# LAPORAN EKSEKUSI BUBBLE SORT DENGAN OPEN MPI PADA UBUNTU DESKTOP

Disusun untuk memenuhi tugas Mata Kuliah Pemrosesan Paralel


Disusun Oleh :

| | |
|---|---|
| Diki Riskiyanto | (09011282227111) |
| Syafaat Muhammad Bahril Huda | (09011282227075) |
| M. Nauval Perdana | (09011282227060) |
| Fakhri Naufal Dhaifullah | (09011282227108) |

Dosen Pengampu :

**Adi Hermansyah, S.Kom., M.T.**

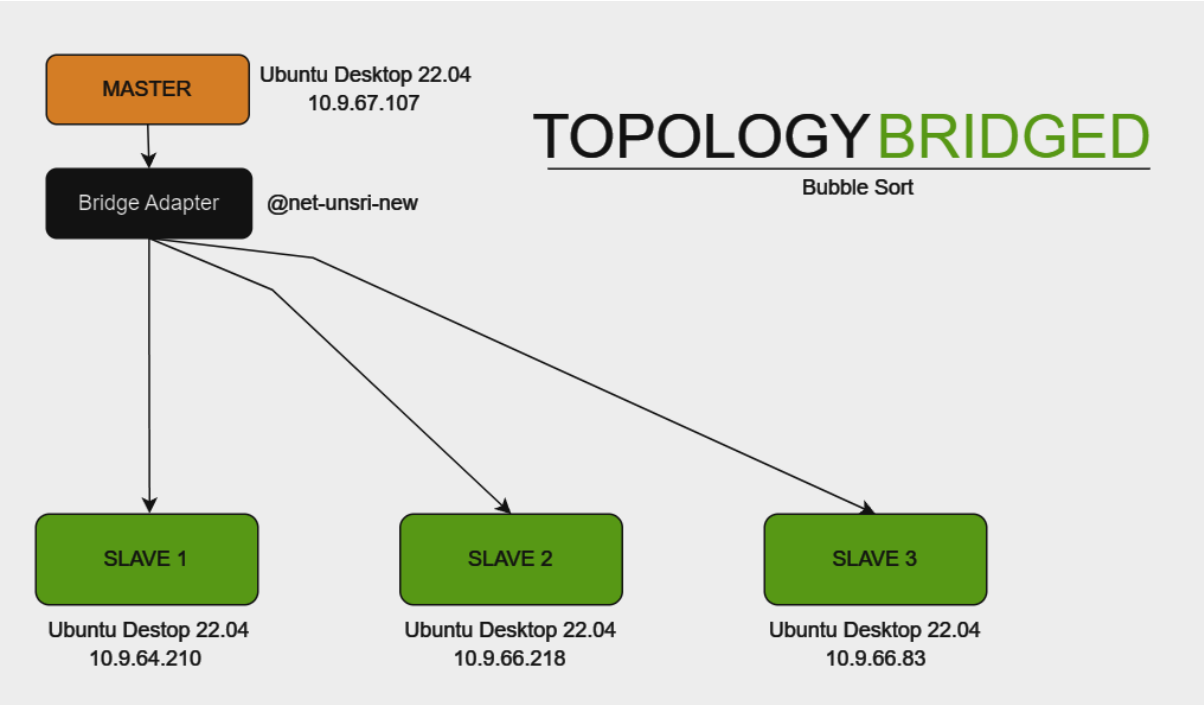
**PROGRAM STUDI SISTEM KOMPUTER**
**FAKULTAS ILMU KOMPUTER**
**UNIVERSITAS SRIWIJAYA**

