

CS F364 Design & Analysis of Algorithms

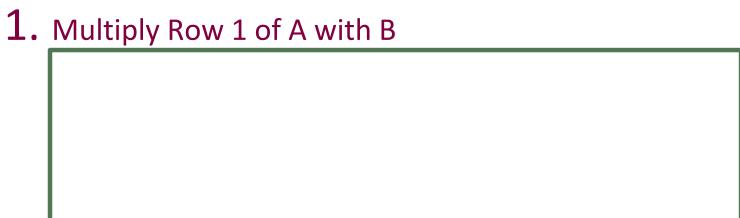
DIVIDE-AND-CONQUER

Example: Matrix Multiplication

Classic Algorithm: Linear Division

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Multiply matrices A and B (each of size N*N)



2. Multiply matrix A' (rows 2 to N of A) with B



- Multiply matrices A and B (each of size N*N)
 - 1. Multiply Row 1 of A with B
 - 1. Multiply Row 1 of A with Column 1 of B
 - 2. Multiply Row 1 of A with B' (columns 2 to N of B)
 - 2. Multiply matrix A' (rows 2 to N of A) with B



- Multiply matrices A and B (size N*N)
 - 1. Multiply Row 1 of A with B
 - 1. Multiply Row 1 of A with Column 1 of B
 - 1. Add A11*B11 to C11 (the result)
 - 2. Multiply Row 1' of A with Column 1' of B
 - 2. Multiply Row 1 of A with B' (columns 2 to N of B)
 - 2. Multiply matrix A' (rows 2 to N of A) with B
- In each case, <u>sub-problem 2 has the same structure</u> as the problem it was decomposed from
 - i.e. <u>sub-problem 2 is the induction hypothesis</u>



- This translates to a straightforward program with three nested loops.
 - If we assume each matrix is of size N*N
 - then the time complexity is $O(N^3)$.
- Can we do better?

