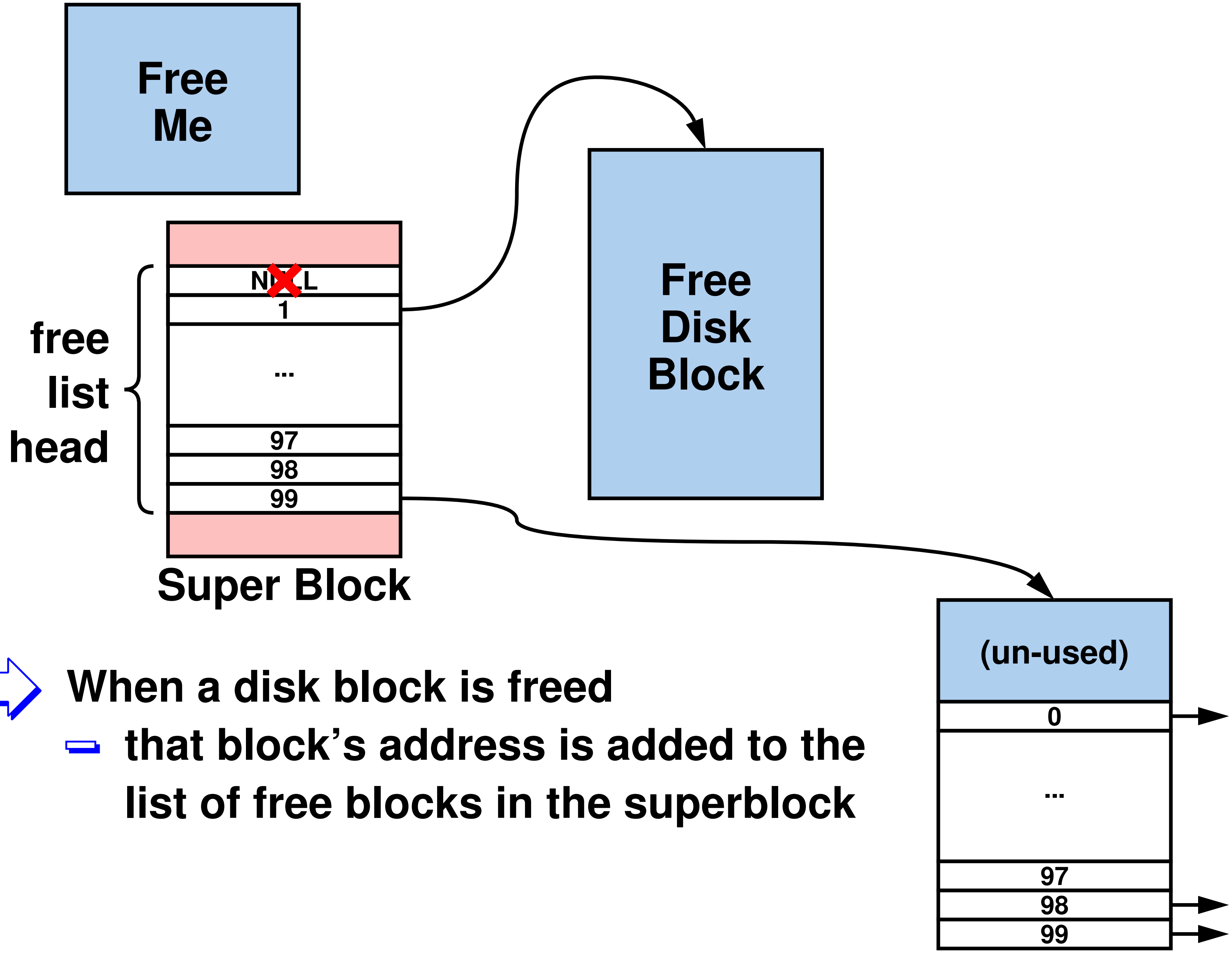
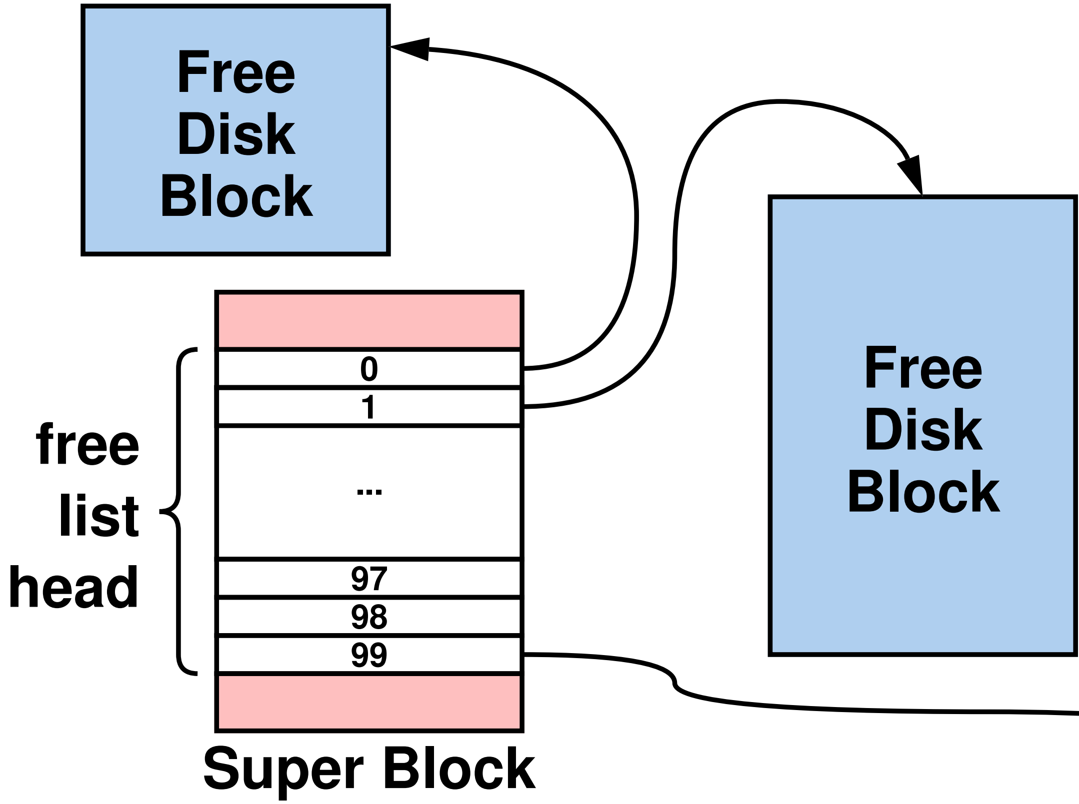
S5FS Free List: Deallocation - Case (1)

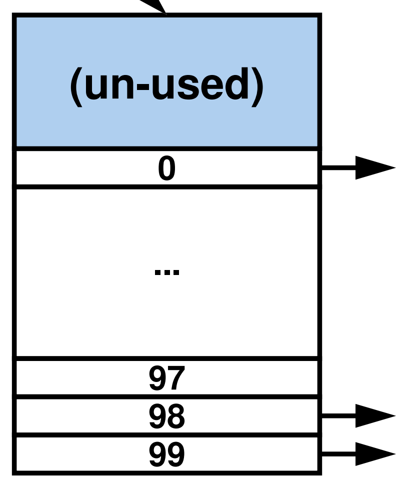


- When a disk block is freed
  - that block's address is added to the list of free blocks in the superblock

S5FS Free List: Deallocation - Case (1)



