

PEMROSESAN PARALEL
” CREATING AN MPI CLUSTER”



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Langkah-langkah Membuat Cluster MPI

▪ Sebelum Membuat Cluster MPI

1. Pastikan sudah dalam satu jaringan yang sama untuk setiap (Master, Worker, Worker1 dan Worker2)
2. Melakukan upgrade OS

```
$ sudo apt update && sudo apt upgrade
```

```
rahayu@worker2:~$ sudo apt update && sudo apt upgrade
[sudo] katasandi untuk rahayu:
Abai:1 http://packages.linuxmint.com vanessa InRelease
Ada:2 http://archive.ubuntu.com/ubuntu jammy InRelease
Ada:3 http://ppa.launchpad.net/deadsnakes/ppa/ubuntu jammy InRelease
Und:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Ada:5 http://packages.linuxmint.com vanessa Release
Abai:6 http://live.linuxmint.com vanessa InRelease
Und:7 http://archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Ada:8 http://live.linuxmint.com vanessa Release
Und:11 http://security.ubuntu.com/ubuntu jammy-security/main amd64 DEP-11 Metadata [42,9 kB]
Und:12 http://security.ubuntu.com/ubuntu jammy-security/universe amd64 DEP-11 Metadata [55,0 kB]
Und:13 http://archive.ubuntu.com/ubuntu jammy-backports InRelease [109 kB]
Und:14 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 DEP-11 Metadata [101 kB]
Und:15 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 DEP-11 Metadata [305 kB]
Und:16 http://archive.ubuntu.com/ubuntu jammy-updates/multiverse amd64 DEP-11 Metadata [940 B]
Und:17 http://archive.ubuntu.com/ubuntu jammy-backports/main amd64 DEP-11 Metadata [4.900 B]
Und:18 http://archive.ubuntu.com/ubuntu jammy-backports/universe amd64 DEP-11 Metadata [18,9 kB]
Mengambil 866 kB dalam waktu 17s (51,3 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Semua paket mutakhir.
W: http://ppa.launchpad.net/deadsnakes/ppa/ubuntu/dists/jammy/InRelease: Key is stored in legacy t
rusted.gpg keyring (/etc/apt/trusted.gpg), see the DEPRECATION section in apt-key(8) for details.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
Paket-paket berikut dipasang secara otomatis dan tak diperlukan lagi:
```

```
dew@worker3:~$ sudo apt update && sudo apt upgrade
[sudo] password for dew:
Get:1 http://deb.debian.org/debian unstable InRelease [198 kB]
Ign:2 http://packages.linuxmint.com vanessa InRelease
Err:1 http://deb.debian.org/debian unstable InRelease
  The following signatures couldn't be verified because the public key is not available: NO_PUBK
  0E98404D386FA1D9 NO_PUBKEY 6ED0E7B82643E131
Hit:3 http://archive.ubuntu.com/ubuntu jammy InRelease
Get:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Hit:5 http://packages.linuxmint.com vanessa Release
Get:6 http://archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Hit:8 http://archive.ubuntu.com/ubuntu jammy-backports InRelease
Reading package lists... Done
```

3. Melakukan penginstalan berikut: net-tools untuk ngecek IP, vim untuk teks editor.

```
$ sudo apt install net-tools vim
```

```
rahayu@worker2:~$ sudo apt net-tools vim
apt
Usage: apt command [options]
       apt help command [options]

Commands:
  add-repository - Add entries to apt sources.list
  autoclean      - Erase old downloaded archive files
  autopurge      - Remove packages with their configuration files and automatically remove all u
nused packages
  autoremove     - Remove automatically all unused packages
  build          - Build binary or source packages from sources
  build-dep      - Configure build-dependencies for source packages
  changelog      - View a package's changelog
  check          - Verify that there are no broken dependencies
  clean          - Erase downloaded archive files
  contains       - List packages containing a file
  content        - List files contained in a package
  deb            - Install a .deb package
  depends        - Show raw dependency information for a package
  dist-upgrade   - Upgrade the system by removing/installing/upgrading packages
  download       - Download the .deb file for a package
  edit-sources   - Edit /etc/apt/sources.list with your preferred text editor
  dselect-upgrade - Follow dselect selections
  full-upgrade   - Same as 'dist-upgrade'
  held           - List all held packages
  help           - Show help for a command
  hold           - Hold a package

dew@worker3:~$ sudo apt net-tools vim
apt
Usage: apt command [options]
       apt help command [options]

Commands:
  add-repository - Add entries to apt sources.list
  autoclean      - Erase old downloaded archive files
  autopurge      - Remove packages with their configuration files and automatically remove al
nused packages
  autoremove     - Remove automatically all unused packages
  build          - Build binary or source packages from sources
  build-dep      - Configure build-dependencies for source packages
  changelog      - View a package's changelog
  check          - Verify that there are no broken dependencies
  clean          - Erase downloaded archive files
  contains       - List packages containing a file
  content        - List files contained in a package
  deb            - Install a .deb package
  depends        - Show raw dependency information for a package
  dist-upgrade   - Upgrade the system by removing/installing/upgrading packages
  download       - Download the .deb file for a package
  edit-sources   - Edit /etc/apt/sources.list with your preferred text editor
  dselect-upgrade - Follow dselect selections
  full-upgrade   - Same as 'dist-upgrade'
  held           - List all held packages
  help           - Show help for a command
  hold           - Hold a package
  install        - Install/upgrade packages
  list           - List packages based on package names
```

