Sistemi Operativi I

Corso di Laurea in Informatica

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SAPIENZA
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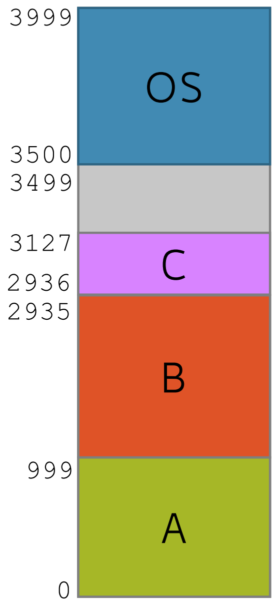

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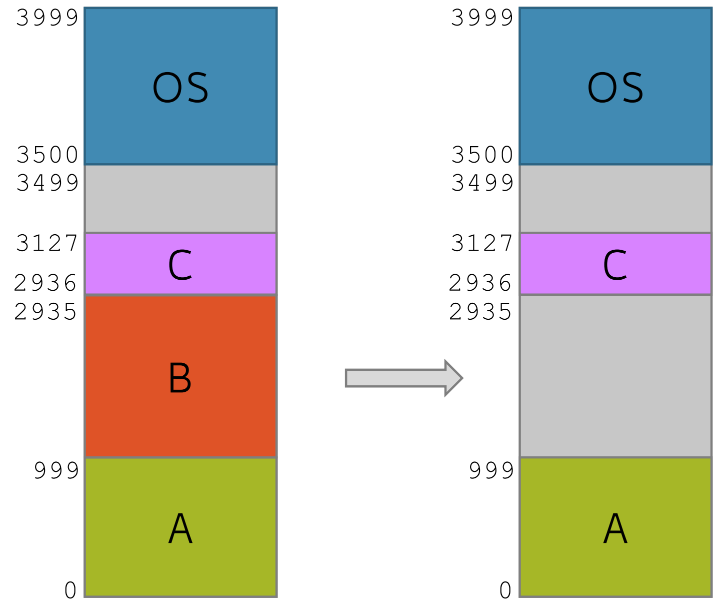

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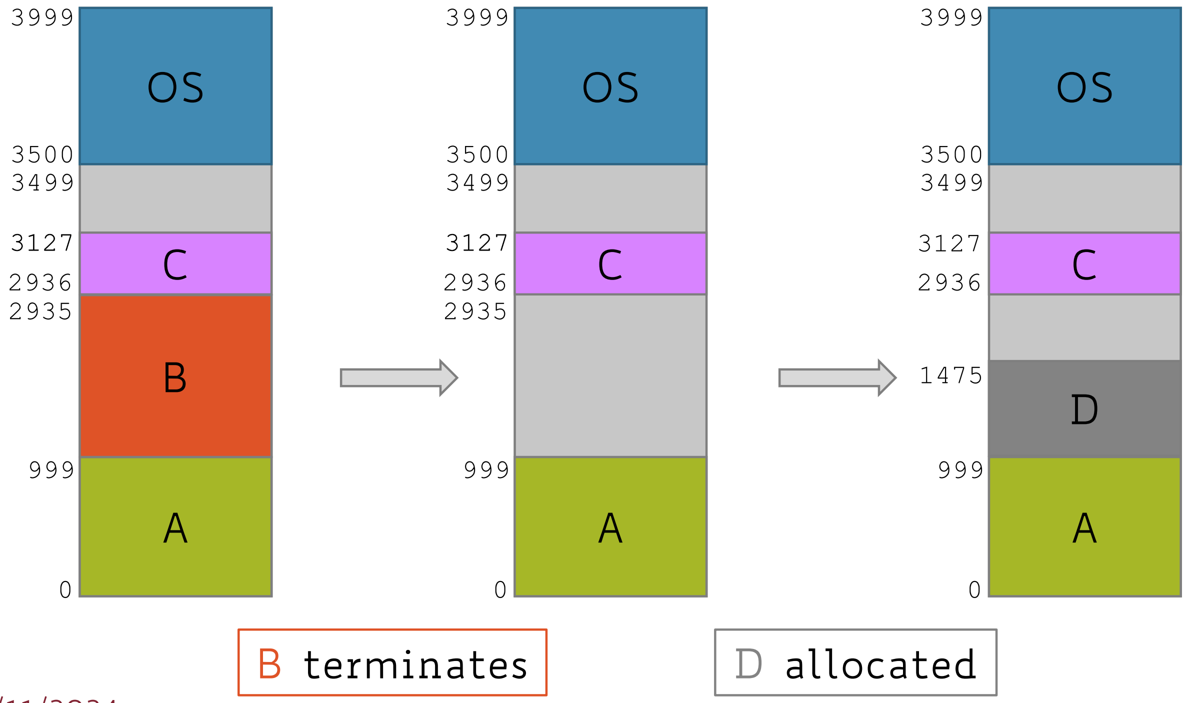

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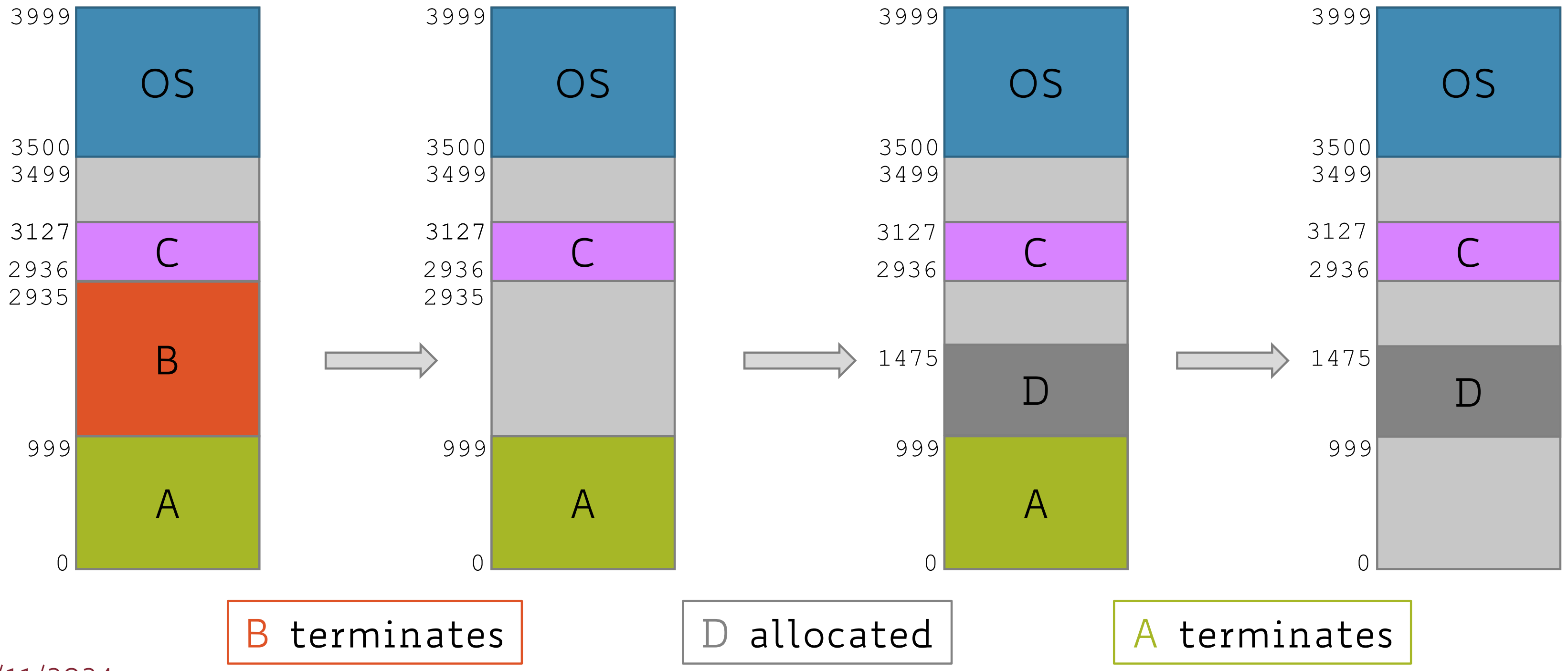

