

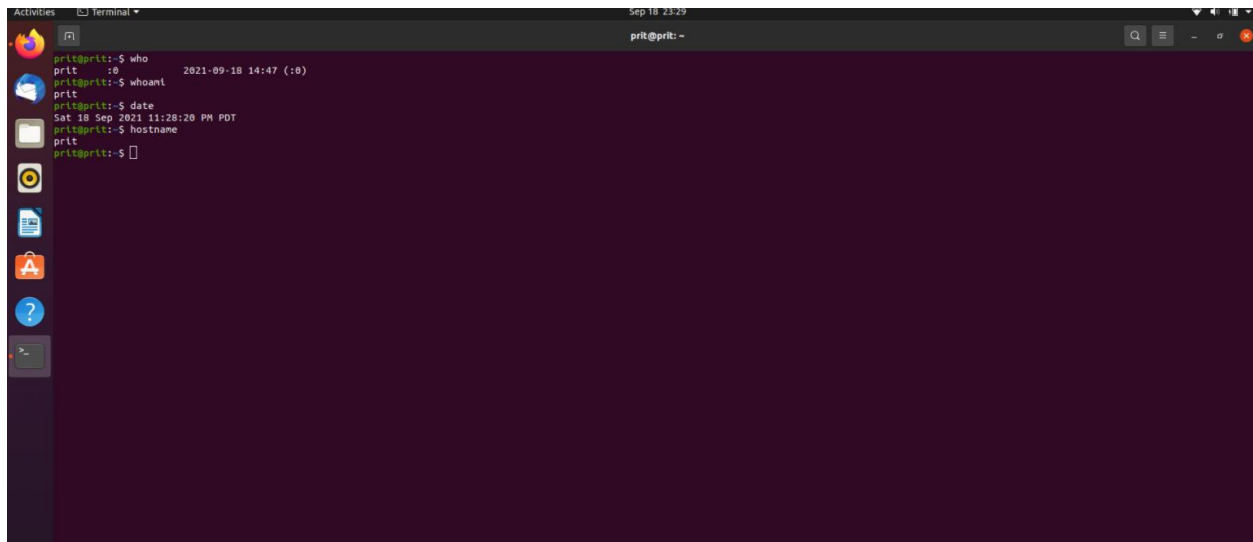
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CS 646 Principles of Operating Systems

HW 1

1.

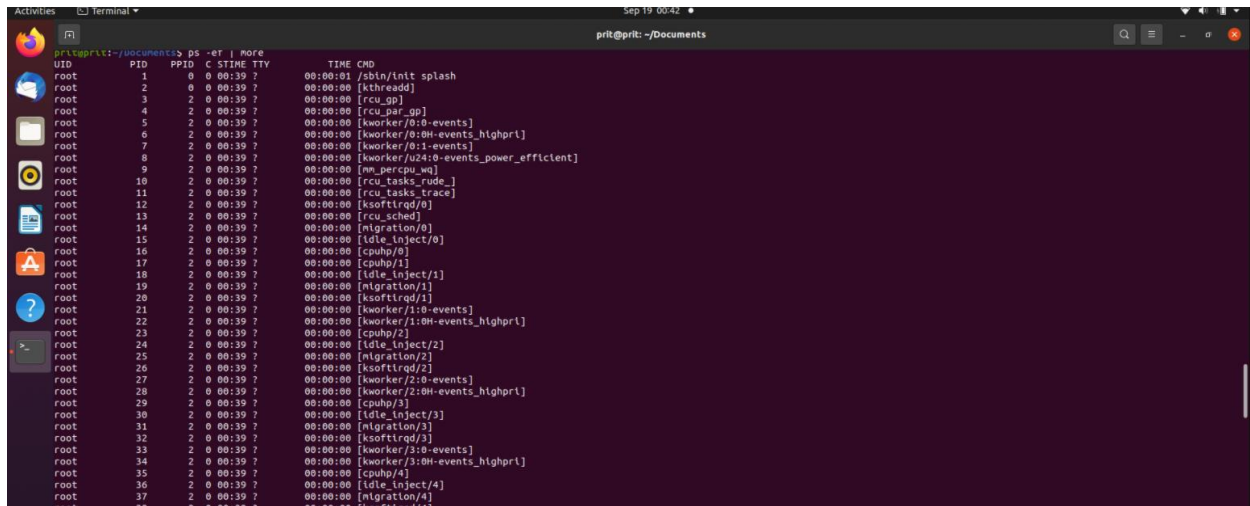
Shell Commands: whoami, who, date, hostname

