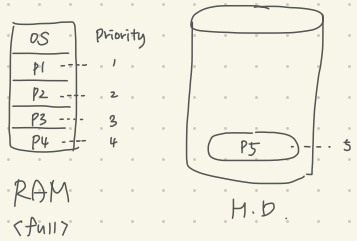
Types of scheduler, Context switching

every process has a process control block & attributes

= Context of a process

1. which & how many processors in hard disk should be moved into the RAM? by **Long term scheduler**
2. which processor in RAM should access the CPU first? by **Short term scheduler** (= scheduler)
3. which & how many processors in RAM should be moved back into the H.D? by **Medium term scheduler**



: P5가 priority가 높아 RAM에 들어가면 먼저 실행되겠지만 RAM에 남은 공간이 없는 상황.

⇒ 기존의 RAM에 있던 process 中

low priority를 가진 process를 H.D에 옮기고

H.D에 있는 higher priority process를 RAM에 옮김

swapping
- swap-out
- swap-in

- **Context switching**

CPU에서 실행되던 process보다 높은 priority의 process가 RAM에 있을 때

CPU에서 처리되던 process의 context를 보관한 후 higher priority process를 실행하는 것

(2 두 해당 작업이 끝나면 이전 process를 실행하던 지점 (context 정보를 가지고) 부터 다시 실행하도록)

Context switching

: 멀티프로세스 환경에서 CPU가 어떤하나의 프로세스를 실행하고 있는 상태에서 인터럽트 (interrupt) 요청에 의해 다음 우선순위의 프로세스가 실행되어야 할 때, 기존 프로세스의 상태 혹은 레지스터값 (context)을 저장하고 CPU가 다음 프로세스를 실행하도록 새로운 프로세스의 상태 혹은 context를 교체하는 작업

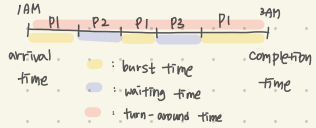
Various times of a process

1. **Arrival time** : time when process has arrived RAM
2. **Burst time** (= execution time) :
3. **Completion time** : time when process has completed execution & can be removed from RAM
4. **Turn-around time** : time between arrival time to completion time
5. **Waiting time** : waiting time for execution or I/O (process is idle at this moment)
   - ① completion time - arrival time
   - ② burst time + waiting time + I/O time
6. **Response time** : 서로의 다른 값
7. **I/O time** : amount of time spent in reading & writing I/O

(cf)

- **point in time**
  arrival time, completion time
- **duration in time**
  burst time, turn-around time, waiting time, response time

ex) Various times for process 1



Types of scheduling algorithms

목적 : CPU의 efficiency를 높이기 위함

CPU scheduling algorithms

- **Preemtive scheduling algorithms** : preempt the process
- **Non-preemtive scheduling algorithms** : CPU에서 process를 execute하는 중일 때, RAM의 higher priority process가 방해로 execution을 멈추지 않는 방식

· CPU scheduling algorithms are applied only to processes which are in ready state.
Process which are in I/O state will be "blocked" and will not be considered by scheduling algorithms
I/O state = block state

: P1 - running state / P2, P3 - ready state / P4 - I/O state 일 경우
P4의 priority가 P2, P3보다 높다라도 P1 방해이 끝난 뒤 P2, P3 중에 priority가 높은 process가 실행된다.

SJF scheduling algorithm

Shortest Job First scheduling algorithm

is optimal in terms of average waiting time among SJF, SRTF, FCFS

: Among the arrived process, process with the least burst time will be given preference (higher priority)

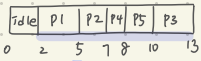
non-preemptive scheduling & priority based algorithm

ex1)

process Id	1	2	3	4	5
arrival time	②	3	4	6	8
burst time	3	2	3	1	2

Q) Find the average TAT, WT, Throughput and schedule length

S)



이 시간이전에 arrive 한 process들 中 burst time이 짧은 것이 먼저 실행됨

A).

CT	5	7	13	8	10
TAT (CT-AT)	3	4	9	2	2
WT (TAT-BT)	0	2	6	1	0

→ avg = 4

└ in this case we don't assume I/O time

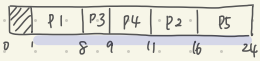
- Schedule length = CT of last process - AT of first process = 11
- Throughput : number of processes executed in unit time = Number of processes / schedule length
  = 5/11 = Processes / unit time

ex2)

process Id	1	2	3	4	5
arrival time	1	2	3	4	5
burst time	7	5	1	2	8

Q) Find the average TAT, WT, Throughput and schedule length

S)



CT	8	16	9	11	24
TAT (CT-AT)	7	14	6	7	19
WT (TAT-BT)	0	9	5	5	11

→ avg = 10.6

- Scheduling length = 23
- Throughput = 5/23

SRTF Scheduling algorithm

SJF & SRTF may cause Starvation when the long process is in ready state and shorter processes keeps coming