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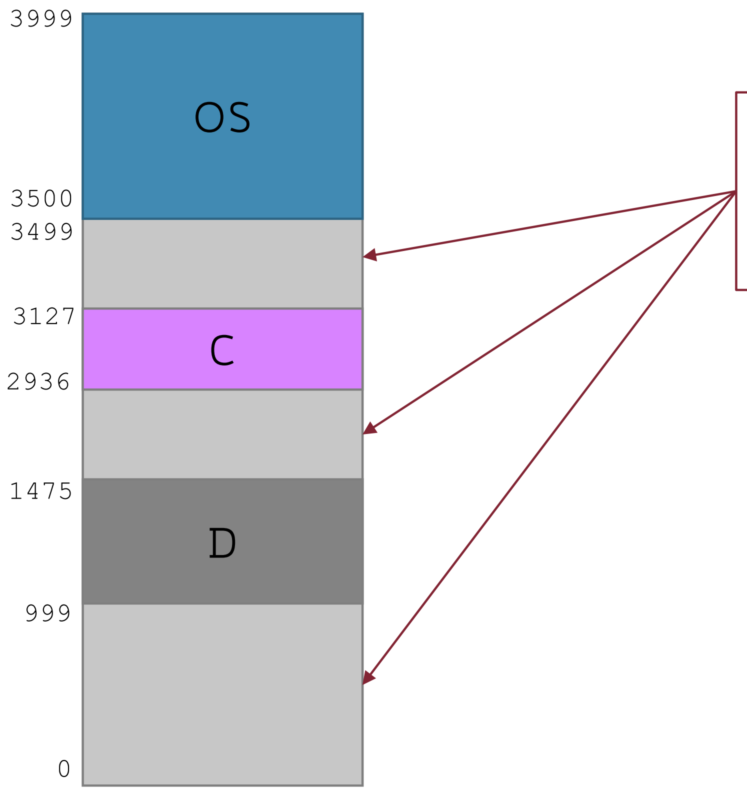

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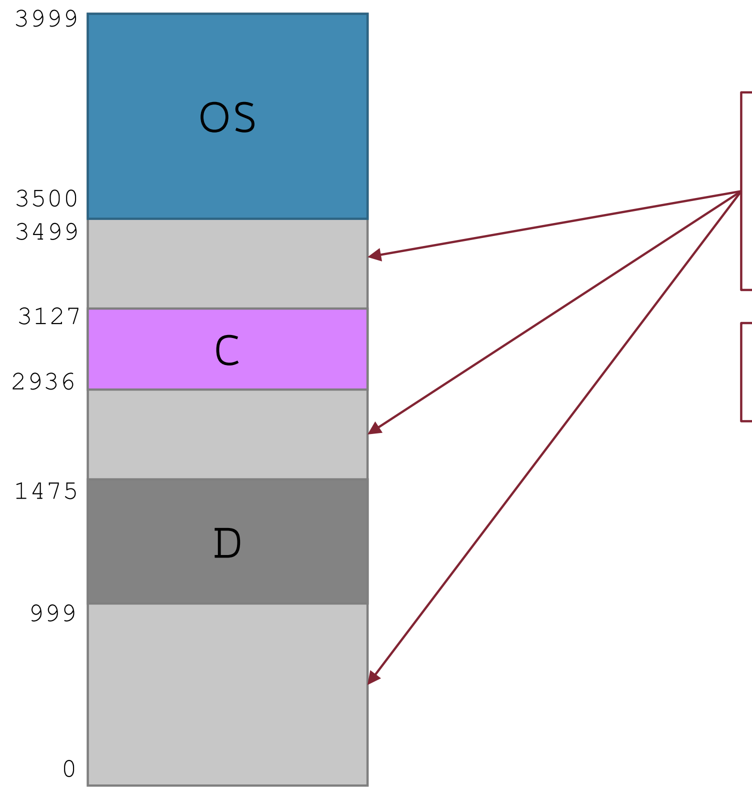

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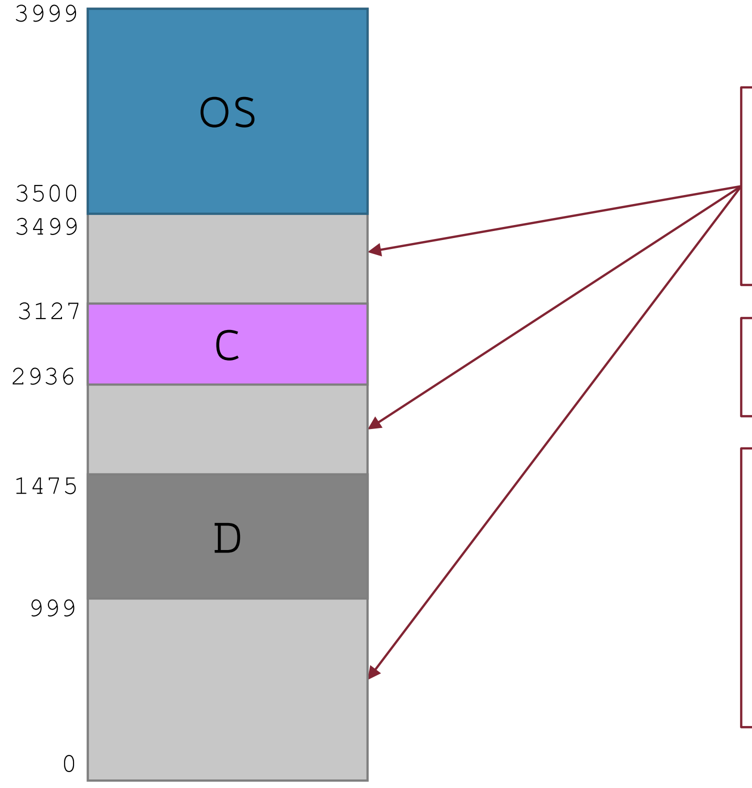

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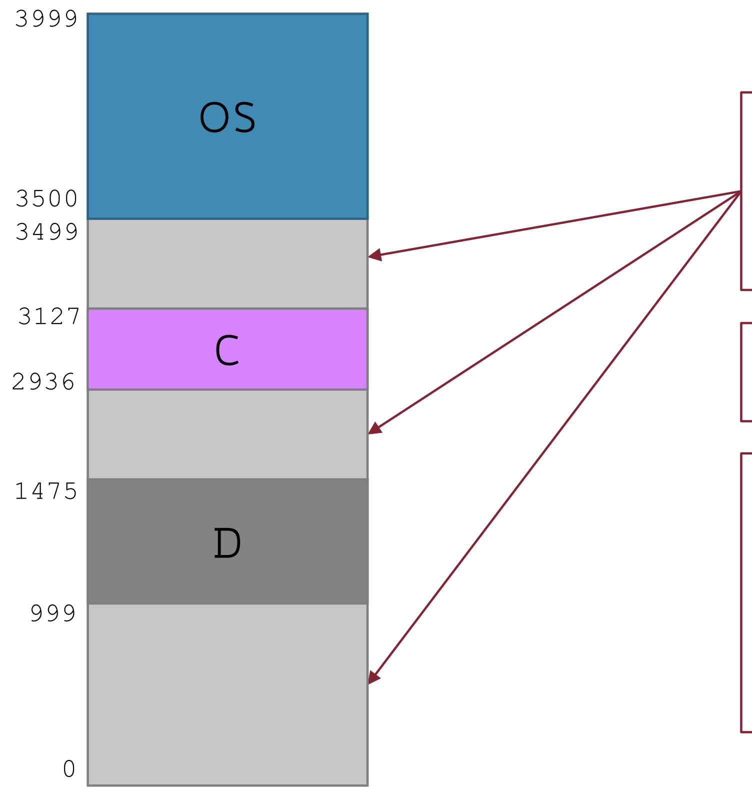

