Memory Management Technique

Fragmentation

Fragmentation is a phenomenon or situation that occurs in computer memory such as Random Access Memory (RAM) or hard disks, which causes wastage and inefficient usage of free space. As a result, the efficient usage of available space is hindered or wasted, this causes performance issues, as well.

Fragmentation

- **Internal Fragmentation**
- **External Fragmentation**

Internal fragmentation

- Consider the figure A, where a fixed sized memory allocation mechanism is being used.
- Initially, the memory is empty. Then, three programs named A, B, C have been loaded to the first three partitions while the 4th partition is still free.
- Program A matches the size of the partition, so there is no wastage in that partition, but Program B and Program C are smaller than the partition size. So in partition 2 and partition 3 there is remaining free space.

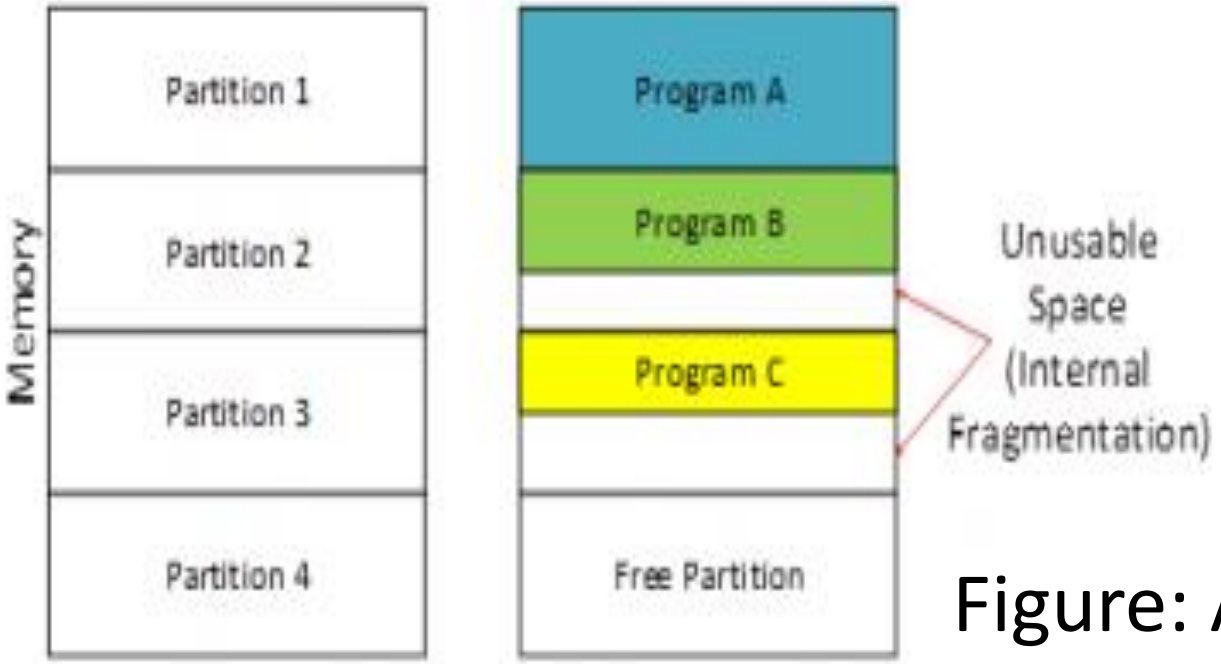

Figure: A

- However, this free space is unusable as the memory allocator only assigns full partitions to programs but not parts of it. This wastage of free space is called internal fragmentation.

