Project 0: Getting Real

Preliminaries

> Fill in your name and email address.

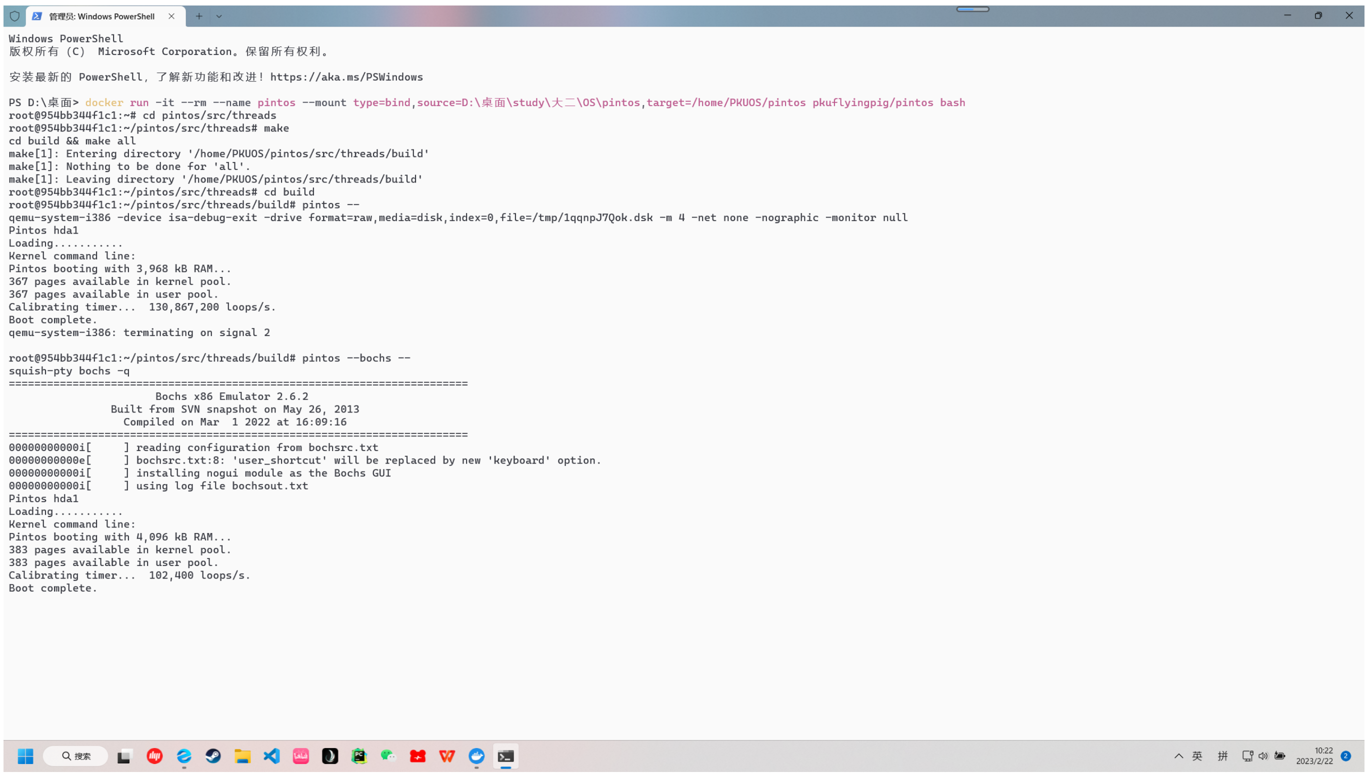
罗兆丰 2100012985@stu.pku.edu.cn

> If you have any preliminary comments on your submission, notes for the TAs, please give them here.

> Please cite any offline or online sources you consulted while preparing your submission, other than the Pintos documentation, course text, lecture notes, and course staff.

