1)

#include <pthread.h>

#include <stdio.h>

double globalVariable = 1;

static pthread\_mutex\_t mtx = PTHREAD\_MUTEX\_INITIALIZER;

void \* multiply(void \* arg){

int i;

for(i = 0; i<100; i++){

globalVariable = globalVariable \* 2.0;

}

return NULL;

}

void \* divide(void \* arg){

int i;

for(i = 0; i<100; i++){

globalVariable = globalVariable / 2.0;

}

return NULL;

}

int main(){

int i;

pthread\_t pt1[10];

//increment should give a value of 1000

//decrement should deviate this number back to zero if everything goes well

for (i = 0; i < 10; i++)

{

pthread\_create(&pt1[i], NULL, &multiply, NULL);

pthread\_create(&pt1[i], NULL, &divide, NULL);

}

//we only need to ask the parent wait once since both threads are being done simulteanously

for ( i = 0; i < 10; i++)

{

pthread\_join(pt1[i], NULL);

}

printf("Global Variable: %f\n", globalVariable);

return 0;

}

A close up of a logo

Description automatically generated

No it does not always show 1 because, when I created the 10 children in for loop, all the children are trying to access the globalVariable. Due to the timing of access by each child not working out well, there is collision (i.e two children multiplying the value at the same time) hence they both read the same value as the global counter is stored in the same address space. So 2 threads could have the same value.

When the counter is being divided I have created the 10 children in for loop, all the children are trying to access the same global counter. Due to the timing of access by each child not working out well, there is collision (i.e two children dividing the value at the same time) hence they both read the same value as the global counter is stored in the same address space. So 2 threads could have the same value causing us to get a value that is not 0.

3)

execve("./lab1b", ["./lab1b"], 0x7ffdaf4a83e0 /\* 53 vars \*/) = 0

brk(NULL) = 0x55f9b9d73000

arch\_prctl(0x3001 /\* ARCH\_??? \*/, 0x7ffe5ac35910) = -1 EINVAL (Invalid argument) access("/etc/ld.so.preload", R\_OK) = -1 ENOENT (No such file or directory) openat(AT\_FDCWD, "/etc/ld.so.cache", O\_RDONLY|O\_CLOEXEC) = 3

fstat(3, {st\_mode=S\_IFREG|0644, st\_size=66556, ...}) = 0

mmap(NULL, 66556, PROT\_READ, MAP\_PRIVATE, 3, 0) = 0x7f191a7d7000

close(3) = 0

openat(AT\_FDCWD, "/lib/x86\_64-linux-gnu/libpthread.so.0", O\_RDONLY|O\_CLOEXEC) = 3 read(3, "\177ELF\2\1\1\0\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\220\201\0\0\0\0\0\0"..., 832) = 832

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0w\\\273\377\370\24Ef`xg\200\260\263\264\0"..., 68,

824) = 68

fstat(3, {st\_mode=S\_IFREG|0755, st\_size=157224, ...}) = 0

mmap(NULL, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS, -

1, 0) = 0x7f191a7d5000

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0w\\\273\377\370\24Ef`xg\200\260\263\264\0"..., 68,

824) = 68

mmap(NULL, 140408, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f191a7b2000

mmap(0x7f191a7b9000, 69632, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x7000) = 0x7f191a7b9000 mmap(0x7f191a7ca000, 20480, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x18000) = 0x7f191a7ca000 mmap(0x7f191a7cf000, 8192, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1c000) = 0x7f191a7cf000 mmap(0x7f191a7d1000, 13432, PROT\_READ|PROT\_WRITE,

MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f191a7d1000

close(3) = 0

openat(AT\_FDCWD, "/lib/x86\_64-linux-gnu/libc.so.6", O\_RDONLY|O\_CLOEXEC) = 3 read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\360q\2\0\0\0\0\0"..., 832) = 832

pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784

pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0", 32, 848) = 32

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0cBR\340\305\370\2609W\242\345)q\235A\1"..., 68,

880) = 68

fstat(3, {st\_mode=S\_IFREG|0755, st\_size=2029224, ...}) = 0

pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 784, 64) = 784

pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0", 32, 848) = 32

pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0cBR\340\305\370\2609W\242\345)q\235A\1"..., 68,

880) = 68

mmap(NULL, 2036952, PROT\_READ, MAP\_PRIVATE|MAP\_DENYWRITE, 3, 0) = 0x7f191a5c0000

mprotect(0x7f191a5e5000, 1847296, PROT\_NONE) = 0

mmap(0x7f191a5e5000, 1540096, PROT\_READ|PROT\_EXEC, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x25000) = 0x7f191a5e5000 mmap(0x7f191a75d000, 303104, PROT\_READ, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x19d000) = 0x7f191a75d000 mmap(0x7f191a7a8000, 24576, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_FIXED|MAP\_DENYWRITE, 3, 0x1e7000) = 0x7f191a7a8000 mmap(0x7f191a7ae000, 13528, PROT\_READ|PROT\_WRITE,

