CSE312 OS HW2 Report
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```c
typedef struct Page
{
    int index;
    int array[PAGE_SIZE];
    int load_time;
    int last_reference_time;
    int R_bit;
    int M_bit;
    int second_chance;
}Page;


typedef struct pagetable {
    Page pages[NUMBER_OF_PAGE];
}pagetable;


typedef struct my_program {
    pagetable table;
}my_program;

#endif
```

```c
#define VIRTUAL_ADDRESS_SPACE 64 //2^6
#define PAGE_SIZE 16 //2^4
#define NUMBER_OF_PAGE 4 //2^2
#define DISK_ARRAY_SIZE 128
```

I have these structs, My program holds a page table and it has a number of pages in it, then each page has integer content , disk index, load time last reference time, R-M bits and second chance bit to indicate second chance

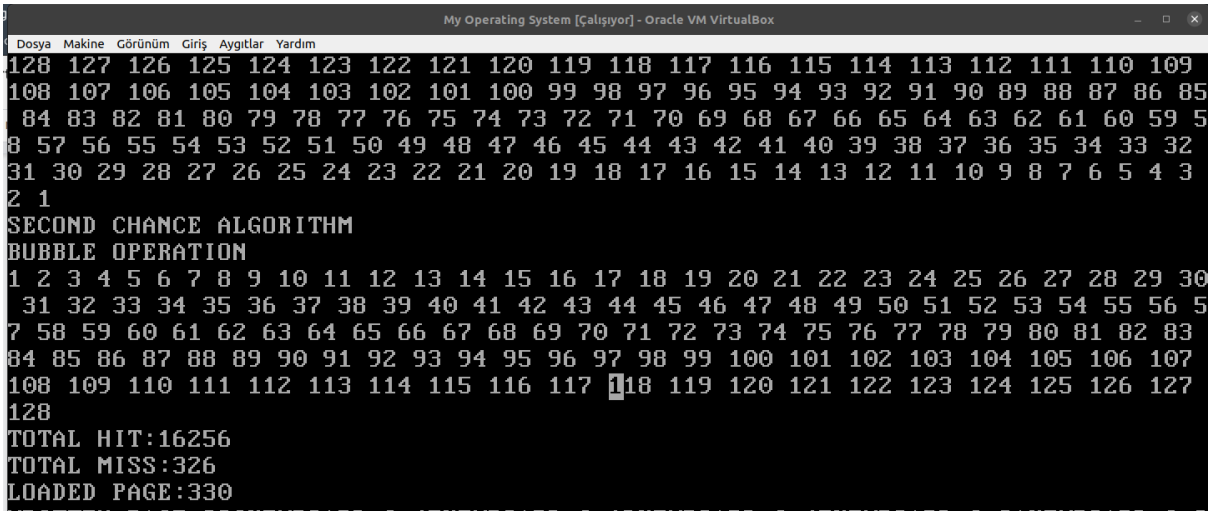
Firstly I created arrays and put the array to the page table, but array length was high such that I can't hold the entire array in my pages. So I decided to start from index 0 of array, and copy the elements as soon as I can. In this case, it is half of the entire array. So, My page table can hold half of the entire array.

```c
int disk_array[DISK_ARRAY_SIZE];
int insertion_sort_array[DISK_ARRAY_SIZE];
int bubble_sort_array[DISK_ARRAY_SIZE];
int quick_sort_array[DISK_ARRAY_SIZE];
for(int i=0;i<DISK_ARRAY_SIZE;i++) {
    disk_array[i]=DISK_ARRAY_SIZE-i;
    insertion_sort_array[i]=disk_array[i];
    bubble_sort_array[i]=disk_array[i];
    quick_sort_array[i]=disk_array[i];
    char buf[50];
    toChar(buf,(disk_array[i]));
    printf(buf);
    printf(" ");
}
```