Booting Pintos

> A1: Put the screenshot of Pintos running example here.



```
Windows PowerShell
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安装最新的 PowerShell，了解新功能和改进！https://aka.ms/PSWindows

PS D:\桌面> docker run -it --rm --name pintos --mount type=bind,source=D:\桌面\study\大二\OS\pintos,target=/home/PKUOS/pintos pkuflyingpig/pintos bash
root@954bb344f1c1:~# cd pintos/src/threads
root@954bb344f1c1:~/pintos/src/threads# make
cd build && make all
make[1]: Entering directory '/home/PKUOS/pintos/src/threads/build'
make[1]: Nothing to be done for 'all'.
make[1]: Leaving directory '/home/PKUOS/pintos/src/threads/build'
root@954bb344f1c1:~/pintos/src/threads# cd build
root@954bb344f1c1:~/pintos/src/threads/build# pintos --
qemu-system-i386 -device isa-debug-exit -drive format=raw,media=disk,index=0,file=/tmp/1qqnpJ7Qok.dsk -m 4 -net none -nographic -monitor null
Pintos hda1
Loading...........
Kernel command line:
Pintos booting with 3,968 kB RAM...
367 pages available in kernel pool.
367 pages available in user pool.
Calibrating timer...  130,867,200 loops/s.
Boot complete.
qemu-system-i386: terminating on signal 2

root@954bb344f1c1:~/pintos/src/threads/build# pintos --bochs --
squish-pty bochs -q
========================================================================
                       Bochs x86 Emulator 2.6.2
                Built from SVN snapshot on May 26, 2013
                  Compiled on Mar  1 2022 at 16:09:16
========================================================================
00000000000i[     ] reading configuration from bochsrc.txt
00000000000e[     ] bochsrc.txt:8: 'user_shortcut' will be replaced by new 'keyboard' option.
00000000000i[     ] installing nogui module as the Bochs GUI
00000000000i[     ] using log file bochsout.txt
Pintos hda1
Loading...........
Kernel command line:
Pintos booting with 4,096 kB RAM...
383 pages available in kernel pool.
383 pages available in user pool.
Calibrating timer...  102,400 loops/s.
Boot complete.
```

Debugging

QUESTIONS: BIOS

> B1: What is the first instruction that gets executed?

add %al,(%eax)

> B2: At which physical address is this instruction located?

0x0000fff0

QUESTIONS: BOOTLOADER

> B3: How does the bootloader read disk sectors? In particular, what BIOS interrupt is used?

调用名为read_sector的函数。该函数使用了“int $0x13”中断来进行读取。

> B4: How does the bootloader decides whether it successfully finds the Pintos kernel?

首先通过检查磁盘的MBR signature是否为0xaa55来确定该磁盘是否分区，若不是则前往下一块磁盘。然后检查当前分区是否使用。然后通过“cmpb $0x20, %es:4(%si)”检查是否为Pintos kernel。最后通过“cmpb $0x80, %es:(%si)”检查该分区是否为bootable的。当以上检查均通过后，说明找到了Pintos kernel。

> B5: What happens when the bootloader could not find the Pintos kernel?

输出“Not found”，然后触发一个int $0x18的中断。

> B6: At what point and how exactly does the bootloader transfer control to the Pintos kernel?

首先bootloader使用read__sector读取磁盘内容并放在从0x20000开始的内存位置，随后将位于ELF header的0x18处的kernel入口指针放在内存的start位置处，最后执行跳转到start位置将控制转移给Pintos kernel。

QUESTIONS: KERNEL

> B7: At the entry of pintos_init(), what is the value of expression `init_page_dir[pd_no(ptov(0))]` in hexadecimal format?

该值为0x0

> B8: When `palloc_get_page()` is called for the first time,

> > B8.1 what does the call stack look like?

使用bt查看调用栈，结果如下：

#0 palloc_get_page (flags=(PAL_ASSERT | PAL_ZERO)) at ../../threads/palloc.c:113

#1 0xc00203aa in paging_init () at ../../threads/init.c:168

#2 0xc002031b in pintos_init () at ../../threads/init.c:100

#3 0xc002013d in start () at ../../threads/start.S:180

> > B8.2 what is the return value in hexadecimal format?

