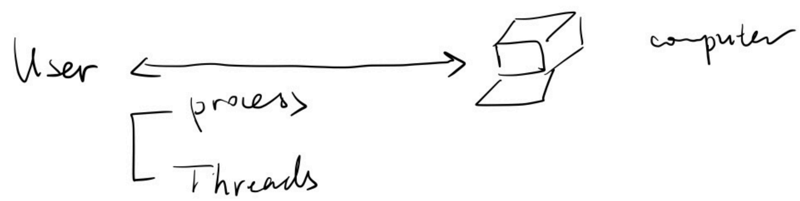
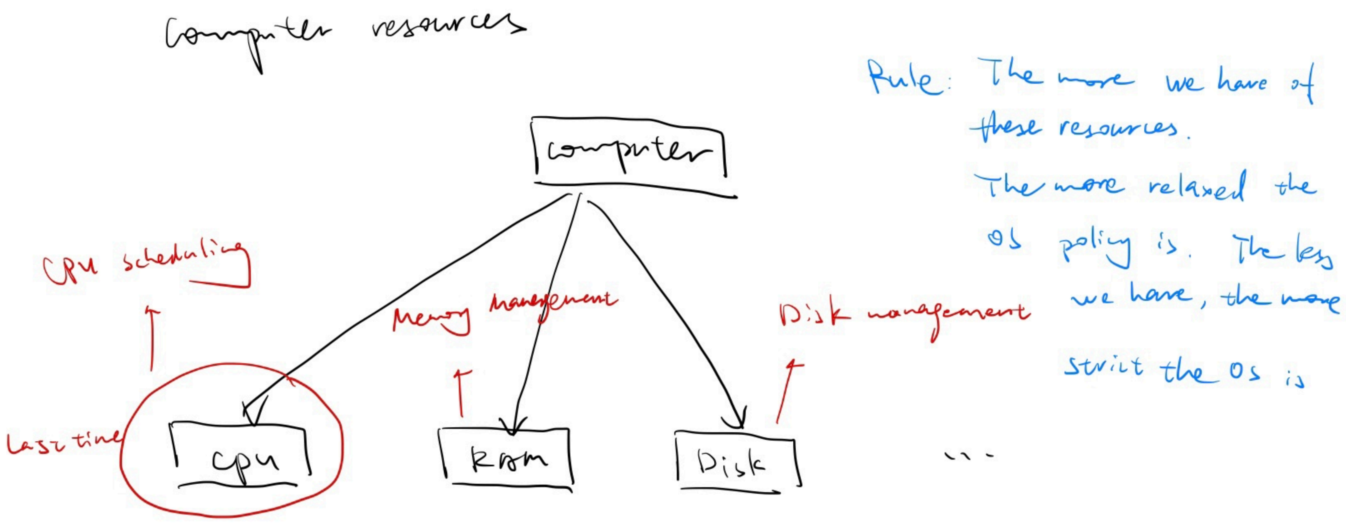
Lecture 5

Feb-23-2023

Mid-term: after spring break

Review:





OS: must manage all of these CPU, RAM, Disk

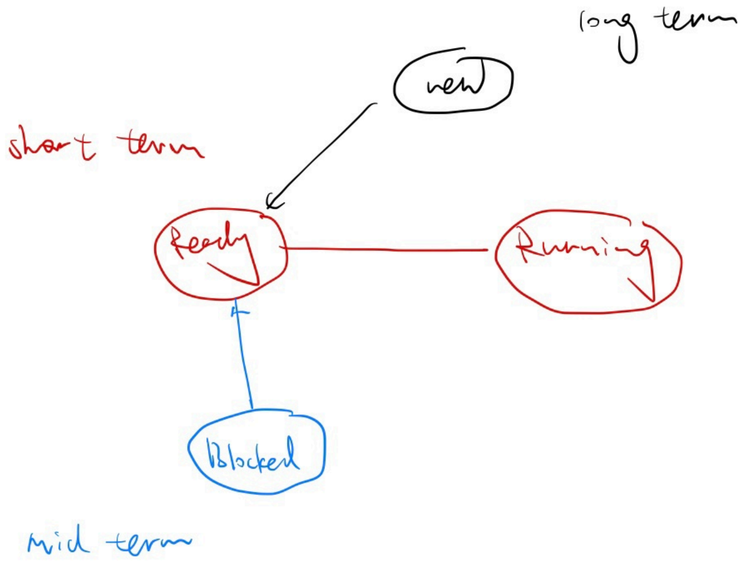
manage: make sure that all processes/threads have access to the resources in a fair, and secure manner, with reasonable response time.

