实验名称	编译 Linux 内核		
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1. 实验目的

1. 了解操作系统内核的编译方法，熟悉内核的工作原理。
2. 修改源码的某些参数而不会影响当前的原本系统，以便接下来实验的进行。
3. 了解操作系统的主要组成部分。

二、实验内容

1. 下载内核源代码
2. 修改 Makefile 文件内容
3. 编译内核并安装内核模块
4. 修改配置菜单

三、实验环境及配置方法

VMware Workstation Pro 16.0.0

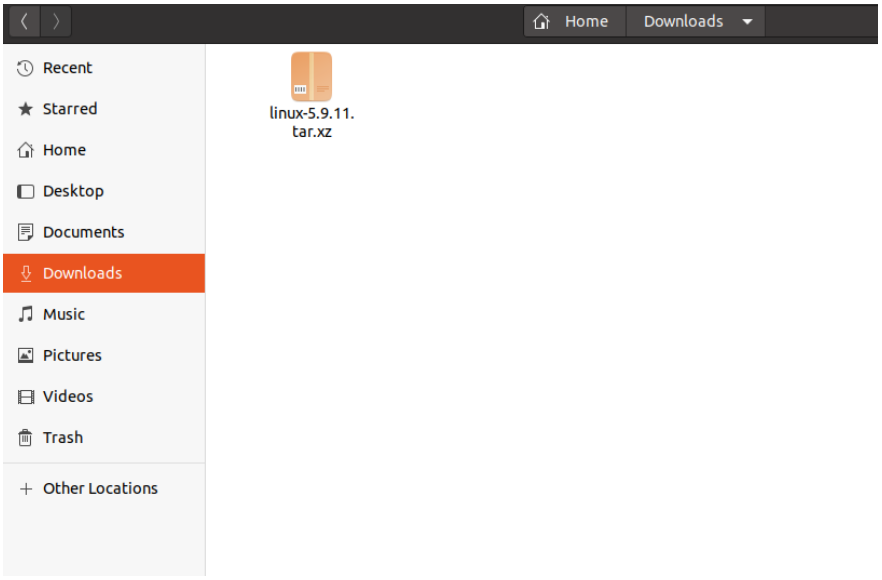
