Slide 1

Administrivia

- (Next homework?)

Slide 2

User-Defined Types — Review/Recap

- `typedef` provides a way to give a new name to an existing type.
- `enum` provides a way to define enumerated types (sort of — really just integer values).
- More complex types can be defined with `struct`.

Slide 3

User-Defined Types in C — `struct`

- `struct` lets you define a new type as a collection of other types — something like a Java class, but with no methods, and public fields only. (Also, unlike Java, C lets you have both `struct`s and pointers to `struct`s.)
- Two versions of syntax (next slide) . . .

Slide 4

User-Defined Types in C — `struct`

- One way to define uses `typedef`:

```
typedef struct {
    int dollars;
    int cents;
} money;
money bank_balance;
```

- Another way doesn't:

```
struct money {
    int dollars;
    int cents;
};
struct money bank_balance;
```

Slide 5

User-Defined Types in C — `struct`, Continued

- Either way you define a `struct`, how you access its fields is the same:

  `.` if what you have is a `struct` itself:

```
struct money bank_balance;
bank_balance.dollars = 100;
bank_balance.cents = 100;
```

  `->` if what you have is a pointer to a `struct`:

```
struct money * bank_balance_ptr = &bank_balance;
bank_balance_ptr->dollars = 100;
bank_balance_ptr->cents = 100;
```

Slide 6

User-Defined Types in C — `union`

- For completeness, we should mention that C also provides a way of defining a structure that can contain one of several alternatives ("this OR that", as opposed to the "this AND that" of `struct`) — `union`.
- See the discussion in the book for more about this; it can be useful, but can also make code more difficult to understand.

Slide 7

Example — Singly-Linked List

- As an example, consider code for a singly-linked list of integers, using two `structs`, one for list nodes and one for the list itself.
- To make things more interesting, we could write all the functions to use recursion.
- We may end up with a bit more code than comfortably fits into one file, though, so this may be time to learn more about compiling . . .

Slide 8

A Little More About `gcc`

- Many, many compiler options for `gcc`. One of the most useful is `-Wall`.
- To automate using them every time, you can use the UNIX utility `make` . . .

Slide 9

A Little About `make`

- Motivation: Most programming languages allow you to compile programs in pieces ("separate compilation"). This makes sense when working on a large program — when you change something, just recompile parts that are affected.
- Idea behind `make` — have computer figure out what needs to be recompiled and issue right commands to recompile it.

Slide 10

Makefiles

- First step in using `make` is to set up "makefile" describing how files that make up your program (source, object, executable, etc.) depend on each other and how to update the ones that are generated from others. Normally call this file `Makefile` or `makefile`.

  Simple example (assuming `main.c` `#includes` `defs.h` and `foo.h`):

```
main:   main.o foo.o
        gcc -o main main.o foo.o
main.o: main.c defs.h foo.h
        gcc -c main.c
foo.o:  foo.c
        gcc -c foo.c
```

- When you type `make`, `make` figures out (based on files' timestamps) which files need to be recreated and how to recreate them.

Slide 11

Predefined Implicit Rules

- `make` already knows how to "make" some things — e.g., `foo` or `foo.o` from `foo.c`.
- In applying these rules, it makes use of some variables, which you can override.
- A simple but useful makefile might just contain:

```
CFLAGS = -Wall -pedantic -O -std=c99
```

- Or you could use

```
OPT = -O
CFLAGS = -Wall -pedantic -std=c99 $(OPT)
```

and then optionally override the `-O` by saying, e.g., `make OPT=-g foo`.

Slide 12

Minute Essay

- None — sign in.