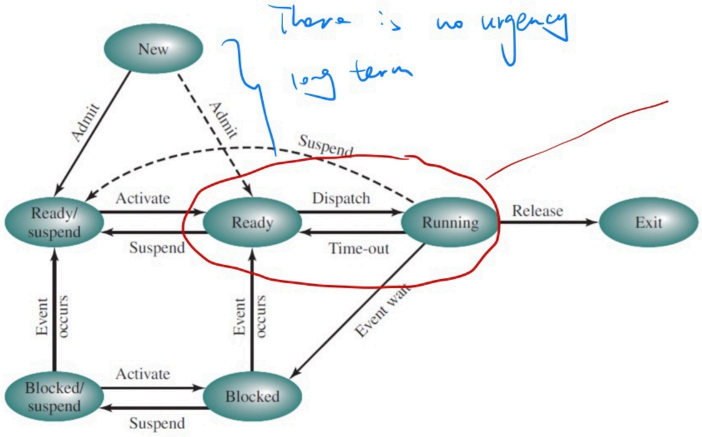
We discussed a few CPU: scheduling Algorithms that apply to **short term** scheduling:

(1) Short term scheduling

(2) Mid term scheduling

(3) Long term scheduling





There is no urgency
long term

The thing that we have to pay attention to immediately because everything it's ready it's just waiting CPU turn.
short term.

Anything that is in memory it's important, but is not as important as Ready ⟷ Running.

That's why it's called mid-term.

CPU scheduling:

1. FCFS: Non-preemptive, the longer waiting goes next
2. Round Robin: Preemptive, time slice.
3. Shortest Process Next (SPN) or Shortest Job First (SJF): Non-preemptive

   The one with the least service time.
4. Shortest Remaining Time (SRT): Preemptive
5. Highest Response Ratio: Non-preemptive

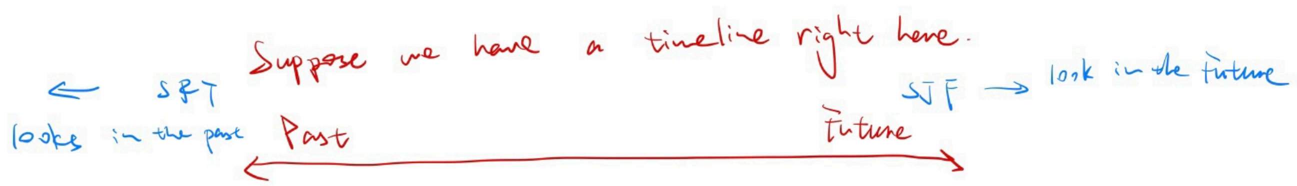
6. Feedback: preemptive

Shortest Remaining Time

Shortest Remaining Time (SRT): Preemptive

We recall the SJF is the best in term of responded time and throughput, but its major weakness is that we must predict the future. We have to know in advance how much processing time for a given job. Guess work. Practice is not possible.

(If you're writing a program say in Java and execute, do you know how much time it is going to take? you don't. Only statistically if you do so many times you'll be able to guess.)



Shortest Process time or SRT is a policy in which the process with the shortest expected remaining time goes next. This is a preemptive algorithm. That is, if a new process. Joins the ready queue, with processing time that is less than the remaining process time that is currently running, then the new process will take over the CPU and the current process is preempted.

