CS 1550

Week 10

Project 3

Teaching Assistant

Henrique Potter

Project 3 - Virtual Memory Simulator

- Simulate memory page allocation and page eviction algorithm

Project 3 - Virtual Memory Simulator

- Simulate memory page allocation and page eviction algorithm
  - Your program will read from a memory trace

Project 3 - Virtual Memory Simulator

- Simulate memory page allocation and page eviction algorithm
  - Your program will read from a memory trace

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Simulate memory page allocation and page eviction algorithm
  - Your program will read from a memory trace
  - Access Type: load(l); store(s)
  - You will implement how loaded pages are evicted

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Since it is a 32-bit address space.
  - Each page in size of 4KB (2^12 bytes per page)

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

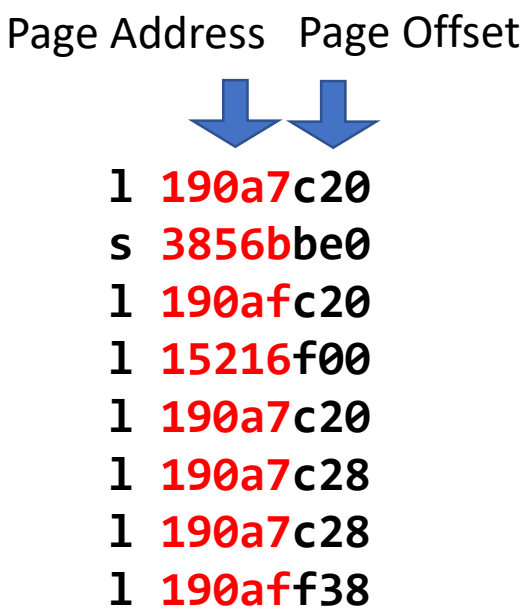
- Since it is a 32-bit address space.
  - First 20 bits is used for the address

Page Address

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Since it is a 32-bit address space.
  - First 20 bits is used for the address
  - The rest is used for offset



Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	
1	
2	

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	
1	
2	

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	
1	
2	

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	
2	

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	
2	

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	
2	

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	**3856b**
2	

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	**3856b**
2	

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	**3856b**
2	**190af**

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	**3856b**
2	**190af**

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Least Recently Used(LRU)

0	**190a7**
1	**3856b**
2	**190af**

We need to evict someone!!

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Pagefault again

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume **Least Recently Used(LRU)**

Pagefault again

0	**190a7**
1	**3856b**
2	**190af**

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume **Least Recently Used(LRU)**

Pagefault again

0	**190a7**
1	**3856b**
2	**190af**

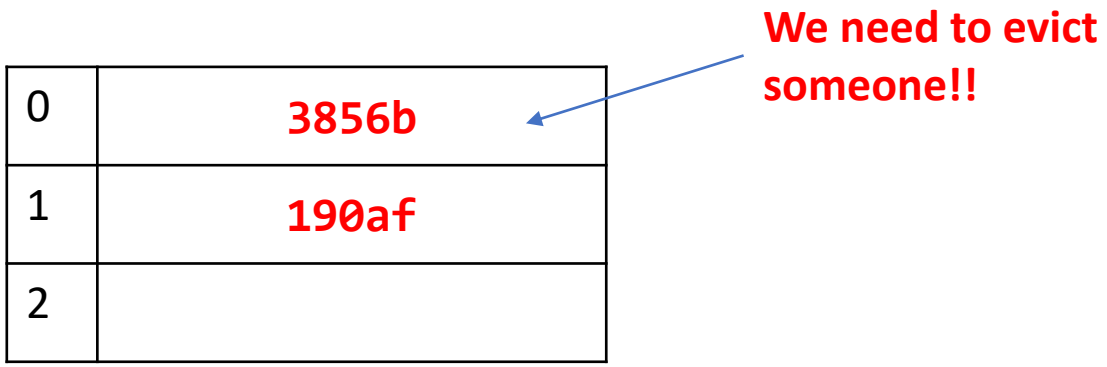
We need to evict someone!!