**2023**

## DEVICE DAN TOOLS YANG PERLU DISIAPKAN

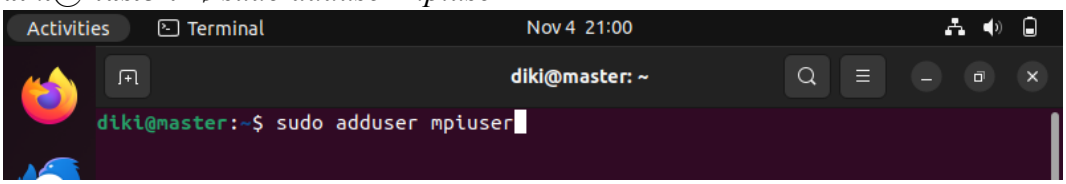
1. Ubuntu Desktop
   - Ubuntu Desktop Master
   - Ubuntu Desktop Slave 1
   - Ubuntu Desktop Slave 2
   - Ubuntu Desktop Slave 3
2. MPI (Master dan Slave)
3. SSH (Master dan Slave)
4. NFS (Master dan Slave)
5. Kodingan Bubble Sort Python

## TOPOLOGI BRIDGED



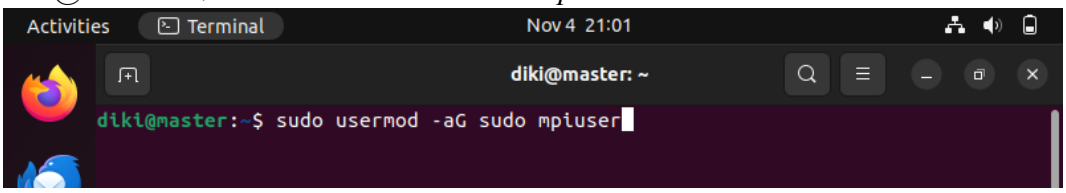

## PEMBUATAN MASTER DAN SLAVE

1. Sebelum menginstal pastikan master dan setiap slave menggunakan Network Bridge Adapter, dan menggunakan internet yang sama
2. Tentukanlah device mana yang sebagai master, slave1, slave2, slave3
3. Pertama, buatlah user baru dengan perintah dibawah ini
   ***diki@master:~$*** *sudo adduser mpiuser*



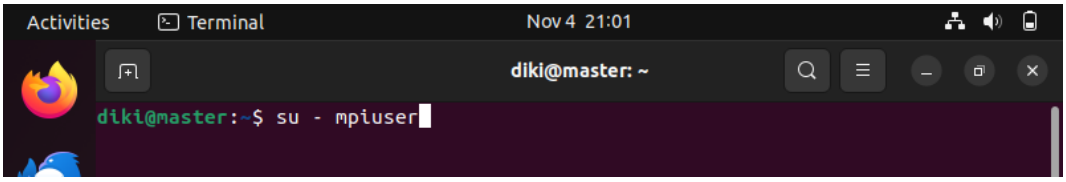

Untuk dislave perintahnya sama, ganti bagian master menjadi slave1, slave2, dst.