P_1

ready

P_1 has only 5 seconds remaining time

P_0

running queue.

suppose P_0 has remaining time of 7 seconds

Decision: kick P_0 and replace with P_1

P_1 has arrived, and it only needs 6 seconds; P_2 needs 3 seconds

ready queue.

empty

P_0

running

remaining time of 7 seconds

Q: P_1 came and it only needs 6 seconds, P_0 is running but it needs 7 seconds who is gonna take over

A: P_1 will be first follow by P_0

P_0, P_1

Now P_1 started for one second, so by the time it ran, it is 5 seconds and at the second P_2 come in and P_2 only need 3 seconds. P_2 will go next P_0, P_1, P_2

Example set of processes, consider each a batch job

Process	Arrival Time	Service Time
A	0	3
B	2	6
C	4	4
D	6	5
E	8	2

Process\Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A																				
B																				
C																				
D																				
E																				
Ready queue	[ ]	[B]	[B]	[B]	[B]	[B, D]	[B, D]	[B, D]	[B, D]	[B]	[B]	[B]	[B]	[B]	[]	[]	[]	[]	[]	[]
CPU	[A]	[A]	[A]	[C]	[C]	[C]	[C]	[E]	[E]	[D]	[D]	[D]	[D]	[D]	[B]	[B]	[B]	[B]	[B]	[B]

Shortest Remaining Time (SRT)

	Remaining Time
A	0
B	0
C	0
D	0
E	0

Highest Response Ratio (HRR)

Highest Response Ration: Non-preemptive

We use a ratio that determines which process goes next. But must be fair: a process that has been waiting for a long time must be consider before a process that is waiting for a shorter time. **(FCFS)**.

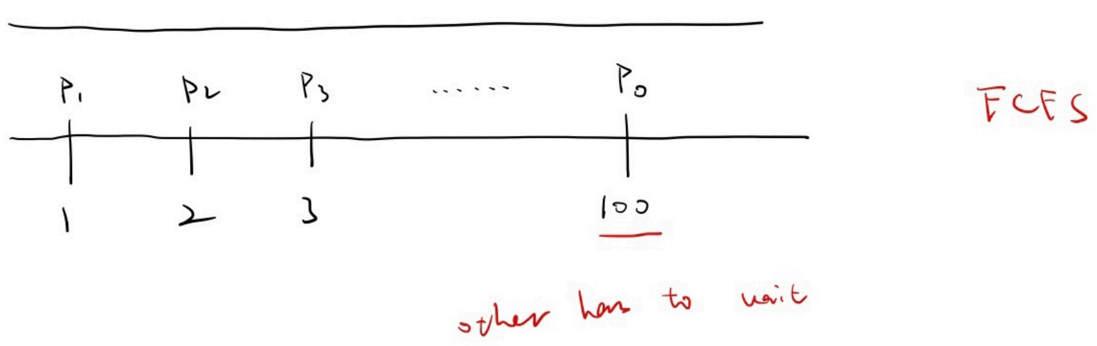
On the other hand: a Job that is small should be also considered.

- waiting time is a factor. (FCFS)
- service time is a factor. (SJF/SPN)

The definition of service time: the time it takes for the whole job to run

Maximize: Throughput. Number of processes that have completed pair amount of time if I can finish 100 jobs in an hour obviously it's better than only 70 right.

If I only do FCFS, the throughput is going to be low, for example:



Solution: Ratio

Ratio

Let us come up with a ratio: The higher the ration of a process, the first it acquires the CPU. Must consider wait time + service time. The longer you wait should go first.

$$ration\ (R) = \frac{time\ spent\ waiting + expected\ service\ time}{expected\ service\ time} = \frac{w+s}{s} \tag{1}$$

(1) If w is big R is big.

(2) If s is small R is big.