4. Melakukan pengecekan IP dengan perintah berikut:

\$ Ifconfig

NAMA	Master	Worker	Worker2	Worker3
IP	172.20.10.13	172.20.10.12	172.20.10.10	172.20.10.14

▪ Steps to Create an MPI Cluster

1. Konfigurasi hosts file /etc/hosts

- Pada master

```
kiput@master: ~  
GNU nano 6.2 /etc/hosts *  
172.20.10.13 master  
172.20.10.12 worker  
172.20.10.10 worker2  
172.20.10.14 worker3  
  
# The following lines are desirable for IPv6 capable hosts  
::1 ip6-localhost ip6-loopback  
fe00::0 ip6-localnet  
ff00::0 ip6-mcastprefix  
ff02::1 ip6-allnodes  
ff02::2 ip6-allrouters
```

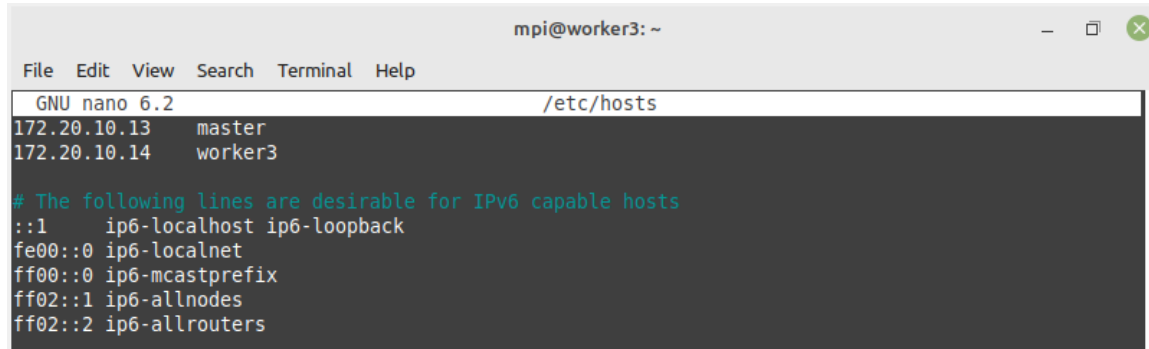
- Pada worker

```
GNU nano 6.2 /etc/hosts  
192.168.69.245 master  
192.168.69.216 worker  
  
# The following lines are desirable for IPv6 capable hosts  
::1 ip6-localhost ip6-loopback  
fe00::0 ip6-localnet  
ff00::0 ip6-mcastprefix  
ff02::1 ip6-allnodes  
ff02::2 ip6-allrouters
```

- Pada worker2

```
rahayu@worker2: ~  
Berkas Edit Tampilan Cari Terminal Bantuan  
GNU nano 6.2 /etc/hosts  
172.20.10.13 master  
172.20.10.10 worker2  
  
# The following lines are desirable for IPv6 capable hosts  
::1 ip6-localhost ip6-loopback  
fe00::0 ip6-localnet  
ff00::0 ip6-mcastprefix  
ff02::1 ip6-allnodes  
ff02::2 ip6-allrouters
```

- Pada worker3



```

mpi@worker3: ~
File Edit View Search Terminal Help
GNU nano 6.2 /etc/hosts
172.20.10.13 master
172.20.10.14 worker3

# The following lines are desirable for IPv6 capable hosts
::1 ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters

```

▪ Step 2: Create a new user

Buat user baru di **SERVER** dan **CLIENT**. Nama user harus sama semua di seluruh komputer.

