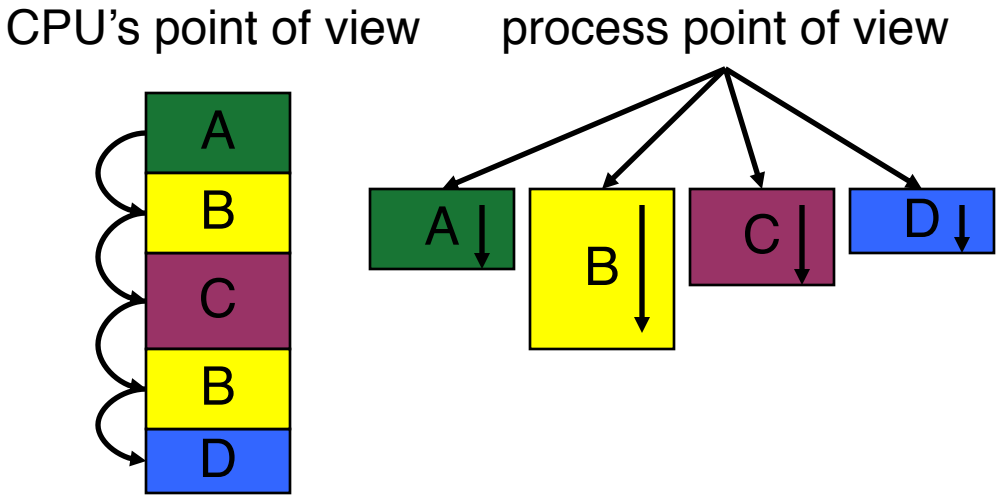

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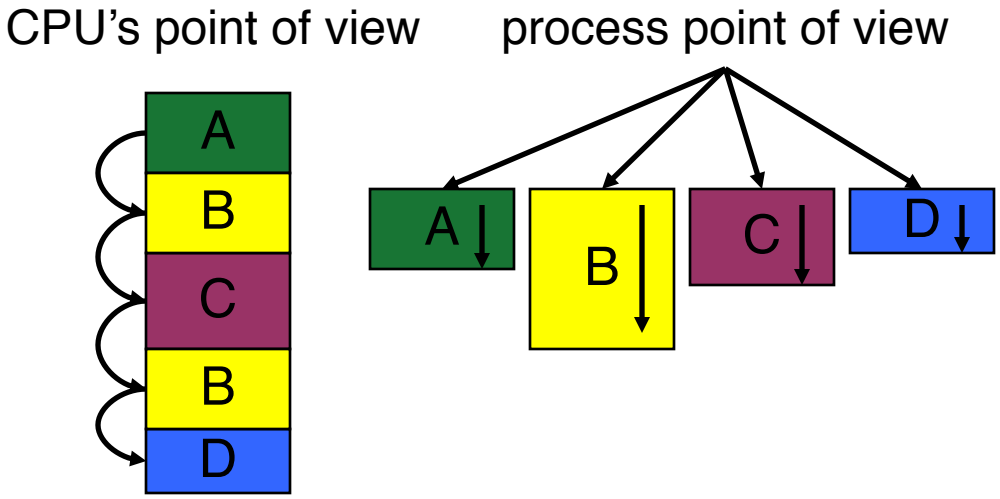

- Multiprogramming of four programs
- Conceptual model
  - 4 independent processes
  - Processes run sequentially
- Only one program active at any instant!
  - That instant can be very short…

