

Recitation 15: Exam Review - Signals

Instructor: TA(s)

Outline

-  **Proxylab**
-  **Final Exam**
-  **TA Applications**
-  **Signals**

Proxylab

■ Proxylab is due Thursday (or late by Friday)

- No submissions will be accepted after Friday!
- Submit something, even if doesn't pass everything

■ Worth almost a letter grade

■ Submit early

- Autolab may compile / run differently if you have undefined behavior or race conditions

Final Exam Logistics

- **Fill out Piazza Post about exam timings ASAP!**
- **213/613 Spring 2020 Final Exam Review**
 - Time: May 3, 2020 06:00 PM Eastern Time
 - Fill out Piazza Poll on what topics you want to review
- **Monitor Piazza for more information about the final exam**

So you wanna TA for 213



What qualifications are we looking for?

- Decent class performance, but also critical thinking skills
- Like computer systems + want to help others like systems!
- Have a reasonable ability to gauge your schedule + responsibilities
- Leadership potential! Take initiative, we love to see it 😊
- Ability to tell students:
 - “Did you write your heap checker”
 - “Run backtrace for me”
 - rinse and repeat, it’s mouthwash baby

Apply at <https://www.ugrad.cs.cmu.edu/ta/F20/>

Signals and Handling Reminders

■ Signals can happen at any time

- Control when through blocking signals

■ Signals also communicate that events have occurred

- What event(s) correspond to each signal?

■ Write separate routines for receiving (i.e., signals)

- What can you do / not do in a signal handler?

Signal Blocking

- We need to block and unblock signals. Which sequence?

```
pid_t pid;      sigset_t mysigs, prev;
sigemptyset(&mysigs);
sigaddset(&mysigs, SIGCHLD);
sigaddset(&mysigs, SIGINT);
// need to block signals. what to use?
// A. sigprocmask(SIG_BLOCK, &mysigs, &prev);
// B. sigprocmask(SIG_SETMASK, &mysigs, &prev);

if ((pid = fork()) == 0) {
    // need to unblock signals. what to use?
    /* A. sigprocmask(SIG_BLOCK, &mysigs, &prev);
     * B. sigprocmask(SIG_UNBLOCK, &mysigs, &prev);
     * C. sigprocmask(SIG_SETMASK, &prev, NULL);
     * D. sigprocmask(SIG_BLOCK, &prev, NULL);
     * E. sigprocmask(SIG_SETMASK, &mysigs, &prev);
```

Signal Blocking

■ We need to block and unblock signals. Which sequence?

```
pid_t pid;      sigset_t mysigs, prev;  
sigemptyset(&mysigs);  
sigaddset(&mysigs, SIGCHLD);  
sigaddset(&mysigs, SIGINT);  
// need to block signals. what to use?  
// A. sigprocmask(SIG_BLOCK, &mysigs, &prev);  
// B. sigprocmask(SIG_SETMASK, &mysigs, &prev);  
  
if ((pid = fork()) == 0) {  
    // need to unblock signals. what to use?  
    /* A. sigprocmask(SIG_BLOCK, &mysigs, &prev);  
     * B. sigprocmask(SIG_UNBLOCK, &mysigs, &prev);  
     * C. sigprocmask(SIG_SETMASK, &prev, NULL);  
     * D. sigprocmask(SIG_BLOCK, &prev, NULL);  
     * E. sigprocmask(SIG_SETMASK, &mysigs, &prev);
```

Signal Blocking

■ We need to block and unblock signals. Which sequence?

```
pid_t pid;      sigset_t mysigs, prev;
sigemptyset(&mysigs);
sigaddset(&mysigs, SIGCHLD);
sigaddset(&mysigs, SIGINT);
// need to block signals. what to use?
// A. sigprocmask(SIG_BLOCK, &mysigs, &prev);
// B. sigprocmask(SIG_SETMASK, &mysigs, &prev);

if ((pid = fork()) == 0) {
    // need to unblock signals. what to use?
    /* A. sigprocmask(SIG_BLOCK, &mysigs, &prev);
     * B. sigprocmask(SIG_UNBLOCK, &mysigs, &prev);
     * C. sigprocmask(SIG_SETMASK, &prev, NULL);
     * D. sigprocmask(SIG_BLOCK, &prev, NULL);
     * E. sigprocmask(SIG_SETMASK, &mysigs, &prev);
```

Signal Blocking cont.