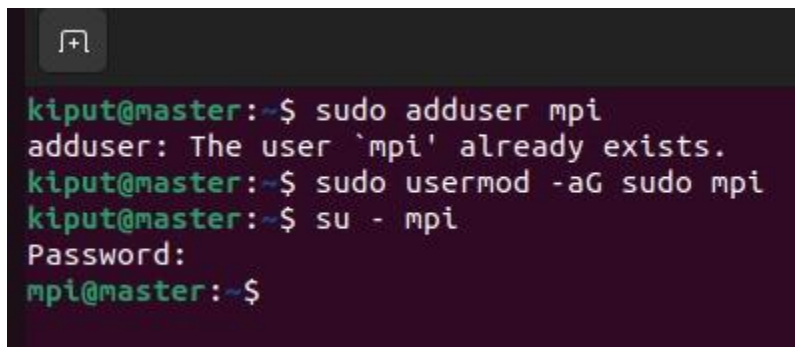
```

$ sudo adduser <nama user>
$ sudo usermod -aG sudo <nama user>
$ su - <nama user>

```

Server

- Master



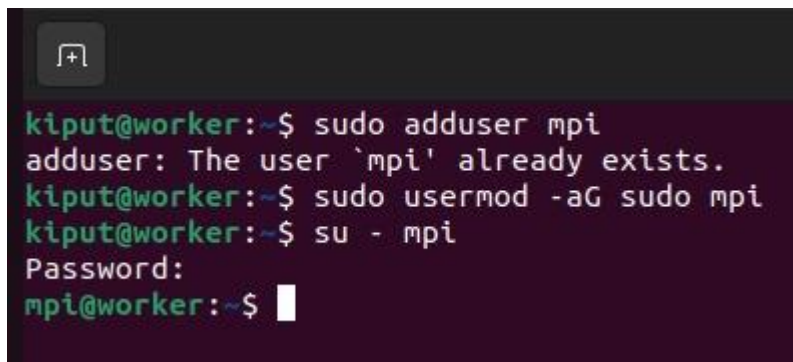
```

kiput@master:~$ sudo adduser mpi
adduser: The user `mpi' already exists.
kiput@master:~$ sudo usermod -aG sudo mpi
kiput@master:~$ su - mpi
Password:
mpi@master:~$

```

Client

- Worker



```

kiput@worker:~$ sudo adduser mpi
adduser: The user `mpi' already exists.
kiput@worker:~$ sudo usermod -aG sudo mpi
kiput@worker:~$ su - mpi
Password:
mpi@worker:~$

```

- Worker2


```

rahayu@worker2:~$ sudo adduser mpi
adduser: Pengguna `mpi' sudah ada.
rahayu@worker2:~$ sudo usermod -aG sudo mpi
rahayu@worker2:~$ su - mpi
Sandi:
mpi@worker2:~$

```

- Worker3

```

dew@worker3:~$ sudo adduser mpi
adduser: The user `mpi' already exists.
dew@worker3:~$ sudo usermod -aG sudo mpi
dew@worker3:~$ su - mpi
Password:

```

- **Konfigurasi SSH**

Setelah membuat dan masuk ke user, lakukan konfigurasi SSH.

1. Install SSH

\$ sudo apt install openssh-server

- Pada master

```

mpi@master:~$ sudo apt install openssh-server
[sudo] password for mpi:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).
0 upgraded, 0 newly installed, 0 to remove and 86 not upgraded.

```

- Pada worker

```

mpi@worker:~$ sudo apt install openssh-server
[sudo] password for mpi:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).
0 upgraded, 0 newly installed, 0 to remove and 86 not upgraded.

```

- Pada worker2

```

mpi@worker2:~$ sudo apt install openssh-server
[sudo] katasandi untuk mpi:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openssh-server sudah versi terbaru (1:8.9p1-3ubuntu0.4).
Paket-paket berikut dipasang secara otomatis dan tak diperlukan lagi:
  libjs-highlight.js libnode72 nodejs-doc
Gunakan 'sudo apt autoremove' untuk menghapus itu.
0 dimutakhirkan, 0 baru terinstal, 0 akan dihapus dan 0 tidak akan dimutakhirkan.
mpi@worker2:~$

```

- Pada worker3

```
mpi@worker3:~$ sudo apt install openssh-server
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
openssh-server is already the newest version (1:8.9p1-3ubuntu0.4).
0 upgraded, 0 newly installed, 0 to remove and 538 not upgraded.
mpi@worker3:~$
```

