Cloud Infrastructure And Services (CS3204)

Assignment 4: Virtual Machine

1. **A brief description of the application you developed.**

   The application developed for this assignment is a Matrix Multiplication program in Python. It multiplies two matrices each of n x n size. The size varies from 2 to 150. The program also calculates the time taken for each multiplication task performed on matrices of given size.

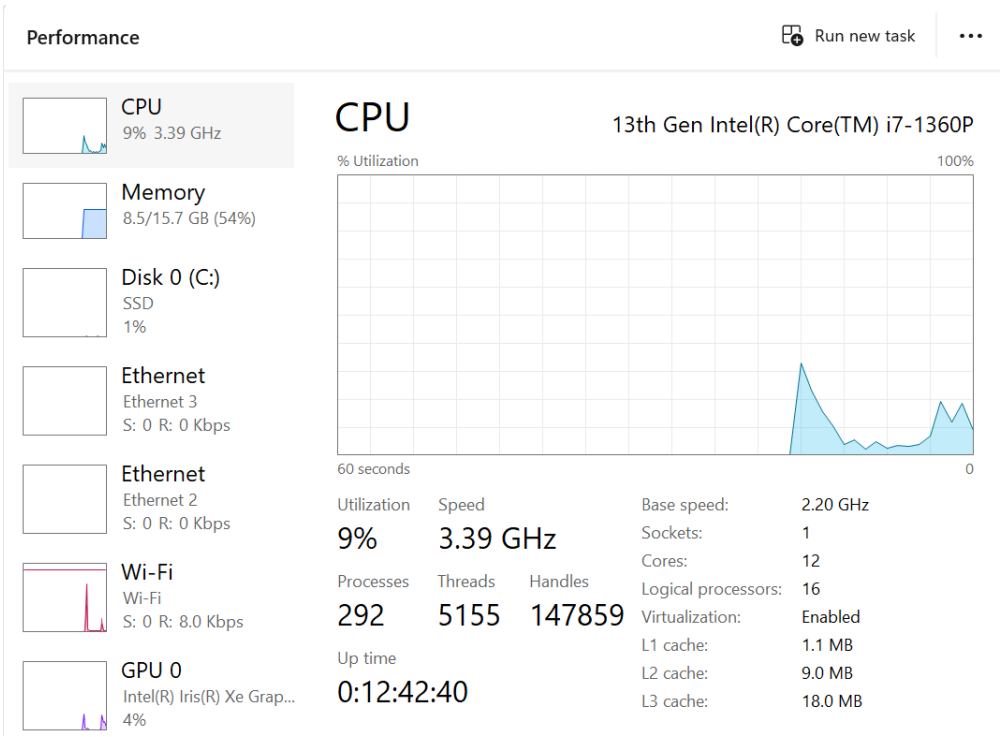
2. **A brief overview of the virtual machine software you installed.**

   The application used for Virtual Machine is Oracle Virtualbox Manager (7.1.4). The operating system on the VM is Ubuntu (64 bit).

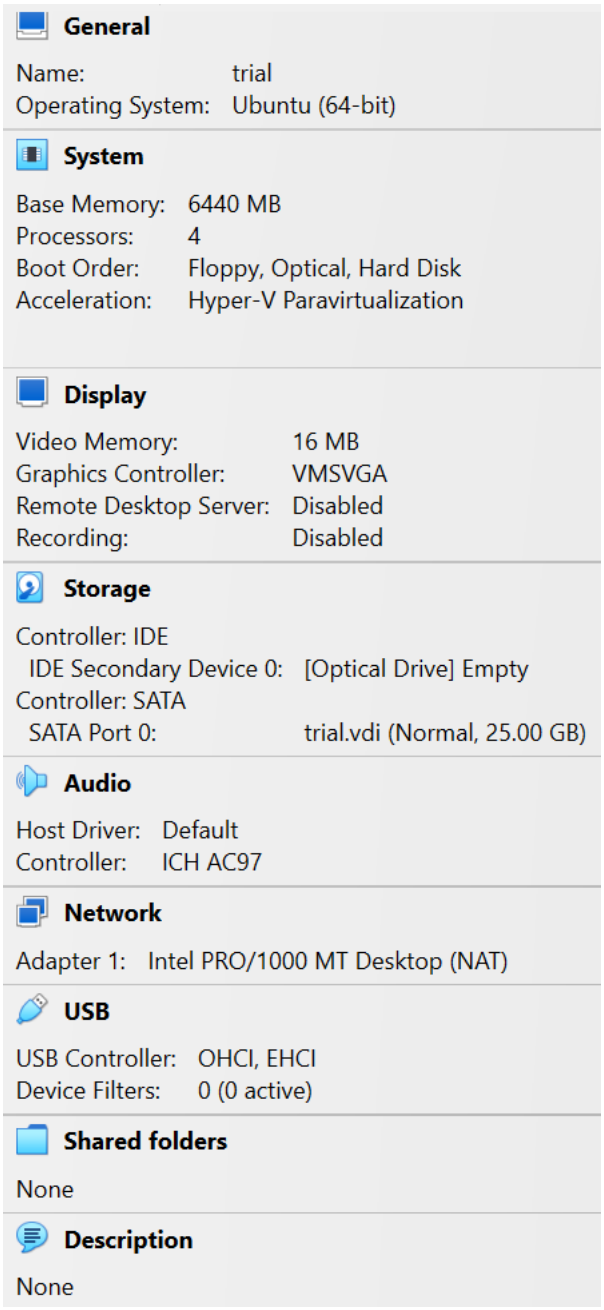
3. **Specification of the host OS, guest OS, and host machine and (e.g., CPU model and type, RAM, etc). Also you should provide the information on the resources allocated to the VM.**