4. Kemudian berikan akses kepada root dengan perintah dibawah ini
***diki@master:~$*** *sudo usermod -aG sudo mpiuser*



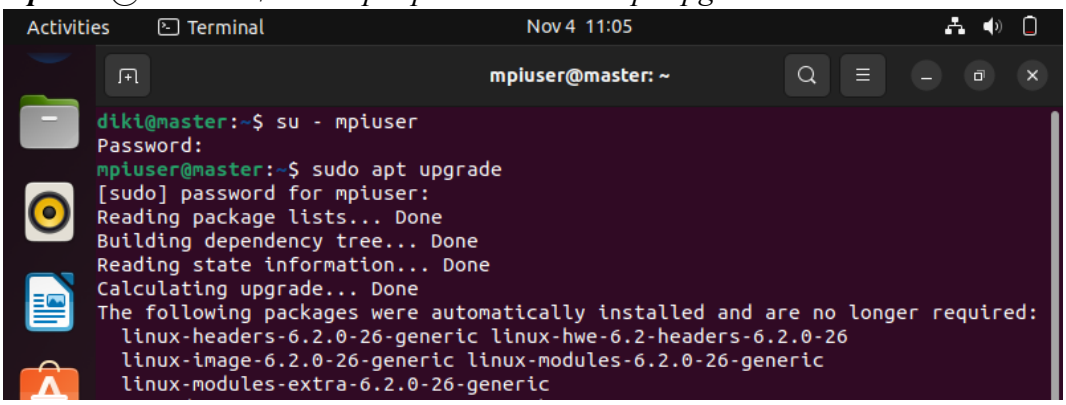

Lakukanlah perintah diatas disemua slave dengan merubah user master menjadi slave1, slave2, dst

5. Masuklah ke server dengan user dibawah ini dengan perintah berikut
***diki@master:~$*** *su – mpiuser*

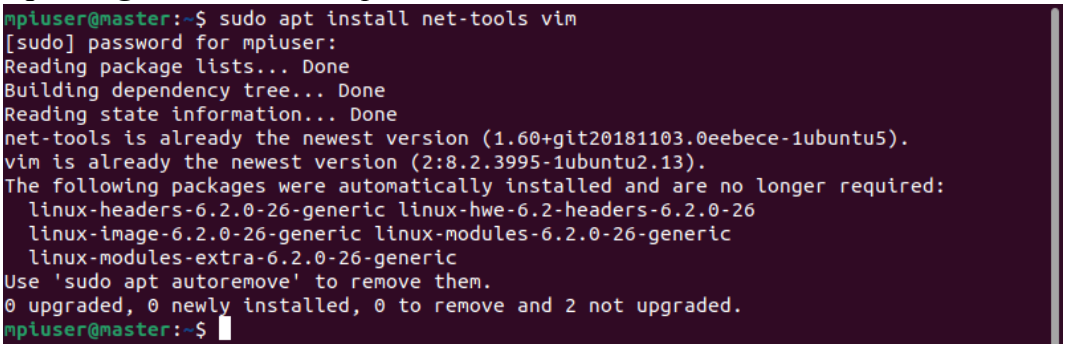



Menjadi ***mpiuser@master:~$***

6. Langkah selanjutnya update ubuntu desktop dengan perintah berikut, lalu install tools untuk mengecek Ip, vim editor teks
***mpiuser@master:~$*** *sudo apt update && sudo apt upgrade*

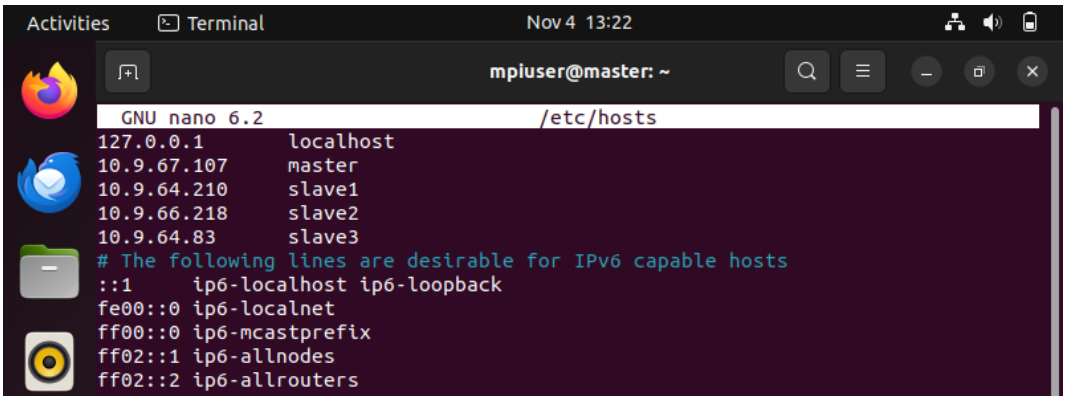



Selanjutnya install tools dengan perintah dibawah ini
***mpiuser@master:~$*** *sudo apt install net-tools vim*