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume **Least Recently Used(LRU)**

Pagefault again



```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

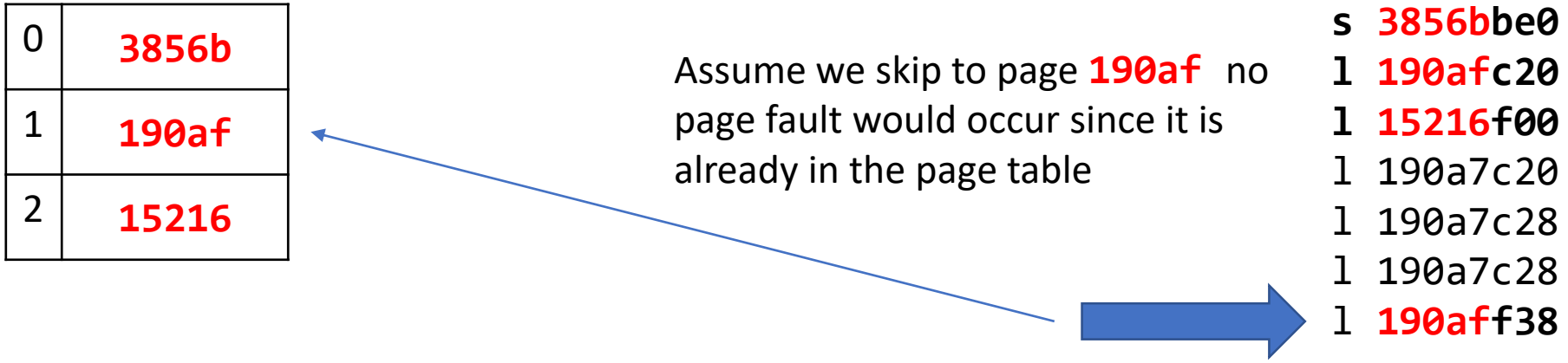
Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume **Least Recently Used(LRU)**

Pagefault again

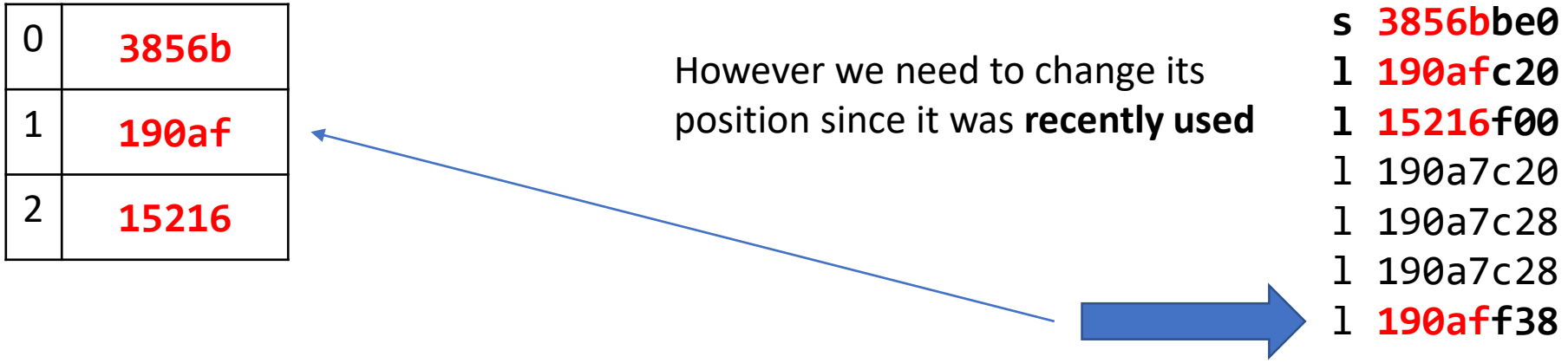
Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB



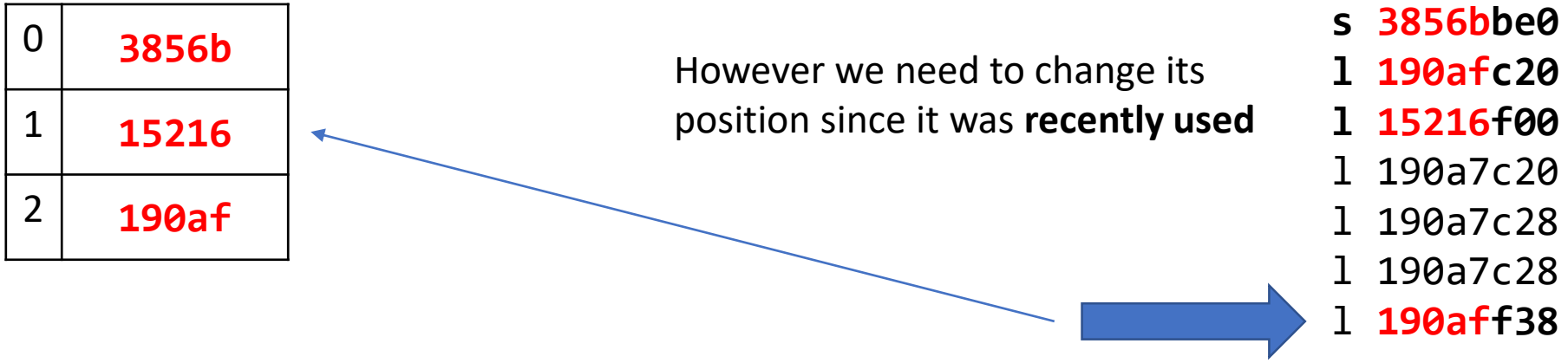
Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB



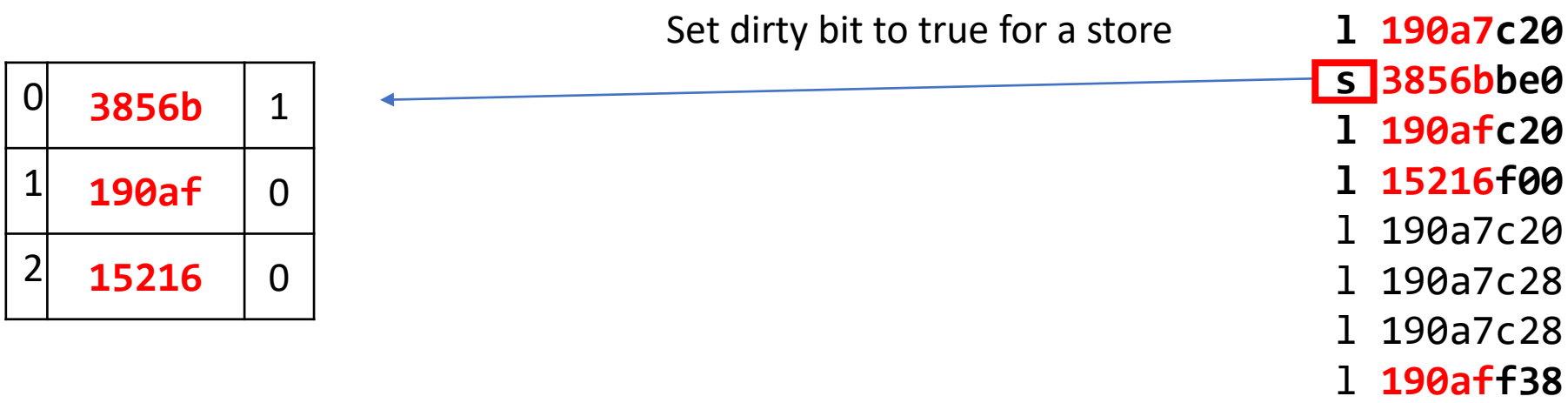
Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB



Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Set dirty bit to true if a store



Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Set dirty bit to true if a store

0	3856b	1
1	190af	0
2	15216	0

Set dirty bit to true for a store

Dirty bit identifies a memory address that will need to be "written to" since it was modified.

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

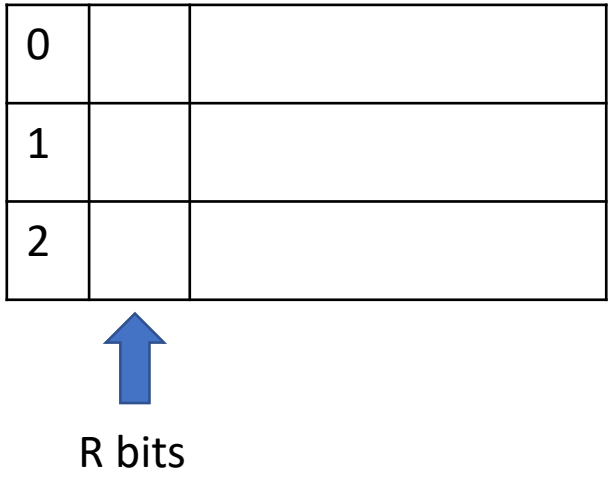
- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm

0		
1		
2		

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

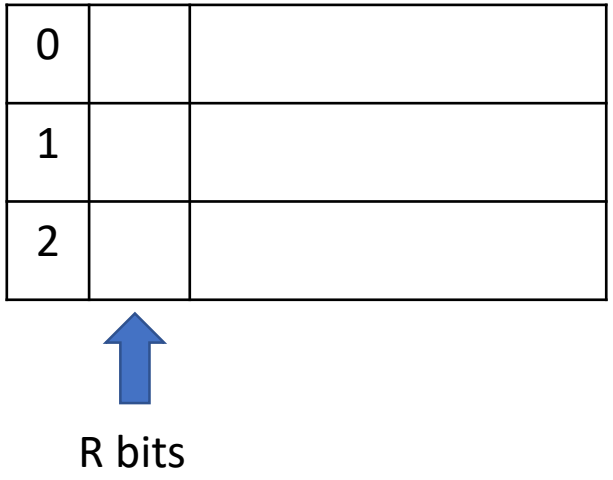
- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit): set to 1 **If page accessed again** **after allocated in memory**




