



Contiguous Allocation



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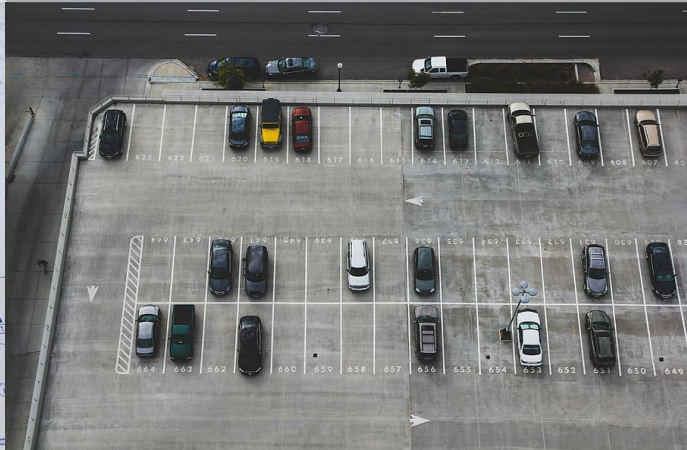
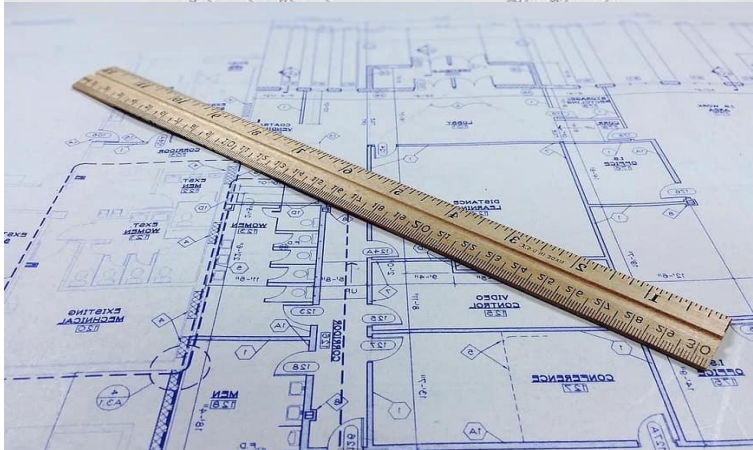
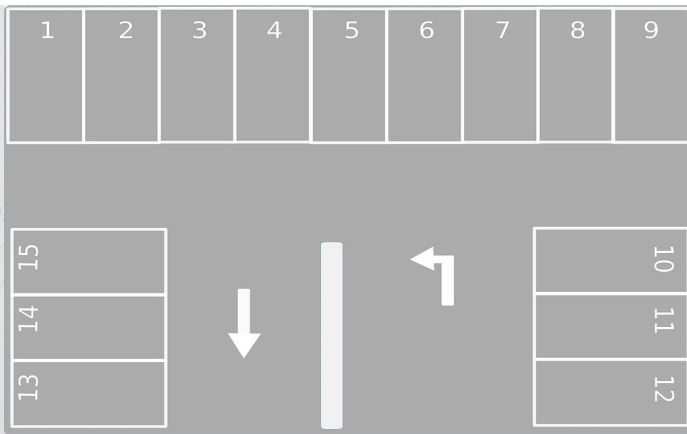
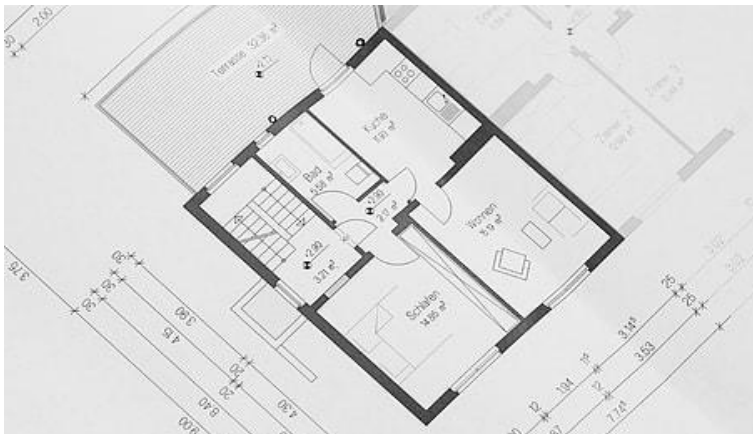
Contiguous Memory Allocation