   The specifications of Host OS, Guest OS, and Host Machine are as follows:

   Host OS: Windows 11
   Host Machine Specifications:

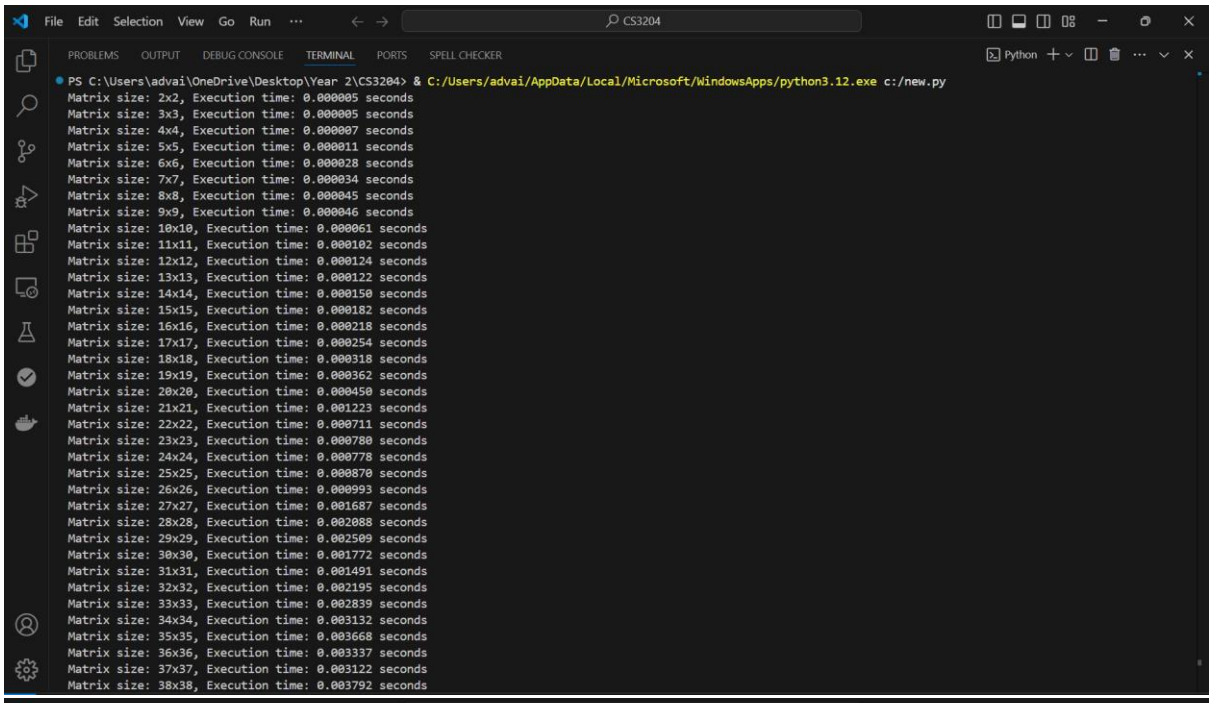


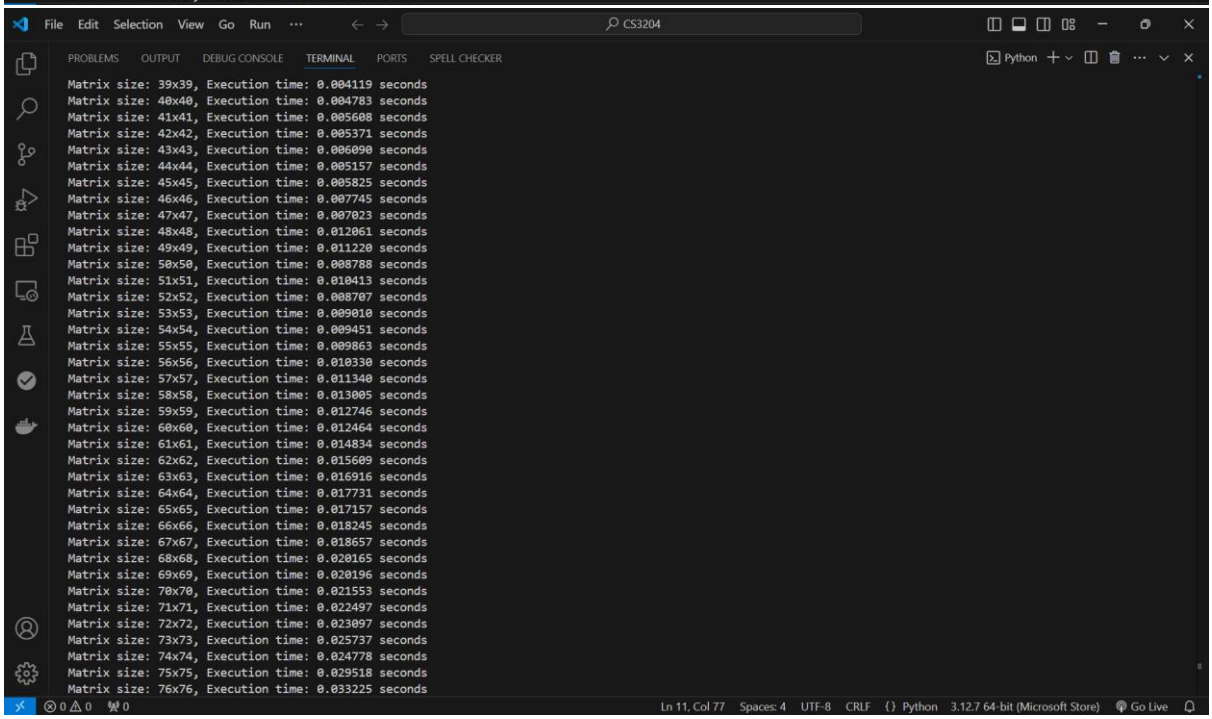
Guest OS: Ubuntu (64 bit)
Guest OS Type: Linux
VM Specifications:

