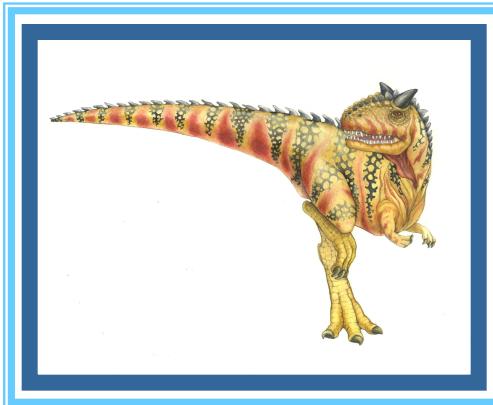


# Project 1 Tutorial





# Common commands

---

- cd: change directory
  - make: compile the source code using the accompany Makefile
  - sudo: using the root permission
  - rm: remove files
  - ls: list the files in the current directory
  - .....
- 
- [The 10 Most Important Linux Commands](#)
  - [50 Most Frequently Used UNIX / Linux Commands \(With Examples\)](#)





# Project 1

---

- Mainly based on programming project of Chapter 2 in the textbook
- There are some minor changes of requirement
- The examples and code in this lecture do not necessarily follow the requirement of the project
- See the requirement and deadline in the document posted on iCollege





# Part I

---

- Create, load, unload a kernel module





# Listing Kernel Modules

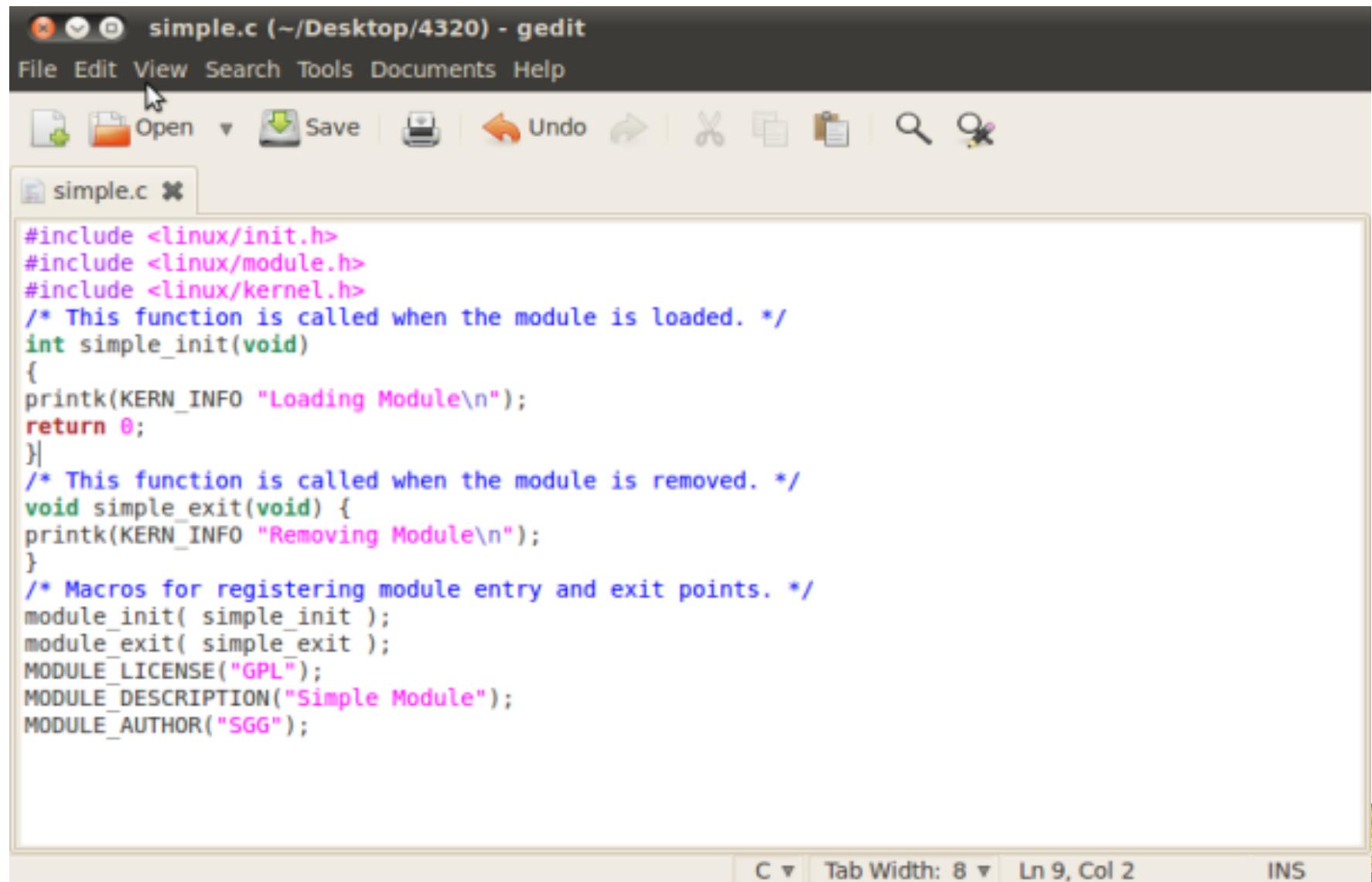
- lsmod: list all kernel modules that are currently loaded

```
zhisheng@zhisheng-ubuntu: ~
File Edit View Terminal Help
zhisheng@zhisheng-ubuntu:~$ lsmod
Module           Size  Used by
binfmt_misc      6523   1
snd_intel8x0     25652   2
snd_ac97_codec   100646  1 snd_intel8x0
ac97_bus          1002   1 snd_ac97_codec
snd_pcm_oss       35308   0
snd_mixer_oss     13746   1 snd_pcm_oss
snd_pcm           70918   3 snd_intel8x0,snd_ac97_codec,snd_pcm_oss
snd_seq_dummy     1338   0
snd_seq_oss        26722   0
snd_seq_midi       4557   0
snd_rawmidi        19056   1 snd_seq_midi
snd_seq_midi_event  6003   2 snd_seq_oss,snd_seq_midi
snd_seq            47295   6 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_seq_m
idi_event
snd_timer          19130   2 snd_pcm,snd_seq
snd_seq_device     5700    5 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_rawmi
di snd_seq
ppdev              5259   0
fbcon              35102   71
tileblit           1999   1 fbcon
font               7557   1 fbcon
bitblit             4707   1 fbcon
```