- Goal: shared RAM by many processes
- Memory Partitions
 - Place one process in one partition
- **Fixed-Sized** Partitions
 - Location and size of each partition are predefined by the OS
- **Variable-Sized** Partitions
 - Location and size of each partition are determined on-demand, per process' request



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Fixed-Size Partitions



Dynamic/Variable-Sized Partitions

Angeborene Stellen

Lagerverwalter
Beschreibung: In größeren Betrieben...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

Wir suchen für sofort oder spätere Einstellung Buchhalterinnen und Stenotypistinnen
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

Perfekte Kontoristin
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

ON CREDIT
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

10 CENTS A WEEK!
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

ON CREDIT
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

My Old Friend D. L. Moody, Who Used the Old
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

5,000 Pieces of Gift Furniture
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

Dainty Blouses Now \$5.95 and \$7.50
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

New Evening Gowns
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

Wardrobe Trunks, \$24
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

Men's Silk Socks, \$1.25
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

These \$60 Luxurious OVERCOATS Will Go on Tuesday for \$43.50
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

Christmas Watches
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

ON CREDIT
Beschreibung: In einem der größten...
Anforderungen: Hochschulabschluss...
Angebot: 40 bis 4500 Mark...
Kontakt: Köln, 737

Fixed-Sized Partitions

- RAM is divided into **N partitions** (of different sizes but fixed)
 - Configured at boot time
- Only max **N processes** can reside in RAM at any time
 - One partition = one process
 - Fixed multiprogramming level
- When a process must be loaded to RAM to run, the system selects a free partition big enough to fit the process
 - When it terminates, the partition is free again
- **(Internal) Fragmentation**: unused portion (wasted space) of a partition
- Scheduling Issues? Ready Queue(s)?
- Advantages/disadvantages?

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Internal Fragmentation = unused chairs



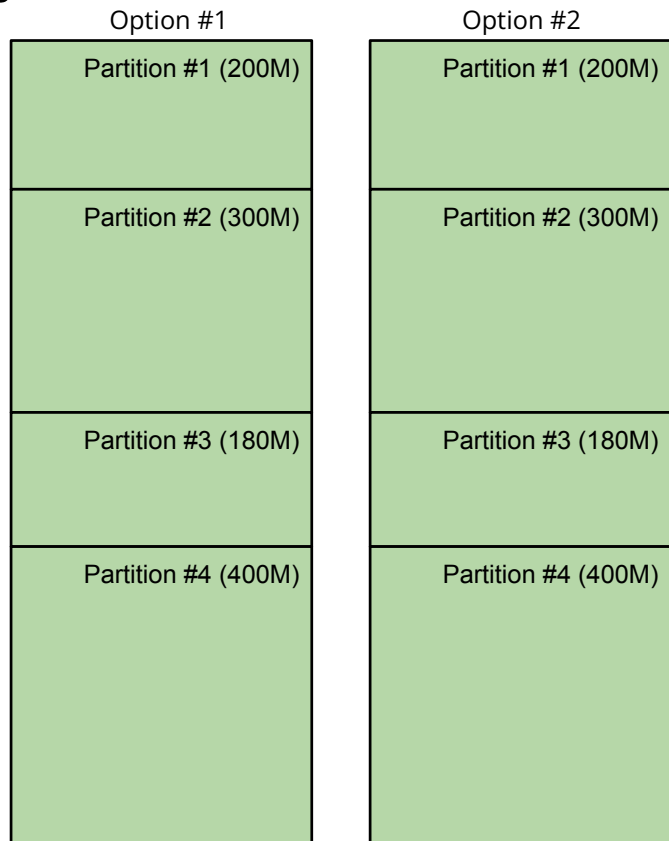
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Fixed-Sized Partitions

Constraint: *Only one process per partition*

1. Process A (100M) begins
2. Process B (310M) begins
3. Process C (200M) begins
4. Process B ends
5. Process D (80M) begins
6. Process A ends
7. Process E (195M) begins
8. Process E ends
9. Process D ends
10. Process C ends