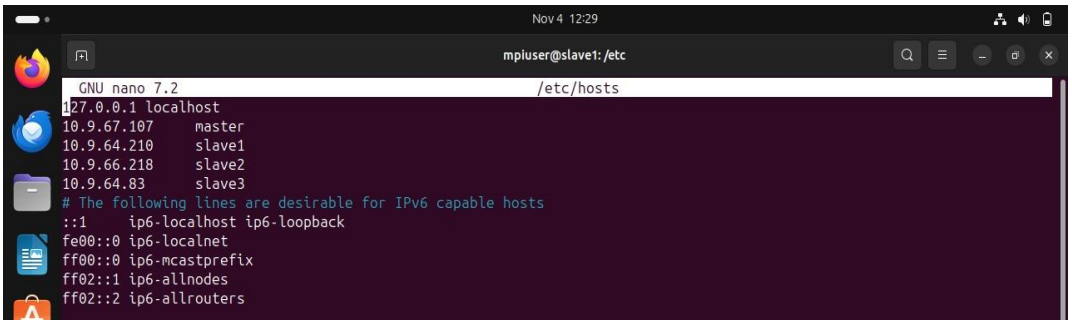


7. Selanjutnya konfigurasi file pada master, slave1, slave2, dan slave3
   ***mpiuser@master:~$*** *sudo nano /etc/hosts*

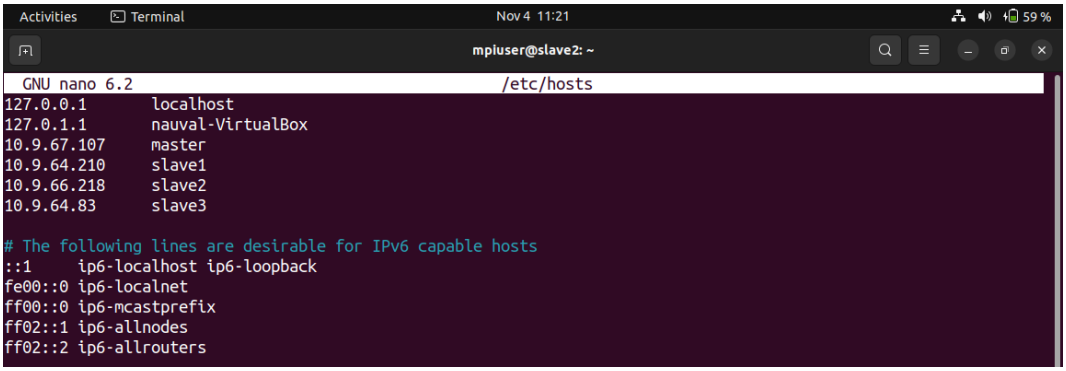
***MASTER***



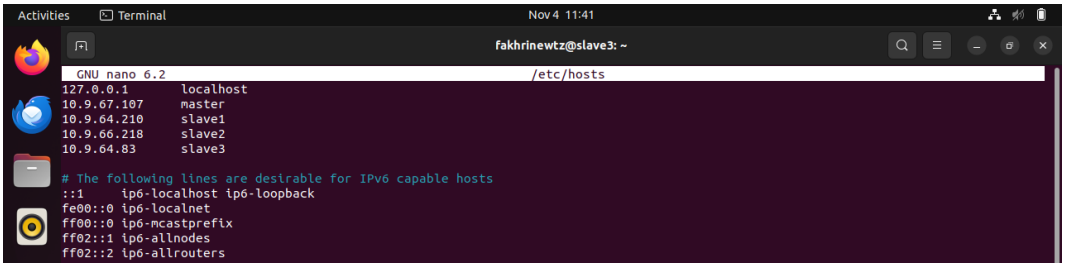

***SLAVE 1***




***SLAVE 2***




***SLAVE 3***




Daftarkan IP Master dan Slave berserta hostname masing masing komputer

## KONFIGURASI SSH

1. Langkah berikutnya kita akan konfigurasi SSH, pertama kita install SSH. Lakukan pada master dan semua slave
   ***mpiuser@master:~$*** *sudo apt install openssh-server*