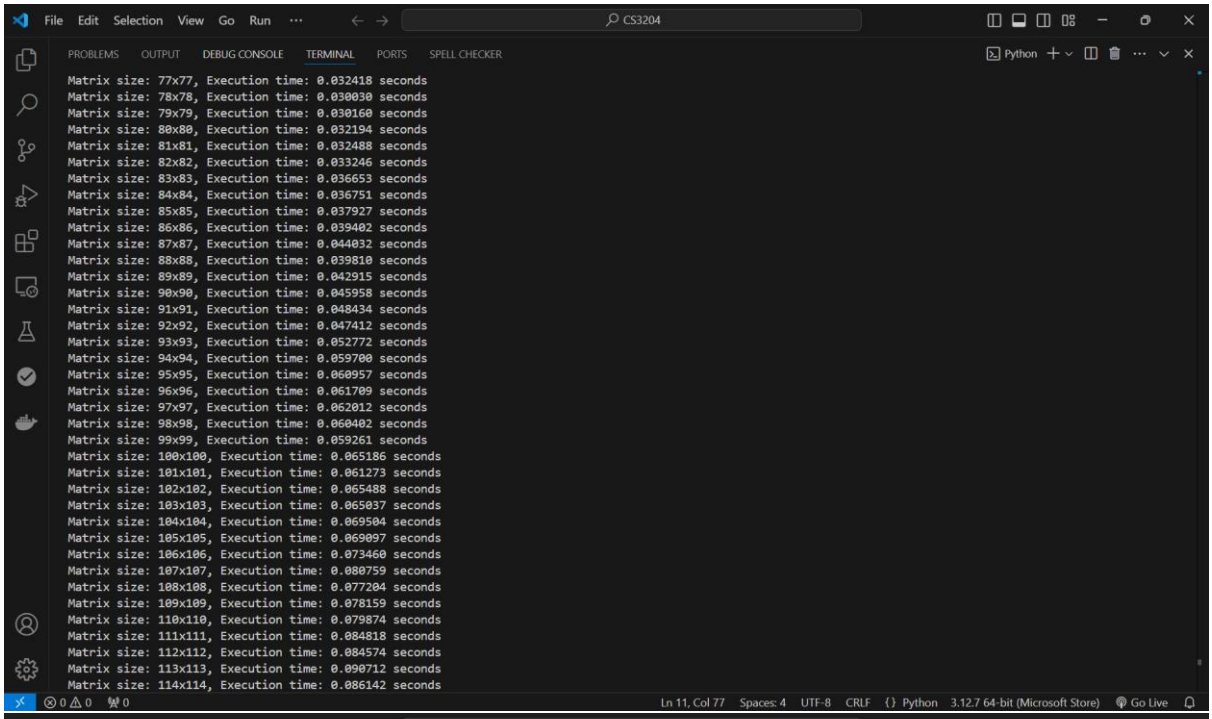


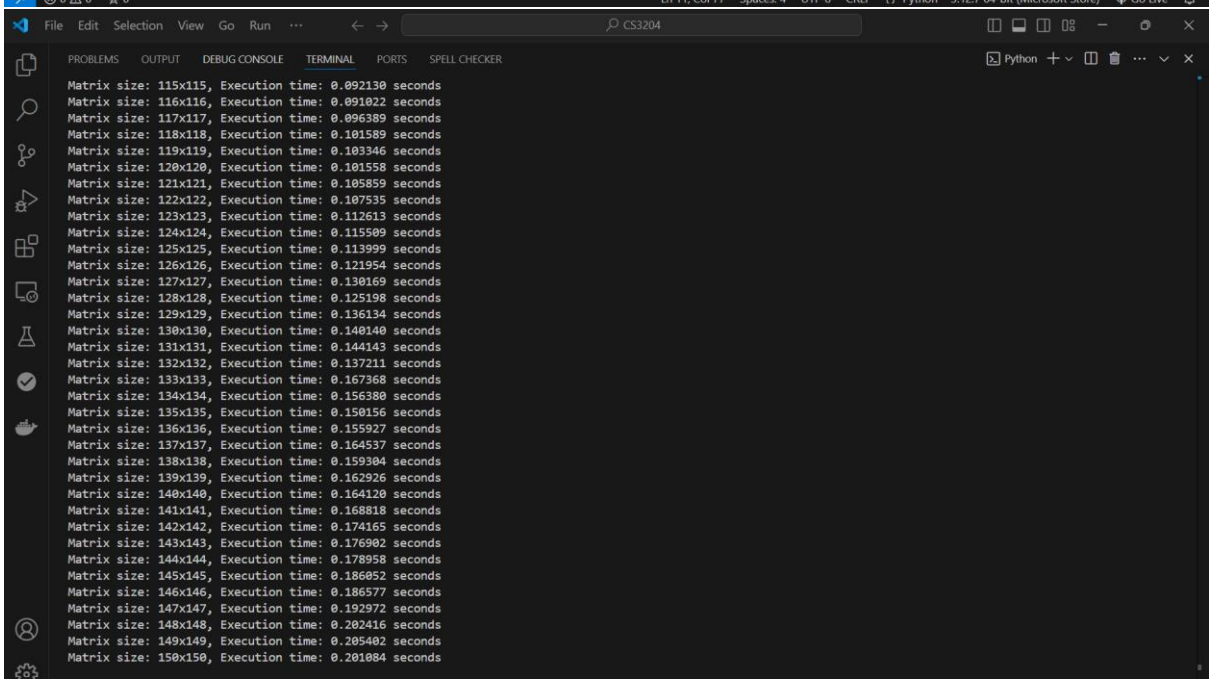
4. **A comparative analysis of the execution results between the host machine and the virtual machine environment, supported by screenshots, graphs, and any relevant data.**

