

Build systems and Make

Class 8

Overview

1. Announcements
2. Review
3. Q&A
4. Basic assignment

Announcements

- Git 2 assignments due March 15
- Make assignments due March 22
- Discord server!

Review

- Makefiles specify how to build files and how they depend on each other
- Makefiles are composed of **rules**

```
target: prerequisites  
    recipe # <- actual tab character, not spaces!
```

- **Target:** file to be produced
- **Prerequisites:** list of files that the rule depends on
- **Recipe:** shell commands that build the target file

Review

```
file1.o: file1.cpp  
    g++ -c -o file1.o file1.cpp  
  
file2.o: file2.cpp  
    g++ -c -o file2.o file2.cpp  
  
file3.o: file3.cpp  
    g++ -c -o file3.o file3.cpp  
  
app: file1.o file2.o file3.o  
    g++ -o app file1.o file2.o file3.o
```

Review

- Phony targets are targets that aren't files
 - Can represent ideas/concepts/commands e.g. `all`, `clean`, `test`
- Specify a target as phony by adding a `.PHONY` rule with the target as a prerequisite

Review

```
.PHONY: all
all: app

.PHONY: clean
clean:
    rm -f app

file1.o: file1.cpp
    g++ -c -o file1.o file1.cpp

file2.o: file2.cpp
    g++ -c -o file2.o file2.cpp

file3.o: file3.cpp
    g++ -c -o file3.o file3.cpp

app: file1.o file2.o file3.o
    g++ -o app file1.o file2.o file3.o
```

Review

- Two types of variables you can assign
 - Recursively expanded (via `=`)
 - Simply expanded (via `:`)
- Automatic variables
 - `$$`, `$<`, `^`, and more

Review

```
.PHONY: all
all: $(BIN)

.PHONY: clean
clean:
    rm -f $(BIN)

CXX = g++
BIN = app

file1.o: file1.cpp
    $(CXX) -c -o $@ $<

file2.o: file2.cpp
    $(CXX) -c -o $@ $<

file3.o: file3.cpp
    $(CXX) -c -o $@ $<

$(BIN): file1.o file2.o file3.o
    $(CXX) -o $@ $^
```

Review

- Make provides functions to help with text manipulation and other tasks
 - `$(wildcard <pattern>)`
 - `$(shell find . -name "*.c")`
 - `$(dir $@)`
- Make also provides pattern substitution and matching functionality
 - `$(<var>:<pattern>=<replacement>)` (substitution reference)
 - `$(SOURCES:%.c=%.o)`

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

```
OBJS := $(SRCS:src/%.c=obj/%.o) # substitution reference  
$(OBJS): obj/%.o : src/%.c # static pattern rule  
$(CC) -c -o $@ $<
```

Review

```
.PHONY: $(BIN)
all: app

.PHONY: $(BIN)
clean:
    rm -f app

CXX = g++
BIN = app
SRCS = $(find . -name "*.cpp")
OBJS = $(SRCS:%.cpp=%.o)

$(OBJS): %.o: %.cpp
    $(CXX) -c -o $@ $<

$(BIN): $(OBJS)
    $(CXX) -o $@ $^
```

Q&A

Basic assignment