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Experiment No 7

Aim:

To implement memory management using linux commands.

Theory:

Memory management is an essential aspect of every System Administrator to improve the performance of a Linux system. It is always a good practice to monitor swap space usage in Linux to ensure that your system operates relative to its memory demands.

What is Swap space?

Swap space is a restricted amount of physical memory that is allocated for use by the operating system when available memory has been fully utilized. It is memory management that involves swapping sections of memory to and from physical storage.

On most distributions of Linux, it is recommended that you set swap space when installing the operating system. The amount of swap space you can set for your Linux system may depend on the architecture and kernel version.

1. Using the swapon Command

This command helps you to specify the devices on which paging and swapping will be done and we shall look at few important options.

To view all devices marked as swap in the /etc/fstab file you can use the `--all` option. Though devices that are already working as swap space are skipped.

```
# swapon --all
```

If you want to view a summary of swap space usage by device, use the `--summary` option as follows.

swapon --summary

Filename	Priority	Type	Size	Used
/dev/sda10		partition	8282108	0
				-1

Use `--help` option to view help information or open the manpage for more usage options.

2. Using /proc/swaps which is equivalent to swapon

The /proc filesystem is a very special virtual filesystem in Linux. It is also referred to as a process information pseudo-file system.

It actually does not contain 'real' files but runtime system information, for example system memory, devices mounted, hardware configuration and many more. Therefore you can also refer to it as a control and information base for the kernel.

To check swap usage information, you can view the /proc/swaps file using the cat utility.

cat /proc/swaps

Filename	Priority	Type	Size	Used
/dev/sda10		partition	8282108	0
				-1

3. Using 'free' Command

The free command is used to display the amount of free and used system memory. Using the free command with -h option, which displays output in a human readable format.

free -h

	total	used	free	shared	buffers	cached
Mem:	7.7G	4.7G	3.0G	408M	182M	1.8G
-/+ buffers/cache:		2.7G	5.0G			
Swap:	7.9G	0B	7.9G			

From the output above, you can see that the last line provides information about the system swap space.

4. Using top Command

The top command displays processor activity of your Linux system, tasks managed by kernel in real-time.

```
# top
```

```
top - 16:04:38 up 5:48, 2 users, load average: 1.72, 1.88, 1.99
Tasks: 206 total, 2 running, 204 sleeping, 0 stopped, 0 zombie
%Cpu(s): 9.5 us, 1.2 sy, 0.0 ni, 87.4 id, 1.9 wa, 0.0 hi, 0.0 si, 0.0 st
KiB Mem: 8066460 total, 4938956 used, 3127504 free, 187268 buffers
KiB Swap: 8282108 total, 0 used, 8282108 free, 1913420 cached Mem
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
2788	tecmint	20	0	20.742g	1.260g	65240	S	24.6	16.4	95:05.84	firefox
3991	tecmint	20	0	713320	187596	27772	S	8.3	2.3	21:38.86	plugin-cont+
2481	tecmint	20	0	1458560	60508	36788	S	7.7	0.8	0:33.95	caja
1640	root	20	0	587500	180176	154232	S	2.3	2.2	7:59.56	Xorg
2403	tecmint	20	0	651556	16864	11940	S	0.7	0.2	0:21.79	wnck-applet
2959	tecmint	20	0	1301428	177200	65468	S	0.7	2.2	3:40.00	chrome
7	root	20	0	0	0	0	R	0.3	0.0	0:04.52	rcu_sched
2365	tecmint	20	0	763932	19820	12764	S	0.3	0.2	0:13.68	marco
5648	root	20	0	0	0	0	S	0.3	0.0	0:11.24	kworker/2:2
8674	tecmint	20	0	738408	18524	13296	S	0.3	0.2	0:01.13	mate-termin+
9535	root	20	0	0	0	0	S	0.3	0.0	0:00.51	kworker/ul6+
10145	tecmint	20	0	24948	1700	1172	R	0.3	0.0	0:00.05	top
1	root	20	0	33896	3196	1504	S	0.0	0.0	0:01.88	init
2	root	20	0	0	0	0	S	0.0	0.0	0:00.00	kthreadd
3	root	20	0	0	0	0	S	0.0	0.0	0:00.05	ksoftirqd/0
5	root	0	-20	0	0	0	S	0.0	0.0	0:00.00	kworker/0:0H
8	root	20	0	0	0	0	S	0.0	0.0	0:01.26	rcuos/0

5. Using atop Command

The atop command is a system monitor that reports about activities of various processes. But importantly it also shows information about free and used memory space.

