CS246
Unix: processes
C: more defines, structs

March 18

Processes and management

```c
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>

/**
 * A stupid program that just runs for the number of seconds given
 * on the command line
 * Prints a ping every 10 seconds
 * **/
int main(int argc, char const *argv[])
{
    int tim = atoi(argv[1]);
    tim++;
    for (int i = 1; i < tim; i++) {
        if (0==(i%10)) {
            printf("%d\n", i);
        }
        sleep(1);
    }
    return 0;
}
```

Background and foreground

- foreground
    - program runs and you get back the cursor on completion
- “background”
    - program runs, but you get cursor immediately.
        - can do other things in the shell.
- Start in backgound
    - & at end of line starts program “in background”
        - ./longrunner &
            - problem it is still putting info to the console
            - ./longrunner > longrun.out &
- Note all jobs are tied to their shell.
    - So if shell dies, jobs dies.
        - Can be avoided with some extra work

Stopping (killing) processes

- Foreground
  - CTRL-C
- Background
  - need to know “process id” or “job id”

- Job id is shell specific.
  - Each shell knows what processes are running under its aegis
  - UNIX> jobs
    - job id are on left in []
    - typically small integers (1,2,3,…)
- UNIX> kill %jid — kills well behaved jobs

Job id

```
[gtowell@powerpuff L10]$ ./a.out 600 > aa &
[1] 3805534
[gtowell@powerpuff L10]$ ./a.out 600 > bb &
[2] 3805543
[gtowell@powerpuff L10]$ jobs
[1]-  Running                 ./a.out 600 > aa &
[2]+  Running                 ./a.out 600 > bb &
[gtowell@powerpuff L10]$
```

Process id

- Process id is across entire machine
    - usually a largeish integer
- UNIX> ps
    - default – all processes in the current shell
    - ps aux
        - all processes on device
    - ps aux | grep myunixname
        - all processes that are running for me
- UNIX> kill pid

process id

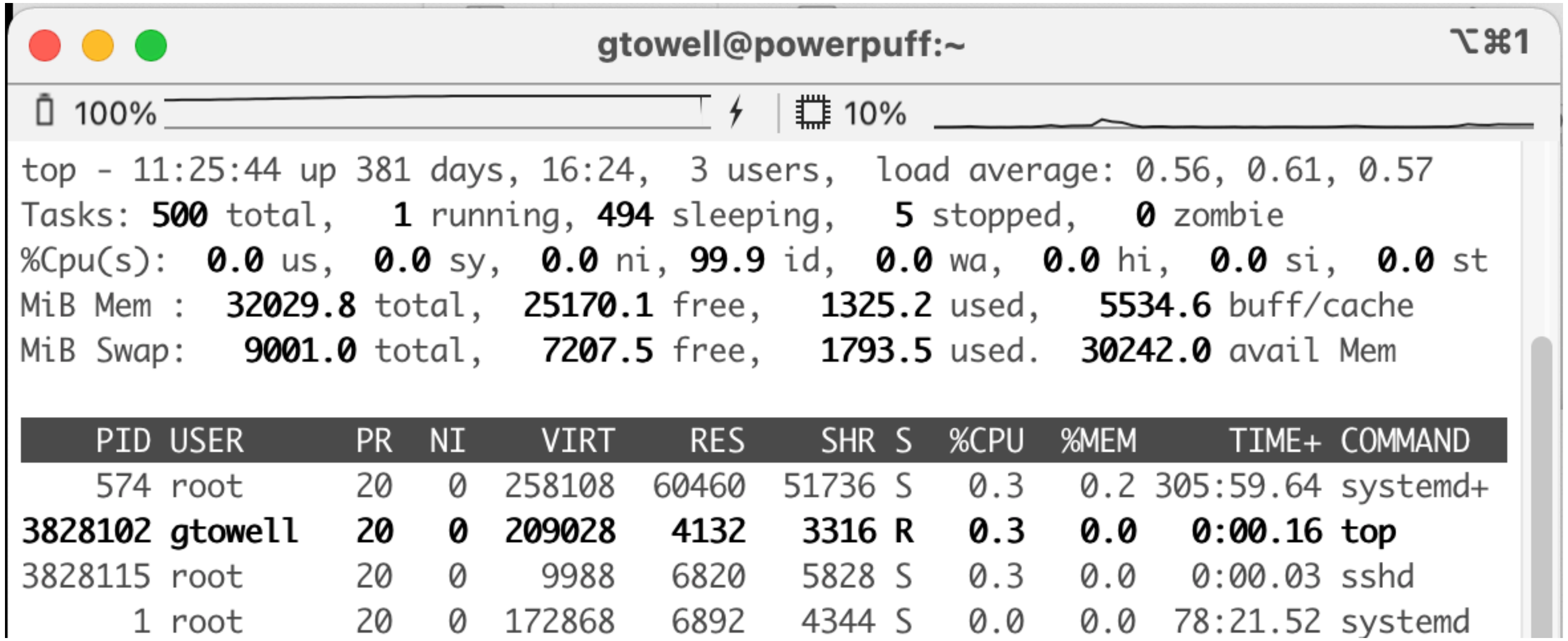
```
[gtowell@powerpuff L10]$ ./a.out 600 > bb &
[1] 3807567
[gtowell@powerpuff L10]$ ./a.out 600 > aa &
[2] 3807740
[gtowell@powerpuff L10]$ ps
    PID TTY          TIME CMD
3802628 pts/13   00:00:00 bash
3807567 pts/13   00:00:00 a.out
3807740 pts/13   00:00:00 a.out
3807858 pts/13   00:00:00 ps
```