*Partitions are configured by the OS,
may require system reboot to change*



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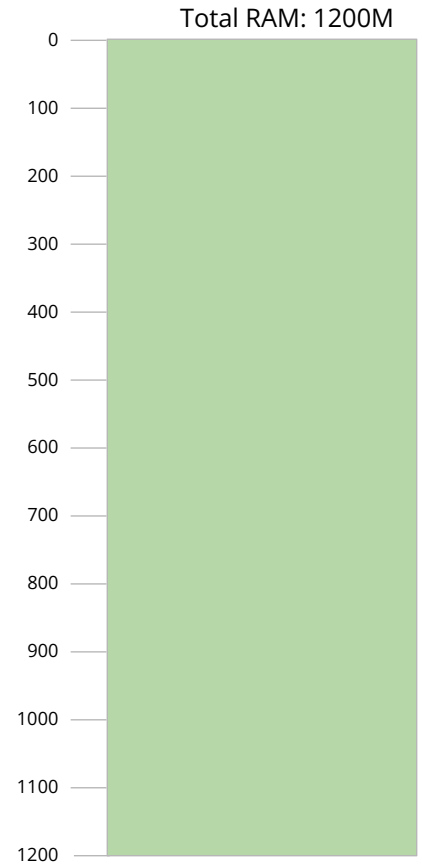
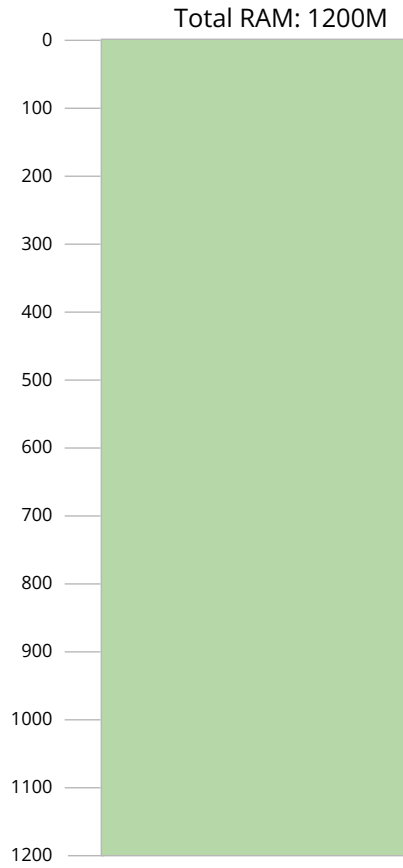
Variable-Sized Partitions

- Partitions are created **on-demand** as processes are loaded
 - Partition size = size of the process just loaded
 - **No internal fragmentation**
- The RAM beings as *one giant hole* (the entire free space)
- **But**, when a process terminates, it leaves a **hole (free partition)**
 - Adjacent holes combine into a larger hole
- Necessary OS data structures
 - A list of **allocated partitions**
 - A list of **holes** (free partitions) link the "holes" themselves into a linked list
- When a process must be loaded, the OS looks for a hole big enough for the process
 - *Unused portion of the hole becomes a smaller hole*

