

# Homework2 for CS450 (Spring 2022)

Due day: Mar 25 2022

1. Explain the concept of Copy on Write (CoW). Explain how Copy on Write works when a child process is forked from its parent. Why is it more efficient and also saves memory?

**“Copy on Write” means you only make a copy when there is a write event.**

**When a child process is forked from its parent, both parent’s page table and child’s page table point to the same set of physical pages, and these pages are all marked as read-only in both page tables. Then when there is a memory write happening in either parent or child process, we will make a new copy of that page to be written, and that new page is mapped to the page table of the process that is writing the memory.**

**Copy on Write is more efficient, because during fork, we don’t need to copy the entire memory pages from the parent to the child process, which can be very slow. We simply make both processes point to the same set of pages. Copy happens on when absolutely necessary, when the parent or child process writes to a shared page.**

**Copy on Write saves memory too, because the child process often only need to write a small number of pages, and we only copy these pages, instead of all the pages belonging to that process.**

2. A group of 5 people goes to a restaurant. They wait until the last person arrives before they start ordering. Implement this scenario using threads and semaphores. (hint: use `pthread_create`, `sem_init`, `sem_wait`, `sem_post`.)

```
sem_t s[5]; //initialize each s[i] to 0  
void person(int p) //p is set to be between 0 and 4  
{  
    int i;  
    printf("Person %d has arrived.\n", p+1);  
    for(i=0; i<4; i++)  
        sem_post(s[p]); //signal other people that this person has arrived.  
    for(i=0; i<5; i++) {  
        if(i != p)  
            sem_wait(s[i]); //wait for other people  
    }  
    printf("Person %d starts ordering.\n", p+1);  
}
```

3. Compare spinlock and semaphore. Both can be used to protect a critical region. In what case is spinlock better? In what case is semaphore better?

**spinlock is good for short critical regions with no IO operations in it.**  
**semaphore is good for long critical regions which may have IO operations.**

4. Consider a 32-bit address space with 4KB pages. Assume each PTE is 4 bytes:

1). How many bits do we need to represent the offset within a page?

**12**

2). How many virtual pages will we have?

**$2^{20}$**

3). What will be the overall size of the page table?

**4MB**