# Standard I/O Lesson Outline



# Output via `printf`

In C, we output to standard output using a `printf` statement:

```
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:

```
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***.

# Placeholders

```
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

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

- float: %f

```
printf("%f", pi);
```

- char: %c

```
printf("%c", middle_initial);
```

# Mixing Literal Text and Variables' Values #1

We now know that we can output a string literal:

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

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

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

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

```
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:

```
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 MUST 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 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);
```

**NOTE**: The same rule applies to `scanf` statements (coming up).

# Placeholder/Variable Same Statement: Example

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

int main ()
{ /* 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);
} /* main */
% 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:

```
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.`

# Input via `scanf`: Ampersand Before Variable

The `scanf` statement has a somewhat strange syntax:

```
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

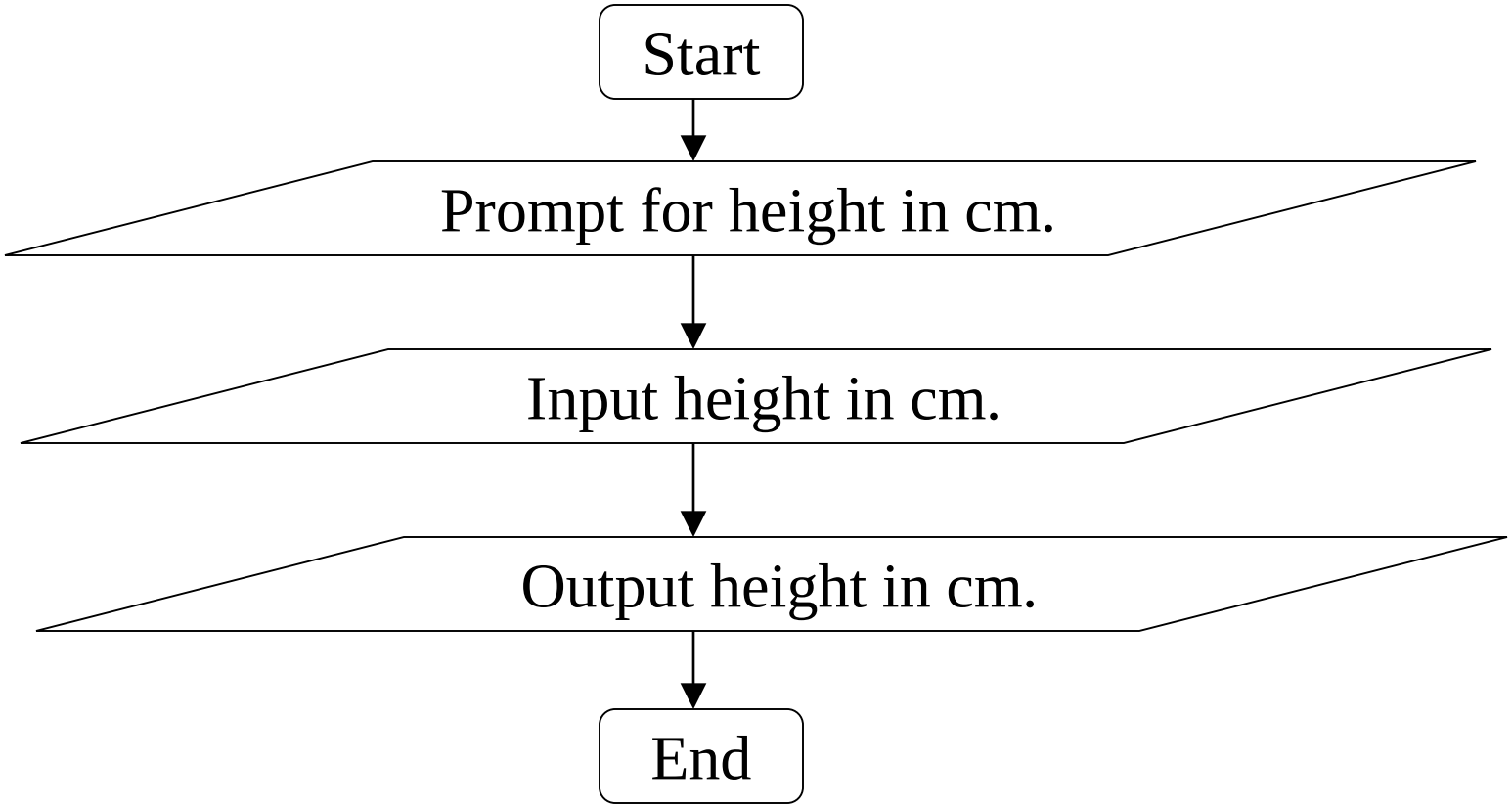
```
% cat read_variable.c
#include <stdio.h>

int main ()
{ /* 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);
} /* main */
% gcc -o read_variable read_variable.c
% read_variable
What's my height in centimeters?
160
My height is 160 cm.
```

# Input via `scanf` Example's Flowchart

```
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

```
#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 initial 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.