```
# atop
```

ATOP - tecmint		2015/10/12		16:19:50		-----		10s elapsed		
PRC	sys	0.59s	user	5.80s	#proc	208	#zombie	0	#exit	?
CPU	sys	5%	user	57%	irq	0%	idle	331%	wait	7%
cpu	sys	1%	user	19%	irq	0%	idle	79%	cpu001 w	0%
cpu	sys	1%	user	18%	irq	0%	idle	77%	cpu003 w	4%
cpu	sys	1%	user	10%	irq	0%	idle	88%	cpu000 w	0%
cpu	sys	2%	user	9%	irq	0%	idle	87%	cpu002 w	2%
CPL	avg1	1.77	avg5	1.90	avg15	1.92	csw	25299	intr	9799
MEM	tot	7.7G	free	2.7G	cache	1.9G	buff	185.7M	slab	164.3M
SWP	tot	7.9G	free	7.9G			vmcom	6.6G	vmlim	11.7G
DSK	sda	busy	5%	read	0		write	82	avio	6.44 ms
NET	transport	tcpi	48	tcpo	57		udpi	27	udpo	26
NET	network	ipi	75	ipo	83		ipfrw	0	deliv	75
NET	eth0	0%	pcki	61	pcko	69	si	19 Kbps	so	6 Kbps
NET	lo	----	pcki	14	pcko	14	si	2 Kbps	so	2 Kbps
NET	wlan0	----	pcki	1	pcko	0	si	0 Kbps	so	0 Kbps

PID	SYSCPU	USRCPU	VGROW	RGROW	RUID	THR	ST	EXC	S	CPU	CMD	1/8
2788	0.06s	2.96s	-384K	-26.7M	tecmint	59	--	-	R	30%	firefox	
3092	0.04s	1.08s	-6144K	-7612K	tecmint	13	--	-	S	11%	chrome	
3991	0.19s	0.53s	0K	0K	tecmint	8	--	-	S	7%	plugin-contain	
2481	0.01s	0.34s	0K	0K	tecmint	5	--	-	S	4%	caja	
1640	0.13s	0.14s	-6720K	-4648K	root	3	--	-	S	3%	Xorg	
3476	0.00s	0.25s	492K	260K	tecmint	4	--	-	S	3%	pluma	

6. Using htop Command

The htop command is used to view processes in an interactive mode and also displays information about memory usage.

```
# htop
```

1	[]	6.8%	Tasks: 114, 351 thr; 2 running
2	[]	11.8%	Load average: 1.02 1.89 1.92
3	[]	10.1%	Uptime: 06:06:48
4	[]	4.0%	
Mem	[]	2938/7877MB	
Swp	[]	0/8087MB	

PID	USER	PRI	NI	VIRT	RES	SHR	S	CPU%	MEM%	TIME+	Command
2788	tecmint	20	0	2795M	1349M	65416	S	9.3	17.1	1h42:36	firefox
3991	tecmint	20	0	696M	183M	27688	S	7.3	2.3	23:02.67	/home/tecmint/fire
2481	tecmint	20	0	1438M	60488	36656	S	6.7	0.7	0:38.57	caja -n
1640	root	20	0	639M	219M	193M	S	3.3	2.8	8:32.99	/usr/bin/X :0 -aud
2403	tecmint	20	0	651M	17188	11960	S	2.7	0.2	0:24.23	/usr/lib/mate-pane
2802	tecmint	20	0	2795M	1349M	65416	S	2.0	17.1	1:17.12	firefox
2959	tecmint	20	0	1281M	174M	65680	S	1.3	2.2	3:57.34	/opt/google/chrome
2799	tecmint	20	0	2795M	1349M	65416	S	1.3	17.1	1:16.64	firefox
10202	tecmint	20	0	680M	37536	10888	S	0.7	0.5	0:05.60	/opt/google/chrome
11574	tecmint	20	0	26040	2328	1436	R	0.7	0.0	0:00.13	htop
1713	root	20	0	156M	15956	4320	S	0.7	0.2	0:14.14	/opt/teamviewer/tv
11091	tecmint	20	0	680M	37536	10888	S	0.0	0.5	0:00.22	/opt/google/chrome
1758	root	20	0	156M	15956	4320	S	0.0	0.2	0:03.41	/opt/teamviewer/tv
2365	tecmint	20	0	760M	19780	12724	S	0.0	0.2	0:14.65	marco

F1	Help	F2	Setup	F3	Search	F4	Filter	F5	Free	F6	SortBy	F7	Nice	F8	Nice	F9	Kill	F10	Quit
----	------	----	-------	----	--------	----	--------	----	------	----	--------	----	------	----	------	----	------	-----	------

7. Using the Glances Command

This is a cross-platform system monitoring tool that displays information about running processes, cpu load, storage space usage, memory usage, swap space usage and many more.