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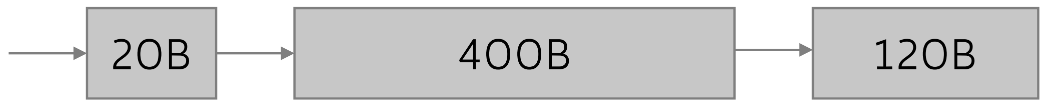

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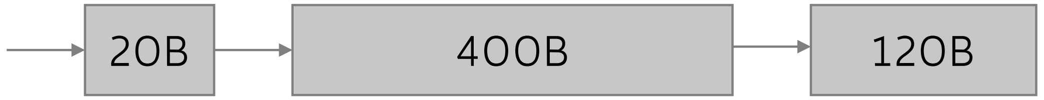

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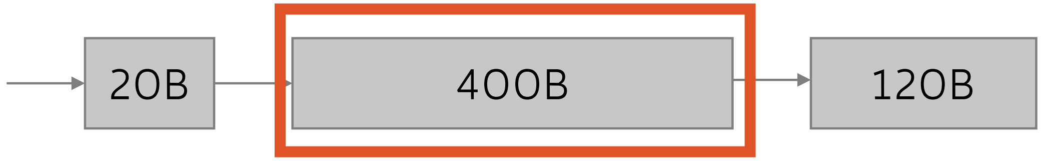

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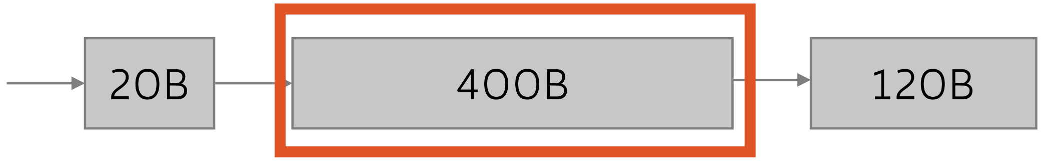

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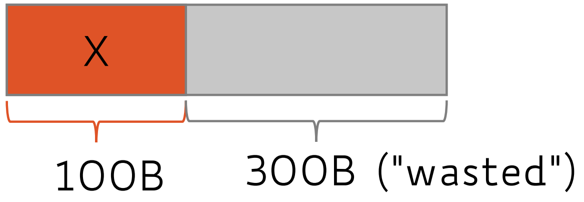

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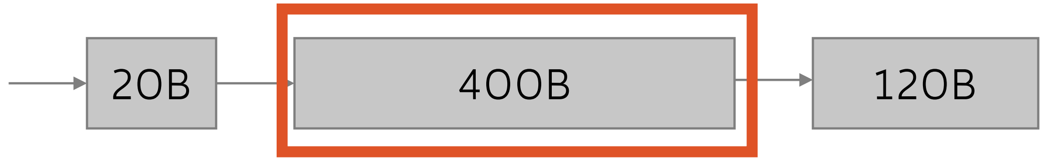

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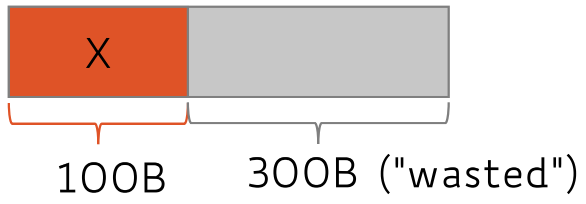

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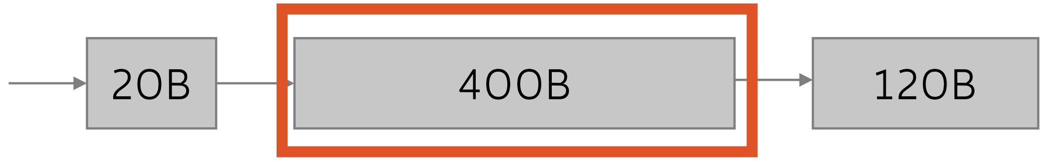

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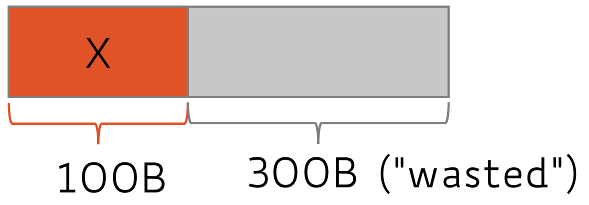

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We will not be able to satisfy this request even if theoretically we could

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Binary Search Tree (BST)

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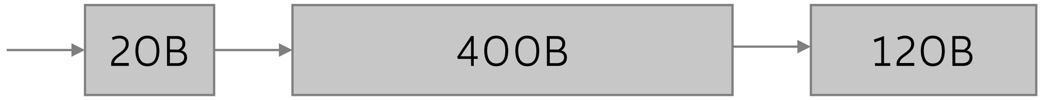

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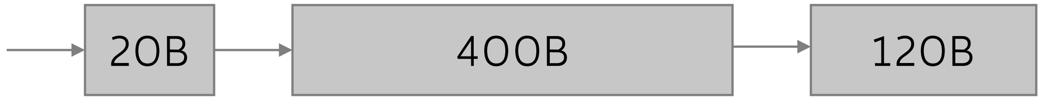

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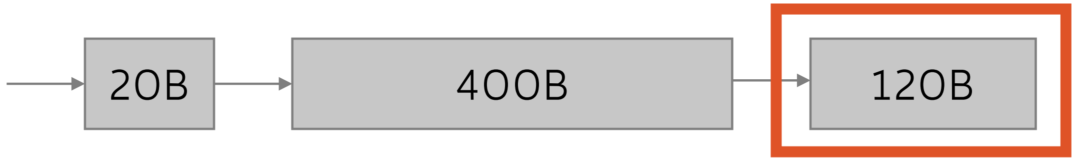

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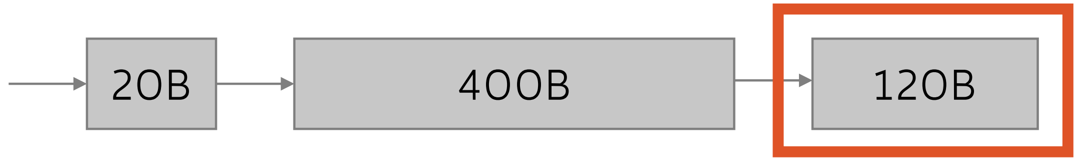

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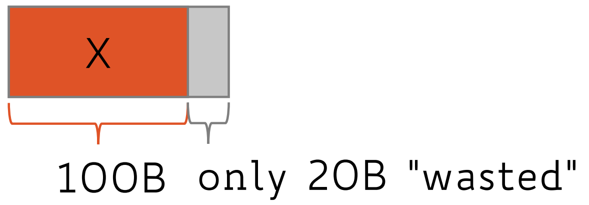

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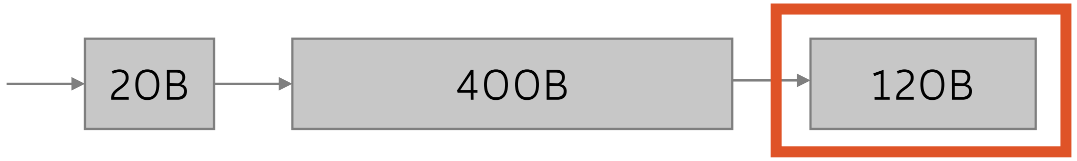