External fragmentation

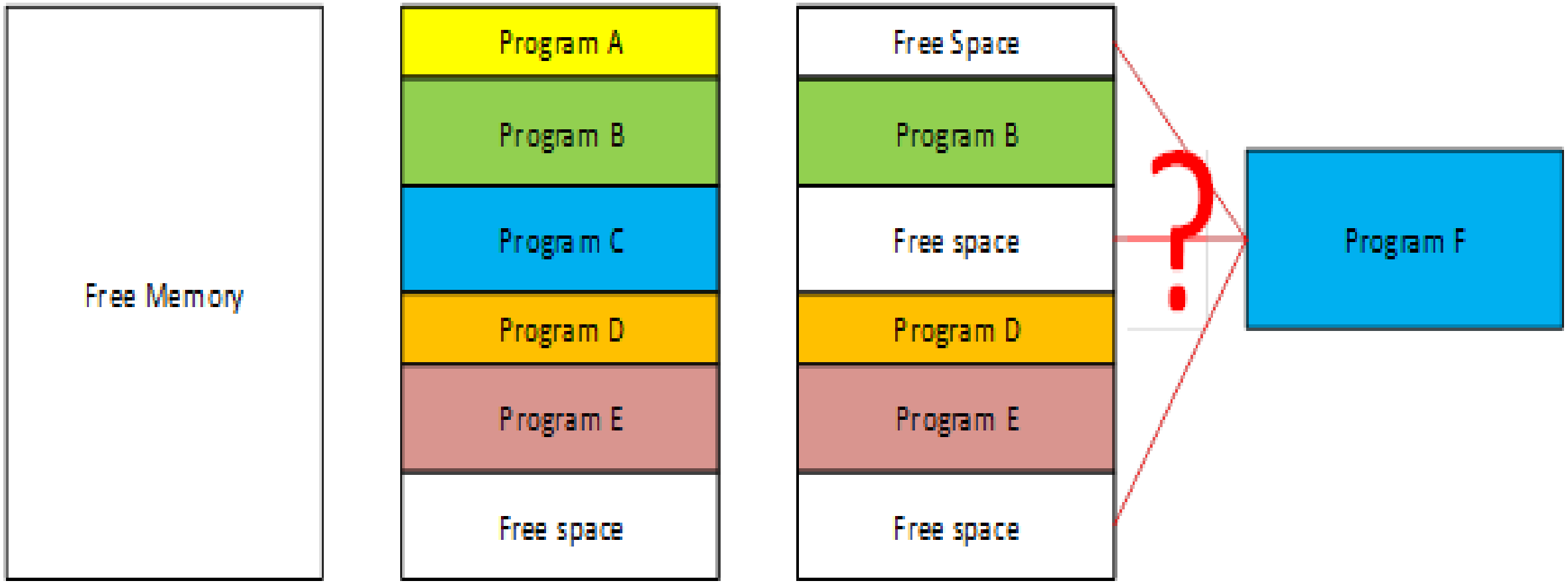

Figure: B

External fragmentation

- Consider the figure B, where a dynamic (variable) sized memory allocation mechanism is being used. The allocator allocates only the exact needed size for that program.
- The Programs A, B, C, D and E of different sizes are loaded one after the other and they are placed in memory contiguously in that order.
- Then later, Program A and Program C closes and they are unloaded from memory. There are three free space areas in the memory, but they are not adjacent.
- Now a large program called Program F is going to be loaded but neither of the free space block is not enough for Program F. The addition of all the free spaces is definitely enough for Program F, but due to the lack of adjacency that space is unusable for Program F. This lack of enough adjacent space is called External Fragmentation.

Difference between Internal and External Fragmentation

Internal fragmentation occurs when a fixed size partition is assigned to a program/file with less size than the partition making the rest of the space in that partition unusable.

External fragmentation occurs when a dynamic memory allocation technique is used. After loading and unloading of programs or files for some time, all free space is distributed here and there. Due to the lack of enough adjacent space, it is not possible to load a new program.

Solution for External fragmentation

- External fragmentation can be solved by re-arrange where the assigned blocks are moved to one side, so that contiguous space is gained. However, this operation takes time.

- External fragmentation can be prevented by paging. In paging, a logical contiguous virtual memory space is given while in reality the files/programs are break into parts and placed random places in the physical memory.

MMU uses one of the two approach.

1. Segment oriented approach : a segment is a variable-sized block

2. Page oriented approach : a page is a fixed-sized block

BASIS FOR COMPARISON	PAGING	SEGMENTATION
Basic	A page is of fixed block size.	A segment is of variable size.
Fragmentation	Paging may lead to internal fragmentation.	Segmentation may lead to external fragmentation.
Address	The user specified address is divided by CPU into a page number and offset.	The user specifies each address by two quantities a segment number and the offset (Segment limit).
Size	The hardware decides the page size.	The segment size is specified by the user.