The application runtime on Host machine using VS Code is as follows:

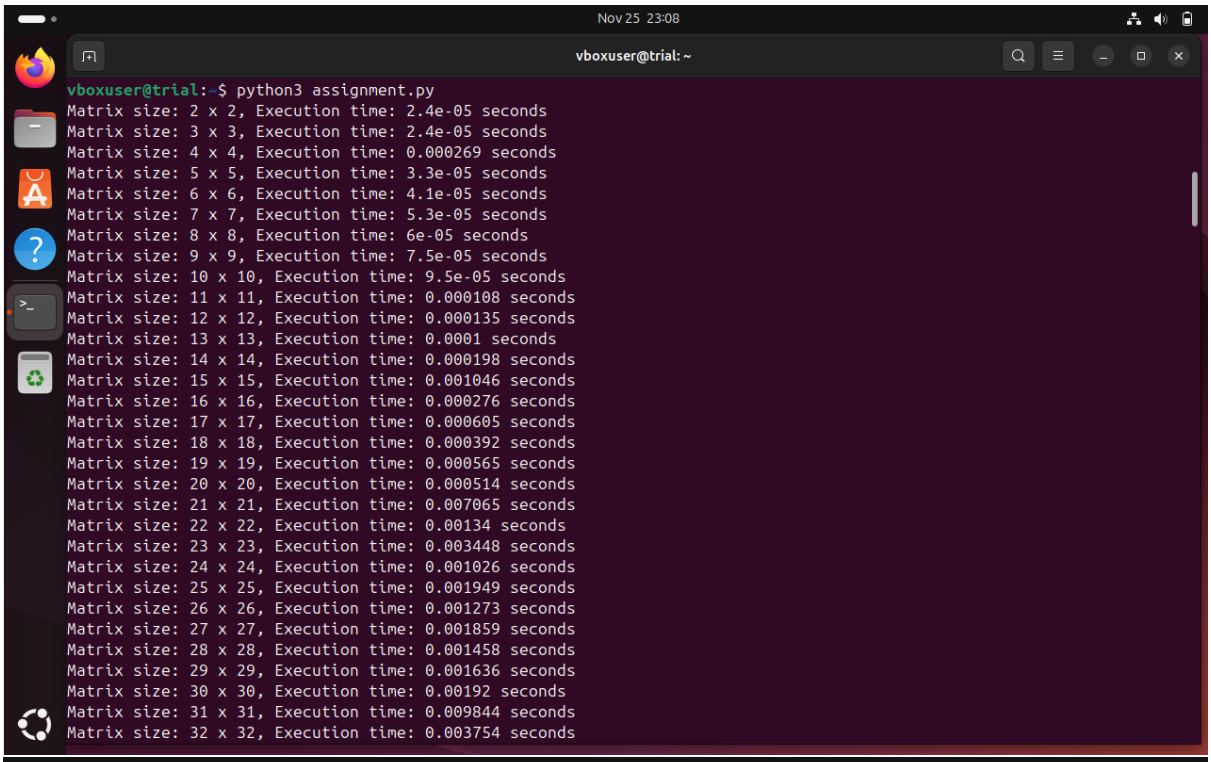


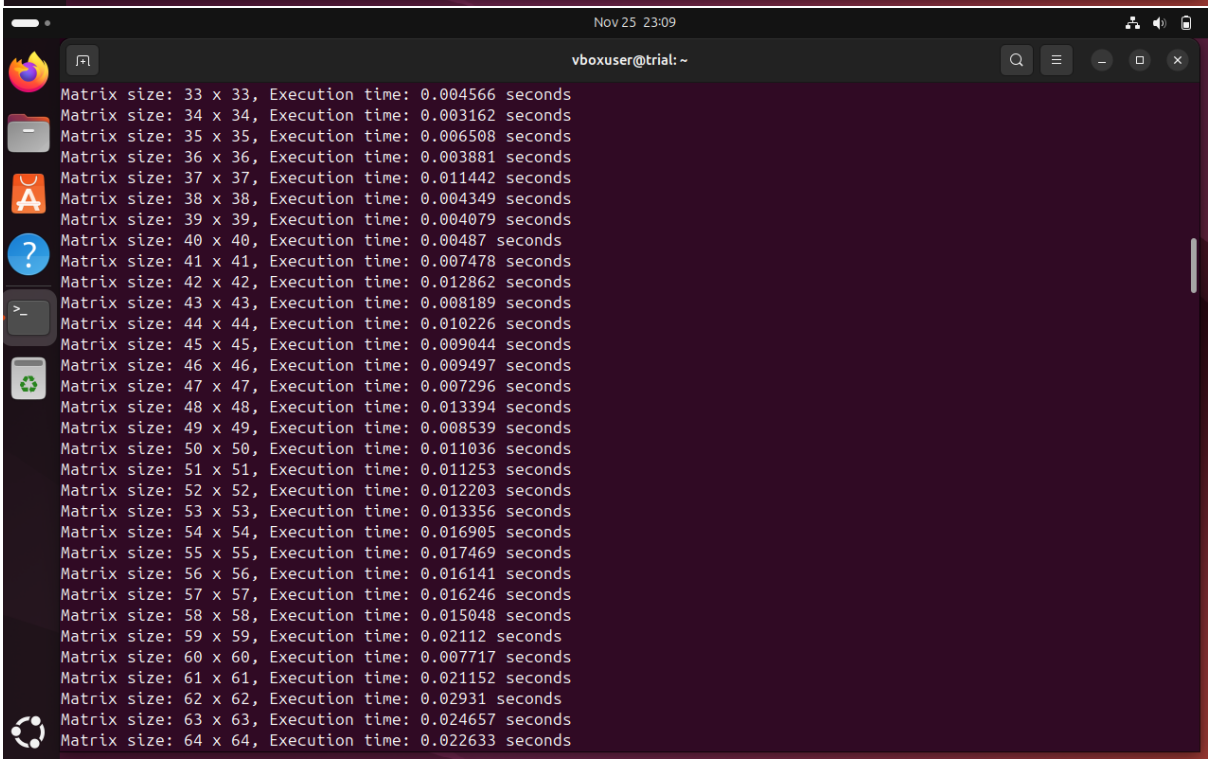


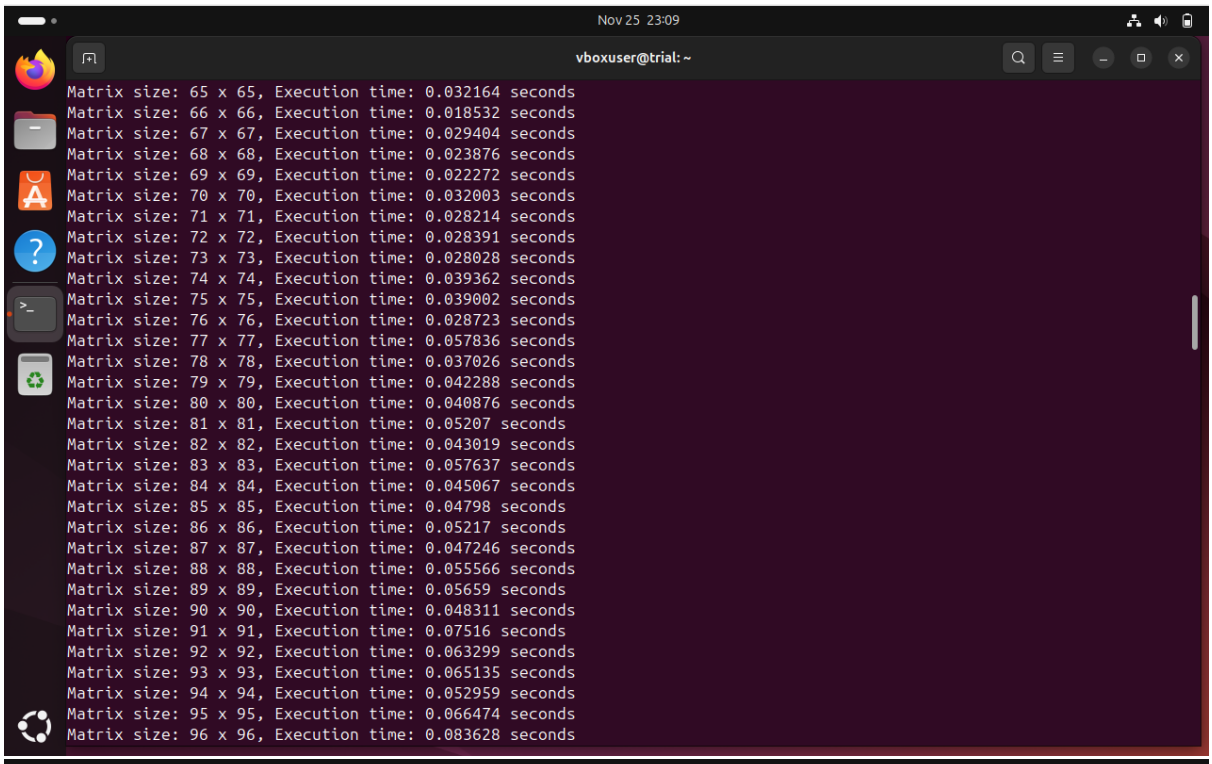

File Edit Selection View Go Run ···
CS3204
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS SPELL CHECKER
Python
Matrix size: 77x77, Execution time: 0.032418 seconds
Matrix size: 78x78, Execution time: 0.030030 seconds
Matrix size: 79x79, Execution time: 0.030160 seconds
Matrix size: 80x80, Execution time: 0.032194 seconds
Matrix size: 81x81, Execution time: 0.032488 seconds
Matrix size: 82x82, Execution time: 0.033246 seconds
Matrix size: 83x83, Execution time: 0.036653 seconds
Matrix size: 84x84, Execution time: 0.036751 seconds
Matrix size: 85x85, Execution time: 0.037927 seconds
Matrix size: 86x86, Execution time: 0.039402 seconds
Matrix size: 87x87, Execution time: 0.044032 seconds
Matrix size: 88x88, Execution time: 0.039810 seconds
Matrix size: 89x89, Execution time: 0.042915 seconds
Matrix size: 90x90, Execution time: 0.045958 seconds
Matrix size: 91x91, Execution time: 0.048434 seconds
Matrix size: 92x92, Execution time: 0.047412 seconds
Matrix size: 93x93, Execution time: 0.052772 seconds
