EI338 Computer System Engineering Homework 11

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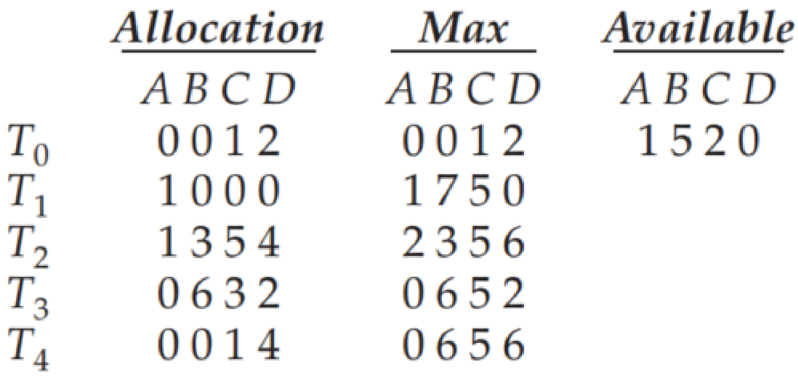
Exercise 1 Consider the following snapshot of a system:



	Allocation	Max	Available
	A B C D	A B C D	A B C D
T_0	0 0 1 2	0 0 1 2	1 5 2 0
T_1	1 0 0 0	1 7 5 0	
T_2	1 3 5 4	2 3 5 6	
T_3	0 6 3 2	0 6 5 2	
T_4	0 0 1 4	0 6 5 6	

Answer the following questions using the banker algorithm:

a) What is the content of the matrix Need?

b) Is the system in a safe state?

c) If a request from thread T_1 arrives for (0,4,2,0), can the request be granted immediately?

Solution.

1. The need matrix is shown in Figure 1

	A	B	C	D
T0	0	0	0	0
T1	0	7	5	0
T2	1	0	0	2
T3	0	0	2	0
T4	0	6	4	2

Table 1: Need matrix

2. Yes. The sequence can be $\langle T_0(1,5,3,2), T_3(1,11,6,4), T_4(1,11,7,8), T_2(2,14,12,12), T_1(3,14,12,12)\rangle$, where the numbers in the parenthesis are the available resources after the thread is terminated.

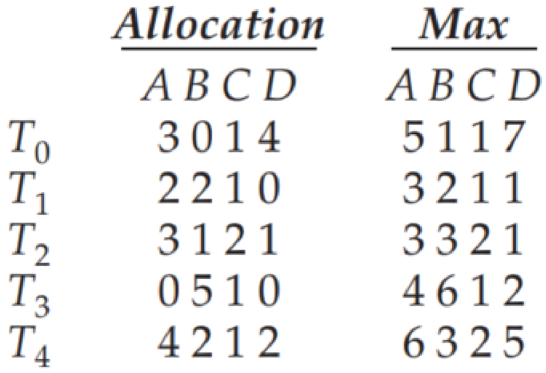
3. Check that $(0,4,2,0) \leq (1,7,5,0)$ and $(0,4,2,0) \leq (1,5,2,0)$. We can make a virtual allocation to T_1, at this moment, the available vector will be $(1,1,0,0)$ and the need matrix will be Figure 2 We can find a sequence $\langle T_0(1,1,1,2), T_2(2,4,6,6), T_1(3,8,8,6), T_3(3,14,11,8), T_4(3,14,12,12)\rangle$ to ensure the safety condition. The request will be immediately granted.

□

	A	B	C	D
T0	0	0	0	0
T1	0	3	3	0
T2	1	0	0	2
T3	0	0	2	0
T4	0	6	4	2

Table 2: Need matrix

Exercise 2 Consider the following snapshot of a system:



	Allocation	Max
	$A B C D$	$A B C D$
T_0	3 0 1 4	5 1 1 7
T_1	2 2 1 0	3 2 1 1
T_2	3 1 2 1	3 3 2 1
T_3	0 5 1 0	4 6 1 2
T_4	4 2 1 2	6 3 2 5

Using the banker algorithm, determine whether or not each of the following states is unsafe. If the state is safe, illustrate the order in which the threads may complete. Otherwise, illustrate why the state is unsafe.

a) Available = (0, 3, 0, 1)

b) Available = (1, 0, 0, 2)