Ubuntu 20.04

Linux 5.4.0-42

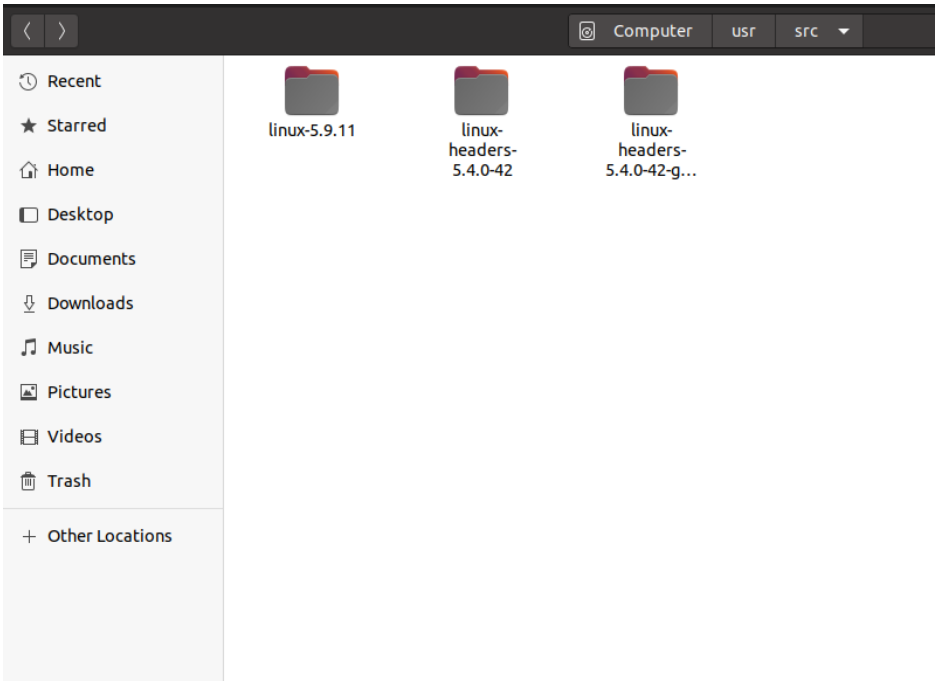
四、 实验方法和实验步骤（程序设计与实现）

1. 下载内核代码

(1). 在 https://www.kernel.org/下载源代码，版本号为 5.9.11。

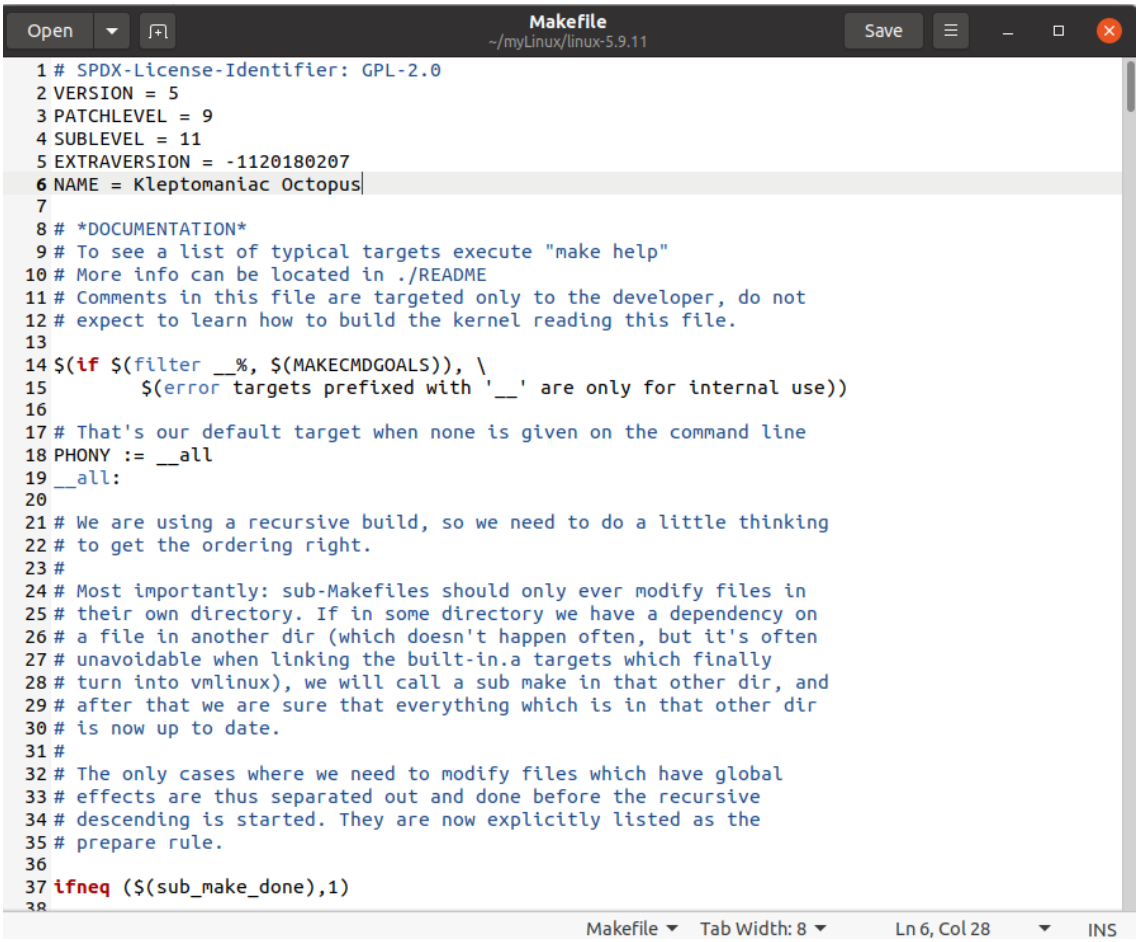


(2). 并将源代码压缩包解压到/usr/src 下。



2. 修改 Makefile 文件

修改 makefile 文件中有字段 EXTRAVERSION，其后添加-1120180207，保存。