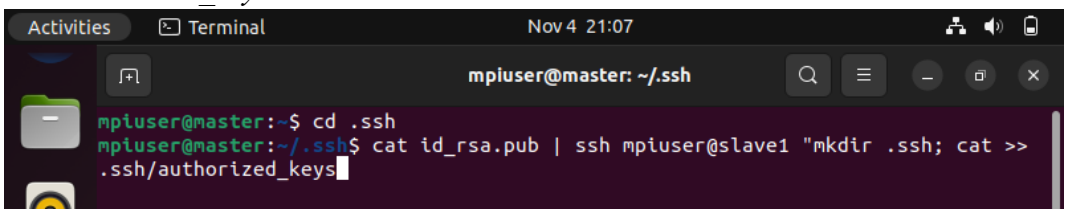
```
mpiuser@master:~$ sudo apt install openssh-server
[sudo] password for mpiuser:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).
The following packages were automatically installed and are no longer required:
  linux-headers-6.2.0-26-generic linux-hwe-6.2-headers-6.2.0-26
  linux-image-6.2.0-26-generic linux-modules-6.2.0-26-generic
  linux-modules-extra-6.2.0-26-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.
mpiuser@master:~$
```

   Pastikan semua slave mengintall OpenSSH server sampai selesai dan berhasil

2. Generate key lakukan pada master saja dengan perintah berikut
   ***mpiuser@master:~$*** *ssh-keygen -t rsa*

```
mpiuser@master:~$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/mpiuser/.ssh/id_rsa):
/home/mpiuser/.ssh/id_rsa already exists.
Overwrite (y/n)?
mpiuser@master:~$
```

3. Copy key public ke slave (Lakukan di Master), ketikkan perintah berikut pada direktori ".ssh"
   ***mpiuser@master:~$*** *cd .ssh*
   ***mpiuser@master:~/.ssh$*** *cat id_rsa.pub | ssh mpiuser@slave1 "mkdir .ssh; cat >> .ssh/authorized_keys"*




   Lakukan perintah diatas berulang kali sebanyak slave, untuk pengecekan file authorized_keys di slave, yang terletak di folder .ssh

## KONFIGURASI NFS

1. Buatlah shared folder, lakukanlah dimaster dan per slave
   ***mpiuser@master:~$*** *mkdir bubble*

```
File  Edit  View  Search  Terminal  Help
mpiuser@master:~$ mkdir bubblee
mpiuser@master:~$
```

2. Selanjutnya install NFS untuk master
   ***mpiuser@master:~$*** *sudo apt install nfs-kernel-server*

```
File  Edit  View  Search  Terminal  Help
mpiuser@master:~$ sudo apt install nfs-kernel-server
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
nfs-kernel-server is already the newest version (1:2.6.1-1ubuntu1.2).
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.
mpiuser@master:~$
```

3. Lakukan konfigurasi file pada master, masuk ke file export dengan perintah
   ***mpiuser@master:~$*** *sudo vim /etc/export*

```
File  Edit  View  Search  Terminal  Help
mpiuser@master:~$ sudo vim /etc/exports
```

   Konfigurasi file tambahkan commend ini pada baris berikut, ketikkan pada baris terakhir.
   *<lokasi shared folder> *(rw,sync,no_root_squash,no_subtree_check)*

```
File  Edit  View  Search  Terminal  Help
# /etc/exports: the access control list for filesystems which may be exported
#               to NFS clients.  See exports(5).
#
# Example for NFSv2 and NFSv3:
# /srv/homes       hostname1(rw,sync,no_subtree_check) hostname2(ro,sync,no_subtree_che
ck)
#
# Example for NFSv4:
# /srv/nfs4        gss/krb5i(rw,sync,fsid=0,crossmnt,no_subtree_check)
# /srv/nfs4/homes  gss/krb5i(rw,sync,no_subtree_check)
#
/home/mpiuser/bubble *(rw,sync,no_root_squash,no_subtree_check)
~
~
~
```