```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

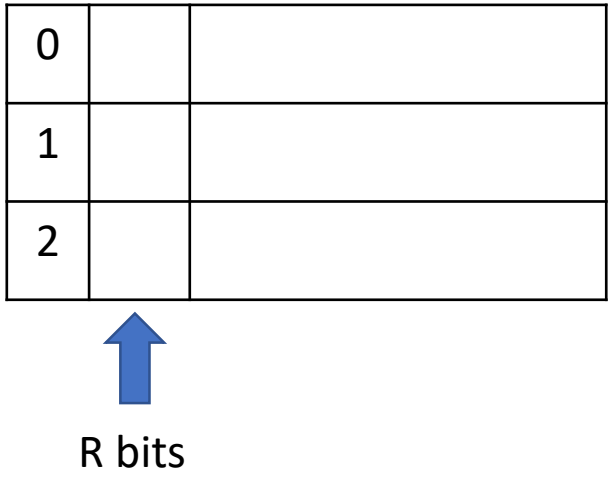
- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

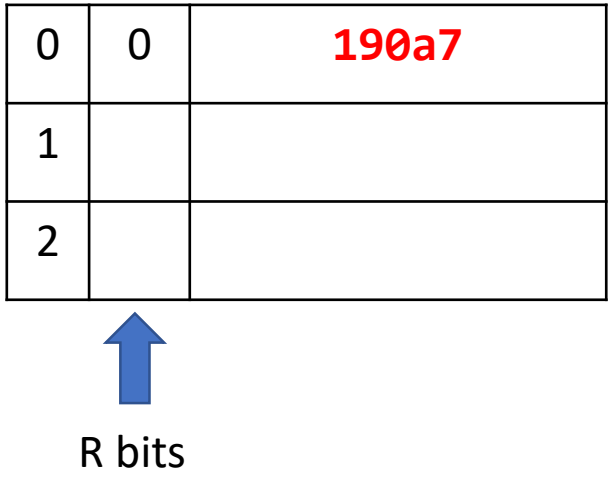


Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

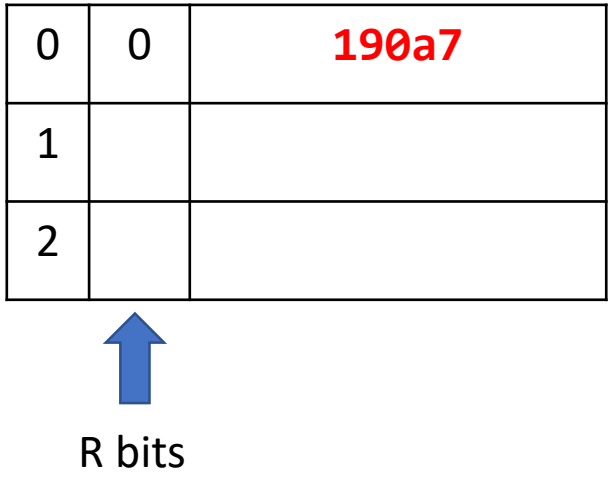


Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	0	**190a7**
1		
2		

R bits

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	0	**190a7**
1	0	**3856b**
2		