3. 编译内核

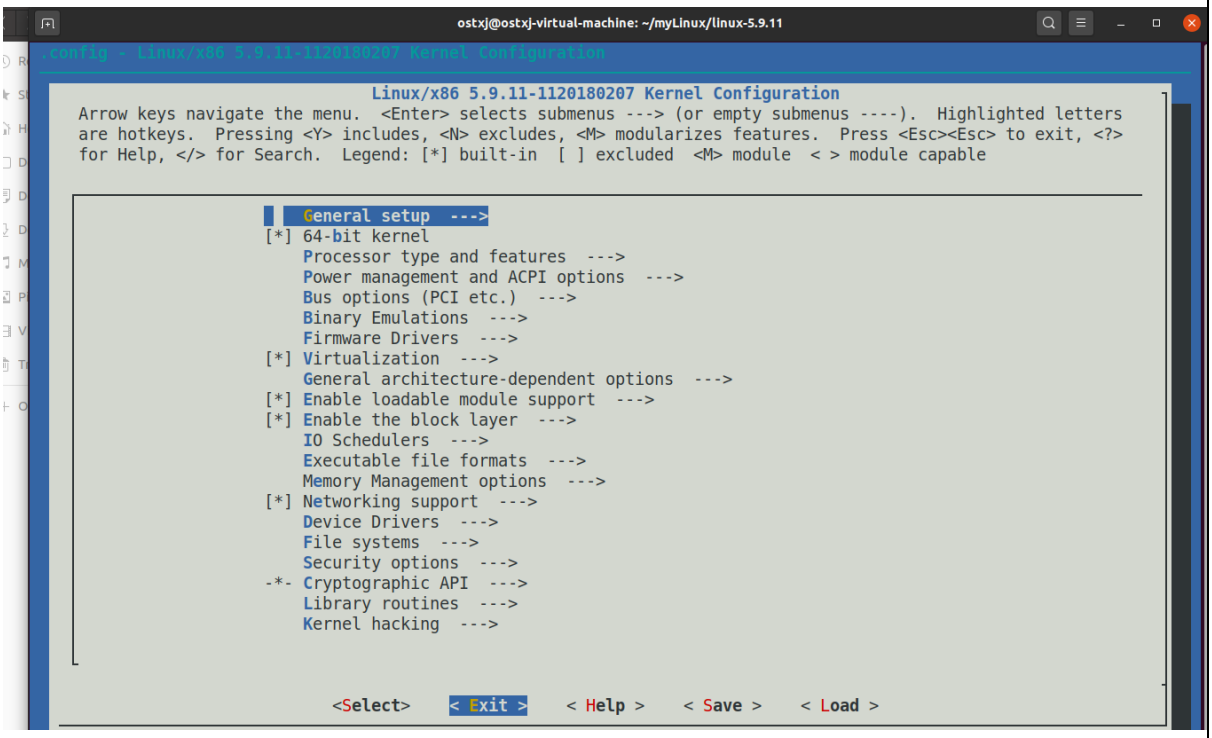
(1). 安装必要依赖

打开终端，以此输入：

```
sudo apt-get update
sudo apt-get install libncurses5-dev
sudo apt-get install build-essential
sudo apt-get install kernel-package
sudo apt-get install flex
sudo apt-get install bison
sudo apt-get install libssl-dev
```