```c
for(int i=0;i<NUMBER_OF_PAGE;i++) {
    p.table.pages[i].last_reference_time=0;
    p.table.pages[i].load_time=i;
    p.table.pages[i].M_bit=0;
    p.table.pages[i].R_bit=0;
    p.table.pages[i].second_chance=0;
    p.table.pages[i].index=i;
    loaded_page++;
    for(int j=0;j<PAGE_SIZE;j++) {
        p.table.pages[i].array[j]=disk_array[i*PAGE_SIZE+j];
    }
}
```

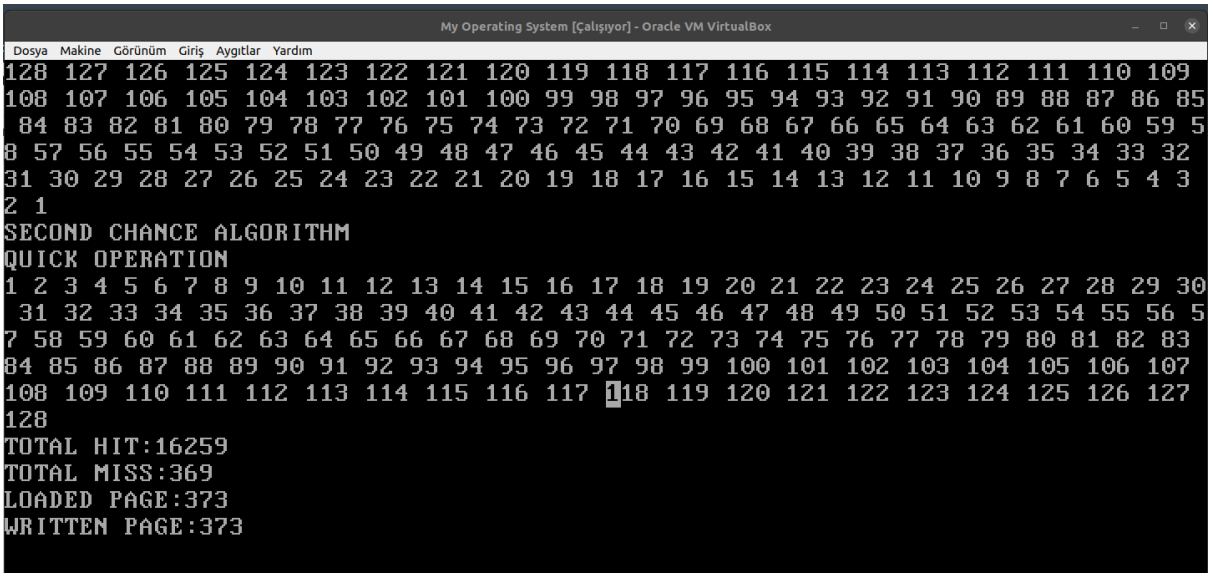
Bubble Sort:

```
void bubbleSort(my_program*p,int arr[], int n)
{
    int i, j;
    for (i = 0; i < n - 1; i++) {
        for (j = 0; j < n - i - 1; j++) {
            int* arrj=reference_memory(p,arr,j);
            int* arrjp=reference_memory(p,arr,j+1);
            if((*arrj)>(*arrjp)) {
                swap(arrj,arrjp);
            }
        }
    }
}
```



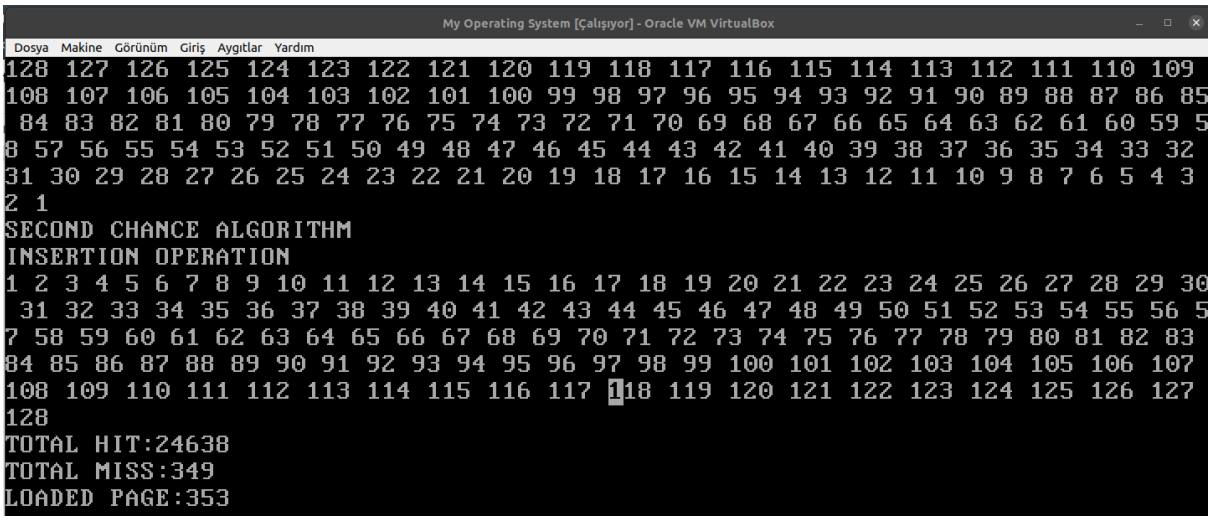
Quick Sort:

```
int partition (my_program*p,int arr[], int low, int high){
    int pivot=(*reference_memory(p,arr,high));
    int i = (low - 1);
    for (int j = low; j <= high - 1; j++){
        if (*reference_memory(p,arr,j) < pivot){
            i++;
            swap(reference_memory(p,arr,i), reference_memory(p,arr,j));
        }
    }
    swap(reference_memory(p,arr,i+1), reference_memory(p,arr,high));
    return (i + 1);
}
void quickSort(my_program*p,int arr[], int low, int high){
    if (low < high){
        int pi = partition(p,arr, low, high);
        quickSort(p,arr, low, pi - 1);
        quickSort(p,arr, pi + 1, high);
    }
}
```



Insertion sort:

```
void insertionSort(my_program*p,int arr[], int n){
    int i, key, j;
    for (i = 1; i < n; i++){
        key=(*(reference_memory(p,arr,i)));
        j = i - 1;
        while (j >= 0 && (*reference_memory(p,arr,j)) > key){
            *(reference_memory(p,arr,j+1))=(*reference_memory(p,arr,j));
            j = j - 1;
        }
        *reference_memory(p,arr,j+1)=key;
    }
}
```



Fifo replacement

```
void fifo_replacement(my_program*p,int arr_index,int*arr) {
    int min_load_time=current_clock;
    int page_index=0;
    int page_i=0;
    for(int i=0;i<NUMBER_OF_PAGE;i++) {
        if(p->table.pages[i].load_time<min_load_time) {
            page_i=i;
            page_index=p->table.pages[i].index;
            min_load_time=p->table.pages[i].load_time;
        }
    }
    int needed_start_index=(arr_index/PAGE_SIZE)*PAGE_SIZE;
    for(int i=needed_start_index;i<(needed_start_index+PAGE_SIZE);i++) {
        p->table.pages[page_i].array[i%PAGE_SIZE]=arr[i];
    }
    p->table.pages[page_i].index=needed_start_index/PAGE_SIZE;
    p->table.pages[page_i].last_reference_time=current_clock;
    p->table.pages[page_i].load_time=current_clock++;
    p->table.pages[page_i].M_bit=0;
    p->table.pages[page_i].R_bit=0;
    p->table.pages[page_i].second_chance=0;
}
```

Looks for minimum load time

Second chance replacement:

```
void second_chance_replacement(my_program*p,int arr_index,int*arr) {
    int page_index=0;
    int page_i=0;
    int flag=0;
    while(!flag) {
        for(int i=0;i<NUMBER_OF_PAGE;i++) {
            if(p->table.pages[i].second_chance==0) {
                page_i=i;
                page_index=p->table.pages[i].index;
                flag=1;
                break;
            }
            else if(p->table.pages[i].second_chance==1) {
                p->table.pages[i].second_chance=0;
            }
        }
    }
    int needed_start_index=(arr_index/PAGE_SIZE)*PAGE_SIZE;
    for(int i=needed_start_index;i<(needed_start_index+PAGE_SIZE);i++) {
        p->table.pages[page_i].array[i%PAGE_SIZE]=arr[i];
    }
    p->table.pages[page_i].index=needed_start_index/PAGE_SIZE;
    p->table.pages[page_i].last_reference_time=
    p->table.pages[page_i].load_time=current_clock++;
    p->table.pages[page_i].M_bit=0;
    p->table.pages[page_i].R_bit=0;
    p->table.pages[page_i].second_chance=0;
}
```

Looks for second chance - R bits, if R bit is 0, replace it, if R bit is 1, make it 0

Least recently used
Looks for last reference time, replaces minimum one

```
void least_recently_used(my_program*p,int arr_index,int*arr) {
    int min_ref_time=current_clock;
    int page_index=0;
    int page_i=0;
    for(int i=0;i<NUMBER_OF_PAGE;i++) {
        if(p->table.pages[i].last_reference_time<min_ref_time) {
            page_i=i;
            page_index=p->table.pages[i].index;
            min_ref_time=p->table.pages[i].load_time;
        }
    }
    int needed_start_index=(arr_index/PAGE_SIZE)*PAGE_SIZE;
    for(int i=needed_start_index;i<(needed_start_index+PAGE_SIZE);i++) {
        p->table.pages[page_i].array[i%PAGE_SIZE]=arr[i];
    }
    p->table.pages[page_i].index=needed_start_index/PAGE_SIZE;
    p->table.pages[page_i].last_reference_time=current_clock;
    p->table.pages[page_i].load_time=current_clock++;
    p->table.pages[page_i].M_bit=0;
    p->table.pages[page_i].R_bit=0;
    p->table.pages[page_i].second_chance=0;
}
```

Referencing a memory

```
int* reference_memory(my_program*p,int arr[], int index) {
    int needed_page_index=(index/PAGE_SIZE);
    for(int i=0;i<NUMBER_OF_PAGE;i++) {
        if(p->table.pages[i].index==needed_page_index) {
            p->table.pages[i].last_reference_time=current_clock++;
            p->table.pages[i].R_bit=1;
            p->table.pages[i].second_chance=1;
            print_hit();
            return &(p->table.pages[i].array[index%PAGE_SIZE]);
        }
    }
    print_miss();
    replace_page(p,index,arr);
    return reference_memory(p,arr,index);

}
```

Replacing a page

```
void replace_page(my_program*p,int arr_index,int*arr) {
    if(fifo_flag==1) {
        fifo_replacement(p,arr_index,arr);
    }
    else if(lru_flag==1) {
        least_recently_used(p,arr_index,arr);
    }
    else if(second_chance_flag==1) {
        second_chance_replacement(p,arr_index,arr);
    }
    else {
        printf("ERROR DETECT TO REPLACEMENT ALGO\n");
    }
    loaded_page++;
    written_page++;
    return;
}
```

Writing back page to the disk

```
void write_back_to_disk(my_program*p,int*array) {
    for(int i=0;i<NUMBER_OF_PAGE;i++) {
        written_page++;
        for(int j=0;j<PAGE_SIZE;j++) {
            array[p->table.pages[i].index*PAGE_SIZE+j]=p->table.pages[i].array[j];
        }
    }
}
```