A screenshot of a Linux terminal window. The window has a title bar with 'Activities', 'Terminal', and 'Sep 18 23:29'. The terminal content shows a series of commands and their outputs: 'prtt@prtt:~\$ who' outputs 'prtt :0 2021-09-18 14:47 (:0)', 'prtt@prtt:~\$ whoami' outputs 'prtt', 'prtt@prtt:~\$ date' outputs 'Sat 18 Sep 2021 11:28:20 PM PDT', and 'prtt@prtt:~\$ hostname' outputs 'prtt'. The prompt 'prtt@prtt:~\$' is shown at the end of the last command. The terminal has a dark purple background and a light-colored text. On the left side of the terminal window, there is a vertical dock with several application icons: a red and yellow icon, a blue and white icon, a yellow and black icon, a blue and white icon, an orange and white icon, a blue and white icon, and a red and white icon.

```
prtt@prtt:~$ who
prtt :0 2021-09-18 14:47 (:0)
prtt@prtt:~$ whoami
prtt
prtt@prtt:~$ date
Sat 18 Sep 2021 11:28:20 PM PDT
prtt@prtt:~$ hostname
prtt
prtt@prtt:~$
```

2.

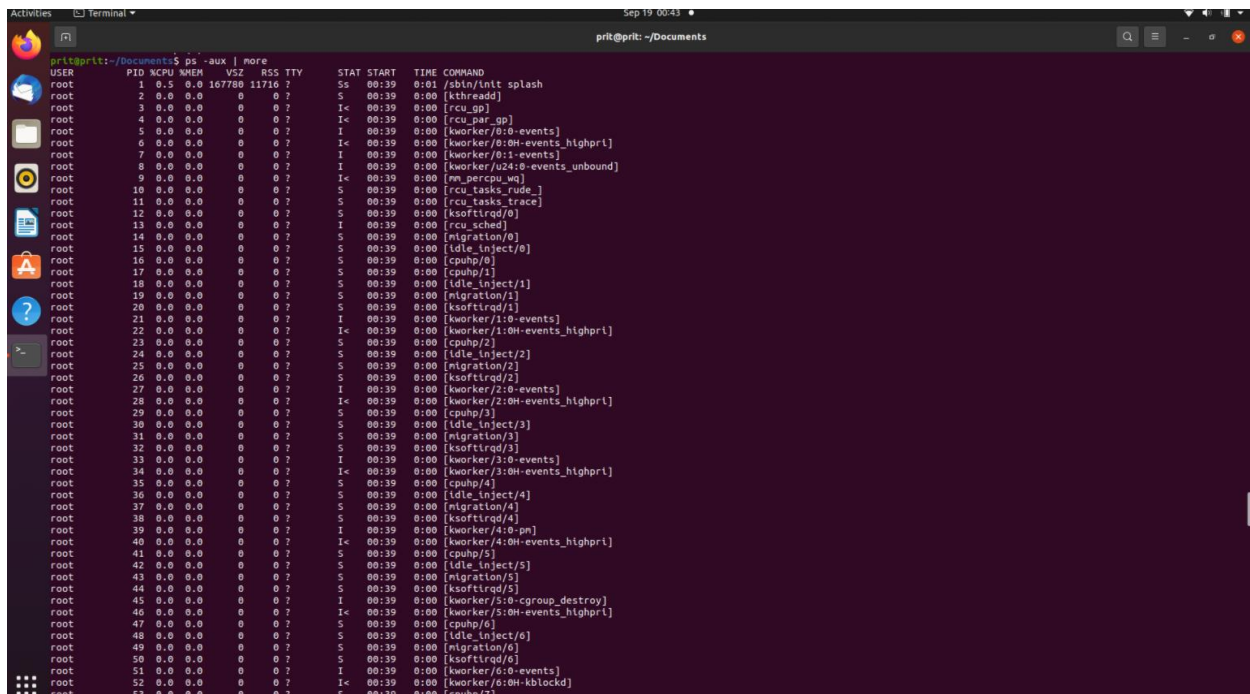
“ps -ef | more” command:



A terminal window showing the output of the command 'ps -ef | more'. The output is a list of processes with columns: UID, PID, PPID, C, STIME, TTY, and TIME CMD. The processes listed include system daemons like /sbin/init, kthreadd, rcu\_gp, rcu\_par\_gp, kworker/0:0-events, kworker/0:0H-events\_highpri, kworker/0:1-events, kworker/u24:0-events\_power\_efficient, mm\_percpu\_wq, rcu\_tasks\_rude, rcu\_tasks\_trace, ksoftirqd/0, rcu\_sched, migration/0, idle\_inject/0, cpuhp/0, cpuhp/1, idle\_inject/1, migration/1, ksoftirqd/1, kworker/1:0-events, kworker/1:0H-events\_highpri, cpuhp/2, idle\_inject/2, migration/2, ksoftirqd/2, kworker/2:0-events, kworker/2:0H-events\_highpri, cpuhp/3, idle\_inject/3, migration/3, ksoftirqd/3, kworker/3:0-events, kworker/3:0H-events\_highpri, cpuhp/4, idle\_inject/4, and migration/4.

```
priti@priti:~/Documents$ ps -ef | more
UID        PID     PPID  C  STIME TTY          TIME CMD
root         1         0  0  00:39 ?        00:00:01 /sbin/init splash
root         2         0  0  00:39 ?        00:00:00 [kthreadd]
root         3         2  0  00:39 ?        00:00:00 [rcu_gp]
root         4         2  0  00:39 ?        00:00:00 [rcu_par_gp]
root         5         2  0  00:39 ?        00:00:00 [kworker/0:0-events]
root         6         2  0  00:39 ?        00:00:00 [kworker/0:0H-events_highpri]
root         7         2  0  00:39 ?        00:00:00 [kworker/0:1-events]
root         8         2  0  00:39 ?        00:00:00 [kworker/u24:0-events_power_efficient]
root         9         2  0  00:39 ?        00:00:00 [mm_percpu_wq]
root        10         2  0  00:39 ?        00:00:00 [rcu_tasks_rude_]
root        11         2  0  00:39 ?        00:00:00 [rcu_tasks_trace]
root        12         2  0  00:39 ?        00:00:00 [ksoftirqd/0]
root        13         2  0  00:39 ?        00:00:00 [rcu_sched]
root        14         2  0  00:39 ?        00:00:00 [migration/0]
root        15         2  0  00:39 ?        00:00:00 [idle_inject/0]
root        16         2  0  00:39 ?        00:00:00 [cpuhp/0]
root        17         2  0  00:39 ?        00:00:00 [cpuhp/1]
root        18         2  0  00:39 ?        00:00:00 [idle_inject/1]
root        19         2  0  00:39 ?        00:00:00 [migration/1]
root        20         2  0  00:39 ?        00:00:00 [ksoftirqd/1]
root        21         2  0  00:39 ?        00:00:00 [kworker/1:0-events]
root        22         2  0  00:39 ?        00:00:00 [kworker/1:0H-events_highpri]
root        23         2  0  00:39 ?        00:00:00 [cpuhp/2]
root        24         2  0  00:39 ?        00:00:00 [idle_inject/2]
root        25         2  0  00:39 ?        00:00:00 [migration/2]
root        26         2  0  00:39 ?        00:00:00 [ksoftirqd/2]
root        27         2  0  00:39 ?        00:00:00 [kworker/2:0-events]
root        28         2  0  00:39 ?        00:00:00 [kworker/2:0H-events_highpri]
root        29         2  0  00:39 ?        00:00:00 [cpuhp/3]
root        30         2  0  00:39 ?        00:00:00 [idle_inject/3]
root        31         2  0  00:39 ?        00:00:00 [migration/3]
root        32         2  0  00:39 ?        00:00:00 [ksoftirqd/3]
root        33         2  0  00:39 ?        00:00:00 [kworker/3:0-events]
root        34         2  0  00:39 ?        00:00:00 [kworker/3:0H-events_highpri]
root        35         2  0  00:39 ?        00:00:00 [cpuhp/4]
root        36         2  0  00:39 ?        00:00:00 [idle_inject/4]
root        37         2  0  00:39 ?        00:00:00 [migration/4]
```

