

Crear llave maestra, es para poder acceder a los nodos sin necesidad de introducir la contraseña.

```

pi@rpi-lania3: ~
login as: pi
pi@192.168.100.41's password:

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the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun  7 18:17:09 2017
pi@rpi-lania5:~ $ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/pi/.ssh/id_rsa):
Created directory '/home/pi/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/pi/.ssh/id_rsa.
Your public key has been saved in /home/pi/.ssh/id_rsa.pub.
The key fingerprint is:
be:43:c6:62:c4:db:25:4c:a2:92:97:bf:6f:22:39:07 pi@rpi-lania5
The key's randomart image is:
+---[RSA 2048]-----+
|
|      . .
|    . + +
|  o + o o .
|    o o +So
|
+-----+

```

```

pi@rpi-lania3: ~
pi@rpi-lania5:~ $ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/pi/.ssh/id_rsa):
Created directory '/home/pi/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/pi/.ssh/id_rsa.
Your public key has been saved in /home/pi/.ssh/id_rsa.pub.
The key fingerprint is:
be:43:c6:62:c4:db:25:4c:a2:92:97:bf:6f:22:39:07 pi@rpi-lania5
The key's randomart image is:
+---[RSA 2048]-----+
|
|      . .      |
|    . + +      |
|  o + o o .    |
|    o o +So    |
|      E =.=    |
|      + =.     |
|    + + o.     |
|    + +o.     |
|-----+-----+
pi@rpi-lania5:~ $ cat .ssh/id_rsa.pub.
cat: .ssh/id_rsa.pub.: No such file or directory
pi@rpi-lania5:~ $ cat .ssh/id_rsa.pub
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQBD2hZiJOrnRQBTUZS+avjP5tfg4dxs+VU+1ck7I1vTR
jQrHlBmnEsEfI2UgU7QSnRjXqP9DpXwyjqbV/+tFPxJ9/vwx6NWJ09A1JImW4fWY0on4fdePFEs5Va

```

Copiar llave maestra al nodo 3.

```
pi@rpi-lania3: ~  
+-----+  
pi@rpi-lania5:~ $ cat .ssh/id_rsa.pub.  
cat: .ssh/id_rsa.pub.: No such file or directory  
pi@rpi-lania5:~ $ cat .ssh/id_rsa.pub  
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQD2hZIJOrnRQBTUZS+avjp5tfg4dxs+VU+1ck7I1vTR  
jQRhIbmESfI2UgU7QSnRjXqP9DpXwyjqbV/+tFPxJ9/vwx6NWJ09A1JImW4fWY0on4fdePfeDLeS5Va  
Csxppf0vMjKBWZ7hSKG99rh9Wawy+pNyIvombG3Ezrcvi0qQNpJ18CVlLmynmkRP96DGc8nNk1u8cXpv  
X3I2Pgm65fx8h5f3aN7uQxYpucWL+fvk3lKANYQsX0RnWPoleUxV2cY1euzuPudlZs8MOtdD6lXOV85N  
yVCJq3Qhi5zIPcjBwlu8BrEd0MWcMPmBeSvaTI53Xr7KuhwFyz85u02xdOL1 pi@rpi-lania5  
pi@rpi-lania5:~ $ ssh-copy-id rpi-lania3.local  
The authenticity of host 'rpi-lania3.local (192.168.100.98)' can't be establishe  
d.  
ECDSA key fingerprint is 83:43:75:73:60:68:d2:ad:fb:49:94:03:8a:5f:8a:41.  
Are you sure you want to continue connecting (yes/no)? y  
Please type 'yes' or 'no': y  
Please type 'yes' or 'no': n  
Please type 'yes' or 'no': yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania3.local's password:  
  
Number of key(s) added: 1
```