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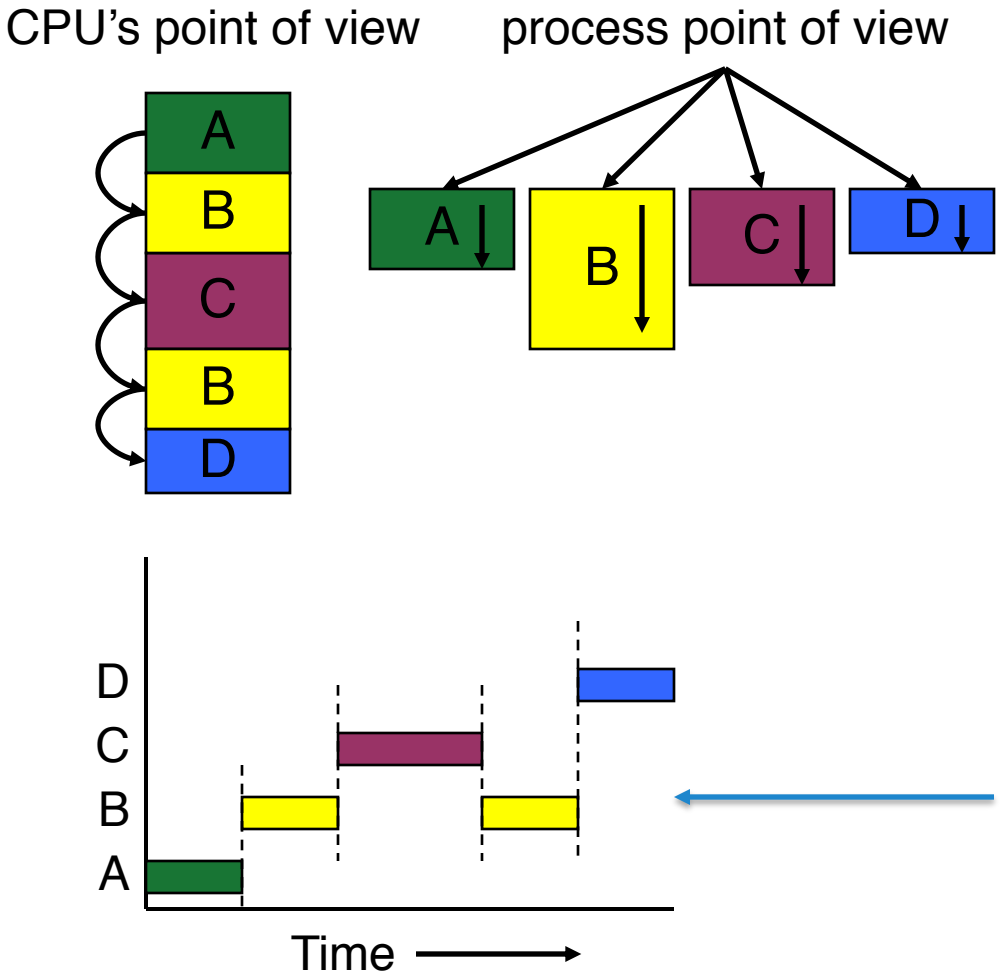

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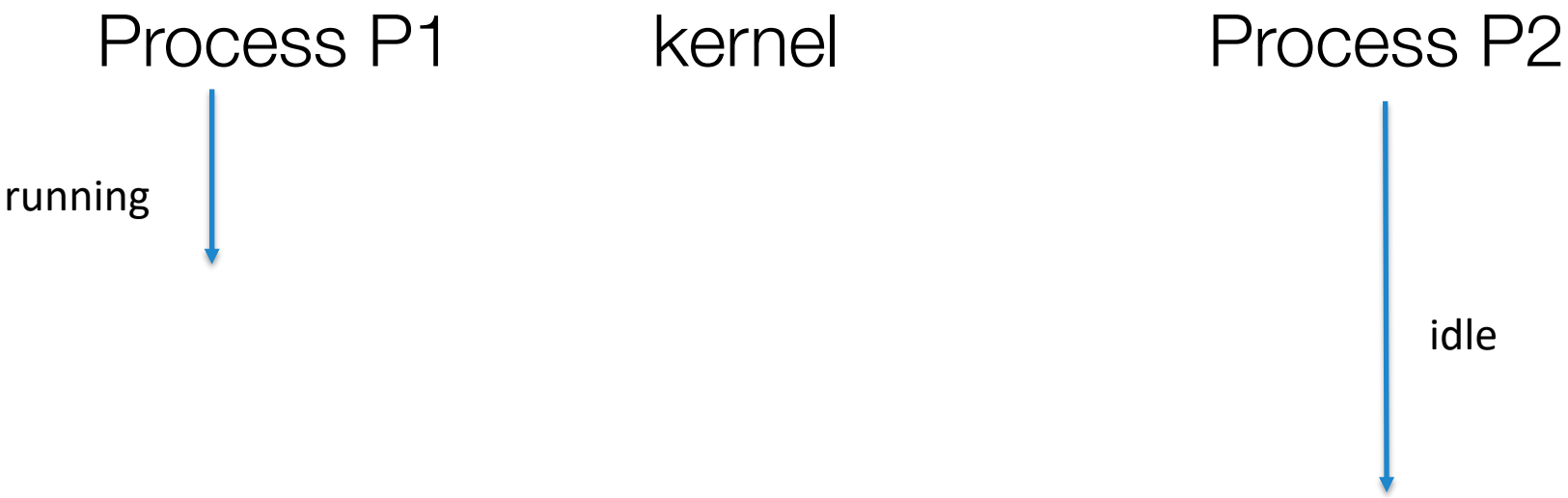
Gantt chart for multiprogramming

How to interleave processes?