“ps -aux | more” command:



A terminal window showing the output of the command 'ps -aux | more'. The output is a detailed list of processes with columns: USER, PID, NCPUs, MEM, VSZ, RSS, TTY, STAT, START, TIME, and COMMAND. The processes listed include system daemons like /sbin/init, kthreadd, rcu\_gp, rcu\_par\_gp, kworker/0:0-events, kworker/0:0H-events\_highpri, kworker/0:1-events, kworker/u24:0-events\_unbound, mm\_percpu\_wq, rcu\_tasks\_rude, rcu\_tasks\_trace, ksoftirqd/0, rcu\_sched, migration/0, idle\_inject/0, cpuhp/0, cpuhp/1, idle\_inject/1, migration/1, ksoftirqd/1, kworker/1:0-events, kworker/1:0H-events\_highpri, cpuhp/2, idle\_inject/2, migration/2, ksoftirqd/2, kworker/2:0-events, kworker/2:0H-events\_highpri, cpuhp/3, idle\_inject/3, migration/3, ksoftirqd/3, kworker/3:0-events, kworker/3:0H-events\_highpri, cpuhp/4, idle\_inject/4, migration/4, kworker/4:0-pm, kworker/4:0H-events\_highpri, cpuhp/5, idle\_inject/5, migration/5, kworker/5:0-cgroup\_destroy, kworker/5:0H-events\_highpri, cpuhp/6, idle\_inject/6, migration/6, ksoftirqd/6, kworker/6:0-events, kworker/6:0H-kblockd, and cpuhp/7.

```
priti@priti:~/Documents$ ps -aux | more
USER        PID  NCPUs  MEM  VSZ  RSS  TTY          STAT  START  TIME  COMMAND
root         1    0.5  0.0 167780 11716 ?        Ss   00:39  0:01 /sbin/init splash
root         2    0.0  0.0  0  0 ?        S    00:39  0:00 [kthreadd]
root         3    0.0  0.0  0  0 ?        I<   00:39  0:00 [rcu_gp]
root         4    0.0  0.0  0  0 ?        I<   00:39  0:00 [rcu_par_gp]
root         5    0.0  0.0  0  0 ?        I    00:39  0:00 [kworker/0:0-events]
root         6    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/0:0H-events_highpri]
root         7    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/0:1-events]
root         8    0.0  0.0  0  0 ?        I    00:39  0:00 [kworker/u24:0-events_unbound]
root         9    0.0  0.0  0  0 ?        I<   00:39  0:00 [mm_percpu_wq]
root        10    0.0  0.0  0  0 ?        S    00:39  0:00 [rcu_tasks_rude_]
root        11    0.0  0.0  0  0 ?        S    00:39  0:00 [rcu_tasks_trace]
root        12    0.0  0.0  0  0 ?        S    00:39  0:00 [ksoftirqd/0]
root        13    0.0  0.0  0  0 ?        I    00:39  0:00 [rcu_sched]
root        14    0.0  0.0  0  0 ?        S    00:39  0:00 [migration/0]
root        15    0.0  0.0  0  0 ?        S    00:39  0:00 [idle_inject/0]
root        16    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/0]
root        17    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/1]
root        18    0.0  0.0  0  0 ?        S    00:39  0:00 [idle_inject/1]
root        19    0.0  0.0  0  0 ?        S    00:39  0:00 [migration/1]
root        20    0.0  0.0  0  0 ?        S    00:39  0:00 [ksoftirqd/1]
root        21    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/1:0-events]
root        22    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/1:0H-events_highpri]
root        23    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/2]
root        24    0.0  0.0  0  0 ?        S    00:39  0:00 [idle_inject/2]
root        25    0.0  0.0  0  0 ?        S    00:39  0:00 [migration/2]
root        26    0.0  0.0  0  0 ?        S    00:39  0:00 [ksoftirqd/2]
root        27    0.0  0.0  0  0 ?        I    00:39  0:00 [kworker/2:0-events]
root        28    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/2:0H-events_highpri]
root        29    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/3]
root        30    0.0  0.0  0  0 ?        S    00:39  0:00 [idle_inject/3]
root        31    0.0  0.0  0  0 ?        S    00:39  0:00 [migration/3]
root        32    0.0  0.0  0  0 ?        S    00:39  0:00 [ksoftirqd/3]
root        33    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/3:0-events]
root        34    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/3:0H-events_highpri]
root        35    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/4]
root        36    0.0  0.0  0  0 ?        S    00:39  0:00 [idle_inject/4]
root        37    0.0  0.0  0  0 ?        S    00:39  0:00 [migration/4]
root        38    0.0  0.0  0  0 ?        S    00:39  0:00 [ksoftirqd/4]
root        39    0.0  0.0  0  0 ?        I    00:39  0:00 [kworker/4:0-pm]
root        40    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/4:0H-events_highpri]
root        41    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/5]
root        42    0.0  0.0  0  0 ?        S    00:39  0:00 [idle_inject/5]
root        43    0.0  0.0  0  0 ?        S    00:39  0:00 [migration/5]
root        44    0.0  0.0  0  0 ?        S    00:39  0:00 [ksoftirqd/5]
root        45    0.0  0.0  0  0 ?        I    00:39  0:00 [kworker/5:0-cgroup_destroy]
root        46    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/5:0H-events_highpri]
root        47    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/6]
root        48    0.0  0.0  0  0 ?        S    00:39  0:00 [idle_inject/6]
root        49    0.0  0.0  0  0 ?        S    00:39  0:00 [migration/6]
root        50    0.0  0.0  0  0 ?        S    00:39  0:00 [ksoftirqd/6]
root        51    0.0  0.0  0  0 ?        I    00:39  0:00 [kworker/6:0-events]
root        52    0.0  0.0  0  0 ?        I<   00:39  0:00 [kworker/6:0H-kblockd]
root        53    0.0  0.0  0  0 ?        S    00:39  0:00 [cpuhp/7]
```