- super block is cached in memory
- no need to write to disk



- When a disk block is freed
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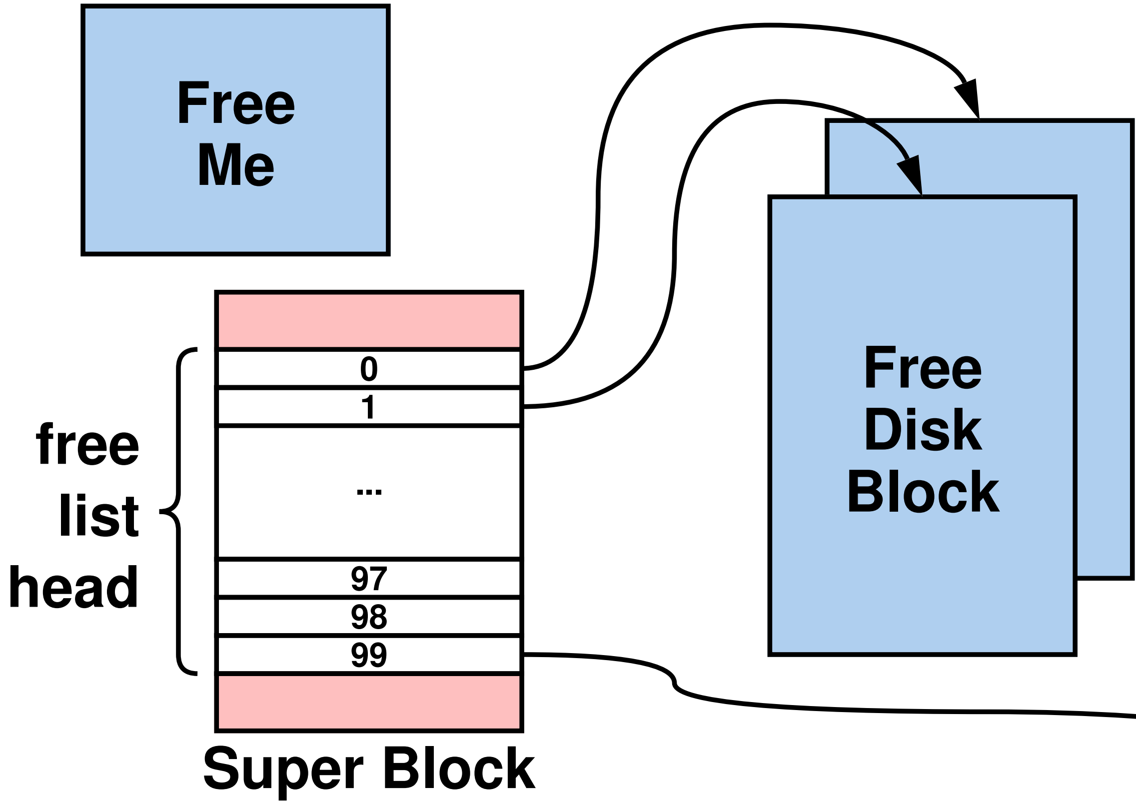
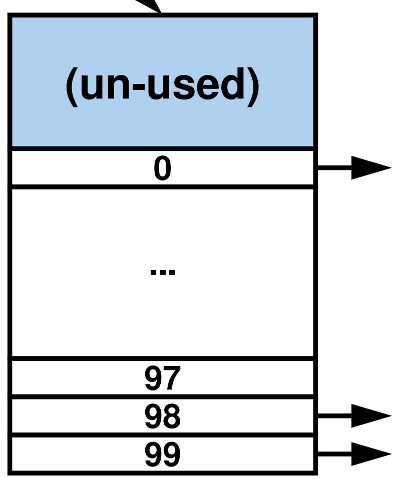
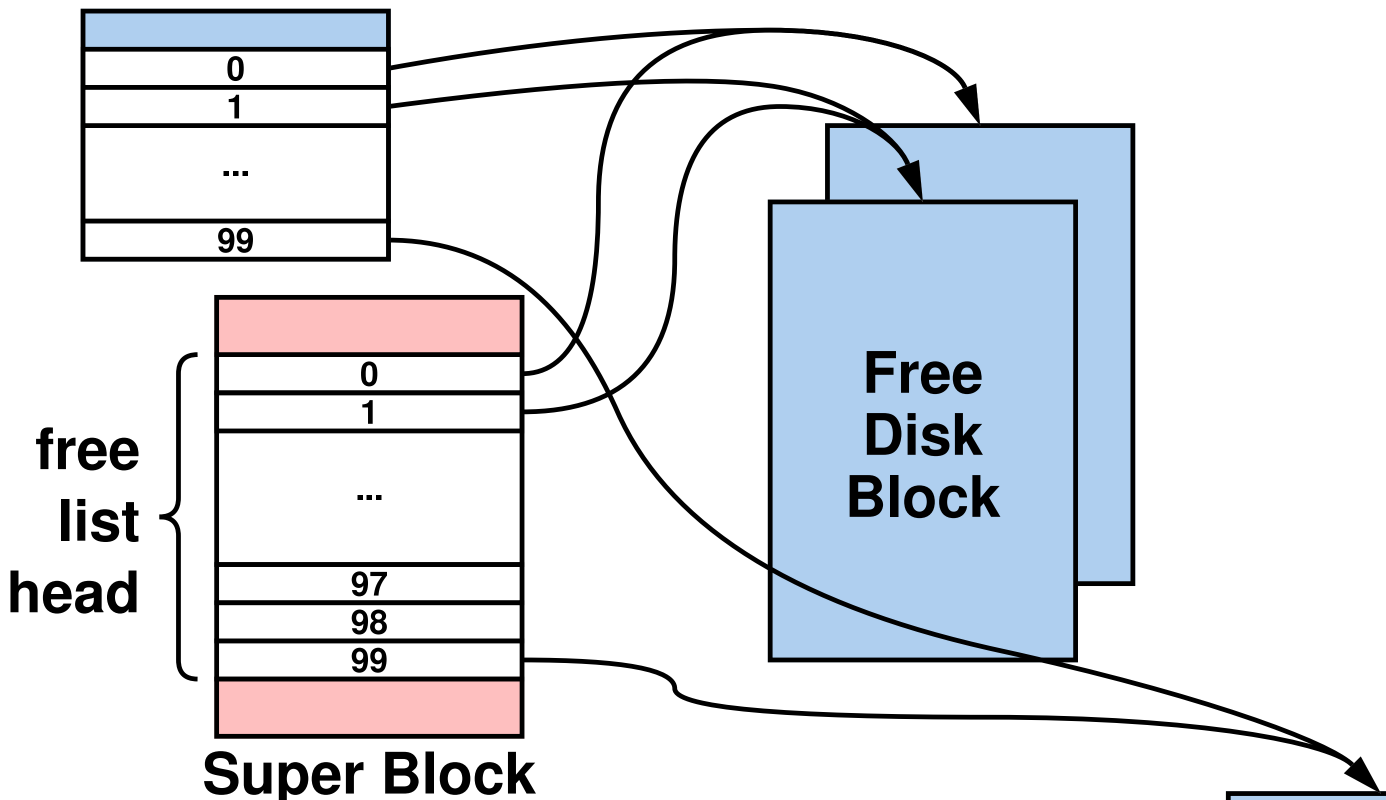
S5FS Free List: Deallocation - Case (2)

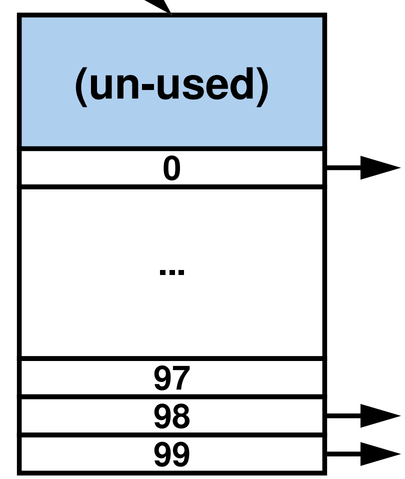




- When a disk block is freed
  - that block's address is added to the list of free blocks in the superblock
  - if the list is full
    - copy first node from super block into the newly freed block and update superblock

S5FS Free List: Deallocation - Case (2)





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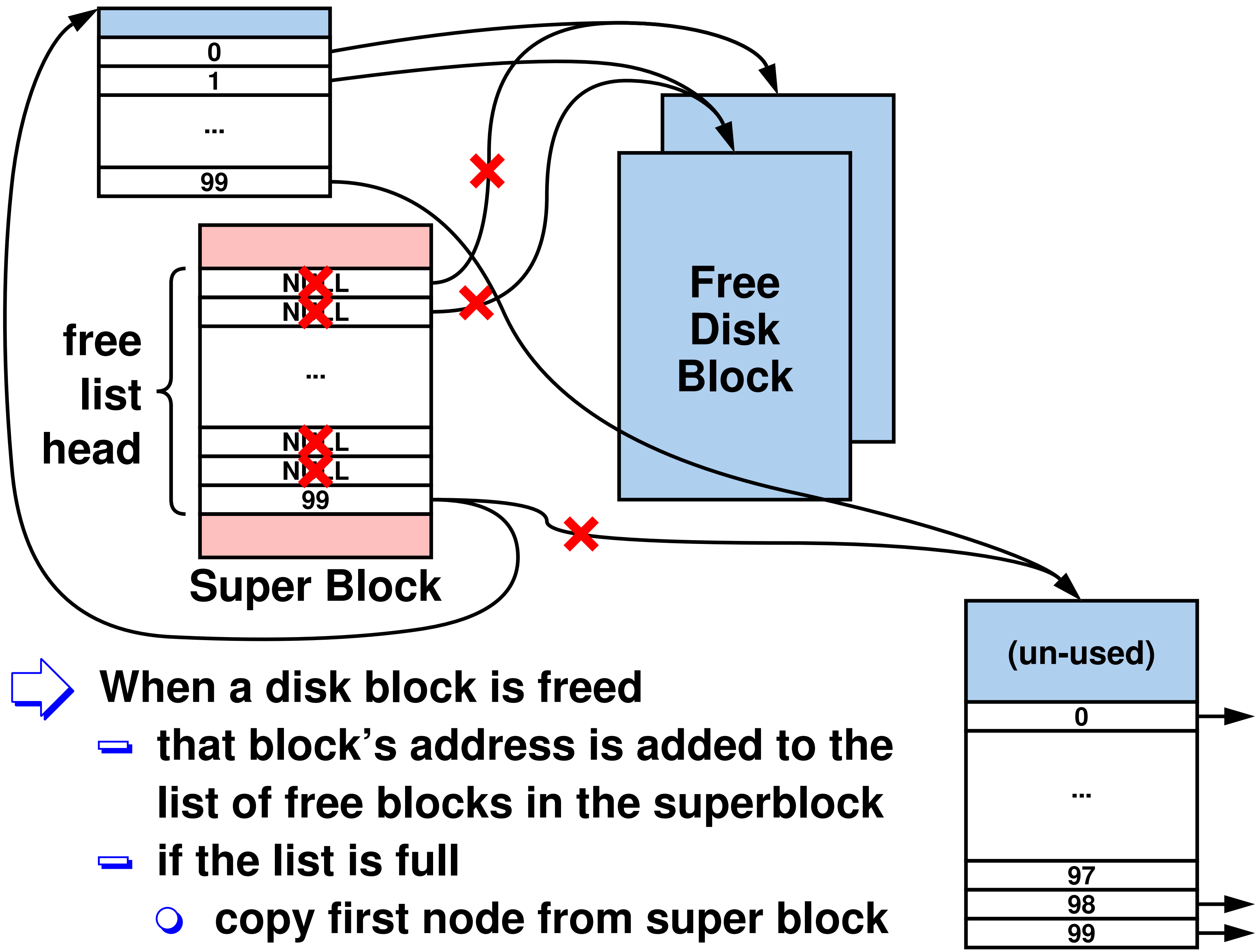