MAP\_PRIVATE|MAP\_FIXED|MAP\_ANONYMOUS, -1, 0) = 0x7f191a7ae000

close(3) = 0

mmap(NULL, 12288, PROT\_READ|PROT\_WRITE, MAP\_PRIVATE|MAP\_ANONYMOUS,

-1, 0) = 0x7f191a5bd000

arch\_prctl(ARCH\_SET\_FS, 0x7f191a5bd740) = 0 mprotect(0x7f191a7a8000, 12288, PROT\_READ) = 0

mprotect(0x7f191a7cf000, 4096, PROT\_READ) = 0

mprotect(0x55f9b99b7000, 4096, PROT\_READ) = 0

mprotect(0x7f191a815000, 4096, PROT\_READ) = 0

munmap(0x7f191a7d7000, 66556) = 0

set\_tid\_address(0x7f191a5bda10) = 9693

set\_robust\_list(0x7f191a5bda20, 24) = 0

rt\_sigaction(SIGRTMIN, {sa\_handler=0x7f191a7b9bf0, sa\_mask=[], sa\_flags=SA\_RESTORER|SA\_SIGINFO, sa\_restorer=0x7f191a7c73c0}, NULL, 8) = 0 rt\_sigaction(SIGRT\_1, {sa\_handler=0x7f191a7b9c90, sa\_mask=[], sa\_flags=SA\_RESTORER|SA\_RESTART|SA\_SIGINFO, sa\_restorer=0x7f191a7c73c0},

NULL, 8) = 0

rt\_sigprocmask(SIG\_UNBLOCK, [RTMIN RT\_1], NULL, 8) = 0 prlimit64(0, RLIMIT\_STACK, NULL, {rlim\_cur=8192\*1024, rlim\_max=RLIM64\_INFINITY}) = 0

mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1919dbc000

mprotect(0x7f1919dbd000, 8388608, PROT\_READ|PROT\_WRITE) = 0 brk(NULL) = 0x55f9b9d73000

brk(0x55f9b9d94000) = 0x55f9b9d94000 clone(child\_stack=0x7f191a5bbfb0,

flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f191a5bc9d0, tls=0x7f191a5bc700, child\_tidptr=0x7f191a5bc9d0) = 9694 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19195bb000

mprotect(0x7f19195bc000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1919dbafb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1919dbb9d0, tls=0x7f1919dbb700, child\_tidptr=0x7f1919dbb9d0) = 9695 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1918dba000

mprotect(0x7f1918dbb000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19195b9fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19195ba9d0, tls=0x7f19195ba700, child\_tidptr=0x7f19195ba9d0) = 9696 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19185b9000

mprotect(0x7f19185ba000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1918db8fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1918db99d0, tls=0x7f1918db9700, child\_tidptr=0x7f1918db99d0) = 9697 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1917db8000

mprotect(0x7f1917db9000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19185b7fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19185b89d0, tls=0x7f19185b8700, child\_tidptr=0x7f19185b89d0) = 9698

mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19175b7000

mprotect(0x7f19175b8000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1917db6fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1917db79d0, tls=0x7f1917db7700, child\_tidptr=0x7f1917db79d0) = 9699 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1916db6000

mprotect(0x7f1916db7000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19175b5fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19175b69d0, tls=0x7f19175b6700, child\_tidptr=0x7f19175b69d0) = 9700 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19165b5000

mprotect(0x7f19165b6000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1916db4fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1916db59d0, tls=0x7f1916db5700, child\_tidptr=0x7f1916db59d0) = 9701 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1915db4000

mprotect(0x7f1915db5000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19165b3fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19165b49d0, tls=0x7f19165b4700, child\_tidptr=0x7f19165b49d0) = 9702 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19155b3000

mprotect(0x7f19155b4000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1915db2fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1915db39d0, tls=0x7f1915db3700, child\_tidptr=0x7f1915db39d0) = 9703 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1914db2000

mprotect(0x7f1914db3000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19155b1fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19155b29d0, tls=0x7f19155b2700, child\_tidptr=0x7f19155b29d0) = 9704 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19145b1000

mprotect(0x7f19145b2000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1914db0fb0,

flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1914db19d0, tls=0x7f1914db1700, child\_tidptr=0x7f1914db19d0) = 9705 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1913db0000

mprotect(0x7f1913db1000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19145affb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19145b09d0, tls=0x7f19145b0700, child\_tidptr=0x7f19145b09d0) = 9706 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19135af000

