COP 4600 – Summer 2014

Introduction To Operating Systems

Exam #2 Review

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Material Covered On Exam

Memory Management – All four sections of memory management will be covered on this exam.

This is the only material that will appear on this exam. Nothing related to device management will appear on this exam.

Format of the Exam

- The exam will consist of multiple choice and true/false questions plus short answer/work problems.
- There will be 20-25 multiple choice and true/false questions and short answer/work problems. The work problems will be most similar to those found on homework 2 and homework 3.

Sample Questions:

1. Given the following process page table and assuming that each page/frame is 1024 bytes in size, determine the physical address that corresponds to each logical address shown.

Page #	Frame #
0	17
1	23
2	19
3	2
4	11

a) Logical address <3, 950>

b) Logical address <2, 1300>

c) Logical address <4, 440>

d) Logical address <0, 256>

Sample Questions:

2. Suppose a dynamic partitioning scheme is used and the free partition list current includes blocks of size 600, 400, 1000, 2200, 1600, and 1050 bytes, in that order.

   (a) which block will be selected to satisfy a request for 1603 bytes using the best-fit strategy?

   (b) which block will be selected to satisfy a request for 949 bytes using the best-fit strategy?

   (c) which block will be selected to satisfy a request for 349 bytes using the worst-fit policy?

   (d) which block will be selected to satisfy a request for 500 bytes using the worst-fit strategy?

Sample Questions:

3. The following sequence of requests are issued to the memory manager:
   - Allocate block b1 of size 100 MB.
   - Allocate block b2 of size 500 MB.
   - Allocate block b3 of size 60 MB.
   - Allocate block b4 of size 100 MB.
   - Release block b1.
   - Release block b3.
   - Allocate block b5 of size 50 MB.
   - Allocate block b6 of size 90 MB.

   Assuming a total memory of size 1024 MB, list the starting addresses and The sizes of all free blocks for the (a) first-fit, and (b) best-fit memory management schemes after all the above requests have been processed. Assume that memory compaction does not occur unless a request cannot be fulfilled.

Sample Questions:

4. Consider a logical address space of 10 pages of 4096 words/page, mapped onto a physical memory of 64 frames. (a) How many bits total are there in the logical address? (b) How many bits total are there in the physical address?

5. Given the reference string shown below, determine the number of page faults that occur for this reference string when a FIFO page replacement policy is used with both a three and a four frame allocation.

   ref. string = 1, 3, 5, 4, 3, 2, 5, 6, 5, 4, 3, 4, 2, 3, 4, 5, 6, 2, 3, 4

Sample Questions:

6. Given the reference string shown below, determine the number of page faults that occur for this reference string when a LRU page replacement policy is used with both a three and a four frame allocation.

   ref. string = 1, 3, 5, 4, 3, 2, 5, 6, 5, 4, 3, 4, 2, 3, 4, 5, 6, 2, 3, 4

7. Given the reference string shown below, determine the number of page faults that occur for this reference string when the Optimal page replacement policy is used with both a three and a four frame allocation.

   ref. string = 1, 3, 5, 4, 3, 2, 5, 6, 5, 4, 3, 4, 2, 3, 4, 5, 6, 2, 3, 4

Sample Questions:

8. Suppose that we are using the PFF (Page Fault Frequency) algorithm for controlling thrashing. We have set the maximum page fault frequency threshold to be 10 faults/10,000 requests and the minimum page fault frequency threshold to be 4 faults/10,000 requests.

   a) A process is currently experiencing a fault rate of 3 faults/10,000 requests. What should happen to the process?

   b) A process is currently experiencing a fault rate of 12 faults/10,000 requests. What should happen to the process?

   c) A process is currently experiencing a fault rate of 6 faults/10,000 requests. What should happen to the process?

Sample Questions:

9. Given the reference string shown below, determine the working set at each reference, the average size of the working set, and the total number of page faults that occur for this reference string when the Working Set algorithm is used to for the page replacement policy. Assume that $\Delta = 3$.

   ref. string = 1, 3, 5, 4, 3, 2, 5, 6, 5, 4, 3, 4, 2, 3, 4, 5, 6, 2, 3, 4

Sample Questions: **ANSWERS**

1. Given the following process page table and assuming that each page/frame is 1024 bytes in size, determine the physical address that corresponds to each logical address shown.

