



Faculty of Engineering and Applied Science

SOFE 3950 Operating Systems

Tutorial Activity 4

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Date: Monday, Feb 3, 2020

Conceptual Questions

1. Read the pthread documentation and explain the following three functions:
pthread_create, pthread_join, pthread_exit.

The function pthread_create() will create a thread with the attributes specified. The function pthread_join() will wait for the created thread to terminate. The function pthread_exit() will terminate the specified calling thread.

2. Explain how the memory of threads work in comparison to processes, do threads share the same memory, can threads access the memory of other threads?

Threads share all the same parameters as a process however they do not share the same stack. Even though threads have different call stacks, the stack of any thread is still accessible from other stacks.

3. Name the differences between multithreading and multiprocessing (multiple processes). What are the advantages and disadvantages of each?

Multithreading utilizes multiple threads in order to increase computing power however multiprocessing utilizes multiple CPU cores to increase processing power.

Multiprocessing is normally more powerful than multithreading as entire CPU cores are dedicated to handling new tasks/processes, whereas multiple threads can run on one CPU core. Usually a combination of multithreading and multiprocessing is most effective. Threads are also easier and faster to create than processes.

4. Provide an explanation of mutual exclusion, what is a critical section?

Mutual exclusion is used for concurrency control and to eliminate race conditions. The key principle is that one thread should never enter its critical section while another concurrent thread is entering its critical section. A critical section is a period of time where a thread accesses a shared resource, such as shared memory.

5. Research the functions used to perform **mutual exclusion with pthreads** and explain the purpose of each function.

One way to deal with mutual exclusion in pthreads is to use the mutex functions. The function pthread_mutex_init() will create the mutex with the given attributes. By default, it will be initialized and unlocked. The function pthread_mutex_lock() will lock the resource to a given thread and it will not be accessible to other threads. When the thread is done with its critical section, the function pthread_mutex_unlock() will unlock the resource and allow other threads to enter their critical section.

Application Questions

Question 1

```
Hello world!  
Goodbye!  
avdonr@Avdons-MacBook-Pro Tutorial 4 %
```

Question 2

```
Enter first grade: 32  
Enter second grade: 42  
Enter third grade: 56  
Enter fourth grade: 78  
Enter fifth grade: 34  
48.00  
63.00  
84.00  
117.00  
51.00  
avdonr@Avdons-MacBook-Pro Tutorial 4 %
```

Question 3

```
Enter first grade: 123  
Enter first Student ID: 421  
Enter first Student Name: fas  
Enter second grade: 123  
Enter second Student ID: 51  
Enter second Student Name: ds  
Enter third grade: 53  
Enter third Student ID: 346  
Enter third Student Name: gf  
Enter fourth grade: 123  
Enter fourth Student ID: 321  
Enter fourth Student Name: da  
Enter fifth grade: 123  
Enter fifth Student ID: 532  
Enter fifth Student Name: af  
zsh: segmentation fault "/Users/avdonr/Documents/GitKraken/Operating-Systems/Tutorial 4/"task3  
avdonr@Avdons-MacBook-Pro Tutorial 4 %
```

Question 4

```
Enter first grade: 43
Enter second grade: 67
Enter third grade: 90
Enter fourth grade: 34
Enter fifth grade: 53
Enter sixth grade: 23
Enter seventh grade: 68
Enter eighth grade: 98
Enter ninth grade: 97
Enter tenth grade: 65
638.00
avdonr@Avdons-MacBook-Pro Tutorial 4 %
```

Question 5