Se accedió al nodo 3 si pedir la contraseña.

```
pi@rpi-lania3: ~  
d.  
ECDSA key fingerprint is 83:43:75:73:60:68:d2:ad:fb:49:94:03:8a:5f:8a:41.  
Are you sure you want to continue connecting (yes/no)? y  
Please type 'yes' or 'no': y  
Please type 'yes' or 'no': n  
Please type 'yes' or 'no': yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania3.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with:  "ssh 'rpi-lania3.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $ ssh rpi-lania3.local  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Wed Jun 14 15:48:50 2017 from 192.168.100.71  
pi@rpi-lania3:~ $
```

Copiar la llave maestra al nodo 1.

```
pi@rpi-lania5: ~  
Are you sure you want to continue connecting (yes/no)? yes  
Warning: Permanently added 'rpi-lania5.local,192.168.100.41' (ECDSA) to the list  
of known hosts.  
pi@rpi-lania5.local's password:  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Wed Jun 14 15:43:34 2017 from 192.168.10.202  
pi@rpi-lania5:~ $ ssh-copy-id rpi-lania1.local  
The authenticity of host 'rpi-lania1.local (192.168.100.25)' can't be establishe  
d.  
ECDSA key fingerprint is 0b:8f:70:24:19:a0:6c:88:78:8a:41:3a:f9:e1:20:3a.  
Are you sure you want to continue connecting (yes/no)? yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania1.local's password:  
Permission denied, please try again.  
pi@rpi-lania1.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with: "ssh 'rpi-lania1.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $
```

Copiar la llave maestra a nodo 2.

```
pi@rpi-lania5: ~  
Are you sure you want to continue connecting (yes/no)? yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania1.local's password:  
Permission denied, please try again.  
pi@rpi-lania1.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with: "ssh 'rpi-lania1.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $ ssh-copy-id rpi-lania2.local  
The authenticity of host 'rpi-lania2.local (192.168.100.71)' can't be establishe  
d.  
ECDSA key fingerprint is 56:85:0f:5e:34:8d:7b:cc:21:2b:58:66:31:d7:a5:a0.  
Are you sure you want to continue connecting (yes/no)? yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania2.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with: "ssh 'rpi-lania2.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $
```

Copiar la llave maestra al nodo 4.

```
pi@rpi-lania5: ~  
d.  
ECDSA key fingerprint is 56:85:0f:5e:34:8d:7b:cc:21:2b:58:66:31:d7:a5:a0.  
Are you sure you want to continue connecting (yes/no)? yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania2.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with: "ssh 'rpi-lania2.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $ ssh-copy-id rpi-lania4.local  
The authenticity of host 'rpi-lania4.local (192.168.100.54)' can't be establishe  
d.  
ECDSA key fingerprint is 3f:ff:f9:0e:2a:35:32:1c:ae:cc:d6:69:8b:ff:28:e1.  
Are you sure you want to continue connecting (yes/no)? yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania4.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with: "ssh 'rpi-lania4.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $
```

Copiar la llave maestra al nodo 0.

```
pi@rpi-lania5: ~  
d.  
ECDSA key fingerprint is 3f:ff:f9:0e:2a:35:32:1c:ae:cc:d6:69:8b:ff:28:e1.  
Are you sure you want to continue connecting (yes/no)? yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania4.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with: "ssh 'rpi-lania4.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $ ssh-copy-id rpi-lania0.local  
The authenticity of host 'rpi-lania0.local (192.168.100.53)' can't be establishe  
d.  
ECDSA key fingerprint is fe:8e:b1:92:a3:b1:8b:fd:c6:71:8a:f1:4d:d8:c8:7f.  
Are you sure you want to continue connecting (yes/no)? yes  
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter  
out any that are already installed  
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt  
ed now it is to install the new keys  
pi@rpi-lania0.local's password:  
  
Number of key(s) added: 1  
  
Now try logging into the machine, with: "ssh 'rpi-lania0.local'"  
and check to make sure that only the key(s) you wanted were added.  
  
pi@rpi-lania5:~ $
```