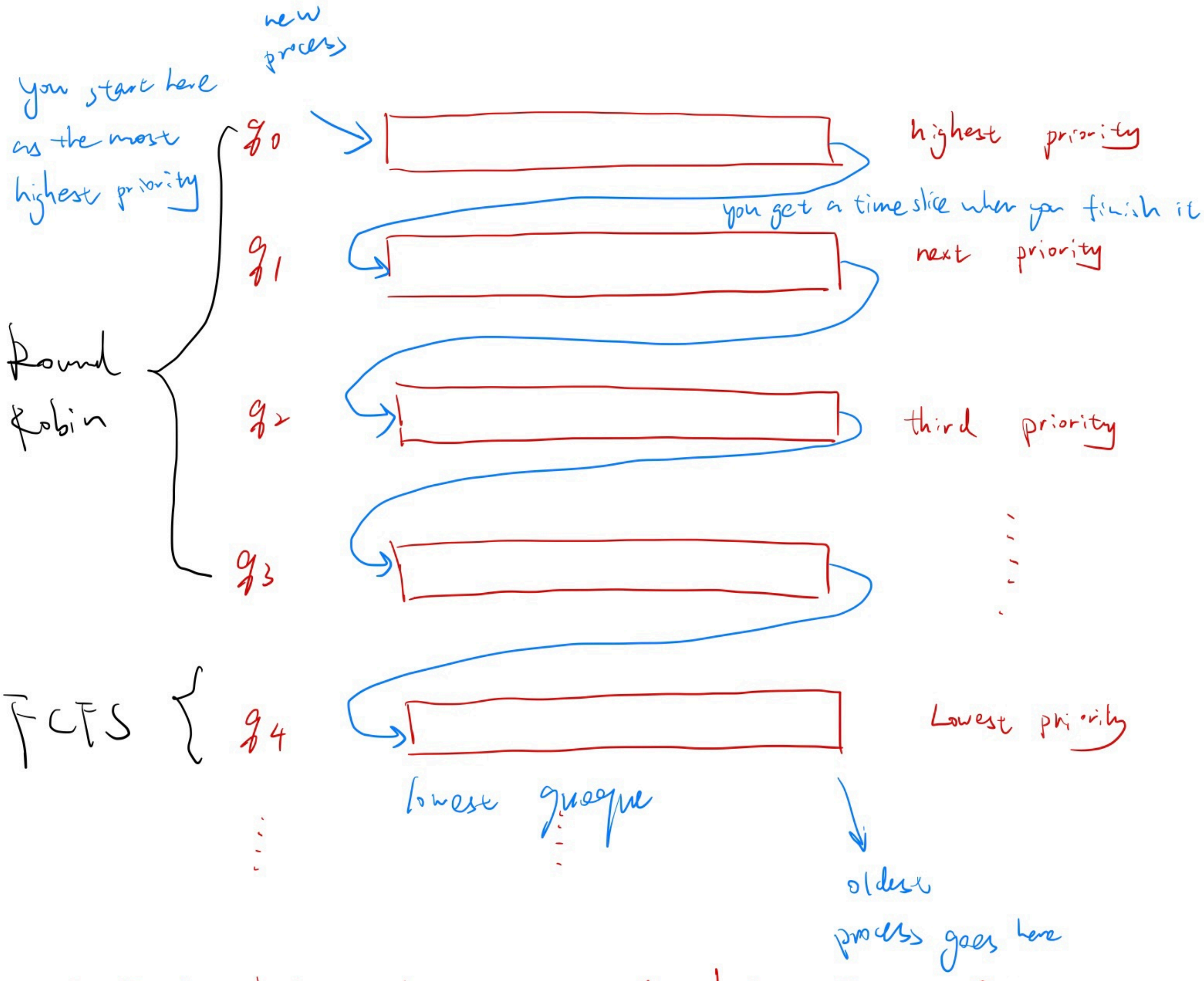
R is non preemptive policies, so it basically takes the best of FCFS, shortest job first. A compromise between two.

Feedback

Round Robin, priority based, multi queue policy preemptive with possible case of starvation and with the least queue is FCFS based.

q_0, q_1, q_2, q_3, q_4 are all ready queue.