Shortest Remaining time first scheduling algorithm : preemptive version of SJF

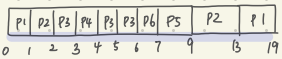
: 이미 process가 실행 중이더라도 제출된 (RAM에 있는) process의 실행에 필요한 총 시간이 현재 process 에서 남은 시간보다 짧다면, 현재 실행 중단, 모든 process가 ready queue에 있다면 SJF와 같은 방식으로 실행

ex1)

process Id	1	2	3	4	5	6
arrival time	0	1	2	3	4	5
burst time	~~7~~ 6 0	~~8~~ ~~4~~ 3 0	~~3~~ ~~2~~ 1 0	~~6~~ ~~3~~ ~~0~~ 0	~~2~~ 0	~~1~~ 0

Q) Find the average TAT, WT, Throughput and schedule length (같은 시간이 겹쳐도 먼저 arrive한 것이 실행됨)

S)



A)

CT	19	13	6	4	9	7
TAT (CT-AT)	19	12	4	1	5	2
WT (TAT-BT)	12	7	1	0	3	1

← last completed process의 CT 계산하는 값이 같다.

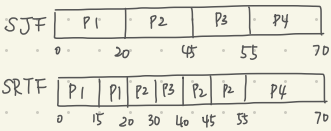
→ avg = 43/6

└ in this case we don't assume I/O time

- Schedule length = CT of last process − AT of first process = 19
- Throughput : number of processes executed in unit time = Number of processes / schedule length = 6/19 = Processes / unit time

*** Response time** : waiting time of certain process until it gets to the CPU for the first time

process Id	1	2	3	4
arrival time	0	15	30	45
burst time	20	25	10	15



SJF RT	0	5	15	10
SRTF RT	0	5	0	10

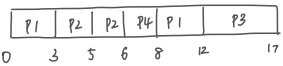
⇨ In any non-preemptive scheduling algorithm, Response time = waiting time, but it may not be true in preemptive scheduling algorithm.

ex2)

Problem :

Consider the following CPU processes with arrival times (in milliseconds) and length of CPU bursts (in milliseconds) as given below:

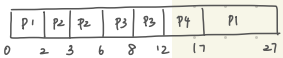
Process	Arrival Time	Burst Time	CT	TAT	WT	RT
P1	0	~~7~~ ~~4~~ 0	12	12	5	0
P2	3	~~3~~ ~~1~~ 0	6	3	0	0
P3	5	~~5~~ 0	17	12	7	7
P4	6	~~2~~ 0	8	2	0	0



If the pre-emptive shortest remaining time first scheduling algorithm is used to schedule the processes, then the average waiting time across all processes is __3__ milliseconds.

An operating system uses shortest remaining time first scheduling algorithm for pre-emptive scheduling of processes. Consider the following set of processes with their arrival times and CPU burst times (in milliseconds):

Process	Arrival Time	Burst Time	CT	TAT	WT	RT
P1	0	~~12~~ ~~8~~ 0	27	27	15	0
P2	2	~~4~~ ~~3~~ 0	6	4	0	0
P3	3	~~6~~ ~~4~~ 0	12	9	3	3
P4	8	~~5~~ 0	17	9	4	4



The average waiting time (in milliseconds) of the processes is __5.5__.

FCFS scheduling algorithm

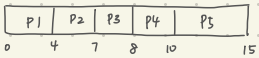
First Come First Served Scheduling Algorithm : Cause long waiting times, especially when the first job takes too much CPU time.

The process which has the least arrival time will be scheduled first

non-preemptive # not priority based (not depending on a property of a process ex. burst time)

priority based algorithm의 단점은 나중에 알아보기

process Id	1	2	3	4	3
arrival time	0	1	2	3	4
burst time	4	3	1	2	5



CT	4	7	8	10	15
TAT	4	6	6	7	11
WT	0	3	5	5	6
RT	0	3	5	5	6

} in non-preemptive scheduling, WT = RT

Context Switching : preempt the process and schedule some other process

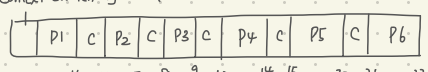
많은 context switching이 시간이 많이듦 ⇒ decreases the efficiency of CPU = slower (degrade the performance)

ex) context switching overhead = 1

$$\text{CPU efficiency} = \frac{\text{Useful time}}{\text{Total time}}$$

process Id	1	2	3	4	3	6
arrival time	0	1	2	3	4	5
burst time	3	2	1	4	5	2

Context Switching : CPU is idle



CPU efficiency = $17/23$

CPU inefficiency = $6/23$

CT	4	7	9	14	20	23
TAT	4	6	7	11	16	18
WT	1	4	6	7	11	16
RT	1	4	6	7	11	16