



BITS Pilani
Pilani Campus



CS F364 Design & Analysis of Algorithms

DIVIDE-AND-CONQUER

Example: Matrix Multiplication

Classic Algorithm: Linear Division

Classic Matrix Multiplication

- Multiply matrices A and B (size $N \times N$)

1. Multiply Row 1 of A with B



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

Classic Matrix Multiplication

- Multiply matrices A and B (size $N \times N$)

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

Classic Matrix Multiplication

- Multiply matrices A and B (size $N \times N$)
 1. Multiply Row 1 of A with B
 1. Multiply Row 1 of A with Column 1 of B
 1. Add $A_{11} \times B_{11}$ to C_{11} (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, sub-problem 2 has the same structure as the problem it was decomposed from
 - i.e. sub-problem 2 is the induction hypothesis



Classic Matrix Multiplication

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

