CS 341 | #41 The Critical Section Problem

~~ Welcome to the **Critical Section Problem** game show! ~~

Example Critical Section

```
if( data[i] > data[j] {
  temp=data[i]; data[i] = data[j]; data[j] = temp
}
```

The Critical Section Problem

while(running) {

1. Wait to enter the critical section if another thread is in the CS.
2. Critical Section Code; Only one thread/process in here at a time!
3. Leave critical section. Allow another waiting thread to enter.
4. // do other stuff most of the time

}

Today's prizes:

Mutual exclusion

Bounded wait

Progress

Candidate #1. Use a single, boolean "flag"

```
boolean flag
```

Thread A	*Thread B*
wait while the flag is up raise the flag! *Critical Section* code here lower the flag! ...	wait while the flag is up raise the flag! *Critical Section* code here lower the flag! ...

// Then each thread does other work but will repeat this again sometime in the future. Problems?

Candidate #2. Give each thread its own a flag.

```
boolean flagA, flagB
```

wait while B's flag is up raise A flag *Critical Section* code here lower A flag	wait while A's flag is up raise B flag *Critical Section* code here lower B flag

Problems?

Candidate #3. Change the sequence order

raise A flag wait until B flag is down *Critical Section* code here lower A flag	raise B flag wait until A flag is down *Critical Section* code here lower B flag

Problems?

Candidate #4. Try a single turn-based shared variable.

```
turn=1
```

while(turn == 2) { } *Critical Section* code here turn = *2*	while(turn == 1) { } *Critical Section* code here turn = 1

Problems?

Dekker's N=2 solution (1962) to the Critical Section Problem.

```
raise my flag
while(your flag is raised) :
   if it's your turn to win :
     lower my flag
     wait while your turn
     raise my flag

// Do Critical Section stuff here

set your turn to win
lower my flag
```

Peterson's N=2 solution to the Critical Section Problem? (1981!)

```
raise my flag

turn = your_id

wait while your flag is raised and turn is your_id

// Do Critical Section stuff

lower my flag
```

Code Examples-

Example code for ____?

```
void lock_init(){
  flag[0] = flag[1] = 0;
  turn = 0;
}

//Call before critical section
void lock(int self){
  flag[self] = 1;
  turn = 1 - self;
  while(flag[1-self]==1 && turn==1-self);
}

// Call after critical section
void unlock(int self){
  flag[self] = 0;
}
```

Also

https://android.googlesource.com/kernel/tegra.git/+/android-tegra-3.10/arch/arm/mach-tegra/sleep.S#58

spinlock implementation with no atomic test-and-set and no coherence

```
 * using Peterson's algorithm on strongly-ordered registers
 * used to synchronize a cpu waking up from wfi with entering
lp2 on idle
      mov   r12, #1
      str   r12, [r2]   @ flag[cpu] = 1
      dsb
      str   r12, [r1]   @ !turn = cpu
1:    dsb
      ldr   r12, [r3]
      cmp   r12, #1     @ flag[!cpu] == 1?
      ldreq r12, [r1]
      cmpeq r12, r0     @ !turn == cpu?
      beq   1b          @ while !turn == cpu &&
flag[!cpu] == 1
      mov   pc, lr      @ locked
```

Challenges with code implementations?