

Assignment 7 Solutions

Saturday, November 26, 2022

17:05

- Each colorpoint is 32 bits (8 long bits \cdot 4 colors)
- Cache is 64 bits, only 1 block, so it could hold up to 2 colorpoint addresses.
- Cache always starts empty

7-2a) pseudocode:

```
sum = 0
n = 32
for i = 0, i < n, i++:
    for j = 0, j < n, j++:
        sum += Arr[j][i].a
        sum += Arr[j][i].b
        sum += Arr[j][i].c
        sum += Arr[j][i].d
```

- 1st Loop, cache always misses so miss + 1.

loop 1 i = 0, j = 0

Arr[0][0].a/.b/.c/.d (32 bits)

.b/.c/.d are hits

loop 2 i = 0, j = 1

Arr[1][0].a/.b/.c/.d (32 bits)

miss + 1 due to going from Arr[0][0] \Rightarrow Arr[1][0]
(acts as jump of 32 \cdot 32)

⋮

loop 32 arr[31][0]

miss = 32 / 128 accesses

loop 33 Arr[0][1]

miss + 1 as Arr[31][0] \Rightarrow Arr[0][1] > 64 bit jump

⋮

loop 1024 (32 i loops - 32 j)

Arr[31][31]

miss total = 1024

Total : 1024 / 4,096 possible cache hits/misses

7-2b) pseudocode:

```
sum = 0
n = 32
for i = 0, i < n, i++:
    for j = 0, j < n, j++:
        sum += Arr[i][j].a
        sum += Arr[i][j].b
        sum += Arr[i][j].c
        sum += Arr[i][j].d
```

Loop 1: 1st cache access so miss + 1

Arr[0][0].a/.b/.c/.d (32 bits)

.b/.c/.d are hits, so 1/4 misses

Loop 2: Arr[0][1].a/.b/.c/.d (32 bits)

No miss as cache is 64 bits and currently contains both Arr[0][0] & [0][1] (32 + 32 = 64)

so 4 hits

Loop 3: Arr[0][2].a/.b/.c/.d (32 bits)

Cache miss as previous cache ended at [0][1].d

miss + 1

⋮

Overall pattern for j loop is 16 cache misses total / 128 possible misses

(Every other even access is a miss)

(1/8 misses, \cdot 16 \Rightarrow 16/128)

Loop 32: Arr[0][31].a/.b/.c/.d

Loop 33: Arr[1][0].a/.b/.c/.d (32 bits)

miss + 1 as previous cache hold Arr[0][31] & Arr[0][31]

Arr[1][0] is sequential in memory however from Arr[0][31]

Loop 34: Arr[1][1].a/.b/.c/.d (32 bits)

hit, as cache currently contains Arr[1][0] and Arr[1][1] (32 + 32 = 64 bits)

⋮

Overall pattern

j loops: 16 misses (includes 1st initial miss) (128 total accesses)

i loops: always miss, 32 of them (even though sequential)

Results: 16 \cdot 32 = 512 total misses / 3,840 total hits / 4,096 possible misses