Lesson 2 Outline

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Consider the function

\[ a(y) = |y| \]

So we know that

\[
\begin{align*}
  a(-2.5) &= | -2.5 | = +2.5 \\
  a(-2) &= | -2 | = +2 \\
  a(-1) &= | -1 | = +1 \\
  a(0) &= | 0 | = 0 \\
  a(+1) &= | +1 | = +1 \\
  a(+2) &= | +2 | = +2 \\
  a(+2.5) &= | +2.5 | = +2.5 \\
\end{align*}
\]
Absolute Value Definition

How is $|y|$ defined?
Well, you could always define it as the nonnegative square root of $y^2$:  

$|y| = \sqrt{y^2}$

But here’s another definition:

$|y| = \begin{cases} 
- y, & \text{if } y \text{ is negative} \\
 y, & \text{otherwise} 
\end{cases}$
Absolute Value Implementation

\[ |y| = \begin{cases} 
  -y, & \text{if } y \text{ is negative} \\
  y, & \text{otherwise} 
\end{cases} \]

Here’s an implementation of absolute value in C:

```c
if (y < 0) {
    absolute_value_of_y = -y;
} /* if (y < 0) */
else {
    absolute_value_of_y = y;
} /* if (y < 0)...else */
```
What Does This Mean?

```java
if (y < 0) {
    absolute_value_of_y = -y;
} /* if (y < 0) */
else {
    absolute_value_of_y = y;
} /* if (y < 0)...else */
```

1. Evaluate the **condition** ($y < 0$), which is a Boolean expression, resulting in either true (1) or false (0).
2. If the condition evaluates to true, then execute the statement inside the `if` clause.
3. Otherwise, execute the statement inside the `else` clause.
Examples of if-else

if (a > b) {
    printf("Wow, a is greater than b!\n");
} /* if (a > b) */
else {
    printf("Loser, a is not greater than b!\n");
} /* if (a > b)...else */

if (my_height < your_height) {
    shortest_height = my_height;
} /* if (my_height < your_height) */
else {
    shortest_height = your_height;
} /* if (my_height < your_height)...else */
What If the Condition Fails? #1

What if we have something that we want executed only in the event that the Boolean expression in the if condition fails? That is, when the condition evaluates to false (0).
What If the Condition Fails? #2

If there’s something that we want to do when the `if` condition fails, we could simply use another `if` block with the exact opposite condition:

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That’s not between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */

if (!((users_number < minimum_number) ||
      (users_number > maximum_number))) {
    printf("Woohoo! That’s between %d and %d!\n", minimum_number, maximum_number);
} /* if (!((users_number < minimum_number) || ... */
```
What If the Condition Fails? #3

Using another `if` block with the exact opposite condition is cumbersome:

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That’s not between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */

if (!((users_number < minimum_number) ||
    (users_number > maximum_number))) {
    printf("Woohoo! That’s between %d and %d!\n", minimum_number, maximum_number);
} /* if (!((users_number < minimum_number) || ... */
```
What If the Condition Fails? #4

Using another `if` block with the exact opposite condition is cumbersome:

(a) It increases the likelihood of bugs, since you’re typing twice as much.

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That’s not between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */
if (!((users_number < minimum_number) ||
    (users_number > maximum_number))) {
    printf("Woohoo! That’s between %d and %d!\n", minimum_number, maximum_number);
} /* if (!((users_number < minimum_number) || ... */
```
What If the Condition Fails? #5

Using another `if` block with the exact opposite condition is cumbersome:

(b) If we later change the first condition, but we forget to change the second, that’ll introduce a hard-to-find bug.

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That’s not between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */
if (!((users_number < minimum_number) ||
    (users_number > maximum_number))) {
    printf("Woohoo! That’s between %d and %d!\n", minimum_number, maximum_number);
} /* if (!((users_number < minimum_number) || ... */
```
... statement_before;
if (condition) {
    statement_inside_true1;
    statement_inside_true2;
} /* if (condition) */
if (!condition) {
    statement_inside_false1;
    statement_inside_false2;
} /* if (!condition) */
statement_after;
...

Condition Fails Flowchart

statement_before

condition
True
statement_inside_true1

condition
False
statement_inside_true2

condition
True
statement_inside_false1

condition
False
statement_inside_false2

statement_after
The else clause #1

Often, we want to have not only

- a sequence of statements to execute in the event that the `if` condition evaluates to true (1),

but also

- a sequence of statements to execute in the event that the `if` condition evaluates to false (0).