Page #	Frame #
0	17
1	23
2	19
3	2
4	11

a) Logical address <3, 950> = (2 x 1024 + 950) = 2998

b) Logical address <2, 1300> = invalid, 1300 > 1024

c) Logical address <4, 440> = (11 x 1024 + 440) = 11704

d) Logical address <0, 256> = (17 x 1024 + 256) = 17664

Sample Questions: **ANSWERS**

2. Suppose a dynamic partitioning scheme is used and the free partition list current includes blocks of size 600, 400, 1000, 2200, 1600, and 1050 bytes, in that order.

   (a) which block will be selected to satisfy a request for 1603 bytes using the best-fit strategy? The block of size 2200.

   (b) which block will be selected to satisfy a request for 949 bytes using the best-fit strategy? The block of size 1000.

   (c) which block will be selected to satisfy a request for 349 bytes using the worst-fit policy? The block of size 2200.

   (d) which block will be selected to satisfy a request for 500 bytes using the worst-fit strategy? The block of size 2200.

Sample Questions: **ANSWERS**

3. First-fit:

Action:							
Allocate b1	b1 = 100 MB	924 MB					
0	100			1024			
Allocate b2	b1 = 100 MB	b2 = 500 MB	424 MB				
0	100	600		1024			
Allocate b3	b1 = 100 MB	b2 = 500 MB	b3 = 60 MB	364 MB			
0	100	600	660		1024		
Allocate b4	b1 = 100 MB	b2 = 500 MB	b3 = 60 MB	b4 = 100 MB	264 MB		
0	100	600	660	760	1024		
Deallocate b1	100 MB	b2 = 500 MB	b3 = 60 MB	b4 = 100 MB	264 MB		
0	100	600	660	760	1024		
Deallocate b3	100 MB	b2 = 500 MB	60 MB	b4 = 100 MB	264 MB		
0	100	600	660	760	1024		
Allocate b5	b5 = 50 MB	50 MB	b2 = 500 MB	60 MB	b4 = 100 MB	264 MB	
0	50	100	600	660	760	1024	
Allocate b6	b5 = 50 MB	50 MB	b2 = 500 MB	60 MB	b4 = 100 MB	b6 = 90 MB	174 MB
0	50	100	600	660	760	850	1024

Sample Questions: **ANSWERS**

3. Best-fit:

Action:							
Allocate b1	b1 = 100 MB	924 MB					
0	100			1024			
Allocate b2	b1 = 100 MB	b2 = 500 MB	424 MB				
0	100	600		1024			
Allocate b3	b1 = 100 MB	b2 = 500 MB	b3 = 60 MB	364 MB			
0	100	600	660		1024		
Allocate b4	b1 = 100 MB	b2 = 500 MB	b3 = 60 MB	b4 = 100 MB	264 MB		
0	100	600	660	760	1024		
Deallocate b1	100 MB	b2 = 500 MB	b3 = 60 MB	b4 = 100 MB	264 MB		
0	100	600	660	760	1024		
Deallocate b3	100 MB	b2 = 500 MB	60 MB	b4 = 100 MB	264 MB		
0	100	600	660	760	1024		
Allocate b5	100 MB	b2 = 500 MB	b5 = 50 MB	10 MB	b4 = 100 MB	264 MB	
0	100	600	650	660	760	1024	
Allocate b6	b6 = 90 MB	10 MB	b2 = 500 MB	b5 = 50 MB	10 MB	b4 = 100 MB	264 MB
0	90	100	600	650	660	760	1024

Sample Questions: ANSWERS

4. Consider a logical address space of 10 pages of 4096 words/page, mapped onto a physical memory of 64 frames.
   (a) How many bits total are there in the logical address?
   (b) How many bits total are there in the physical address?

(a) Logical address space = 10 x 4096 = 40960 words

2^{15} =32768 and 2^{16} = 65536, so 16 bits are required to cover the logical address space.

(b) Physical address space = 64 x 4096 = 262144 words

2^{18} = 262144, so 18 bits are required for the physical address

Sample Questions: ANSWERS

5.