- Someone implemented the wrong choices. Which signals are now blocked?

```
pid_t pid;      sigset_t mysigs, prev;  
sigemptyset(&mysigs);  
sigaddset(&mysigs, SIGCHLD);  
sigaddset(&mysigs, SIGINT);  
  
sigprocmask(SIG_SETMASK, &mysigs, &prev);  
// What is blocked?  
  
if ((pid = fork()) == 0) {  
    sigprocmask(SIG_BLOCK, &prev, NULL);  
    // What is blocked?
```

Signal Queuing

■ How many times is the handler invoked?

```
void handler(int sig)
{ ... }

...
sigset_t mysigs, prev;
signal(SIGUSR1, handler);
sigemptyset(&mysigs);
sigaddset(&mysigs, SIGUSR1);
sigprocmask(SIG_BLOCK, &mysigs, &prev);
kill(getpid(), SIGUSR1);
kill(getpid(), SIGUSR1);
sigprocmask(SIG_SETMASK, &prev, NULL);
```

Signal Delivery

- What can be printed?
- When is a blocked signal delivered?

```
sigset_t mysigs, prev;
sigemptyset(&mysigs);
sigaddset(&mysigs, SIGINT);
sigprocmask(SIG_BLOCK, &mysigs, &prev);
pid_t pid = fork();

if (pid > 0) {
    kill(pid, SIGINT);
    sigprocmask(SIG_SETMASK, &prev, NULL);
    printf("A");
} else {
    kill(getppid(), SIGINT);
    sigprocmask(SIG_SETMASK, &prev, NULL);
    printf("B");
}
```

Signal Delivery

- Child calls `kill(parent, SIGUSR{1,2})` between 2-4 times.
What sequence of kills may print 1?
Can you guarantee printing 2?
What is the range of values printed?

```
int counter = 0;
void handler (int sig) {
    atomically {counter++;}
}
int main(int argc, char** argv) {
    signal(SIGUSR1, handler);
    signal(SIGUSR2, handler);
    int parent = getpid();    int child = fork();
    if (child == 0) {
        /* insert code here */
        exit(0);
    }
    sleep(1);    waitpid(child, NULL, 0);
    printf("Received %d USR{1,2} signals\n", counter);
}
```

Signal Delivery

- Suppose the program is currently inside the signal handler, which signals are blocked?

```
int counter = 0;
void handler (int sig)
{
    counter++;
}
int main(int argc, char** argv)
{
    signal(SIGUSR1, handler);
    signal(SIGUSR2, handler);
}
```

Final Exam Q&A

Appendix: Thread Synchronization

You can assume `pthread_create` and `pthread_join` executed successfully. And `printf` always flushes stdout.

```

sem_t add_sem;
sem_t rem_sem;

void add() {
    printf("A");
}

void remove() {
    printf("R");
}

void *thread1(void *vargp) {
    V(&add_sem);
    V(&rem_sem);

    remove();
    P(&add_sem);
    P(&rem_sem);

    add();

    V(&add_sem);
    V(&rem_sem);

    remove();
    add();
}

void *thread2(void *vargp) {
    P(&rem_sem);
    P(&add_sem);

    add();
    remove();
}

```

```

int main() {
    pthread_t tid1, tid2;

    sem_init(&add_sem, 0, 0);
    sem_init(&rem_sem, 0, 0);

    pthread_create(&tid1, NULL, thread1, NULL);
    pthread_create(&tid2, NULL, thread2, NULL);

    pthread_join(tid1, NULL);
    pthread_join(tid2, NULL);

    return 0;
}

```

1. How many potential deadlock situations are present in the above code?
2. For lengths 0-6, list the number of possible outcomes of that length that can be produced.

Appendix: Thread Synchronization (Contd.)

Now, we redefine the thread1 and thread2 functions and add a global variable i, but keep main the same. (Main is still shown for easy reference.)

```
int i = 0;
sem_t add_sem;

void *thread1(void *vargp) {
    V(&add_sem);
    for (i = 0; i < 2; i++);
}

void *thread2(void *vargp) {
    for (int count = 0; count < 2; count++){
        P(&add_sem);
        printf("%d", i);
        V(&add_sem);
    }
}

int main() {
    pthread_t tid1, tid2;

    sem_init(&add_sem, 0, 0);

    pthread_create(&tid1, NULL, thread1, NULL);
    pthread_create(&tid2, NULL, thread2, NULL);

    pthread_join(tid1, NULL);
    pthread_join(tid2, NULL);

    return 0;
}
```

How many outcomes are possible?