(2). 配置内核编译选项

打开终端，输入 sudo make menuconfig，命令执行完成后打开配置菜单,直接关闭按回车键即可。



(3). 编译内核

输入 sudo make -j8。

编译结果如下：

```
  LD [M]  sound/soc/intel/common/snd-soc-sst-ipc.ko
  LD [M]  sound/soc/snd-soc-acpi.ko
  LD [M]  sound/soc/snd-soc-core.ko
  LD [M]  sound/soc/intel/haswell/snd-soc-sst-haswell-pcm.ko
  LD [M]  sound/soc/sof/intel/snd-sof-intel-byt.ko
  LD [M]  sound/soc/sof/intel/snd-sof-intel-hda-common.ko
  LD [M]  sound/soc/sof/intel/snd-sof-intel-hda.ko
  LD [M]  sound/soc/sof/intel/snd-sof-intel-ipc.ko
  LD [M]  sound/soc/sof/snd-sof-acpi.ko
  LD [M]  sound/soc/sof/snd-sof-pci.ko
  LD [M]  sound/soc/sof/snd-sof.ko
  LD [M]  sound/soc/sof/xtensa/snd-sof-xtensa-dsp.ko
  LD [M]  sound/soc/xilinx/snd-soc-xlnx-formatter-pcm.ko
  LD [M]  sound/soc/xilinx/snd-soc-xlnx-i2s.ko
  LD [M]  sound/soc/xtensa/snd-soc-xtfpga-i2s.ko
  LD [M]  sound/soc/xilinx/snd-soc-xlnx-spdif.ko
  LD [M]  sound/soc/zte/zx-tdm.ko
  LD [M]  sound/soundcore.ko
  LD [M]  sound/synth/emux/snd-emux-synth.ko
  LD [M]  sound/synth/snd-util-mem.ko
  LD [M]  sound/usb/6fire/snd-usb-6fire.ko
  LD [M]  sound/usb/bcd2000/snd-bcd2000.ko
  LD [M]  sound/usb/caiaq/snd-usb-caiaq.ko
  LD [M]  sound/usb/hiface/snd-usb-hiface.ko
  LD [M]  sound/usb/line6/snd-usb-line6.ko
  LD [M]  sound/usb/line6/snd-usb-pod.ko
  LD [M]  sound/usb/line6/snd-usb-podhd.ko
  LD [M]  sound/usb/line6/snd-usb-toneport.ko
  LD [M]  sound/usb/line6/snd-usb-variax.ko
  LD [M]  sound/usb/misc/snd-ua101.ko
  LD [M]  sound/usb/snd-usb-audio.ko
  LD [M]  sound/usb/snd-usbmidi-lib.ko
  LD [M]  sound/usb/usx2y/snd-usb-us122l.ko
  LD [M]  sound/usb/usx2y/snd-usb-usx2y.ko
  LD [M]  sound/x86/snd-hdmi-lpe-audio.ko
  LD [M]  sound/xen/snd_xen_front.ko
```

(4). 安装内核模块

打开终端，输入：

```
sudo make modules_install
```

```
sudo make install
```

结果如下：

```
ostxj@ostxj-virtual-machine:/usr/src/linux-5.9.11$ sudo make install
[sudo] password for ostxj:
sh ./arch/x86/boot/install.sh 5.9.11-1120180207 arch/x86/boot/bzImage \
        System.map "/boot"
run-parts: executing /etc/kernel/postinst.d/apt-auto-removal 5.9.11-1120180207 /boot/vmlinuz-5.9.11-1120180207
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 5.9.11-1120180207 /boot/vmlinuz-5.9.11-1120180207
update-initramfs: Generating /boot/initrd.img-5.9.11-1120180207
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 5.9.11-1120180207 /boot/vmlinuz-5.9.11-1120180207
run-parts: executing /etc/kernel/postinst.d/update-notifier 5.9.11-1120180207 /boot/vmlinuz-5.9.11-1120180207
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 5.9.11-1120180207 /boot/vmlinuz-5.9.11-1120180207
Sourcing file `/etc/default/grub'
Sourcing file `/etc/default/grub.d/init-select.cfg'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.9.11-1120180207
Found initrd image: /boot/initrd.img-5.9.11-1120180207
Found linux image: /boot/vmlinuz-5.9.11-1120180207.old
Found initrd image: /boot/initrd.img-5.9.11-1120180207
Found linux image: /boot/vmlinuz-5.4.0-42-generic
Found initrd image: /boot/initrd.img-5.4.0-42-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.bin
done
ostxj@ostxj-virtual-machine:/usr/src/linux-5.9.11$
```

