

601.220 Intermediate Programming

Makefiles

Outline

- Make and makefiles

make and Makefiles

- `make` is a tool that helps you keep track of which files need to be recompiled
 - Save time by not re-compiling unnecessarily
 - Avoid headaches from forgetting to recompile code that you changed!
 - Save yourself lots of typing
- in a configuration-type file called `Makefile`, carefully specify which files depend on which other files, and which commands should be used to create them

make and Makefiles

- Simplest to name the file `Makefile` or `makefile`, otherwise need to run `make` command with extra flags
- There are very strict rules about structure of `Makefile`, so easiest to follow a template and modify
- Beware: tabs and spaces are not equivalent in a `Makefile`!

make and Makefiles

- Lines in a makefile that begin with # are comments
- May define symbolic constants using \$ operator, e.g.
`CFLAGS=-std=c99 -pedantic -Wall -Wextra`, then refer to them in a command using `$(constant-name)`, e.g. `$(CFLAGS)`
- Then list any number of rules...
 - First (topmost) target listed is default target to run
- Format of a Makefile rule
 - `target_name`: list of files on which target depends
 - `TAB` followed by command-line instruction to generate target
- Multiple targets can be triggered by making a single target
 - If you make target `main`, then first any files on which `main` depends will be re-made if not up-to-date

make and Makefiles

```
// Makefile:
CC=gcc
CFLAGS=-std=c99 -pedantic -Wall -Wextra

main: mainFile.o functions.o
    $(CC) -o main mainFile.o functions.o

mainFile.o: mainFile.c functions.h
    $(CC) $(CFLAGS) -c mainFile.c

functions.o: functions.c functions.h
    $(CC) $(CFLAGS) -c functions.c

clean:
    rm -f *.o main
```

```
$ make clean
```

```
rm -f *.o main
```

```
make: Warning: File 'Makefile' has modification time 0.68 s in the future
```

```
make: warning: Clock skew detected. Your build may be incomplete.
```

```
$ make
```

```
make: Warning: File 'Makefile' has modification time 0.67 s in the future
```

```
make: *** No rule to make target 'mainFile.c', needed by 'mainFile.o'.
```

```
$ ./main
```

Using make: commands to type at command prompt

- `make functions.o`
 - compiles (or re-compiles) `functions.c` if needed, to create `functions.o`
 - re-compiling is needed if *either* `functions.c` or `functions.h` has changed, since the `functions.o` target lists both files in its dependency list
- `make mainFile.o`
 - compiles (or re-compiles, if needed) `mainFile.c` if needed, to create `mainFile.o`
 - re-compiling is needed if *either* `mainFile.c` or `functions.h` has changed, since the `functions.o` target lists both files in its dependency list
- The above commands are helpful, but aren't usually what we need...

Using make: commands to type at command prompt

- `make main`
 - links (or re-links, if needed) `mainFile.o` and `functions.o` to create an executable we decided to call `main` (see the `-o` flag?)
 - first it checks that `mainFile.o` and `functions.o` are up-to-date, based on the target rules specified for these (so `make` can have a cascading effect through multiple rules)
 - there's nothing special about the name `main` as the target here; we could've called this target `bob` if we'd wanted
- `make`
 - has same effect as `make main`, since `main` was listed as first target in Makefile
 - this is what we'll type most often; it's the quickest way to get the entire program built!
- `make clean`
 - removes intermediate files and executable called `main`, so we can start fresh