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Variable-Sized Partitions

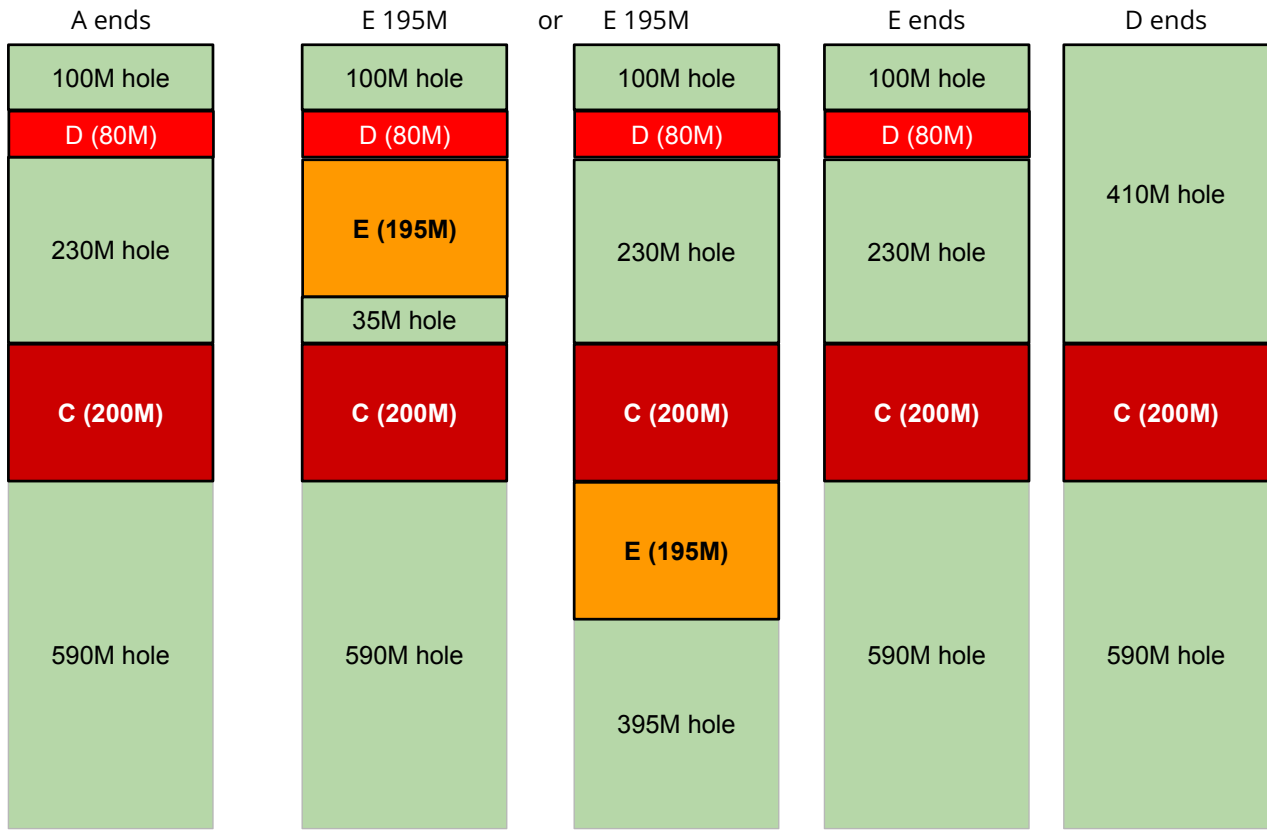
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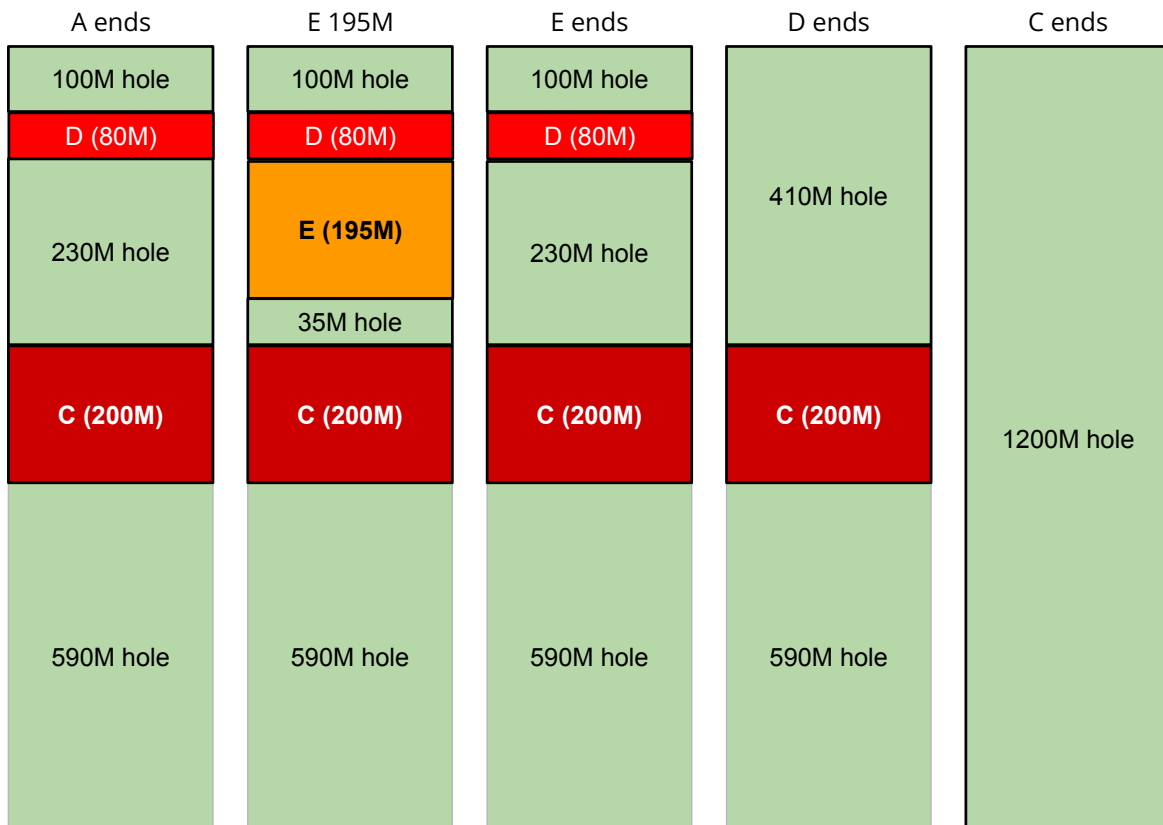
Variable-Sized Partitions (Total RAM 1200M)