FIFO

ref. string	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 1	1	3	5	4	4	2	2	6	5	4	3	3	2	2	2	5	6	6	3	4
frame 2		1	3	5	5	4	4	2	6	5	4	4	3	3	3	2	5	5	6	3
frame 3			1	3	3	5	5	4	2	6	5	5	4	4	4	3	2	2	5	6
page fault	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	Y

total page faults = 14

ref. string	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 1	1	3	5	4	4	2	2	6	6	6	3	3	3	3	3	5	5	5	5	4
frame 2		1	3	5	5	4	4	2	2	2	6	6	6	6	6	3	3	3	3	5
frame 3			1	3	3	5	5	4	4	4	2	2	2	2	2	6	6	6	6	3
frame 4				1	1	3	3	5	5	5	4	4	4	4	4	2	2	2	2	6
page fault	Y	Y	Y	Y	N	Y	N	Y	N	N	Y	N	N	N	N	Y	N	N	N	Y

total page faults = 9

Sample Questions: ANSWERS

6.

LRU

ref. string	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 1	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 2		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3
frame 3			1	3	5	4	3	2	2	6	5	5	3	4	2	3	4	5	6	2
page fault	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y

total page faults = 15

ref. string	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 1	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 2		1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	6	3
frame 3			1	3	5	4	3	2	2	6	5	5	3	4	2	3	4	5	5	6
frame 4				1	1	5	4	3	3	2	6	6	5	5	5	2	3	4	4	5
page fault	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	N	N	Y	Y	Y	N

total page faults = 13

Sample Questions: ANSWERS

7.

Optimal

ref. string	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 1	1	3	3	3	5	5	5	5	4	4	4	3	3	4	2	2	2	2	2	2
frame 2		1	5	5	4	4	4	4	5	5	3	4	4	2	3	3	3	3	3	3
frame 3			1	4	3	2	2	6	6	6	5	5	2	3	4	5	6	6	6	4
page fault	Y	Y	Y	Y	N	Y	N	Y	N	N	Y	N	Y	N	N	Y	Y	N	N	Y

total page faults = 11

ref. string	1	3	5	4	3	2	5	6	5	4	3	4	2	3	4	5	6	2	3	4
frame 1	1	3	3	3	5	5	5	5	4	3	4	3	3	4	5	2	2	2	2	2
frame 2		1	5	5	4	4	4	4	3	4	3	4	4	5	2	3	3	3	3	3
frame 3			1	4	3	3	3	3	5	5	5	5	5	2	3	4	4	4	4	4
frame 4				1	1	2	2	6	6	6	6	6	2	3	4	5	6	6	6	6
page fault	Y	Y	Y	Y	N	Y	N	Y	N	N	N	N	Y	N	N	N	Y	N	N	N

total page faults = 8

Sample Questions: ANSWERS

8. Suppose that we are using the PFF (Page Fault Frequency) algorithm for controlling thrashing. We have set the maximum page fault frequency threshold to be 10 faults/10,000 requests and the minimum page fault frequency threshold to be 4 faults/10,000 requests.

   a) A process is currently experiencing a fault rate of 3 faults/10,000 requests. What should happen to the process?

   The page frame allocation should be decreased as the process is faulting below the minimum threshold, thus it has too many page frames.

   b) A process is currently experiencing a fault rate of 12 faults/10,000 requests. What should happen to the process?

   The page frame allocation should be increased as the process if faulting above the maximum threshold, thus it has an insufficient number of page frames to cover its locality.

   c) A process is currently experiencing a fault rate of 6 faults/10,000 requests. What should happen to the process?

   Do nothing. The process is executing within the threshold settings and has an optimal number of page frames.

Sample Questions: ANSWERS

9.

Working Set Model: Δ = 3			
Reference String	Working Set	Working Set Size	Page Fault
1	{1}	1	Y
3	{1,3}	2	Y
5	{1,3,5}	3	Y
4	{3,5,4}	3	Y
3	{5,4,3}	3	N
2	{4,3,2}	3	Y
5	{3,2,5}	3	Y
6	{2,5,6}	3	Y
5	{6,5}	2	N
4	{6,5,4}	3	Y
3	{5,4,3}	3	Y
4	{3,4}	2	N
2	{3,4,2}	3	Y
3	{4,2,3}	3	N
4	{2,3,4}	3	N
5	{3,4,5}	3	Y
6	{4,5,6}	3	Y
2	{5,6,2}	3	Y
3	{6,2,3}	3	Y
4	{2,3,4}	3	Y
	average size =	2.75	
		Page Faults =	13