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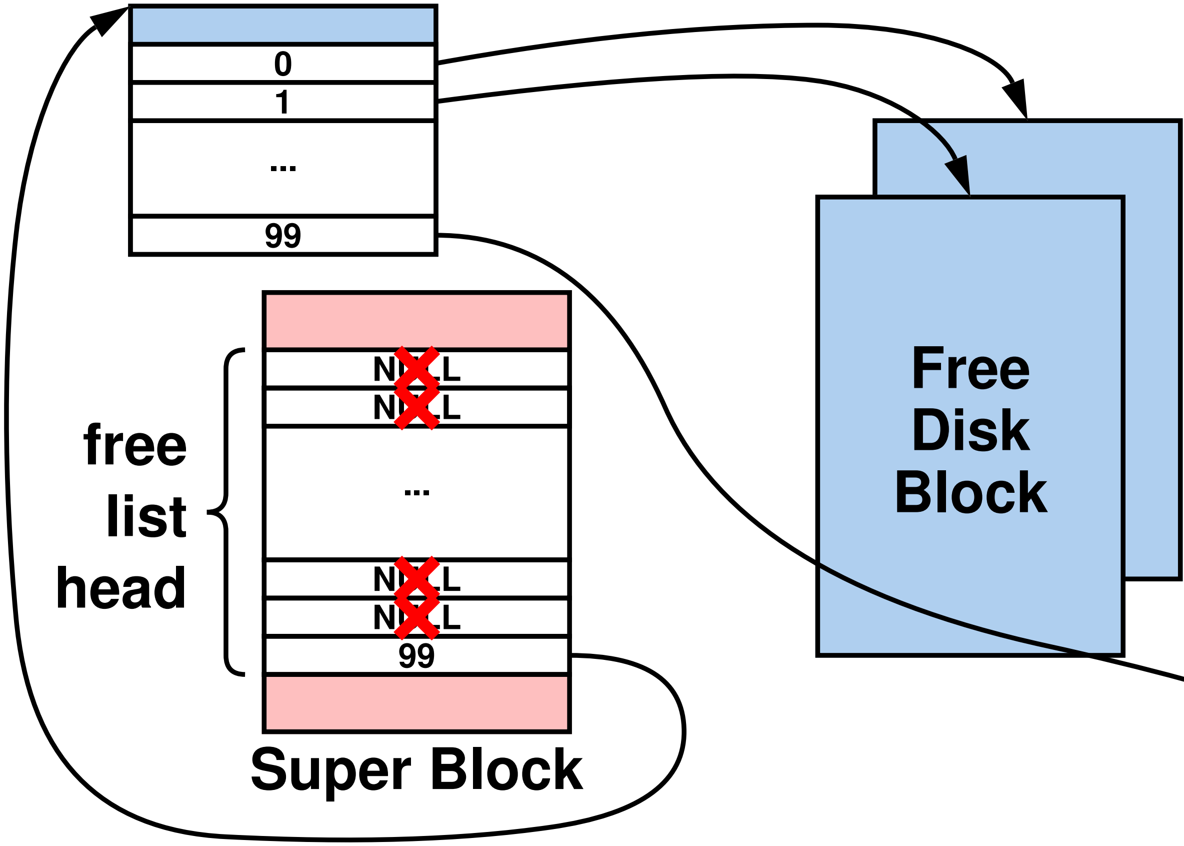
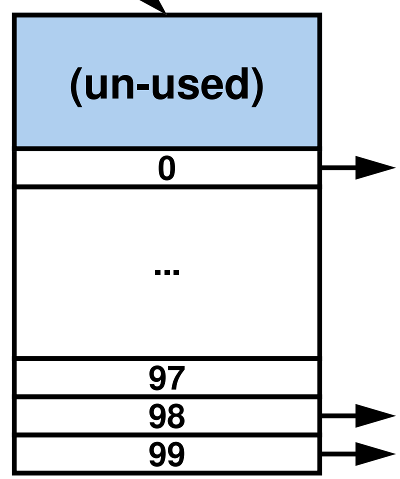
S5FS Free List: Deallocation - Case (2)



- one disk write to copy disk block pointers
- only happens 1 out of 100 frees

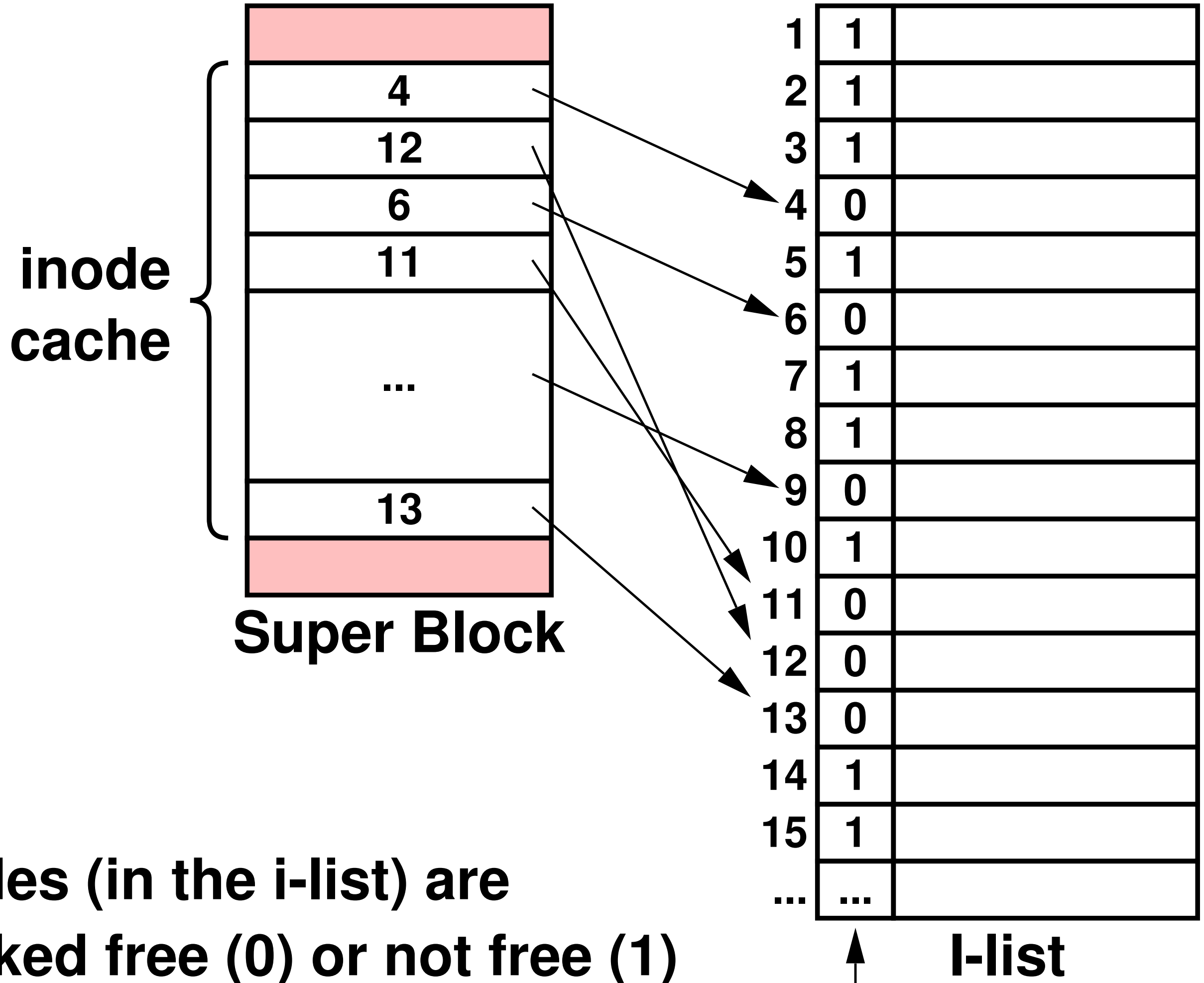


- When a disk block is freed
  - that block's address is added to the list of free blocks in the superblock
  - if the list is full
    - copy first node from super block into the newly freed block and update superblock