Solution. The need matrix is shown in Table 3

	A	B	C	D
T0	2	1	0	3
T1	1	0	0	1
T2	0	2	0	0
T3	4	1	0	2
T4	2	1	1	3

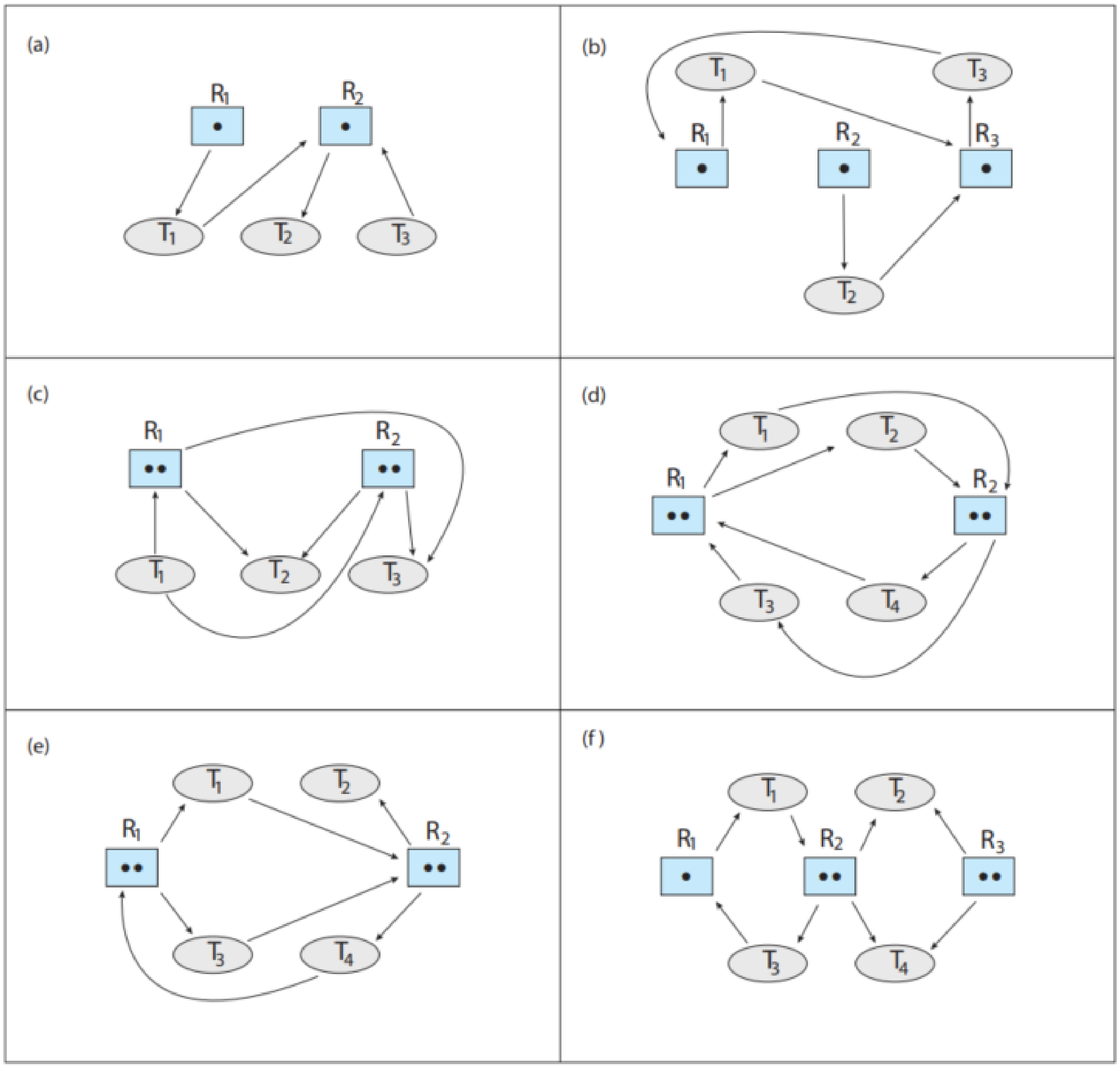
Table 3: Need Matrix

1. First, only T_2 can be selected as the first thread in the safety sequence. The available resources for later threads are $(3, 4, 2, 2)$. Then only T_1 can be selected. After T_1 release its resources, the available vector will be $(5, 6, 3, 2)$. Now T_3 can be added to the sequence, making the available vector become $(5, 11, 4, 2)$. However, neither T_0 nor T_4 can be added to the sequence for lack of D resource. The state is unsafe.

2. The state is safe. We can find a sequence $\langle T_1(3, 2, 1, 2), T_2(6, 3, 3, 3), T_3(6, 8, 4, 3), T_4(10, 10, 5, 5), T_0(12, 11, 5, 8)\rangle$ to ensure the safety condition.

□

Exercise 3 Which of the six resource-allocation graphs shown in below illustrate deadlock? For those situations that are deadlocked, provide the cycle of threads and resources. Where there is not a deadlock situation, illustrate the order in which the threads may complete execution.



Solution.

a) Not a deadlock. After T_2 terminates, either T_1 or T_3 can access R_2 and terminates. Then the remained threads can also terminate.

b) Is a deadlock, formed by R_1, T_1, R_3, T_3.

c) Not a deadlock. T_3 and T_2 have gained their resources and can terminate. After that, T_1 can access the resource and terminate.

d) Is a deadlock, formed by T_1, R_2, T_3, R_1 and R_1, T_2, R_2, T_4

e) Not a deadlock. T_2 terminates first. Then T_1 can get the resource released by T_2 and terminate. Finally, T_3 and T_4 can both access the resources and terminate.

f) The graph is invalid, since there are only two instances for R_2 but three instances are assigned to different threads.

□