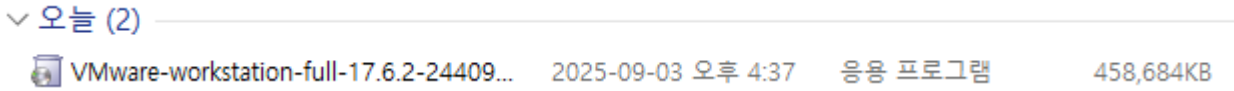
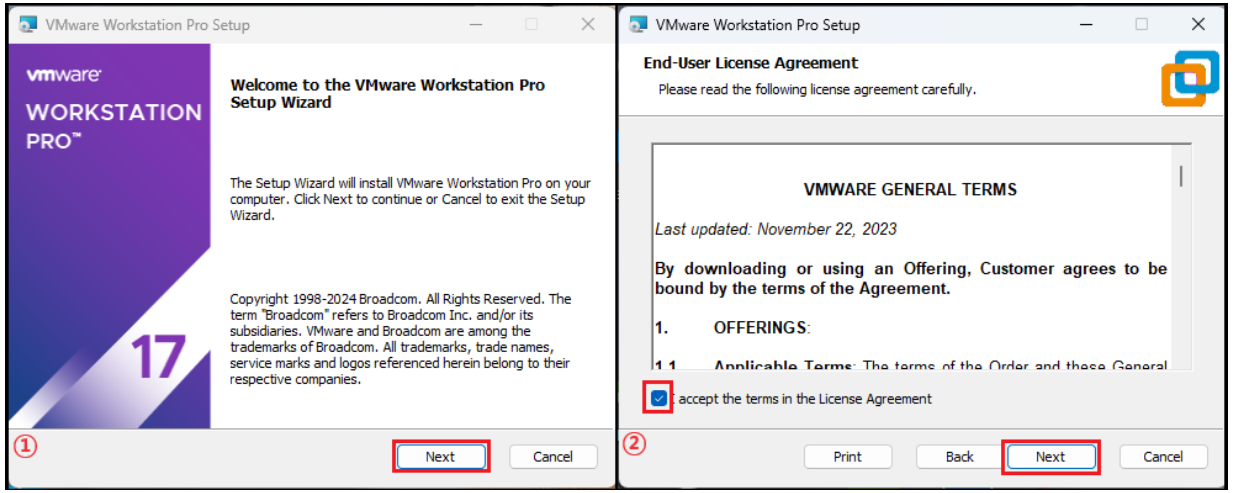
VMware 설치파일 다운로드

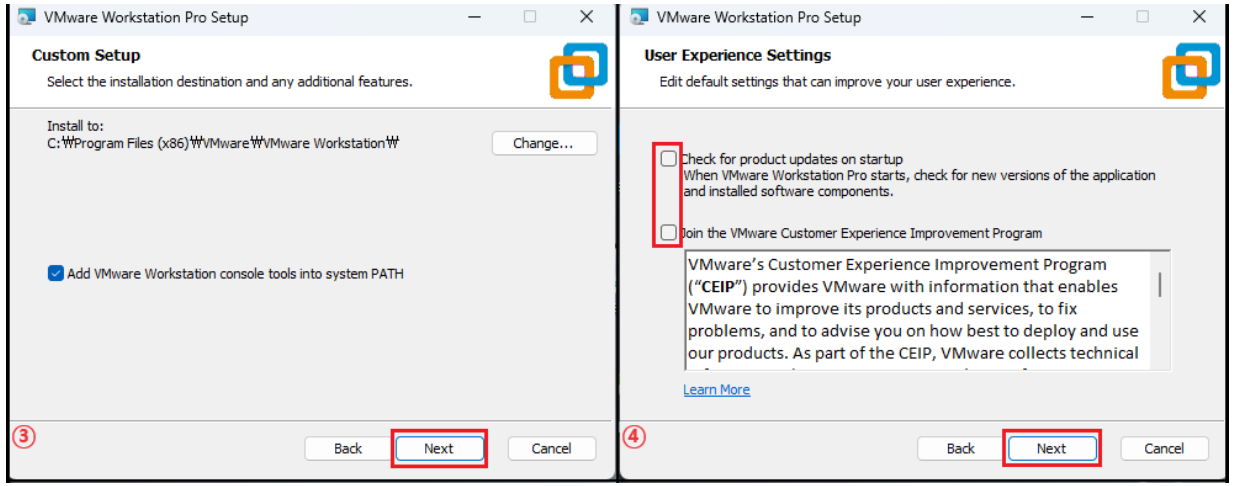
링크 참고: https://foxydog.tistory.com/176

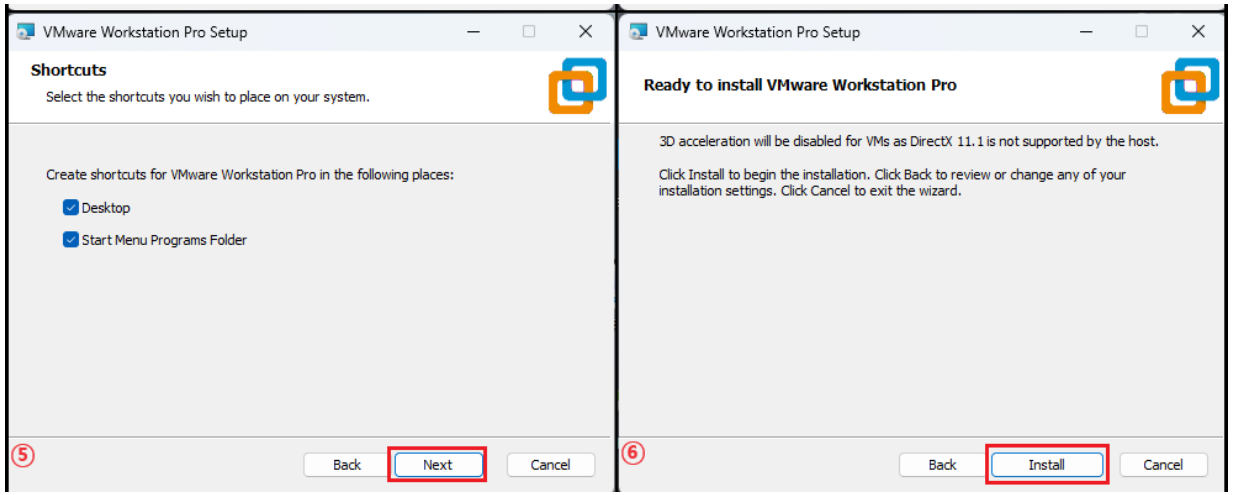
설치파일 다운로드 이후 실행

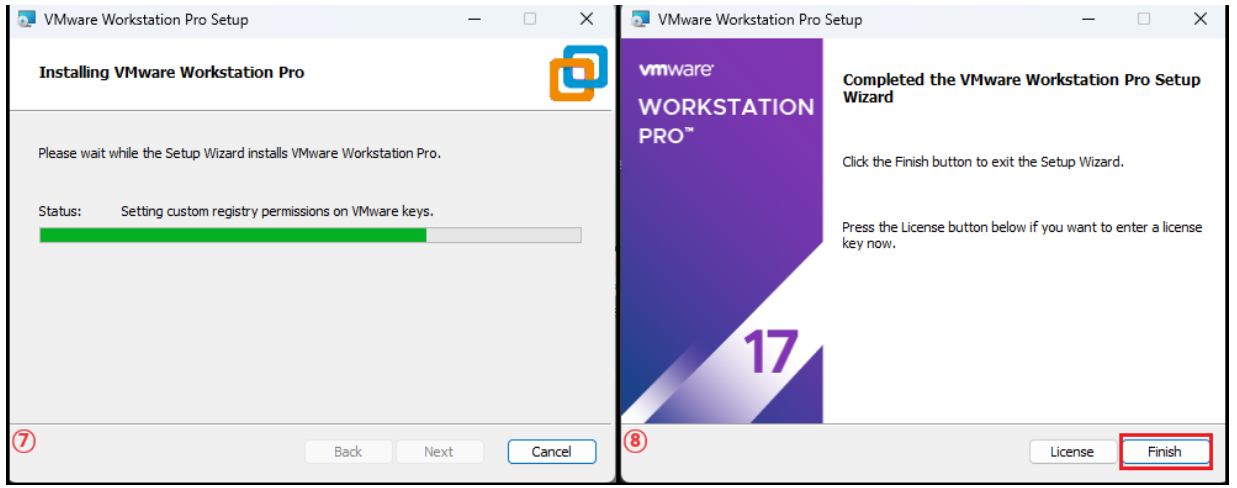


VMware 설치


VMware Workstation Pro Setup
vmware
WORKSTATION PRO™
17
Welcome to the VMware Workstation Pro Setup Wizard
The Setup Wizard will install VMware Workstation Pro on your computer. Click Next to continue or Cancel to exit the Setup Wizard.
Copyright 1998-2024 Broadcom. All Rights Reserved. The term "Broadcom" refers to Broadcom Inc. and/or its subsidiaries. VMware and Broadcom are among the trademarks of Broadcom. All trademarks, trade names, service marks and logos referenced herein belong to their respective companies.
Next
Cancel
①
VMware Workstation Pro Setup
End-User License Agreement
Please read the following license agreement carefully.
VMWARE GENERAL TERMS
Last updated: November 22, 2023
By downloading or using an Offering, Customer agrees to be bound by the terms of the Agreement.
1. OFFERINGS:
I accept the terms in the License Agreement
Print
Back
Next
Cancel
②

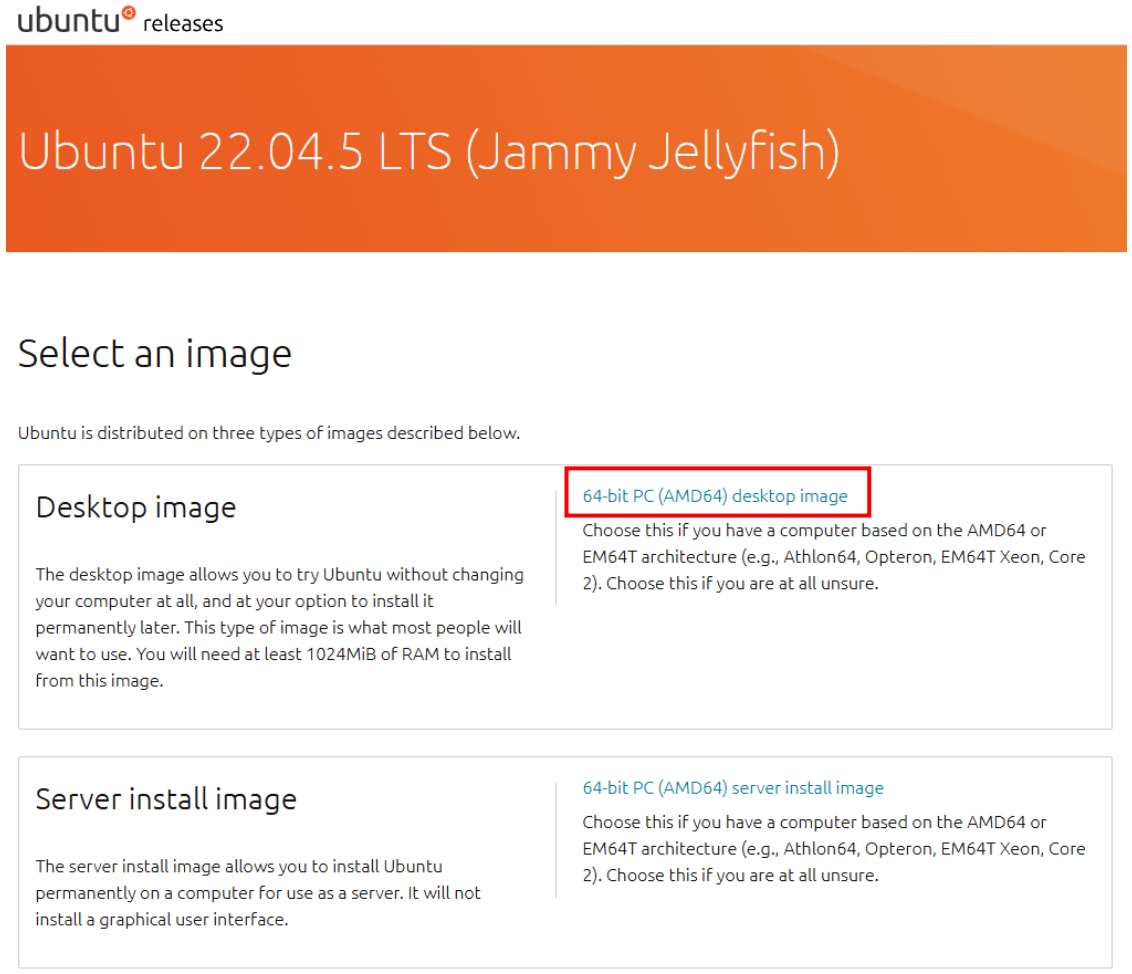

VMware Workstation Pro Setup
Custom Setup
Select the installation destination and any additional features.
Install to:
C:₩Program Files (x86)₩VMware₩VMware Workstation₩
Change...
Add VMware Workstation console tools into system PATH
Back
Next
Cancel
③
VMware Workstation Pro Setup
User Experience Settings
Edit default settings that can improve your user experience.
Check for product updates on startup
When VMware Workstation Pro starts, check for new versions of the application and installed software components.
Join the VMware Customer Experience Improvement Program
VMware's Customer Experience Improvement Program ("CEIP") provides VMware with information that enables VMware to improve its products and services, to fix problems, and to advise you on how best to deploy and use our products. As part of the CEIP, VMware collects technical
Learn More
Back
Next
Cancel
④