Feedback



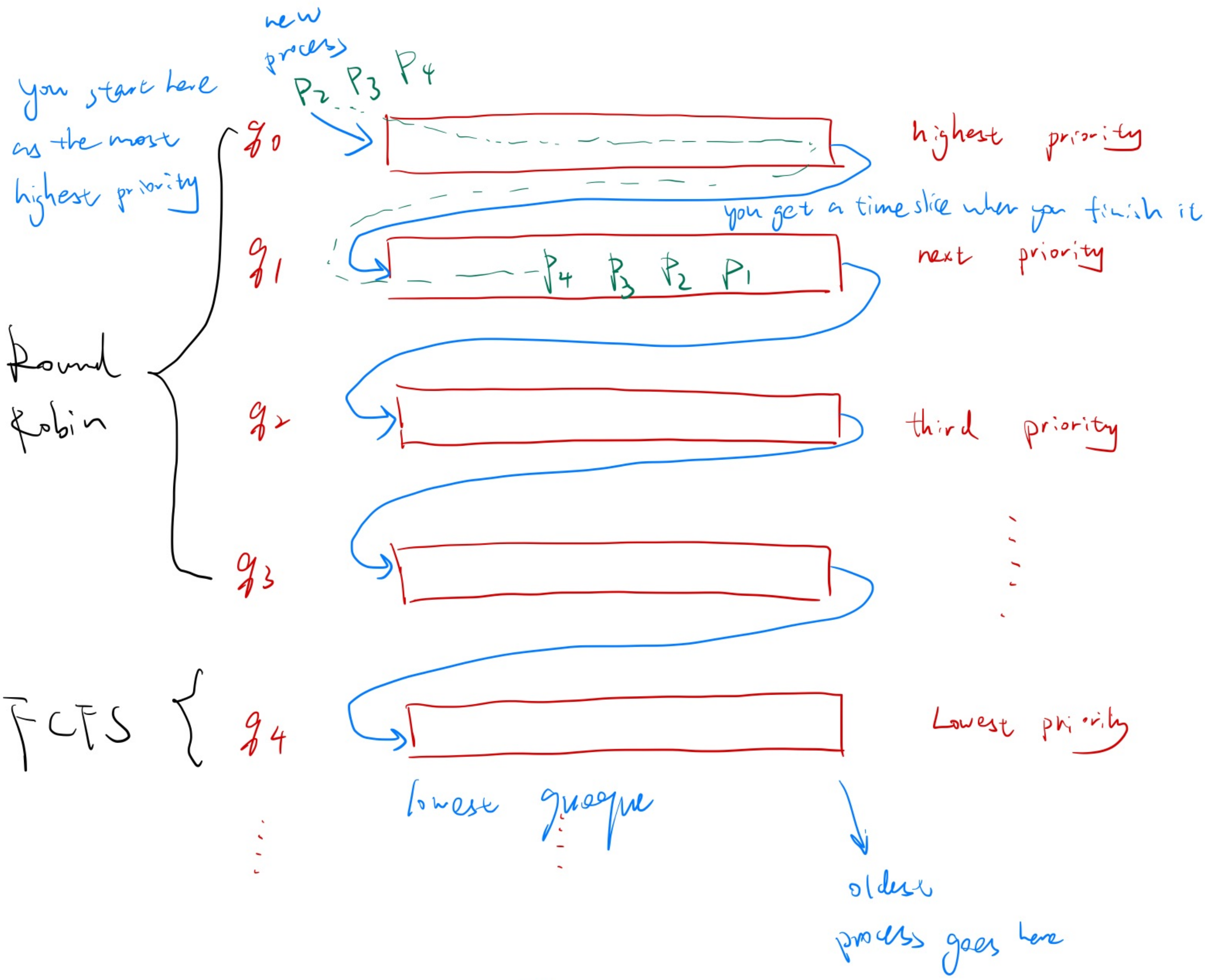
It's feeding back until you get to the bottom. You wish that you go back but you can't, you're gonna stuck right here.

starvation: a process will never get its turn, it will wait indefinitely.

Q: How would the starvation happen? Who gets the highest priority?

A: New processes.

For example:



P_1 is in the q_2, at the sudden, P_2 come in as new process in q_1, and then it take single time slice and then move to q_2. P_1 want to go next, but P_3 come in ...... P_1 has to wait and never get its turn. In realistically, it probably will never happen. However, you have to consider it.

