Course Code: MCAS2140 Course Name: Algorithm Analysis and Design

#### MATRIX MULTIPLICATION

Input: 
$$A = [a_{ij}], B = [b_{ij}].$$
  
Output:  $C = [c_{ij}] = A \cdot B.$   $i, j = 1, 2, ..., n.$ 

$$c_{ij} = \sum_{k=1}^{n} a_{ik} \cdot b_{kj}$$

Name of the Faculty: Unnikrishnan

**Program Name: MCA** 

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# Standard algorithm

for 
$$i \leftarrow 1$$
 to  $n$ 

$$\mathbf{do} \ \mathbf{for} \ j \leftarrow 1 \ \mathbf{to} \ n$$

$$\mathbf{do} \ c_{ij} \leftarrow 0$$

$$\mathbf{for} \ k \leftarrow 1 \ \mathbf{to} \ n$$

$$\mathbf{do} \ c_{ij} \leftarrow c_{ij} + a_{ik} \cdot b_{kj}$$

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## Standard algorithm

for 
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 to  $n$ 

$$\mathbf{do} \ \mathbf{for} \ j \leftarrow 1 \ \mathbf{to} \ n$$

$$\mathbf{do} \ c_{ij} \leftarrow 0$$

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$$\mathbf{do} \ c_{ij} \leftarrow c_{ij} + a_{ik} \cdot b_{kj}$$

Running time = 
$$\Theta(n^3)$$

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# Divide-and-conquer algorithm

#### **IDEA:**

 $n \times n$  matrix =  $2 \times 2$  matrix of  $(n/2) \times (n/2)$  submatrices:

$$\Upsilon r \mid s \rangle = \Upsilon a \mid b \rangle \Upsilon e \mid f \rangle$$

$$\underline{A} \mid \mathcal{U}f = \underline{C} \mid df \mathcal{G} \mid hf$$

$$C = A \cdot B$$

$$r = ae + bg$$

$$s = af + bh$$

$$t = ce + dg$$

$$u = cf + dh$$

s = af + bh 8 mults of  $(n/2) \times (n/2)$  submatrices t = ce + dg 4 adds of  $(n/2) \times (n/2)$  submatrices

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# Divide-and-conquer algorithm

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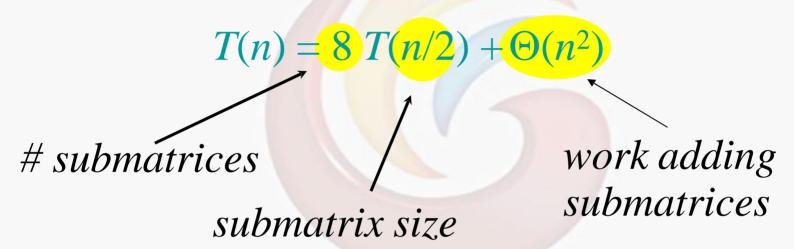
recursive

8 mults of  $(n/2)\times(n/2)$  submatrices

t = ce + dh 4 adds of  $(n/2) \times (n/2)$  submatrices

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# Analysis of D&C algorithm



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# Analysis of D&C algorithm

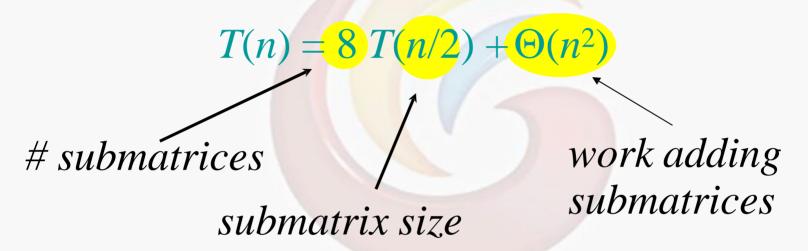
$$T(n) = 8T(n/2) + \Theta(n^2)$$
# submatrices | work adding submatrices | submatrices |

$$n^{\log_b a} = n^{\log_2 8} = n^3 \implies \text{CASE } 1 \implies T(n) = \Theta(n^3).$$

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## Analysis of D&C algorithm



$$n^{\log_b a} = n^{\log_2 8} = n^3 \implies \text{Case } 1 \implies T(n) = \Theta(n^3).$$

No better than the ordinary algorithm.



# Thank You