

# CSE3241: Operating System and System Programming

Class-3

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# Concepts of Process

1. Process is a program in execution.
2. Program is a passive entity stored on disk (executable file); process is an active entity.
3. Program becomes process when an executable file is loaded into memory.
4. One program can have several processes
  - ▶ multiple users or one user can execute multiple copies of the same program at a time.
5. Process execution must progress in sequential fashion.
  - ▶ No parallel execution of instructions of a single process.
6. Modern OS manages thousand of processes of a variety of application software, system software as well as its own processes at a time.

## Check Process in Linux based OS

To see all processes, currently managed by a Linux based OS (e.g., Ubuntu), at real time:

- ▶ Open a terminal, the black screen, by typing `Ctrl + Alt + T`.
- ▶ Type `'top'` and press Enter. Press `'Q'` to exit.
- ▶ `$ top`

To get a snapshot of all processes, currently managed by a Linux based OS (e.g., Ubuntu): `$ ps aux`

# Check Process in Linux based OS

\$ top

```
Activities Terminal
File Edit View Search Terminal Tabs Help

cse@cse-MS-7809 ~
top - 05:40:16 up 117, 1 user, load averages: 0.19, 0.15, 0.11
Tasks: 539 total, 2 running, 365 sleeping, 0 stopped, 0 zombie
MiB(s): 3.0 us, 0.1 sy, 0.0 ni, 96.9 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem : 3285408 total, 1533160 free, 1135940 used, 612458 buff/cache
KiB Swap: 2097140 total, 2097140 free, 0 used, 20748616 avail Mem

  PID USER      VIRT  RES  SHR S %CPU   MEMNO   TIME COMMAND
 212 root      0 0 0 S 0.0 0.0 0:00 python
3668 cse      20 0 30.448g 7.804g 665280 R 96.0 24.9 59:20.53 python
2119 cse      20 0 1044508 64120 49524 S 0.7 0.2 0:02.41 skypeforlinux
1214 root     -51 0 0 0 S 0.3 0.0 0:27.01 irq/124-midi1a
1794 cse      20 0 5879936 341796 105044 S 0.3 1.0 1:56.09 gnome-shell
2148 cse      20 0 5791800 253180 119012 S 0.3 0.8 0:12.49 skypeforlinux
2407 cse      20 0 3793640 411344 204932 S 0.3 1.3 4:00.78 firefox
2400 cse      20 0 3161692 439084 144636 S 0.3 1.3 0:37.28 web Content
3409 cse      20 0 794408 38516 28032 S 0.3 0.1 0:01.73 gnome-terminal
4120 cse      20 0 2950868 206024 136912 S 0.3 0.8 1:44.69 web Content
6547 cse      20 0 3104056 376556 129332 S 0.3 1.1 0:04.90 web Content
7536 cse      20 0 44936 4492 3528 R 0.3 0.0 0:00.06 top
  1 root      20 0 225584 9276 6688 S 0.0 0.0 0:05.00 systemd
  2 root      20 0 0 0 S 0.0 0.0 0:00.01 kthreadd
  3 root      0 -20 0 0 S 0.0 0.0 0:00.00 rcu_gp
  4 root      0 -20 0 0 S 0.0 0.0 0:00.00 rcu_par_gp
  6 root      0 -20 0 0 S 0.0 0.0 0:00.00 kworker/0:0H-kb
  8 root      20 0 0 0 S 0.0 0.0 0:00.18 kworker/u256:0-
10 root      0 -20 0 0 S 0.0 0.0 0:00.00 mm_percpu_wq
11 root      20 0 0 0 S 0.0 0.0 0:00.01 ksoftirqd/0
12 root      20 0 0 0 S 0.0 0.0 0:00.73 rcu_sched
13 root      rt 0 0 0 S 0.5 0.0 0.0 0:00.01 migration/0
14 root     -51 0 0 0 S 0.5 0.0 0.0 0:00.00 idle_inject/0
15 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 cpulp/0
16 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 cpulp/1
17 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 idle_inject/1
18 root      rt 0 0 0 S 0.5 0.0 0.0 0:00.13 migration/1
19 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 ksoftirqd/1
21 root      0 -20 0 0 S 0.0 0.0 0.0 0:00.00 kworker/1:0H-kb
22 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 cpulp/2
23 root     -51 0 0 0 S 0.5 0.0 0.0 0:00.00 idle_inject/2
24 root      rt 0 0 0 S 0.5 0.0 0.0 0:00.13 migration/2
25 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 ksoftirqd/2
27 root      0 -20 0 0 S 0.0 0.0 0.0 0:00.00 kworker/2:0H-kb
28 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 cpulp/3
29 root     -51 0 0 0 S 0.5 0.0 0.0 0:00.00 idle_inject/3
30 root      rt 0 0 0 S 0.5 0.0 0.0 0:00.13 migration/3
31 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 ksoftirqd/3
33 root      0 -20 0 0 S 0.0 0.0 0.0 0:00.00 kworker/3:0H-kb
34 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 cpulp/4
35 root     -51 0 0 0 S 0.5 0.0 0.0 0:00.00 idle_inject/4
36 root      rt 0 0 0 S 0.5 0.0 0.0 0:00.14 migration/4
37 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 ksoftirqd/4
39 root      0 -20 0 0 S 0.0 0.0 0.0 0:00.00 kworker/4:0H-kb
40 root      20 0 0 0 S 0.5 0.0 0.0 0:00.00 cpulp/5
41 root     -51 0 0 0 S 0.5 0.0 0.0 0:00.00 idle_inject/5
42 root      rt 0 0 0 S 0.5 0.0 0.0 0:00.14 migration/5
```