Pausing and restarting

- Pause a foreground process
  - CRTL-z
- Restart a paused process
  - fg [%jid][pid]— restart in foreground
  - bg [%jid][pid]— restart in background
  - realistically, I only ever use bg and fg on the “current” process

More with processes

- pid also appears in /proc directory
- UNIX> top
    - a continually updating view on what is using resources on computer
    - pid in far left of top



```
top - 11:25:44 up 381 days, 16:24,  3 users,  load average: 0.56, 0.61, 0.57
Tasks: 500 total,   1 running, 494 sleeping,   5 stopped,   0 zombie
%Cpu(s):  0.0 us,  0.0 sy,  0.0 ni, 99.9 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :  32029.8 total,  25170.1 free,   1325.2 used,   5534.6 buff/cache
MiB Swap:   9001.0 total,   7207.5 free,   1793.5 used.  30242.0 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
    574 root      20   0  258108  60460  51736 S   0.3   0.2 305:59.64 systemd+
3828102 gtowell   20   0  209028   4132   3316 R   0.3   0.0   0:00.16 top
3828115 root      20   0    9988   6820   5828 S   0.3   0.0   0:00.03 sshd
      1 root      20   0  172868   6892   4344 S   0.0   0.0  78:21.52 systemd
```

Yet more

- Pause a process
  - foreground – CTRL-z
  - background – UNIX> kill -SIGSTOP pid
- Resume a process
  - foreground – fg [%jid][pid]
  - background – UNIX> kill -SIGCONT pid
- Killing zombies
  - UNIX> kill -SIGKILL pid
    - this is super aggressive

uptime

- UNIX>uptime
    - Stats about how heavily used computer is. Last 3 numbers give number of CPUs in use.
- To really understand, need to know # of CPUs and maybe info about the CPUs.
- https://cs.brynmawr.edu/~gtowell/chks.html

```
[gtowell@powerpuff ~]$ uptime
 12:51:29 up 381 days, 17:50,  3 users,  load average: 0.69, 0.63, 0.58
[gtowell@powerpuff ~]$ cat /proc/stat | grep cpu[0-9] | wc
     32     363    2088
model name	: Intel(R) Xeon(R) CPU E5-2640 v3 @ 2.60GHz

gtowell@benz:~$ uptime
 12:55:21 up 23:11,  1 user,  load average: 0.18, 0.08, 0.03
gtowell@benz:~$ cat /proc/stat | grep cpu[0-9] | wc
      8      88     343
gtowell@benz:~$ cat /proc/cpuinfo | grep 'model name' | uniq
model name	: Intel(R) Core(TM) i7-9700 CPU @ 3.00GHz
```