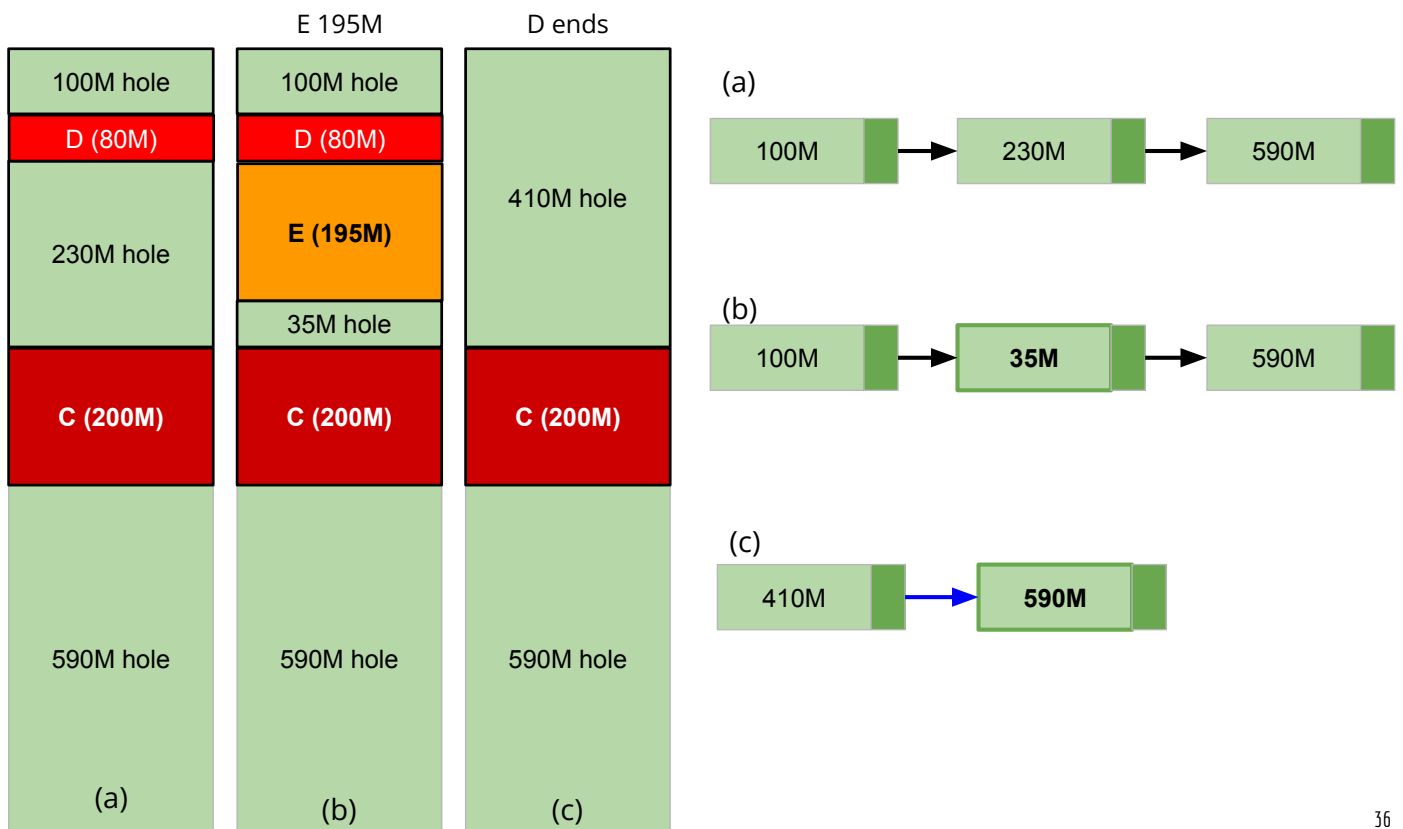
Variable-Sized Partitions



Variable-Sized Partitions



Variable-Sized Partitions: List of Holes



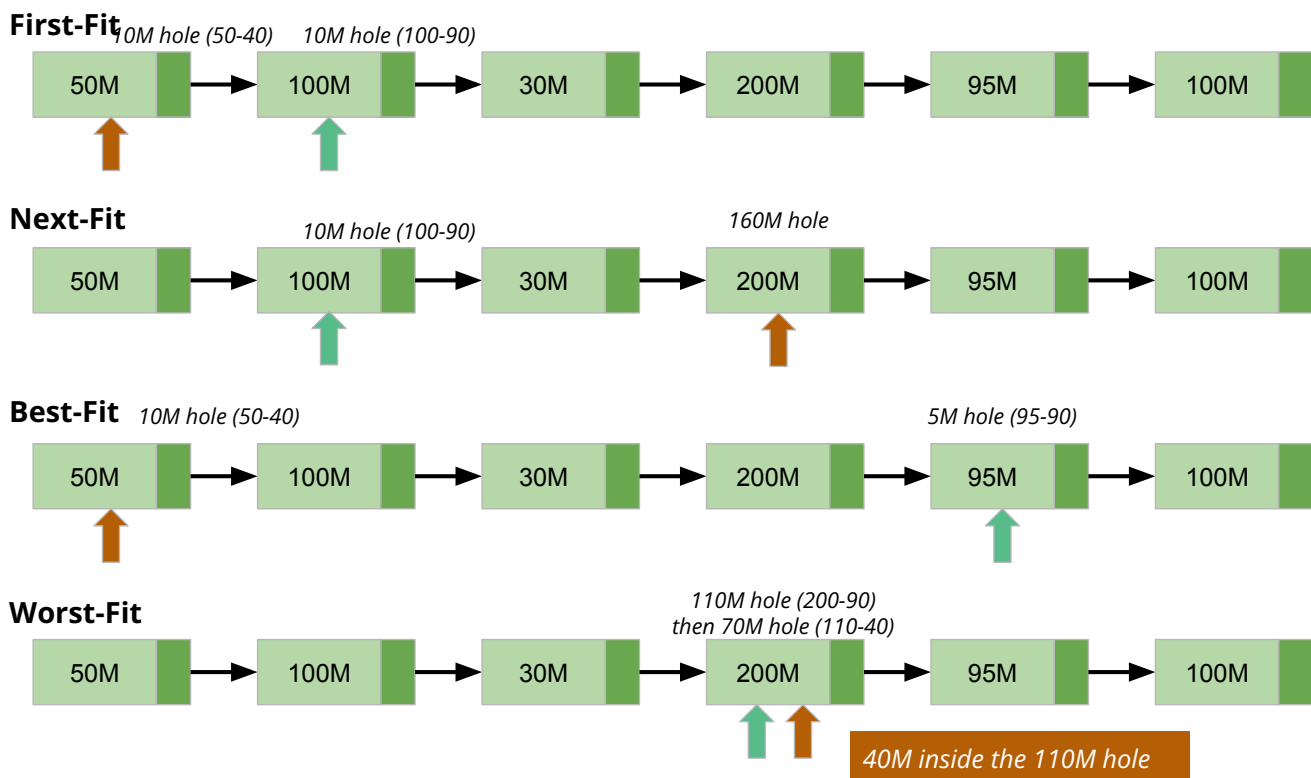
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Variable-Sized Partitions: Allocation Algo.

- Allocation Algorithms (how to select a free partition)
 - **First-Fit:** allocate the first hole big enough to accommodate the request. Start searching from the **beginning** of the hole list
 - **Next-Fit:** allocate the first hole big enough to accommodate the request. Start searching from the **last position of previous search**
 - **Best-Fit:** search the entire list (from the beginning) for the hole that gives **minimum leftover**
 - **Worst-Fit:** search the entire list (from the beginning) for the hole that gives **maximum leftover**
- Advantages/Disadvantages?
- Big-O of these algorithms?