R bits

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	0	190a7
1	0	3856b
2		

R bits

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

Page 190a7
accessed **again**

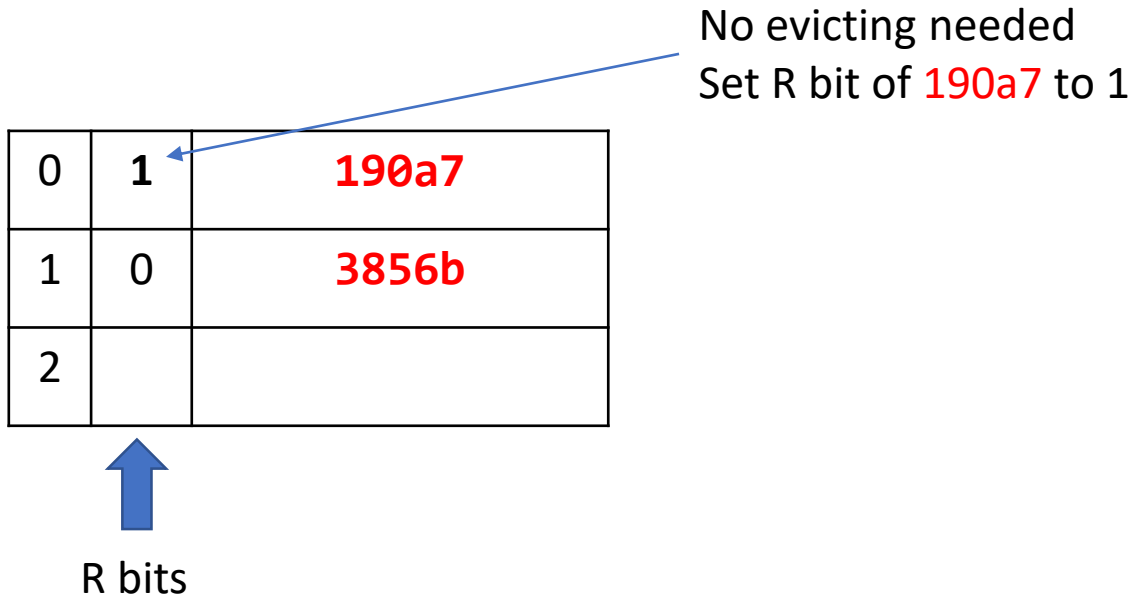
0	0	**190a7**
1	0	**3856b**
2		

R bits

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



Page 190a7
accessed **again**

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	**1**	**190a7**
1	0	**3856b**
2		

R bits

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	**1**	**190a7**
1	0	**3856b**
2		

R bits

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	**1**	**190a7**
1	0	**3856b**
2	0	**190af**

R bits

Pagefault since it is not in the page table

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	**1**	**190a7**
1	0	**3856b**
2	0	**190af**

R bits

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	**1**	**190a7**
1	0	**3856b**
2	0	**190af**

R bits

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

0	**1**	**190a7**
1	0	**3856b**
2	0	**190af**

R bits

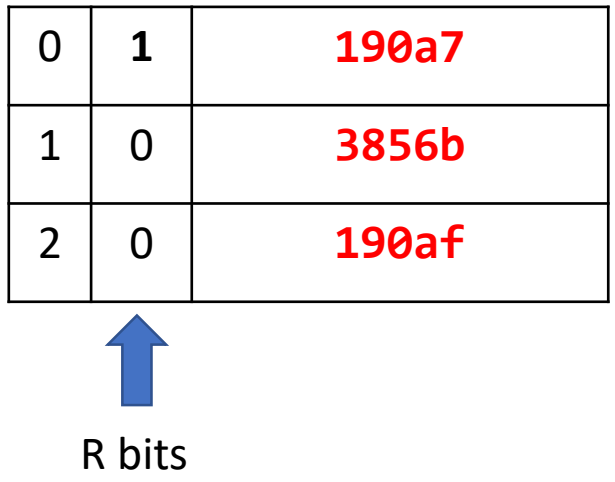
We need to evict someone!!

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



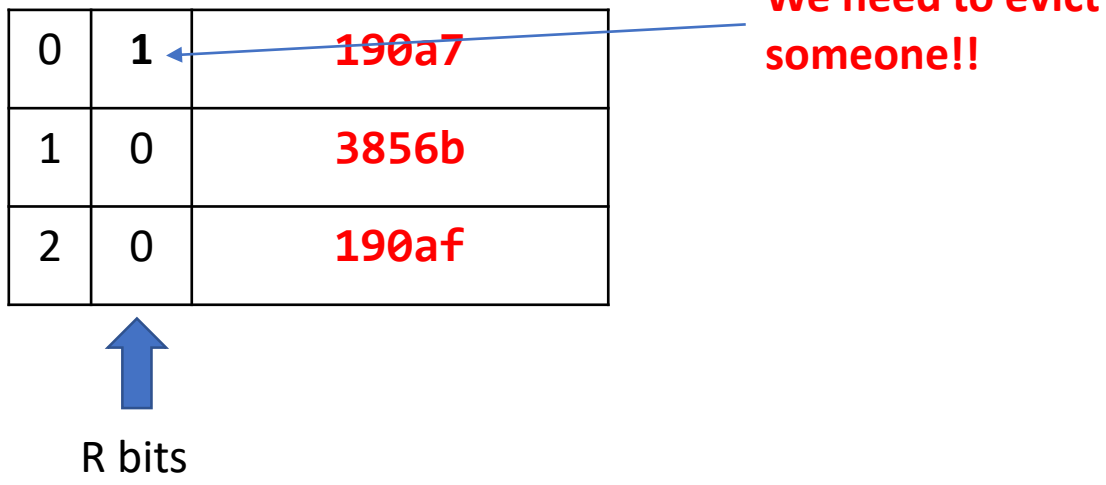
We need to evict someone!!

