[2024-25] COMP2432 Operating Systems — **Assignment III**
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Question 1: Consider the following reference string of length 20 generated by a process for which 3 memory frames are allocated for a process with 7 pages: 0, 1, 2, 3, 4, 5, 6. Indicate the content of the frames after each page indicated by the reference string is accessed, including the page fault. How many page faults are generated from the reference string? Answer the question based on 3 different page replacement algorithms: (a) FIFO, (b) Optimal, and (c) LRU based on stack implementation. Show the content of the stack for (c). For Optimal, there could be multiple possible answers.

Reference String: 0 4 1 4 2 3 5 6 2 4 0 1 3 5 6 0 2 4 1 3

Repeat the question with 4 memory frames.

(d) Consider the case with 3 memory frames. Is it possible to insert one item in the reference string that will reduce the number of page faults for FIFO? If possible, indicate your reference string. If not possible, say so. Is it possible to insert one item in the reference string that will reduce the number of page faults for LRU? If possible, indicate your reference string. Is it possible to insert one item in the reference string that will reduce the number of page faults for both FIFO and LRU? If possible, indicate your reference string. If not possible, say so.

Question 2: In a computer system, a new page replacement algorithm called the "Cyclic History Prediction" (CHP) is proposed. This algorithm predicts future page references based on a cyclic pattern observed in past references. The algorithm uses a cycle period CC to predict future references by looking back CC steps in the reference string. If the reference string is shorter than CC, the algorithm wraps around to the beginning of the string. Consider the following reference string of length 20 for a process with 3 memory frames and 7 pages: 0, 1, 2, 3, 4, 5, 6.

Reference String: 0 4 1 4 2 3 5 6 2 4 0 1 3 5 6 0 2 4 1 3

Apply the CHP algorithm on the reference string for 3 memory frames, by selecting C=6and C=4 respectively. Indicate the page faults. Repeat the question with 4 memory frames.

Compare the page fault performance of CHP with the LRU algorithm for the same reference string and memory frames. Which algorithm performs better in terms of page faults?

Question 3: Consider a system with 6 processes (P0, P1, P2, P3, P4, P5) and 4 resource types (A, B, C, D). The current allocation, maximum demand, and available resources are given below. Use the Banker's Algorithm to analyze the system's state. The current allocation and maximum demand are as follows:

Process	Allocation (A, B, C, D)	Maximum (A, B, C, D)
P0	2, 0, 1, 1	4, 3, 3, 4
P1	1, 1, 2, 1	3, 4, 2, 3
P2	1, 0, 0, 2	2, 0, 1, 2
P3	2, 4, 3, 2	4, 4, 3, 4
P4	0, 0, 1, 0	1, 0, 1, 1
P5	1, 0, 1, 1	2, 3, 2, 2

Available Resources: 1, 1, 1, 1
Request by P0: 1, 0, 1, 1

Questions:

(a) Show that the request by P0 can be granted with respect to the resource allocation state using deadlock avoidance. Provide a possible safe sequence after the pretended allocation and indicate the number of possible safe sequences.

(b) After the request by P0 is satisfied, another process Px apologizes for under-reporting its maximum need in one of the resource types by one. Due to network noise, only the last two bits of the identity of x are correctly received by the operating system, and the type of the resource under-reported is corrupted. However, the operating system concludes that the corrected resource allocation state remains safe. Determine the possible identities of x. Explain your reasoning.

(c) After a while, Px reports that its original report on maximum need was correct, and the mistake was a false alarm. Another distinct process Py ($y \neq x$) apologizes for under-reporting its maximum need in one of the resource types Y by one. Knowing Y, the operating system concludes that the corrected resource allocation state remains safe. Determine the possible identities of Y. Explain your reasoning.

Question 4: Consider a computer system with a memory of 8KB allocated for users, with physical addresses ranging from 0 to 8191. The memory from 0 to 999 and from 6789 to 8191 is reserved by the operating system. The remaining memory is available for user processes. Process P1 has the following segment table:

Segment	Base	Length/Limit
0	3011	135
1	1901	234
2	5678	543
3	2432	304
4	4434	787
5	1011	345
6	3901	135

Segment 3 of P1 is a shared segment with segment 6 of P2. Process P2 has 7 segments with sizes 55, 604, 103, 212, 72, 352, and 304, respectively, starting from segment 0 to segment 6. Segment 3 of P1 and segment 6 of P2 have the same size because they are shared.

Allocate segments for P2 using the following memory allocation algorithms: (a) First-fit algorithm (b) Best-fit algorithm (c) Worst-fit algorithm. Show the segment tables for P2 under each algorithm. Draw diagrams to illustrate memory allocation for clarity.

(d) Translate the following logical addresses for P1 and P2 by filling in the table below:

Allocation Algorithm for P2	Logical Address	Physical Address for P1	Physical Address for P2
FF	(0, 44)		
BF	(1, 231)		
WF	(2, 82)		
FF	(3, 199)		
BF	(4, 56)		
WF	(5, 304)		
FF	(6, 135)		