

CIT 5950 Recitation 5 **Solutions** - Processes and Threads

Welcome back to recitation! We're glad that you're here :)

Exercise 1

- a) **List some reasons why it's better to use multiple threads within the same process rather than multiple processes running the same program**

Processes are more expensive, since they need their own address space. Threads are more lightweight.

- b) **What benefits could there be to using multiple processes instead of multiple threads?**

Memory safety and (possible) crash tolerance. Processes can't overwrite each other's work because they don't share an address space. Multiple processes can keep running independently if one crashes (depends of the task), whereas one thread seg faulting could crash the whole program.

- c) **Which registers will for sure be different between two threads that are executing different functions?**

The stack pointer is guaranteed to be different, since threads have their own stacks.

The program counters run independently, but might hold the same value if two threads are running the same function.

- d) **How does the OS distinguish the threads?**

Thread IDs. The OS will track its own data about threads, including the current register states, and the `pthread_t` type is used as an identifier from the user program (similar to how a file descriptor identifies a file or socket).

Exercise 2

Consider the following multithreaded program...

```
int g = 0;
void *worker(void *ignore) {
    for (int k = 1; k <= 3; k++) {
        g = g + k;
    }
    printf("g = %d\n", g);
    return NULL;
}

int main() {
    pthread_t t1, t2;
    int ignore;
    ignore = pthread_create(&t1, NULL, &worker, NULL);
    ignore = pthread_create(&t2, NULL, &worker, NULL);
    pthread_join(t1, NULL);
    pthread_join(t2, NULL);
    return EXIT_SUCCESS;
}
```

Give three different possible outputs (there are many)

Here are a few

g = 6
g = 12

g = 12
g = 12

g = 7
g = 9

g = 6
g = 11

g = 7
g = 10

What are the possible final values of the global variable 'g'? (circle all possible)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15+

See diagram for sample interleavings that lead to each possible result:

<https://courses.cs.washington.edu/courses/cse333/19sp/sections/10/worksheet-sol-diagram.pdf>