VMware Workstation Pro Setup
Shortcuts
Select the shortcuts you wish to place on your system.
Create shortcuts for VMware Workstation Pro in the following places:
Desktop
Start Menu Programs Folder
Back
Next
Cancel
⑤
VMware Workstation Pro Setup
Ready to install VMware Workstation Pro
3D acceleration will be disabled for VMs as DirectX 11.1 is not supported by the host.
Click Install to begin the installation. Click Back to review or change any of your installation settings. Click Cancel to exit the wizard.
Back
Install
Cancel
⑥

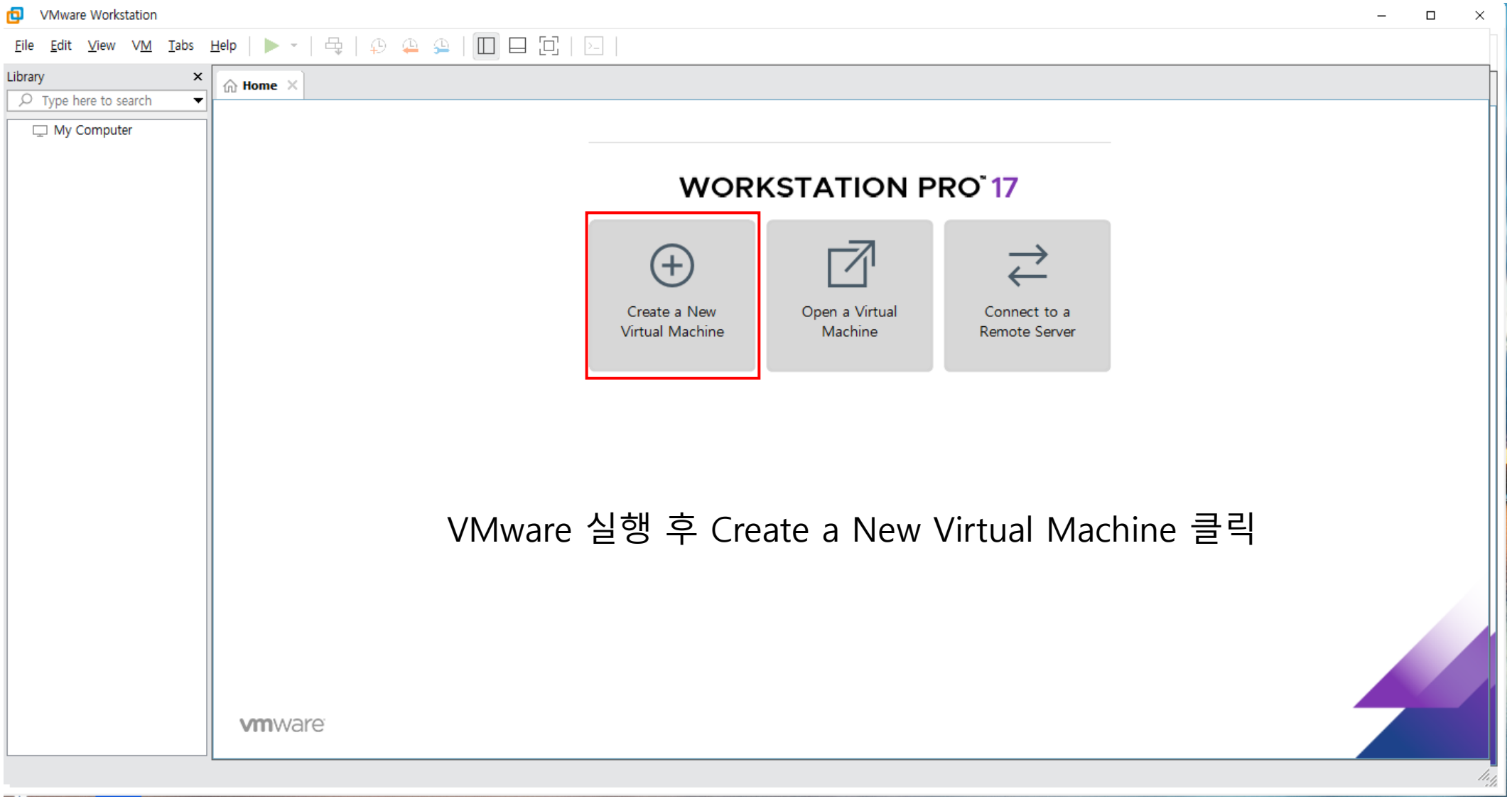

VMware Workstation Pro Setup
Installing VMware Workstation Pro
Please wait while the Setup Wizard installs VMware Workstation Pro.
Status: Setting custom registry permissions on VMware keys.
Back
Next
Cancel
⑦
VMware Workstation Pro Setup
vmware
WORKSTATION PRO™
17
Completed the VMware Workstation Pro Setup Wizard
Click the Finish button to exit the Setup Wizard.
Press the License button below if you want to enter a license key now.
License
Finish
⑧