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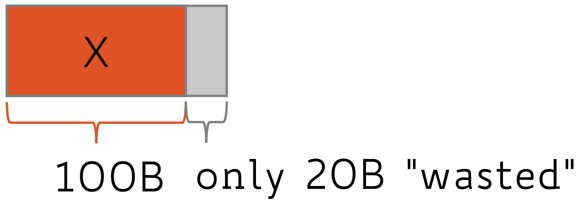

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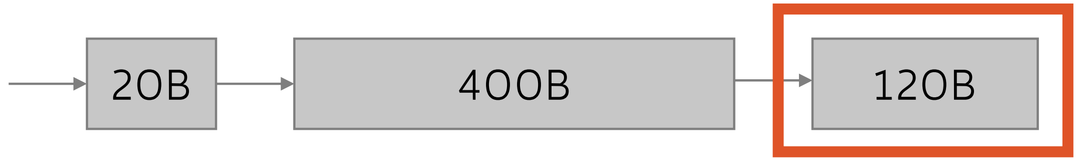

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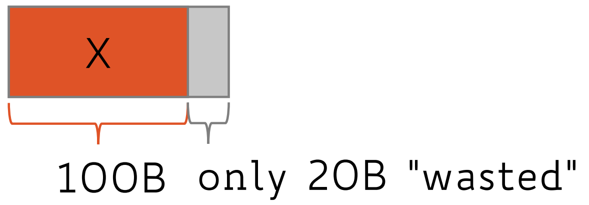

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We can now assign it the second available hole segment (400B)

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- First-Fit is also generally faster than Best-Fit

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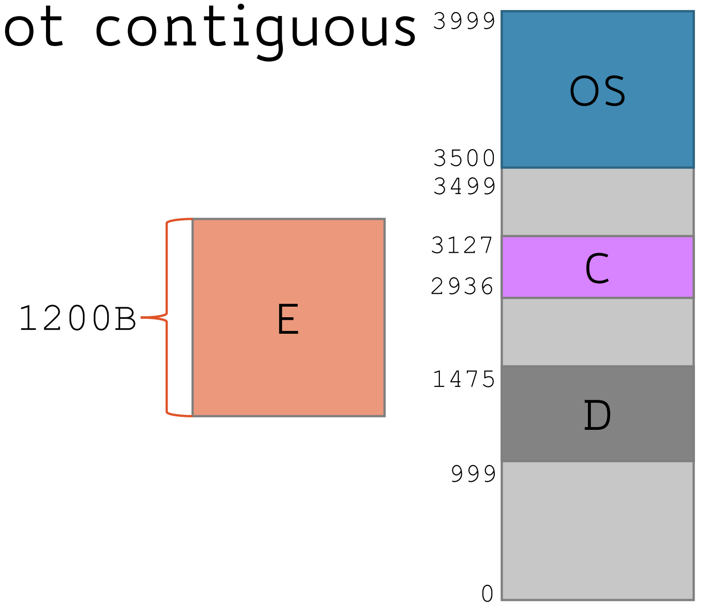

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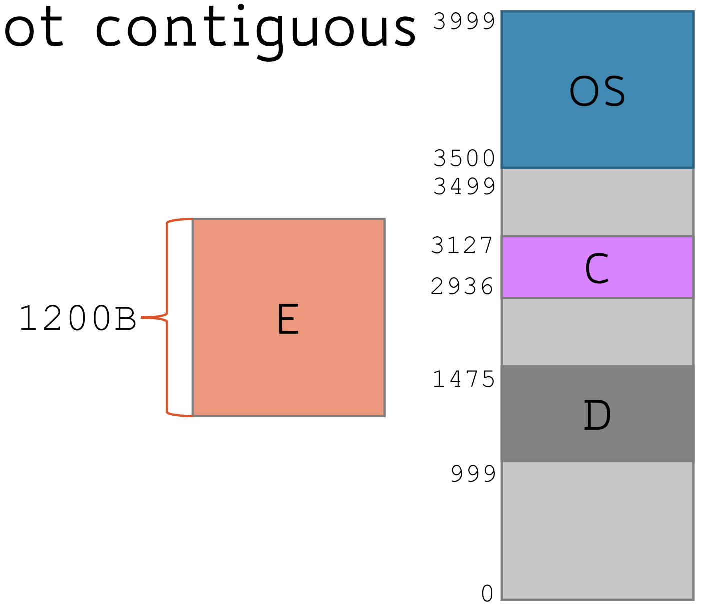

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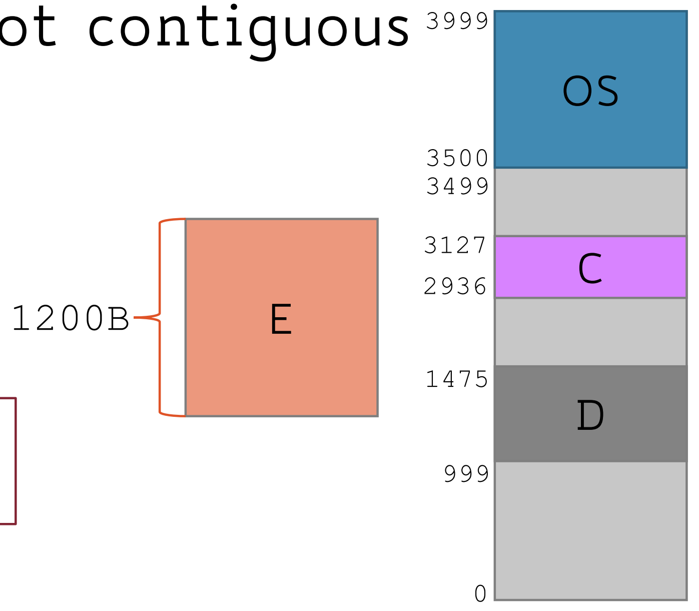
Goal:
Allocation policy that minimizes wasted space!



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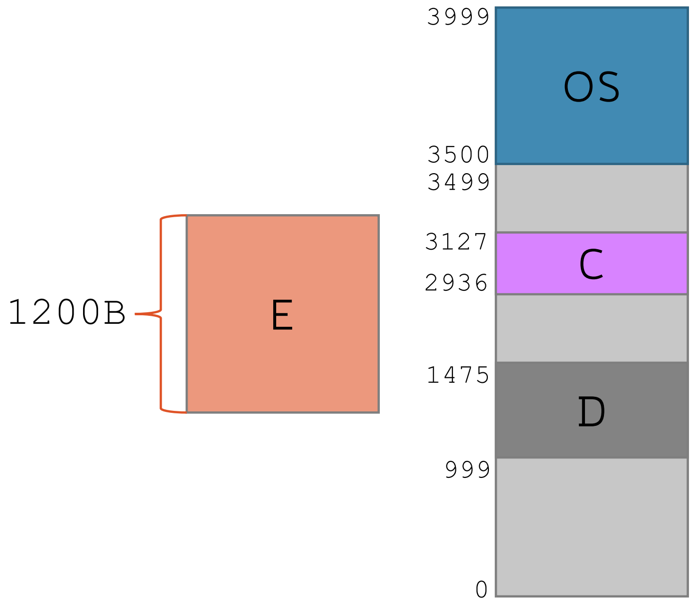
- For example, consider a process whose size is 8,846B and a hole of size 8,848B
- It may be much more efficient to allocate the process the whole block (and waste 2B) rather than keep track of a tiny 2B hole