2. Melakukan pengecekan SSH

\$ ssh <nama user>@<host>

- SSH dari Master ke Worker

```
mpi@master:~$ ssh mpi@worker
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-36-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

Expanded Security Maintenance for Applications is not enabled.

84 updates can be applied immediately.
61 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

3 additional security updates can be applied with ESM Apps.
Learn more about enabling ESM Apps service at https://ubuntu.com/esm

Last login: Mon Nov  6 11:02:01 2023 from 172.20.10.13
mpi@worker:~$
```

- SSH dari Worker ke Master

```

mpi@worker:~$ ssh mpi@master
The authenticity of host 'master (192.168.1.11)' can't be established.
ED25519 key fingerprint is SHA256:01MDXynMeJhe9yNs+Wrs2lFjsXx6WLjDwPdIhecP4Ps.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'master' (ED25519) to the list of known hosts.
mpi@master's password:
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-36-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

Expanded Security Maintenance for Applications is not enabled.

84 updates can be applied immediately.
61 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

3 additional security updates can be applied with ESM Apps.
Learn more about enabling ESM Apps service at https://ubuntu.com/esm

Last login: Mon Nov  6 11:29:00 2023 from 172.20.10.10
mpi@master:~$

```

3. Generate Keygen

Lakukan di **SERVER**

\$ ssh-keygen -t rsa

```

mpi@master:~$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/mpi/.ssh/id_rsa):
/home/mpi/.ssh/id_rsa already exists.
Overwrite (y/n)? y
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/mpi/.ssh/id_rsa
Your public key has been saved in /home/mpi/.ssh/id_rsa.pub
The key fingerprint is:
SHA256:FSkfT9PF00IgJBz0+MknszTGECCxKv27qrdbeJYcndE mpi@master
The key's randomart image is:
+---[RSA 3072]---+
|  o..+=00.o.. o.|
|  o  o* +.o.. .|
|  . .oE+.+. .|
| .. . o=.o .. o |
|... . o S@ . . .|
|. + o  o *      |
|. B              |
|. + .           |
|.O++O.         |
+-----[SHA256]-----+

```


4. Copy key publik ke client

```
$ cd .ssh  
$ cat id_rsa.pub | ssh <nama user>@<host> "mkdir .ssh; cat >> .ssh/authorized_keys"
```

```
mpi@master:~$ cd .ssh  
mpi@master:~/ssh$ cat id_rsa.pub | ssh mpi@worker "mkdir .ssh; cat >> .ssh/authorized_keys"  
mpi@worker's password:  
mkdir: cannot create directory '.ssh': File exists  
mpi@master:~/ssh$
```

▪ Konfigurasi NFS

1. Buat shared folder

```
$ mkdir cloud
```

- Pada Master

```
mpi@master:~$ mkdir cloud  
mkdir: cannot create directory 'cloud': File exists
```

- Pada Worker

```
mpi@worker:~$ mkdir cloud  
mkdir: cannot create directory 'cloud': File exists  
mpi@worker:~$
```

- Pada Worker2

```
rahayu@worker2:~$ mkdir cloud  
rahayu@worker2:~$
```

- Pada Worker3

```
mpi@worker3:~$ mkdir cloud  
mpi@worker3:~$
```

2. Install NFS Server

```
$ sudo apt install nfs-kernel-server
```

```
mpi@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 86 not upgraded.  
mpi@master:~$
```

3. Konfigurasi file /etc/exports

<lokasi shared folder> *(rw, sync, no_root_squash, no_subtree_check)

```
GNU nano 6.2 /etc/exports
# /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_check)
#
# 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/mpi/cloud *(rw, sync, no_root_squash, no_subtree_check)
```

```
$ sudo exportfs -a
```

```
$ sudo systemctl restart nfs-kernel-server
```

```
mpi@master:~$ sudo nano /etc/exports
mpi@master:~$ sudo exportfs -a
mpi@master:~$ sudo systemctl restart nfs-kernel-server
mpi@master:~$
```

4. Install NFS Client

```
$ sudo apt install nfs-common
```

- Worker

```
mpi@worker:~$ sudo apt install nfs-common
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
nfs-common is already the newest version (1:2.6.1-1ubuntu1.2).
0 upgraded, 0 newly installed, 0 to remove and 86 not upgraded.
```