```
# glances
```

```
LinuxMint 17.1 64bit with Linux 3.13.0-37-generic on tecmint.com

CPU      29.4%   Load  4-core   Mem    37.8%  active:  3.38G   Swap    0.0%
user:    26.7%   1 min:  1.75   total:  7.69G  inactive: 1.32G  total:  7.90G
system:  1.6%   5 min:  1.83  used:    2.91G  buffers:   188M  used:    0
idle:    70.6% 15 min:  1.89  free:    4.78G  cached:   1.90G  free:   7.90G

Network  Rx/s    Tx/s    Processes 207, 1 running, 206 sleeping, 0 other
eth0     27Kb    26Kb
lo        7Kb     7Kb
wlan0     0b       0b

Disk I/O In/s    Out/s
sda1      0        0    2.7G  1.4G  44.8  17.6 firefox
sda10     0        0    947M  82M   32.6   1.0 mintmenu
sda2      0        0    1.4G  59M    7.5   0.7 caja -n
sda3      0        0    696M  183M   7.2   2.3 plugin-container
sda4      0        0    614M  188M   2.9   2.4 Xorg
sda5      0        0    651M  17M    2.3   0.2 /usr/lib/mate-panel/wnck-applet
sda6      0        0    776M  26M    2.3   0.3 pluma
sda7      0        0    76M   14M    2.3   0.2 glances
sda8      0        0    737M  20M    1.6   0.2 mate-terminal
sda9      0        0    761M  20M    1.0   0.2 marco
sda10     0        0    580M  13M    0.7   0.2 mate-volume-control-applet
sda11     0        0     0    0    0.3   0.0 khugepaged

Press 'h' for help                                     2015-10-12 16:28:32
```

8. Using the vmstat Command

This command is used to display information about virtual memory statistics. To install vmstat on your Linux system, you can read the article below and see more usage examples:

[Linux Performance Monitoring with Vmstat](#)

```
# vmstat
```

```

tecmint ~ vmstat
procs -----memory----- --swap-- -----io-----system-- -----cpu-----
r b swpd free buff cache si so bi bo in cs us sy id wa st
2 0 0 2848452 193296 1989676 0 0 44 217 566 1011 25 4 69 1
0

tecmint ~ vmstat 2 6
procs -----memory----- --swap-- -----io-----system-- -----cpu-----
r b swpd free buff cache si so bi bo in cs us sy id wa st
1 0 0 2867304 193304 1990160 0 0 44 217 566 1011 25 4 69 1
0
1 0 0 2864540 193304 1990088 0 0 0 0 1653 2983 12 1 87 0
0
0 0 0 2855288 193304 1990088 0 0 0 0 532 1840 7 1 92 1
0
0 0 0 2850824 193324 1990072 0 0 0 284 419 1283 5 1 91 4
0
0 0 0 2870372 193324 1990088 0 0 0 0 475 1280 9 1 90 1
0
0 0 0 2867692 193324 1990088 0 0 2 0 2120 2143 11 1 87 1
0

