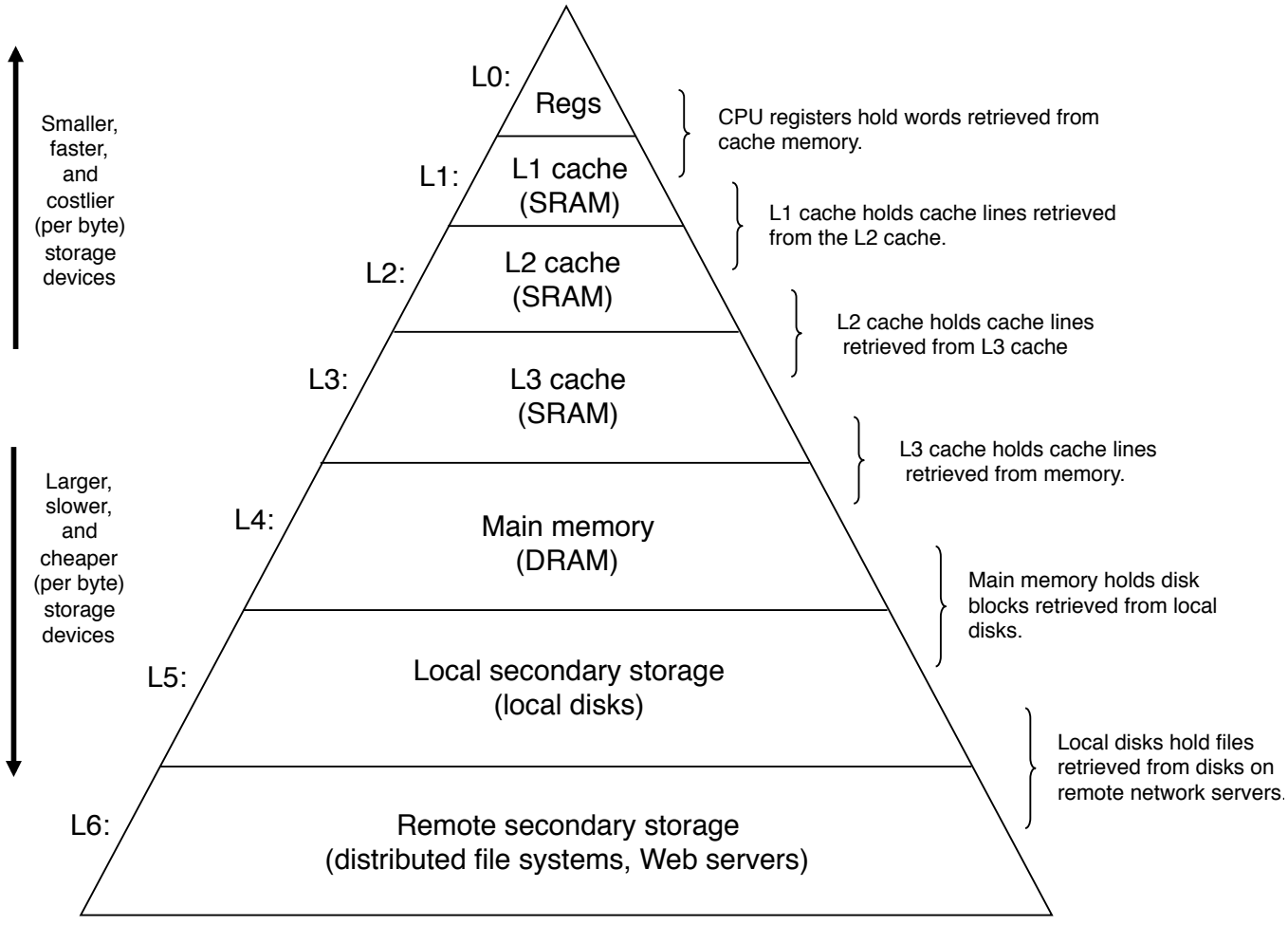
06_04_caching

caches are everywhere

- Web caches
- Browser caches
- Google music app
- many other places within and between machines

hierarchy



- each layer cache for layer below it
- high cache hit rate $\rightarrow$ illusion of much larger, faster memory

locality

some code

```
for (i=0; i<SIZE; i++)
    sum+=A[i]
```

i, sum good temporal locality

array elements bad temporal, good spatial

2D array. Difference in performance?

```
sum=0;
for (i=0; i<NROWS; i++)
    for (j=0; j<NCOLS; j++)
        sum+=A[i][j];
```

```
sum=0;
for (i=0; i<NCOLS; i++)
    for (j=0; j<NROWS; j++)
        sum+=A[j][i];
```

some math

Suppose that reading from the *slow* memory is 100x slower than the *fast* memory.

- a hit takes 1x time
- a miss is 100x time

some math

Average access time

$$\text{avg} = p(\textit{hit}) * \text{hit time} + p(\textit{miss}) * \text{miss time}$$

some math

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Hit rate of 97%

$$\begin{aligned} \text{avg} &= (0.97) * 1 + (0.03) * (1 + 100) \\ &= 4 \text{ units} \end{aligned}$$

some math

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Hit rate of 99%

$$\begin{aligned}\text{avg} &= (0.99) * 1 + (0.01) * (1 + 100) \\ &= 2 \text{ units}\end{aligned}$$

some math

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So if you increase the hit rate by 2%, the performance doubles.

Intel i7 Caches