Matrix size: 94x94, Execution time: 0.059700 seconds
Matrix size: 95x95, Execution time: 0.060957 seconds
Matrix size: 96x96, Execution time: 0.061709 seconds
Matrix size: 97x97, Execution time: 0.062012 seconds
Matrix size: 98x98, Execution time: 0.060402 seconds
Matrix size: 99x99, Execution time: 0.059261 seconds
Matrix size: 100x100, Execution time: 0.065186 seconds
Matrix size: 101x101, Execution time: 0.061273 seconds
Matrix size: 102x102, Execution time: 0.065488 seconds
Matrix size: 103x103, Execution time: 0.065037 seconds
Matrix size: 104x104, Execution time: 0.069504 seconds
Matrix size: 105x105, Execution time: 0.069097 seconds
Matrix size: 106x106, Execution time: 0.073460 seconds
Matrix size: 107x107, Execution time: 0.080759 seconds
Matrix size: 108x108, Execution time: 0.077204 seconds
Matrix size: 109x109, Execution time: 0.078159 seconds
Matrix size: 110x110, Execution time: 0.079874 seconds
Matrix size: 111x111, Execution time: 0.084818 seconds
Matrix size: 112x112, Execution time: 0.084574 seconds
Matrix size: 113x113, Execution time: 0.090712 seconds
Matrix size: 114x114, Execution time: 0.086142 seconds
Ln 11, Col 77 Spaces: 4 UTF-8 CRLF {} Python 3.12.7 64-bit (Microsoft Store) Go Live