S5FS Free List

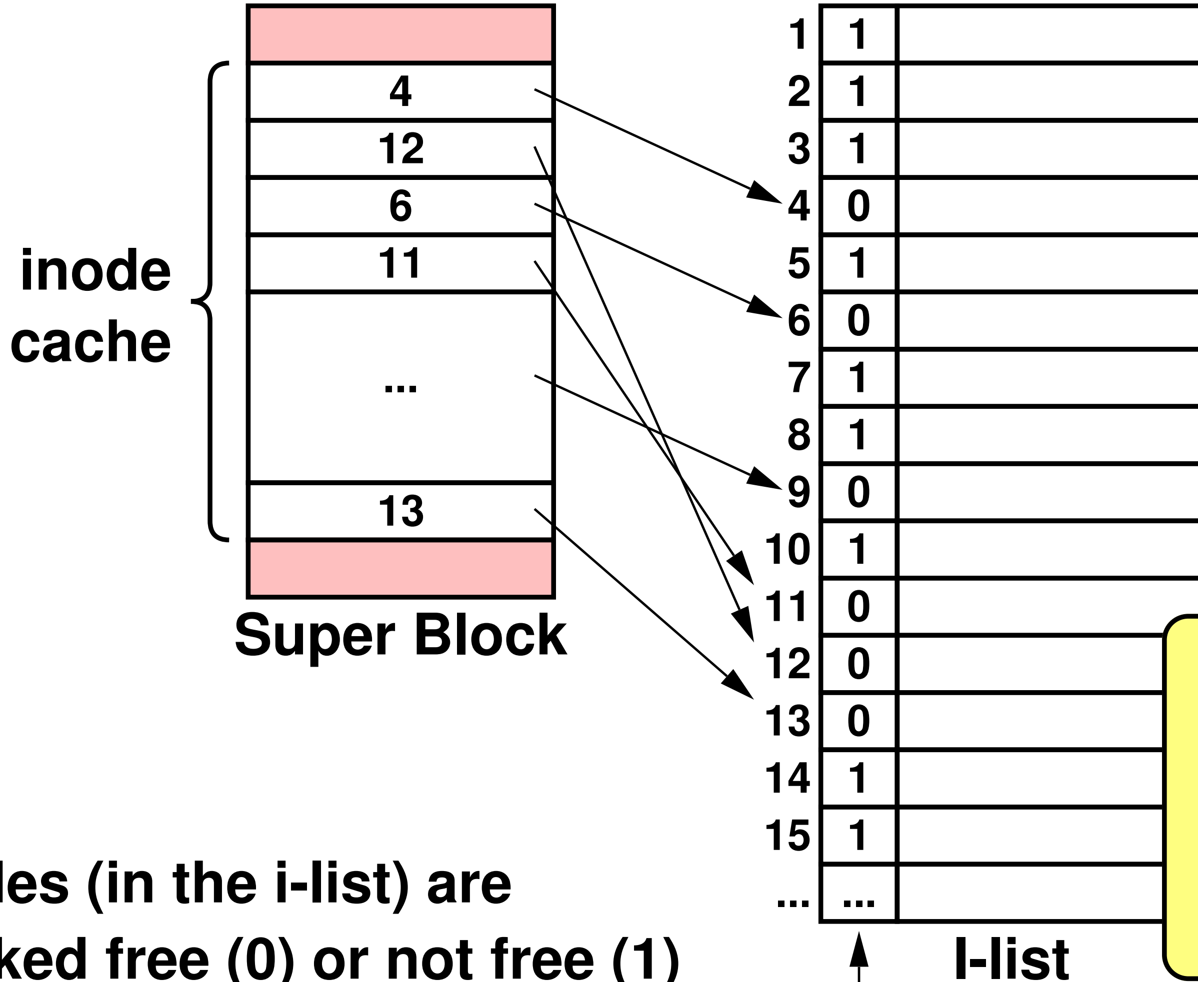
- Why 100 disk pointers in each free block?
  - to *reduce the number of disk accesses*
    - for every 100 times you need to allocate/deallocate a free block, you only need to go to the disk 1 time (on the average)
      - effective allocation/deallocation time is 100 times faster!
  - is the reason also to reduces the length of the free list?
    - no
    - but reducing the length of the free list reduces the number of disk accesses
      - correct, but that's a secondary effect
      - it's important to be able to distinguish between what's primary and what's secondary effects

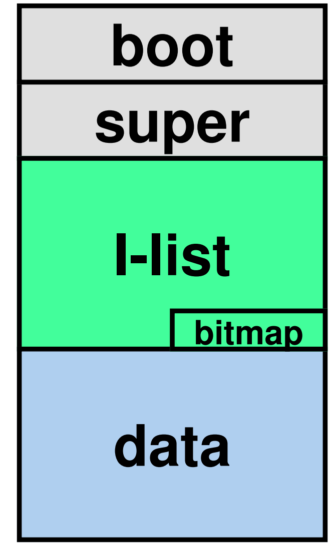
S5FS Free Inode List



- Inodes (in the i-list) are marked free (0) or not free (1)
  - use a "bitmap" to store this
  - no additional organization in the i-list
  - the superblock *caches* *free* inodes *(i.e., in the inode cache)*

S5FS Free Inode List

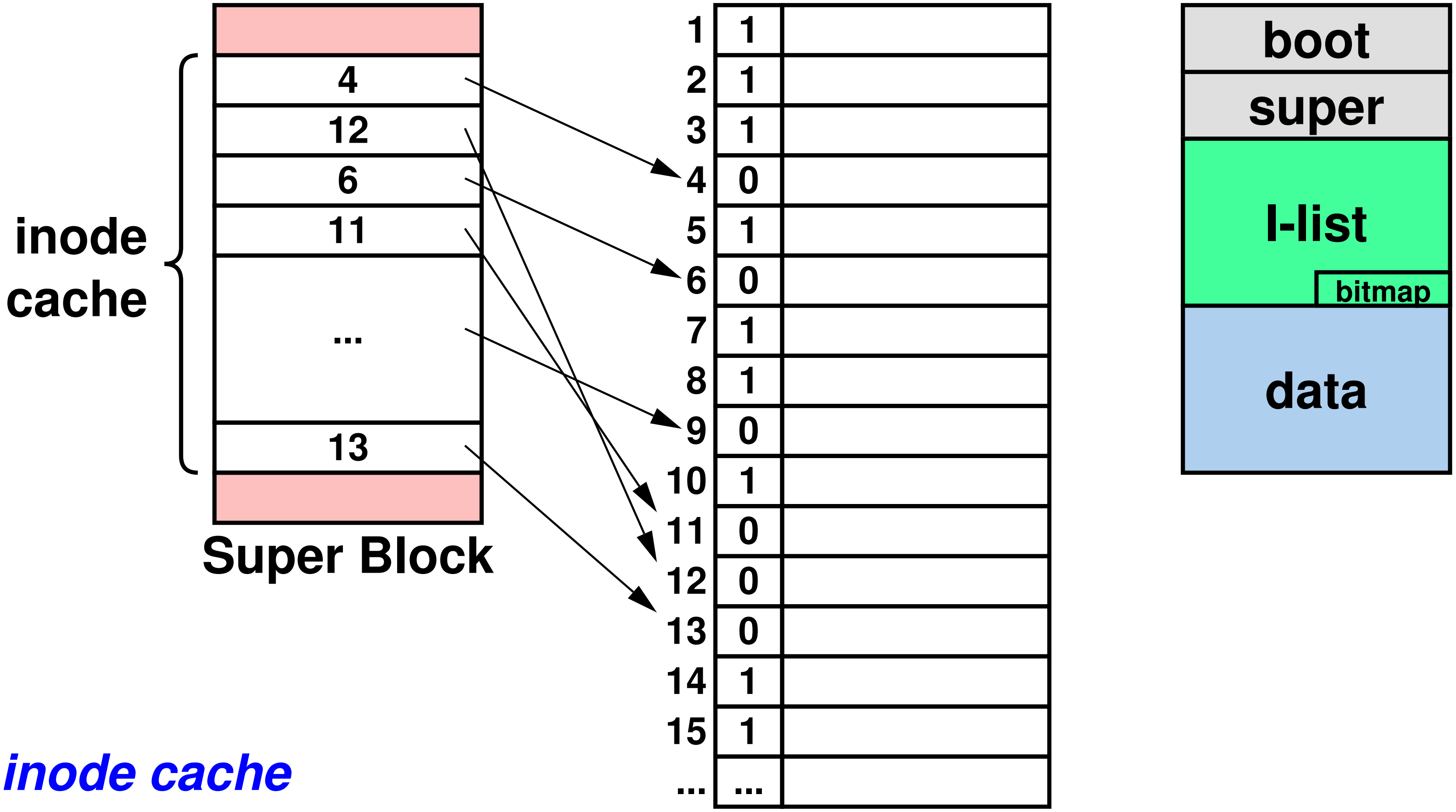




- can store location of bitmap, # of inodes, etc. in super block
- bitmap can be cached in memory for speed

- Inodes (in the i-list) are marked free (0) or not free (1)
  - use a "bitmap" to store this
  - no additional organization in the i-list
  - the superblock *caches free* inodes *(i.e., in the inode cache)*