   Lokasi Shared Folder merupakan tempat direktori membuat file diatas tadi

4. Kemudian ketikkan perintah berikut ini, untuk memulai kembali atau merestart NFS Server
   ***mpiuser@master:~$*** *sudo exportfs -a*
   ***mpiuser@master:~$*** *sudo systemctl restart nfs-kernel-server*

```
File  Edit  View  Search  Terminal  Help
mpiuser@master:~$ sudo exportfs -a
mpiuser@master:~$ sudo systemctl restart nfs-kernel-server
mpiuser@master:~$
```

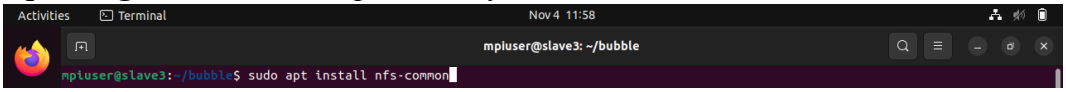
5. Selanjutnya install NFS untuk slave
   ***mpiuser@slave1:~$*** *sudo apt install nfs-common*

```
mpiuser@slave1:~$ sudo apt install nfs-common
[sudo] password for mpiuser:
```

   ***mpiuser@slave2:~$*** *sudo apt install nfs-common*

```
mpiuser@slave2:~$ sudo apt install nfs-common
```

   ***mpiuser@slave3:~$*** *sudo apt install nfs-common*



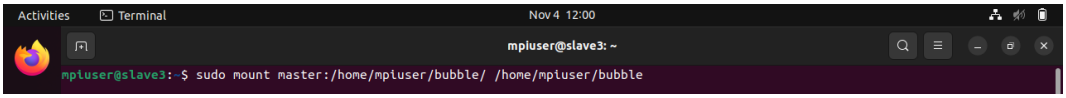
6. Kemudian Mounting, lakukanlah pada semua slave
   ***mpiuser@slave1:~$*** *sudo mount master:/home/mpiuser/bubble /home/mpiuser/bubble*

```
mpiuser@slave1:~$ sudo mount master:/home/mpiuser/bubble
```

   ***mpiuser@slave2:~$*** *sudo mount master:/home/mpiuser/bubble /home/mpiuser/bubble*

```
mpiuser@slave2:~$ sudo mount master:/home/mpiuser/bubble /home/mpiuser/bubble
```

   ***mpiuser@slave3:~$*** *sudo mount master:/home/mpiuser/bubble /home/mpiuser/bubble*




## INSTALASI MPI

1. Instalasi MPI, lakukan pada master dan semua slave
   ***mpiuser@master:~$*** *sudo apt install openmpi-bin libopenmpi-dev*

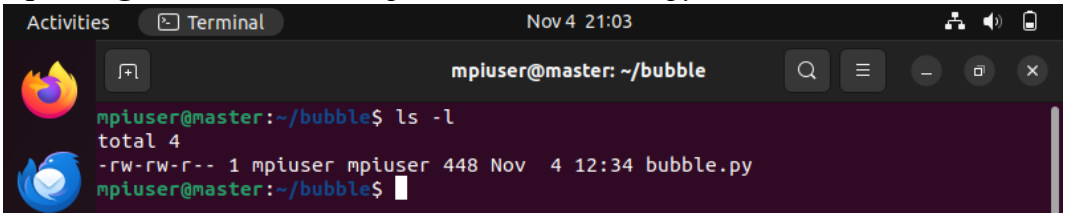
```
File  Edit  View  Search  Terminal  Help
mpiuser@master:~$ sudo apt install openmpi-bin libopenmpi-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
libopenmpi-dev is already the newest version (4.1.2-2ubuntu1).
openmpi-bin is already the newest version (4.1.2-2ubuntu1).
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.
mpiuser@master:~$
```