# A Simple Kernel Module



The screenshot shows a Gedit window titled "simple.c (~/Desktop/4320) - gedit". The menu bar includes File, Edit, View, Search, Tools, Documents, and Help. The toolbar contains icons for Open, Save, Undo, and various document-related functions. The main text area displays the following C code:

```
#include <linux/init.h>
#include <linux/module.h>
#include <linux/kernel.h>
/* This function is called when the module is loaded. */
int simple_init(void)
{
printk(KERN_INFO "Loading Module\n");
return 0;
}
/* This function is called when the module is removed. */
void simple_exit(void) {
printk(KERN_INFO "Removing Module\n");
}
/* Macros for registering module entry and exit points. */
module_init( simple_init );
module_exit( simple_exit );
MODULE_LICENSE("GPL");
MODULE_DESCRIPTION("Simple Module");
MODULE_AUTHOR("SGG");
```

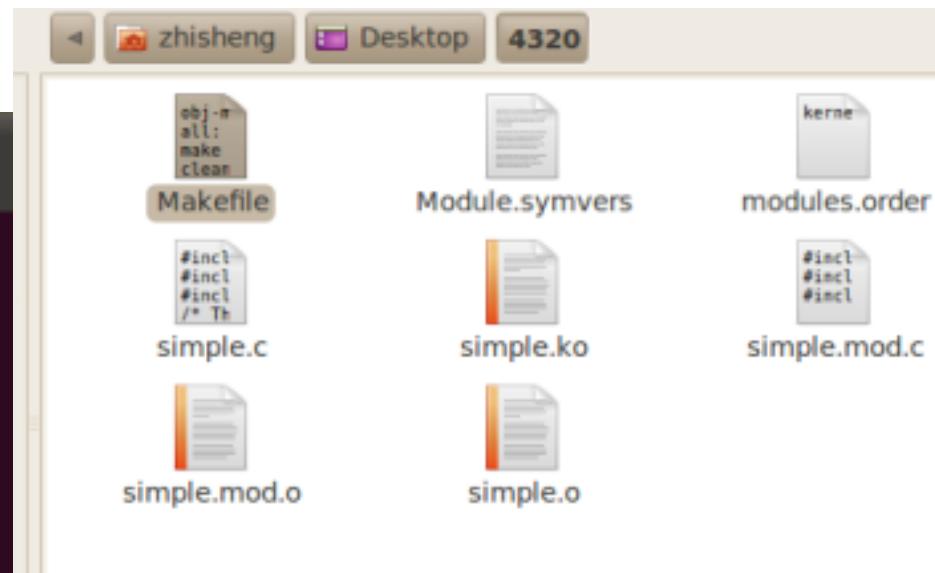
The status bar at the bottom shows "C" with a dropdown arrow, "Tab Width: 8", "Ln 9, Col 2", and "INS". There is also a small green and yellow feather icon in the bottom right corner.



# Compile the Source Code

- simple.c and Makefile in folder “4320”
- make: compile the source code

```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320
File Edit View Terminal Help
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ 
zhisheng@zhisheng-ubuntu:~$ cd .. /zhisheng/Desktop/4320/
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ make
make: Nothing to be done for 'all'.
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ make
make: *** No rule to make target 'make', needed by 'all'. Stop.
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ make
make -C /lib/modules/2.6.32-53-generic-pae/build M=/home/zhiheng/Desktop/4320 m
odules
make[1]: Entering directory `/usr/src/linux-headers-2.6.32-53-generic-pae'
 CC [M] /home/zhiheng/Desktop/4320/simple.o
Building modules, stage 2.
MODPOST 1 modules
 CC      /home/zhiheng/Desktop/4320/simple.mod.o
 LD [M] /home/zhiheng/Desktop/4320/simple.ko
make[1]: Leaving directory `/usr/src/linux-headers-2.6.32-53-generic-pae'
zhisheng@zhisheng-ubuntu:~/Desktop/4320$
```





# Load the Kernel Module

- sudo insmod: load a kernel module

```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320
File Edit View Terminal Help
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ sudo insmod simple.ko
[sudo] password for zhisheng:
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ lsmod
Module           Size  Used by
simple          654    0
binfmt_misc     6523    1
snd_intel8x0    25652   2
snd_ac97_codec  100646   1 snd_intel8x0
ac97_bus        1002    1 snd_ac97_codec
snd_pcm_oss     35308   0
snd_mixer_oss   13746   1 snd_pcm_oss
snd_pcm         70918   3 snd_intel8x0,snd_ac97_codec,snd_pcm_oss
snd_seq_dummy   1338    0
snd_seq_oss     26722   0
snd_seq_midi    4557    0
snd_rawmidi     19056   1 snd_seq_midi
snd_seq_midi_event  6003   2 snd_seq_oss,snd_seq_midi
snd_seq          47295   6 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_seq_m
idi_event
snd_timer       19130   2 snd_pcm,snd_seq
snd_seq_device  5700    5 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_rawmi
di snd_seq
ppdev           5259    0
fbcon           35102   71
```