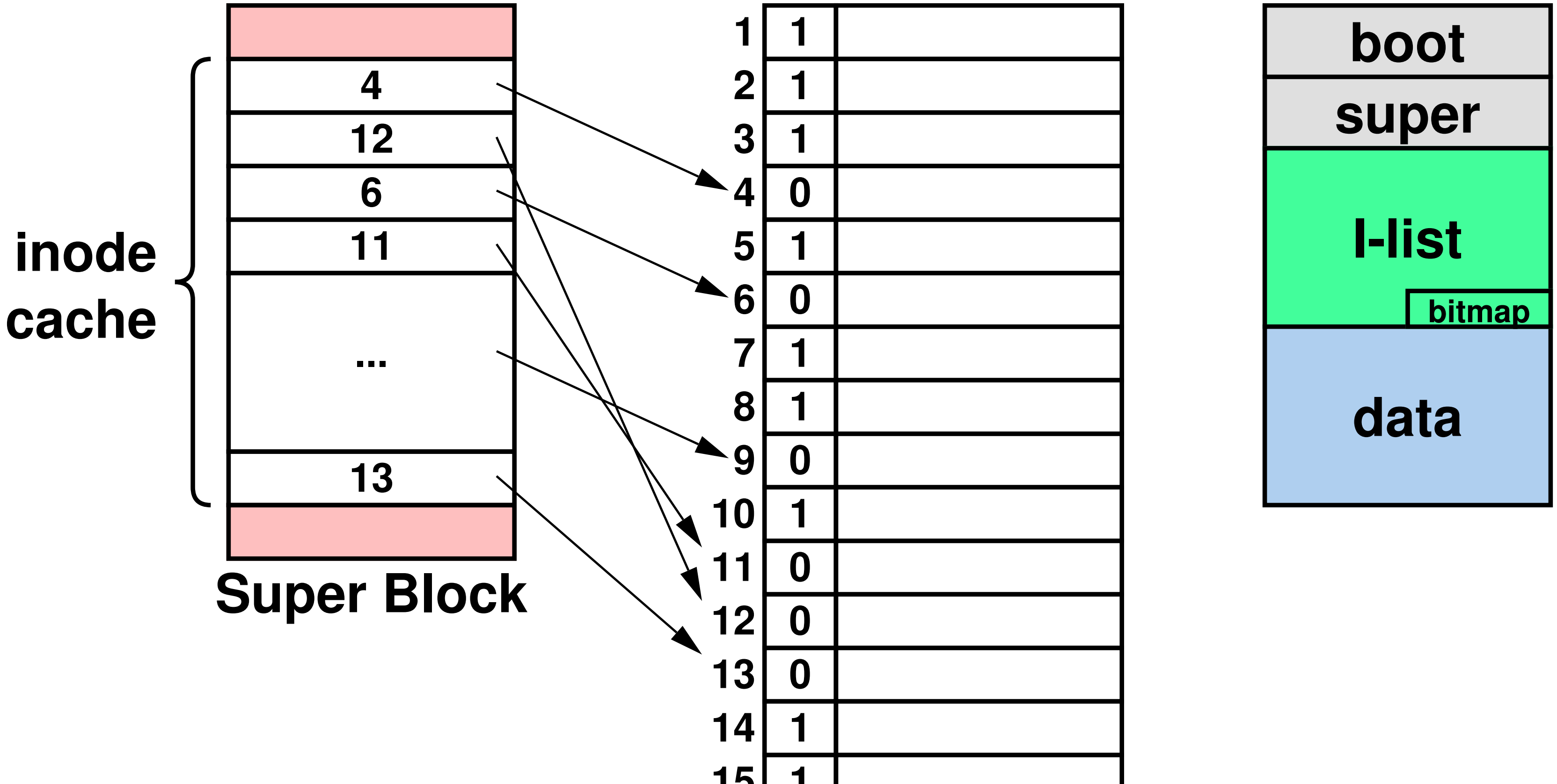
S5FS Free Inode List



I-list

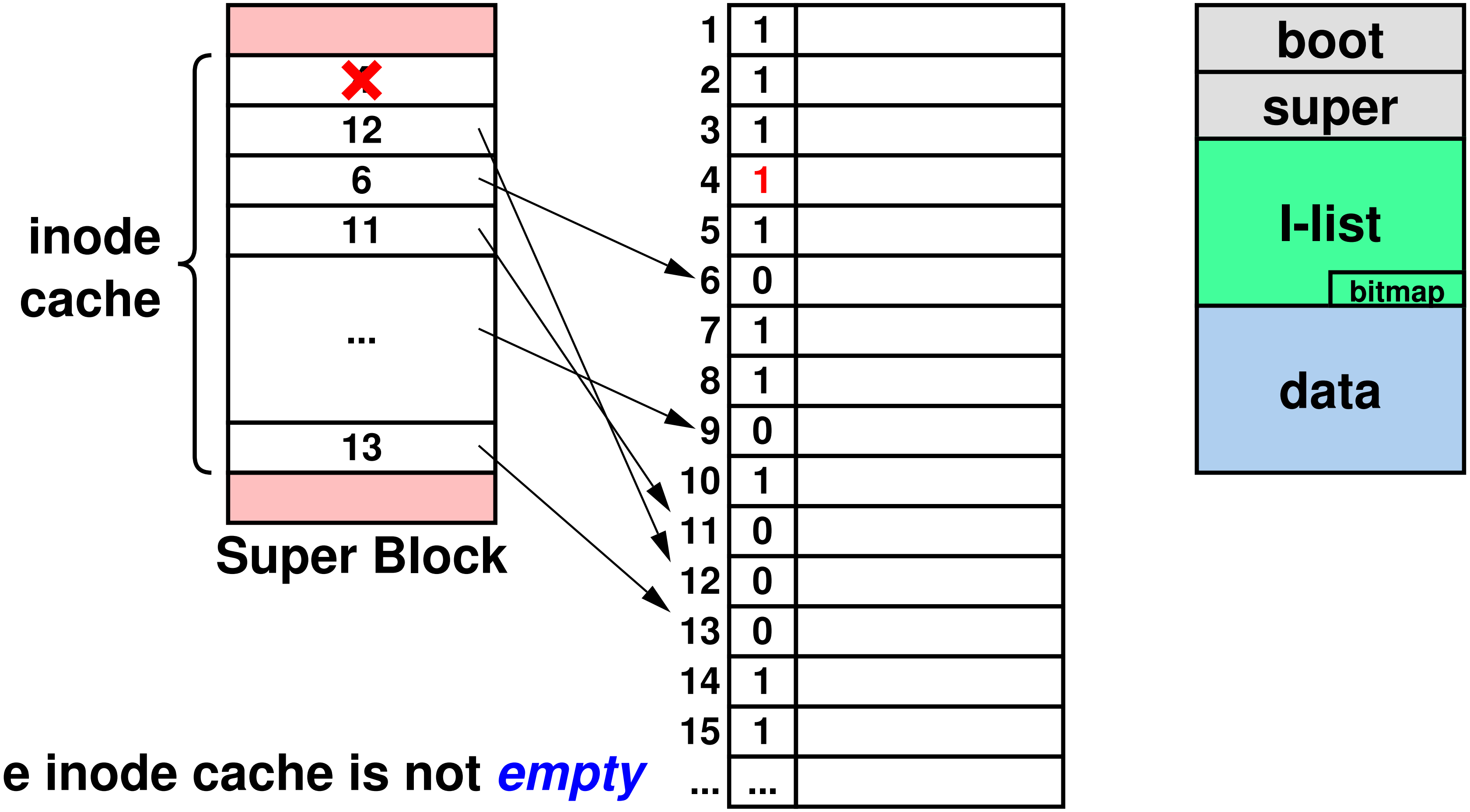
- The *inode cache*
  - to *allocate* an inode, simply mark it not free and remove it from the inode cache
  - to *free* an inode, simply mark it free and add to the inode cache if there is room

S5FS Free Inode List: Allocation - Case (1)



- If the inode cache is not *empty*
  - mark an inode not free and remove it from the inode cache
    - ex: need a free inode

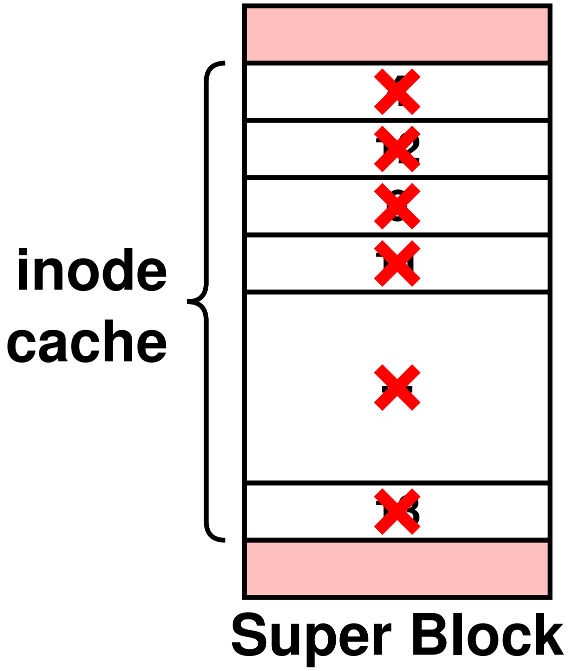
S5FS Free Inode List: Allocation - Case (1)

