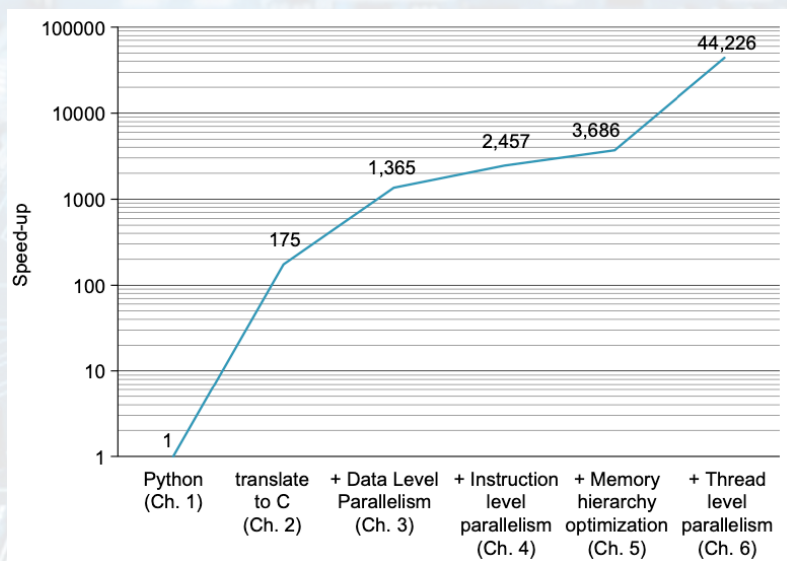


Computer Architecture Homework #01

Yoon, Myung Kuk (윤명국)
Department of Computer Science and Engineering

Going Faster: Matrix Multiply in Python



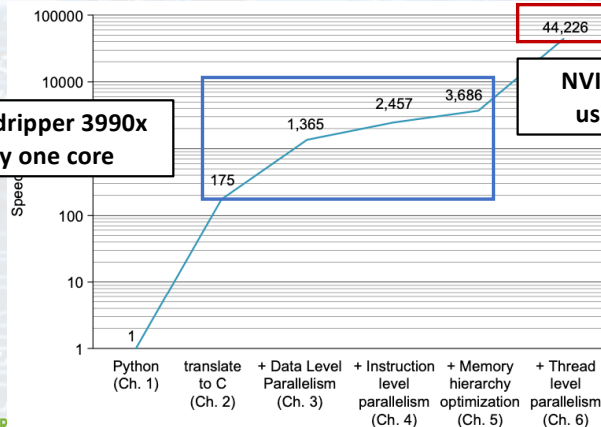
[Optimizations of matrix multiply program in Python in the next five chapters of this book]

Real Example

```
ClockMeasure[CPU CODE][Total Time: 23.615664 (s), Avg Time: 2.361566 (s), Count: 10]
ClockMeasure[GPU CODE][Total Time: 9.087855 (ms), Avg Time: 0.908786 (ms), Count: 10]
```

960 x 960 Matrix

AMD Threadripper 3990x
using only one core



NVIDIA RTX3090
using all cores

Performance?

$$\frac{Excution\ Time_y}{Excution\ Time_x} = \frac{2.361566}{0.000908786} = 2598.6$$

Performance?
GPU code is 2598.6 times faster than CPU code

Guide

- **Grading: 0% ~ 100%**
 - Based on the corrected number of answers
 - If the program doesn't run, you'll get 0 points (such as Segmentation Fault!!)
- **Due date: 2022-09-28 (11:59 PM)**
 - Late homework is not allowed
 - A compressed file must be uploaded to the cyber campus
 - Folder name must be studentID_YourName (Ex: 1234567_MyungKukYoon)
 - The compressed file name must be studentID_YourName.zip (Ex: 1234567_MyungKukYoon.zip)
- **Q/A**
 - I will be happy to answer your questions about homework #01 until **September 23rd**. After September 23rd, I will not answer your questions about homework #01
- **Execution time: less than 5 seconds**