Lab from Thursday

```c
#include <stdio.h>

long factorial(int factorialOf) {
    if(factorialOf <= 1) {
        return (long)1;
    }
    return factorialOf ∗ factorial(factorialOf − 1);
}


long factorialTail(int factorialOf, long product) {
    if (factorialOf <= 1) {
        return product;
    }

    return factorialTail(factorialOf − 1, product ∗ factorialOf);
}

void main(void) {
    int factorialOf = 0;
    printf("Enter an int to find factorial of: ");
    scanf("%d", &factorialOf);

    printf("No tail recursion: %ld\n", factorial(factorialOf));
    printf("Tail recursion: %ld\n", factorialTail(factorialOf, 1));
}
```

More with #define

- define useful functions
- Have parts of code that get “commented out” depending on presence of a define

```
#define SIZE 20
#define RAND_RANGE(min, max) min + rand() / (RAND_MAX
#define SWAP_INT(a, b) {int t=a; a=b; b=t;}
#ifndef max
    #define max(a,b) (a > b ? a : b)
#endif
#ifndef min
    #define min(a,b) (a > b ? (b) : (a))
#endif
#define MEDIAN(a,b,c) ( (a > b) ? max(b, min(a,c)) : m
#define DO_MEDIAN 1
#define DO_SORT 1
#if DOSORT
void iSort(int *arr, int lo, int hi) {
    printf("iSort %d %d\n", lo, hi);
    SWAP_INT(arr[lo], arr[hi]);
}
#endif
// more here
```

Yet more #define

- can add defines at compile time via gcc
  - NO code change
  - gcc -D LOG_LEVEL=5 xx.c
- Most production shops are paranoid (rightly) about code changes

```
#ifndef LOG_LEVEL
#define LOG_LEVEL 0
#endif
#define LOG_VERBOSE 1
#define LOG_INFO 5
#define LOG_ERROR 10
// basic logging comment
#define LOG(level, ...) if (LOG_LEVEL <= level) fprintf(LOG_LEVEL>=
// log the start of a function ... arguably should include the args
#define FUNC_START() if (LOG_LEVEL <= LOG_INFO) fprintf(LOG_LEVEL>=
__func__)
// log the end of a function
#define FUNC_END() if (LOG_LEVEL <= LOG_INFO) fprintf(LOG_LEVEL>=LO
__func__)
void v1() {
    FUNC_START();
    for (int i=0; i<10; i++) {
        LOG(LOG_VERBOSE, "%d %c %c\n", i, 'a'+i, TO_UPPER('a'+i));
    }
    FUNC_END();
}

int main(int argc, char * argv[]) {
    for (int i=0; i<argc; i++) {
        LOG(LOG_INFO, "%s\n", argv[i]);
    }
    v1();
}
```

Defining new types

- C allows fairly arbitray definition of new data types
  - typedef type name
- look in stdio.h — used a lot
- allows compile time checking for some error types

```
#define DOLLAR_FORMAT "$%.2f"

// define a new type named "dollar"
// typedefs should be global although you can make t
// but is it reasonable to do so?
typedef float dollar;

void pdollars(dollar d) {
    printf(DOLLAR_FORMAT, d);
}

int main(int argc, char * argv[])
{
    dollar money = 5.5;
    pdollars(money);
    printf("\n");
}
```

Structs

- Way of grouping disparate data types
    - NOT objects
        - No methods
        - No access controls
- Two ways of defining
    - recommendation: use typedef

```
// define a struct
struct p {
    int a;
    int b;
};

// define a struct using typedef
typedef struct {
    int a;
    int b;
} pType;
```