tecmint ~ 

```

Commands:

Top

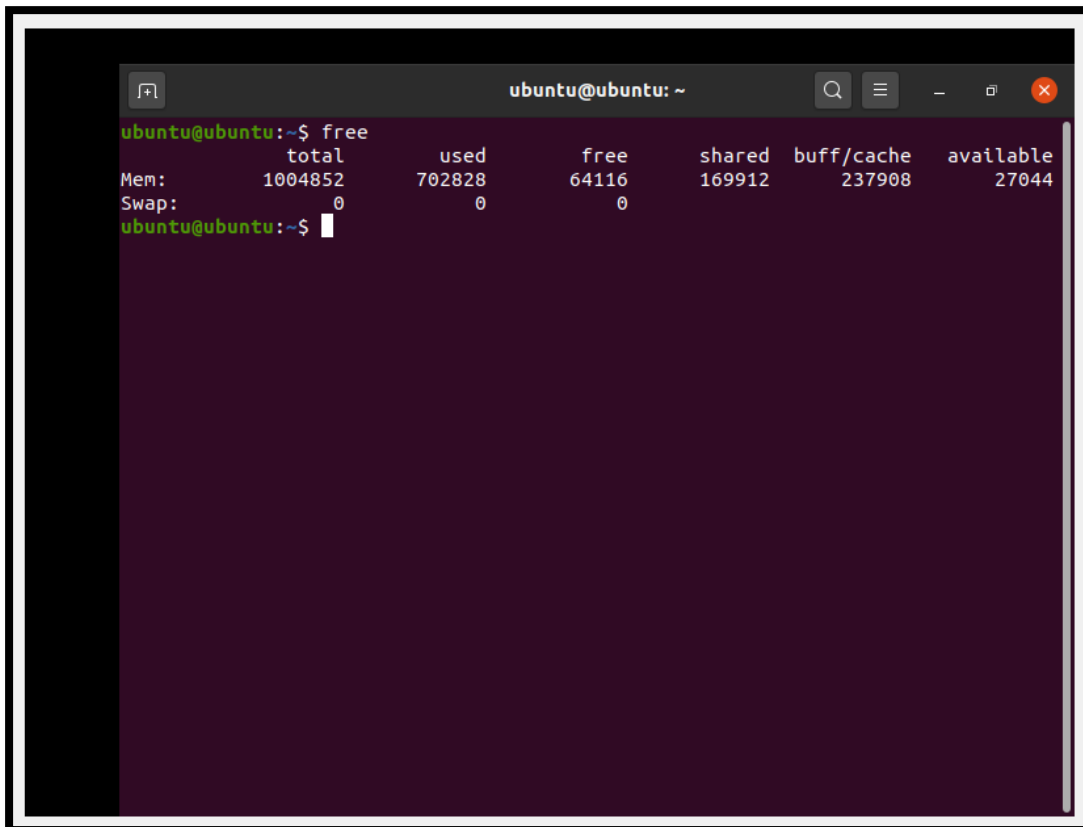
```

top - 12:18:58 up 8 min, 1 user, load average: 0.49, 2.33, 1.48
Tasks: 179 total, 1 running, 178 sleeping, 0 stopped, 0 zombie
%Cpu(s): 3.7 us, 1.0 sy, 0.0 ni, 95.3 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem : 981.3 total, 61.1 free, 677.2 used, 243.0 buff/cache
MiB Swap: 0.0 total, 0.0 free, 0.0 used. 87.2 avail Mem

  PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM    TIME+  COMMAND
 6526 ubuntu    20   0 3352368 198888 25332 S   3.0   19.8   0:30.57 gnome-+
 7205 ubuntu    20   0 967704   19240  7008 S   1.0    1.9   0:02.36 gnome-+
 6309 ubuntu    20   0 216008   24888  6332 S   0.7    2.5   0:03.09 Xorg
 7486 ubuntu    20   0  22224    3940  3284 R   0.7    0.4   0:00.15 top
   250 root      -51   0     0     0     0 S   0.3    0.0   0:00.15 irq/18+
 6769 root      20   0 719060   13132   504 S   0.3    1.3   0:01.12 snapd
    1 root      20   0 168928   6476  1900 S   0.0    0.6   0:08.88 systemd
    2 root      20   0     0     0     0 S   0.0    0.0   0:00.00 kthrea+
    3 root      0 -20     0     0     0 I   0.0    0.0   0:00.00 rcu_gp
    4 root      0 -20     0     0     0 I   0.0    0.0   0:00.00 rcu_pa+
    6 root      0 -20     0     0     0 I   0.0    0.0   0:00.00 kworke+
    8 root      20   0     0     0     0 I   0.0    0.0   0:00.00 kworke+
    9 root      0 -20     0     0     0 I   0.0    0.0   0:00.00 mm_per+
   10 root      20   0     0     0     0 S   0.0    0.0   0:02.88 ksofti+
   11 root      20   0     0     0     0 I   0.0    0.0   0:02.55 rcu_sc+
   12 root      rt   0     0     0     0 S   0.0    0.0   0:00.01 migrat+
   13 root     -51   0     0     0     0 S   0.0    0.0   0:00.00 idle_i+
   14 root      20   0     0     0     0 S   0.0    0.0   0:00.00 cpuhp/0
   15 root      20   0     0     0     0 S   0.0    0.0   0:00.00 kdevtm+
   16 root      0 -20     0     0     0 I   0.0    0.0   0:00.00 netns
   17 root      20   0     0     0     0 S   0.0    0.0   0:00.00 rcu_ta+
   18 root      20   0     0     0     0 S   0.0    0.0   0:00.00 kauditd

```

Free



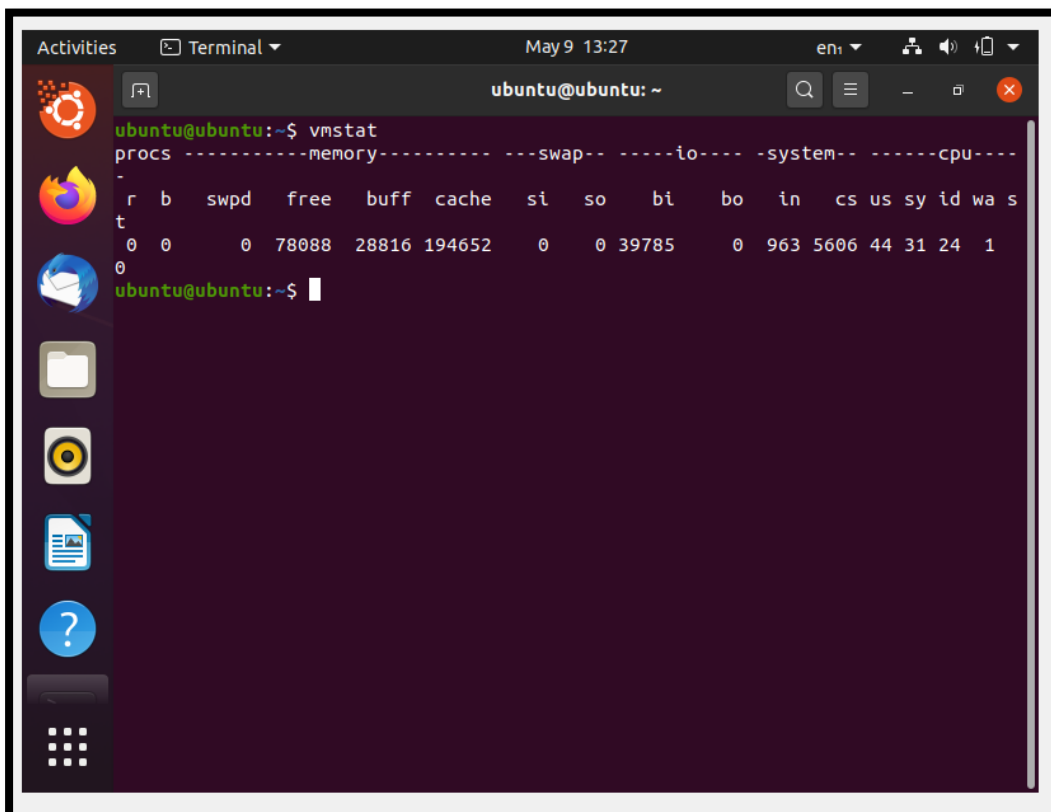
A terminal window titled 'ubuntu@ubuntu: ~' showing the output of the 'free' command. The output is a table with 7 columns: total, used, free, shared, buff/cache, and available. The rows are for Mem and Swap.