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Requests: 90M and then 40M



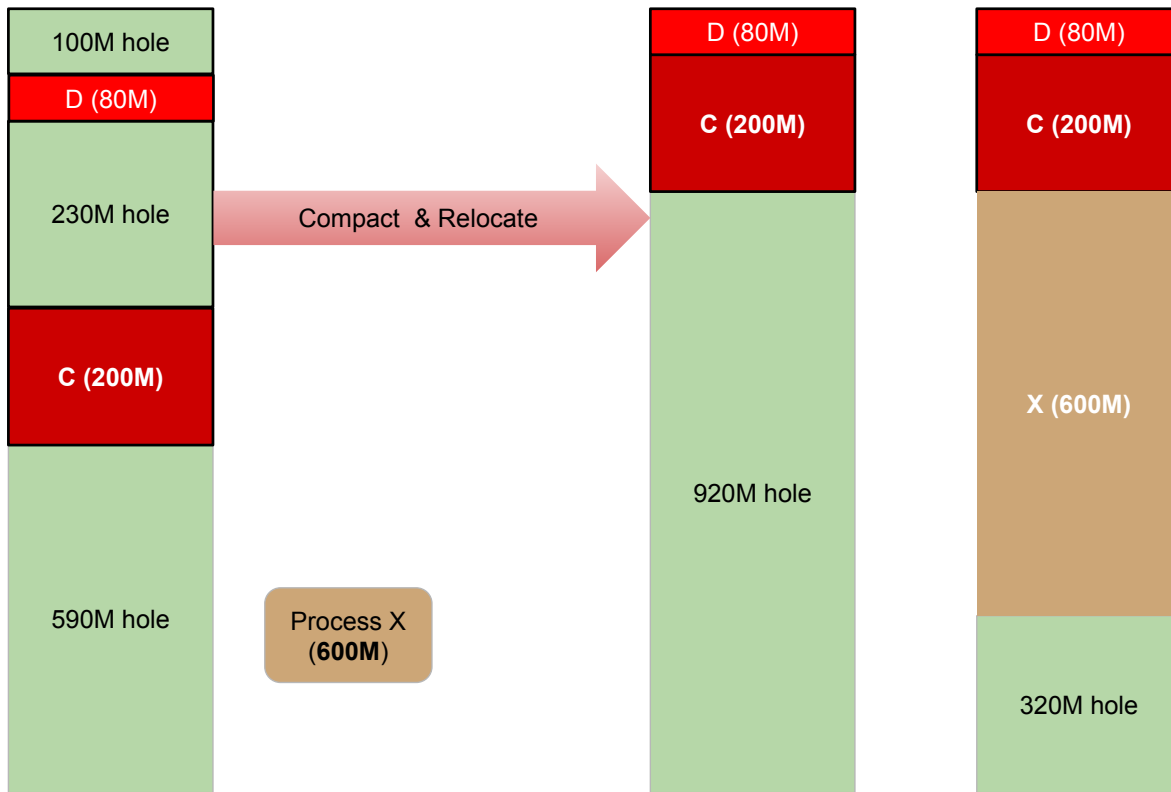
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(In|Ex)ternal Fragmentation

- **Internal Fragmentation**: unused space *within* a partition (of **Fixed-Sized Partitions**)
- **External Fragmentation**: (of **Variable-Sized Partitions**)
 - holes are scattered throughout RAM
 - **The TOTAL size of holes is big enough** to hold the next process
 - **none of the holes** is big enough to hold the next process
 - Solution: run compaction algorithm (consolidates scattered holes into one free contiguous partition)

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External Fragmentation & Relocation