- CPU switches to another process
  - the system saves the state of the old process and load the saved state for the new process via a context switch
  - Context of a process == PCB
  - More complex the OS and PCB, longer to switch

Context switch



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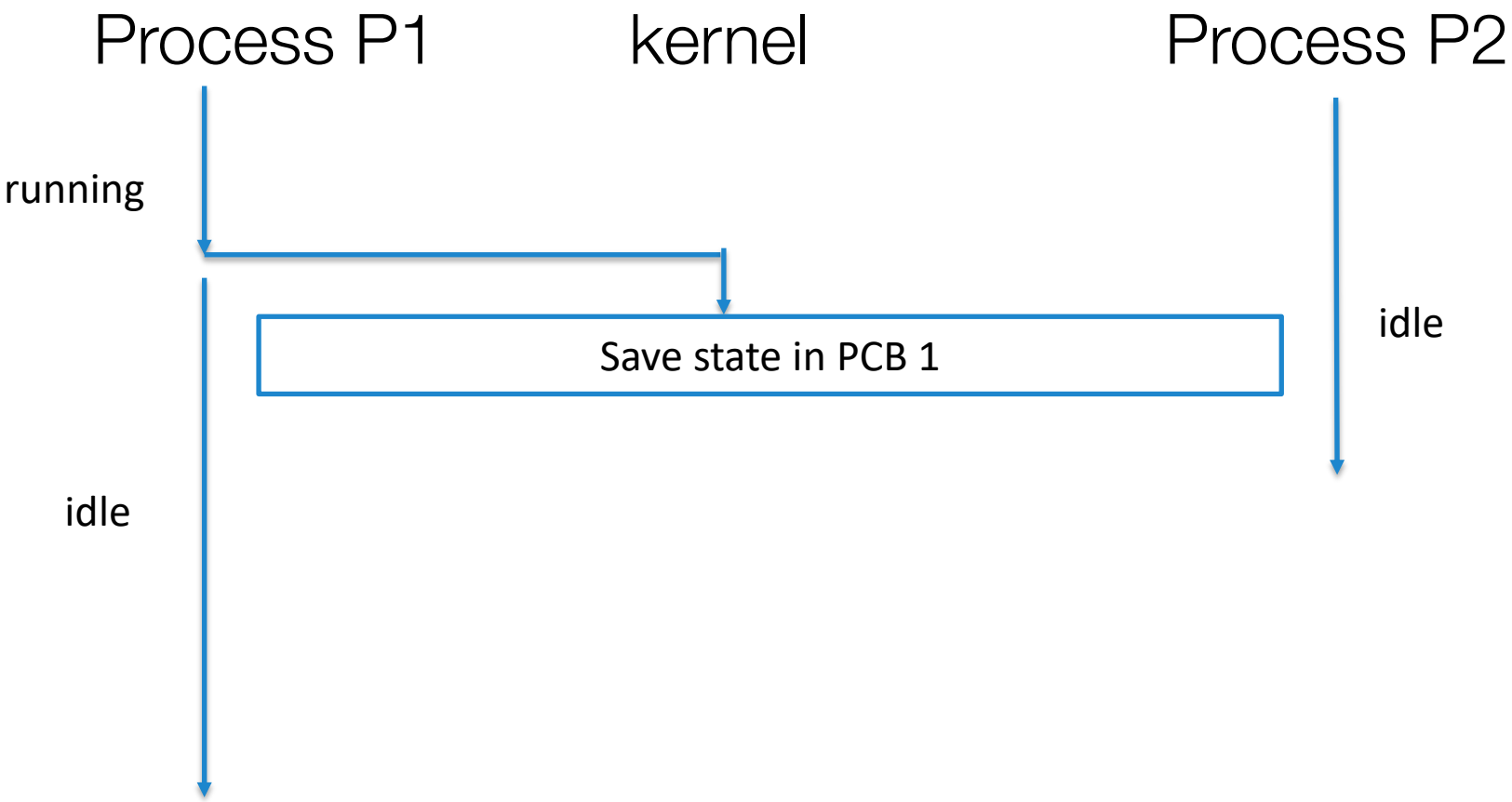

