C Bootcamp

Day 4

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Alan Mislove

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C Debugging
Debugging with gdb

GDB is a debugger that helps you debug your program
   Time you spend learning gdb will save you days of debugging time

You need to compile with the –g option to use gdb

The –g option adds debugging information to your program
   gcc -g -o hello hello.c

Should be done automatically in all Makefiles we give you
Running gdb

To run a program with gdb type

    gdb exename
    ....
    (gdb)

Then set a breakpoint in the main function

    Marker in your program that will make the program stop
    Return control back to gdb
    (gdb) break main

Now run your program

    If your program has arguments, you can pass them after run
    (gdb) run arg1 arg2 ... argN
Stepping through

Your program will start and will stop at `main`

```gdb>
```

You have the following commands to run your program step by step

```gdb) step
  It will run the next line of code and stop
  If it is a function call, it will enter into it
```

```gdb) next
  It will run the next line of code and stop
  If it is a function call, it will go through it
```

If the program is running without stopping, regain control `CTRL-C`
You can set breakpoints in a program in multiple ways:

(gdb) break function
   Set a breakpoint in a function

(gdb) break line
   Set a break point at a line number in the current file

(gdb) break file:line
   Set a break point at a line number in a specific file
Inspecting the stack

The command

(gdb) where

Prints the current function being executed
And the chain of functions that are calling that function
This is also called the backtrace

Example:

(gdb) where
#0  main () at test_mysting.c:22
#1  test () at test_mysting.c:38
(gdb)
Inspecting variables

To print the value of a variable

(gdb) print variable

Will automatically print char*s and arrays

(gdb) print i
$1 = 5
(gdb) print s1
$1 = 0x10740 "Hello"
(gdb) print stack[2]
$1 = 56
(gdb) print stack
$2 = {0, 0, 56, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}
Catching seg faults

If your program seg faults, gdb will catch it

(gdb) run
Starting program: /home/amislove/a.out
test string

Program received signal SIGSEGV, Segmentation fault.
0x4007fc13 in _IO_getline_info () from /lib/libc.so.6

(gdb) backtrace
#0 0x4007fc13 in _IO_getline_info () from /lib/libc.so.6
#1 0x4007fb6c in _IO_getline () from /lib/libc.so.6
#2 0x4007ef51 in fgets () from /lib/libc.so.6
#3 0x80484b2 in main (argc=1, argv=0xbffffaf4) at segfault.c:10
#4 0x40037f5c in __libc_start_main () from /lib/libc.so.6
Other C debugging tools

Purify
- Checks code at runtime
- Looks for errors like buffer overflows, accessing unallocated memory

Valgrind
- Tool to help find memory leaks
- Tracks allocation, tells you where memory allocated but never freed

Shark, Performance Tools
- OS X has many tools built into Developer Tools
Using Makefiles
Makefiles

`make` is an early precursor to `ant`

Uses a `Makefile`, which holds the build instructions

In this class, I’ll give you the `Makefile`

But, you may want/need to extend it

Basic idea: Dependency graph

`make` determines what requires what

Builds graph

Also determines what needs to be updated

Based on file timestamps

Executes commands, stops if error occurs
Makefile format

Unfortunately, Makefiles have a somewhat archaic format

target: [dependency1] [dependency2] ... [dependencyN]
   command1
   command2
   ...
   commandN

Basically, says target depends on targets dependency[1–N]
   And, if those exist, build target by executing command[1–N]

Note that commands must be indented with <tab> characters
   Otherwise, you’ll be debugging your Makefile
Makefile variables

All variables are accessed with $(name)

Defined with =

Built-in variables include $(input)[$<], $(output)[$@], $(inputs)[$^]

A number of built-in functions

Use file wildcards with $(wildcard pattern)

Remove/add suffixes with $(addsuffix suffix paths), $(basename paths)

Can express patterns with the % character

CC = gcc

%.o: %.c
  $(CC) -c $< -o $@
Example Makefile

```
CFILES = $(wildcard *.c)

cp%: cp%.c
    gcc -std=c99 -O0 -g -lm -Wall -pedantic -Werror -o $@ $<

test: all
    ./test $(basename $(CFILES))

all: $(basename $(CFILES))

clean:
    rm $(basename $(CFILES))
```
Debugging Makefiles

Sometimes, \texttt{make} will use built-in rules

E.g., compile C files with \texttt{gcc}
Can disable these with \texttt{make -r}

Sometimes, \texttt{make} doesn’t do what you want

Executes different commands than you expect
Can debug with \texttt{make -n}
  Just prints commands to be executed
UNIX Shell
Shell environment

Consists of a set of variables with values
Important for the shell and the programs that run from the shell
You can define new variables, change the values

Usually set up in `.bashrc`, `.tshrc` files

Examples

- `PATH` determines where to look for executables
- `SHELL` indicates the type of shell you are using

bash% echo $PATH
/usr/bin:/bin:/usr/sbin:/sbin:/usr/local/bin
Viewing/setting env variables

bash% export FOO=BAR
bash% echo $FOO
BAR
bash% unset FOO
bash% echo $FOO

bash% export
declare -x CLICOLOR="1"
declare -x COMMAND_MODE="unix2003"
declare -x HOSTNAME="joshua"
....
Configuration files

When bash is executed, it reads and runs certain configuration files:

`.profile, .bash_profile`: runs when you log in
  Contains one time initialization, like `TERM, HOME` etc

`.bashrc`: run each time another bash process is invoked
  Sets lots of variables, like `PATH, HISTORY` etc

Only modify the lines that you fully understand!
  Can cause very bad errors if not careful

E.g., Adding the line `logout` to the `.profile` file is bad
  Will cause you to be logged out every time you log in
  Probably not what you want