Ubuntu 22.04 다운로드

링크: https://mirror.kakao.com/ubuntu-releases/jammy/ 접속하여 Ubuntu 22.04.5 LTS 다운로드

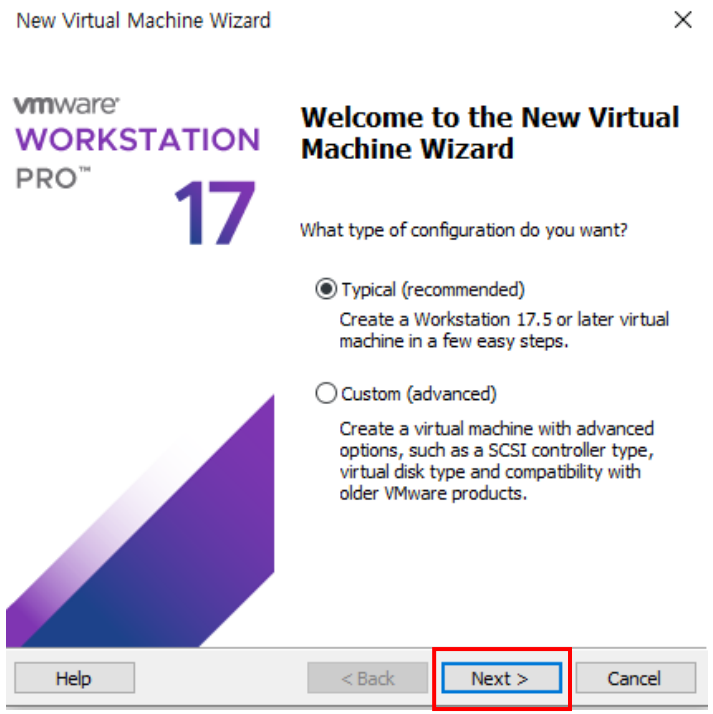


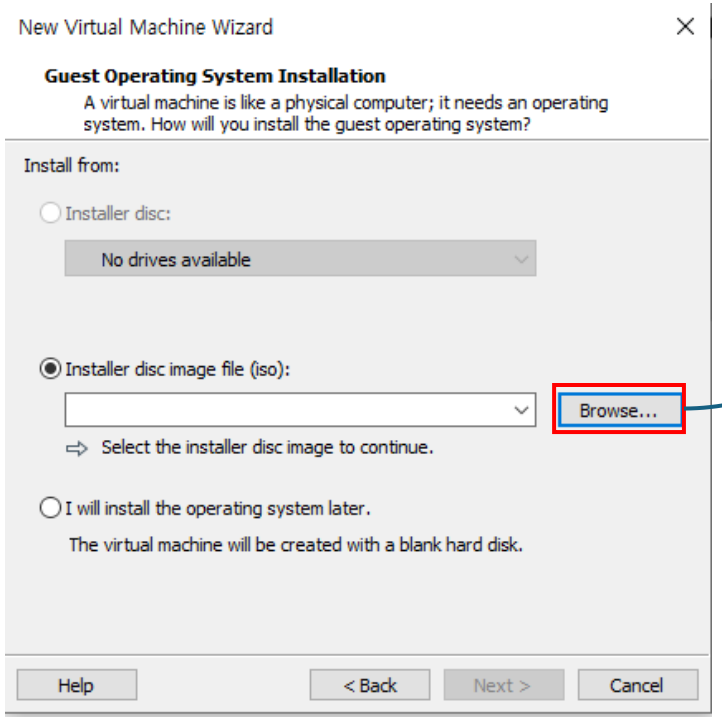
Ubuntu 22.04 설치 @ VMware

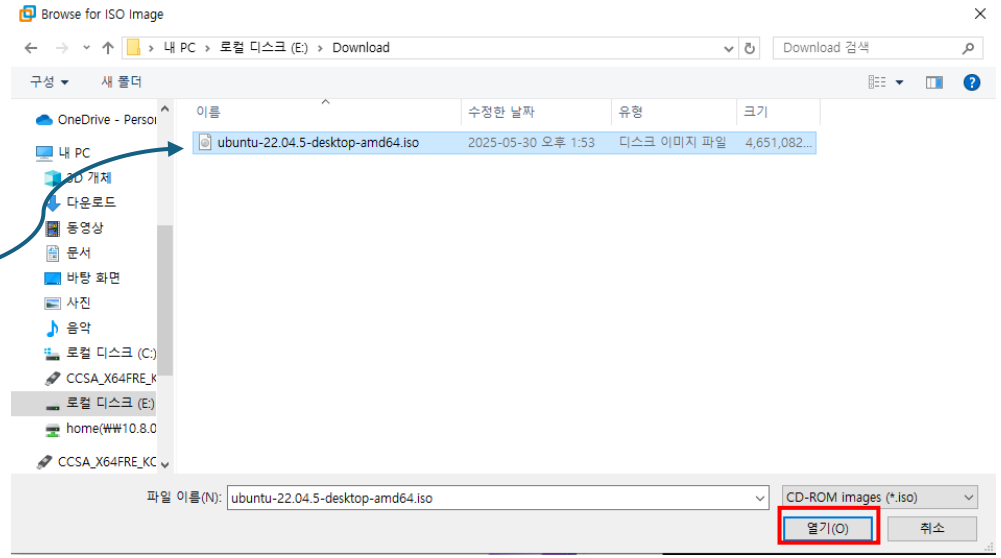


VMware 실행 후 Create a New Virtual Machine 클릭

Ubuntu 22.04 설치 @ VMware

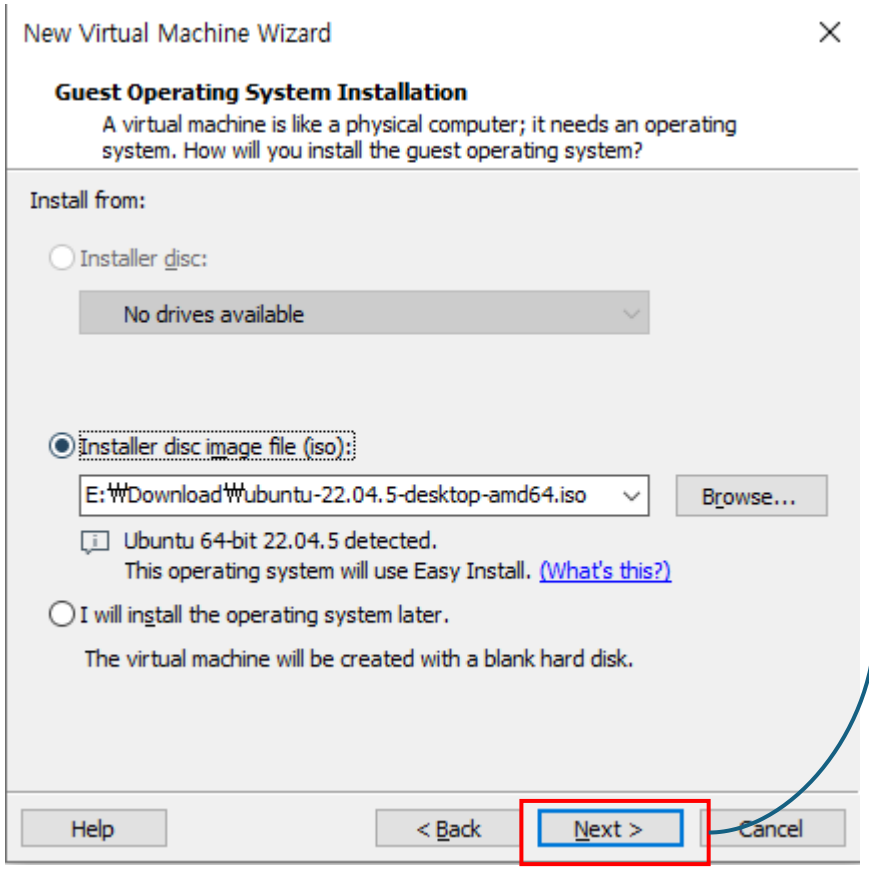


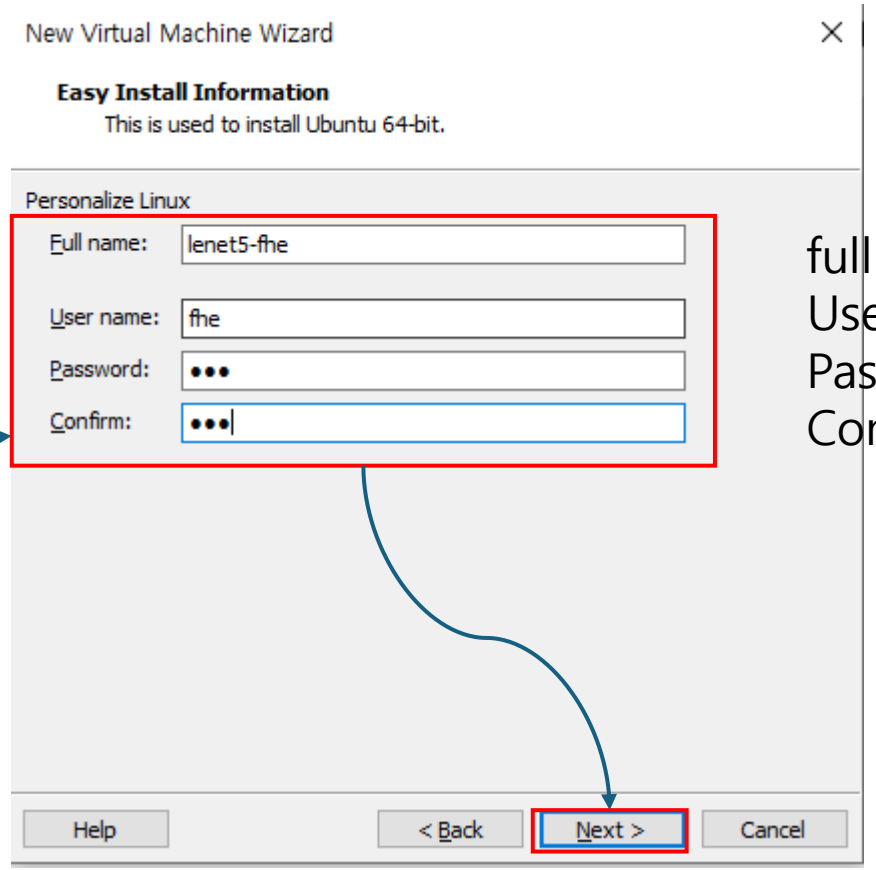




Next > Browse > 다운로드한 Ubuntu 22.04.5 desktop 선택

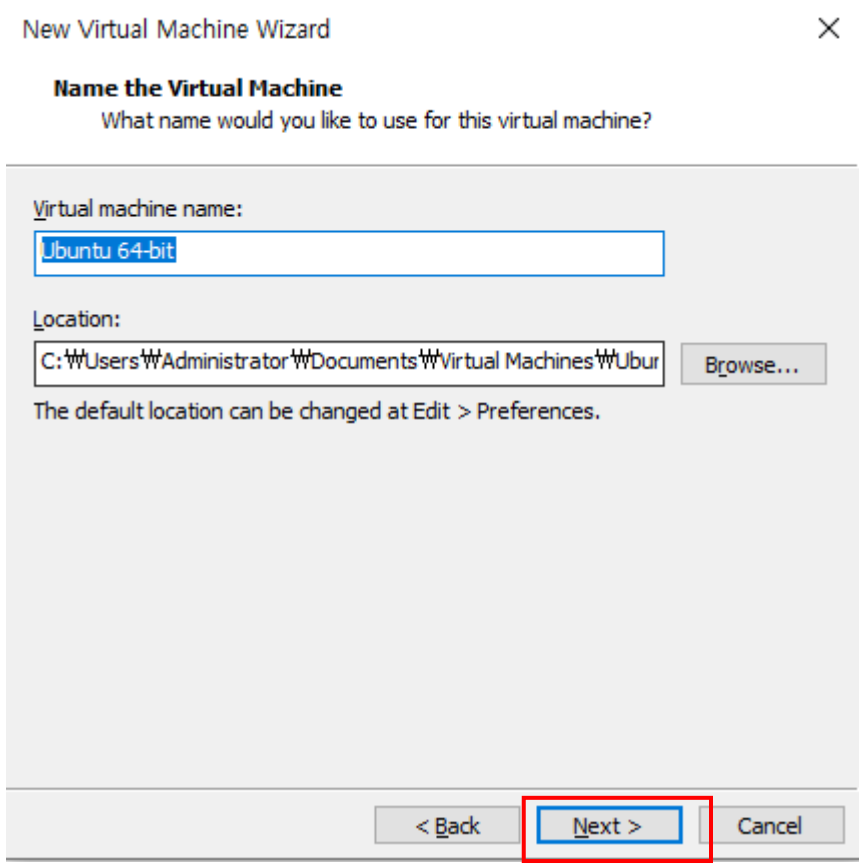