Solution to Fragmentation: Full Compaction



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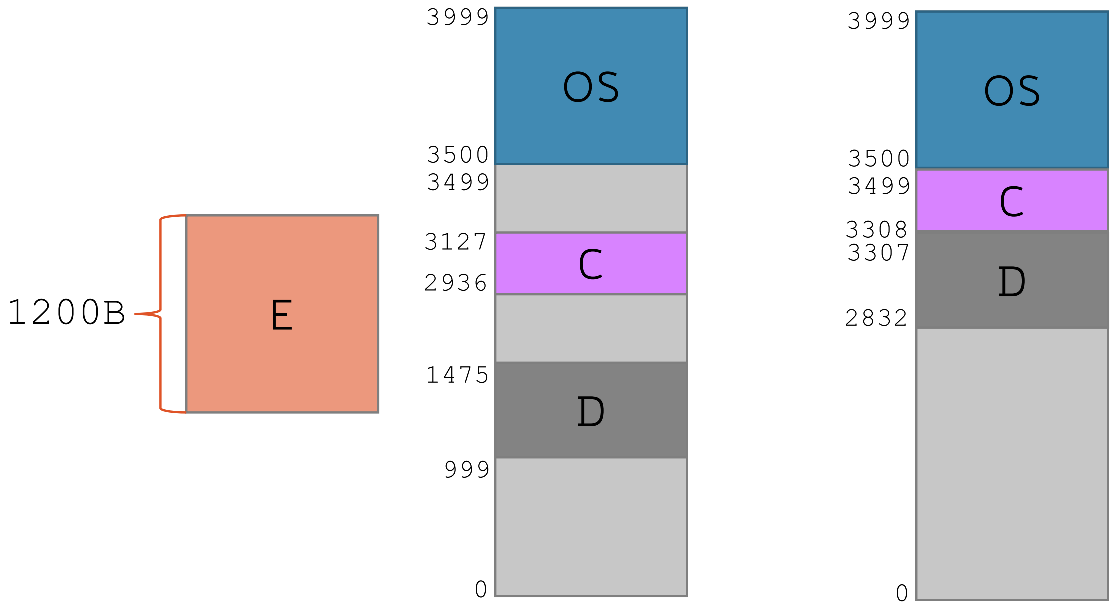

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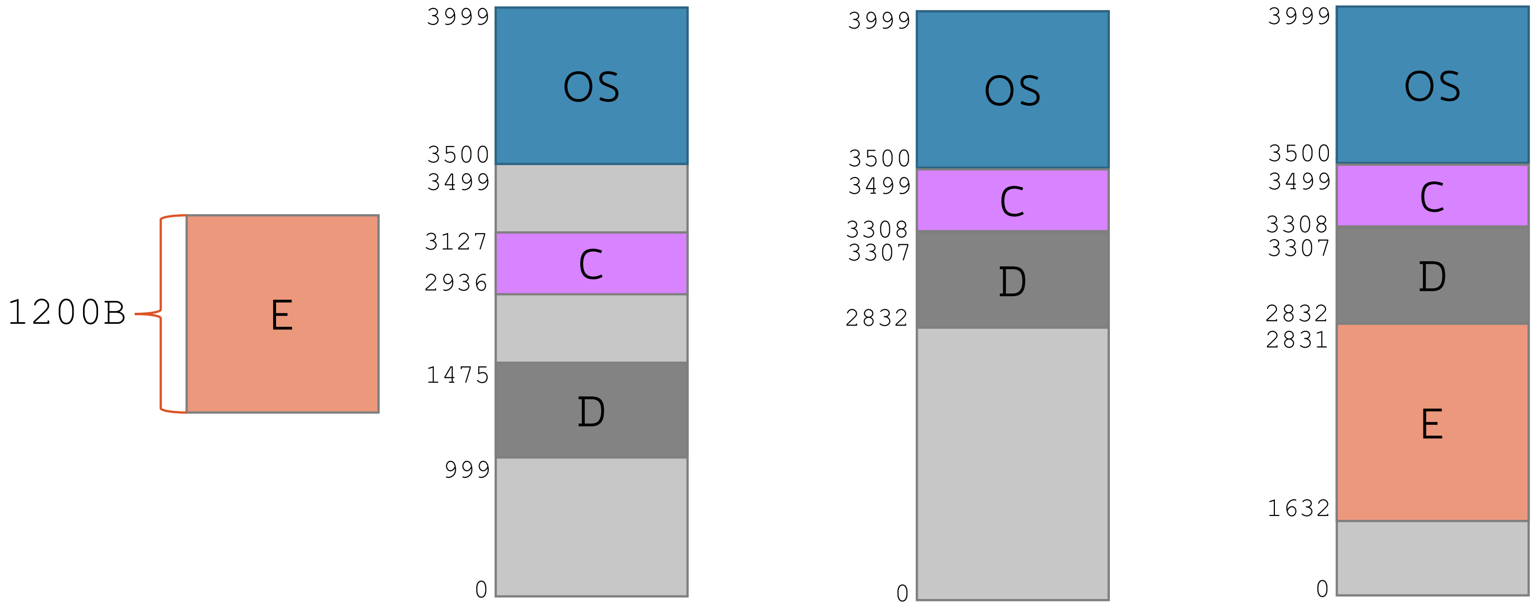

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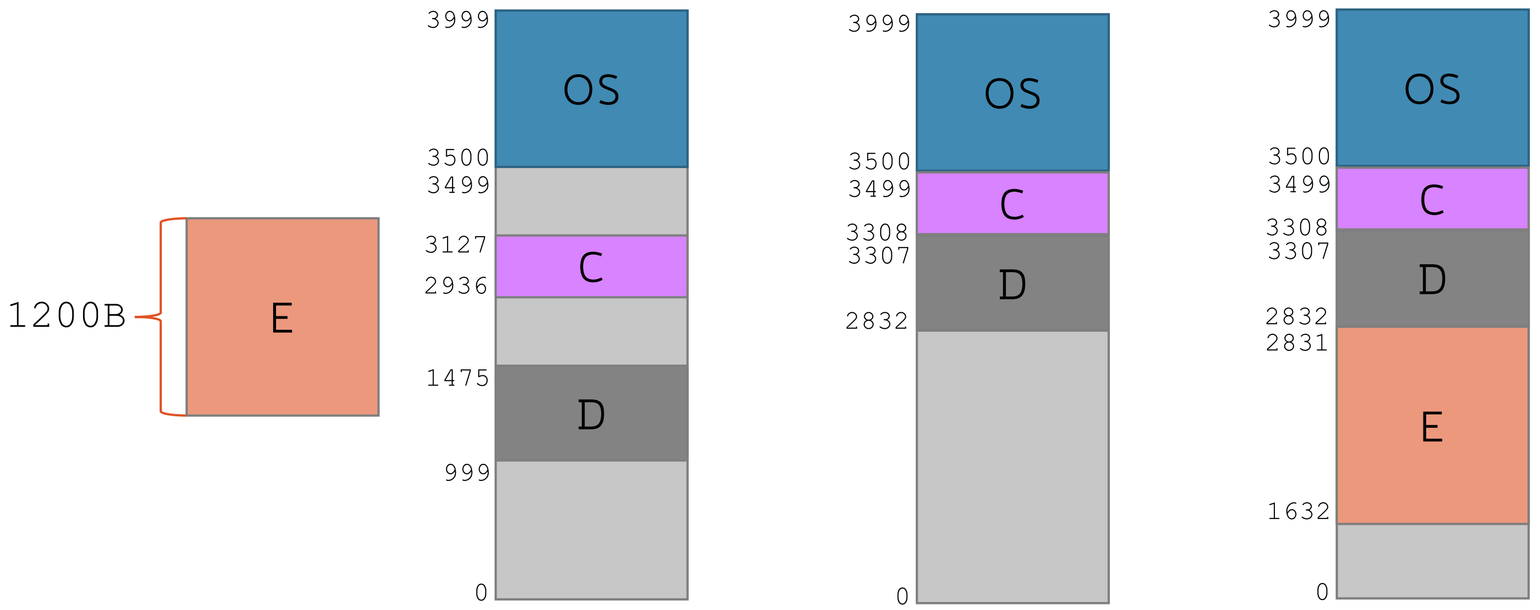

Only one hole is left but two processes need to be moved (C and D)

