# CS506: Quiz #1

Due on Monday, February 11, 2022

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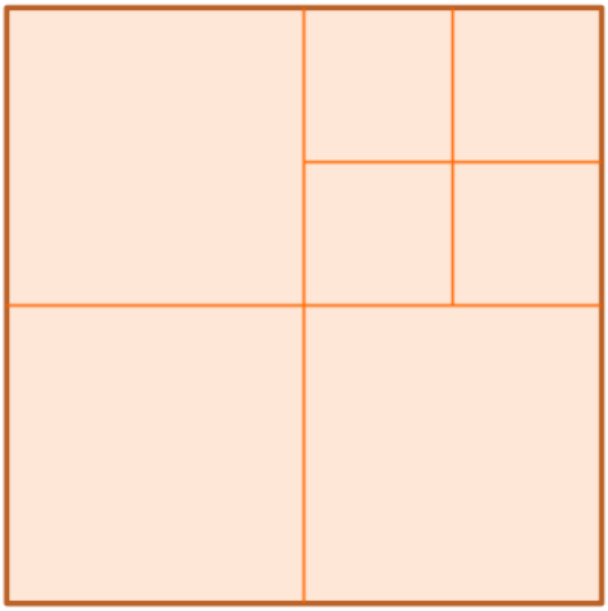
**Question 1 : Give an algorithm for squaring a matrix. Analyse its I/O Complexity. You are required to type your answers and submit a pdf file of your work. LaTeXgenerated pdfs are preferred.**

We will try to give an algorithm for squaring of a matrix.
Let's say we have a mxm square matrix A.
To calculate square of it. We can use divide and conquor algorithm. It will be a cache oblivious algorithm. We will break the square matrix in 4 parts. Top left A1, top right A2, bottom left A3 and bottom right A4 of size m/2 x m/2.(Like in below diagram)



Let's say B is squared matrix and corresponding to A1 sub-matrix, B has B1, corresponding to A2, we have B2 and so on...
Then
B= A x A We can calculate matrix multiplication of those 4 smaller - matrices.
And then,we can get B by calculating, B1, B2, B3, B4...
B1 = A1*A1+ A2* A3
B2 = A1*A2+ A2 * A3
B3 = A3*A3 = A1 * A4
B4 = A4*A3+ A4*A2
We will take 2 sub-matrices at any time(except the cases when we require A1*A1 and A3*A3) and move them to main memory. We will divide matrix till, we have sub matrix of size smaller or equal to of M/2(Main memory size/2) and then, we will move that sub-matrix in main memory, calculate the multiplication and then, we will follow above steps to get the final square.

**Complexity analysis**:

**Case1**
We need to do 8 operations(2 operations for each B1, B2 , B3 and B4) plus some work on half size matrices. If matrix size is greater than block size:
So, we have
T(m) = 8*T(m/2)

**Case 2**
If matrix is smaller, such that both sub-matrices in operation can fit in main memory, than we need to do only O($m^2/B$) I/O operation.
T(m) = O($m^2/B$)
It is very similar to calculating transpose of matrix. And we have done calculation for that already.
If we calculate time complexity it comes to O($n^2/B$) for nxn matrix.