

Detection Algorithm

1. Let *Work* and *Finish* be vectors of length *m* and *n*, respectively
Initialize:

(a) *Work* = *Available*

(b) For $i = 1, 2, \dots, n$, if $Allocation_i \neq 0$, then
 $Finish[i] = false$; otherwise, $Finish[i] = true$

2. Find an index *i* such that both:

(a) $Finish[i] == false$

(b) $Request_i \leq Work$

If no such *i* exists, go to step 4

Detection Algorithm (Cont.)

3. $Work = Work + Allocation;$
 $Finish[i] = true$
go to step 2
4. If $Finish[i] == false$, for some $i, 1 \leq i \leq n$, then the system is in deadlock state. Moreover, if $Finish[i] == false$, then P_i is deadlocked

Algorithm requires an order of $O(m \times n^2)$ operations to detect whether the system is in deadlocked state

Example of Detection Algorithm

- Five processes P_0 through P_4 ; three resource types A (7 instances), B (2 instances), and C (6 instances)
- Snapshot at time T_0 :

	<u>Allocation</u>			<u>Request</u>			<u>Available</u>		
	A	B	C	A	B	C	A	B	C
P_0	0	1	0	0	0	0	0	0	0
P_1	2	0	0	2	0	2			
P_2	3	0	3	0	0	0			
P_3	2	1	1	1	0	0			
P_4	0	0	2	0	0	2			

- Sequence $\langle P_0, P_2, P_3, P_1, P_4 \rangle$ will result in $Finish[i] = \text{true}$ for all i

Example (Cont.)

- P_2 requests an additional instance of type C

	<u>Request</u>		
	A	B	C
P_0	0	0	0
P_1	2	0	1
P_2	0	0	1
P_3	1	0	0
P_4	0	0	2

- State of system?
 - Can reclaim resources held by process P_0 , but insufficient resources to fulfill other processes; requests
 - Deadlock exists, consisting of processes P_1 , P_2 , P_3 , and P_4

Detection-Algorithm Usage

- When, and how often, to invoke depends on:
 - How often a deadlock is likely to occur?
 - How many processes will need to be rolled back?
 - one for each disjoint cycle
- If detection algorithm is invoked arbitrarily, there may be many cycles in the resource graph and so we would not be able to tell which of the many deadlocked processes “caused” the deadlock

Recovery from Deadlock: Process Termination

- Abort all deadlocked processes
- Abort one process at a time until the deadlock cycle is eliminated
- In which order should we choose to abort?
 - Priority of the process
 - How long process has computed, and how much longer to completion
 - Resources the process has used
 - Resources process needs to complete
 - How many processes will need to be terminated
 - Is process interactive or batch?

Recovery from Deadlock: Resource Preemption

- Selecting a victim – minimize cost
- Rollback – return to some safe state, restart process for that state
- Starvation – same process may always be picked as victim, include number of rollback in cost factor