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

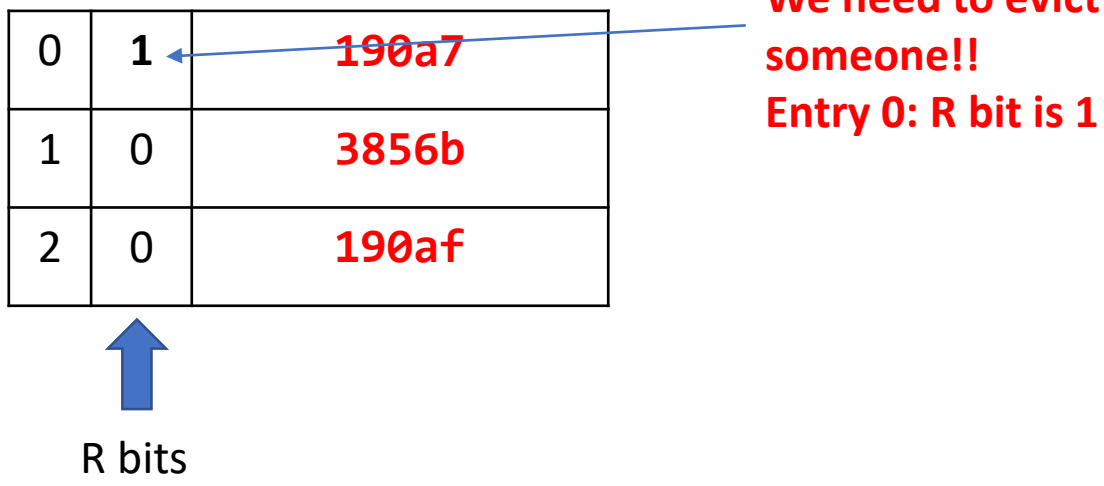


Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

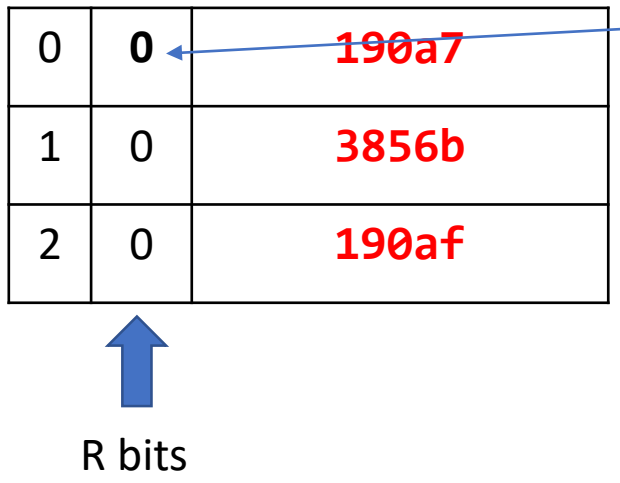


Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



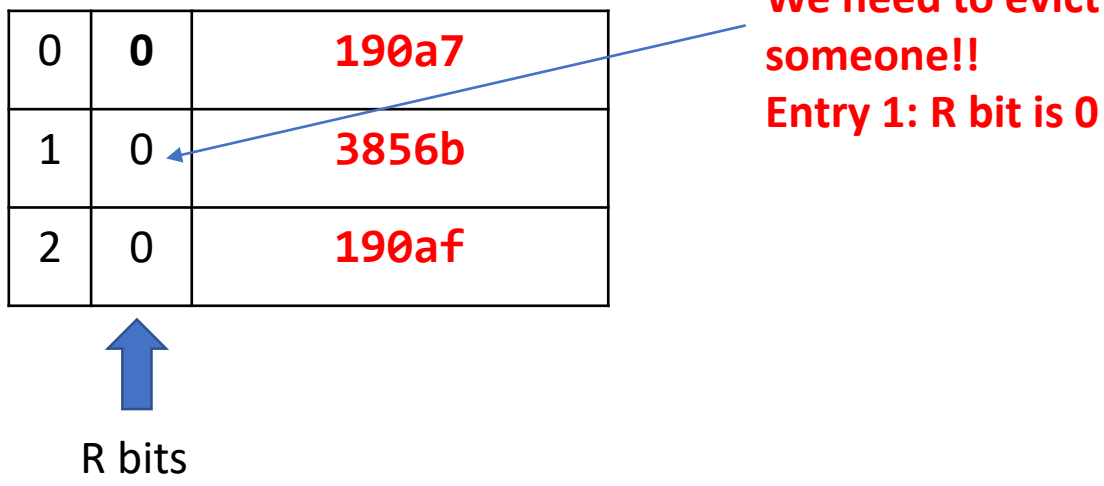
We need to evict someone!!
Entry 0: R bit is 1
Set it to 0 and go to next entry