Ubuntu 22.04 설치 @ VMware

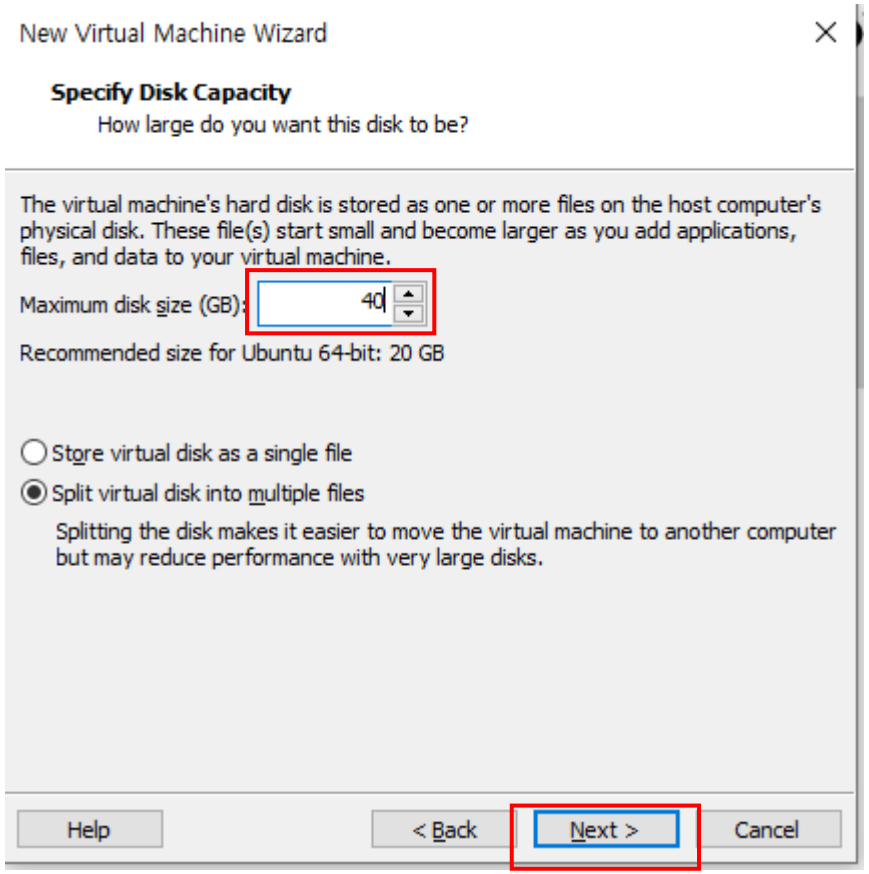




full name: lenet5-fhe
User name: fhe
Password: fhe
Confirm: fhe

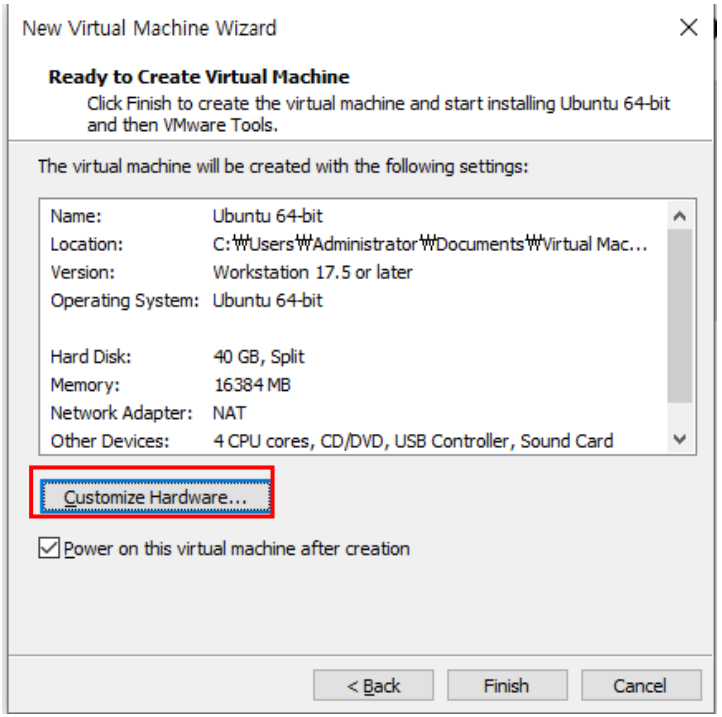
Ubuntu 22.04 설치 @ VMware

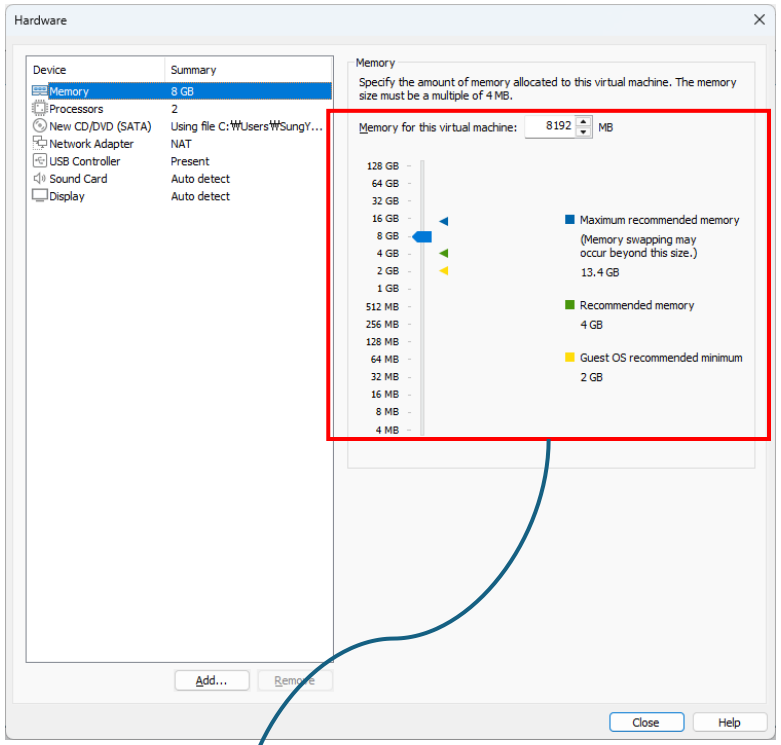


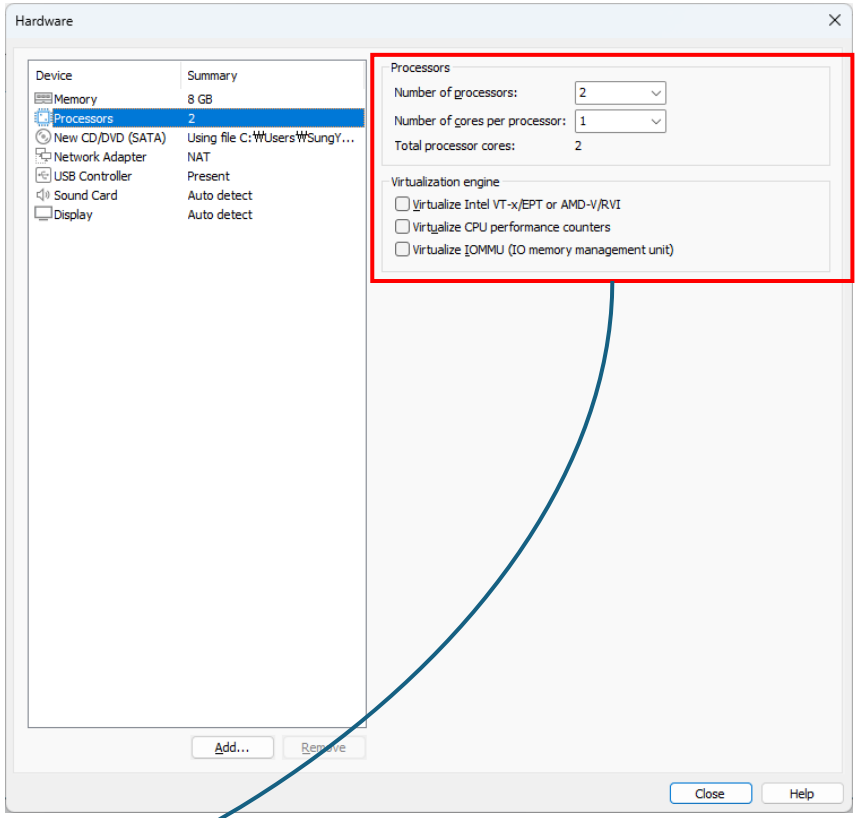


용량은 40GB로 설정

Ubuntu 22.04 설치 @ VMware

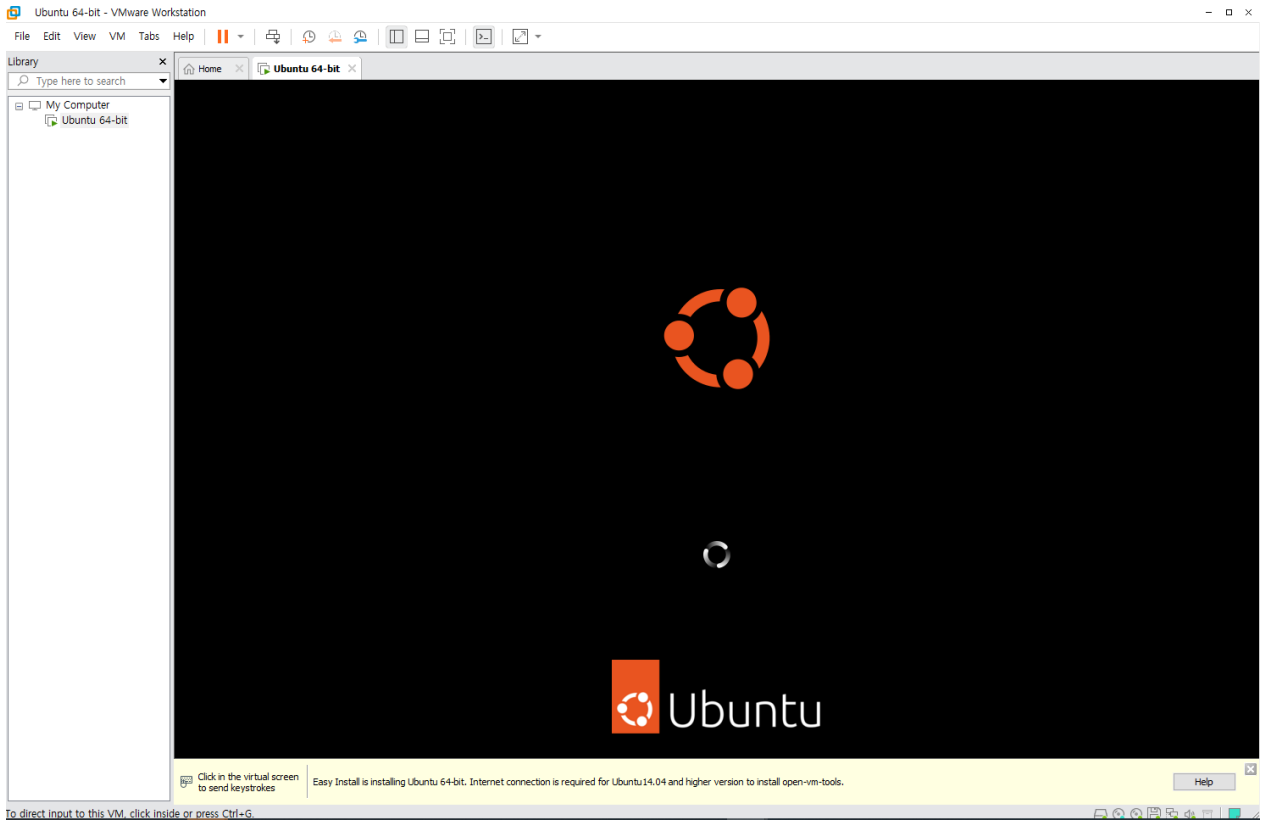


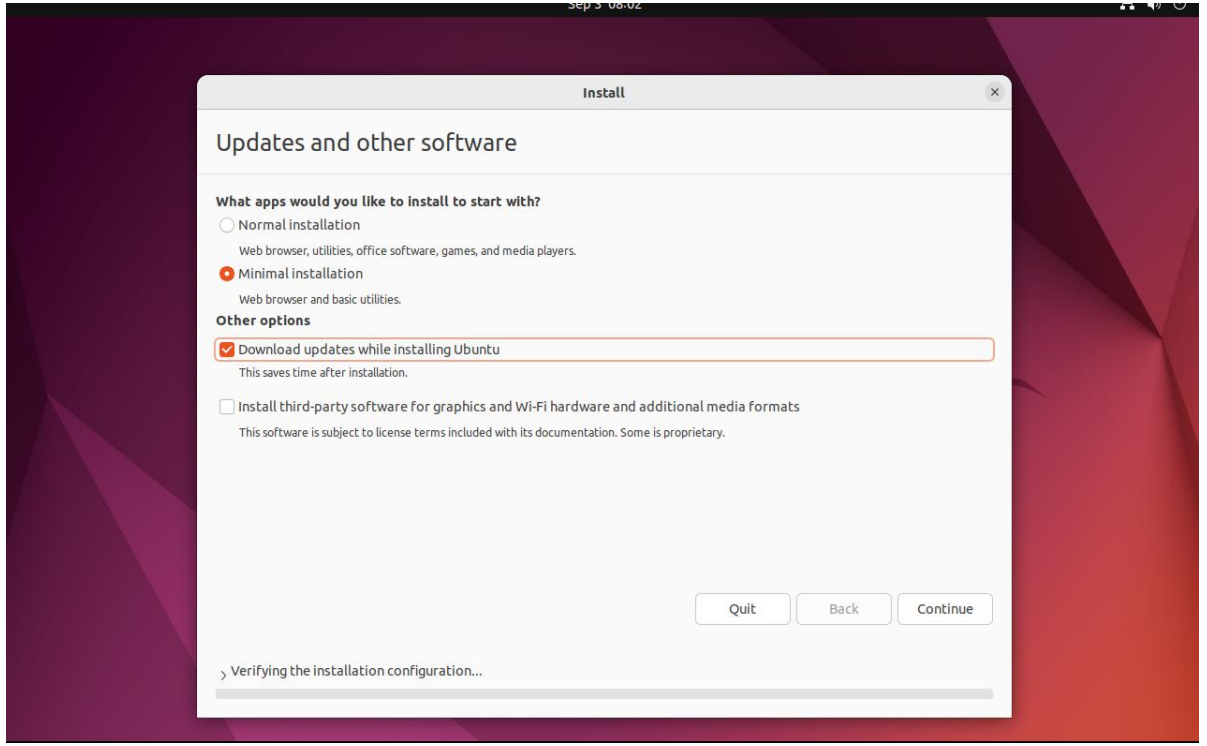




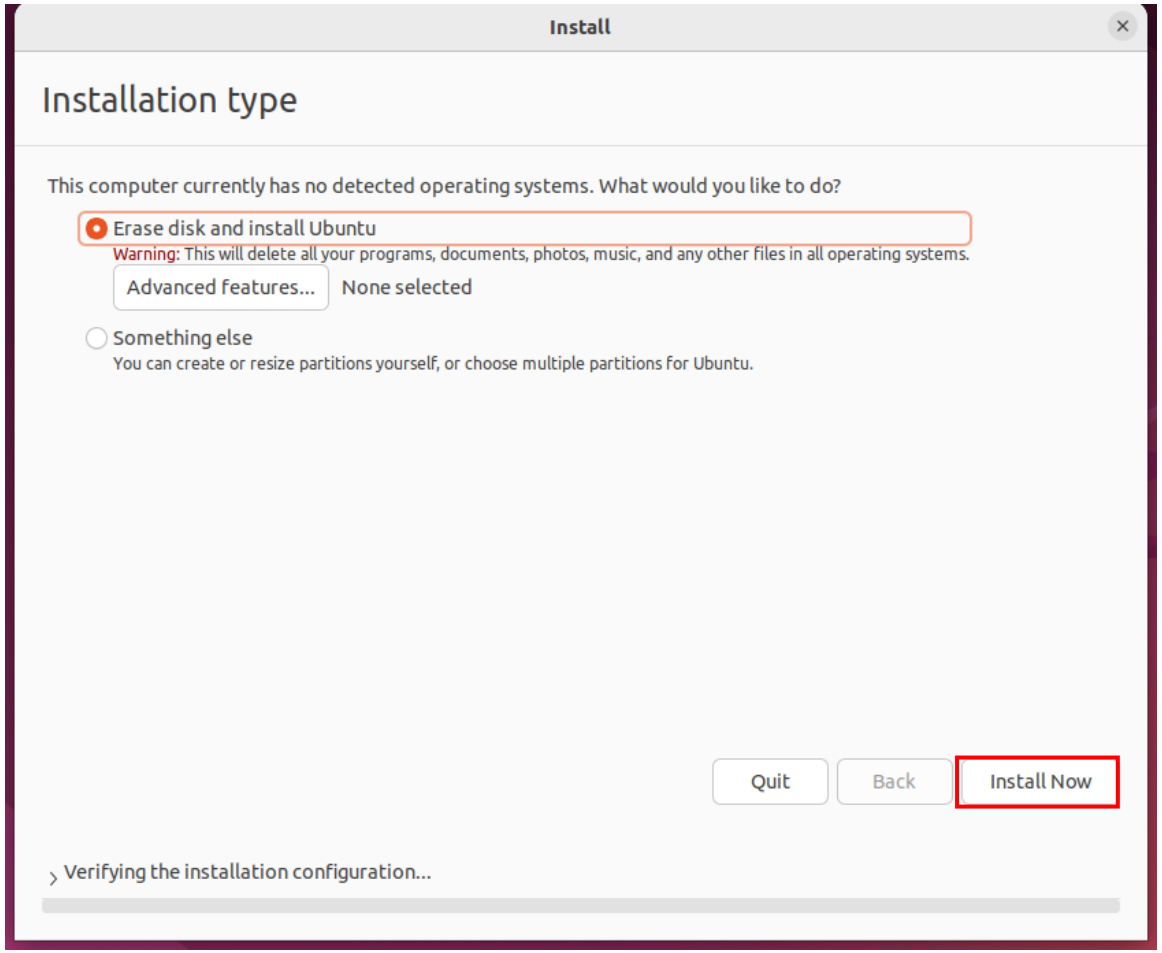
메모리는 8GB 이상, Maximum 이하로 설정
Processor는 2개로 설정

