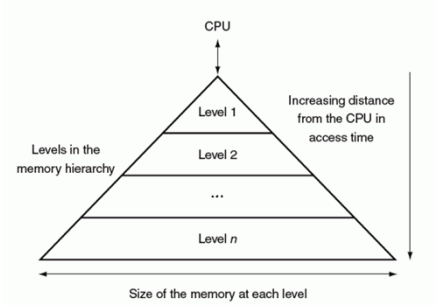
جلسه یازدهم: سلسله مراتب حافظه
فصل هفت کتاب پترسن

- انواع حافظه
- سلسله مراتب حافظه
- مفهوم محلی بودن
  - زمانی
  - مکانی
- نگاشت مستقیم
- مثال های متنوع
- نگاشت مجموعه انجمنی (اشتراکی)

انواع حافظه

Speed	CPU	Size	Cost ($/bit)	Current Technology
Fastest	Memory	Smallest	Highest	SRAM
	Memory			DRAM
Slowest	Memory	Biggest	Lowest	Magnetic Disk

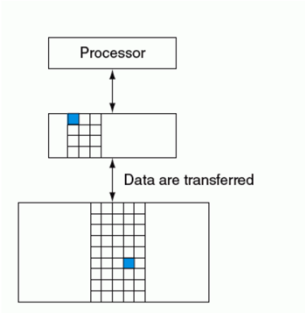
سلسله مراتب حافظه



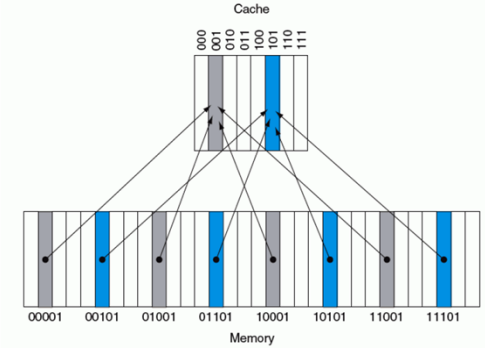
محلی بودن ارجاعات زمانی و مکانی

- **Temporal locality** (locality in time): If an item is referenced, it will tend to be referenced again soon. If you recently brought a book to your desk to look at, you will probably need to look at it again soon.
- **Spatial locality** (locality in space): If an item is referenced, items whose addresses are close by will tend to be referenced soon. For example, when

مفهوم حافظه نهان



نگاشت مستقیم



وضعیت اولیه

Index	V	Tag	Data
000	N		
001	N		
010	N		
011	N		
100	N		
101	N		
110	N		
111	N		

a. The initial state of the cache after power-on

بعد از اولین درخواست 10110

Index	V	Tag	Data
000	N		
001	N		
010	N		
011	N		
100	N		
101	N		
110	Y	10_{two}	Memory(10110_{two})
111	N		

b. After handling a miss of address (10110_{two})

بعد از درخواست 11010

Index	V	Tag	Dlata
000	N		
001	N		
010	Y	11_{two}	Memory (11010_{two})
011	N		
100	N		
101	N		
110	Y	10_{two}	Memorlly (10110_{two})
111	N		

c. After handling a miss of address (11010_{two})

بعد از درخواست 10000

Index	V	Tag	Data
000	Y	10_{two}	Memory (10000_{two})
001	N		
010	Y	11_{two}	Memory (11010_{two})
011	N		
100	N		
101	N		
110	Y	10_{two}	Memory (10110_{two})
111	N		

d. After handling a miss of address (10000_{two})

بعد از درخواست 00011

Index	V	Tag	Data
000	Y	10_{two}	Memory (10000_{two})
001	N		
010	Y	11_{two}	Memory (11010_{two})
011	Y	00_{two}	Memory (00011_{two})
100	N		
101	N		
110	Y	10_{two}	Memory (10110_{two})
111	N		

e. After handling a miss of address (00011_{two})

بعد از درخواست 10010

Index	V	Tag	Data
000	Y	10_{two}	Memory (10000_{two})
001	N		
010	Y	10_{two}	Memory (10010_{two})
011	Y	00_{two}	Memory (00011_{two})
100	N		
101	N		
110	Y	10_{two}	Memory (10110_{two})
111	N		

f. After handling a miss of address (10010_{two})

مثال از نگاشت مستقیم

Bits in a Cache

How many total bits are required for a direct-mapped cache with 16 KB of data and 4-word blocks, assuming a 32-bit address? هر کلمه ۴ بایت است

We know that 16 KB is 4K words, which is 2^{12} words, and, with a block size of 4 words (2^2), 2^{10} blocks. Each block has $4\times$ 32 or 128 bits of data plus a tag, which is $32 - 10 - 2 - 2$ bits, plus a valid bit. Thus, the total cache size is

$$2^{10} \times (128 + (32 - 10 - 2 - 2) + 1) = 2^{10} \times 147 = 147 \text{ Kbits}$$

or 18.4 KB for a 16 KB cache. For this cache, the total number of bits in the cache is about 1.15 times as many as needed just for the storage of the data.

مثال از نگاشت مستقیم

- *How many total bits are required for a direct-mapped cache with 128 KB of data and 1-word block size, assuming a 32-bit address?* هر کلمه ۴ بایت است
- Cache data = 128 KB = 2^{17} bytes = 2^{15} words = 2^{15} blocks
- Cache entry size = block data bits + tag bits + valid bit
  = 32 + (32 – 15 – 2) + 1 = 48 bits
- Therefore, cache size = $2^{15} \times 48$ bits =
  $2^{15} \times (1.5 \times 32)$ bits = 1.5×2^{20} bits = 1.5 Mbits
  - data bits in cache = 128 KB × 8 = 1 Mbits
  - total cache size/actual cache data = 1.5

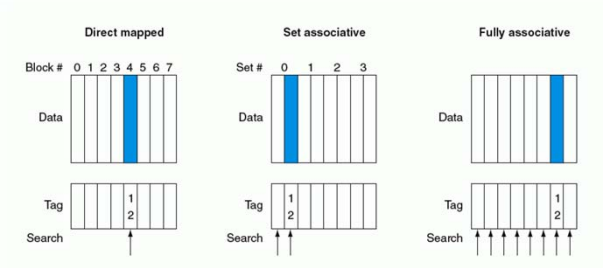
مثال از نگاشت مستقیم

هر کلمه ۴ بایت است

- *How many total bits are required for a direct-mapped cache with 128 KB of data and 4-word block size, assuming a 32-bit address?*

- Cache size = 128 KB = 2^{17} bytes = 2^{15} words = 2^{13} blocks
- Cache entry size = block data bits + tag bits + valid bit
  = 128 + (32 – 13 – 2 – 2) + 1 = 144 bits
- Therefore, cache size = 2^{13} × 144 bits =
  2^{13} × (1.25 × 128) bits = 1.25 × 2^{20} bits = 1.25 Mbits
  - data bits in cache = 128 KB × 8 = 1 Mbits
  - total cache size/actual cache data = 1.25

نگاشت مجموعه انجمنی (اشتراکی)



نگاشت مجموعه انجمنی (اشتراکی)