在 boot 目录下存放着 initrd.img-5.9.11-1120180207。

4. 修改配置菜单

(1) 修改/etc/default/grub 文件

找到 GRUB_TIMEOUT_STYLE=hidden 注释掉，修改 GRUB_TIMEOUT 的值为 10。

Open | grub /etc/default | Save

```
# If you change this file, run 'update-grub' afterwards to update
# /boot/grub/grub.cfg.
# For full documentation of the options in this file, see:
#   info -f grub -n 'Simple configuration'

GRUB_DEFAULT=0
#GRUB_TIMEOUT_STYLE=hidden
GRUB_TIMEOUT=10
GRUB_DISTRIBUTOR=`lsb_release -i -s 2> /dev/null || echo Debian`
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash"
GRUB_CMDLINE_LINUX=""

# Uncomment to enable BadRAM filtering, modify to suit your needs
# This works with Linux (no patch required) and with any kernel that obtains
# the memory map information from GRUB (GNU Mach, kernel of FreeBSD ...)
#GRUB_BADRAM="0x01234567,0xfefefefe,0x89abcdef,0xefefefef"

# Uncomment to disable graphical terminal (grub-pc only)
#GRUB_TERMINAL=console

# The resolution used on graphical terminal
# note that you can use only modes which your graphic card supports via VBE
# you can see them in real GRUB with the command `vbeinfo'
#GRUB_GFXMODE=640x480

# Uncomment if you don't want GRUB to pass "root=UUID=xxx" parameter to Linux
#GRUB_DISABLE_LINUX_UUID=true

# Uncomment to disable generation of recovery mode menu entries
#GRUB_DISABLE_RECOVERY="true"

# Uncomment to get a beep at grub start
#GRUB_INIT_TUNE="480 440 1"
```

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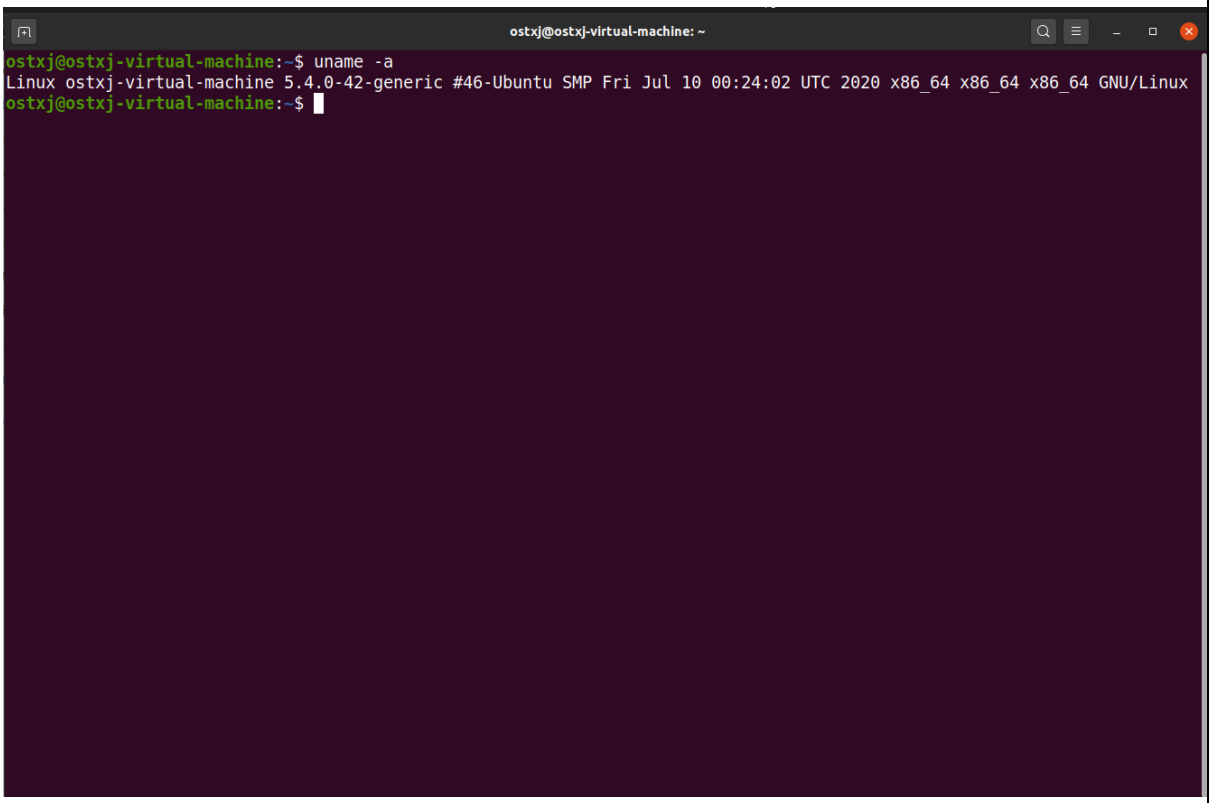
(2) 更新 grub 文件