More on Structs

- Pass by Value!
- When working with a pointer to a struct can use -> to access components

```c
void printit(struct p pa) {
    printf("struct p %d %d %d\n", &pa, pa.a, pa.b);
}
void printitPT(pType pa) {
    printf("pType %d %d %d\n", &pa, pa.a, pa.b);
}
void printitPoint(pType * paP) {
    // note use of two ways to get to pointed to struct cont
    // -> is just shorthand and is supposed to be easier.
    printf("pType* %d %d %d\n", paP, (*paP).a, paP->b);
}

int main(int argc, char const *argv[])
{
    struct p aa;
    aa.a = 5; aa.b = 10;
    pType bb = {.a=6, .b=12};
    printf("Pointers %d  %d\n", &aa, &bb);
    printit(aa);
    printitPT(bb);
    printitPoint(&bb);
    return 0;
}
```

Does the same thing

More Structs

- strtok and the weather data from thursday
- strcpy!
- strtol is equivalent to atoi

```
typedef struct {
    char time[10];
    int temp;
    int dewPoint;
    int relHum;
    char windDir[10];
    int windSpeed;
} WeatherData;
```

```
// this does not work – quite

void parseA(char* line, WeatherData w) {
    //printf("WaP %d\n", &w);
    char* c = strtok(line, " \t");
    strcpy(w.time, c);
    strtok(NULL, " \t"); // AM / PM skipped
    c = strtok(NULL, " \t");
    w.temp = (int)strtol(c, NULL, 10);
    c = strtok(NULL, " \t");
    c = strtok(NULL, " \t");
    w.dewPoint = (int)strtol(c, NULL, 10);
    c = strtok(NULL, " \t");
    c = strtok(NULL, " \t");
    w.relHum = (int)strtol(c, NULL, 10);
    c = strtok(NULL, " \t");
    strcpy(w.windDir, c);
    c = strtok(NULL, " \t");
    c = strtok(NULL, " \t");
    w.windSpeed = (int)strtol(c, NULL, 10);
}
```

Structs again!

- Both of these work.
- You can return a struct from a function!

```
WeatherData parseB(char* line)
{
    WeatherData w;
    char* c = strtok(line, " \t”);
    // SAME AS PARSEA
    return w;
}

/**
 * Parse the passed in line into a WeatherData object
 * that is passed as a pointer!
 * @param line -- the data to be parsed
 * @param w -- a pointer to a struct to be filled
 * **/
void parseC(char* line, WeatherData * w){
    char* c = strtok(line, “\t”);
    // SAME AS PARSEA
    strtok(NULL, " \t"); // AM / PM skipped
}
```

Weather end

- Look at differing calls to parseA, parseB and parseC
- A
  - does not work
- B
  - return by value so the struct created in function gets copied into weather[c]
- C
  - pass the reference to the array object
  - fastest and cleanest.
  - recommend: always (almost) pass pointers to structs.

```c
void wprinter(WeatherData* w) {
    printf("%d Time:%s  Temp:%d F\n", w, w->time, w->temp);
}
WeatherData weather[100];
int main(void) {
   char line[256];
    FILE* f = fopen(WFILE, "r");
    if (f==NULL) {
        fprintf(stderr, "Could not open %s -- quitting\n", WFILE);
        return 1;
    }
    int c = 0;
    while (NULL != fgets(line, 256, f))
    { switch (METHOD) {
            case 1:
                parseA(line, weather[c]);
                break;
            case 2:
                weather[c] = parseB(line);
                break;
            case 3:
            default:
                parseC(line, &weather[c]);
                break;
            }
        c++;
    }
    for (int i=0; i<c; i++) {
        wprinter(&weather[i]);
    }
}
```

Lab

- Define a struct that holds one integer and one character
- in main, create an array holding 51 instances of your struct
- in a separate function called from main, fill those 51 instances with a random character and a random integer. The loop for doing things 51 times should be in main.
- In a separate function called from main (and not the same as your previous function), print the 51 instances.