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

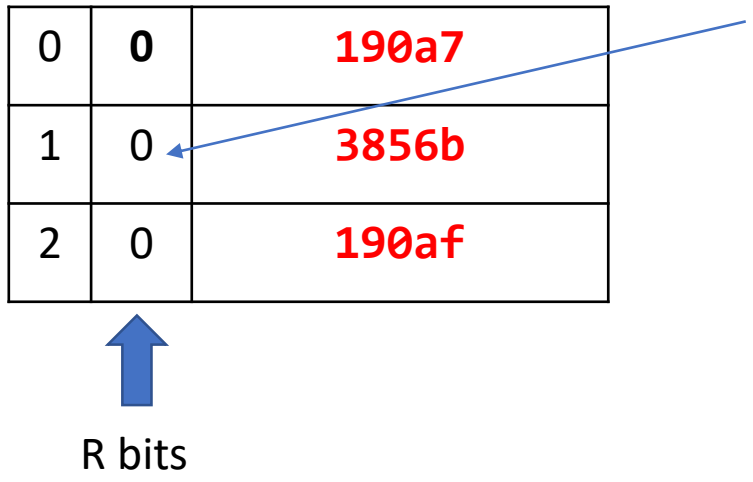


Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



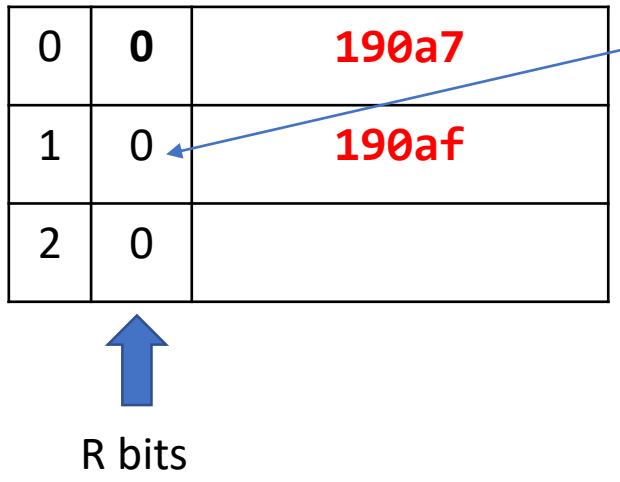
We need to evict someone!!
Entry 1: R bit is 0
Evict entry 1

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



We need to evict someone!!
Entry 1: R bit is 0
Evict entry 1

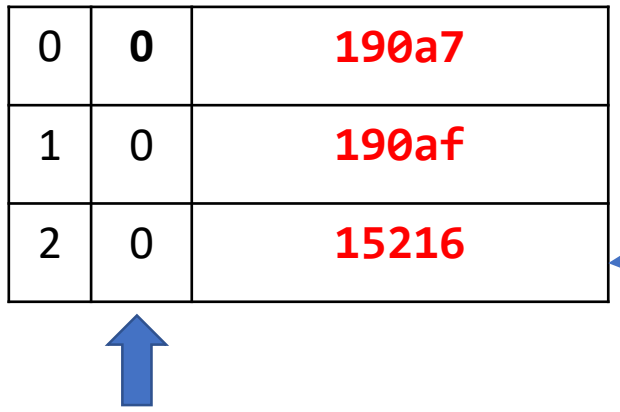
Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)