To display all process, ps -e command is used. To view full format listing, ps -f is used. ps -aux displays the most amount of information of running processes including owner of the process, CPU percentage usage, memory percentage usage, running time etc.

The columns of the ps -aux command meaning:

- USER : The owner of the process
- PID : Process ID
- %CPU : Ratio of CPU time and the time the process has been running
- %MEM: Ratio of the process size and physical memory of the system
- VSZ : Virtual memory usage of the process in KiB (1024 bytes)
- RSS : Resident set size in KiB
- TTY : Controlling terminal
- STAT : Multi-character process state
- START : Starting time of the process
- TIME : Cumulative CPU time
- COMMAND : Command with all its arguments

For example,

```
prlt      3259  6.3  2.2 3780232 366572 ?        Sl    00:34   0:16 /usr/lib/firefox/firefox -new-window
```

In this process, the owner is prlt with process id of 3259. It uses 2.2 % of physical memory of the machine. The process started at 00:34 and is running for 16 minutes. At the very end of the line, the process is running for Firefox browser in the new window tab.

Again,

```
root      41  0.0  0.0    0    0 ?        S     00:12   0:00 [cpuhp/5]
```

In this process, owner of it is root and the process ID is 41. It does not use any memory. The process started at 00:12 and the cumulative runtime for this process is 0.

rootprocesses-1.txt, rootprocesses-2.txt, my-processes-1.txt and my-processes-2.txt are attached in the zip file. Most processes which are under 'root' owner start at the start of the system and in most cases, the processes do not show any memory usage in ps command. The starting time of the root processes 1 and 2 are different as the system was restarted in between.

However, the processes which are under 'prlt' owner depend on the user. After starting the system, the owner starts some processes such as opening browser, opening terminal. These processes can be found in the my-processes-1.txt and my-processes-2.txt files. In the first file, the Firefox browser was open. The result can be found in the process list. But in the second file, the Firefox browser was not launched. So, the details of that process cannot be found inside my-processes-2.txt file. These processes use the most memory and CPU time.

