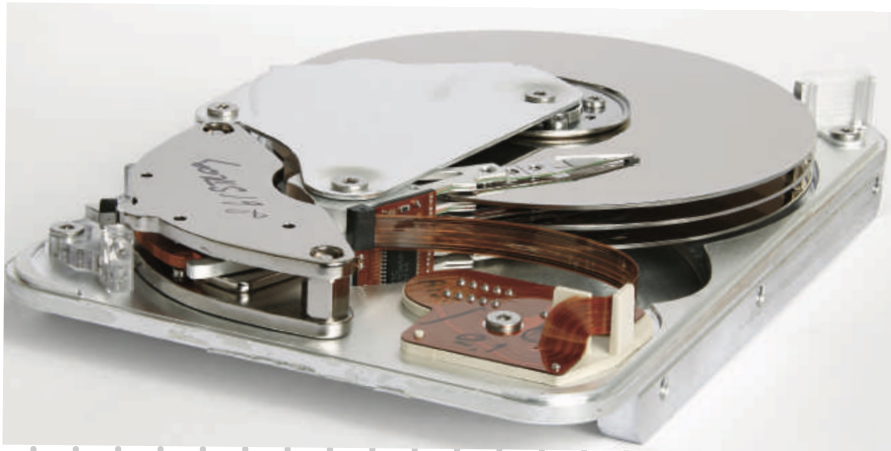


- OUR FOCUS TODAY: HARD DISKS

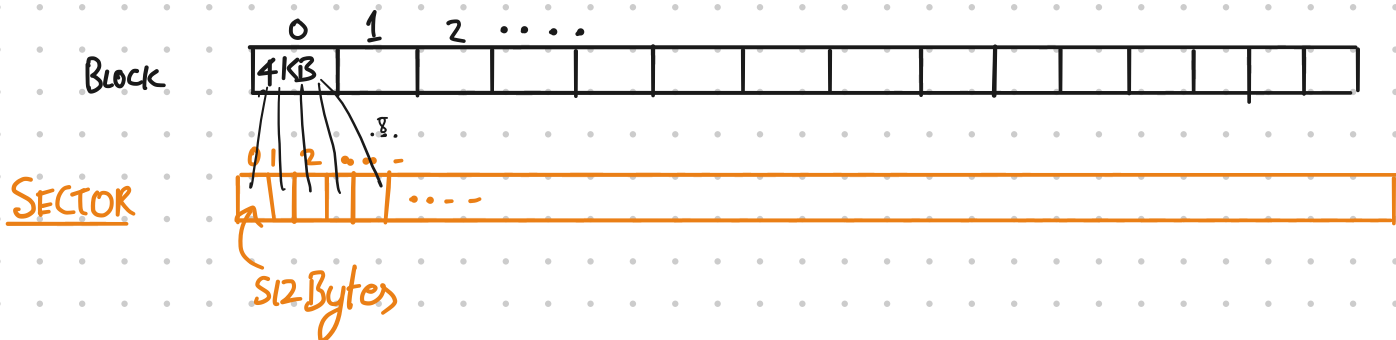


What are they

- Magnetic storage
- Can find ones that store several TBs
- Historically important
 - ↳ Inform lots of the design decisions made by Operating systems

- Still used in the cloud, NAS, etc.
 - ↳ Cost/PERF. TRADEOFF

Abstraction offered to software



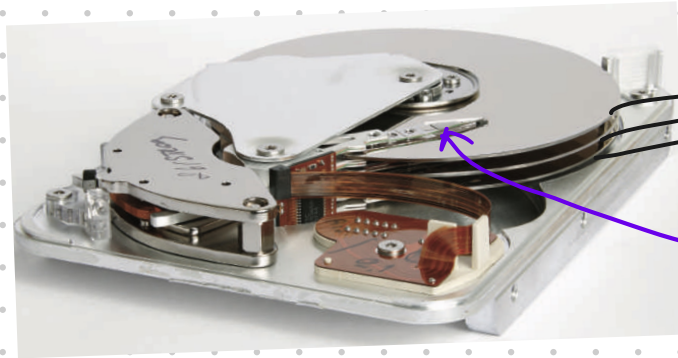
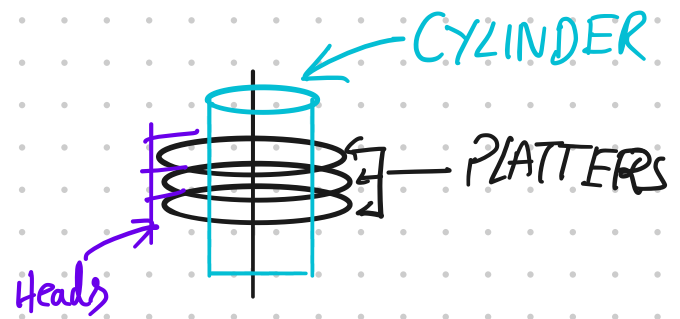
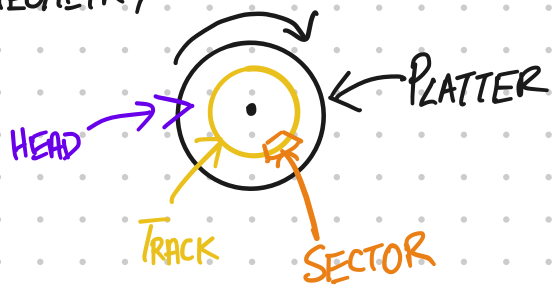
Linear array