Se accedió al nodo 2 si pedir la contraseña.

```
pi@rpi-landia2: ~
Number of key(s) added: 1

Now try logging into the machine, with:  "ssh 'rpi-landia4.local'"
and check to make sure that only the key(s) you wanted were added.

pi@rpi-landia5:~ $ ssh-copy-id rpi-landia0.local
The authenticity of host 'rpi-landia0.local (192.168.100.53)' can't be established.
ECDSA key fingerprint is fe:8e:b1:92:a3:b1:8b:fd:c6:71:8a:f1:4d:d8:c8:7f.
Are you sure you want to continue connecting (yes/no)? yes
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter
out any that are already installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompt
ed now it is to install the new keys
pi@rpi-landia0.local's password:

Number of key(s) added: 1

Now try logging into the machine, with:  "ssh 'rpi-landia0.local'"
and check to make sure that only the key(s) you wanted were added.

pi@rpi-landia5:~ $ ssh rpi-landia2.local

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Last login: Wed Jun 14 15:59:56 2017 from 192.168.100.25
pi@rpi-landia2:~ $
```

Se accedió al nodo 0, sin pedir la contraseña.

```
pi@rpi-landia1: ~
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

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permitted by applicable law.
Last login: Wed Jun 14 15:59:56 2017 from 192.168.100.25
pi@rpi-landia2:~ $ exit
logout
Connection to rpi-landia2.local closed.
pi@rpi-landia5:~ $ ssh rpi-landia0.local

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individual files in /usr/share/doc/*/copyright.

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permitted by applicable law.
Last login: Wed Jun 14 11:00:33 2017 from 192.168.100.71
pi@rpi-landia0:~ $ exit
logout
Connection to rpi-landia0.local closed.
pi@rpi-landia5:~ $ ssh rpi-landia1.local

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the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun 14 16:00:52 2017 from 192.168.100.71
pi@rpi-landia1:~ $
```

Se accedió al nodo 4, sin pedir la contraseña.

```
pi@rpi-landia4: ~
individual files in /usr/share/doc/*/copyright.

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permitted by applicable law.
Last login: Wed Jun 14 11:00:33 2017 from 192.168.100.71
pi@rpi-landia0:~ $ exit
logout
Connection to rpi-landia0.local closed.
pi@rpi-landia5:~ $ ssh rpi-landia1.local

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun 14 16:00:52 2017 from 192.168.100.71
pi@rpi-landia1:~ $ exit
logout
Connection to rpi-landia1.local closed.
pi@rpi-landia5:~ $ ssh rpi-landia4.local

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun 14 16:01:13 2017 from 192.168.100.71
-bash: PATH: command not found
pi@rpi-landia4:~ $
```