Guide

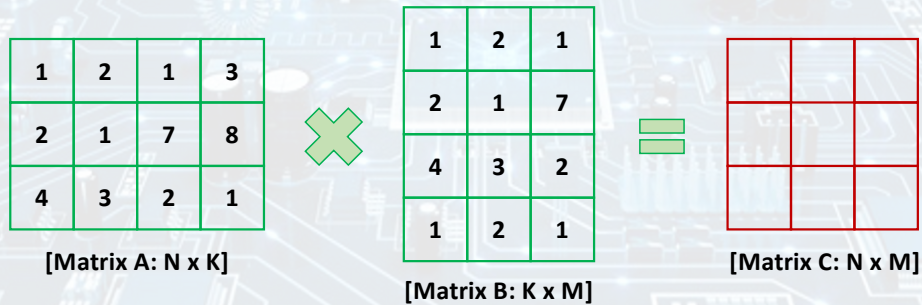
```
/*
* ***** Please read the instructions below carefully *****
* Your name and student ID must be printed when this project is executed
* Do not print anything other than your name and student ID (Delete printf functions used for debugging when submitting this homework)
* - If not, there will be 20% penalty
* Run make clean command before submitting your homework
* Change this project folder name to studentID_yourname (EX: 1234567_myungkukyoonyoon)
* You must compress this project folder (not the files in this folder)
* - If not, there will be 20% penalty
* - Use ZIP compression utility (DO NOT USE TAR COMMAND)
* The name of ZIP file must be studentID_yourname.zip (EX: 1234567_myungkukyoonyoon.zip)
* All the tests must be done in 5 seconds
* - If not, you will get 0%
```

Prerequisite

- **Operating system (Linux)**
 - Ubuntu OS 20.04
- **Install build-essential (If you are using virtualbox)**
 - \$sudo apt-get install build-essential gcc g++ make
- **Compiler version**
 - \$g++ --version
 - g++ (Ubuntu 9.4.0-...)
- **Download the base code from the cyber campus**

Matrix Multiplication

- N, K, and M ≤ 100
- Input values ≤ 100
- Total test case ≤ 100



Input and Output Files

- Input file: input.txt
- Output file: output.txt
- Your output file: hw01_output.txt

Outputs for the First MM

Outputs for the Second MM

...

36	115	136	162
56	55	58	85
91	189	219	171
159	210	254	256
115	56	102	85
99	50	95	80
139	85	181	152
29	8	18	19
77	78	166	135
82	66	129	105
142	74	151	127
112	67	153	131
24	44	40	50
15	56	36	9

4
2 6 4
9 1 3 4 3 5
9 0 0 1 0 1
5 5 5 8
0 6 3 6
9 5 7 4
9 4 4 8
6 1 2 5
6 9 5
2 9 6
2 0 7 3 6 3 9 4 3
5 8 9 5 4 6 9 3 0
4 1 7 6 4 3
8 0 3 4 2 2
1 5 3 8 9 9
1 8 4 4 4 3
4 0 7 0 0 1
1 4 3 9 1 8
2 9 9 5 4 2
7 5 7 1 3 6
0 5 4 5 0 9

Total # of Test

Matrix A and B Sizes

Inputs for Matrix A

Inputs for Matrix B

Matrix A and B Sizes

Inputs for Matrix A

Inputs for Matrix B

...

Additional information

- **Changing directory**
 - `$cd FOLDER_NAME`
 - `$cd ..`
- **Printing the path of the working directory**
 - `$pwd`
- **Listing files or directoris**
 - `$ls`

Additional information

- **Build/Clean/Run**
 - `$make`
 - `$make clean`
 - `$/hw01`
- **Diff (this command will be used to check your answer)**
 - `$diff hw01_output.txt output.txt`
- **ZIP & UNZIP**
 - `$zip FILE_NAME.zip FOLDER_NAME/*`
 - `$unzip FILE_NAME.zip`

Thank You!

- Questions?