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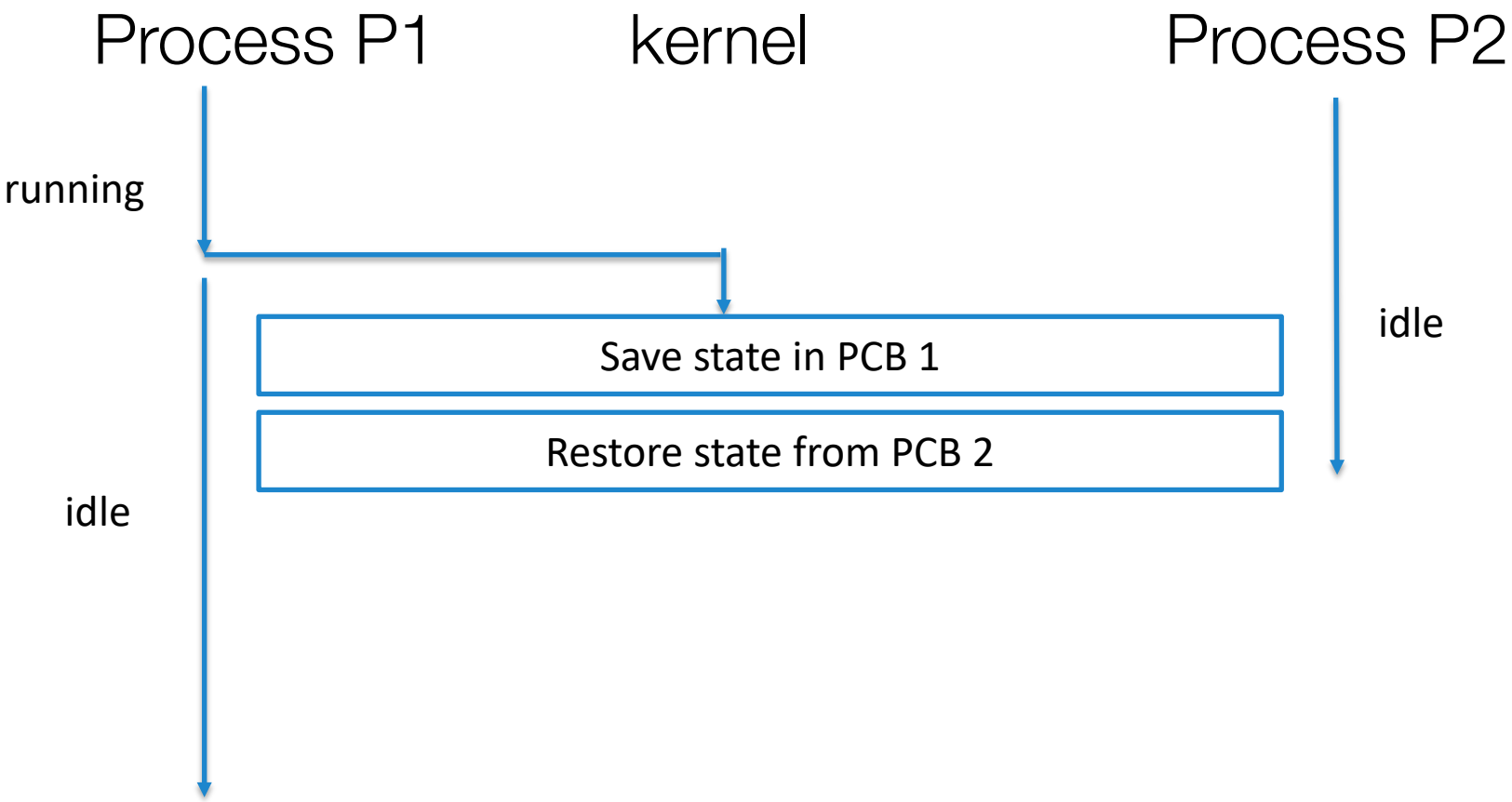

