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Administrivia

- No class Thursday; I plan to be at a conference.
- Homework 1 on Web later today. Due next Tuesday. If you need help this week, okay to talk to other PAD I instructors, Dr. Lewis and Dr. Zhang. Open lab hours Thursday 3:30pm–5:30pm in HAS 228 (Lewis) and Thursday 5pm–7pm HAS 228 (Zhang).
- (Review minute essay from last time. Notice that normally answers to minute essays that *have* right/wrong answers will be on the Web later the day of class.)

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Binary Numbers

- We humans usually use the decimal (base 10) number system, but other (positive integer) bases work too. (Well, maybe not base 1.) Binary (base 2) is more widely used in computers because it makes the hardware simpler.
- In base 10, there are ten possible digits, with values 0 through 9.

  In base 2, there are 2 possible digits (*bits*), with values 0 and 1.
- In base 10, 1010 means what? What about in base 2?

Converting Between Bases

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- Converting from another base to base 10 is easy if tedious (just use definition).
- Converting from base 10 to another base? Let's try to develop an algorithm for that . . .

Decimal to Binary, Take 1

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- One way is to first find the highest power of 2 smaller than or equal to the number, write that down, subtract it from the number, and continue.
- We could write this in *pseudocode* thus (letting n be the number we want to convert:

  while $(n > 0)$

  find largest p such that $2^p \leq n$

  write a 1 in the p-th output position

  subtract 2^p from n

  end while
- Is this okay? What's not quite right about it? (We don't say what to put in the positions that don't have ones in them.)
- (Example.)

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Decimal to Binary, Take 2

- Another way produces the answer from right to left rather than left to right, repeatedly dividing by 2 (again n will be the number we want to convert):

  while $(n > 0)$

  divide n by 2, giving quotient q and remainder r

  write down r

  set n equal to q

  end while

- Is this okay? What's not quite right about it? (We don't say to write down the remainders from right to left.)
- (Example.)

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Octal and Hexadecimal Numbers

- Binary numbers are convenient for computer hardware, but cumbersome for humans to write. Octal (base 8) and hexadecimal (base 16) are more compact, and conversions between these bases and binary are straightforward.
- To convert binary to octal, group bits in groups of three (right to left), and convert each group to one octal digit using the same rules as for converting to decimal (base 10).
- Converting binary to hexadecimal is similar, but with groups of four bits. What to do with values greater than 9? represent using letters A through F (upper or lower case).
- (Examples.)

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Now Back to C — Functions

- C programs are organized in terms of *functions*.
- More about this later; for now, they're a little like mathematical functions, except that evaluating them can have "side effects".

  For example, evaluating the library function `printf` has the side effect of writing some text to standard output (by default, displaying it in the terminal window).
- A complete C program must contain a function called `main`. When you type `a.out`, the operating system calls this function. The return value can be used to indicate whether the program succeeded.
- Let's look again at the "hello world" program ...

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Variables

- To do anything interesting in a program, we need some place to store input and intermediate values.

  (E.g., consider a really simple program that asks the user for two numbers, adds them, and prints the result. It needs a place to hold the numbers and (maybe) their sum.)
- For this we use *variables*. Can think of them as boxes holding values. Each has a *name* and a *type*.
- (To be continued.)

Minute Essay

- What is 110_2 in base 10?
- What's the largest number (base 10) you can represent with 4 bits?

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Minute Essay Answer

- 110_2 is 6_{10}.
- This question might be ambiguous. What I wanted was the base-10 value of the largest binary number you can represent with 4 bits, i.e., 1111_2, i.e., 15_{10}.

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