mprotect(0x7f19135b0000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1913daefb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1913daf9d0, tls=0x7f1913daf700, child\_tidptr=0x7f1913daf9d0) = 9707 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1912dae000

mprotect(0x7f1912daf000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19135adfb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19135ae9d0, tls=0x7f19135ae700, child\_tidptr=0x7f19135ae9d0) = 9708 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19125ad000

mprotect(0x7f19125ae000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1912dacfb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1912dad9d0, tls=0x7f1912dad700, child\_tidptr=0x7f1912dad9d0) = 9709 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1911dac000

mprotect(0x7f1911dad000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19125abfb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19125ac9d0, tls=0x7f19125ac700, child\_tidptr=0x7f19125ac9d0) = 9710 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19115ab000

mprotect(0x7f19115ac000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1911daafb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1911dab9d0, tls=0x7f1911dab700, child\_tidptr=0x7f1911dab9d0) = 9711 mmap(NULL, 8392704, PROT\_NONE,

AP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f1910daa000

mprotect(0x7f1910dab000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19115a9fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f19115aa9d0, tls=0x7f19115aa700, child\_tidptr=0x7f19115aa9d0) = 9712 mmap(NULL, 8392704, PROT\_NONE,

MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK, -1, 0) = 0x7f19105a9000

mprotect(0x7f19105aa000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1910da8fb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1910da99d0, tls=0x7f1910da9700, child\_tidptr=0x7f1910da99d0) = 9713 futex(0x7f1919dbb9d0, FUTEX\_WAIT, 9695, NULL) = 0

munmap(0x7f19195bb000, 8392704) = 0

munmap(0x7f19185b9000, 8392704) = 0

munmap(0x7f19175b7000, 8392704) = 0

munmap(0x7f19165b5000, 8392704) = 0

munmap(0x7f19155b3000, 8392704) = 0

munmap(0x7f19145b1000, 8392704) = 0

fstat(1, {st\_mode=S\_IFCHR|0620, st\_rdev=makedev(0x88, 0), ...}) = 0 write(1, "Counter = -100\n", 15Counter = -100

) = 15

exit\_group(0) = ?

+++ exited with 0 +++

4)

arent\_tidptr=0x7f191a5bc9d0, tls=0x7f191a5bc700, child\_tidptr=0x7f191a5bc9d0) = 9694 mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK,

-1, 0) = 0x7f19195bb000

mprotect(0x7f19195bc000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f1919dbafb0, flags=CLONE\_VM|CLONE\_FS|CLONE\_FILES|CLONE\_SIGHAND|CLONE\_THREAD|CLO NE\_SYSVSEM|CLONE\_SETTLS|CLONE\_PARENT\_SETTID|CLONE\_CHILD\_CLEARTID,

parent\_tidptr=0x7f1919dbb9d0, tls=0x7f1919dbb700, child\_tidptr=0x7f1919dbb9d0) = 9695 mmap(NULL, 8392704, PROT\_NONE, MAP\_PRIVATE|MAP\_ANONYMOUS|MAP\_STACK,

-1, 0) = 0x7f1918dba000

mprotect(0x7f1918dbb000, 8388608, PROT\_READ|PROT\_WRITE) = 0

clone(child\_stack=0x7f19195b9fb0,

5)

#include <pthread.h>

#include <stdio.h>

double globalVariable = 1;

static pthread\_mutex\_t mtx = PTHREAD\_MUTEX\_INITIALIZER;

void \* multiply(void \* arg){

int i;

for(i = 0; i<100; i++){

pthread\_mutex\_lock(&mtx);

globalVariable = globalVariable \* 2.0;

pthread\_mutex\_unlock(&mtx);

}

return NULL;

}

void \* divide(void \* arg){

int i;

for(i = 0; i<100; i++){

pthread\_mutex\_lock(&mtx);

globalVariable = globalVariable / 2.0;

pthread\_mutex\_unlock(&mtx);

}

return NULL;

}

int main(){

int i;

pthread\_t pt1[10];

//increment should give a value of 1000

//decrement should deviate this number back to zero if everything goes well

for (i = 0; i < 10; i++)

{

pthread\_create(&pt1[i], NULL, &multiply, NULL);

pthread\_create(&pt1[i], NULL, &divide, NULL);

}

//we only need to ask the parent wait once since both threads are being done simulteanously

for ( i = 0; i < 10; i++)

{

pthread\_join(pt1[i], NULL);

}

pthread\_mutex\_destroy(&mtx);

printf("Global Variable: %f\n", globalVariable);

return 0;

}

6)

A close up of a logo

Description automatically generated

Yes it does, I always get 1 as the answer because we are now using a mutex so only one child would ever be able to increment or decrement the counter at any given time.

7)