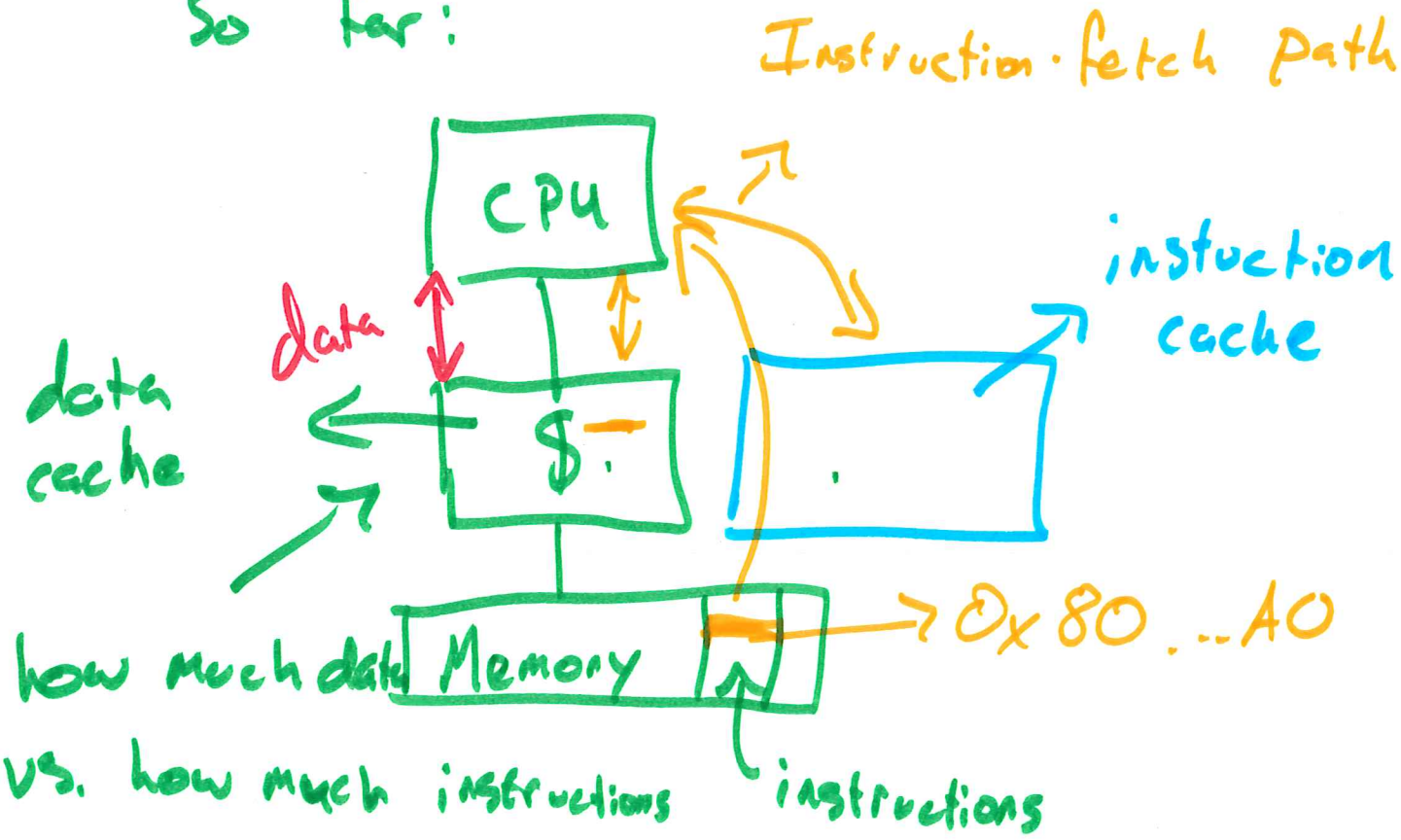
One more thing about caches... oops.