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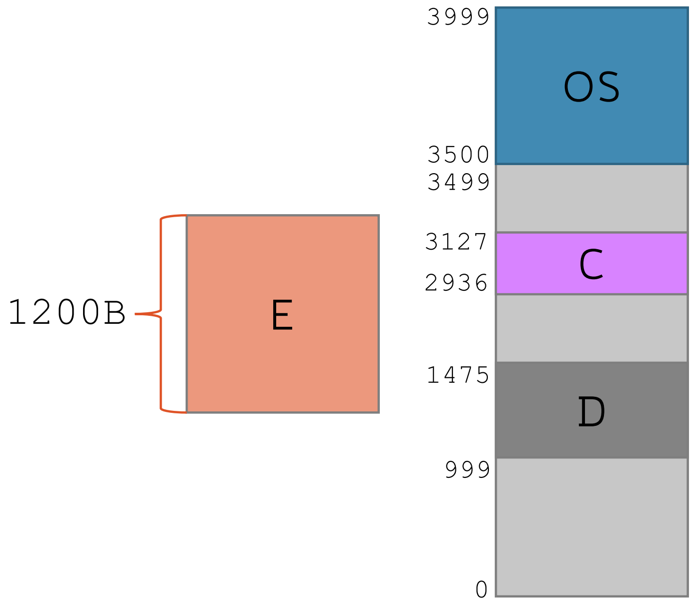

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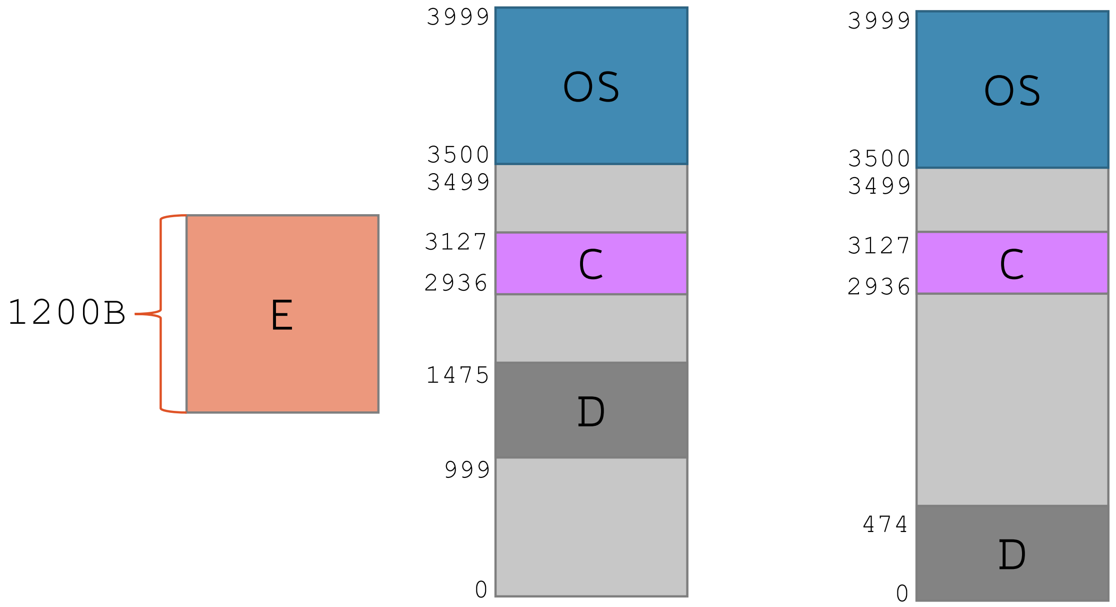

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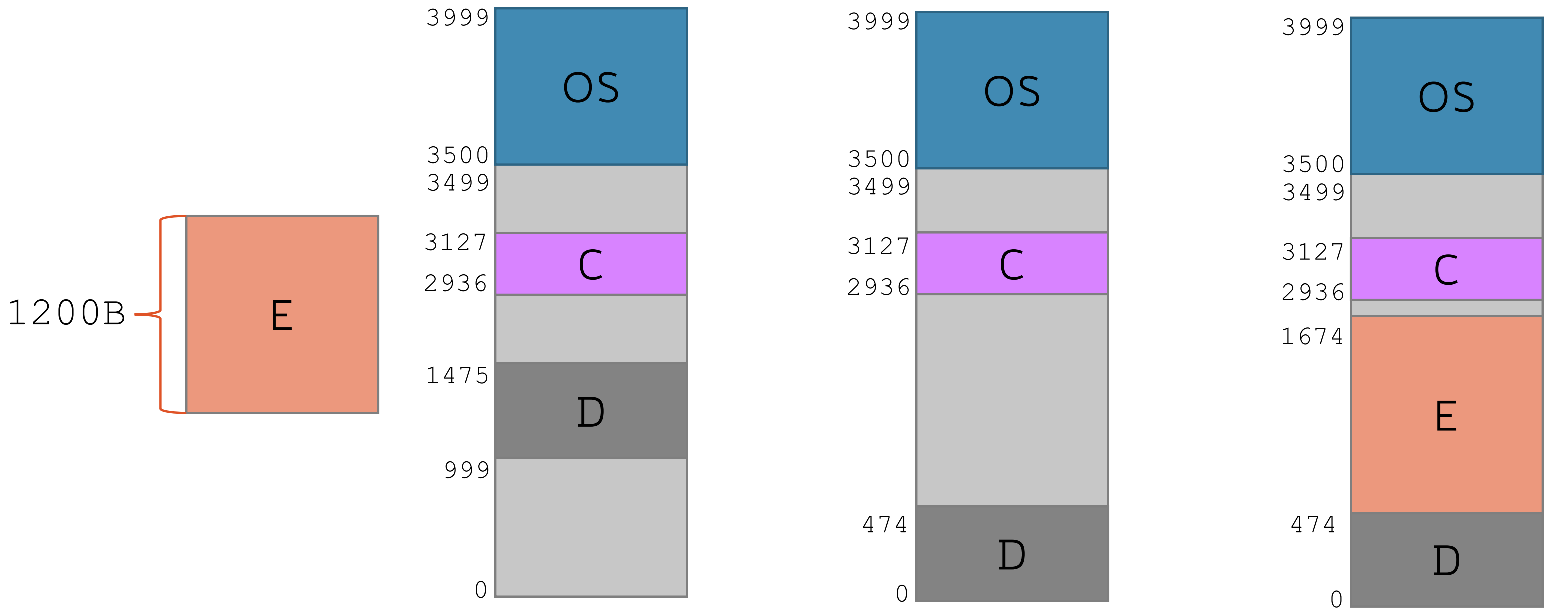

