

# CS186 Discussion 3

(Buffer Management, PySpark)

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# Buffer Management

# Buffer Management

- Buffer pool
  - In-memory cache for database tables
- Not all data can fit in memory at once
- Which data should we keep?
  - Buffer replacement policies
    - Least Recently Used (LRU)
    - Most Recently Used (MRU)
    - Clock

# Least Recently Used (LRU)

- Evict page that has been least recently used
- Must keep track of when pages were used
- Prone to sequential flooding
- Example: A, B, C, D, E, A, B, C, D

<b>1</b>	A								
<b>2</b>		B							
<b>3</b>			C						
<b>4</b>				D					

Hit Rate:

# Least Recently Used (LRU)

- Evict page that has been least recently used
- Must keep track of when pages were used
- Prone to sequential flooding
- Example: A, B, C, D, E, A, B, C, D

1	A				E				D
2		B				A			
3			C				B		
4				D				C	

Hit Rate: 0/9

# Most Recently Used (MRU)

- Evict page that has been most recently used
- Must keep track of when pages were used
- Solves sequential flooding
- Example: A, B, C, D, E, A, B, C, D

<b>1</b>	A								
<b>2</b>		B							
<b>3</b>			C						
<b>4</b>				D					

Hit Rate:

# Most Recently Used (MRU)

- Evict page that has been most recently used
- Must keep track of when pages were used
- Solves sequential flooding
- Example: A, B, C, D, E, A, B, C, D

1	A					*			
2		B					*		
3			C					*	D
4				D	E				

Hit Rate: 3/9

# Clock

- Approximation for LRU
- Use reference bits
- Each page gets a second chance
- Example: A, B, C, D, E, A, B, C, D

<b>1</b>	A								
<b>2</b>		B							
<b>3</b>			C						
<b>4</b>				D					

Hit Rate:



# Clock

```
if HIT:
    reference bit = 1
else:
    while reference bit != 0:
        reference bit = 0
        move hand
    replace page
    reference bit = 1
    move hand
```

# Clock

- Approximation for LRU
- Use reference bits
- Each page gets a second chance
- Example: A, B, C, D, E, A, B, C, D

<b>1</b>	A				E				D
<b>2</b>		B				A			
<b>3</b>			C				B		
<b>4</b>				D				C	

Hit Rate: 0/9

# Buffer Replacement Worksheet

# Buffer Replacement Exercises

Fill in the following tables for the given buffer replacement policies. You have 4 buffer pages, with the access pattern  
**A B C D A F A D G D G E D F**

## 1. Least Recently Used (LRU)

<b>1</b>	A													
<b>2</b>		B												
<b>3</b>			C											
<b>4</b>				D										

Hit Rate:

# Buffer Replacement Exercises

Fill in the following tables for the given buffer replacement policies. You have 4 buffer pages, with the access pattern  
**A B C D A F A D G D G E D F**

## 1. Least Recently Used (LRU)

<b>1</b>	A				*		*							F
<b>2</b>		B				F						E		
<b>3</b>			C						G		*			
<b>4</b>				D				*		*			*	

Hit Rate: 6/14

# Buffer Replacement Exercises

Fill in the following tables for the given buffer replacement policies. You have 4 buffer pages, with the access pattern  
**A B C D A F A D G D G E D F**

## 2. Most Recently Used (MRU)

<b>1</b>	A													
<b>2</b>		B												
<b>3</b>			C											
<b>4</b>				D										

Hit Rate:

# Buffer Replacement Exercises

Fill in the following tables for the given buffer replacement policies. You have 4 buffer pages, with the access pattern  
**A B C D A F A D G D G E D F**

## 2. Most Recently Used (MRU)

<b>1</b>	A				*	F	A							
<b>2</b>		B												
<b>3</b>			C											
<b>4</b>				D				*	G	D	G	E	D	F

Hit Rate: 2/14

# Buffer Replacement Exercises

Fill in the following tables for the given buffer replacement policies. You have 4 buffer pages, with the access pattern  
**A B C D A F A D G D G E D F**

## 3. Clock

<b>1</b>	A													
<b>2</b>		B												
<b>3</b>			C											
<b>4</b>				D										

Hit Rate:



# Buffer Replacement Exercises

Fill in the following tables for the given buffer replacement policies. You have 4 buffer pages, with the access pattern  
**A B C D A F A D G D G E D F**

## 3. Clock

<b>1</b>	A				*	F							D	
<b>2</b>		B					A							F
<b>3</b>			C						G		*			
<b>4</b>				D				*		*		E		

Hit Rate: 4/14

# Buffer Replacement Exercises

Is MRU ever better than LRU?

# Buffer Replacement Exercises

Is MRU ever better than LRU?

Sequential Scans – Flooding

# Buffer Replacement Exercises

Why would we use a clock replacement policy over LRU?

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Efficiency (Clock approximates LRU)

# Buffer Replacement Exercises

Why would it be useful for a database management system to implement its own buffer replacement policy? Why shouldn't we just rely on the operating system?

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Why would it be useful for a database management system to implement its own buffer replacement policy? Why shouldn't we just rely on the operating system?

The database management system knows its data access patterns, which allows it to optimize its buffer replacement policy for each case