# Standard I/O Lesson Outline

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Output via `printf`

In C, we output to standard output using a `printf` statement:
```c
printf("This will be output to stdout.\n");
```

A `printf` statement can output a string literal, but it can also output the value of a variable, a literal constant or a named constant:
```c
printf("%d", number_of_students);
```

The statement above outputs to `stdout` (the terminal screen) the value of a variable named `number_of_students` of type `int` (presumably declared previously in the program that contains this `printf` statement).

The string literal in a `printf` statement is known as a `format string`. 
printf("%d", number_of_students);

The statement above:

- outputs to standard output (stdout)
- the value of the variable named number_of_students
- which is of type int
- (declared previously in the program that contains this printf statement).

The %d is known as a **placeholder**: it holds the place of the value of the variable that we actually want to output.

Another name for a placeholder is a **format specifier**, but we’ll typically say placeholder in CS1313.
Placeholders for Various Data Types

- **int:** \( \%d \)
  
  \texttt{printf("%d", number\_of\_students);}

- **float:** \( \%f \)
  
  \texttt{printf("%f", pi);} 

- **char:** \( \%c \)
  
  \texttt{printf("%c", middle\_initial);}
We now know that we can output a string literal:

```c
printf("This will be output to stdout.\n");
```

We also know that we can output the value of a variable:

```c
printf("%d", number_of_students);
```

Not surprisingly, we can **mix and match** the two:

```c
printf(" on your %d income.\n", tax_year);
```

We can even mix and match while outputting the values of multiple variables of various data types:

```c
printf("The %d federal income tax on $%f\n", tax_year, income);
```
Mixing Literal Text and Variables’ Values #2

In a `printf` statement’s **format specifier**, we can mix and match literal text and variables’ values while outputting the values of multiple variables of various data types:

```
printf("The %d federal income tax on $%f\n",
tax_year, income);
```

This statement means:
- Output to stdout (the terminal screen)
- the literal text "The ", and then
- the value of the int variable named `tax_year`, and then
- the literal text " federal income tax on $", and then
- the value of the float variable named `income`, and then
- a newline.
Placeholder & Variable in Same Statement

When you use a placeholder inside the string literal of a `printf` statement, the variable whose place is being held by the placeholder **MUST** be in the same `printf` statement as the placeholder.

Putting the placeholder in one `printf` statement and the variable in a different `printf` statement is **BAD BAD BAD**!

/* These printsfs are GOOD GOOD GOOD! */
printf("f1=%f, ", f1);
printf("i1=%d, GOOD!\n", i1);

/* These printsfs are BAD BAD BAD! */
printf("BAD! f2=%f, i2=%d, ");
printf("BAD!\n", f2, i2);

**NOTE**: The same rule applies to `scanf` statements (coming up).
Placeholder/Variable Same Statement: Example

% cat placeholder.c
#include <stdio.h>

int main ()
{
    float f1, f2;
    int   i1, i2;

    f1 = 3.75;
    f2 = 5.25;
    i1 = 6;
    i2 = 8;

    /* These printfs are GOOD GOOD GOOD! */
    printf("f1=%f, ", f1);
    printf("i1=%d, GOOD!\n", i1);
    /* These printfs are BAD  BAD BAD!  */
    printf("BAD! f2=%f, i2=%d, ");
    printf("BAD!\n", f2, i2);
    /* This printf is GOOD GOOD GOOD! */
    printf("f2=%f, i2=%d, GOOD!\n", f2, i2);
}

% gcc -o placeholder placeholder.c
% placeholder
f1=3.750000, i1=6, GOOD!
BAD! f2=3.750000, i2=134513662, BAD!
f2=5.250000, i2=8, GOOD!
Input via scanf

The `printf` statement outputs to `stdout` (the terminal screen).
Likewise, the `scanf` statement inputs from `stdin` (a user typing at the keyboard).
The `scanf` statement has a somewhat strange syntax:

```c
scanf("%d", &height_in_cm);
```

This statement says:
- input from `stdin` (a user typing at the keyboard)
- an int value
- and place that int value into the memory location associated with the int variable named `height_in_cm`. 
The `scanf` statement has a somewhat strange syntax:

```c
scanf("%d", &height_in_cm);
```

Notice the **ampersand** `&` before the name of the variable that you’re inputting into.

For now, you must simply **ACCEPT THIS ON FAITH**.

Time permitting, toward the end of the semester we’ll learn about what the ampersand means.
Input via `scanf` Example

```c
#include <stdio.h>

int main ()
{
    int height_in_cm;

    printf("What's my height in centimeters?\n");
    scanf("%d", &height_in_cm);
    printf("My height is %d cm.\n", height_in_cm);
}
```

```bash
% gcc -o read_variable read_variable.c
% read_variable
What's my height in centimeters?
160
My height is 160 cm.
```
printf("What's my height in centimeters?\n");
scanf("%d", &height_in_cm);
printf("My height is %d cm.\n", height_in_cm);
Reading Multiple Variables with a Single `scanf`

C allows inputting multiple variables per `scanf` statement.

**At runtime**, when the user types in the input values, they can separate the individual input values

- by blank spaces, and/or
- by tabs, and/or
- by carriage returns (newlines).

Blank spaces, tabs and carriage returns, as a group, are known as **white space**.
Multiple Variables per `scanf` Example #1

```c
#include <stdio.h>

int main ()
{ /* main */
    float CS1313_average_height_in_m;
    int number_of_silly_people, number_of_nonsilly_people;
    char Henrys_middle_initial;

    printf("In CS1313, how many silly people are there,\n");
    printf(" and how many non-silly people are there?\n");
    scanf("%d %d",
         &number_of_silly_people,
         &number_of_nonsilly_people);
    printf("What is the average height in m in CS1313,\n");
    printf(" and what is Henry's middle initial?\n");
    scanf("%f %c",
         &CS1313_average_height_in_m, &Henrys_middle_initial);
    printf("In CS1313, there are %d silly people\n",         number_of_silly_people);
    printf(" and %d non-silly people.\n",         number_of_nonsilly_people);
    printf("In CS1313, the average height is %f m.\n",         CS1313_average_height_in_m);
    printf("Henry's middle inițial is %c.\n",         Henrys_middle_initial);
}
/* main */
```
Multiple Variables per scanf Example #2

% gcc -o read_list read_list.c
% read_list
In CS1313, how many silly people are there, and how many non-silly people are there?
20 120
What is the average height in m in CS1313, and what is Henry's middle initial?
1.75
J
In CS1313, there are 20 silly people and 120 non-silly people.
In CS1313, the average height is 1.750000 m.
Henry's middle initial is J.
printf vs scanf

- **printf**
  - outputs
  - to stdout
  - the string literal **CAN** (and typically does) contain literal text as well as placeholders
  - the string literal typically **DOES** end with a newline (but that’s **NOT** required)
  - variable names after the string literal **CANNOT** be preceded by &

- **scanf**
  - inputs
  - from stdin
  - the string literal **CANNOT** contain literal text – **EXCEPT**, if there are multiple placeholders, then between each adjacent pair of placeholders there **MUST** be a **SINGLE BLANK SPACE (REQUIRED)**
  - the string literal **CANNOT** contain a newline
  - variable names after the string literal **MUST** be preceded by &
Programming Exercise

Create a program that:

1. Greets the user.
2. Prompts the user for their age in years.
3. Inputs the user’s age in years.
4. Outputs the user’s age in years.

Begin by drawing a flowchart, and then write the program. The program does not have to have comments. The data type for the age variable must be appropriate.