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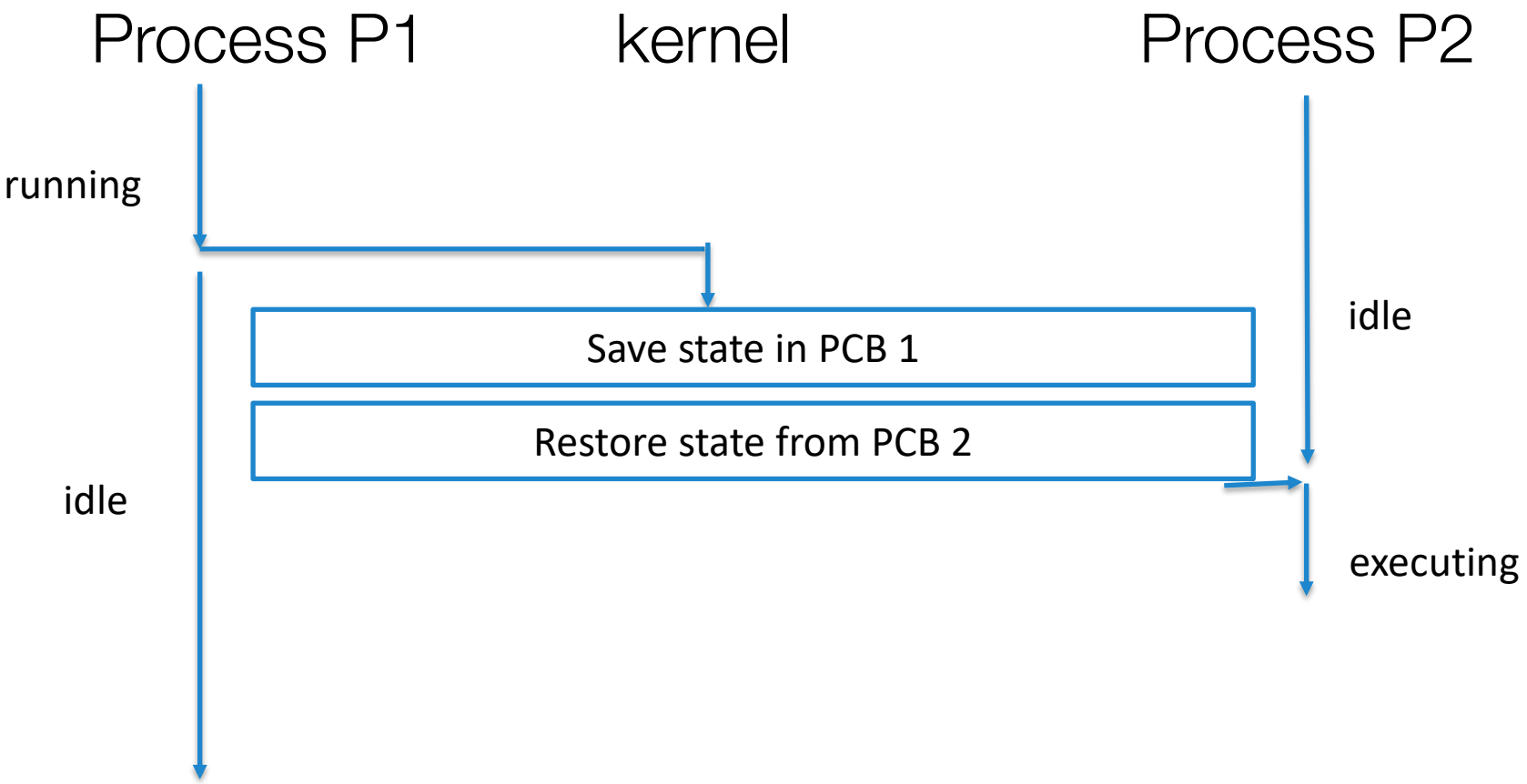