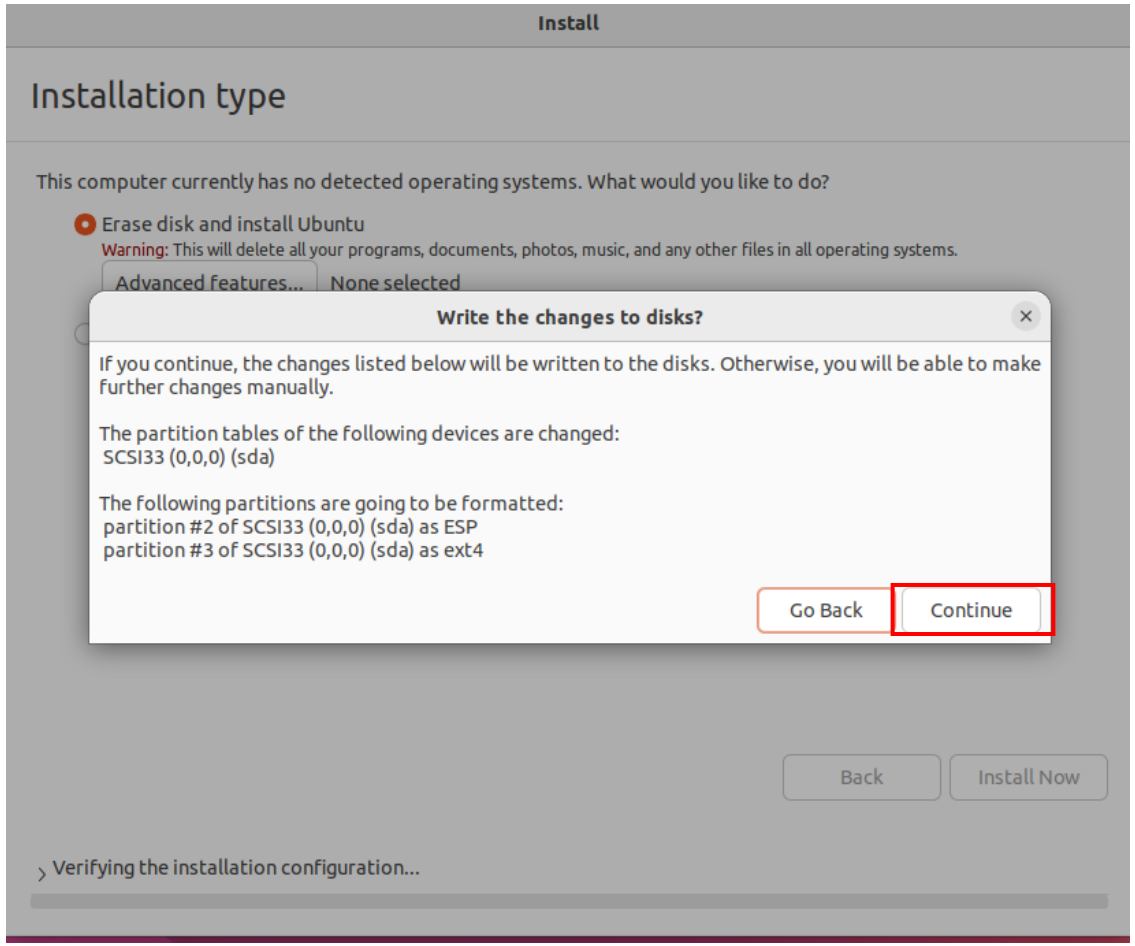
Ubuntu 22.04 설치 @ VMware



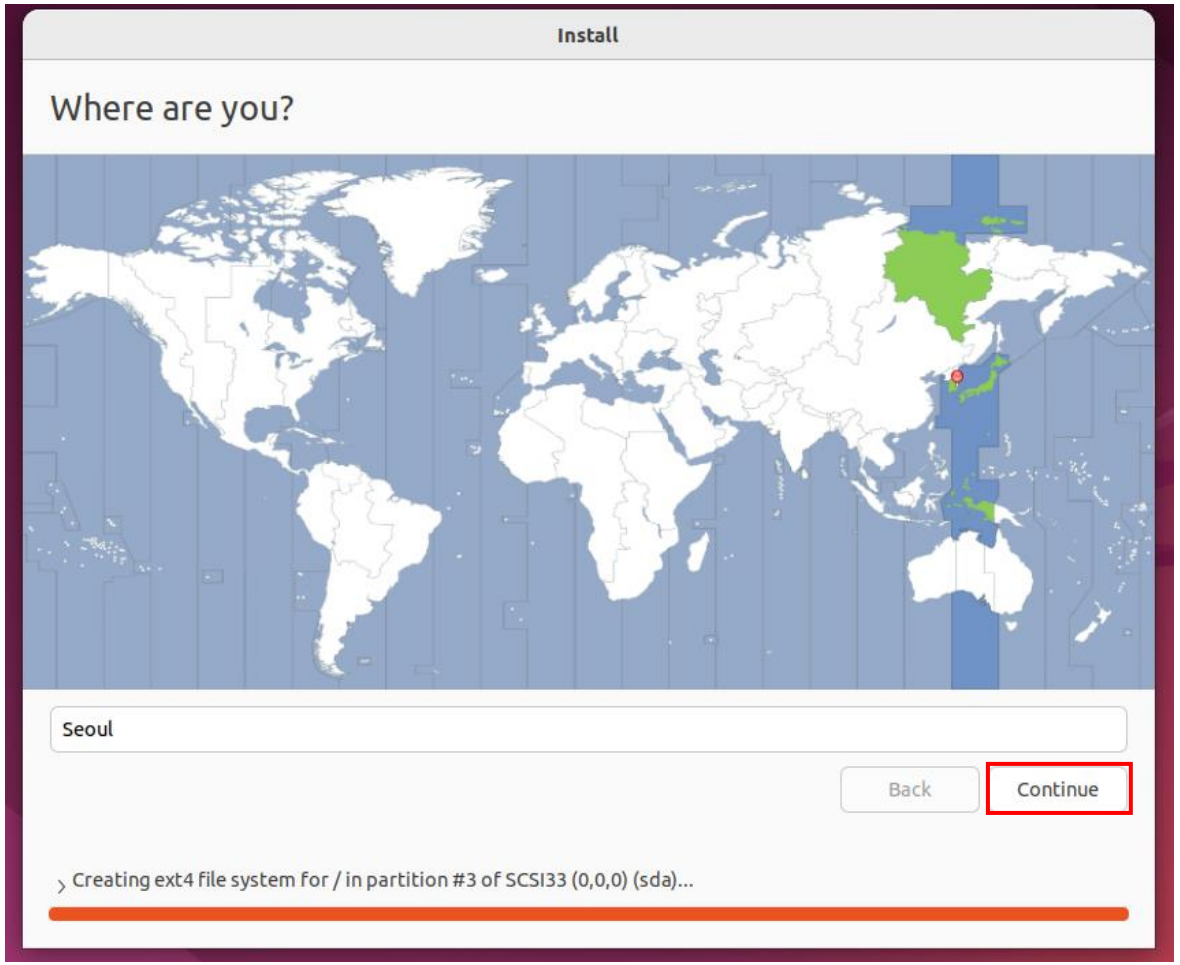


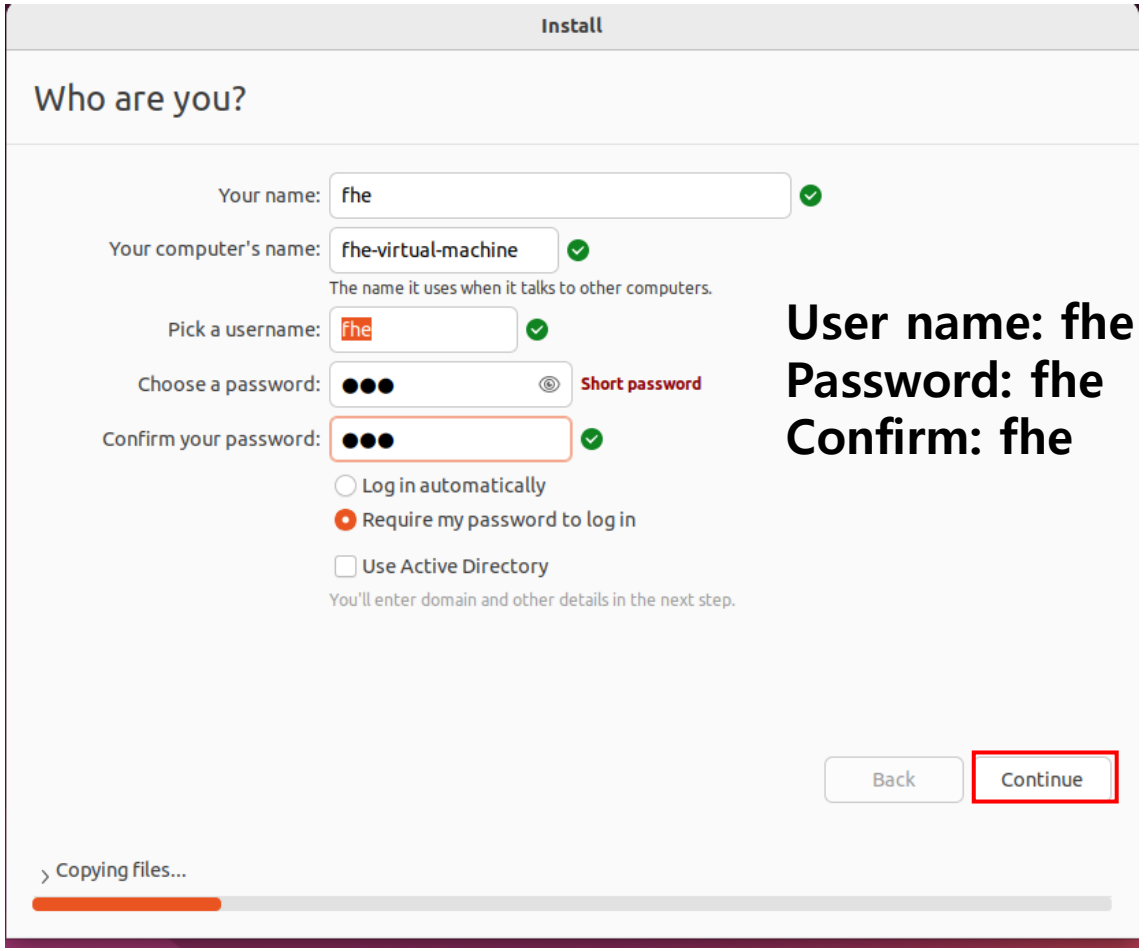
Ubuntu 22.04 설치 @ VMware





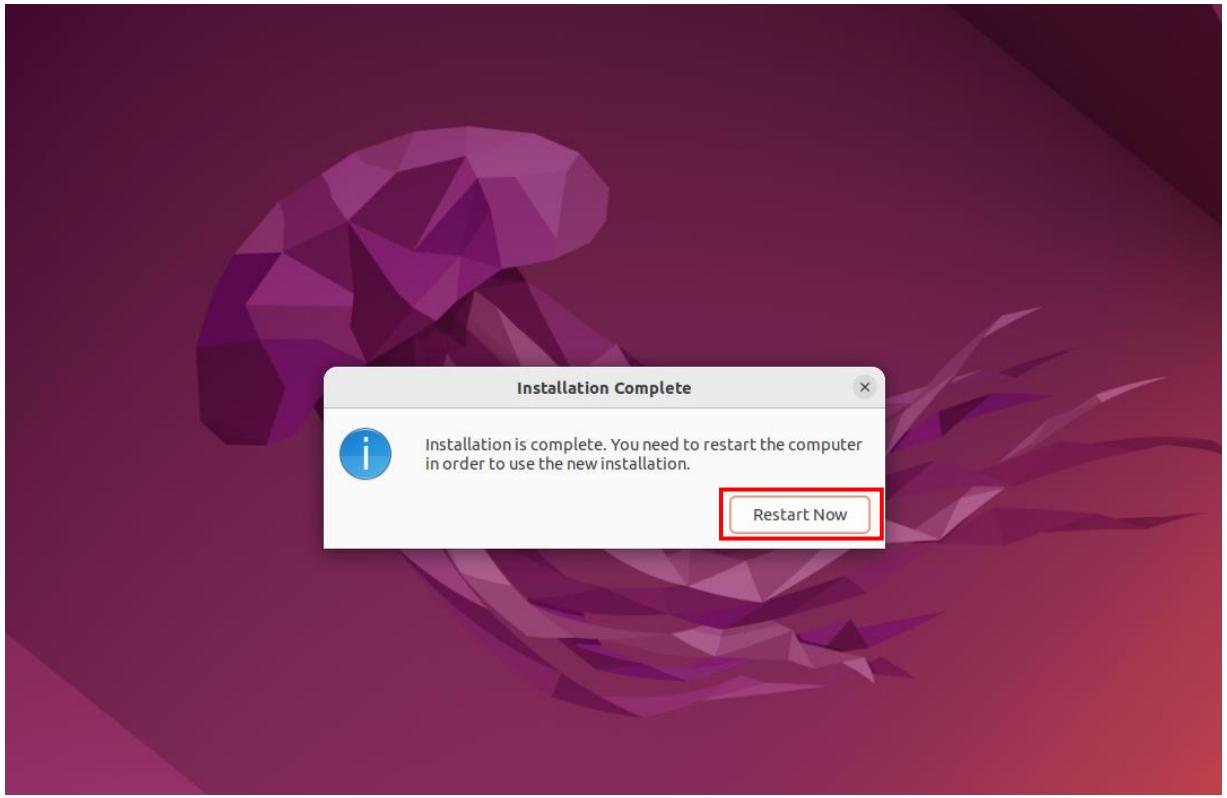
Ubuntu 22.04 설치 @ VMware



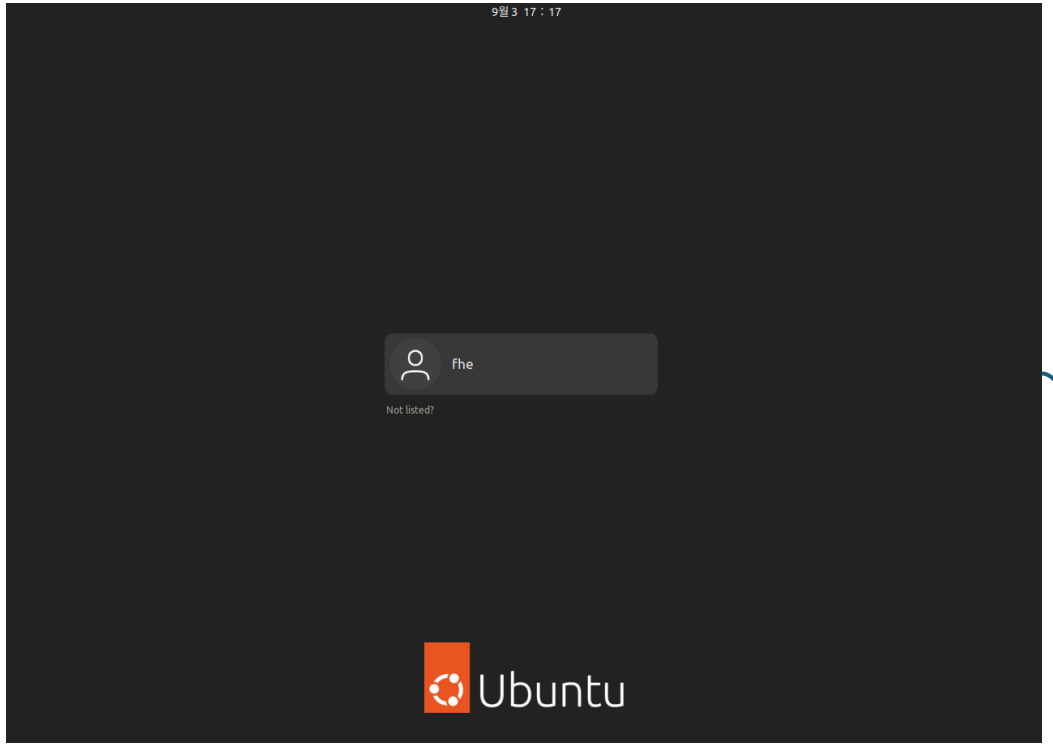


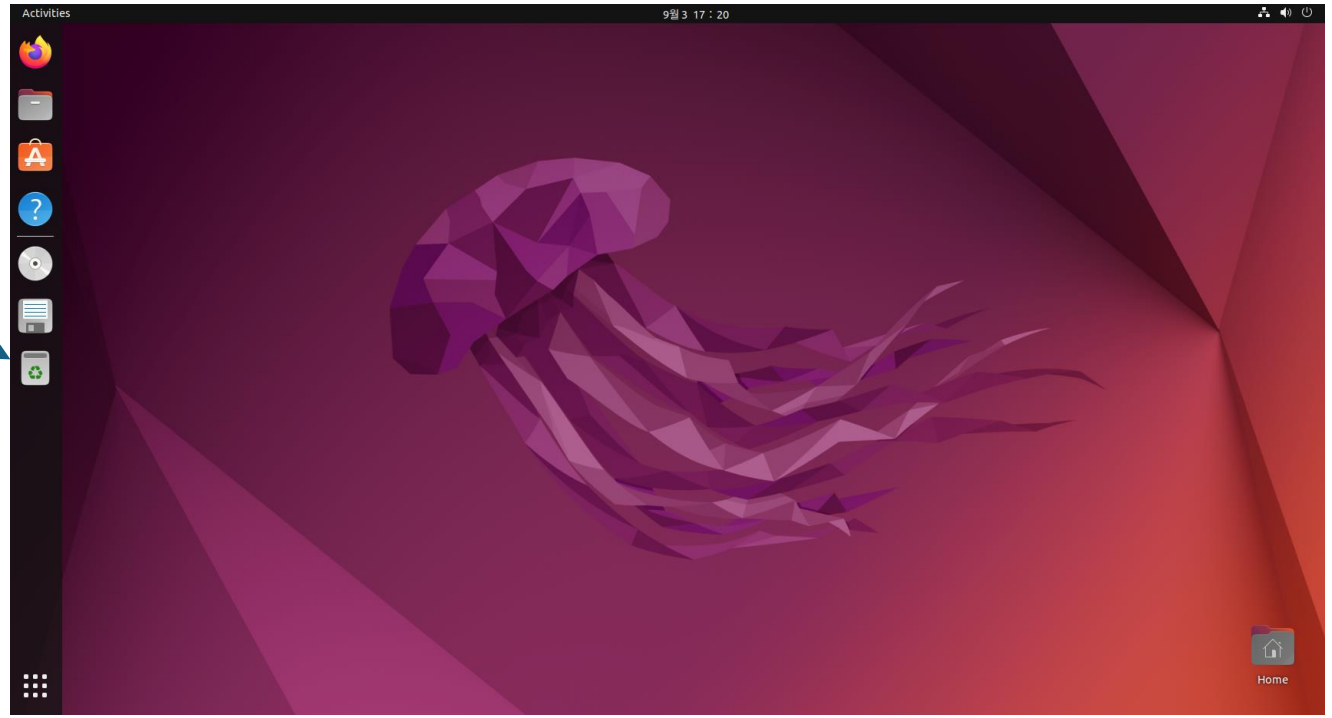
User name: fhe
Password: fhe
Confirm: fhe

Ubuntu 22.04 설치 @ VMware