- Worker2

```
mpi@worker2:~$ sudo apt install nfs-common
[sudo] katasandi untuk mpi:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
nfs-common sudah versi terbaru (1:2.6.1-1ubuntu1.2).
Paket-paket berikut dipasang secara otomatis dan tak diperlukan lagi:
  libjs-highlight.js libnode72 nodejs-doc
Gunakan 'sudo apt autoremove' untuk menghapus itu.
0 dimutakhirkan, 0 baru terinstal, 0 akan dihapus dan 8 tidak akan dimutakhirkan
.
mpi@worker2:~$
```

- Worker3

```
mpi@worker3:~$ sudo apt install nfs-common
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
nfs-common is already the newest version (1:2.6.1-1ubuntu1.2).
0 upgraded, 0 newly installed, 0 to remove and 538 not upgraded.
mpi@worker3:~$ |
```

5. Mounting

\$ sudo mount <server host>:<lokasi shared folder di server>
<lokasi shared folder di client>

```
mpi@worker:~$ sudo mount master:/home/mpi/cloud /home/mpi/cloud
mpi@worker:~$
```

▪ MPI

1. Install MPI

\$ sudo apt install openmpi-bin libopenmpi-dev

- Pada Master

```
mpi@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 86 not upgraded.
```

- Pada Worker

```
mpi@worker:~/cloud$ 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 86 not upgraded.
mpi@worker:~/cloud$
```

- Pada Worker2

```
mpi@worker2:~$ sudo apt install openmpi-bin libopenmpi-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
libopenmpi-dev sudah versi terbaru (4.1.2-2ubuntu1).
openmpi-bin sudah versi terbaru (4.1.2-2ubuntu1).
Paket-paket berikut dipasang secara otomatis dan tak diperlukan lagi:
  libjs-highlight.js libnode72 nodejs-doc
Gunakan 'sudo apt autoremove' untuk menghapus itu.
0 dimutakhirkan, 0 baru terinstal, 0 akan dihapus dan 8 tidak akan dimutakhirkan.
.
mpi@worker2:~$
```

- Pada Worker3

```
0 upgraded, 0 newly installed, 0 to remove and 538 not upgraded.
mpi@worker3:~$ 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 538 not upgraded.
mpi@worker3:~$
```

2. Testing

```
$ touch test.py
```

```
mpi@master:~$ touch test.py
mpi@master:~$ touch bubblesort.py
mpi@master:~$
```


- Running MPI programs

1. code program

```
GNU nano 6.2                                     bubblesort.py
from mpi4py import MPI
import random
import time

def bubble_sort(arr):
    n = len(arr)
    for i in range(n):
        swapped = False
        for j in range(0, n-i-1):
            if arr[j] > arr[j+1]:
                arr[j], arr[j+1] = arr[j+1], arr[j]
                swapped = True
        if not swapped:
            break

# Membuat 10 array acak
array_list = [random.sample(range(1, 1000), 10) for _ in range(10)]

# Menampilkan data mentah dan data yang sudah diurutkan
for i, arr in enumerate(array_list):
    print(f>Data mentah array {i + 1}: {arr}")

    # Mengukur waktu eksekusi Bubble Sort dan mengurutkan array
    start_time = time.time()
    bubble_sort(arr)
    end_time = time.time()
    elapsed_time = end_time - start_time

    print(f>Data yang sudah diurutkan array {i + 1}: {arr}")
    print(f>Waktu eksekusi: {elapsed_time:.6f} detik\n")

# Menampilkan array yang belum terurutkan
unsorted_arrays = [unsorted_arrays[i] for i, arr in enumerate(array_list) if arr != sorted(arr)]
print(f>Jumlah array yang belum terurutkan: {len(unsorted_arrays)}")

[ Read 35 lines ]
^G Help      ^O Write Out  ^W Where Is   ^K Cut        ^T Execute    ^C Location   M-l
^X Exit      ^R Read File  ^\ Replace    ^U Paste      ^J Justify    ^_ Go To Line M-;
```