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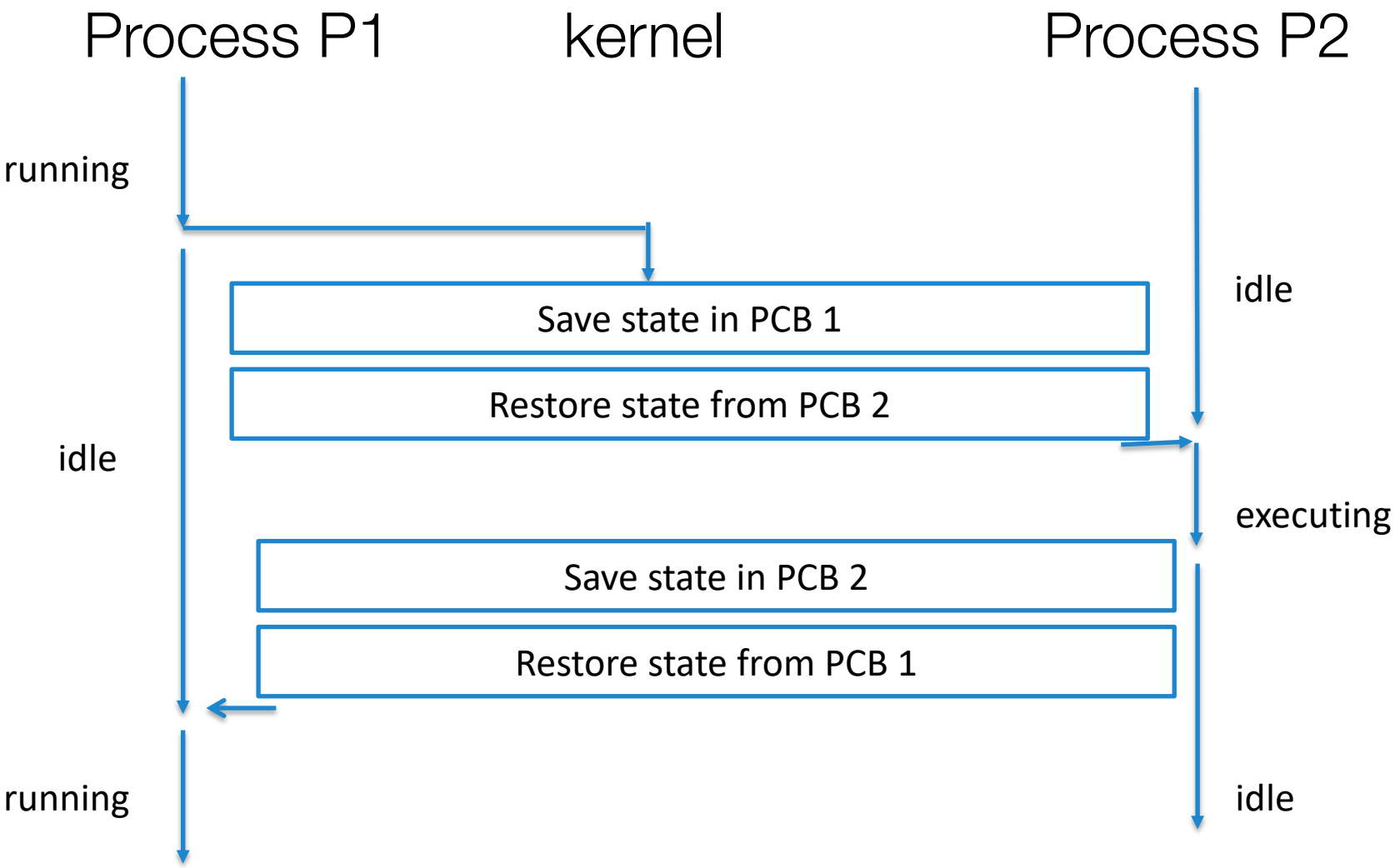

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Process scheduling and operations

- We will look at process scheduling the next day
- Today let’s look at an operation

pipes()

- Acts as a medium to allow two processes to communicate
  - Communication can be uni/bi directional
  - Must there exist a relationship (i.e., parent-child) between the communicating processes?
  - Can the pipes be used over a network?

Ordinary pipes

- A message passing medium between related processes
  - Cannot be accessed from outside the process
  - Typically, a parent process creates a pipe and uses it to communicate with its child process
  - Pipes behave like FIFO queues
  - Read-write in pipe == producer-consumer
  - Producer writes to one end (the write-end of pipe)
  - Consumer reads from the other end (the read-end of pipe)
  - Unidirectional

Producer consumer in pipes

Producer

```
message next_produced;
while(TRUE){
        <produce and put data in next produced>
        ...
        send( next_produced);
}
```

Consumer

```
message next_consumed;
while(TRUE){
        receive(next_consumed);
        …
        <data in next consumed>
}
```

Named pipes

- Accessed as files by processes
  - No parent child relation is necessary
  - Still behave like FIFO queues (even called fifo)
  - Several processes can use the named pipe

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```
char myfifo = '/tmp/myfifo';
mkfifo (myfifo, 0666); // creates the fifo or named pipe
…
fd = open(myfifo, O_WRONLY);  // Process A
write(fd, …);                 // Process A
close(fd);                    // Process A
…
fd = open(myfifo, O_RDONLY);  // Process B
read(fd, …);                  // Process B
close(fd);                    // Process B
```