```
ubuntu@ubuntu:~$ free
```

	total	used	free	shared	buff/cache	available
Mem:	1004852	702828	64116	169912	237908	27044
Swap:	0	0	0			

```
ubuntu@ubuntu:~$
```

Vmstat



A terminal window titled 'ubuntu@ubuntu: ~' showing the output of the 'vmstat' command. The output is a table with 17 columns:procs,-----memory-----,---swap--,-----io----,--system--,-----cpu----. The rows are for r, b, swpd, free, buff, cache, si, so, bi, bo, in, cs, us, sy, id, wa, s.

```
ubuntu@ubuntu:~$ vmstat
```

procs	-----memory-----	---swap--	-----io----	--system--	-----cpu----											
r	b	swpd	free	buff	cache	si	so	bi	bo	in	cs	us	sy	id	wa	s
0	0	0	78088	28816	194652	0	0	39785	0	963	5606	44	31	24	1	

```
ubuntu@ubuntu:~$
```

Vmstat -a

```
Activities Terminal May 9 13:42 en1 ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ vmstat
procs -----memory----- --swap-- -----io----- -system-- -----cpu-----
r b swpd free buff cache si so bi bo in cs us sy id wa s
t
0 0 0 71572 33168 233284 0 0 70922 0 1780 9798 21 69 9 1
0
ubuntu@ubuntu:~$ vmstat -a
procs -----memory----- --swap-- -----io----- -system-- -----cpu-----
r b swpd free inact active si so bi bo in cs us sy id wa s
t
3 0 0 87424 132344 642788 0 0 70306 0 1765 9717 21 69 9 1
0
ubuntu@ubuntu:~$
```

Vmstat -d

