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CS 4/53201 **Exam #2** Operating Systems

Wednesday 8 November 2000

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1. Fill in the table below, writing "yes" or "no" (the whole word) in the second and third columns to describe each of the four CPU scheduling algorithms. (20 points)

Algorithm Name	Pre-emptive?	Starvation Possible?
First-Come First-Served	No	No
Shortest Job First	No	Yes
Round Robin	Yes	No
Shortest Remaining Time	Yes	Yes

2. In the children's game of "Cootie," each player is supposed to roll the dice, and based on the values received, eventually collect enough body parts (1 head, 1 body, 2 antennae, and 6 legs) to build a complete "cootie" (a cootie is a type of insect). When you buy the box, it comes with enough parts for four players to complete the game.

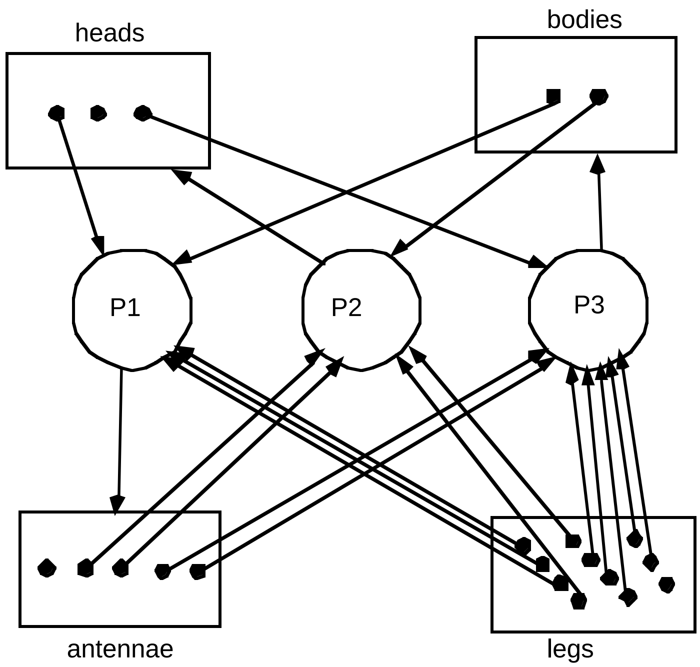
However, in this particular case, some parts have been lost and there are more than four people who want to play. Therefore, the rules are changed slightly — players still roll dice to request parts, but if the parts aren't available, they have to wait until they are. When a player makes a complete Cootie, she takes it apart and returns its pieces to the pile.

Suppose that the box has 3 heads, 2 bodies, 11 legs, and 5 antennae. There are 3 players.

Player 1 has 1 head, 1 body, and 3 legs;
player 2 has 1 body , 2 antennae, and 2 legs; and
player 3 has 5 legs, 1 head, and 2 antennae.

Player 1 is currently waiting for an antenna,
player 2 is currently waiting for a head, and
player 3 is currently waiting for a body.

a. Draw a resource allocation diagram that describes the situation. (Hint: body parts are resources) (10 points)



I had in mind a resource allocation graph like the one above, but if you drew data structures like those for Coffman's deadlock detection algorithm, I gave full credit.

b. List the four conditions of deadlock and explain why each of them does or does not hold in this situation. (10 points)

Mutual exclusion: holds because only one player can hold a body part at a time.

No preemption: holds because parts can not be taken away from a player once held.

Hold and wait: holds because a player can hold some body parts while waiting to acquire more.

Circular wait: does not hold. Although all legs are held, no one is waiting to acquire legs. All bodies are held, but the only one waiting on bodies is P3, which is holding heads and antennae, and unused instances of both those resources are available to those who are waiting on them.

3. Assume that memory has been allocated among 3 processes (P1, P2, and P3) as shown in the diagram below. Now suppose three new processes request memory, in this order: P4 — size 180, P5 — size 95, and P6 — size 220. Draw two additional diagrams, one showing the result of the Next Fit algorithm, and the second showing the result of the Best Fit algorithm, after these new processes have been added. Be sure to label which diagram is which. (20 points)