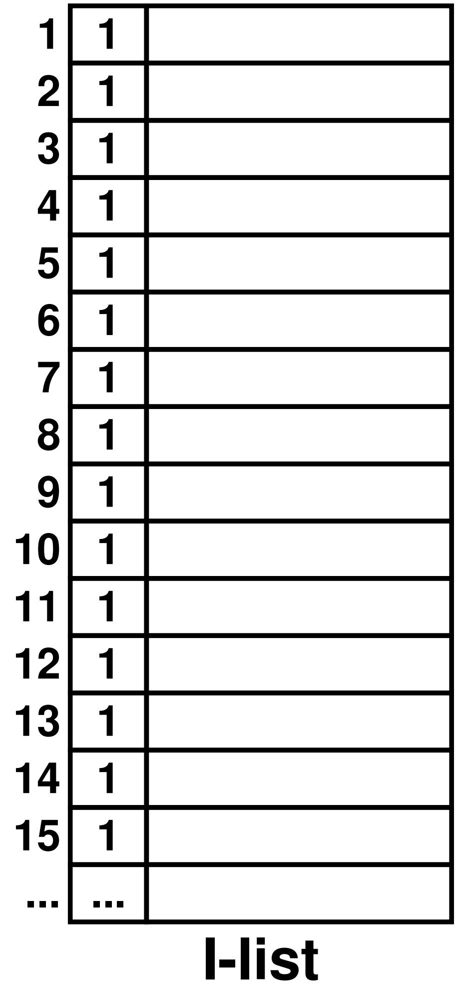


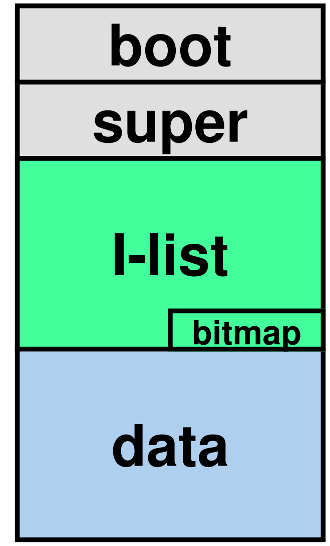
I-list

- If the inode cache is not *empty*
  - mark an inode not free and remove it from the inode cache
    - ex: need a free inode
      - inode 4 is now allocated (i.e., not free)

S5FS Free Inode List: Allocation - Case (2)

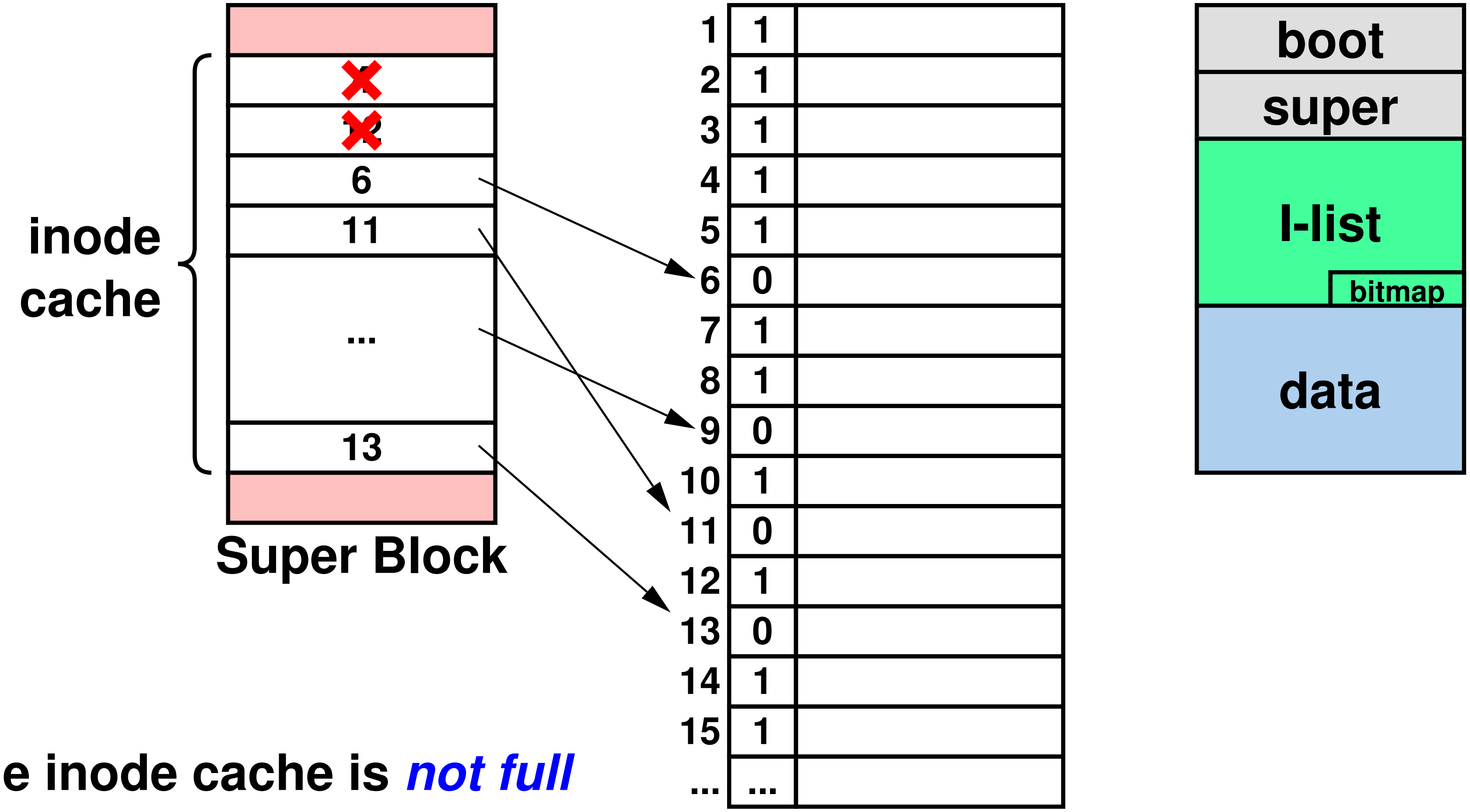






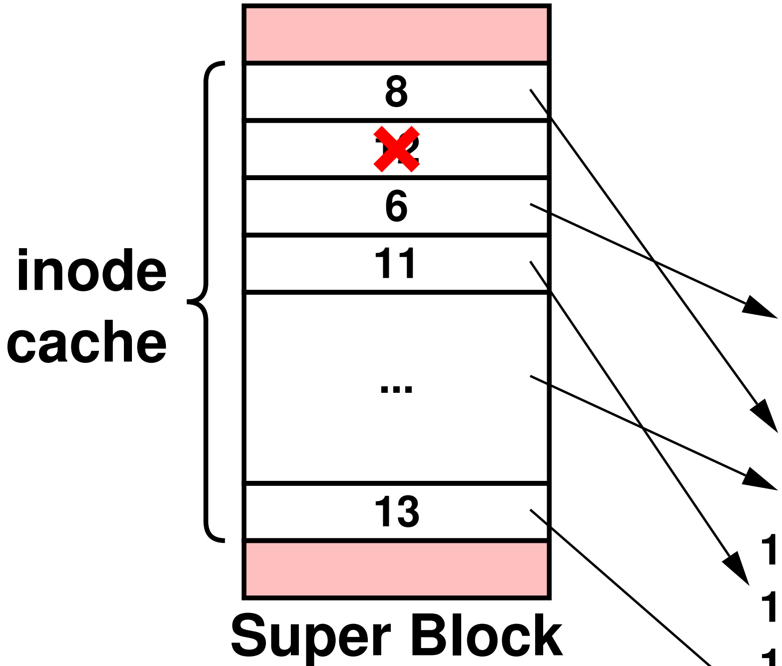
- If the inode cache is ***empty***
  - scan the i-list to refill it
    - to help out with the scan, the super block keeps the first free inode in the i-list ("low water mark")
      - need to maintain this entry when necessary

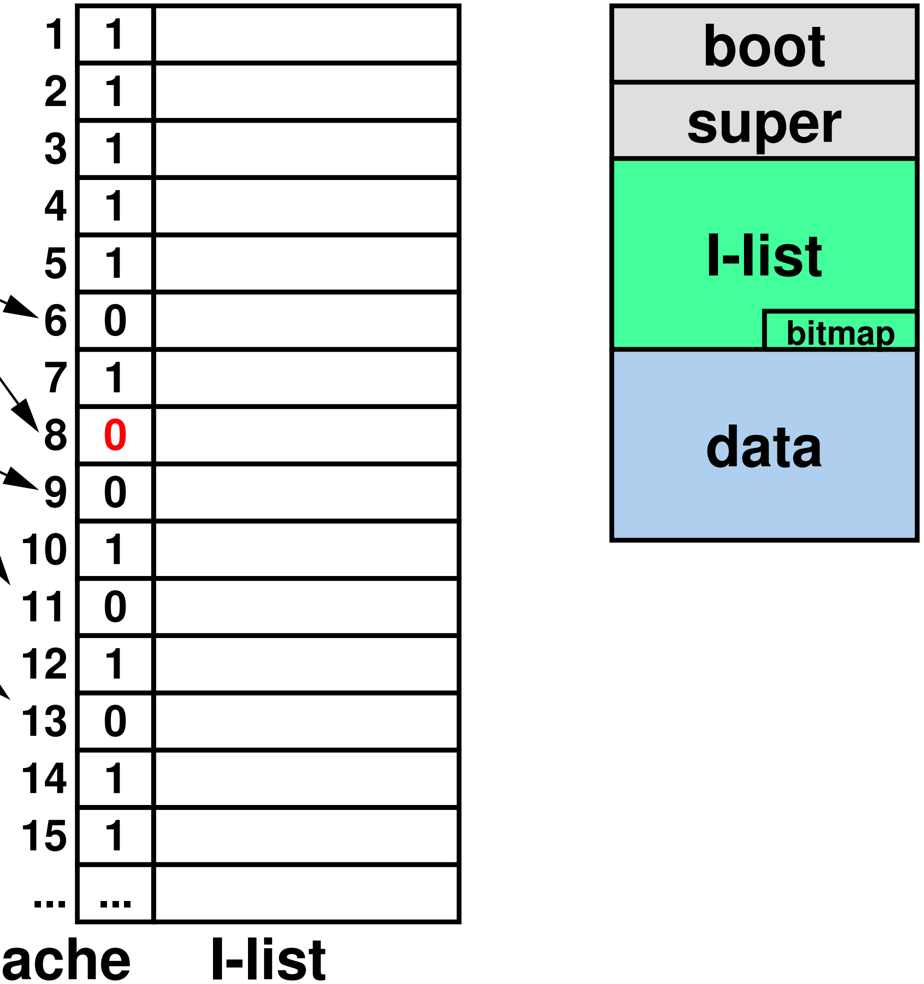
S5FS Free Inode List: Deallocation - Case (1)