In the below figures, the command line of sorting the root and my processes are shown:

```
Activities Terminal Sep 19 00:36
priti@priti: ~/Documents
priti@priti:~/Documents$ ps -aux | more | grep root > rootprocesses-1.txt
priti@priti:~/Documents$ cat rootprocesses-1.txt
root      1  0.0  0.0 167784 11696 ?    Ss   00:12   0:01 /sbin/init splash
root      2  0.0  0.0   0   0 ?        S    00:12   0:00 [kthreadd]
root      3  0.0  0.0   0   0 ?        I<   00:12   0:00 [rcu_gp]
root      4  0.0  0.0   0   0 ?        I<   00:12   0:00 [rcu_par_gp]
root      6  0.0  0.0   0   0 ?        I<   00:12   0:00 [kworker/0:0H-events_highpri]
root      9  0.0  0.0   0   0 ?        I<   00:12   0:00 [mm_percpu_wq]
root     10  0.0  0.0   0   0 ?        S    00:12   0:00 [rcu_tasks_rude_]
root     11  0.0  0.0   0   0 ?        S    00:12   0:00 [rcu_tasks_trace]
root     12  0.0  0.0   0   0 ?        S    00:12   0:00 [ksoftirqd/0]
root     13  0.0  0.0   0   0 ?        I    00:12   0:00 [rcu_sched]
root     14  0.0  0.0   0   0 ?        S    00:12   0:00 [migration/0]
root     15  0.0  0.0   0   0 ?        S    00:12   0:00 [idle_inject/0]
root     16  0.0  0.0   0   0 ?        S    00:12   0:00 [cpuhp/0]
root     17  0.0  0.0   0   0 ?        S    00:12   0:00 [cpuhp/1]
root     18  0.0  0.0   0   0 ?        S    00:12   0:00 [idle_inject/1]
root     19  0.0  0.0   0   0 ?        S    00:12   0:00 [migration/1]
root     20  0.0  0.0   0   0 ?        S    00:12   0:00 [ksoftirqd/1]
root     22  0.0  0.0   0   0 ?        I<   00:12   0:00 [kworker/1:0H-events_highpri]
root     23  0.0  0.0   0   0 ?        S    00:12   0:00 [cpuhp/2]
root     24  0.0  0.0   0   0 ?        S    00:12   0:00 [idle_inject/2]
root     25  0.0  0.0   0   0 ?        S    00:12   0:00 [migration/2]
root     26  0.0  0.0   0   0 ?        S    00:12   0:00 [ksoftirqd/2]
root     28  0.0  0.0   0   0 ?        I<   00:12   0:00 [kworker/2:0H-events_highpri]
root     29  0.0  0.0   0   0 ?        S    00:12   0:00 [cpuhp/3]
root     30  0.0  0.0   0   0 ?        S    00:12   0:00 [idle_inject/3]
root     31  0.0  0.0   0   0 ?        S    00:12   0:00 [migration/3]
root     32  0.0  0.0   0   0 ?        S    00:12   0:00 [ksoftirqd/3]
root     34  0.0  0.0   0   0 ?        I<   00:12   0:00 [kworker/3:0H-events_highpri]
root     35  0.0  0.0   0   0 ?        S    00:12   0:00 [cpuhp/4]
root     36  0.0  0.0   0   0 ?        S    00:12   0:00 [idle_inject/4]
root     37  0.0  0.0   0   0 ?        S    00:12   0:00 [migration/4]
root     38  0.0  0.0   0   0 ?        S    00:12   0:00 [ksoftirqd/4]
root     40  0.0  0.0   0   0 ?        I<   00:12   0:00 [kworker/4:0H-events_highpri]
root     41  0.0  0.0   0   0 ?        S    00:12   0:00 [cpuhp/5]
root     42  0.0  0.0   0   0 ?        S    00:12   0:00 [idle_inject/5]
root     43  0.0  0.0   0   0 ?        S    00:12   0:00 [migration/5]
root     44  0.0  0.0   0   0 ?        S    00:12   0:00 [ksoftirqd/5]
root     46  0.0  0.0   0   0 ?        I<   00:12   0:00 [kworker/5:0H-events_highpri]
