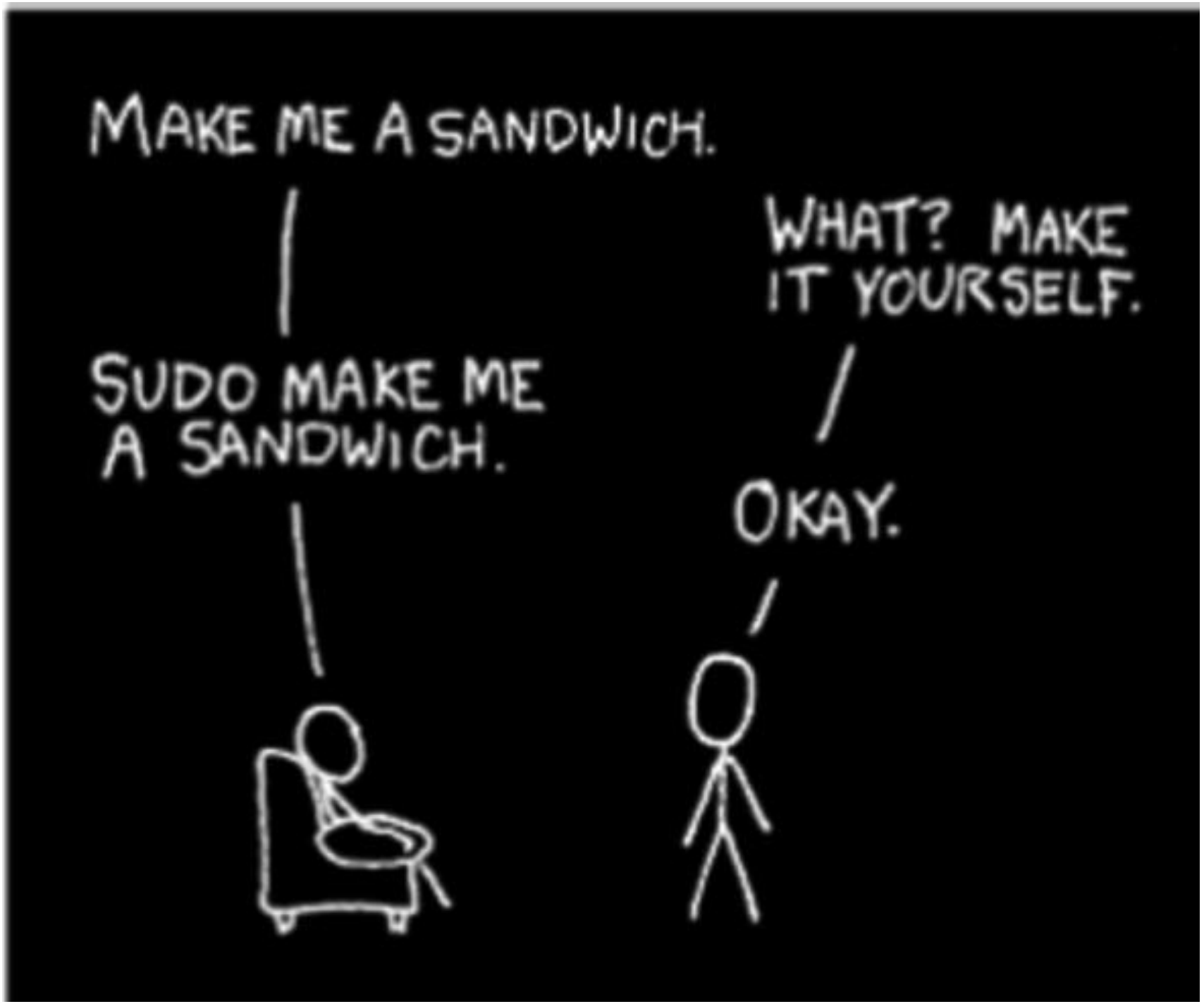

MAKE ME A SANDWICH.
WHAT? MAKE IT YOURSELF.
SUDO MAKE ME A SANDWICH.
OKAY.