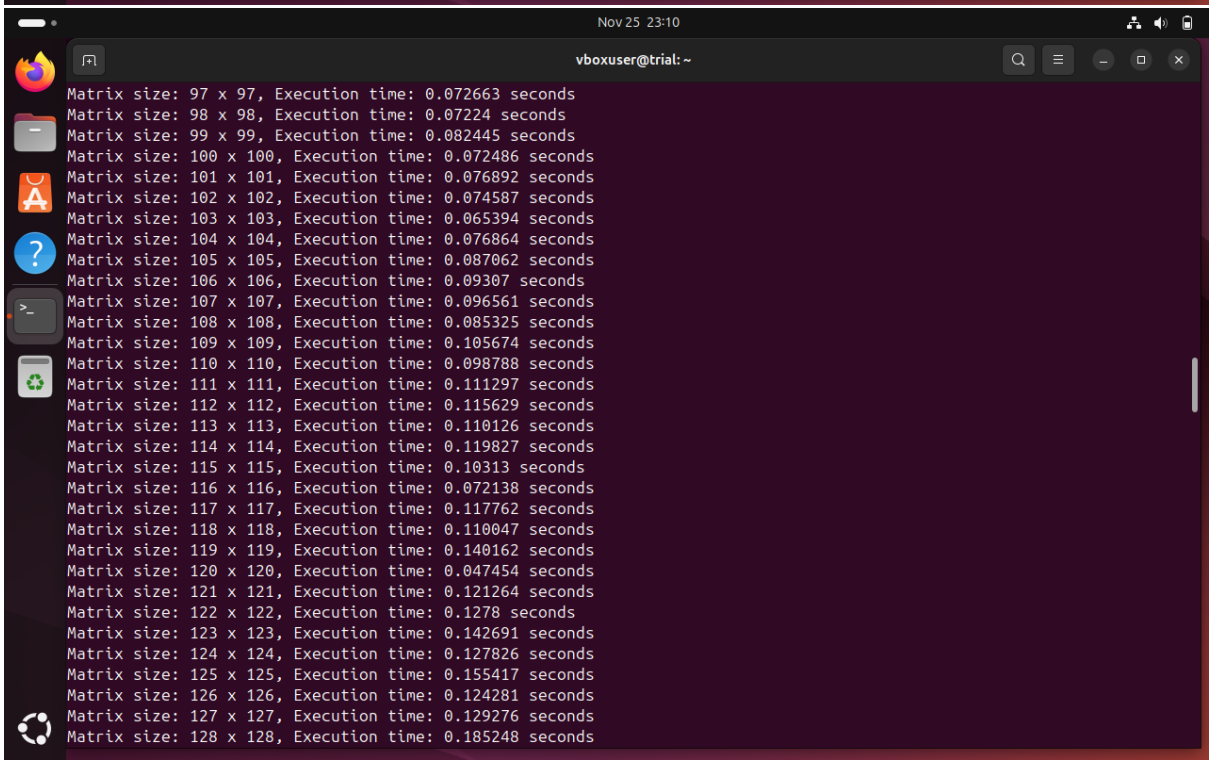

File Edit Selection View Go Run ···
CS3204
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS SPELL CHECKER
Python
Matrix size: 115x115, Execution time: 0.092130 seconds
Matrix size: 116x116, Execution time: 0.091022 seconds
Matrix size: 117x117, Execution time: 0.096389 seconds
Matrix size: 118x118, Execution time: 0.101589 seconds
Matrix size: 119x119, Execution time: 0.103346 seconds
Matrix size: 120x120, Execution time: 0.101558 seconds
Matrix size: 121x121, Execution time: 0.105859 seconds
Matrix size: 122x122, Execution time: 0.107535 seconds
Matrix size: 123x123, Execution time: 0.112613 seconds
Matrix size: 124x124, Execution time: 0.115509 seconds
Matrix size: 125x125, Execution time: 0.113999 seconds
Matrix size: 126x126, Execution time: 0.121954 seconds
Matrix size: 127x127, Execution time: 0.130169 seconds
Matrix size: 128x128, Execution time: 0.125198 seconds
Matrix size: 129x129, Execution time: 0.136134 seconds
Matrix size: 130x130, Execution time: 0.140140 seconds
Matrix size: 131x131, Execution time: 0.144143 seconds
Matrix size: 132x132, Execution time: 0.137211 seconds
Matrix size: 133x133, Execution time: 0.167368 seconds
Matrix size: 134x134, Execution time: 0.156380 seconds
Matrix size: 135x135, Execution time: 0.150156 seconds
Matrix size: 136x136, Execution time: 0.155927 seconds
Matrix size: 137x137, Execution time: 0.164537 seconds
Matrix size: 138x138, Execution time: 0.159304 seconds
Matrix size: 139x139, Execution time: 0.162926 seconds
Matrix size: 140x140, Execution time: 0.164120 seconds
Matrix size: 141x141, Execution time: 0.168818 seconds
Matrix size: 142x142, Execution time: 0.174165 seconds
Matrix size: 143x143, Execution time: 0.176902 seconds
Matrix size: 144x144, Execution time: 0.178958 seconds
Matrix size: 145x145, Execution time: 0.186052 seconds
Matrix size: 146x146, Execution time: 0.186577 seconds
Matrix size: 147x147, Execution time: 0.192972 seconds
Matrix size: 148x148, Execution time: 0.202416 seconds
Matrix size: 149x149, Execution time: 0.205402 seconds
Matrix size: 150x150, Execution time: 0.201084 seconds