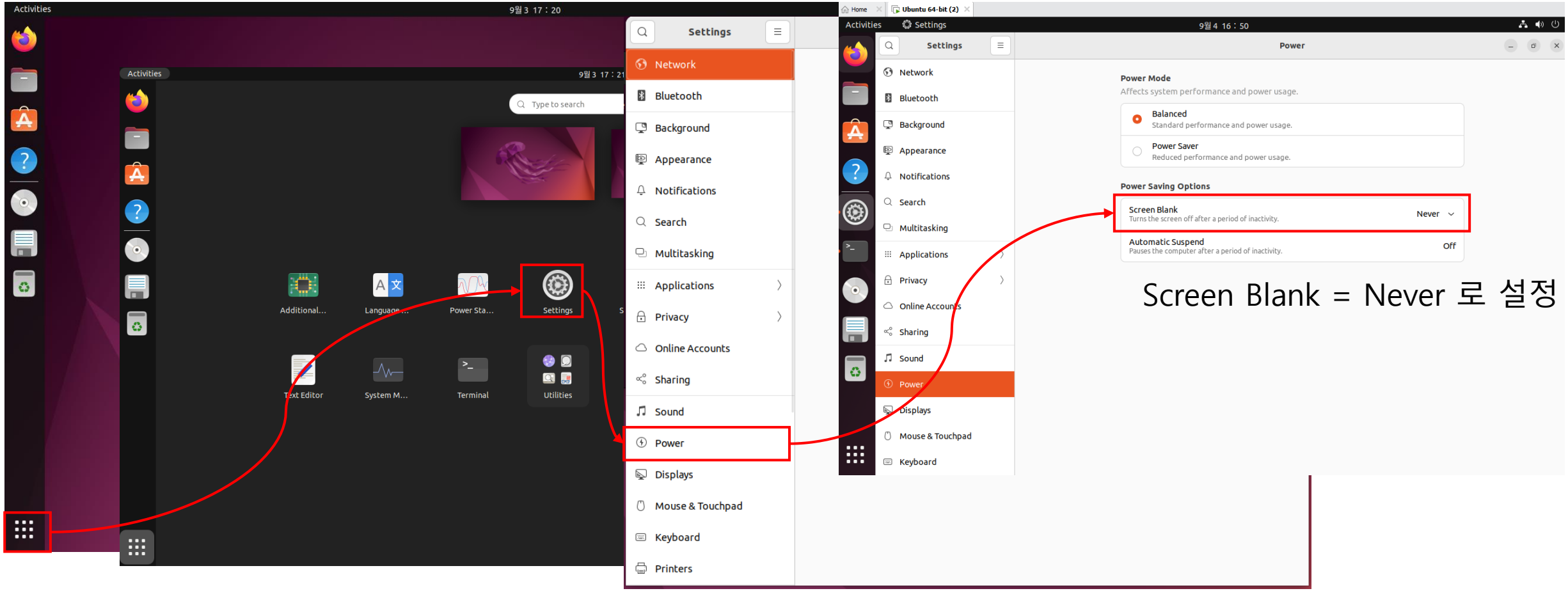
Ubuntu 22.04 Boot-up @ VMware





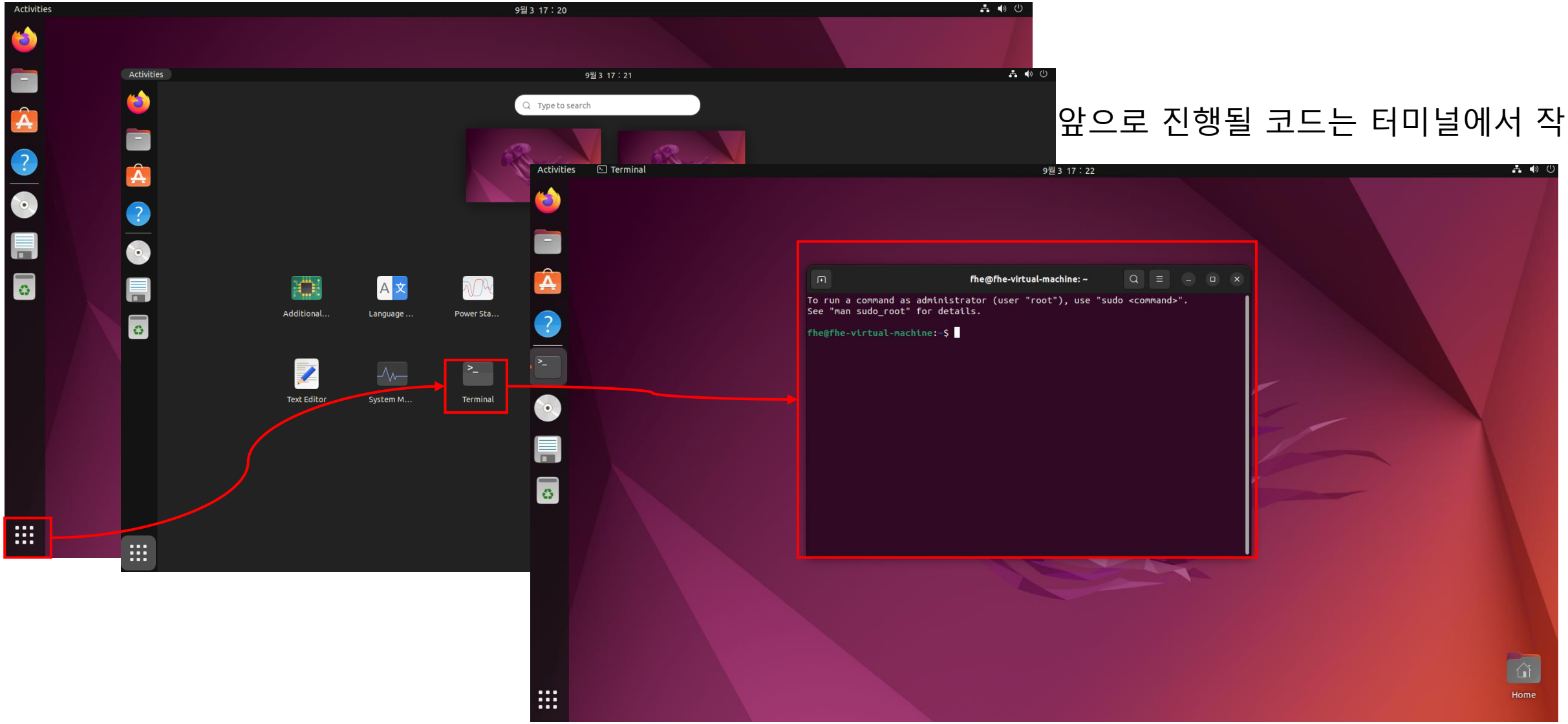
사용자 아이콘 클릭 후 비밀번호 입력

Ubuntu 초기 세팅 @ VMware



Screen Blank = Never 로 설정

Terminal 실행 @ VMware



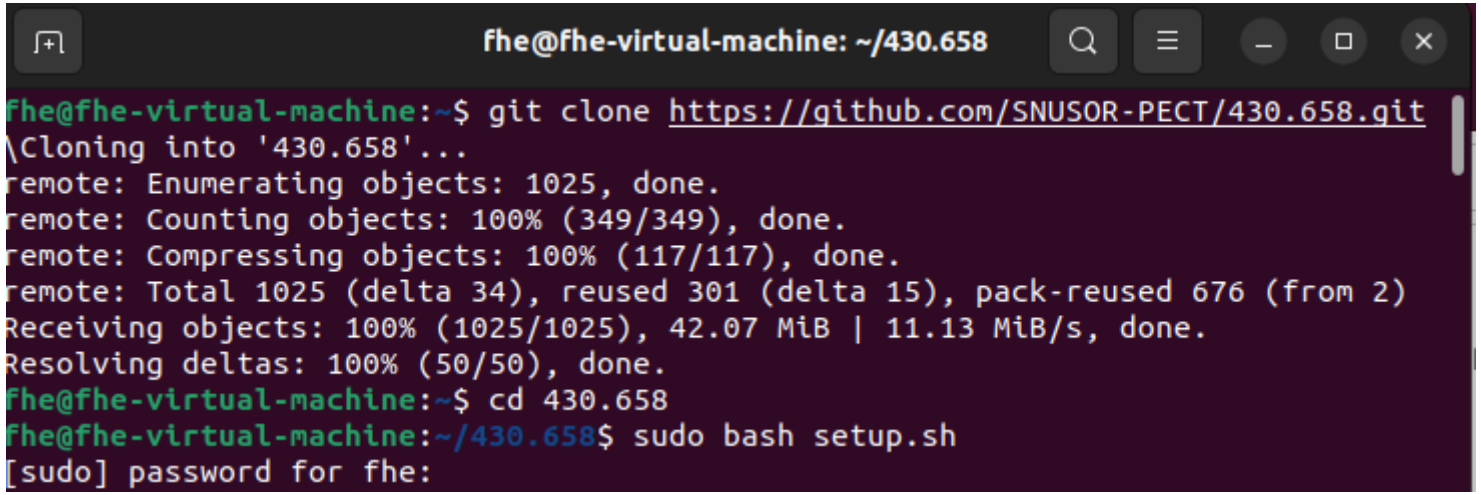
앞으로 진행될 코드는 터미널에서 작성함

Ubuntu 22.04 설치 @ VMware

```
fhe@fhe-virtual-machine:~$ sudo apt install git
[sudo] password for fhe:
```