2. Eksekusi Bubblesort di python3

- Menggunakan Worker

```
Waktu eksekusi: 0.000017 detik

Data mentah array 2: [21, 201, 309, 402, 338, 701, 898, 935, 73, 84]
Data yang sudah diurutkan array 2: [21, 73, 84, 201, 309, 338, 402, 701, 898, 935]
Waktu eksekusi: 0.000012 detik

Data mentah array 3: [514, 820, 386, 832, 20, 79, 899, 415, 996, 604]
Data yang sudah diurutkan array 3: [20, 79, 386, 415, 514, 604, 820, 832, 899, 996]
Waktu eksekusi: 0.000010 detik

Data mentah array 4: [471, 534, 104, 572, 38, 263, 346, 895, 400, 46]
Data yang sudah diurutkan array 4: [38, 46, 104, 263, 346, 400, 471, 534, 572, 895]
Waktu eksekusi: 0.000014 detik

Data mentah array 5: [623, 474, 426, 497, 522, 101, 59, 943, 185, 881]
Data yang sudah diurutkan array 5: [59, 101, 185, 426, 474, 497, 522, 623, 881, 943]
Waktu eksekusi: 0.000013 detik

Data mentah array 6: [291, 477, 544, 720, 474, 856, 442, 307, 233, 567]
Data yang sudah diurutkan array 6: [233, 291, 307, 442, 474, 477, 544, 567, 720, 856]
Waktu eksekusi: 0.000013 detik

Data mentah array 7: [53, 678, 987, 378, 445, 645, 712, 752, 747, 177]
Data yang sudah diurutkan array 7: [53, 177, 378, 445, 645, 678, 712, 747, 752, 987]
Waktu eksekusi: 0.000013 detik

Data mentah array 8: [940, 348, 905, 865, 878, 327, 212, 81, 377, 500]
Data yang sudah diurutkan array 8: [81, 212, 327, 348, 377, 500, 865, 878, 905, 940]
Waktu eksekusi: 0.000015 detik

Data mentah array 9: [62, 730, 134, 773, 222, 575, 133, 620, 96, 359]
Data yang sudah diurutkan array 9: [62, 96, 133, 134, 222, 359, 575, 620, 730, 773]
Waktu eksekusi: 0.000013 detik

Data mentah array 10: [540, 311, 593, 152, 687, 132, 983, 181, 91, 506]
Data yang sudah diurutkan array 10: [91, 132, 152, 181, 311, 506, 540, 593, 687, 983]
Waktu eksekusi: 0.000014 detik

Jumlah array yang belum terurutkan: 0
mpi@worker:~/cloud$
```

- Menggunakan Master

```
Waktu eksekusi: 0.000016 detik

Data mentah array 2: [121, 616, 814, 396, 222, 828, 971, 630, 13, 135]
Data yang sudah diurutkan array 2: [13, 121, 135, 222, 396, 616, 630, 814, 828, 971]
Waktu eksekusi: 0.000015 detik

Data mentah array 3: [254, 889, 653, 773, 631, 428, 555, 506, 682, 470]
Data yang sudah diurutkan array 3: [254, 428, 470, 506, 555, 631, 653, 682, 773, 889]
Waktu eksekusi: 0.000014 detik

Data mentah array 4: [157, 347, 655, 448, 911, 957, 582, 113, 96, 473]
Data yang sudah diurutkan array 4: [96, 113, 157, 347, 448, 473, 582, 655, 911, 957]
Waktu eksekusi: 0.000014 detik

Data mentah array 5: [937, 762, 682, 501, 575, 220, 893, 589, 772, 522]
Data yang sudah diurutkan array 5: [220, 501, 522, 575, 589, 682, 762, 772, 893, 937]
Waktu eksekusi: 0.000015 detik

Data mentah array 6: [952, 760, 333, 825, 141, 487, 683, 938, 6, 565]
Data yang sudah diurutkan array 6: [6, 141, 333, 487, 565, 683, 760, 825, 938, 952]
Waktu eksekusi: 0.000015 detik

Data mentah array 7: [982, 132, 584, 162, 851, 581, 379, 616, 150, 208]
Data yang sudah diurutkan array 7: [132, 150, 162, 208, 379, 581, 584, 616, 851, 982]
Waktu eksekusi: 0.000014 detik

Data mentah array 8: [655, 705, 248, 437, 817, 929, 570, 506, 243, 846]
Data yang sudah diurutkan array 8: [243, 248, 437, 506, 570, 655, 705, 817, 846, 929]
Waktu eksekusi: 0.000014 detik

Data mentah array 9: [833, 741, 82, 760, 254, 121, 860, 503, 880, 10]
Data yang sudah diurutkan array 9: [10, 82, 121, 254, 503, 741, 760, 833, 860, 880]
Waktu eksekusi: 0.000015 detik

Data mentah array 10: [697, 976, 297, 474, 406, 202, 231, 110, 945, 466]
Data yang sudah diurutkan array 10: [110, 202, 231, 297, 406, 466, 474, 697, 945, 976]
Waktu eksekusi: 0.000015 detik

Jumlah array yang belum terurutkan: 0
mpi@master:~/cloud$
```