Revisando el código

```
pi@rpi-landia5: ~/comades/python
Last login: Wed Jun 14 16:01:13 2017 from 192.168.100.71
-bash: PATH: command not found
pi@rpi-landia4:~ $ exit
logout
Connection to rpi-landia4.local closed.
pi@rpi-landia5:~ $ cd comades/python
pi@rpi-landia5:~/comades/python $ cat primero.py
#!/usr/bin/env python

from mpi4py import MPI

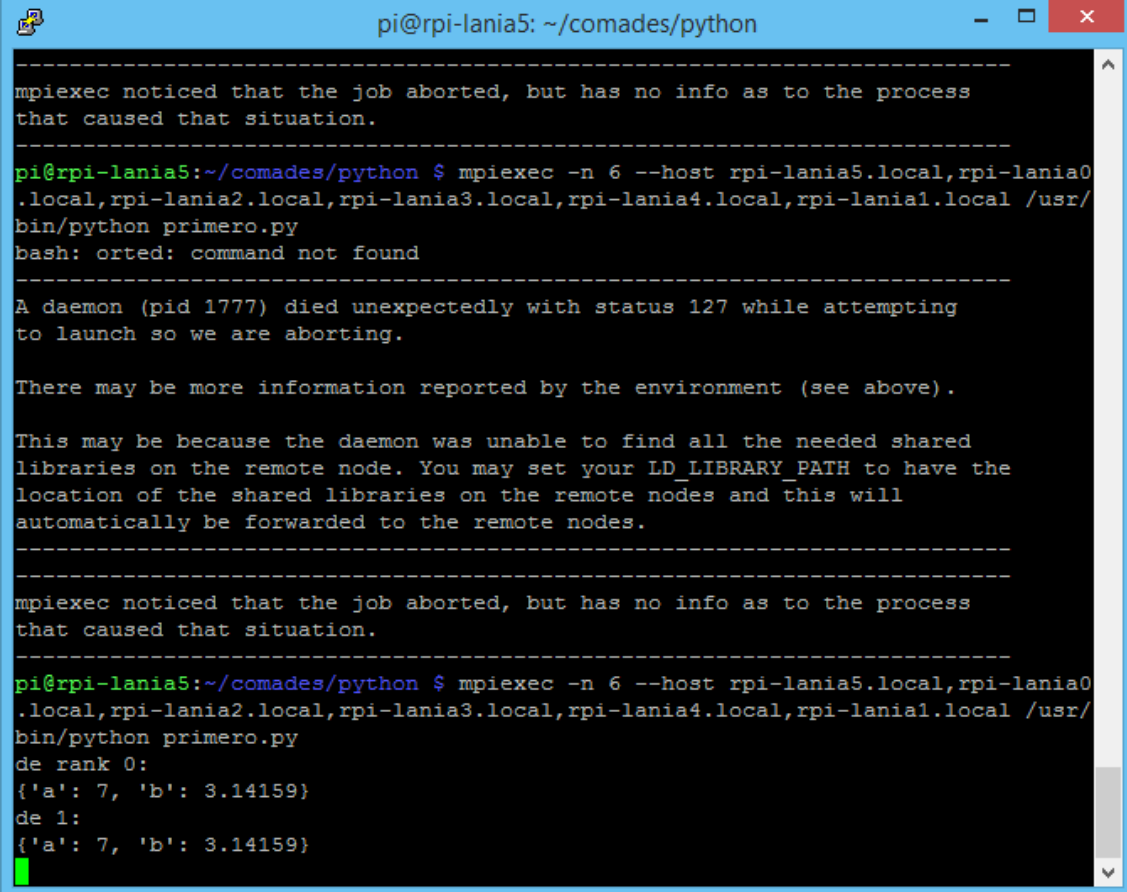
comm = MPI.COMM_WORLD
rank = comm.Get_rank()

if rank == 0:
    data = {'a': 7, 'b': 3.14159}
    comm.send(data, dest = 1, tag=11)
    print('de rank 0: ')
    print(data)
else:
    data = comm.recv(source = 0, tag = 11)
    print('de '+str(rank)+': ')
    print(data)

pi@rpi-landia5:~/comades/python $ mpiexec -n 6 --host rpi-landia5.local,rpi-landia0
.local,rpi-landia2.local,rpi-landia3.local,rpi-landia4.local /usr/bin/python primer
o.py
bash: orted: command not found

-----
A daemon (pid 1771) died unexpectedly with status 127 while attempting
to launch so we are aborting.
```


Enviando copia del código a los otros nodos.

