CS211: Programming and Operating Systems

Semester 2 Assignment, 2019/2020

You are expected to adhere to the highest standards of integrity and honesty when completing this assessment.
If there is any concern in relation to the integrity of the assessment, you may be required to participate in an interview to verify the originality of your work. NUI Galway's policies on ***Academic Integrity*** *will be enforced. For more details, see* `http://www.nuigalway.ie/centre-excellence-learning-teaching/teachinglearning/academicintegrity`

If at all possible, you should submit your work as a typed document, converted to PDF. It should be uploaded to the "Assignment" section of the CS211 Blackboard module. If you cannot do this (for example, you wish to submit hand-written work), you must make alternative arrangements with Niall Madden no later than Monday 6th April.

Deadline: 5pm Thursday 9th April 2020.

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Q1. (a) [**6 Marks**] What are the *First-Fit* (FF), *Best-Fit* (BF) and *Worst-Fit* (WF) schemes for memory allocation?

Suppose a system with memory partitions of size 200k, 500k, 340k, and 200k in that order. In cases **A** and **B** below four jobs requiring (contiguous) memory space of various sizes are submitted at the same in the order given below. Show how the FF, BF and WF schemes would allocate memory for these processes.

A

Process	Size
P_1	240k
P_2	350k
P_3	150k
P_4	200k

B

Process	Size
P_1	240k
P_2	300k
P_3	250k
P_4	210k

(b) [**4 Marks**] Suppose a system's cache has space for three pages, a program has the following stream of virtual pages (also called the "page reference string")

$$\{1, 2, 3, 3, 4, 3, 1, 2, 3, 4\}.$$

Calculate the "hit rate" for each of the *First-In-First-Out* (FIFO), *Optimal* and *Least Recently Used* (LRU) Page Replacement policies.

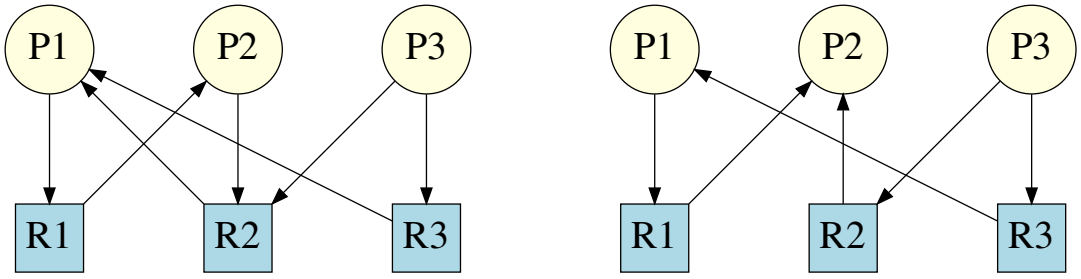
Q2. (a) [**2 Marks**] What is a **Resource Allocation Graph**? Explain the relation between cycles in the graph and system deadlock in the case where there is a single instance of each resource.

(b) [**6 Marks**] Consider the two Resource Allocation Graphs in Figure 1, both for the scenario where we have three processes, $P1$, $P2$, and $P3$, which are three resources, $R1$, $R2$, and $R3$.

i. Determine if it represents a deadlocked state.

ii. If it is deadlocked, explain why.

iii. If it is not deadlocked, explain how the resource allocation would proceed so that, eventually, all processes received their desired resource allocation. (You may assume that if a process has its desired resource allocation it will eventually terminate and release those resources).



(a) Example 1 (b) Example 2

Figure 1: Two resource allocation graphs for Q2-(a)

(c) [**2 Marks**] Suppose a system has four resources of the same type, and three running processes, each of which requires two resources. Will this system reach deadlock? Explain your answer.

. . . . . .

Q3. (a) [**2 Marks**] What is a *process*? Name the five possible states of process activity.

(b) [**8 Marks**] Explain the following CPU scheduling algorithms, mentioning an advantage and a disadvantage of each:

(i) *First-Come-First-Served* (FCFS),

(ii) *Shortest-Job-First* (SJF),

(iii) *Round-Robin* (RR).

The table below shows the CPU burst times (in seconds) of four processes submitted in the given order, all at time $t = 0$. Calculate the average wait and response times for each of FCFS, SJF, and RR with a time quantum of $q = 4$ seconds.

Process	P_1	P_2	P_3	P_4
Burst Time	20	4	10	2