- If the inode cache is ***not full***
  - add inode number to inode cache
  - update bitmap to indicate that the inode is now free
  - update "low water mark" in super block if necessary
    - ex: free inode 8

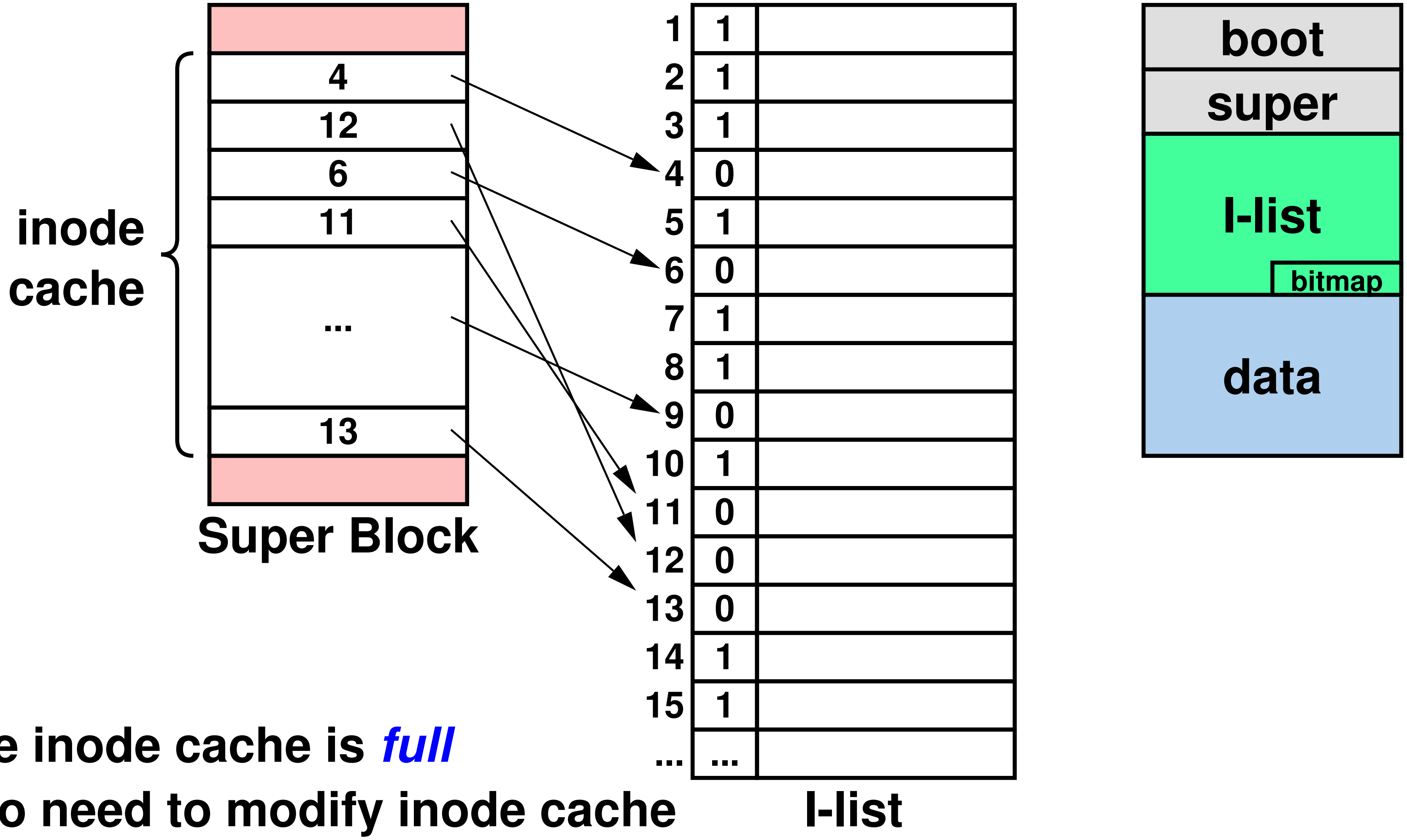
S5FS Free Inode List: Deallocation - Case (1)





- If the inode cache is *not full*
  - add inode number to inode cache
  - update bitmap to indicate that the inode is now free
  - update "low water mark" in super block if necessary
    - ex: free inode 8

S5FS Free Inode List: Deallocation - Case (2)



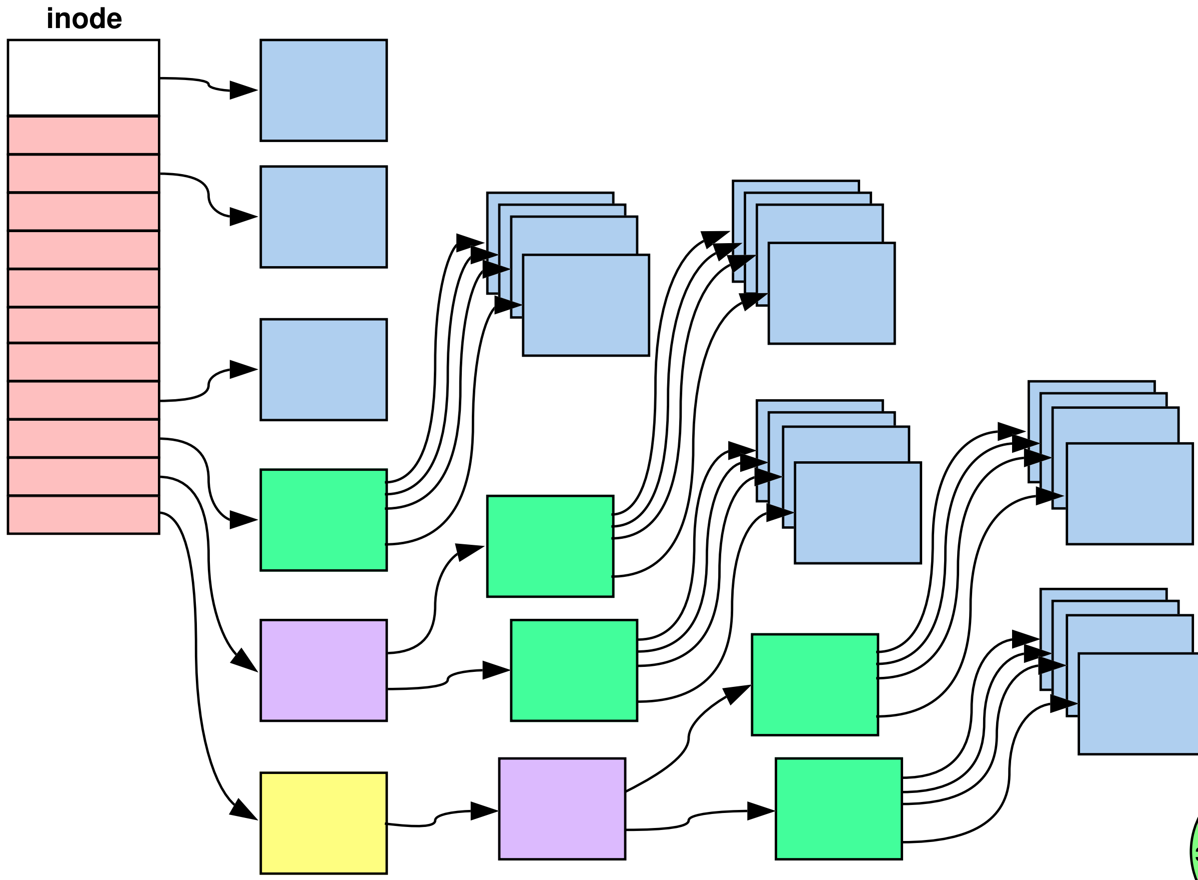
- If the inode cache is *full*
  - no need to modify inode cache
  - update bitmap to indicate that the inode is now free
  - update "low water mark" in super block if necessary