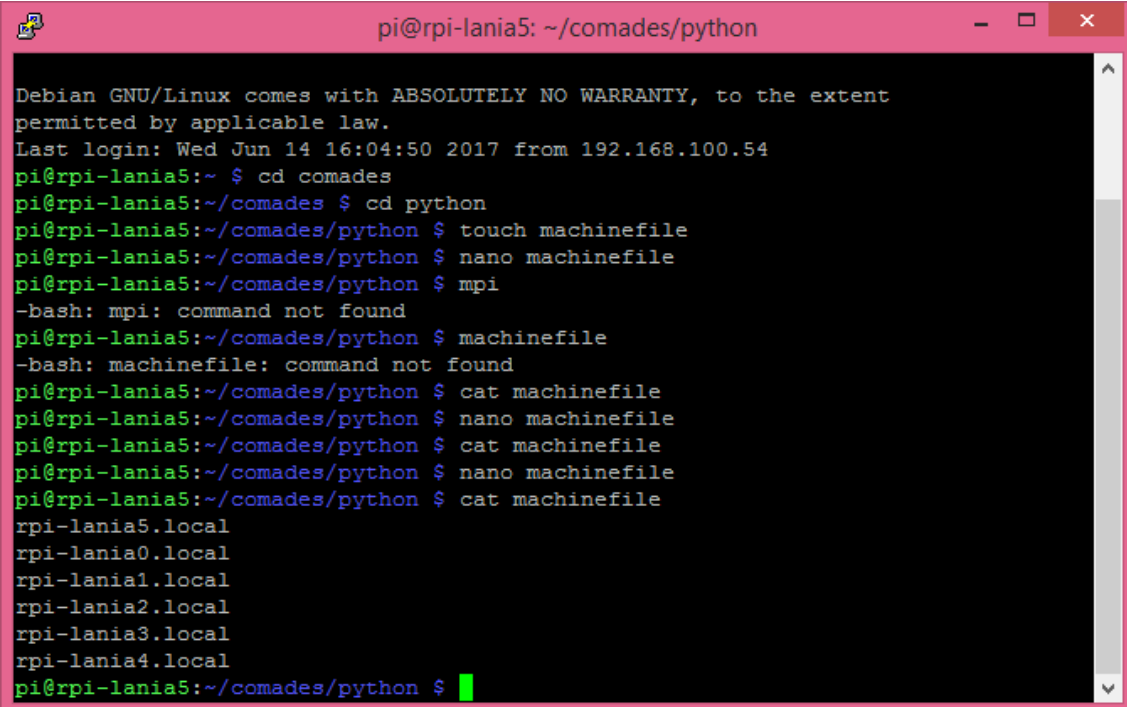


```
pi@rpi-lania5: ~/comades/python
-----
mpirun noticed that the job aborted, but has no info as to the process
that caused that situation.
-----
pi@rpi-lania5:~/comades/python $ mpirun -n 6 --host rpi-lania5.local,rpi-lania0
.local,rpi-lania2.local,rpi-lania3.local,rpi-lania4.local,rpi-lania1.local /usr/
bin/python primero.py
bash: mpirun: command not found
-----
A daemon (pid 1777) died unexpectedly with status 127 while attempting
to launch so we are aborting.

There may be more information reported by the environment (see above).

This may be because the daemon was unable to find all the needed shared
libraries on the remote node. You may set your LD_LIBRARY_PATH to have the
location of the shared libraries on the remote nodes and this will
automatically be forwarded to the remote nodes.
-----
mpirun noticed that the job aborted, but has no info as to the process
that caused that situation.
-----
pi@rpi-lania5:~/comades/python $ mpirun -n 6 --host rpi-lania5.local,rpi-lania0
.local,rpi-lania2.local,rpi-lania3.local,rpi-lania4.local,rpi-lania1.local /usr/
bin/python primero.py
de rank 0:
{'a': 7, 'b': 3.14159}
de 1:
{'a': 7, 'b': 3.14159}
```

Visualización del archivo machinefile, donde se almacena el nombre de los nodos.



```
pi@rpi-lania5: ~/comades/python
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun 14 16:04:50 2017 from 192.168.100.54
pi@rpi-lania5:~ $ cd comades
pi@rpi-lania5:~/comades $ cd python
pi@rpi-lania5:~/comades/python $ touch machinefile
pi@rpi-lania5:~/comades/python $ nano machinefile
pi@rpi-lania5:~/comades/python $ mpirun
-bash: mpirun: command not found
pi@rpi-lania5:~/comades/python $ machinefile
-bash: machinefile: command not found
pi@rpi-lania5:~/comades/python $ cat machinefile
pi@rpi-lania5:~/comades/python $ nano machinefile
pi@rpi-lania5:~/comades/python $ cat machinefile
pi@rpi-lania5:~/comades/python $ nano machinefile
pi@rpi-lania5:~/comades/python $ cat machinefile
rpi-lania5.local
rpi-lania0.local
rpi-lania1.local
rpi-lania2.local
rpi-lania3.local
rpi-lania4.local
pi@rpi-lania5:~/comades/python $
```