Pagefault again

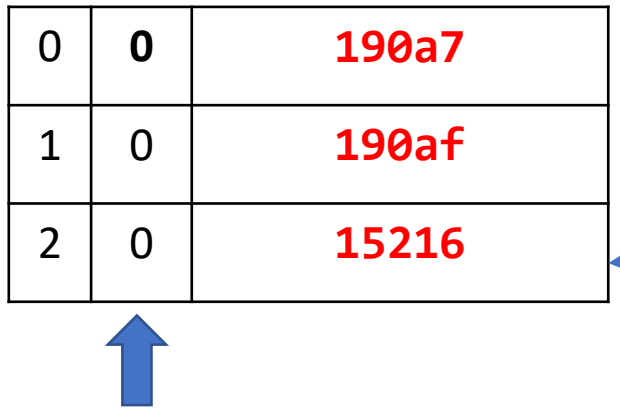


We need to evict someone!!
Entry 1: R bit is 0
Evict entry 1

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume Second Chance Algorithm
  - Referenced bit (R bit)



We need to evict someone!!
Entry 1: R bit is 0
Evict entry 1

Similar as FIFO but pages accessed again will get another chance

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190a7c24
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT

0		
1		
2		

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning

0		
1		
2		

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	**190a7**
1	**3856b**
2	**190af**

We need to evict someone!!

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	**190a7**
1	**3856b**
2	**190af**

We need to evict someone!!

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Pagefault again

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	**190a7**
1	**3856b**
2	**190af**

We need to evict someone!!
But page 190a7 will be used later!

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	190a7
1	3856b
2	190af

We need to evict someone!!
But page 190a7 will be used later!

Go next until find one that is no longer needed in the future

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	190a7
1	190af
2	

We need to evict someone!!
But page 190a7 will be used later!

Go next until find one that is no longer needed in the future

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	**190a7**
1	**190af**
2	**15216**

We need to evict someone!!
But page 190a7 will be used later!

Go next until find one that is no longer needed in the future

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	190a7
1	3856b
2	15216

What if there is a tie?
Multiple pages no longer needed in the future?

We need to evict someone!!
But page 190a7 will be used later!

Go next until find one that is no longer needed in the future

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Let's suppose you have 12KB of physical memory
  - Page has 4KB
  - Assume OPT
  - You already know memory access trace at the beginning
  - When evicting needed

0	190a7
1	3856b
2	15216

What if there is a tie?
Multiple pages no longer needed in the future?
Use LRU among those tie pages

We need to evict someone!!
But page 190a7 will be used later!

Go next until find one that is no longer needed in the future

Pagefault again

```
l 190a7c20
s 3856bbe0
l 190afc20
l 15216f00
l 190a7c20
l 190a7c28
l 190a7c28
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Few Tips about OPT:
  - If you use naïve way of looking up across all traces you will **TIMEOUT**

Project 3 - Virtual Memory Simulator

- Few Tips about OPT:
  - If you use naïve way of looking up across all traces you will **TIMEOUT**
  - **How to reduce looking up time**

Project 3 - Virtual Memory Simulator

- Few Tips about OPT:
  - If you use naïve way of looking up across all traces you will **TIMEOUT**
  - **How to reduce looking up time**: Save all page information in **a hash table**

Project 3 - Virtual Memory Simulator

- Few Tips about OPT:
  - If you use naïve way of looking up across all traces you will **TIMEOUT**
  - **How to reduce looking up time**: Save all page information in **a hash table**
    - **<Page>:<recording number of lines>**

Project 3 - Virtual Memory Simulator

- Few Tips about OPT:
  - If you use naïve way of looking up across all traces you will **TIMEOUT**
  - **How to reduce looking up time**: Save all page information in **a hash table**
    - **<Page>:<recording number of lines>**

```
l 190a7c20
s 3856bbe0
l 190afc21
l 15216f00
l 190a7c22
l 190aff38
```

Project 3 - Virtual Memory Simulator

- Few Tips about OPT:
  - If you use naïve way of looking up across all traces you will **TIMEOUT**
  - **How to reduce looking up time**: Save all page information in **a hash table**
    - **<Page>:<recording number of lines>**

190a7	0, 4
3856b	1
190af	2,5
15216	3

```
l 190a7c20
s 3856bbe0
l 190afc21
l 15216f00
l 190a7c22
l 190aff38
```

Project 3 - Virtual Memory Simulator

- No need to use qemu
- You will write the simulator from scratch with Java, C/C++,Perl, or Python
- Read from memory traces text files
- Count the number of events (pagefaults, page evictions etc.)
  - Compare eviction algorithms

CS 1550 – Project 3

- **Due**: Monday, April 6th, 2020 @11:59pm
- **Late**: Wednesday, Apr 8th, 2020 @11:59pm with 10% reduction per late day