使用fin运行至函数结束，返回值为(void *) 0xc0101000

> > B8.3 what is the value of expression `init_page_dir[pd_no(ptov(0))]` in hexadecimal format?

该值仍为0x0

> B9: When palloc_get_page() is called for the third time,

> > B9.1 what does the call stack look like?

使用c命令两次，重复上述命令，可得：

#0 palloc_get_page (flags=PAL_ZERO) at ../../threads/palloc.c:113

#1 0xc0020a81 in thread_create (name=0xc002e895 "idle", priority=0, function=0xc0020eb0 , aux=0xc000efbc) at ../../threads/thread.c:178

#2 0xc0020976 in thread_start () at ../../threads/thread.c:111

#3 0xc0020334 in pintos_init () at ../../threads/init.c:119

#4 0xc002013d in start () at ../../threads/start.S:180

> > B9.2 what is the return value in hexadecimal format?

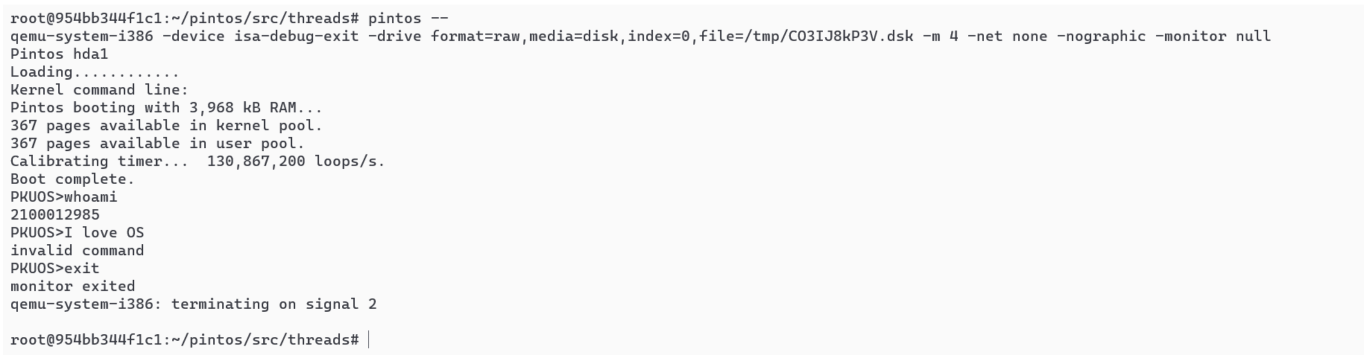
(void *) 0xc0103000

> > B9.3 what is the value of expression `init_page_dir[pd_no(ptov(0))]` in hexadecimal format?

该值为0x102027

Kernel Monitor

> C1: Put the screenshot of your kernel monitor running example here. (It should show how your kernel shell respond to `whoami`, `exit`, and `other input`.)



```
root@954bb344f1c1:~/pintos/src/threads# pintos --
qemu-system-i386 -device isa-debug-exit -drive format=raw,media=disk,index=0,file=/tmp/CO3IJ8kP3V.dsk -m 4 -net none -nographic -monitor null
Pintos hda1
Loading............
Kernel command line:
Pintos booting with 3,968 kB RAM...
367 pages available in kernel pool.
367 pages available in user pool.
Calibrating timer...  130,867,200 loops/s.
Boot complete.
PKUOS>whoami
2100012985
PKUOS>I love OS
invalid command
PKUOS>exit
monitor exited
qemu-system-i386: terminating on signal 2

root@954bb344f1c1:~/pintos/src/threads#
```

> C2: Explain how you read and write to the console for the kernel monitor.

使用input_getc()来逐个字符地获取输入，使用printf()来进行输出