Se ejecuta el código del archivo segundo.py en todos los nodos.

```
pi@rpi-lania5: ~/comades/python
pi@rpi-lania5:~/comades/python $ nano machinefile
pi@rpi-lania5:~/comades/python $ cat machinefile
pi@rpi-lania5:~/comades/python $ nano machinefile
pi@rpi-lania5:~/comades/python $ cat machinefile
rpi-lania5.local
rpi-lania0.local
rpi-lania1.local
rpi-lania2.local
rpi-lania3.local
rpi-lania4.local
pi@rpi-lania5:~/comades/python $ scp led.py rpi-lania1.local:~/comades/python
led.py: No such file or directory
pi@rpi-lania5:~/comades/python $ scp led.py rpi-lania1.local: ~/comades/python
cp: 'led.py' and '/home/pi/comades/python/led.py' are the same file
scp: .: not a regular file
pi@rpi-lania5:~/comades/python $ mpirun.openmpi -np 6 -machinefile machinefile /
usr/bin/python segundo.py
Proceso: 0 {'a': 7, 'b': 3.14159}
Proceso: 1 {'a': 7, 'b': 3.14159}
Proceso: 5 {'a': 7, 'b': 3.14159}
Proceso: 2 {'a': 7, 'b': 3.14159}
Proceso: 3 {'a': 7, 'b': 3.14159}
Proceso: 4 {'a': 7, 'b': 3.14159}
pi@rpi-lania5:~/comades/python $
```

Se visualiza el código led.py, que es para prender LED.

```
pi@rpi-lania5: ~/comades/python
rpi-lania4.local
pi@rpi-lania5:~/comades/python $ cat led.py
"""
LED Demo
"""

from mpi4py import MPI
import RPi.GPIO as GPIO

# Set up GPIO
GPIO.cleanup()
GPIO.setmode(GPIO.BCM)
GPIO.setup(17, GPIO.OUT) #master - Green LED
GPIO.setup(18, GPIO.OUT) #Slave 1 - Purple LED
GPIO.setup(23, GPIO.OUT) #Slave 2 - Red LED

# MPI variables for communication, rank, size, and name of the node
comm = MPI.COMM_WORLD
rank = comm.Get_rank()
size = comm.Get_size()
name = MPI.Get_processor_name()

total_requests = 2500

# This is the master node.
if rank == 0:
    request = 0
    process = 1
```



```
pi@rpi-lania5: ~/comades/python

# Wait for the data to come back
received_processes = 0
while received_processes < total_requests:
    process = comm.recv(source=MPI.ANY_SOURCE, tag=1)
    print "Received data from process", process
    if (process == 1):
        GPIO.output(18, True)
        GPIO.output(23, False)
    elif (process == 2):
        GPIO.output(23, True)
        GPIO.output(18, False)
    received_processes += 1

    if request < total_requests:
        comm.send(request, dest=process, tag=1)
        print "Sending request", request, "to process", process
        GPIO.output(17, True)
        request += 1

# Send the shutdown signal
for process in range(1,size):
    comm.send(-1, dest=process, tag=1)
print "End"

# These are the slave nodes, where rank > 0. They receive the request from the master node and simply send a response back
else:
    while True:
        start = comm.recv(source=0, tag=1)
        if start == -1: break
        comm.send(rank, dest=0, tag=1)

#Clean up GPIO activities after all processing takes place
GPIO.cleanup()
pi@rpi-lania5:~/comades/python $
```