xkcd.com

Our Virtual Machine

Ubuntu 16.04

- Install VirtualBox
- Download VM image from course web site

- Import image
- Boot image

(written details coming)

(Some) Unix Commands You Should Know

- pwd
- ls
- ls -l
- ls -la
- touch
- cat, more, less
- mkdir, rmdir
- rm
- rm -rf
- cd
- hexdump
- wc
- top
- make

Other Key Unix Concepts / Tools

- Absolute vs relative paths
- Editors
  - emacs
  - nano
  - vim
- sudo
  - Execute commands as the administrator
  - sudo shutdown –h now

Input & Output to/from Programs

Every process has 3 default “pipes” for accepting input or producing output:

- Standard Input (stdin)
- Standard Output (stdout): output specific to program’s job
- Standard Error (stderr): output encoding error information

These pipes are streams: the bytes are guaranteed to arrive in order and not be duplicated

Input & Output to/from Programs

When you execute a program from a shell, the default source/destination of the pipes is as follows:

- Standard Input (stdin): Anything typed by the user
- Standard Output (stdout): Displayed in the shell
- Standard Error (stderr): Displayed in the shell

But: these pipes can be shifted to take input from other sources and send output to other destinations (Unix magic!)

Compiling Code Bases

Gnu’s

Not

Unix!

Generating an Executable File

C File (.c)

Compiler: translate from human readable to machine-specific code

Object File (.o)

- Intermediate machine-specific representation of just what is in a C file

Linker: bring together multiple object files so that all functions are known

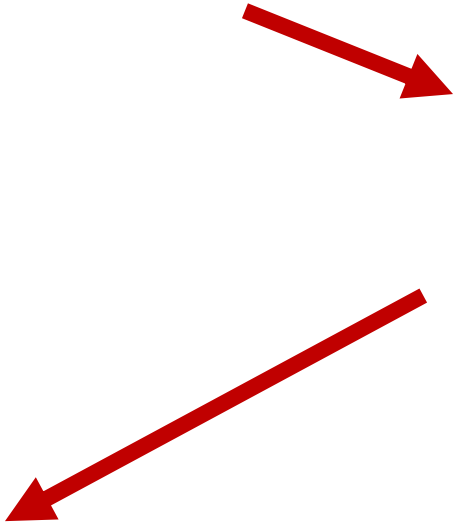
Executable (no extension)

Gnu C Compiler (gcc)

- Performs the compiling and linking phases for us
- Also invokes the assembler as part of the compiling process

Executing an Executable File

Executable (no extension)



Loader: bring together executable and dynamically linked libraries

Executing Process

Compiling Code Bases

As the set of files in a program gets large, we want to:

- Have a way to invoke the compiler easily
- Only compile the code that needs to be compiled
- Have a way to track which files depend on which other files

Invoking gcc at the compiler gets tiring and error prone…

Make Files

One of several ways to manage the compiling/project management process

- Define dependencies: what files depend on other files?
- Define rules for how to create derived files
  - Including the invocation of the compiler
- Uses file time stamps to know what work actually needs to be done

Our First Program

```
#include <stdio.h>

int main(int argc, char** argv)
{
  printf("Hello, World\n");
}
```