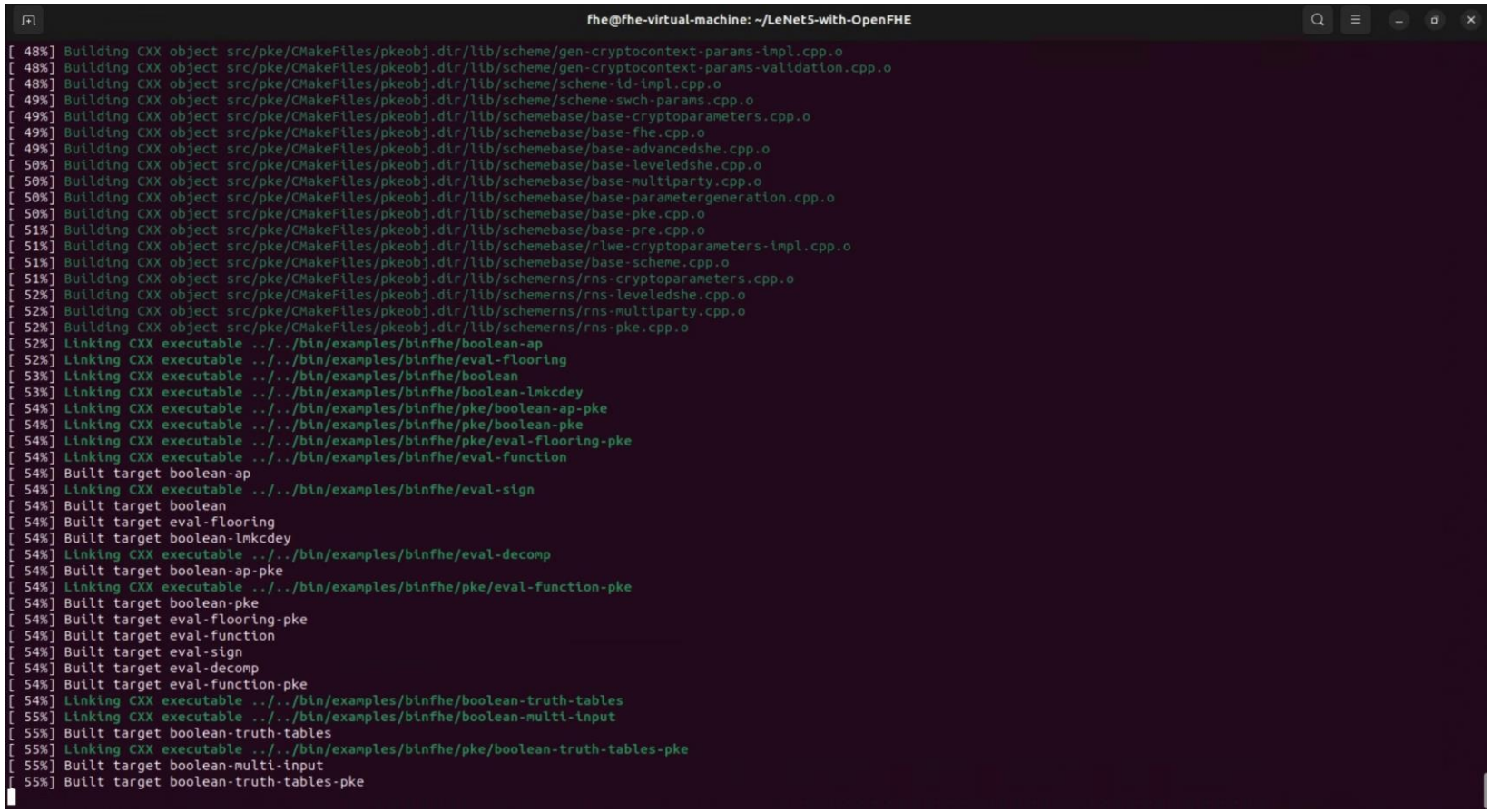
sudo apt install git

비밀번호 입력 후 (가이드를 따라왔다면 fhe)
Do you want to continue?시 Y 입력



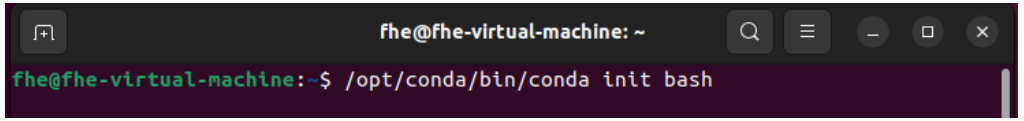
git clone https://github.com/SNUSOR-PECT/430.658.git
cd 430.658
sudo bash setup.sh

Environment Setup @ VMware



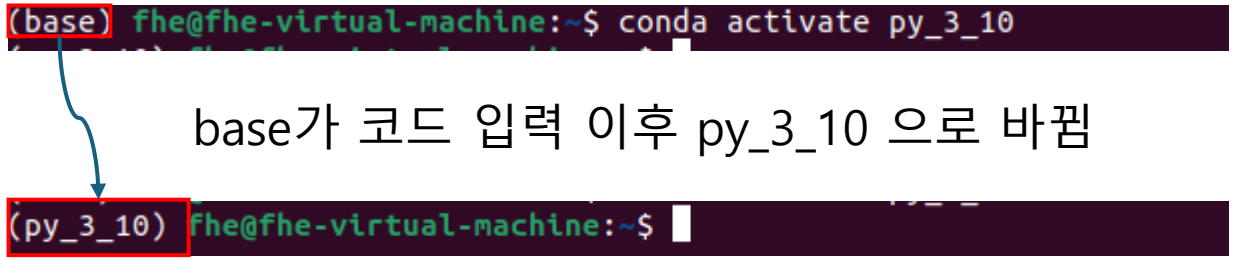
설치과정 진행 중 화면

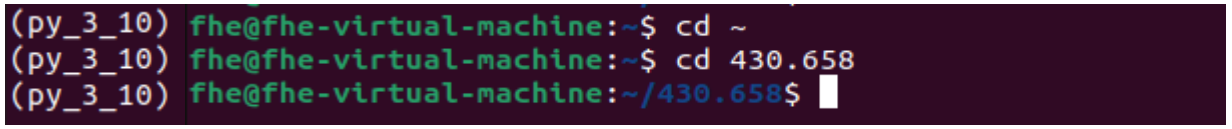
Environment Setup @ VMware



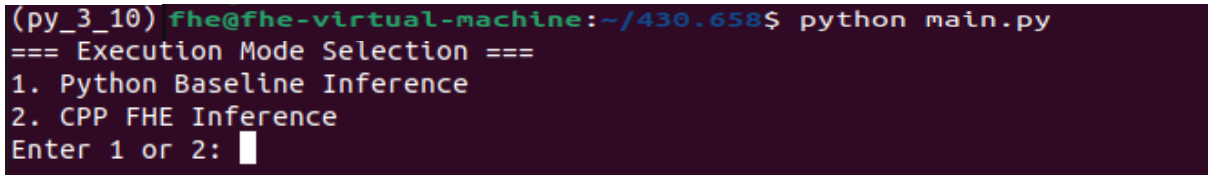
설치 완료 후 /opt/conda/bin/conda init bash 입력후 터미널 종료

새로운 Terminal 창에서 코드 입력 : conda activate py_3_10





cd ~
cd 430.658



python main.py 실행

프로그램 실행

```
(py_3_10) fhe@fhe-virtual-machine:~/430.658$ python main.py
=== Execution Mode Selection ===
1. Python Baseline Inference
2. CPP FHE Inference
Enter 1 or 2:
```

1: Python 기반 코드 실행
2: FHE 기반 코드 실행

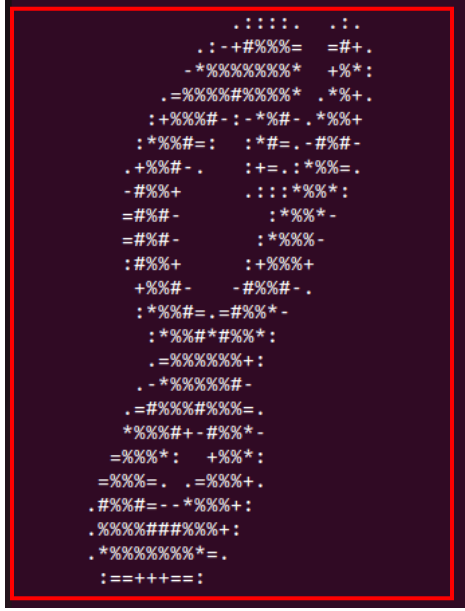
```
Enter 1 or 2: 2
Select Activation function:
 0: linear (x)
 1: square (x^2)
 2: CryptoNet (0.25 + 0.5 * x + 0.125 * x^2)
 3: quad (0.234606 + 0.5 * x + 0.204875 * x^2 - 0.0063896 * x^4)
 4: student (custom polynomial)
```

<ReLU 선택창>
0. f(x) = x
1. f(x) = x^2
2. f(x) = 0.125x^2+0.5x+0.25
3. f(x) = -0.0063896x^4 + 0.204875x^2 + 0.5x + 0.234606
4. f(x) = ?? ← Student's Job

선택 시 단일 추론 실행

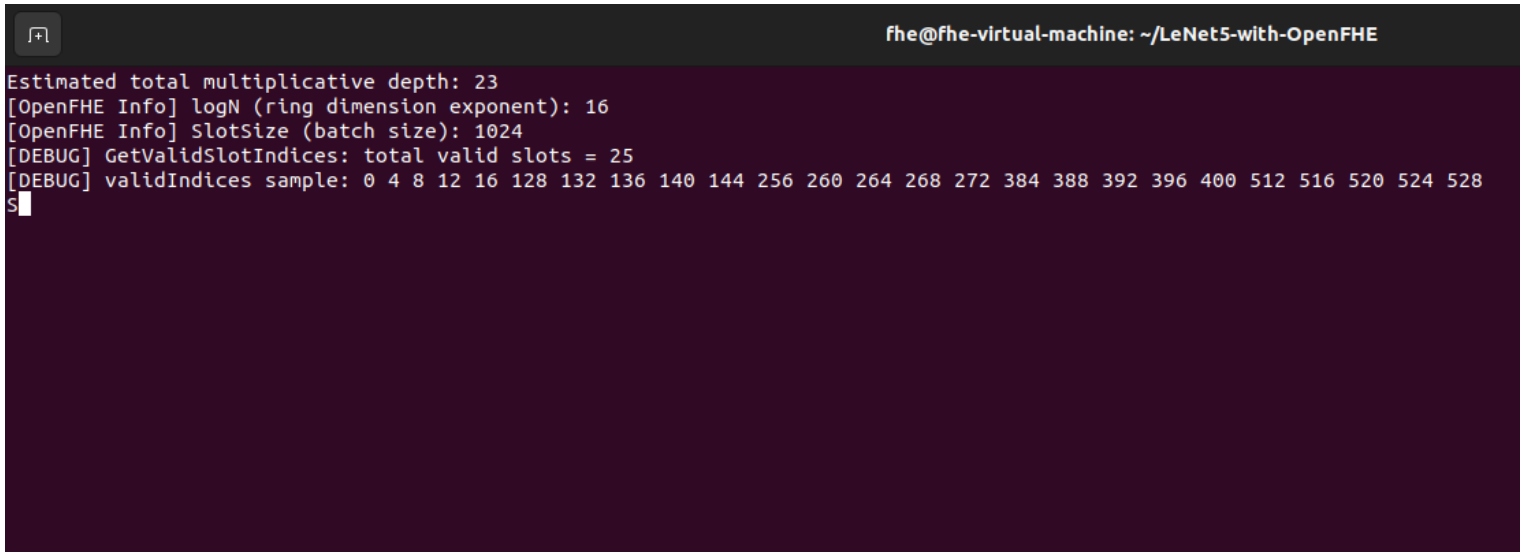
프로그램 실행

```
+-----------------------------------------+
|       Selected Activation Function      |
+-----------------------------------------+
| Name: CryptoNet                         |
| Formula: 0.25 + 0.5 * x + 0.125 * x**2  |
+-----------------------------------------+

Weights and BN parameters loaded from ./pytorch_LeNet5/parameters_standard
[INFO] Generating input image for CPP FHE...
[INFO] Image saved to input_image.txt
[INFO] FC3 output saved to fc3_output.txt
True Label: 8
Predicted Label: 8

Input image:
```

