University of Illinois at Urbana-Champaign
Dept. of Electrical and Computer Engineering

ECE 220: Computer Systems & Programming

Review: Basic I/O in C

Allowing Input from the Keyboard, Output to the Monitor

To control input and output (**I/O**), we use two functions from the standard **C** library.

Put this line at the top of your **C** program:

```
#include <stdio.h>
```

This directive tells the **C** compiler that your program **uses the standard C I/O functions**.

Write Output Using `printf`

To write text onto the display, use **`printf`**.

The "f" means "formatted."
- When using the function,
- you must **specify the desired format** between quotation marks.

Example:

```
printf ("Here is an example.");
```

The function call above **writes the text between the quotes to the monitor**.

Use Backslash to Include Special ASCII Characters

Certain **ASCII** characters
- control text appearance, and
- are hard to put between quotes.

For example
- **ASCII**'s **linefeed** character (or lf, sometimes called newline)
- **starts a new line of text**.

To **include linefeed, write \n** between quotes.

The **backslash indicates a special ASCII character**. Use \\ for one backslash.

One Can Include Many Linefeeds

Example:

```
printf("This\ntext\\has\nlines!\n");
```

The call above prints the three lines below (at the left of the screen).

```
This
text\has
lines!
```

The next **printf** also starts on a new line (because of the linefeed at the end of the format).

Use Format Specifiers to Print Expressions

printf also prints expression values

For example, specifies what and how to print

```
printf ("Integers: %d %d %d\n",
        6 * 7, 17 + 200, 32 & 100);
```

Output: [followed by **ASCII** linefeed]

```
Integers: 42 217 32
```

The **expressions** to print
- appear **after the format specification**, and
- are **separated by commas**.

Many Format Specifiers are Supported

Format Specifier	Interpretation
%c	**int** or **char** as ASCII character
%d	**int** as decimal
%e	**double** as decimal scientific notation
%f	**double** as decimal
%%	one percent sign

These Tables Suffice for Our Class

Format Specifier	Interpretation
%u	**unsigned int** as decimal
%x	integer as lower-case hexadecimal
%X	integer as upper-case hexadecimal

See man pages on a lab machine for more.

Format Specifiers Print Only the Expression Values

If you want spacing, include it in the format.

Example:

```
printf("%d%d%d", 12, -34, 56);
```

prints

```
12-3456
```

Except for format specifiers and special **ASCII** characters like linefeed, **characters print exactly as they appear**.

Pitfall: Passing the Wrong Type of Expression

Be sure that your expressions (and ordering) match the format.

Example:

a **double** an **int**

```
printf("%d %f", 10.0, 17);
```

may print (output is system dependent)

```
0 0.000000
```

A **C** compiler **may be able to warn you** about this kind of error.

Pitfall: Too Few/Many Expressions

If you pass more expressions than format specifiers, **the last expressions are ignored.**

If you pass fewer expressions than format specifiers, **`printf` prints … bits**!
(In other words, behavior is unspecified.)

Again, a **C** compiler **may be able to warn you** about this kind of error.

Read Input Using `scanf`

To read values from the keyboard, use **`scanf`**.

The "f" again means "formatted."

`scanf` also takes
- a format in quotation marks, and
- a comma-separated list of variable addresses

Example:

memory address of variable A

```
int A;
scanf ("%d", &A);
```

reads a decimal integer, converts it to **2's complement**, and stores the bits in **A**.

`scanf` Ignores White Space Typed by User

Example:
```
int A;
int B;
scanf ("%d%d", &A, &B);
```

The user can separate the two numbers with spaces, tabs, and/or linefeeds, such as …

```
5 42        /* A is 5, B is 42 */

  5  /* two lines -> same result */
 42
```

The user must push <Enter> when done.

Other Characters in Format Must be Typed Exactly

If format includes characters
- other than format specifiers and white space
- user must **type them exactly** with no extra spaces. **Rarely useful**.

Example:
```
int A; int B;
scanf ("%d<>%d", &A, &B);
```

Type "`5<>42`" and `A==5`, `B==42`.

But type "`5 <>42`" and `A==5`, while `B` is unchanged (no initializer, so `B` contains bits).

Conversion Specifiers Similar to `printf`

Format Specifier	Interpretation
`%c`	store one ASCII character (as `char`)
`%d`	convert decimal integer to `int`
`%f`	convert decimal real number to `float`
`%lf`	convert decimal real number to `double`

Conversion Specifiers Similar to `printf`

Format Specifier	Interpretation
`%u`	convert decimal integer to `unsigned int`
`%x` or `%X`	convert hexadecimal integer to `unsigned int`

More Pitfalls for `scanf` than for `printf`

`scanf` has the same pitfalls as `printf`

- Be sure to **match format specifiers (and ordering) to variable types**.
- Be sure to **match number of specifiers to number of addresses** given.

And more!

- **Don't forget to write "&" before each variable.** (Behavior is again undefined, but can be quite difficult to find the bug.)

`printf` Returns the Number of Characters Printed

Function calls are expressions.

Both `printf` and `scanf` return `int` (the calls evaluate to values of type `int`).

`printf` returns the number of characters printed to the display (or < 0 on error).

Writing a `printf` followed by a semicolon

- evaluates the expression (calls `printf`),
- then discards the return value.

The return value of `printf` is rarely used.

`scanf` Returns the Number of Conversions

`scanf` returns the number of conversions performed successfully, or -1 for no conversions.

The return value is **important for checking user input**.

For example,

```
if (2 != scanf ("%d%d", &A, &B)) {
    printf ("Bad input!\n");
    A = 42; B = 10; /* defaults */
}
```

