

What advantages does a set-associative cache have over a direct-mapped cache of the same total capacity?

- A Fewer cold misses.
- B Fewer capacity misses.
- C Less false sharing.
- D Fewer conflict misses.
- E Lower latency.

Which phenomena could cause the following code snippet to use the L1-cache ineffectively on a 12-core machine?

```
#define NUM_CHUNKS 12

int sums[NUM_CHUNKS];

void compute_sum(int chunk_id) {
    sums[chunk_id] = 0;
    for (int i = 0; i < 5000; i++) {
        sums[chunk_id] += i;
    }
}

int main() {
    cilk_for (int i = 0; i < NUM_CHUNKS; i++) {
        compute_sum(i);
    }
    return 0;
}
```

- A True sharing.
- B False sharing.
- C Capacity misses.
- D Conflict misses.
- E TLB misses.

Consider the following code for multiplying two matrices:

```
// Assume that n is an exact power of 2.

void Rec_Mult(double *C, double *A, double *B,
              int n, int rowsize) {
    if (n == 1) {
        C[0] += A[0] * B[0];
    } else {
        int d11 = 0;
        int d12 = n/2;
        int d21 = (n/2) * rowsize;
        int d22 = (n/2) * (rowsize+1);

        Rec_Mult(C+d11, A+d11, B+d11, n/2, rowsize);
        Rec_Mult(C+d11, A+d12, B+d21, n/2, rowsize);
        Rec_Mult(C+d12, A+d11, B+d12, n/2, rowsize);
        Rec_Mult(C+d12, A+d12, B+d22, n/2, rowsize);
        Rec_Mult(C+d21, A+d21, B+d11, n/2, rowsize);
        Rec_Mult(C+d21, A+d22, B+d21, n/2, rowsize);
        Rec_Mult(C+d22, A+d21, B+d12, n/2, rowsize);
        Rec_Mult(C+d22, A+d22, B+d22, n/2, rowsize);
    }
}
```

For the following questions, assume that we have a tall cache of size \mathcal{M} , filled with cache lines of size \mathcal{B} , and assume that $\mathcal{B}^2 \leq c\mathcal{M}$ for some sufficiently small constant $c \leq 1$.

1. What recurrence does the cache complexity (number of cache misses) $Q(n)$ satisfy?
2. What is the height of the recurrence tree for $Q(n)$?
3. What is the total number of cache misses that occur in the leaves of the tree?
4. What is the total number of cache misses for the algorithm?

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