S5FS Summary

- To *create a file*
  - get a *free inode*
    - update *i-list*, *inode cache*, and "low water mark"
- *First write to a file*
  - get a *free block*
    - update *free list*
- More writes to the file
  - may need to get a free block and update free list
- To *delete a file*
  - add disk block(s) to *free list*
  - mark inode free in *i-list*, update *inode cache* and "low water mark"

S5FS Summary

- In designing a file system, one tries to *minimize* the number of *disk operations*
  - read vs. write
  - sequential access vs. random access
    - S5FS gives O(1) number of disk operations for random access

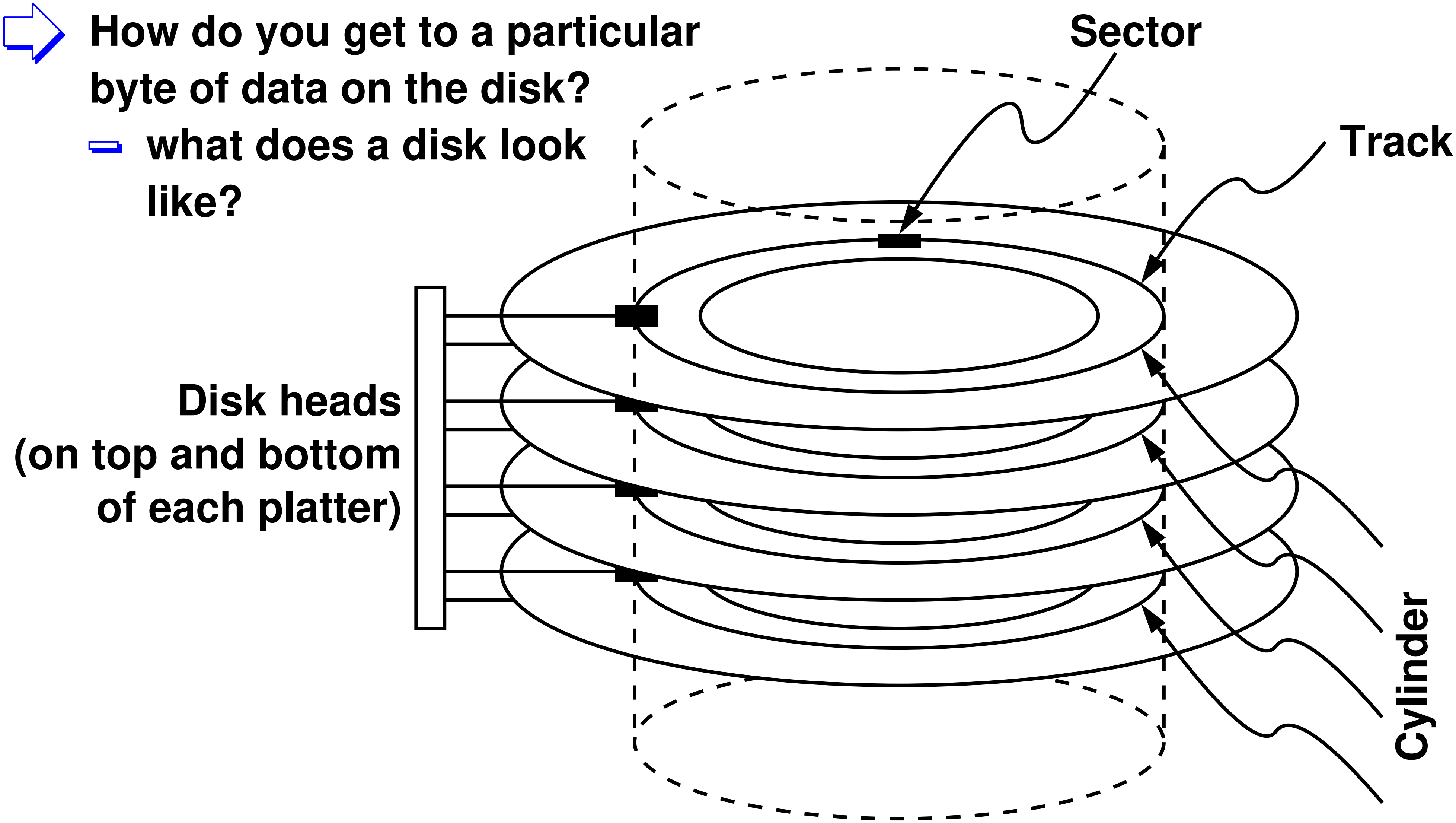


6.1 The Basics of File Systems

- UNIX's S5FS
- *Disk Architecture*
- Problems with S5FS
- Improving Performance

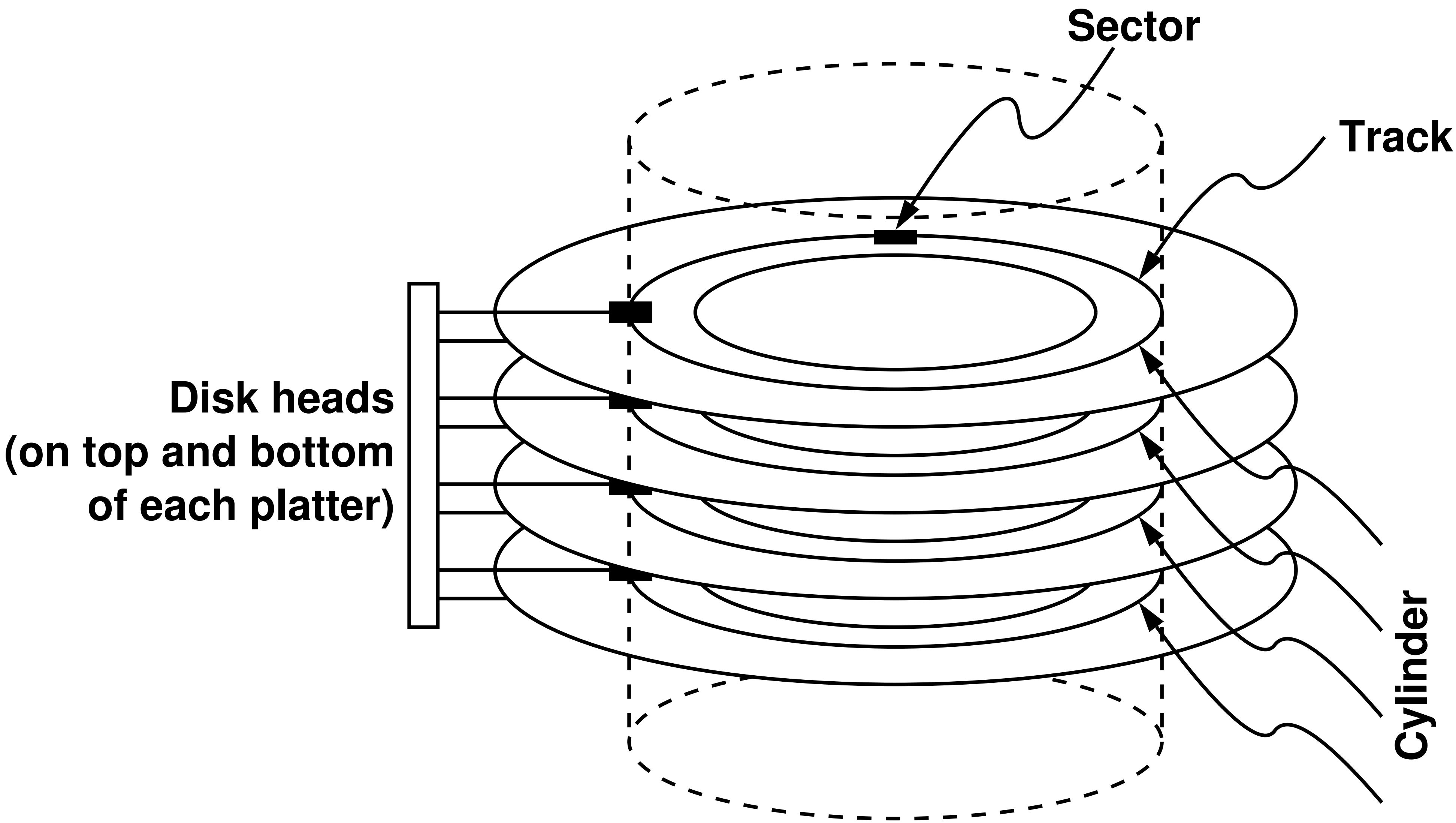
Disk Architecture

- How do you get to a particular byte of data on the disk?
  - what does a disk look like?



- Clearly, this looks nothing like the S5FS layout
  - or any logical file system layout

Disk Architecture



- Smallest addressable unit is a *sector*
  - disk address = (*head/surface#*, *cylinder/track#*, *sector#*)

Rhinopias Disk Drive

Rotation speed	10,000 RPM
Number of surfaces	8
Sector size	512 bytes
Sectors/track	500-1000; 750 average
Tracks/surface	100,000
Storage capacity	307.2 billion bytes
Average seek time	4 milliseconds
One-track seek time	.2 milliseconds
Maximum seek time	10 milliseconds

- ***Disk access time:*** time to copy a sector from disk to controller
  - *access time = seek time + rotational latency + data transfer time*
    - some people would use the term "response time" to mean "access time", but we should avoid the use of the term "response time"

Ch 7: Memory Management

Bill Cheng

http://merlot.usc.edu/william/usc/