# Remove the Kernel Module

- sudo rmmod: remove a kernel module
- dmesg: check kernel log buffer

```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320
File Edit View Terminal Help
[ 27.150636] type=1505 audit(1516325807.227:9): operation="profile_replace" pid=689 name="/sbin/dhclient3"
[ 27.154410] type=1505 audit(1516325807.231:10): operation="profile_replace" pid=689 name="/usr/lib/NetworkManager/nm-dhcp-client.action"
[ 27.154681] type=1505 audit(1516325807.231:11): operation="profile_replace" pid=689 name="/usr/lib/connman/scripts/dhclient-script"
[ 27.316506] type=1505 audit(1516325807.395:12): operation="profile_load" pid=690 name="/usr/bin/evince"
[ 27.328529] type=1505 audit(1516325807.407:13): operation="profile_load" pid=690 name="/usr/bin/evince-previewer"
[ 27.332047] type=1505 audit(1516325807.407:14): operation="profile_load" pid=690 name="/usr/bin/evince-thumbnailer"
[ 27.433177] type=1505 audit(1516325807.511:15): operation="profile_load" pid=693 name="/usr/lib/cups/backend/cups-pdf"
[ 27.433729] type=1505 audit(1516325807.511:16): operation="profile_load" pid=693 name="/usr/sbin/cupsd"
[ 27.476501] type=1505 audit(1516325807.555:17): operation="profile_load" pid=694 name="/usr/sbin/tcpdump"
[ 37.288133] eth0: no IPv6 routers present
[ 1605.095337] Clocksource tsc unstable (delta = 4687093270 ns)
[ 1605.118750] Switching to clocksource acpi_pm
[ 2114.592436] Loading Module
[ 2349.372386] Removing Module
zhisheng@zhisheng-ubuntu:~/Desktop/4320$
```





# Part I

---

- Kernel data structure
- An application of kernel module management





## Part II

---

- Kernel data structure include file: <linux/list.h>
- Define a linked list

```
struct birthday
{
    int month;
    int day;
    int year;

    struct list_head list;
};

/**
 * The following defines and initializes a list_head object named birthday_list
 */
static LIST_HEAD(birthday_list);
```





## Part II

- At module entry point, define each element in the list

```
int simple_init(void)
{
    /* the pointer for memory allocation */
    struct birthday *person;

    person_one = kmalloc(sizeof(*person_one), GFP_KERNEL);
    person_one->month = 8;
    person_one->day = 13;
    person_one->year = 1995;
    INIT_LIST_HEAD(&person_one->list);

    /* add the new node */
    list_add_tail(&person_one->list, &birthday_list);
```





## Part II

---

### ■ Traversing the Linked List

```
struct birthday *ptr;  
  
list_for_each_entry(ptr, &birthday_list, list) {  
    /* on each iteration ptr points */  
    /* to the next birthday struct */  
}
```





## Part II

---

- At module exit point, remove each element from the list

```
struct birthday *ptr, *next  
  
list_for_each_entry_safe(ptr,next,&birthday_list,list) {  
    /* on each iteration ptr points */  
    /* to the next birthday struct */  
    list_del(&ptr->list);  
    kfree(ptr);  
}
```





## Part II

- After compiling, loading, and removing the module, kernel log shows

```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320/proj1
File Edit View Terminal Help
[ 27.332047] type=1505 audit(1516325807.407:14): operation="profile_load" pid=690 name="/usr/bin/evince-thumbnailer"
[ 27.433177] type=1505 audit(1516325807.511:15): operation="profile_load" pid=693 name="/usr/lib/cups/backend/cups-pdf"
[ 27.433729] type=1505 audit(1516325807.511:16): operation="profile_load" pid=693 name="/usr/sbin/cupsd"
[ 27.476501] type=1505 audit(1516325807.555:17): operation="profile_load" pid=694 name="/usr/sbin/tcpdump"
[ 37.288133] eth0: no IPv6 routers present
[ 1605.095337] Clocksource tsc unstable (delta = 4687093270 ns)
[ 1605.118750] Switching to clocksource acpi_pm
[ 2114.592436] Loading Module
[ 2349.372386] Removing Module
[ 5235.577735] Loading Module
[ 5235.577746] Birthday: Month 10 Day 22 Year 1963
[ 5235.577753] Birthday: Month 8 Day 13 Year 1995
[ 5235.577761] Birthday: Month 9 Day 2 Year 1998
[ 5235.577767] Birthday: Month 8 Day 12 Year 1963
[ 5398.896154] Removing Module
[ 5398.896163] Removing 10 22 1963
[ 5398.896169] Removing 8 13 1995
[ 5398.896175] Removing 9 2 1998
[ 5398.896181] Removing 8 12 1963
zhisheng@zhisheng-ubuntu:~/Desktop/4320/proj1$
```