↳ Originally **sectors**

→ Increasingly **BLOCKS** (also what you get in lab 5)

- Combine sectors together

GEOMETRY



PLATTER

HEAD

- Usually, only 1 head active at a time
- All heads are physically on one arm
 - ↳ So seek to a particular cylinder

$$\text{Access Time} \equiv \text{Seek Time} + \text{Rotational Delay} + \text{TRANSFER TIME}$$

Time to move head to Cyl
Time for sector to read/write to come under head
Time to get data to/from memory



Sometimes — asked to compute access time

- Seek time: avg provided in question

[Note, what is meant by avg can be ambiguous in practice, but does not impact you]

- Rot. delay: Provided RPM e.g.

$$12000 \text{ RPM} \Rightarrow 200 \text{ RPS}$$

$$\Rightarrow 1/200 \text{ s per rotation}$$

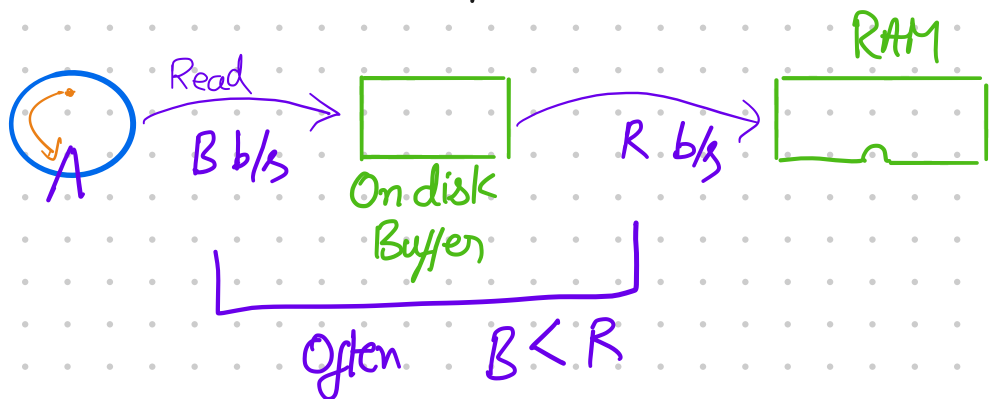
$$\Rightarrow 0.005 \text{ s per rot} \\ = 5 \text{ ms per rotation}$$

$$\text{Avg. rot delay} = 2.5 \text{ ms}$$

[Time to cover
half the circle]

- Transfer time: Bytes/second

This one can be a bit complicated



Example: Putting it together

- Read 10 sectors randomly distributed
around disk

$$1 \text{ sector} = 512 \text{ b}$$

$$\text{avg seek time} = 10 \text{ ms}$$

avg. rot delay = 12000 RPM disk $\Rightarrow$ 2.5ms

Transfer time:

1 MiB = 10^6 Bytes
(Mi $\equiv$ Mebi)

$p \rightarrow b: 64 \text{ MiB/s}$ (a)
 $b \rightarrow R: 356 \text{ MiB/s}$ (b)



Transfer time per sector

$$\equiv \frac{512b}{64 \cdot 10^6 b/s} \equiv 8 \cdot 10^{-6} s$$
$$\equiv .008 \text{ ms}$$

Randomly distributed $\Rightarrow$ Must seek & wait for rotation for each read

$$\Rightarrow 10 \cdot (10 + 2.5 + .008) \text{ ms}$$

- Read 10 SEQUENTIAL sectors



- seek & wait for rotation once.

$$10 + 2.5 + 10 \cdot .008$$

General lesson: Sequential access is faster.

File systems

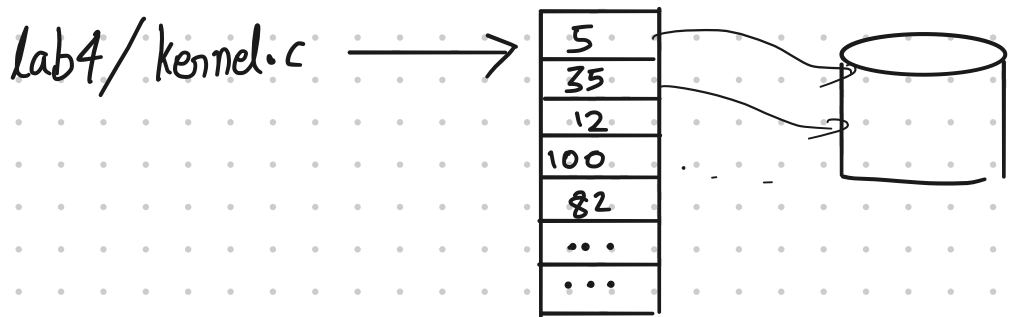
- What disks provide:



- Hard as a human to remember random numbers

↳ Lab 4, that is in blocks 5, 35, 12, 100, 82, ...