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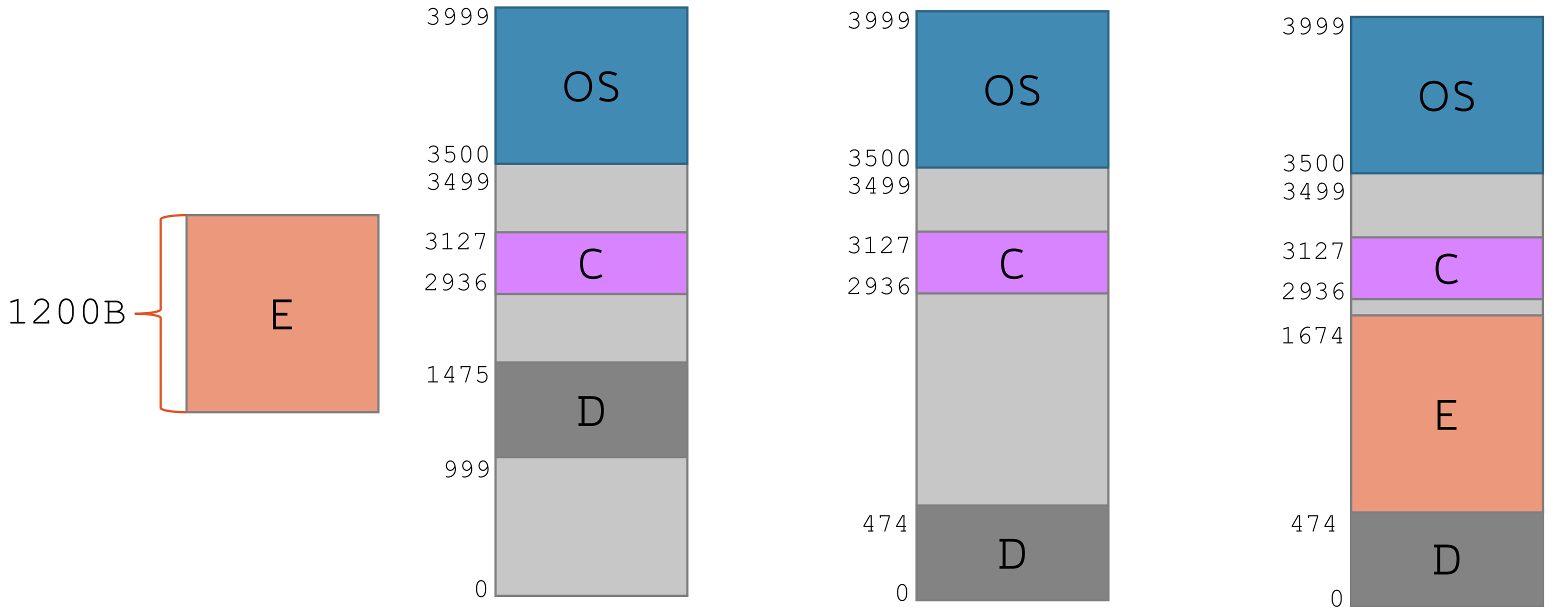

Still some holes left but only one process is moved (D) rather than two

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- That process can be "swapped out" from memory to disk to make room for other processes

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- Using swapping, fragmentation can be tackled easily
  - Just run compaction before swapping-in a process

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- Time slice is usually way smaller than that!

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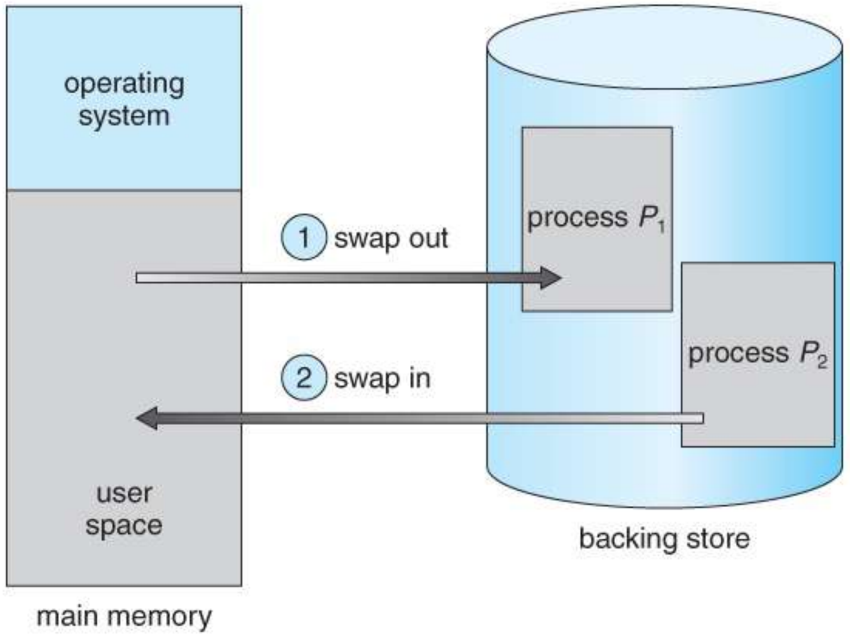

Most modern OSs no longer use swapping, because it is too slow and there are faster alternatives available (e.g., paging)

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- Fragmentation
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- Process entirely loaded
  - Swapping helps but it may be too inefficient

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- External fragmentation is eliminated because pages have fixed size
  - Internal fragmentation may still occur though

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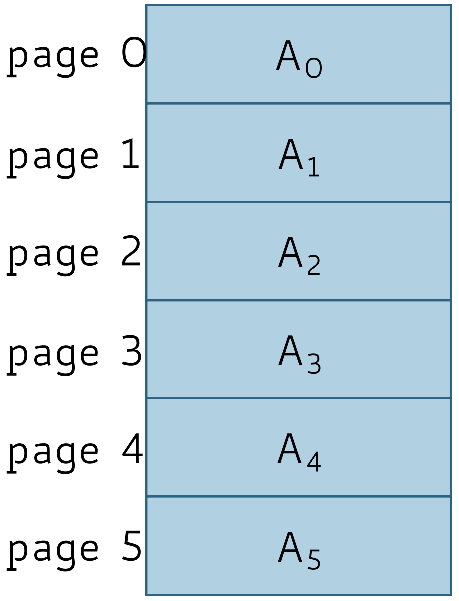
- A memory management scheme that addresses the problems above
- The logical address space of a process is still **contiguous** but it is divided into **fixed-size blocks**, called **pages**
- Contiguous allocation is no longer required as logical pages can be mapped to **non-contiguous** physical **frames**
- External fragmentation is eliminated because pages have fixed size
    - Internal fragmentation may still occur though

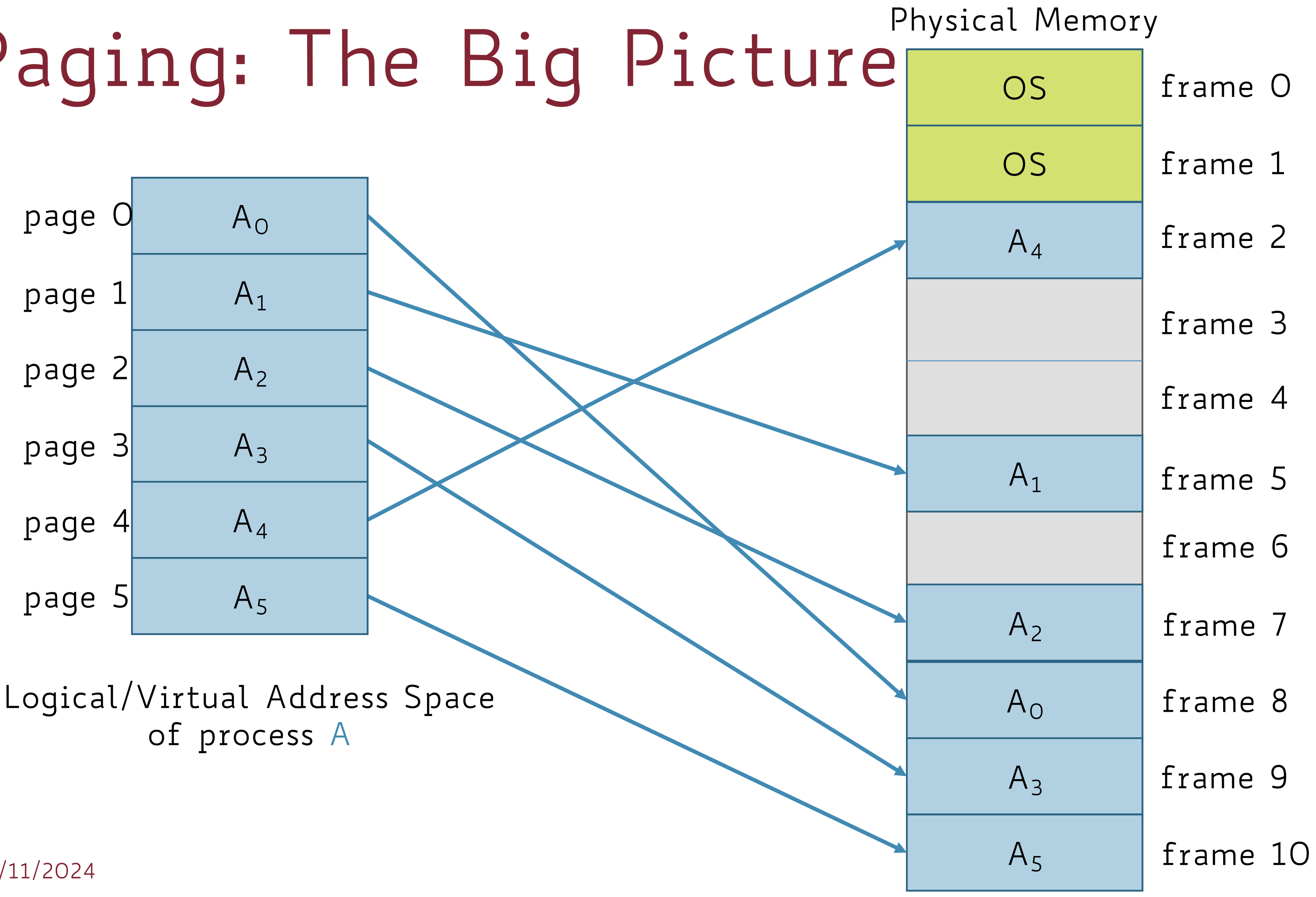
90/10 Rule
Processes spend 90% of their time accessing only 10% of their allocated memory space