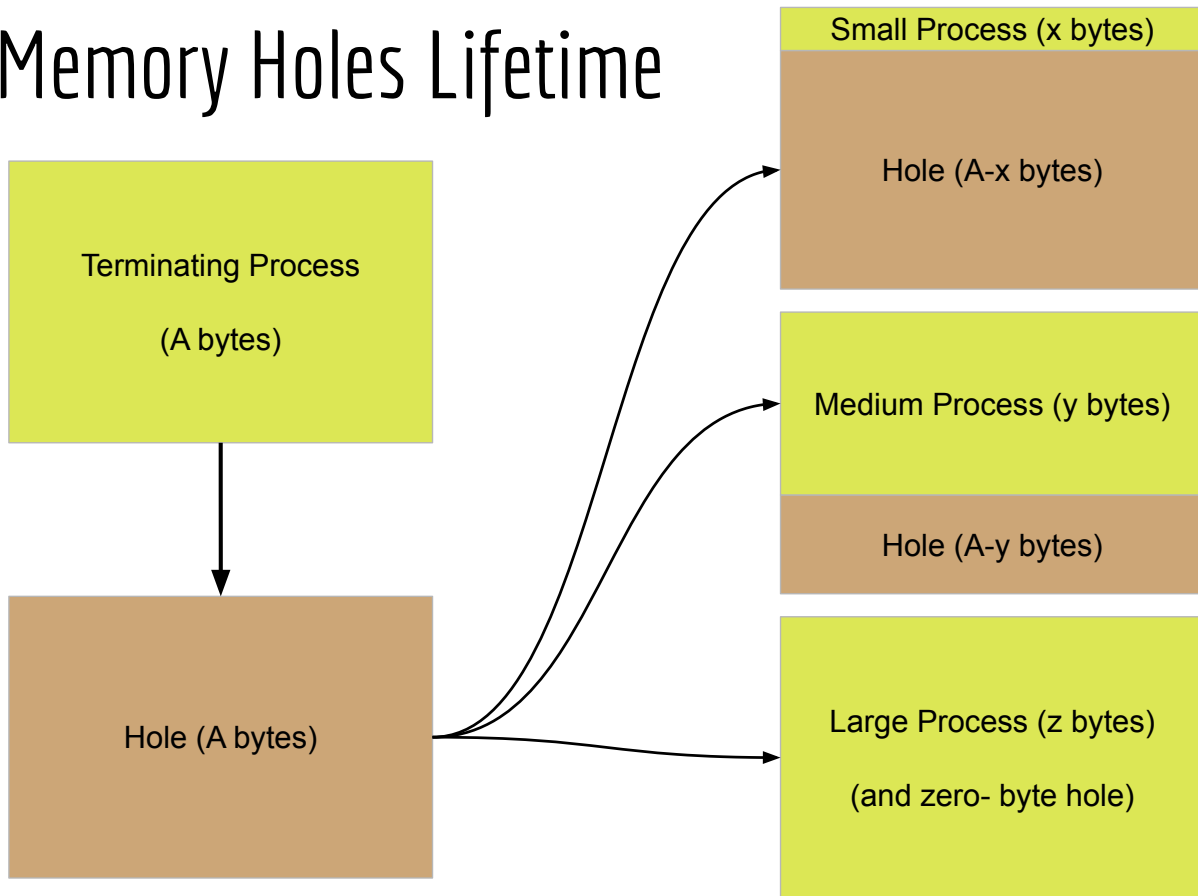


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50-percent rule:
On average, fragmentation results in
 $\frac{1}{3}$ of RAM wasted in holes

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Memory Holes Lifetime



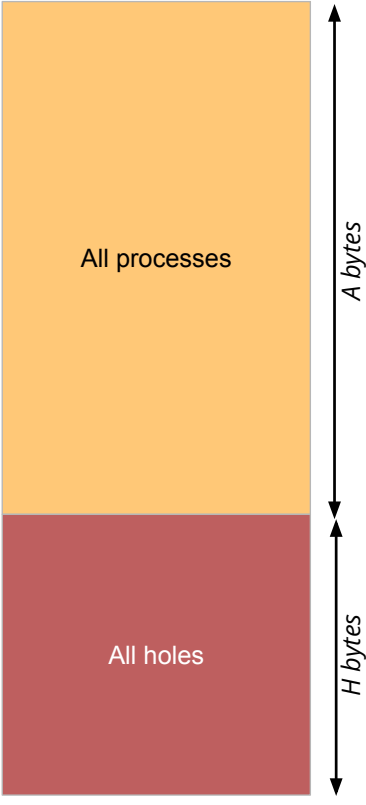
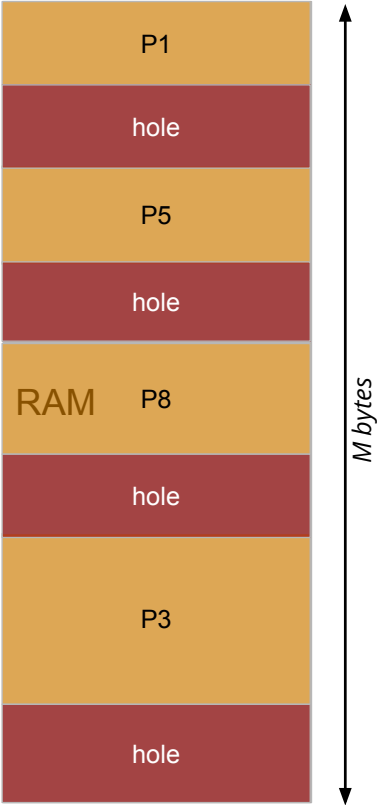
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A process of size A bytes turns into holes of size
0 bytes (min) to A bytes (max)

A process of size A bytes turns into holes with
average size of $\frac{1}{2}$ A bytes

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Wasted RAM Space in Holes?



$$M = A + H$$
$$= A + \frac{1}{2}A$$

$$M = \frac{3}{2}A$$

$$A = \frac{2}{3}M \quad \text{and} \quad H = \frac{1}{3}M$$

$\frac{1}{3}$ of RAM is wasted across memory holes