```
Activities Terminal May 9 13:42 en1 ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ vmstat
procs -----memory----- --swap-- -----io----- -system-- -----cpu-----
r b swpd free buff cache si so bi bo in cs us sy id wa s
t
4 0 0 94176 35092 241880 0 0 66041 0 1662 9142 20 65 15 1
0
ubuntu@ubuntu:~$ vmstat -d
disk- -----reads----- -----writes----- -----IO-----
total merged sectors ms total merged sectors ms cur sec
loop0 11141735 0 22294694 30138208 0 0 0 0 0
386
loop1 38922 0 79862 4813 0 0 0 0 0 4
loop2 64 0 726 0 0 0 0 0 0 0
loop3 75 0 2146 0 0 0 0 0 0 0
loop4 59 0 728 1 0 0 0 0 0 0
loop5 0 0 0 0 0 0 0 0 0 0
loop6 0 0 0 0 0 0 0 0 0 0
loop7 0 0 0 0 0 0 0 0 0 0
sr0 733732 8839 58680132 307914 0 0 0 0 0 38
6
sda 1152 1 59347 734 16 0 0 76 0 0
ubuntu@ubuntu:~$
```

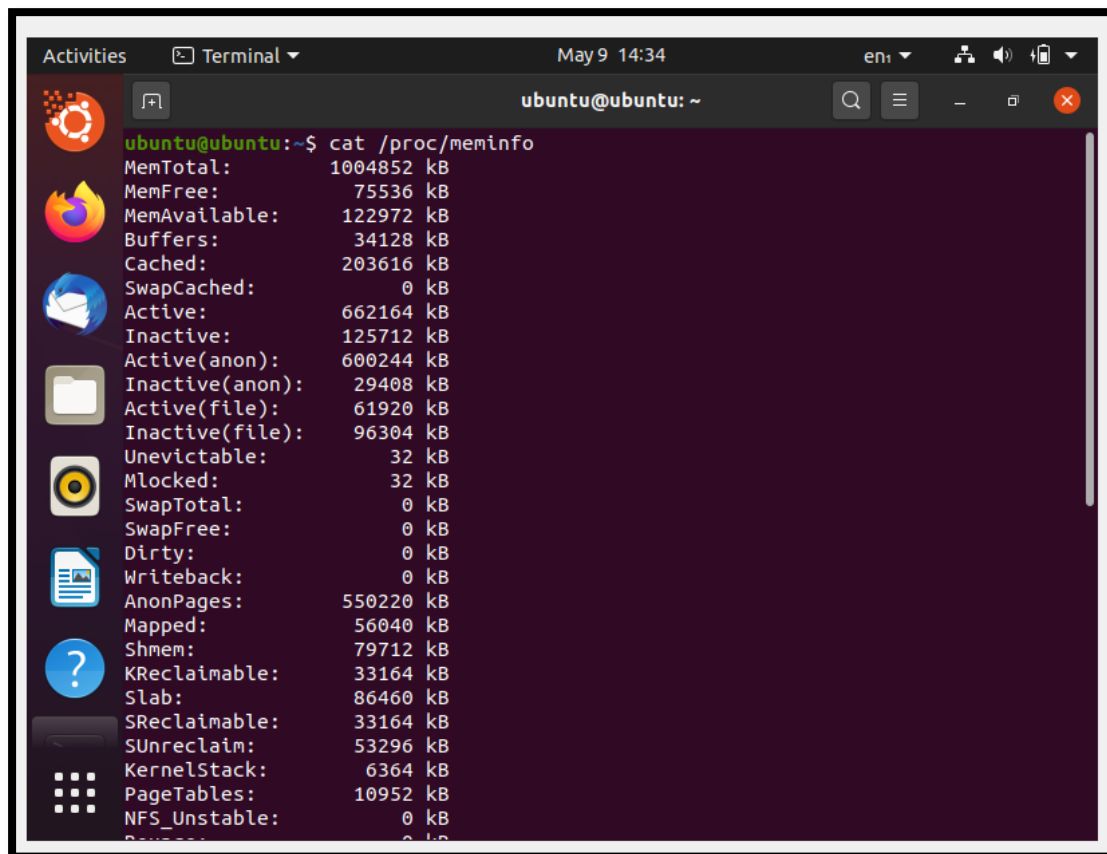

Vmstat -D