Paging: The Big Picture



Logical/Virtual Address Space
of process A

Paging: The Big Picture



Basic OS Responsibilities for Paging

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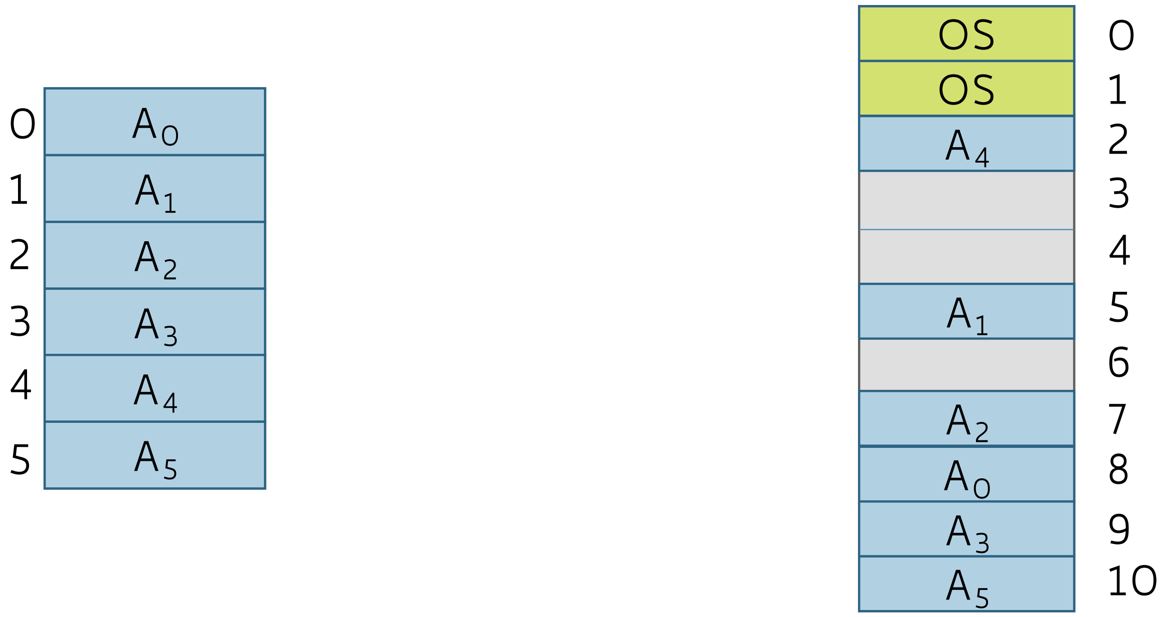
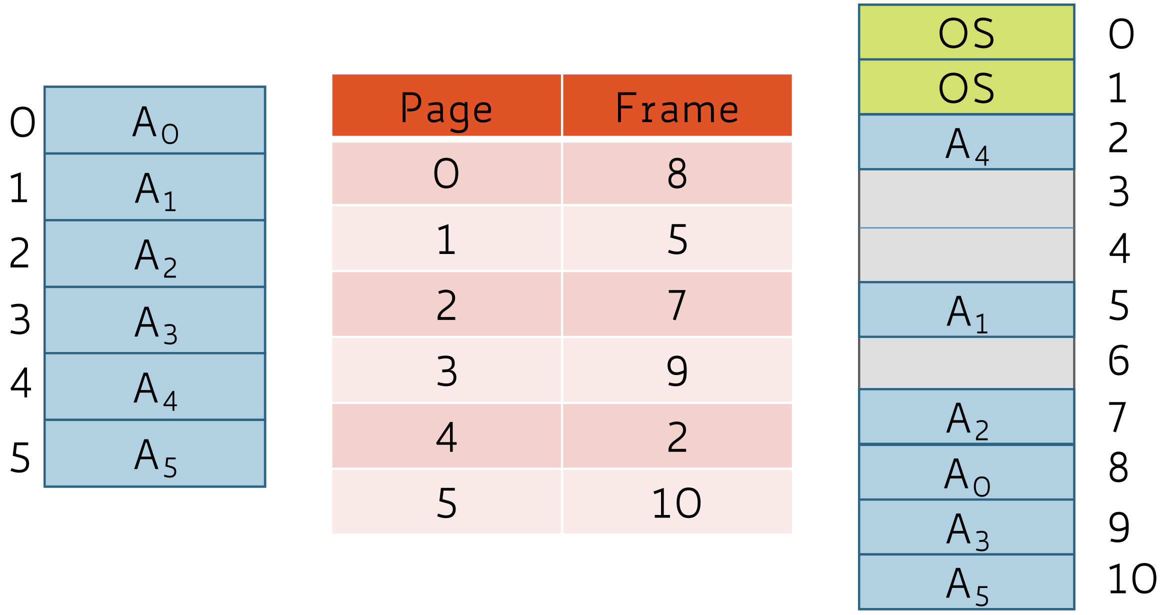
- All of this must be done efficiently!
  - Remember, memory addresses are referenced all the time
- OS needs dedicated support for doing it → **Page Table**

Page Table: Mapping Pages to Frames



Page Table: Mapping Pages to Frames

Lookup table to retrieve what frame a page is stored in



Page	Frame
0	8
1	5
2	7
3	9
4	2
5	10

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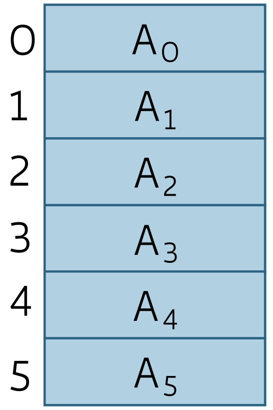

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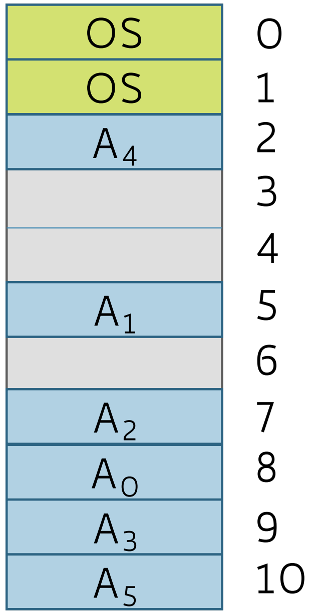

We have assumed all pages of a process are mapped to physical frames, but this is not always the case

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- Existing countermeasures (compaction) exist but they are costly
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- Paging solves all these issues!