-> Caches in a real system

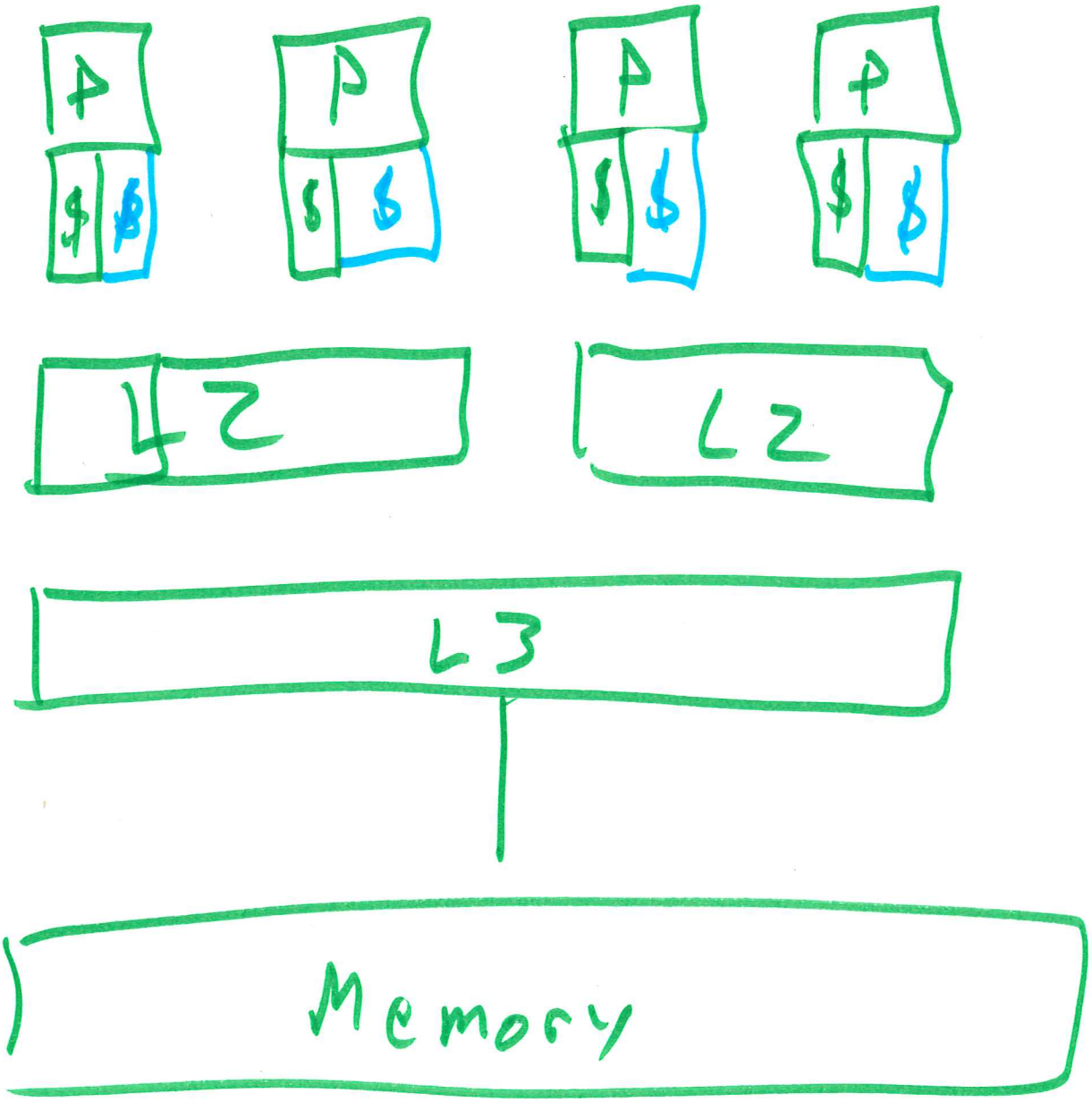
Question: What about instructions?

So far:



- Split Inst. / Data
  I/D

- Need to keep caches ~~coherent~~
  Coherent



Cache coherence

Remember:

Disks:

This where all of your data stored

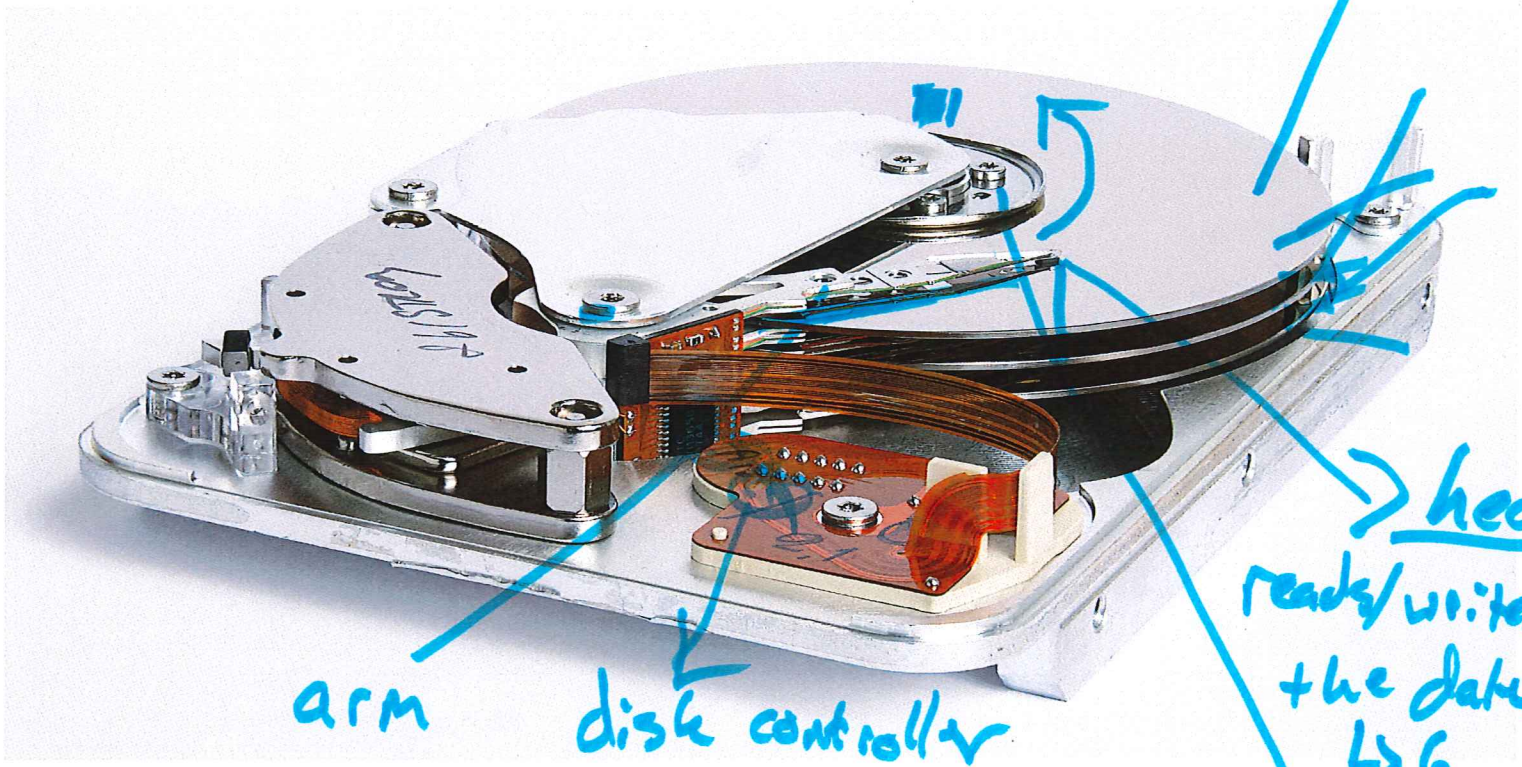
- files - programs - etc

- CPU can't directly access the disk

surface holds the data

top/bottom of platter is a surface

Platter



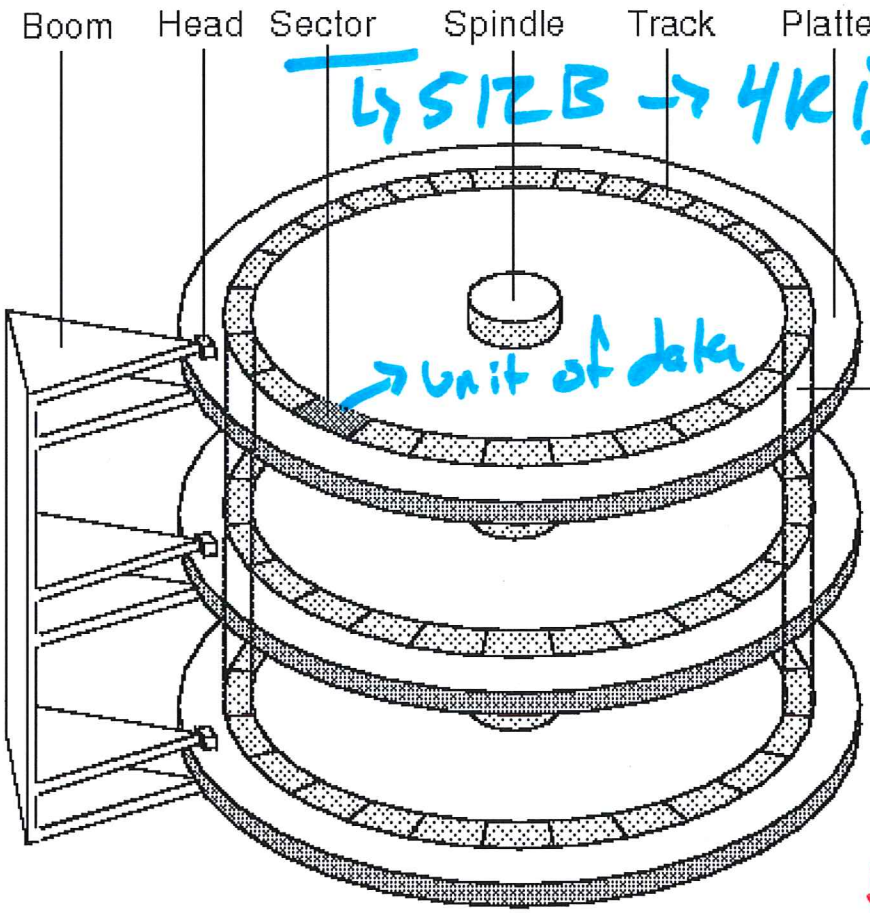
head reads/writes the data
↳ 6 heads

arm

disk controller

Platters rotate around the spindle

↳ 5400 RPM → 15,000 RPM



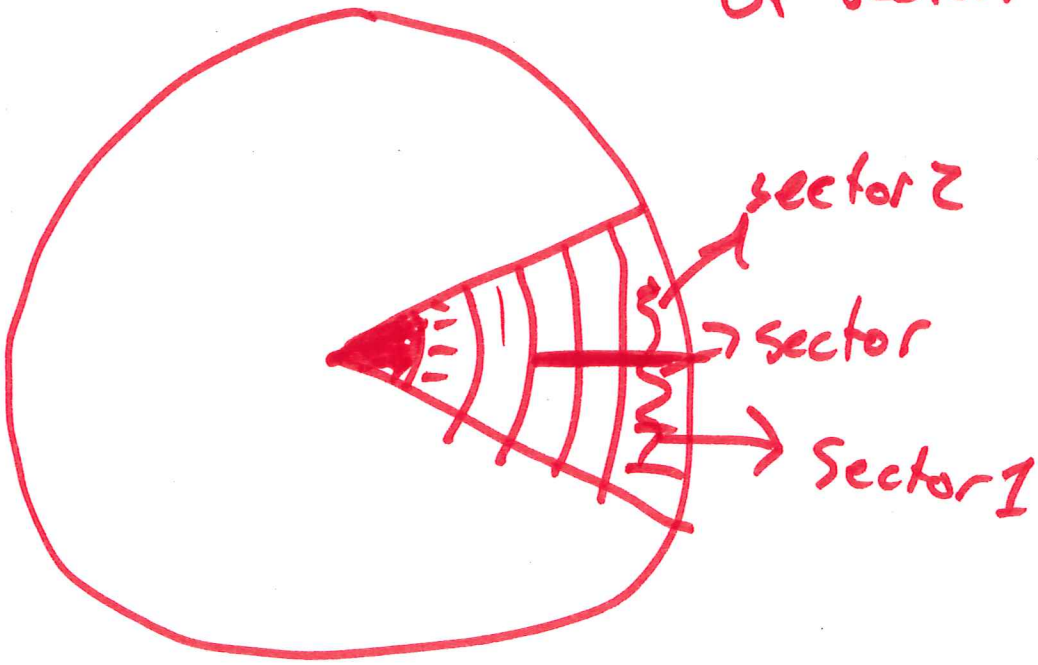
↳ 512B → 4KB

↳ unit of data

↳ 6 tracks

Anatomy of a regular hard disk

Each track may have a diff. # of sectors



Disk access time:

Seek → move the head to the right track

rotate → wait for the right sector to come around

transfer time → read the sector(s)

Seek → avg 3-9ms (max 20ms)

0.003s

$\frac{1}{3}$ ns

rotate → dependent on rotation rate

also where the data is

$\frac{1}{7200}$ RPM · $\frac{1}{2} \approx 4$ ms

transfer time → function of rotation rate and size of data

$$T_{access} = T_{avg\ seek} + T_{rotation} + T_{avg\ transfer}$$

Rot. rate: 7200 RPM

Avg seek: 9 ms

Avg sectors per track: 400

$$T_{avg\ rot} = \frac{1}{2} \cdot \frac{60\,s}{min} \cdot \frac{1000\,ms}{s} \cdot \frac{1}{7200\,RPM}$$

$$= 4\,ms$$

$$T_{avg\ transfer} = \frac{60\,s}{7200\,RPM} \cdot \frac{1}{400\ \frac{sectors}{track}} \cdot \frac{1000\,ms}{s}$$

$$= 0.02\,ms$$

$$T_{access} = 9\,ms + 4\,ms + 0.02\,ms$$

$$= 13.02\,ms$$

512 B from DRAM

~4 μs

from cache 250 ns