```
Activities Terminal May 9 13:43 en1 ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ vmstat
procs -----memory----- ---swap-- ----io---- -system-- -----cpu----
r b swpd free buff cache si so bi bo in cs us sy id wa s
0 0 0 90180 40444 241252 0 0 61441 0 1552 8531 19 60 21 1
0
ubuntu@ubuntu:~$ vmstat -D
10 disks
3 partitions
11931117 total reads
8843 merged reads
81189953 read sectors
30455814 milli reading
16 writes
0 merged writes
0 written sectors
76 milli writing
0 inprogress IO
776 milli spent IO
ubuntu@ubuntu:~$
```

Free/free -h

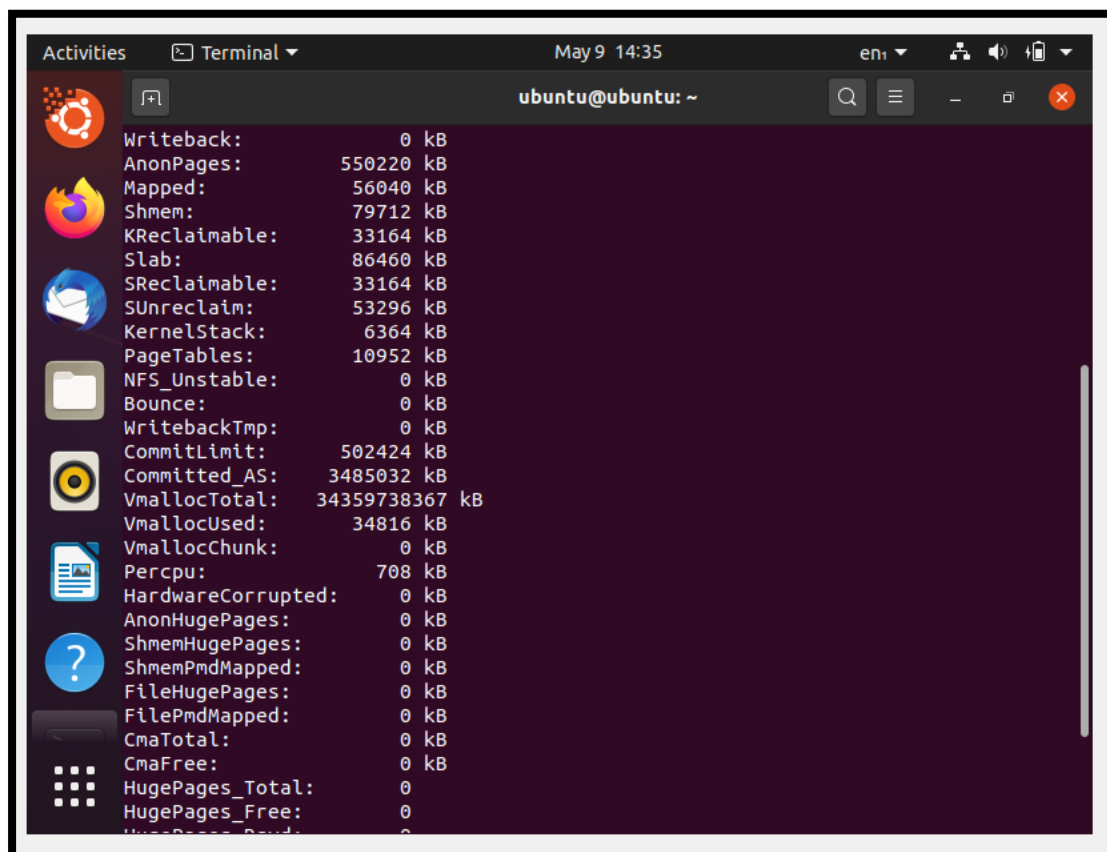
```
Activities Terminal May 9 13:45 en1 ubuntu@ubuntu: ~
ubuntu@ubuntu:~$ free
total used free shared buff/cache available
Mem: 1004852 631248 89040 79768 284564 150780
Swap: 0 0 0
ubuntu@ubuntu:~$ free -h
total used free shared buff/cache available
Mem: 981Mi 616Mi 86Mi 77Mi 277Mi 147Mi
Swap: 0B 0B 0B
ubuntu@ubuntu:~$
```

Cat /proc/meminfo



A terminal window titled 'Terminal' with a date and time of 'May 9 14:34'. The prompt is 'ubuntu@ubuntu: ~'. The command 'cat /proc/meminfo' has been executed, displaying the following memory statistics:

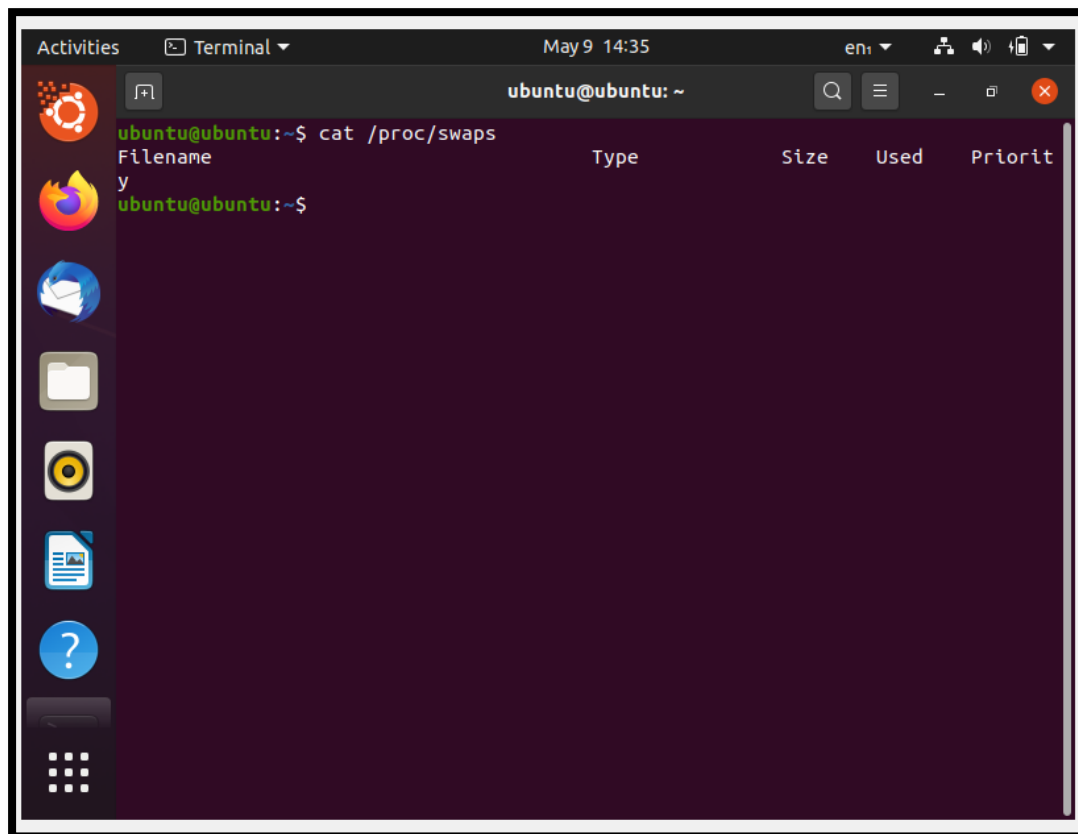
```
MemTotal:      1004852 kB
MemFree:       75536 kB
MemAvailable:  122972 kB
Buffers:       34128 kB
Cached:        203616 kB
SwapCached:    0 kB
Active:        662164 kB
Inactive:      125712 kB
Active(anon):  600244 kB
Inactive(anon): 29408 kB
Active(file):  61920 kB
Inactive(file): 96304 kB
Unevictable:   32 kB
Mlocked:       32 kB
SwapTotal:     0 kB
SwapFree:      0 kB
Dirty:         0 kB
Writeback:     0 kB
AnonPages:     550220 kB
Mapped:        56040 kB
Shmem:         79712 kB
KReclaimable:  33164 kB
Slab:          86460 kB
SReclaimable:  33164 kB
SUnreclaim:    53296 kB
KernelStack:   6364 kB
PageTables:    10952 kB
NFS_Unstable:  0 kB
```



A terminal window titled 'Terminal' with a date and time of 'May 9 14:35'. The prompt is 'ubuntu@ubuntu: ~'. The command 'cat /proc/meminfo' has been executed, displaying the continuation of the memory statistics:

```
Writeback:     0 kB
AnonPages:     550220 kB
Mapped:        56040 kB
Shmem:         79712 kB
KReclaimable:  33164 kB
Slab:          86460 kB
SReclaimable:  33164 kB
SUnreclaim:    53296 kB
KernelStack:   6364 kB
PageTables:    10952 kB
NFS_Unstable:  0 kB
Bounce:        0 kB
WritebackTmp:  0 kB
CommitLimit:   502424 kB
Committed_AS:  3485032 kB
VmallocTotal:  34359738367 kB
VmallocUsed:    34816 kB
VmallocChunk:   0 kB
Percpu:        708 kB
HardwareCorrupted: 0 kB
AnonHugePages: 0 kB
ShmemHugePages: 0 kB
ShmemPmdMapped: 0 kB
FileHugePages: 0 kB
FilePmdMapped: 0 kB
CmaTotal:      0 kB
CmaFree:       0 kB
HugePages_Total: 0
HugePages_Free: 0
```

Cat /proc/swaps



A screenshot of a Linux terminal window. The window title is "Terminal" and the current directory is "~". The prompt is "ubuntu@ubuntu: ~". The command "cat /proc/swaps" has been executed, resulting in the following output:

Filename	Type	Size	Used	Priorit
y				

Conclusion:

Thus, From above experiments, I learn about various linux commands related to memory management.