

---

# **CSE3421**

## **Computer Architecture**

### **Homework 6**

Xiaodong Zhang

## Problem 1

---

The following sequence of 15 virtual page numbers is requested during a virtual-physical memory allocation:

3, 4, 2, 6, 4, 7, 1, 3, 2, 6, 3, 5, 1, 2, 3

**LRU** (Least Recent Used) page replacement is used in the system. The physical memory page capacity has 8 options: 1 page, 2 pages, 3 pages, 4 pages, 5 pages, 6 pages, 7 pages, and 8 pages.

Calculate the page hit ratio for each option, which is the fraction of page references in the physical memory in the 15 references. We assume that the main memory is initially empty.

# Problem 1

---

Review the Slides of LRU and Clock

Building your own LRU stack of pages 2, 3, 4, 5, 6, 7, and 8 to record each access of the page sequence and make the eviction decision. Page hits and misses can be observed in this process.

## Problem 2

---

Considering the following nested sequential loop:

```
For i = 1 to 10
  For j = 1 to 10
    x(j) = x(j) + 1;
```

All the operations are performed in the cache by LRU replacement, and the cache size is 9 elements.

Only consider the access to variable X. Indices i and j are not in the scope of the consideration.

Reviewing the loop example in Slides of LRU and Clock

## **Problem 3**

---

Consider a virtual address space for 32 pages of 2-KBytes each, which is mapped to a 1-MByte physical memory space.

# Inside Page Table

Virtual Address (VA):

virtual page #    offset

## Page Table

Page Table Register

index  
into  
page  
table

...		
<b>V</b>	<b>A.R.</b>	<b>P. P. N.</b>
Val -id	Access Rights	Physical Page Number
1	A.R.	P. P. N.
0	A.R.	
...		

**Access Rights:** None, Read Only,  
Read/Write, Execute  
**Valid bit:** 0 in disk, 1 in memory

Physical  
Memory  
Address (PA)

disk

# What does the Page Table Tell Us?

---

- The number of virtual pages determines the number of entries of the page table, which is the height of the page table
- Physical Page Number (P.P.N) is the physical memory page index bits. (table width disregarding V bit and Access Right bits)
- Page offsets in both virtual and physical space are predefined and consistent, and no need to be stored in the table