gcc hello.c –o hello

Our First Makefile

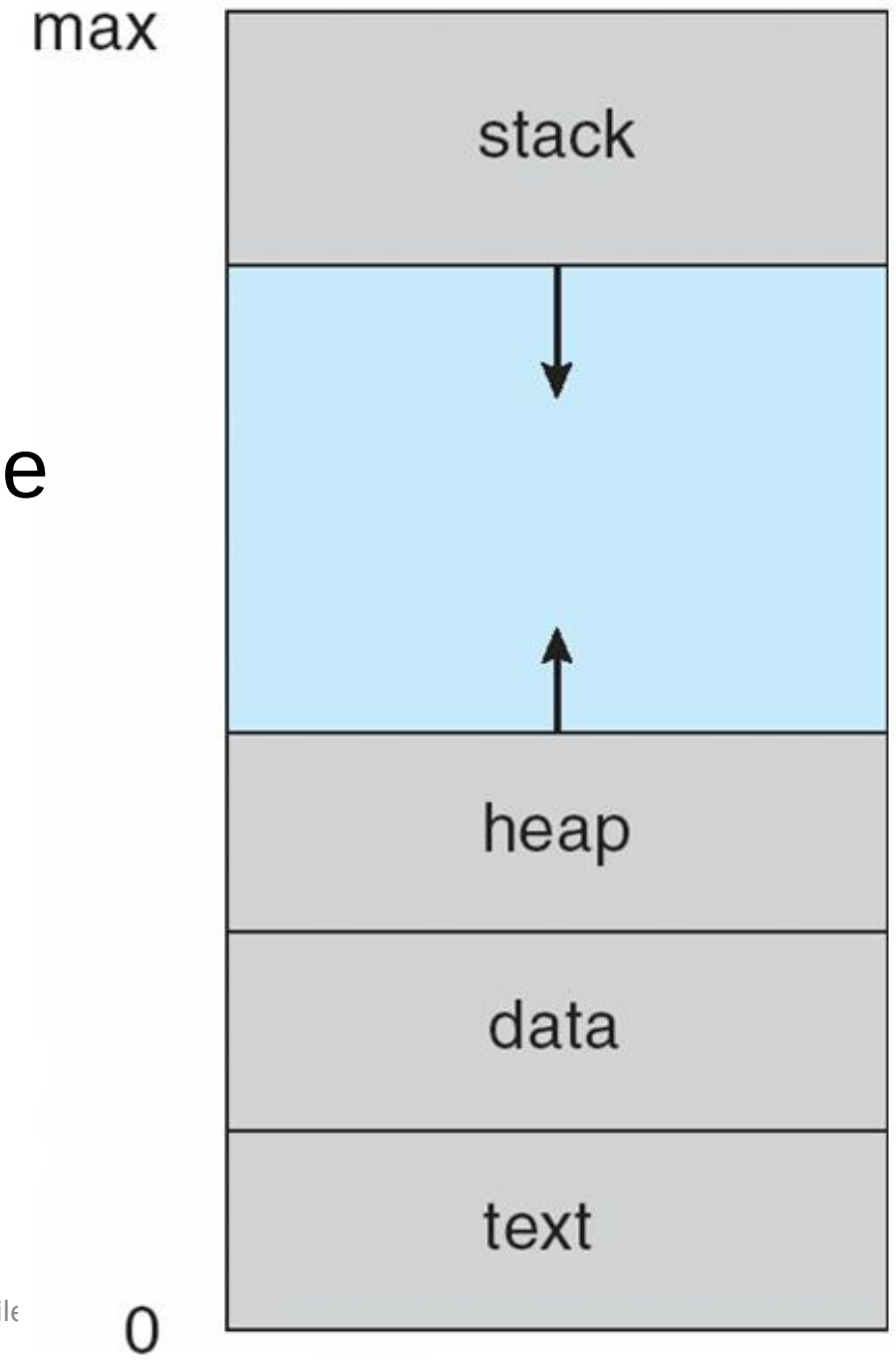
```
# The top rule is executed by default
all: hello

# Other rules are invoked as necessary

# Rule for creating the hello executable
hello: hello.c
    gcc hello.c -o hello
```

Live demo…

Processes and Memory

On process creation, the process is effectively given its own memory space

- Text: storage of code
- Data: global variables (preallocated space)
- Heap: dynamically allocated space
- Stack: local variable storage



Stack and Heap

- Stack grows downward with each nested function call
  - Local variables, register state, return memory address
- Heap
  - Storage of dynamically allocated items that must be persistent across function calls (and returns from function calls)
  - OOP languages: object instantiation is done in the heap

Variables and Pointers

- Every variable declaration results in an allocation of memory
- For primitive data types (int, char, float), the name of the variable refers to the value that is stored in the corresponding memory location
- However, we can get at the actual memory location

```
int a;
a = 5;
&a refers to the address in memory
```

Variables and Pointers

Strings