Threads

CS 113: Introduction to C

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Processes vs. Threads

Processes . . .

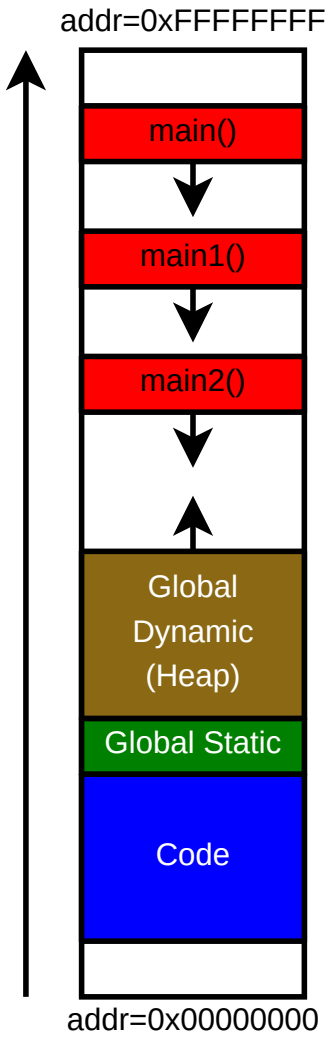
- Multiple simultaneous programs
- Independent memory space
- Independent open file-descriptors

Threads . . .

- Multiple simultaneous functions
- Share the same memory
- Share the same open file-descriptors

Threads

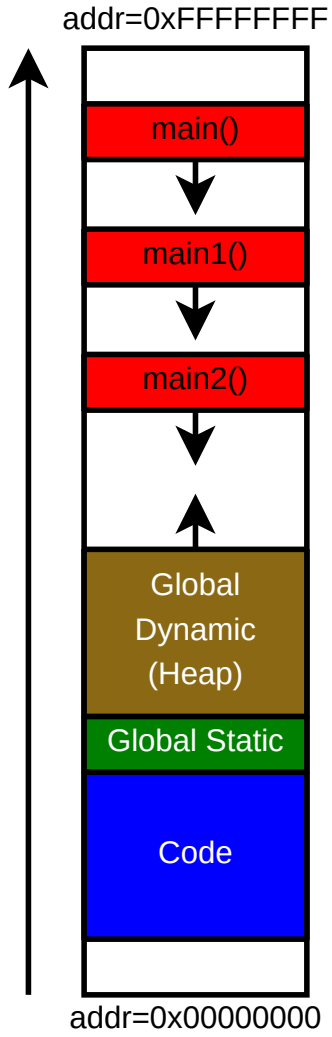
- One copy of the heap
- One copy of the code
- **Multiple** stacks



Threads

```
#include <pthread.h>
void *main2(void *arg) {
    ...
}
void *main1(void *arg) {
    ...
}
int main() {
    pthread_t id1, id2;
    pthread_create(&id1, NULL, main1, NULL);
    pthread_create(&id2, NULL, main2, NULL);
    ...
}
```

...think multiple processors (or cores)



pthread

Starting a thread

```
#include <pthread.h>
...
pthread_t id;
err = pthread_create(&id, NULL, entry_func, arg);
```

Body of a thread

```
void *entry_func(void *arg) {
        ...
```

Exiting current thread

```
        ...
        pthread_exit((void *)return_value);
}
```

pthread

Co-operative Multi-Threading on Single Processor

```
#include <sched.h>
...
    sched_yield()
```

- Store stack pointer, internal state etc. for current thread
- Restore stack pointer, internal state etc. for another thread
- Resume executing other thread

From the caller's perspective, sched_yield() blocks until the other thread calls sched_yield(). Allows multiple threads to share the CPU cooperatively.

pthread

Non-Cooperative Multi-Threading

Thread library (pthread) pre-empts thread when it invokes an OS function.

- Almost transparent when writing code
- Whole new class of bugs: Concurrency bugs
  - Multiple threads accessing same object concurrently
  - Solution: Locks – only one thread can grab lock
  - More of this is CS414/415