root     47  0.0  0.0   0   0 ?        S    00:12   0:00 [cpuhp/6]
root     48  0.0  0.0   0   0 ?        S    00:12   0:00 [idle_inject/6]
root     49  0.0  0.0   0   0 ?        S    00:12   0:00 [migration/6]
```

```
Activities Terminal Sep 19 00:38
priti@priti: ~/Documents
priti  1796  0.0  0.1 428884 29708 ?    Ssl  00:14   0:00 /usr/libexec/gsd-mouse-keye
priti  1796  0.0  0.1 428884 29708 ?    Ssl  00:12   0:00 /usr/libexec/gsd-power
priti  1802  0.0  0.0 256852 11272 ?    Ssl  00:12   0:00 /usr/libexec/gsd-print-notifications
priti  1804  0.0  0.0 465732 6100 ?    Ssl  00:12   0:00 /usr/libexec/gsd-rfkill
priti  1805  0.0  0.0 244140 6088 ?    Ssl  00:12   0:00 /usr/libexec/gsd-screensaver-proxy
priti  1806  0.0  0.0 473408 10532 ?    Ssl  00:12   0:00 /usr/libexec/gsd-sharing
priti  1808  0.0  0.0 323776 8424 ?    Ssl  00:12   0:00 /usr/libexec/gsd-smartcard
priti  1811  0.0  0.0 329772 9004 ?    Ssl  00:12   0:00 /usr/libexec/gsd-sound
priti  1814  0.0  0.0 303576 7884 ?    Ssl  00:12   0:00 /usr/libexec/gsd-usb-protection
priti  1818  0.0  0.1 354080 28064 ?    Ssl  00:12   0:00 /usr/libexec/gsd-wacom
priti  1824  0.0  0.0 322600 8100 ?    Ssl  00:12   0:00 /usr/libexec/gsd-wwan
priti  1825  0.0  0.1 355192 29416 ?    Ssl  00:12   0:00 /usr/libexec/gsd-xsettings
priti  1829  0.0  0.0 171328 7608 ?    Sl   00:12   0:00 /usr/libexec/ibus-engine-simple
priti  1844  0.0  0.0 231800 5600 ?    Sl   00:12   0:00 /usr/libexec/gsd-disk-utility-notify
priti  1858  0.0  0.3 646440 61300 ?    Sl   00:12   0:00 /usr/libexec/evolution-data-server/evolution-alarm-notify
priti  1904  0.0  0.0 350820 15140 ?    Sl   00:12   0:00 /usr/libexec/gsd-printer
priti  2359  0.0  0.1 429004 31744 ?    Sl   00:13   0:00 update-notifier
priti  2362  0.0  0.0 170920 6296 ?    Ssl  00:13   0:00 /usr/libexec/gvfsd-metadata
priti  2603  1.9  0.3 823972 51628 ?    Ssl  00:15  0:27 /usr/libexec/gnome-terminal-server
priti  2701  0.0  0.0 192408 4844 pts/0  Ss   00:15   0:00 bash
root   2920  0.0  0.0   0   0 ?        I    00:19   0:00 [kworker/0:0-events]
root   2923  0.0  0.0   0   0 ?        I    00:19   0:00 [kworker/1:0-events]
root   2961  0.0  0.0   0   0 ?        I    00:19   0:00 [kworker/11:0-events]
root   3120  0.0  0.0   0   0 ?        I    00:23   0:00 [kworker/7:1-events]
root   3163  0.0  0.0   0   0 ?        I    00:25   0:00 [kworker/10:0-events]
root   3179  0.0  0.0   0   0 ?        I    00:25   0:00 [kworker/8:1-mm_percpu_wq]
root   3183  0.0  0.0   0   0 ?        I    00:26   0:00 [kworker/6:0-mm_percpu_wq]
root   3198  0.0  0.0   0   0 ?        I    00:30   0:00 [kworker/7:0-mm_percpu_wq]
root   3208  0.0  0.0   0   0 ?        I    00:32   0:00 [kworker/9:0-mm_percpu_wq]
root   3229  0.0  0.0   0   0 ?        I    00:33   0:00 [kworker/u24:0-l915]
root   3231  0.1  0.0   0   0 ?        I    00:33   0:00 [kworker/3:0-events]
root   3251  0.0  0.0   0   0 ?        I    00:34   0:00 [kworker/6:2-events]
root   3254  0.0  0.0   0   0 ?        I    00:34   0:00 [kworker/u24:1-ext4-rsv-conversion]