打开终端，输入 sudo update-grub。

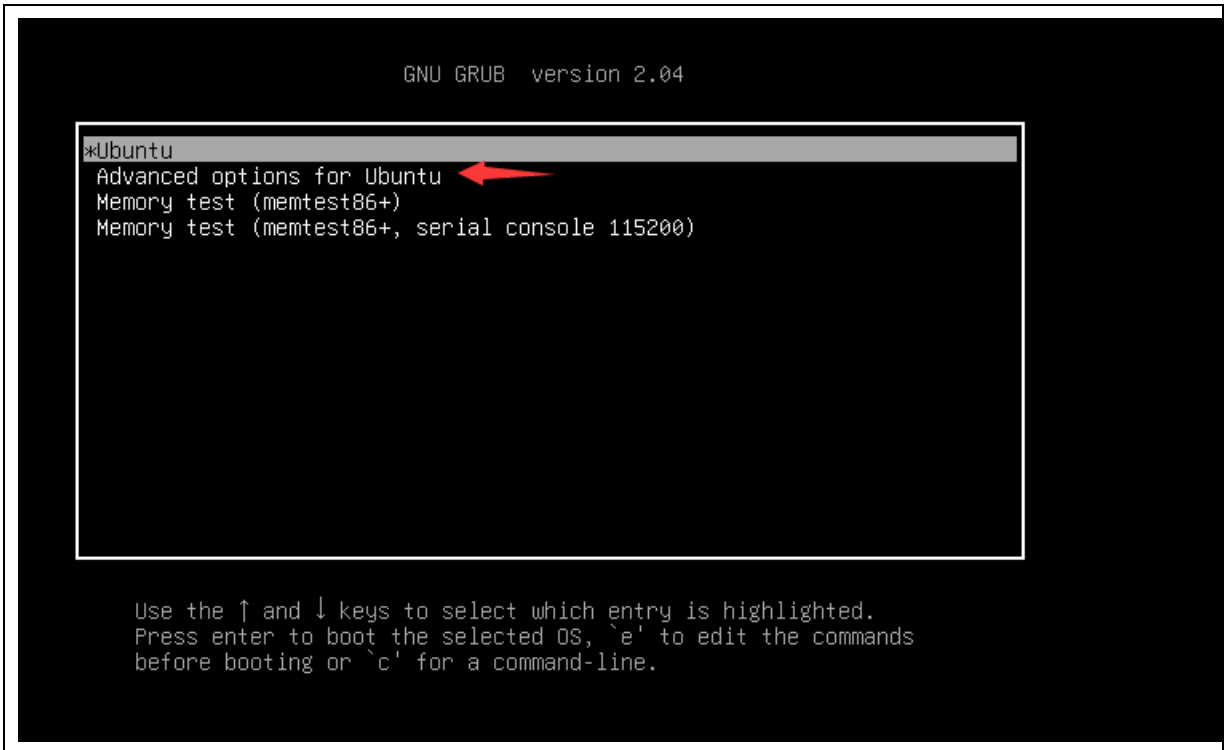
```
ostxj@ostxj-virtual-machine:/usr/src/linux-5.9.11$ sudo update-grub
Sourcing file `/etc/default/grub'
Sourcing file `/etc/default/grub.d/init-select.cfg'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.9.11-1120180207
Found initrd image: /boot/initrd.img-5.9.11-1120180207
Found linux image: /boot/vmlinuz-5.9.11-1120180207.old
Found initrd image: /boot/initrd.img-5.9.11-1120180207
Found linux image: /boot/vmlinuz-5.4.0-42-generic
Found initrd image: /boot/initrd.img-5.4.0-42-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.bin
done
```