- Much nicer:



Goals

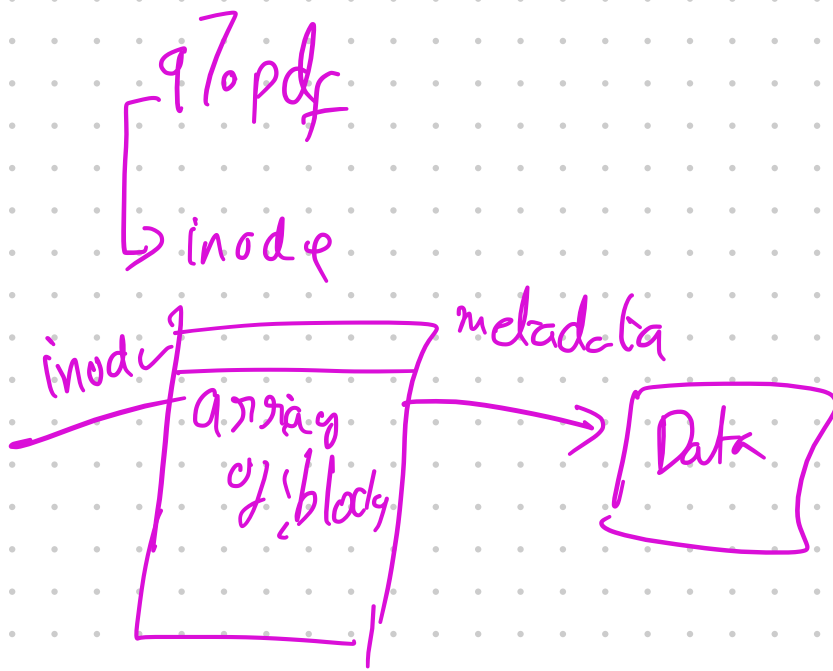
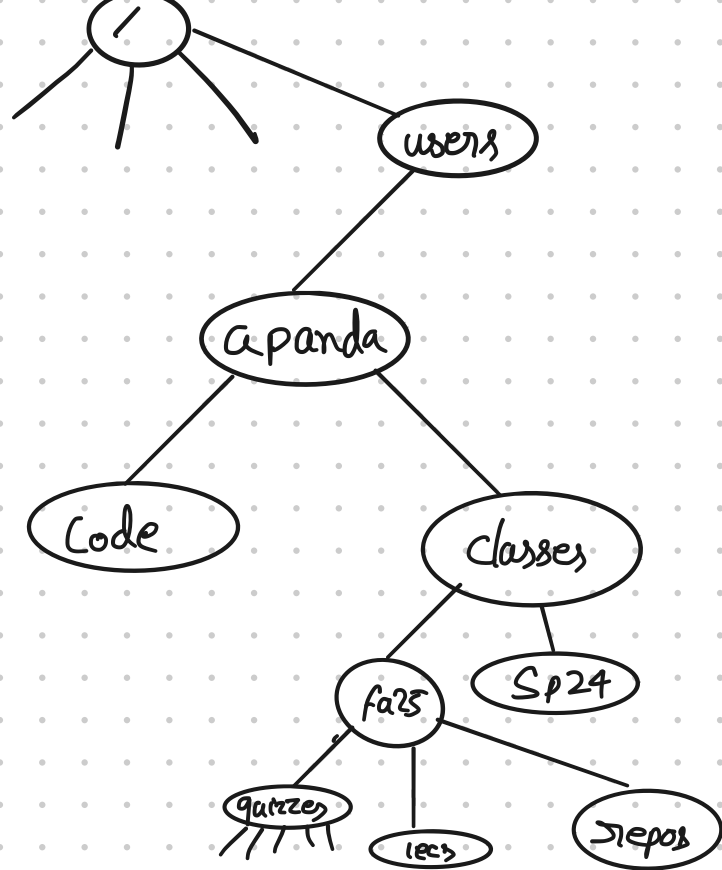
(a) Mapping should persist

↳ Disk contents survive reboots
(contrast w/ memory & registers)

→ Mapping must persist

⇒ Mapping is also stored on disk*

(b) Hierarchy: Arrange related files "together"



quiz/q7.pdf

glrud dnas

name
inode

P - -
- - -
- - -