root   3255  0.0  0.0   0   0 ?        I    00:34   0:00 [kworker/1:2-events]
root   3257  0.0  0.0   0   0 ?        I    00:34   0:00 [kworker/10:2-mm_percpu_wq]
priti  3259  6.3  2.2 3780232 366572 ?  Sl   00:34   0:16 /usr/lib/firefox/firefox -new-window
priti  3352  0.7  0.8 2449404 130380 ?  Sl   00:34   0:01 /usr/lib/firefox/firefox -contentproc -childID 1 -IsForBrowser -prefsLen 1 -prefMapSize 239617 -jsInit 285716 -parentBuildID 20210903235
534 -appdir /usr/lib/firefox/browser 3259 true tab
priti  3389 5.5 2.4 2953312 394068 ?  Sl   00:34   0:13 /usr/lib/firefox/firefox -contentproc -childID 2 -IsForBrowser -prefsLen 167 -prefMapSize 239617 -jsInit 285716 -parentBuildID 202109032
3534 -appdir /usr/lib/firefox/browser 3259 true tab
priti  3399 0.9 0.9 2503368 157472 ?  Sl   00:34   0:02 /usr/lib/firefox/firefox -contentproc -childID 3 -IsForBrowser -prefsLen 167 -prefMapSize 239617 -jsInit 285716 -parentBuildID 202109032
3534 -appdir /usr/lib/firefox/browser 3259 true tab
priti  3413 2.4 1.4 2654424 234724 ?  Sl   00:34   0:06 /usr/lib/firefox/firefox -contentproc -childID 4 -IsForBrowser -prefsLen 167 -prefMapSize 239617 -jsInit 285716 -parentBuildID 202109032
3534 -appdir /usr/lib/firefox/browser 3259 true tab
priti  3476 0.3 0.6 2438784 99760 ?  Sl   00:34   0:00 /usr/lib/firefox/firefox -contentproc -childID 5 -IsForBrowser -prefsLen 5190 -prefMapSize 239617 -jsInit 285716 -parentBuildID 20210903
23534 -appdir /usr/lib/firefox/browser 3259 true tab
priti  3532 0.0 0.0   0   0 ?        I<   00:34   0:00 [kworker/u25:1-rb_allocator]
priti  3561 0.0 0.4 2397932 73144 ?  Sl   00:34   0:00 /usr/lib/firefox/firefox -contentproc -childID 6 -IsForBrowser -prefsLen 6087 -prefMapSize 239617 -jsInit 285716 -parentBuildID 20210903
23534 -appdir /usr/lib/firefox/browser 3259 true tab
root   3600 0.0 0.0   0   0 ?        I    00:34   0:00 [kworker/11:1-mm_percpu_wq]
priti  3601 0.0 0.2 260780 42376 ?  Sl   00:34   0:00 /usr/lib/firefox/firefox -contentproc -parentBuildID 2021090323534 -prefsLen 6153 -prefMapSize 239617 -appdir /usr/lib/firefox/browser
3259 true rdd
priti  3641 0.0 0.0 459000 8206 ?  Sl   00:34   0:00 /usr/lib/speech-dispatcher/modules/sd_espeak-ng/etc/speech-dispatcher/modules/espeak-ng.conf
priti  3647 0.0 0.0 360004 5656 ?  Sl   00:34   0:00 /usr/lib/speech-dispatcher/modules/sd_dummy/etc/speech-dispatcher/modules/dummy.conf
priti  3659 0.0 0.0 168364 2224 ?  Ssl  00:34   0:00 /usr/lib/speech-dispatcher --spawn --communication-method unix socket --socket-path /run/user/1000/speech-dispatcher/speechd.sock
```

3. Python code file is attached inside the zip file. The code runs for values from 1 to  $\sqrt{N}$  for more efficiency.

It returns True if the input number is perfect number and otherwise returns False.

Here's a screenshot:

```
D:\Courses\CS 646 Principal of Operating System\HW1\Submission-HW1>py perfectNumberMultithreading.py
Number: 1500
Number of threads: 1
False

D:\Courses\CS 646 Principal of Operating System\HW1\Submission-HW1>py perfectNumberMultithreading.py
Number: 8128
Number of threads: 1500
True
```