## Check Process in Linux based OS

\$ ps aux

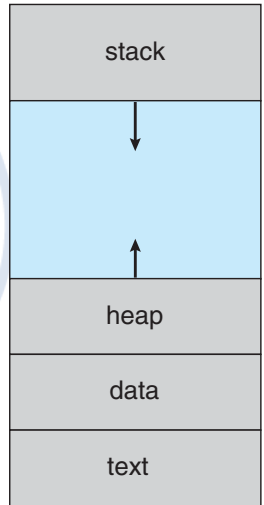
```
Activities Terminal
File Edit View Search Terminal Tabs Help
cse@cse-MS-7809- ~
cse@cse-MS-7809- ~
cse@cse-MS-7809- ~
cse@cse-MS-7809-~$ ps aux
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         0  0.0  0.0  255564 960 ?        Ss   04:30  0:00 [kthreadd]
root         2  0.0  0.0  0 0 ?        Ss   04:30  0:00 [rcu_gp]
root         3  0.0  0.0  0 0 ?        Ss   04:30  0:00 [rcu_par_gp]
root         4  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/0:0-kb]
root         8  0.1  0.0  0 0 ?        Ss   04:30  0:35 [kworker/u256:0-]
root        10  0.0  0.0  0 0 ?        Ss   04:30  0:00 [rm_pcpupkg_wq]
root        11  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/0]
root        12  0.0  0.0  0 0 ?        Ss   04:30  0:03 [rcu_sched]
root        13  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/0]
root        14  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/0]
root        15  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/0]
root        16  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/1]
root        17  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/1]
root        18  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/1]
root        19  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/1]
root        21  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/1:0-kb]
root        22  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/2]
root        23  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/2]
root        24  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/2]
root        25  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/2]
root        27  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/2:0-kb]
root        28  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/3]
root        29  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/3]
root        30  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/3]
root        31  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/3]
root        33  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/3:0-kb]
root        34  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/4]
root        35  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/4]
root        36  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/4]
root        37  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/4]
root        39  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/4:0-kb]
root        40  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/5]
root        41  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/5]
root        42  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/5]
root        43  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/5]
root        45  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/5:0-kb]
root        46  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/6]
root        47  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/6]
root        48  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/6]
root        49  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/6]
root        51  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/6:0-kb]
root        52  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/7]
root        53  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/7]
root        54  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/7]
root        55  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/7]
root        57  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/7:0-kb]
root        58  0.0  0.0  0 0 ?        Ss   04:30  0:00 [cpuhp/8]
root        59  0.0  0.0  0 0 ?        Ss   04:30  0:00 [idle_inject/8]
root        60  0.0  0.0  0 0 ?        Ss   04:30  0:00 [migration/8]
root        61  0.0  0.0  0 0 ?        Ss   04:30  0:00 [ksftirqd/8]
root        63  0.0  0.0  0 0 ?        Ss   04:30  0:00 [kworker/8:0-kb]
```

