HW7

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Question1

(1) 可以看到，其指向正确的代码行。(2) 它还告诉我产生冲突的地址和大小，如下图所示。

```
Possible data race during write of size 4 at 0x10C014 by thread #1
Locks held: none
   at 0x10923F: main (main-race.c:15)

This conflicts with a previous write of size 4 by thread #2
Locks held: none
   at 0x1091BE: worker (main-race.c:8)
   by 0x485396A: ??? (in /usr/libexec/valgrind/vgpreload_helgrind-amd64-linux.so)
   by 0x48FEAC2: start_thread (pthread_create.c:442)
   by 0x498FBF3: clone (clone.S:100)
 Address 0x10c014 is 0 bytes inside data symbol "balance"
```

Question2

(1) 移走一行可能的冲突就不会报错了。(2) 如果对两个地方都上锁，也不会有错误。(3) 如果只对一个地方上锁，可能是会有错误的；但是 helgrind 并没有报告。

Question3

在 main-deadlock.c 中，创建的两个线程都等待对方释放锁，最终会产生死锁。

Question4

helgrind 报告 lock order xxx violated，并在之后进行了进一步说明。

```
Thread #3: lock order "0x10C040 before 0x10C080" violated

Observed (incorrect) order is: acquisition of lock at 0x10C080
   at 0x4850CCF: ??? (in /usr/libexec/valgrind/vgpreload_helgrind-amd64-linux.so)
   by 0x109288: worker (main-deadlock.c:13)
   by 0x485396A: ??? (in /usr/libexec/valgrind/vgpreload_helgrind-amd64-linux.so)
   by 0x48FEAC2: start_thread (pthread_create.c:442)
   by 0x498FBF3: clone (clone.S:100)

 followed by a later acquisition of lock at 0x10C040
   at 0x4850CCF: ??? (in /usr/libexec/valgrind/vgpreload_helgrind-amd64-linux.so)
   by 0x1092C3: worker (main-deadlock.c:14)
   by 0x485396A: ??? (in /usr/libexec/valgrind/vgpreload_helgrind-amd64-linux.so)
   by 0x48FEAC2: start_thread (pthread_create.c:442)
   by 0x498FBF3: clone (clone.S:100)
```

Question5

(1) 在 main-deadlock-global.c 中，引入了第三个锁 g，从理论上说，这时某个线程可以轻松地获得锁 m1 和 m2，再释放；不应该出现问题。(2) 但是 helgrind 仍然报告了 lock order xxx is violated。(3) 说明 valgrind 的这些工具仍然不是完美的，也是会有误解的。

Question6

可以看到，在孩子进行时，父亲一直在循环中；这会导致效率不高，最后耗时多。

Question7

(1)helgrind 报告仍然可能会有数据竞争 (如下图)。(2) 这说明代码是有误的，报告指向了对于变量 done 的修改；说明这种方式既没效率也保证不了避免冲突。

```
Possible data race during write of size 4 at 0x10C014 by thread #2
Locks held: none
   at 0x1091C8: worker (main-signal.c:9)
   by 0x485396A: ??? (in /usr/libexec/valgrind/vgpreload_helgrind-amd64-linux.so)
   by 0x48FEAC2: start_thread (pthread_create.c:442)
   by 0x498FBF3: clone (clone.S:100)

This conflicts with a previous read of size 4 by thread #1
Locks held: none
   at 0x109245: main (main-signal.c:16)
 Address 0x10c014 is 0 bytes inside data symbol "done"
```

Question8

(1) 从正确性来说，两行内容是正确打印的，先后顺序正确（下图涂黄处）。(2) 从表现来说，虽然之前的版本也能正确打印，但是两行文字隔了很远，中间有很多报错信息；最后总结处看出不带-cv 版本有 24 个错，而现在的版本没有错误（下图涂绿处）。

```
==4310== Helgrind, a thread error detector
==4310== Copyright (C) 2007-2017, and GNU GPL'd, by OpenWorks LLP et al.
==4310== Using Valgrind-3.18.1 and LibVEX; rerun with -h for copyright inf
==4310== Command: ./main-signal-cv
==4310==
this should print first
this should print last
==4310==
==4310== Use --history-level=approx or =none to gain increased speed, at
==4310== the cost of reduced accuracy of conflicting-access information
==4310== For lists of detected and suppressed errors, rerun with: -s
==4310== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 7 from 7)
```

Question9

再次运行 valgrind –tool=helgrind ./main-signal-cv，仍然没有报错。