五、实验结果和分析

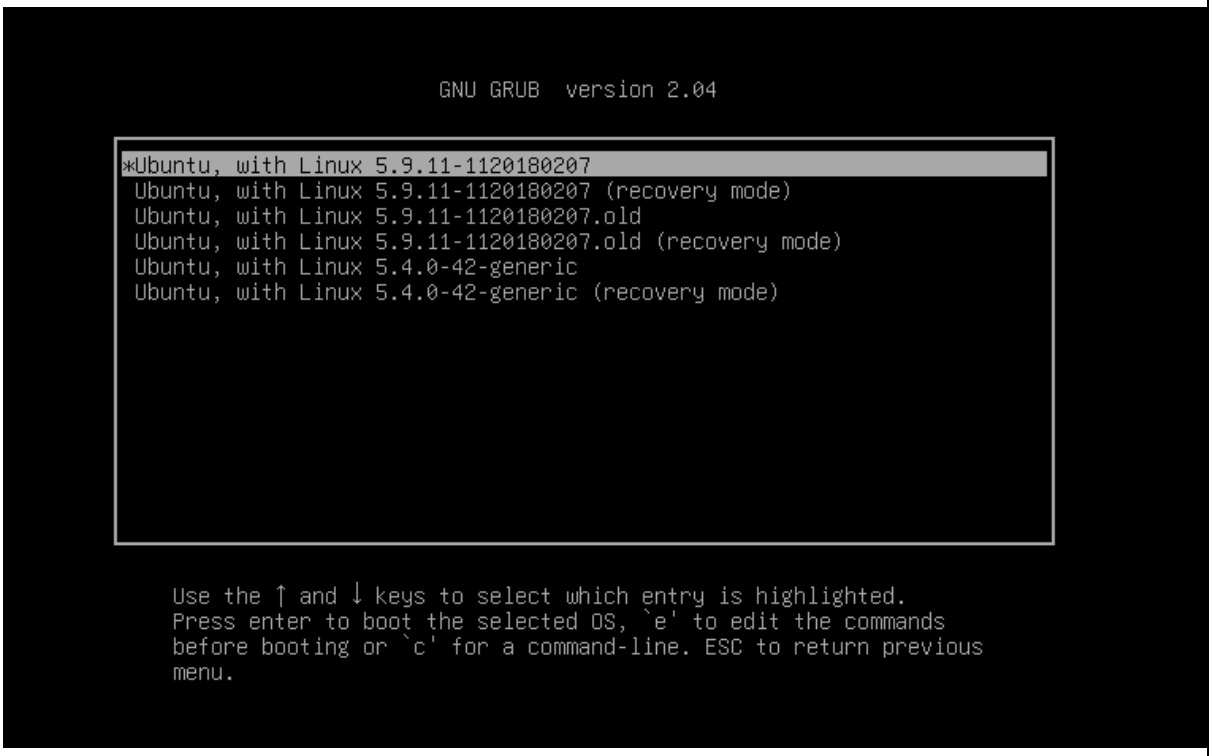
实验开始时用 uname -a 查看内核版本为 5.4.0-42。



实验结束 reboot 后，出现：



选择高级选项后，出现有自己学号信息的 linux 内核版本：



按回车后，再次查看内核版本为 5.9.11，而且后面显示有学号版本信息。

```
ostxj@ostxj-virtual-machine:~$ uname -a
Linux ostxj-virtual-machine 5.9.11-1120180207 #1 SMP Sat Nov 28 01:33:49 CST 2020 x86_64 x86_64 x86_64 GNU/Linux
ostxj@ostxj-virtual-machine:~$
```

六、讨论、心得

在这次实验中，首先由于在执行 sudo make install 的过程中因为等待时间过长，我停止了安装，之后又重新执行命令 sudo make install，所以出现了 old 的版本。

除此之外，由于缺乏各种依赖的问题，需要在谷歌上查找相关问题，得出缺乏的依赖，再依次安装。