# Process in Memory

A process has multiple parts, when it is in memory:

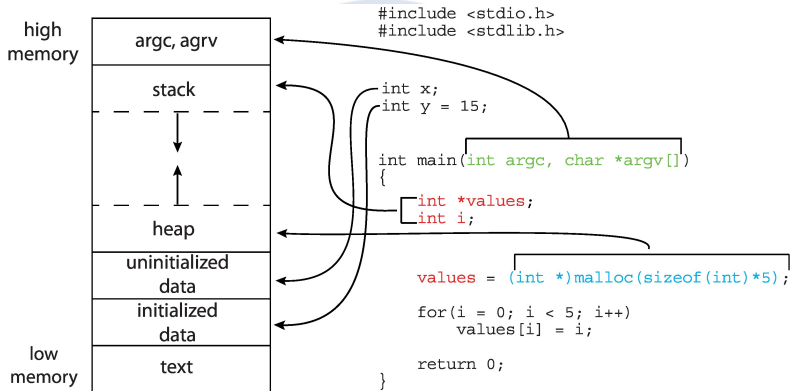
- ▶ **Text:** contains program code
- ▶ **Stack:** contains temporary data  
oitemsepFunction parameters, return  
addresses, local variables
- ▶ **Data:** contains global variables
- ▶ **Heap:** contains dynamically allocated  
memory during run time

max



0

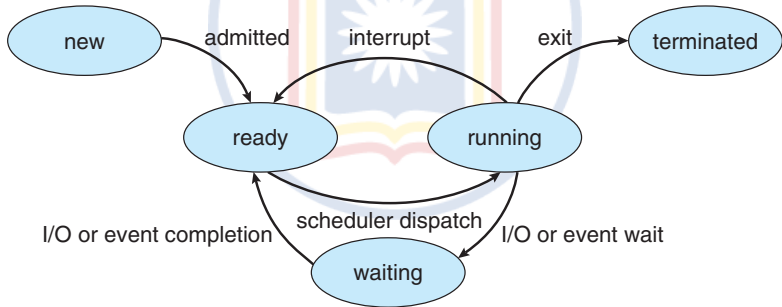
# Memory Layout of a C Program



# Process States

As a process executes, it changes state

- ▶ **New:** The process is being created
- ▶ **Running:** Instructions are being executed
- ▶ **Waiting:** The process is waiting for some event to occur
- ▶ **Ready:** The process is waiting to be assigned to a processor
- ▶ **Terminated:** The process has finished execution





## Process State Code in Ubuntu

As a process executes, it changes state

- ▶ *D* : uninterruptible sleep (usually IO)
- ▶ *R* : running or runnable (on run queue)
- ▶ *S* : interruptible sleep (waiting for an event to complete)
- ▶ *T* : stopped by job control signal
- ▶ *t* : stopped by debugger during the tracing
- ▶ *W* : paging (not valid since the 2.6.xx kernel)
- ▶ *X* : dead (should never be seen)
- ▶ *Z* : defunct ("zombie") process, terminated but not reaped by its parent

Meaning of additional characters:

- ▶ *<* : high-priority (not nice to other users)
- ▶ *N* : low-priority (nice to other users)
- ▶ *L* : has pages locked into memory (for real-time and custom IO)
- ▶ *s* : is a session leader
- ▶ *l* : is multi-threaded
- ▶ *+* : is in the foreground process group

# Home Work

1. Find in total how many processes are running in your system?
2. Find the states of some processes.
3. Figure out the memory layout of any of your C program.

## References:

- ▶ P. B. Galvin A. Silbeschatz and G. Gagne, "Operating System Concepts".
- ▶ Slides of Operating System Concepts