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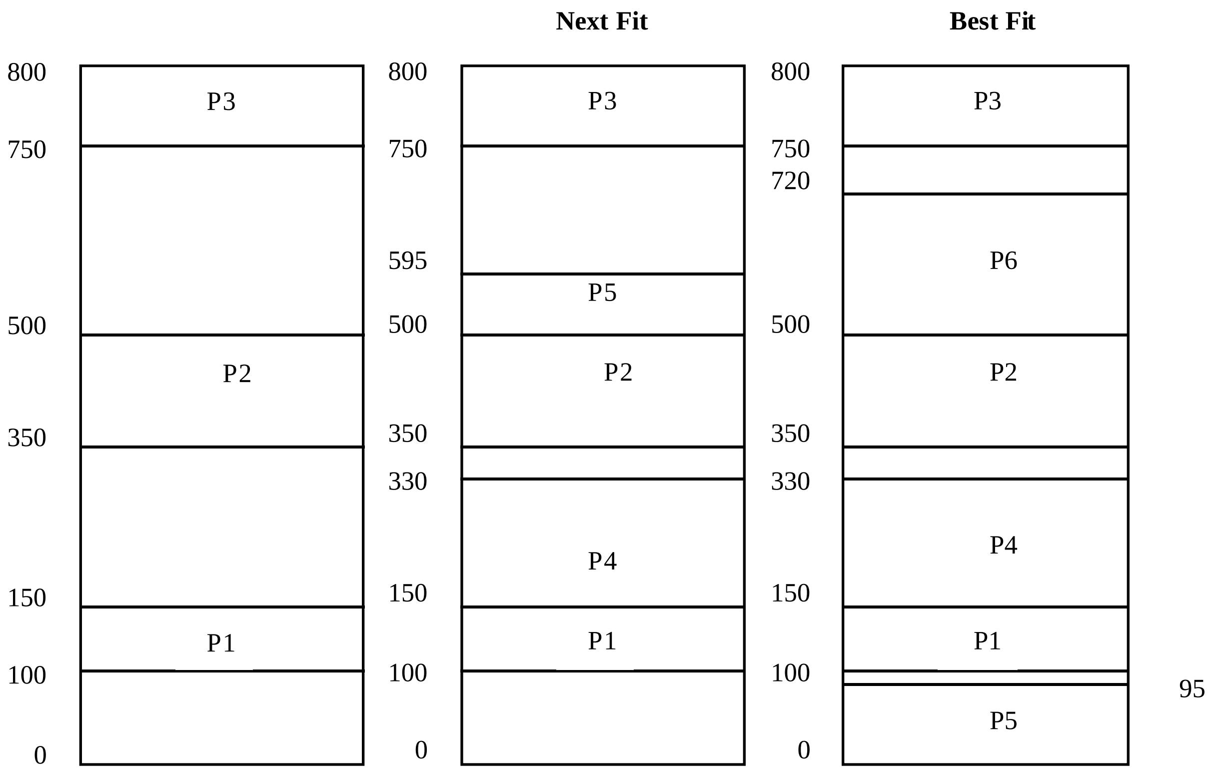

In Next Fit, P6 will not fit into memory.

Note that there really is a "Next Fit" algorithm, as was mentioned in class. However, since I was thinking of "First Fit" when I wrote this question, and since the professor who proctored the exam said First Fit was acceptable, I gave full credit for First Fit as well.

Using First Fit, the diagram looks exactly the same as the one on the right.

(Results vary if you scan from the top instead of the bottom.)

4. In a system that uses paging, each virtual address is 16 bits long, of which the 10 most significant bits specify the page number, and the remaining 6 bits specify the offset. Each entry in the page table specifies an 8-bit base address in physical memory. Answer the following questions (answers specified as powers of two are fine).

a. What is the maximum number of pages of virtual memory available to each process? (3 points)

2^10 = 1024 (since there are 10 bits to specify the page number)

b. What is the maximum number of frames of physical memory? (3 points)

2^8 = 256 (since there are 8 bits to specify the frame number in physical memory)

c. How many words are in a page or frame? (4 points)

2^6 = 64 (since there are 6 bits to specify the offset within the page)

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d. Suppose the page table for a given process is as given below. What is the physical address that corresponds to the virtual address 0000 0000 1100 1001? (Spaces are given only to help you count bits). (10 points)

0: 1010 1111
1: 0000 0000
2: 1110 1000
3: 1111 0000
4: 0011 0011
5: 0100 1001

It is on page 3 (0000 0000 11), so copy the bits corresponding to page 3's frame as shown in the page table (1111 0000) into the most significant bits of the physical address, and then add the offset (00 1001), giving 1111 0000 00 1001.

5. Suppose you have a memory with 4 frames, and the reference string:

7 0 1 2 0 3 0 4 2 3 0 3 2 1 2 7 4 6 5 4 6 (these numbers refer to page numbers)

For each of the following algorithms, what is the total number of page faults? Show your work! (20 points)

a. FIFO

7	**0**	**1**	**2**	**0**	**3**	**0**	**4**	**2**	**3**	**0**	**3**	**2**	**1**	**2**	**7**	**4**	**6**	**5**	**4**	**6**
7					3									2				5		
	0						4								7					
		1								0						4				
			2										1				6			

13 page faults

b. LRU

7	**0**	**1**	**2**	**0**	**3**	**0**	**4**	**2**	**3**	**0**	**3**	**2**	**1**	**2**	**7**	**4**	**6**	**5**	**4**	**6**
7					3											4				
	0														7					
		1					4						1				6			
			2															5		

11 page faults