Important!!!

mid term also

Table 9.3 Characteristics of Various Scheduling Policies

	FCFS	Round Robin	SPN	SRT	HRRN	Feedback
Selection Function	$\max[w]$	constant	$\min[s]$	$\min[s - e]$	$\max\left(\frac{w + s}{s}\right)$	(see text)
Decision Mode	Non-preemptive	Preemp-tive (at time quantum)	Non-preemptive	Preemptive (at arrival)	Non-preemptive	Preemptive (at time quantum)
Throughput	Not emphasized	May be low if quantum is too small	High	High	High	Not emphasized
Response Time	May be high, especially if there is a large variance in process execution times	Provides good response time for short processes	Provides good response time for short processes	Provides good response time	Provides good response time	Not emphasized
Overhead	Minimum	Minimum	Can be high	Can be high	Can be high	Can be high
Effect on Processes	Penalizes short processes; penalizes I/O-bound processes	Fair treatment	Penalizes long processes	Penalizes long processes	Good balance	May favor I/O-bound processes
Starvation	No	No	Possible	Possible	No	Possible

w = time spent in system so far, waiting

e = time spent in execution so far

s = total service time required by the process, including *e*; generally, this quan- tity must be estimated or supplied by the user

For example, the selection function max[*w*] indicates an FCFS discipline.

	FCFS	Round Robin	SPN/SJF	SRT	HRRN	Feedback
Selection Function	max[w]	constant	min[s]	min[s-e]	max[(w+s)/s]	"Priority based"(The last one is not priority)
Decision Mode	Non Preemptive	Preemptive (at time quantum)	Non Preemptive	Prem at arrival	Non Preemptive	Preemptive at time slice
Throughput	Not emphasized	Low if the time slice is small	High But not achievable because you have to predict the future	High	High	Not emphsized
Response Time	may be high if the service time of jobs are large	resonable response time	Provides good response time for short processes (High But not achievable because you have to predict the future)	Provides good response time for short processes	Provides good response time for short processes	Not emphsized
Overhead	Low	high(substantial)	very high	very high	very high	very high
Effect on Process	Bad for short processes	fair	bad for long process	bad for long process	fair	May Favor I/O Bound
Starvation	No	No	May be	May be	No	Possible

Chapter 6 Synchronization Tools

Important: 6.1; 6.2; 6.3; 6.6; 6.7

Read: 6.4; 6.5; 6.8; 6.9

Q: What do we mean by synchronization

A: We have processes, Threads, multiprogramming, multi processing, distributed processing, which are pretty **fancy** but also it adds another level of **complexity** and also forces us to do **complex communications**.

We have two choices: We can have processes only **work in silos** or have **work cooperate** and **communicate**.

possible that they run on each other to each other, or might result in miscommunication or step on each other unless we have synchronization enforced. OS does synchronization enforced.

Critical-Section

Q: Did we see this before ? Did we see a conflict before?

Yes. HW2

```
const int n = 50;
int tallyl
void total()
{
```

```
    int count;
    for (count = 1; count <= n; count++){
      tally++;
    }
}
void main()
{
    tally = 0;
    parbegin (total(), total());
    wrtie(tally);
}
```

We have two threads. `tally` output was unpredictable. Sometimes is 2, sometimes is 50, sometimes is 100... Because there was no synchronization. `tally++` is shared and modified by two threads independent of each other. If we have synchronization we would't have that kind of issues, we would be getting the consistent output all the time.

`tally++` in OS can be called critical section it's something that has to be protected. That's why we need synchronization around it. The critical section must be protected only one thread can execute it at any given time. This is the only way that it will guarantee for us to get the correct results.

The critical-section problem

```
do {
    [entry section]       ---> must protect here

        critical section        --> tally++

    [exit section]        ---> must protect here

        remainder section

}while (TRUE);
```

Protect means synchronized, in such a way only one thread can access this section at any given time.

Chapter 6 and 7 goes around how do we do it?

Have to make sure that my solution does give fair access to both of them without any conflicts.

Synchronization

synchronization can be done in several ways:

1. **Programming level**

   We program it. The user does the synchronization. Most difficult.

2. **synchronization enforced**

   We have machine instructions that does the synchronization. Easy but limited.

3. synchronization enforced

   Programming constructs does the synchronization. Most general but of course complex.

cars: processes or threads

The bus represents it's going to take a lot of service time, first come first service.

The little motorcycle or bicycle: shortest job first (sjf)

Q: What is the critical section here?

A: intersection

Q: What is the way to solve it?

A: like policeman or traffic light. Semaphores