Exercises for lab 4 of CS2101a

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1 Exercise 1

Ask any questions you have about Assignment 1. Moreover, you are welcome to work on Assignment 1 during the lab.

2 Exercise 2

Ask any questions you have about Lab 3 or Julia.

3 Exercise 3

We propose to improve the performances of the previous matrix multiplication program written in Julia during Lab 2 by integrating a divide-and-conquer strategy.

Assume that the input matrices are square matrices A and B of order n where n is a multiple of 2. Then we decompose each of A, B and C into 4 blocks of equal format:

$$A = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix},\ B = \begin{pmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{pmatrix},\ C = \begin{pmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{pmatrix},$$

where each of A_{ij}, B_{ij}, C_{ij} is a square matrix of order $n/2$. Then we have

$$\begin{array}{rcl} C_{11} & = & A_{11}B_{11} + A_{12}B_{21} \\ C_{12} & = & A_{11}B_{12} + A_{12}B_{22} \\ C_{21} & = & A_{21}B_{11} + A_{22}B_{21} \\ C_{22} & = & A_{21}B_{12} + A_{22}B_{22} \end{array}$$

Observe that

- one can first compute the four products $A_{11}B_{11}$, $A_{11}B_{12}$, $A_{21}B_{11}$, $A_{21}B_{12}$ and store them respectively in C_{11}, C_{12}, C_{21}, C_{22}.
- one can secondly compute the four products $A_{12}B_{21}$, $A_{12}B_{22}$, $A_{22}B_{21}$, $A_{22}B_{22}$ and add them respectively to C_{11}, C_{12}, C_{21}, C_{22}.

Modify the program of Exercise 2 of Lab 3 so as to add a function implementating the above observation, that we will refer to *divide-and-conquer matrix multiplication*. Note that the computations of the products $A_{11}B_{11}$, $A_{11}B_{12}$, $A_{21}B_{11}$, $A_{21}B_{12}$, $A_{12}B_{21}$, $A_{12}B_{22}$, $A_{22}B_{21}$, $A_{22}B_{22}$ can be done recursively until n is small enough say $B = 2$, (or $B = 4$ or$B = 16$). For matrices of order n less or equal to this value B, one can simply use the function of Exercise 2 of Lab 3.