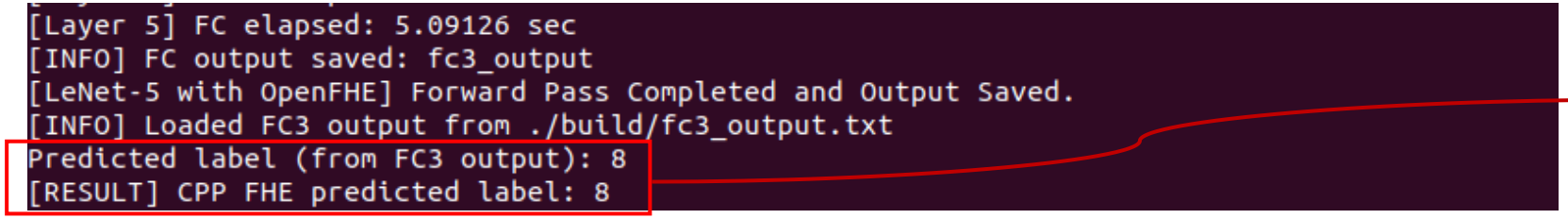


input Image
True Label : 참값
Predicted Label : 선택한 ReLU 사용 추론값

프로그램 실행

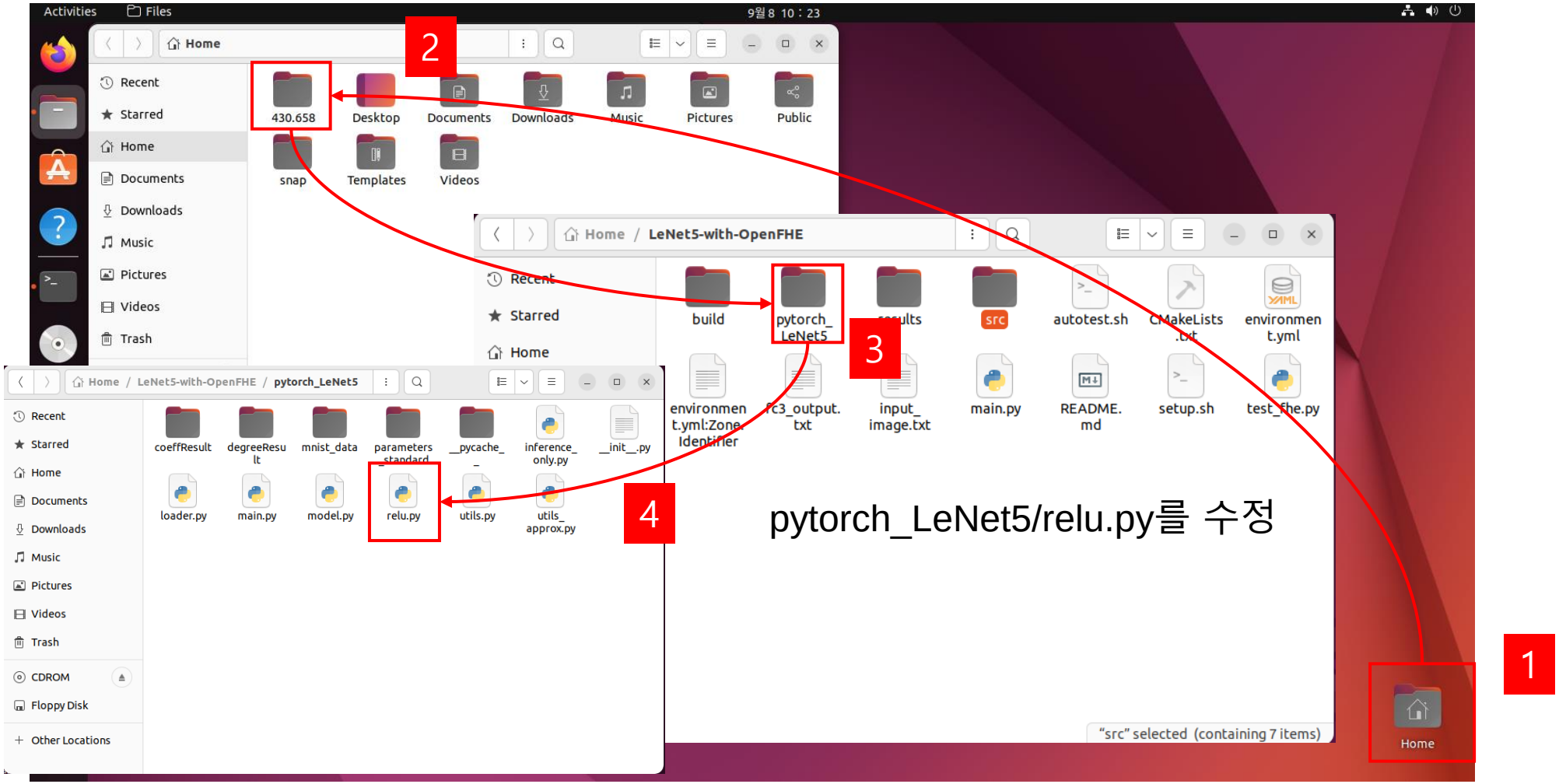


FHE 기반 추론 시작



실행 결과 동일여부 확인

ReLU 수정 방법 - Python



ReLU 수정 방법 - Python

Open | relu.py ~/430.658/pytorch_LeNet5 | Save

```
4 이 파일만 수정해서 새로운 activation을 실험하세요!
5 """
6
7 from .utils_approx import ReLU_maker
8
9 # ------------------------------------------------------------
10 # 학생들이 직접 수정할 수 있는 ReLU 근사 다항식 모음
11 # ------------------------------------------------------------
12 quad_relu_polynomials = {
13     'linear': (lambda x: x, "x"),
14     'square': (lambda x: x ** 2, "x ** 2"),
15     'CryptoNet': (lambda x: 0.125 * x**2 + 0.5 * x + 0.25,
16                   "0.25 + 0.5 * x + 0.125 * x**2"),
17     'quad': (lambda x: 0.234606 + 0.5 * x + 0.204875 * x ** 2 - 0.0063896 * x ** 4,
18              "0.234606 + 0.5 * x + 0.204875 * x ** 2 - 0.0063896 * x ** 4"),
19
20
21     # === 여기에 자신만의 polynomial ReLU를 추가하세요! ==================================
22     # Example
23     # f(x) = x + x^2로 사용하고 싶은 경우 ->  'student': (lambda x: x + x**2, "x + x^2")로 수정
24
25
26
27
28
29     'student': (lambda x: x, "insert your own description")
30
31
32
33
34
35
36
37
38     #=====================================================================
```

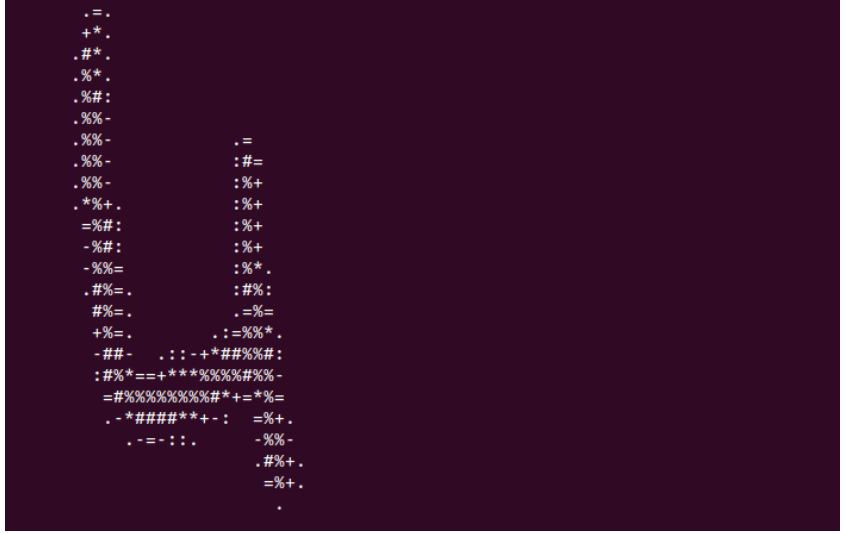
해당 부분을 수정

ReLU 수정 후 실행결과 - Python

```
(py_3_10) fhe@fhe-virtual-machine:~/LeNet5-with-OpenFHE$ python main.py
=== Execution Mode Selection ===
1. Python Baseline Inference
2. CPP FHE Inference
Enter 1 or 2:
```

python main.py 실행
1 입력

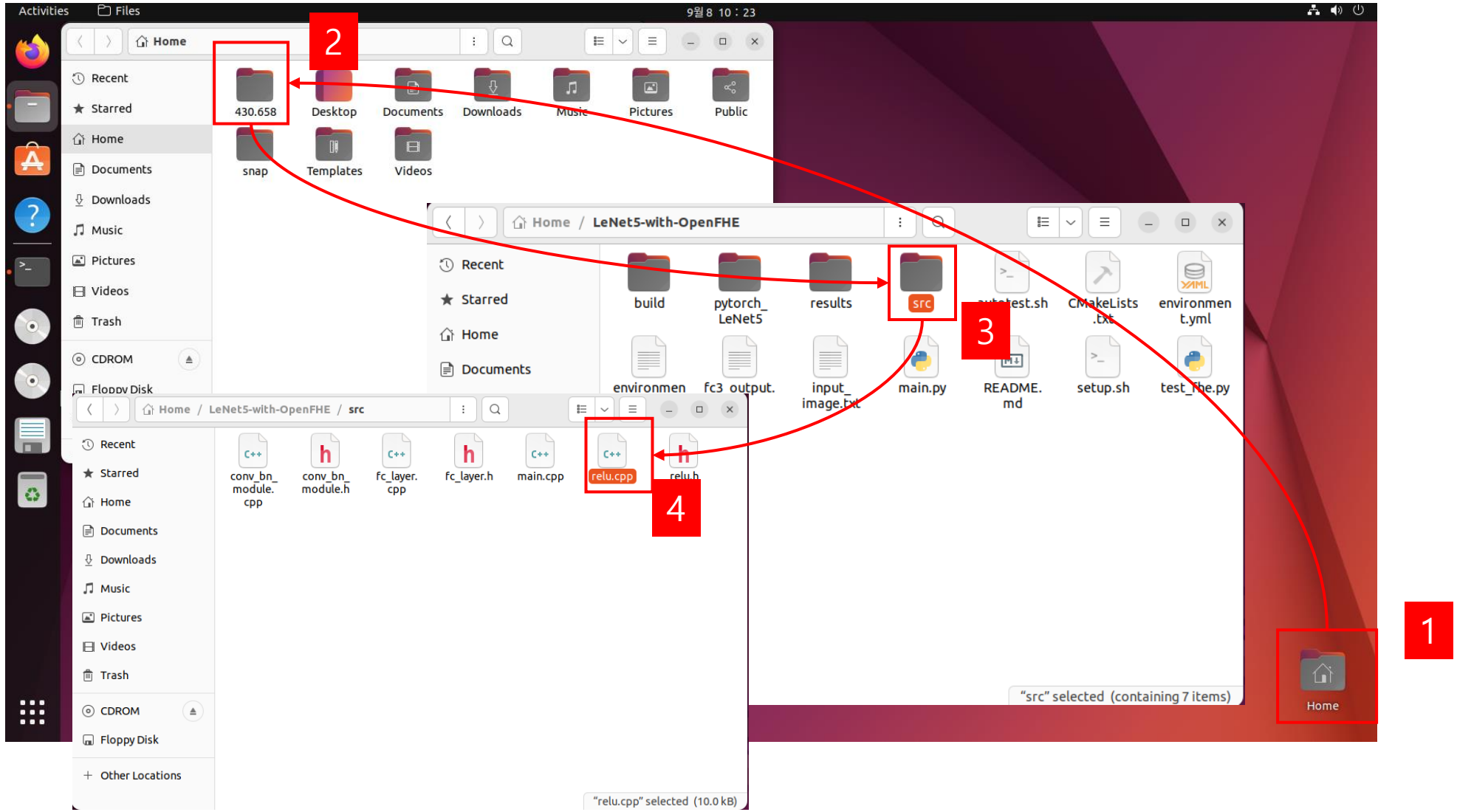
```
+---------------------------------+
|   Selected Activation Function  |
+---------------------------------+
| Name: student                   |
| Formula: x + x^2                |
+---------------------------------+

Weights and BN parameters loaded from ./pytorch_LeNet5/parameters_standard
=== Python Baseline: Single Sample Inference ===
[INFO] Image saved to input_image.txt
[INFO] FC3 output saved to fc3_output.txt
True Label: 4
Predicted Label: 1

Input image:
```



```
=== Python Baseline (F.relu): Full Validation Inference ===
Inference Accuracy: 99.17%

Class-wise Accuracy:
  Class 0: 99.80% (978/980)
  Class 1: 100.00% (1135/1135)
  Class 2: 99.22% (1024/1032)
  Class 3: 99.50% (1005/1010)
  Class 4: 99.59% (978/982)
  Class 5: 98.77% (881/892)
  Class 6: 98.64% (945/958)
  Class 7: 98.83% (1016/1028)
  Class 8: 99.08% (965/974)
  Class 9: 98.12% (990/1009)
[RESULT] Accuracy with F.relu: 99.17%
=== Python Baseline: Full Validation Inference ===
Inference Accuracy: 10.30%

Class-wise Accuracy:
  Class 0: 0.00% (0/980)
  Class 1: 90.04% (1022/1135)
  Class 2: 0.10% (1/1032)
  Class 3: 0.00% (0/1010)
  Class 4: 0.00% (0/982)
  Class 5: 0.00% (0/892)
  Class 6: 0.00% (0/958)
  Class 7: 0.29% (3/1028)
  Class 8: 0.00% (0/974)
  Class 9: 0.40% (4/1009)
[RESULT] Accuracy with acc_custom: 10.30%
=== Accuracy Comparison ===
F.relu: 99.17% vs acc_custom: 10.30%
```

정확도 확인

ReLU 수정 방법 - FHE



ReLU 수정 방법 - FHE

relu.cpp
~/430.658/src

```
78
79      auto result = cc->EvalAdd(sum, pt_const);
80      return result;
81  }
82
83  Ciphertext<DCRTPoly> ApproxReLU4_Student(CryptoContext<DCRTPoly> cc, const
    Ciphertext<DCRTPoly>& ct_x) {
84      // size_t slotCount = cc->GetEncodingParams()->GetBatchSize();
85
86      //=========================FROM HERE=======================================================
87      // Insert your own approximation below
88
89
90
91
92
93
94
95      auto result = ct_x; // modify this when implementing your own code
96
97
98
99
100
101
102
103     // Insert your own approximation above
104     //=========================TO END=========================================================
105
106
107     return result;
108 }
```

해당 부분을 수정

ReLU 수정 이후 재실행

```
(py_3_10) fhe@fhe-virtual-machine:~/430.658$ python main.py
=== Execution Mode Selection ===
1. Python Baseline Inference
2. CPP FHE Inference
Enter 1 or 2:
```

1: Python 기반 코드 실행
2: FHE 기반 코드 실행

```
Enter 1 or 2: 2
Select Activation function:
 0: linear (x)
 1: square (x^2)
 2: CryptoNet (0.25 + 0.5 * x + 0.125 * x^2)
 3: quad (0.234606 + 0.5 * x + 0.204875 * x^2 - 0.0063896 * x^4)
 4: student (custom polynomial)
```

<ReLU 선택창>
0. f(x) = x
1. f(x) = x^2
2. f(x) = 0.125x^2+0.5x+0.25
3. f(x) = -0.0063896x^4 + 0.204875x^2 + 0.5x + 0.234606
4. f(x) = ?? ← Student's Job

선택 시 단일 추론 실행