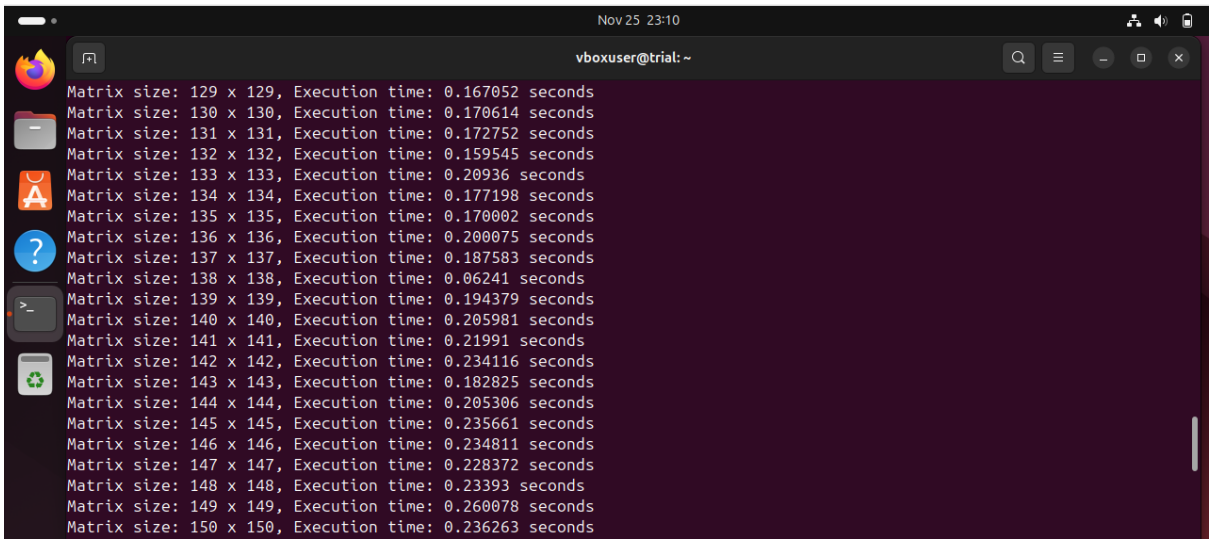
The application runtime on Virtual Machine using terminal is as follows:



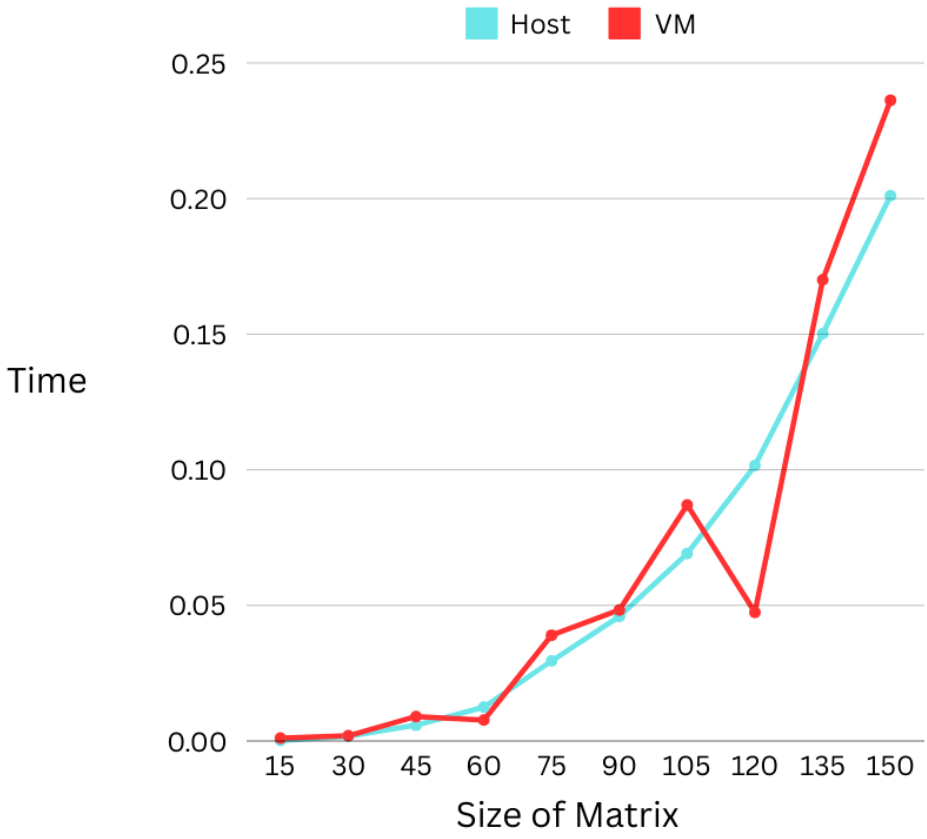



Nov 25 23:09
vboxuser@trial: ~
Matrix size: 65 x 65, Execution time: 0.032164 seconds
Matrix size: 66 x 66, Execution time: 0.018532 seconds
Matrix size: 67 x 67, Execution time: 0.029404 seconds
Matrix size: 68 x 68, Execution time: 0.023876 seconds
Matrix size: 69 x 69, Execution time: 0.022272 seconds
Matrix size: 70 x 70, Execution time: 0.032003 seconds
Matrix size: 71 x 71, Execution time: 0.028214 seconds
Matrix size: 72 x 72, Execution time: 0.028391 seconds
Matrix size: 73 x 73, Execution time: 0.028028 seconds
Matrix size: 74 x 74, Execution time: 0.039362 seconds
Matrix size: 75 x 75, Execution time: 0.039002 seconds
Matrix size: 76 x 76, Execution time: 0.028723 seconds
Matrix size: 77 x 77, Execution time: 0.057836 seconds
Matrix size: 78 x 78, Execution time: 0.037026 seconds
Matrix size: 79 x 79, Execution time: 0.042288 seconds
Matrix size: 80 x 80, Execution time: 0.040876 seconds
Matrix size: 81 x 81, Execution time: 0.05207 seconds
Matrix size: 82 x 82, Execution time: 0.043019 seconds
Matrix size: 83 x 83, Execution time: 0.057637 seconds
Matrix size: 84 x 84, Execution time: 0.045067 seconds
Matrix size: 85 x 85, Execution time: 0.04798 seconds
Matrix size: 86 x 86, Execution time: 0.05217 seconds
Matrix size: 87 x 87, Execution time: 0.047246 seconds
Matrix size: 88 x 88, Execution time: 0.055566 seconds
Matrix size: 89 x 89, Execution time: 0.05659 seconds
Matrix size: 90 x 90, Execution time: 0.048311 seconds
Matrix size: 91 x 91, Execution time: 0.07516 seconds
Matrix size: 92 x 92, Execution time: 0.063299 seconds
Matrix size: 93 x 93, Execution time: 0.065135 seconds
Matrix size: 94 x 94, Execution time: 0.052959 seconds
Matrix size: 95 x 95, Execution time: 0.066474 seconds
Matrix size: 96 x 96, Execution time: 0.083628 seconds


Nov 25 23:10
vboxuser@trial: ~
Matrix size: 97 x 97, Execution time: 0.072663 seconds
Matrix size: 98 x 98, Execution time: 0.07224 seconds
Matrix size: 99 x 99, Execution time: 0.082445 seconds
Matrix size: 100 x 100, Execution time: 0.072486 seconds
Matrix size: 101 x 101, Execution time: 0.076892 seconds
Matrix size: 102 x 102, Execution time: 0.074587 seconds
Matrix size: 103 x 103, Execution time: 0.065394 seconds
Matrix size: 104 x 104, Execution time: 0.076864 seconds
Matrix size: 105 x 105, Execution time: 0.087062 seconds
Matrix size: 106 x 106, Execution time: 0.09307 seconds
Matrix size: 107 x 107, Execution time: 0.096561 seconds
Matrix size: 108 x 108, Execution time: 0.085325 seconds
Matrix size: 109 x 109, Execution time: 0.105674 seconds
Matrix size: 110 x 110, Execution time: 0.098788 seconds
Matrix size: 111 x 111, Execution time: 0.111297 seconds
Matrix size: 112 x 112, Execution time: 0.115629 seconds
Matrix size: 113 x 113, Execution time: 0.110126 seconds
Matrix size: 114 x 114, Execution time: 0.119827 seconds
Matrix size: 115 x 115, Execution time: 0.10313 seconds
Matrix size: 116 x 116, Execution time: 0.072138 seconds
Matrix size: 117 x 117, Execution time: 0.117762 seconds
Matrix size: 118 x 118, Execution time: 0.110047 seconds
Matrix size: 119 x 119, Execution time: 0.140162 seconds
Matrix size: 120 x 120, Execution time: 0.047454 seconds
Matrix size: 121 x 121, Execution time: 0.121264 seconds
Matrix size: 122 x 122, Execution time: 0.1278 seconds
Matrix size: 123 x 123, Execution time: 0.142691 seconds
Matrix size: 124 x 124, Execution time: 0.127826 seconds
Matrix size: 125 x 125, Execution time: 0.155417 seconds
Matrix size: 126 x 126, Execution time: 0.124281 seconds
Matrix size: 127 x 127, Execution time: 0.129276 seconds
Matrix size: 128 x 128, Execution time: 0.185248 seconds



Analysis of both executions:



Size Of Matrix	Virtual Machine	Host
15	0.00104	0.00018
30	0.00192	0.00177
45	0.00904	0.00582
60	0.00771	0.01246
75	0.03900	0.02951
90	0.04831	0.04595
105	0.08706	0.06909
120	0.04745	0.10155
135	0.17000	0.15015
150	0.23626	0.20108

** Graph and Table subject to values mentioned in the same only. Please see screenshots attached as well. **

As depicted through the graph and table, the host machine has outperformed the VM in all cases apart from matrix size 60 and 120. This is due to several factors: -

1. Host Machine has direct access to hardware while VM requires a hypervisor to do so.
2. VMs require additional processing for the hypervisor to emulate hardware and manage resources, adding to latency.
3. VMs share the Host's resource (CPU, RAM, I/O) allocation, which determines the performance.
4. VMs involve frequent context switching between VM and host processes.
5. Disk and network operations are often slower due to virtualization layers.
6. Hypervisor enforces security and isolation between VMs, limiting the performance.

5. **Your personal reflections on the experience of setting up the virtual machine. Discuss any challenges you encountered and insights you gained.**

   The only issue while setting up the virtual machine that I personally faced was to select the right configuration for the graphics card and the right specifications. Allocating huge number of resources is not always a good thing because ultimately, the VM is using the computer's resources. Striking the right balance in allocating resources is the key.
   A few version related issues and beginner level issues persisted, mostly hanging of the VM. But once fixed, it works as required.