1 Deadlock Prevention

If we impose a total ordering of all resource types and we require that each process requests resources in an increasing order of enumeration, which of the four necessary deadlock conditions do we break? (mutual exclusion, hold and wait, no preemption, circular wait)

Circular wait

2 Deadlock Avoidance

Suppose we are executing the Banker’s algorithm among processes $P_1$, $P_2$, $P_3$, $P_4$ and $P_5$. We stop at a point where we have found this partial execution sequence: $P_3$, $P_5$, and now we see that either $P_1$ or $P_2$ can be executed. We decide to execute $P_1$ and we continue the execution of the Banker’s algorithm.

1. If at the end of the algorithm we succeeded in finding a sequence of execution (we are at a safe state), for example $P_3$, $P_5$, $P_1$, $P_2$, $P_4$, would we have been led to the same result if we had chosen $P_2$ instead of $P_1$ at the above execution point?

Yes, because $P_4$ can be executed either way.

2. Answer the same question if choosing $P_1$ led us to an unsafe state.

Unsafe state means that $P_4$ cannot be executed even though $P_2$ has been executed and has released its resources. The same situation will be created if $P_2$ would have been executed first and $P_1$ next.

3 Logical vs Physical Address

Can we have multiprogramming in a system with physical = logical address?

Yes, if we define a specific part of memory for every exiting process.

In a monoprogramming system, do we have to implement allocation, reallocation or protection mechanism?

No, because the process will simply use the entire memory (if there is no OS).

4 Contiguous Memory Allocation

What is the main problem of the contiguous memory allocation?

External fragmentation.

5 Paging

What is the main reason of using Paging as a Memory Management schema?

The limited memory space. In a 16-bit system, where the virtual address is split into 4 bits for page number and 12 bits for offset:

1. For the physical address, how many bits are assigned for the offset and how many for the frame number?

$\text{offset} = 12 \text{ bits, frame number} = 4 \text{ bits.}$
2. Answer the same question if the physical address had 32 bits in total and the virtual 16 bits.

   offset = 12 bits, frame number = 20 bits.

6 Page Replacement

Does the LRU algorithm present the Belady’s Anomaly?

No, only FIFO presents it.