2. Selanjutnya install library untuk MPI melalui pip
   ***mpiuser@master:~$*** sudo apt install python3-pip
   ***mpiuser@master:~$*** pip install mpi4py

```
File  Edit  View  Search  Terminal  Help
mpiuser@master:~$ sudo apt install python3-pip
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3-pip is already the newest version (22.0.2+dfsg-1ubuntu0.3).
0 upgraded, 0 newly installed, 0 to remove and 2 not upgraded.
mpiuser@master:~$ pip install mpi4py
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: mpi4py in ./.local/lib/python3.10/site-packages (3.1.5)
mpiuser@master:~$
```

## RUNNING KONDINGAN PYTHON

1. Buatlah sebuah file python baru dengan cara masukkan perintah dibawah ini
   ***mpiuser@master:~$*** *touch /mpiuser/bubble/bubble.py*



2. Selanjutnya masuk ke direktori tersebut lalu edit file python dan buatlah sebuah kodingan bubble sort python
***mpiuser@master:~$*** *cd bubble*
***mpiuser@master:~/bubble$*** *nano bubble.py*

```
File  Edit  View  Search  Terminal  Help
mpiuser@master:~/bubble$ cd
mpiuser@master:~$ cd bubble
mpiuser@master:~/bubble$ nano bubble.py
mpiuser@master:~/bubble$
```

Lalu buatlah kodingan bubble sort (Jangan lupa disave “CTRL + X”)

```
  GNU nano 6.2                                  bubble.py
from mpi4py import MPI

def parallel_bubble_sort(arr):
    comm = MPI.COMM_WORLD
    rank = comm.Get_rank()
    size = comm.Get_size()

    local_arr = arr[rank::size]

    for i in range(len(local_arr)):
        for j in range(0, len(local_arr) - i - 1):
            if local_arr[j] > local_arr[j + 1]:
                local_arr[j], local_arr[j + 1] = local_arr[j + 1], local_arr[j]

    sorted_arr = comm.gather(local_arr, root=0)

    if rank == 0:
        combined_arr = [item for sublist in sorted_arr for item in sublist]
        combined_arr.sort()
        for i in range(len(arr)):
            arr[i] = combined_arr[i]

if __name__ == '__main__':
    comm = MPI.COMM_WORLD
    rank = comm.Get_rank()

    if rank == 0:
        arr = [5, 3, 4, 1, 2]
    else:
        arr = None

    arr = comm.bcast(arr, root=0)  # Broadcast the arr from rank 0 to all nodes

    comm.barrier()

    parallel_bubble_sort(arr)

    if rank == 0:
        print(f"List sorted with bubble sort in ascending order: {arr}")



^G Help        ^O Write Out   ^W Where Is   ^K Cut         ^T Execute     ^C Location    M-U Undo       M-A Set Mark   M-] To Bracket  M-Q Previous
^X Exit        ^R Read File   ^\ Replace    ^U Paste       ^J Justify     ^/ Go To Line  M-E Redo       M-6 Copy       ^Q Where Was    M-W Next
```

3. Jalankan kodingan tersebut pada master
***mpiuser@master:~/bubble$*** *mpirun -np 4 -host master,slave1,slave2,slave3 python3 bubble.py*

```
mpiuser@master:~/bubble$ mpirun -np 4 -host master,slave1,slave2,slave3 python3
 bubble.py
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
List sorted with bubble sort in ascending order:  [1, 2, 3, 4, 5]
```

Jika sudah keluar output seperti ini sudah berhasil, mengeluarkan output disemua master dan slave, outputnya menjadi 4 yaitu output dari master, slave1, slave2, slave3. Jadi yang kami urutkan disini berupa array : [5, 3, 4, 1, 2]  diurutkan menjadi [1, 2, 3, 4, 5].