So, C (like most programming languages) allows us to set up a special group of statements within the `if` block, known as an `else clause`.
The else clause #2

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That's not between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */
else {
    printf("Woohoo! That's between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... else */
```

- The sequence of statements to execute when the if condition evaluates to `true` (1) is known as the if clause.
- The sequence of statements to execute when the if condition evaluates to `false` (0) is known as the else clause.
The \texttt{else} clause #3

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That's not between %d and %d!\n",
        minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */
else {
    printf("Woohoo! That's between %d and %d!\n",
        minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... else */
```

\textbf{NOTICE}: The \texttt{else} statement \texttt{DOESN'T} have a \textbf{condition} of its own: it’s simply the keyword \texttt{else}, with its condition implied by the \texttt{if} statement.

That is, the \texttt{else} clause’s condition is the opposite of the \texttt{if} clause’s condition, and is \textbf{IMPLIED} instead of stated explicitly.
The `else` clause #4

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That’s not between %d and %d!\n", 
            minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */
else {
    printf("Woohoo! That’s between %d and %d!\n", 
            minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... else */
```

Notice that the presence of the `else` clause guarantees that, for this `if` block, **EXACTLY ONE of the clauses will be executed.**
The Meaning of else

The statements inside the `if` clause are executed if and only if the condition in the `if` statement evaluates to true (1). The statements inside the `else` clause are executed if and only if the `if` condition evaluates to false (0). So, in programming, the keyword `else` means `otherwise`. 
How Many Clauses Will Execute?

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That's not between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */
else {
    printf("Woohoo! That's between %d and %d!\n", minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ...else */
```

When executing an `if` block that has **BOTH** an `if` clause and an `else` clause, **EXACTLY ONE** clause will be executed:

- either the condition will evaluate to true (1), in which case the `if` clause will execute,  

**OR**

- the condition will evaluate to false (0), in which case the `else` clause will execute.
Order of Clauses

```c
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That’s not between %d and %d!\n",
            minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... */
else {
    printf("Woohoo! That’s between %d and %d!\n",
            minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ... else */
```

Notice that the `else` clause comes **AFTER** the `if` clause. That is, **EVERY** `if` block **MUST** begin with an `if` clause. Having an `else` clause is **OPTIONAL**.

In the event that an `if` block has an `else` clause, then the `else` clause comes at the **END** of the `if` block.
if ((users_number < minimum_number) ||
    (users_number > maximum_number)) {
    printf("Hey! That’s not between %d and %d!\n",
           minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ...
else {
    printf("Woohoo! That’s between %d and %d!\n",
           minimum_number, maximum_number);
} /* if ((users_number < minimum_number) || ...else */

Notice that each of the clauses – the if clause and the else clause – has its own block open and its own block close.

Again, regardless of the value of the Boolean expression in the condition of the if statement, any statements after the last block close are always executed.
... statement_before;
if (condition) {
    statement_inside_true1;
    statement_inside_true2;
} /* if (condition) */
else {
    statement_inside_false1;
    statement_inside_false2;
} /* if (condition...else) */
statement_after;
...
#include <stdio.h>

int main ()
{ /* main */
    const int computers_number = 5;
    int users_number;

    printf("Pick an integer:\n");
    scanf("%d", &users_number);
    if (users_number < computers_number) {
        printf("That’s unbelievable! Your number is\n");
        printf("  less than mine!\n");
        printf("Well, okay, maybe it’s believable.\n");
    } /* if (users_number < computers_number) */
    else {
        printf("Wow, you picked a number that isn’t\n");
        printf("  less than mine. Good work!\n");
    } /* if (users_number < computers_number)...else */
    printf("And now I’m sick of you.\n");
    printf("Bye!\n");
} /* main */

if-else Example #1
if-else Example #2

```bash
% gcc -o islesselse islesselse.c
% islesselse
Pick an integer:
6
Wow, you picked a number that isn’t less than mine. Good work!
And now I’m sick of you.
Bye!
% islesselse
Pick an integer:
5
Wow, you picked a number that isn’t less than mine. Good work!
And now I’m sick of you.
Bye!
% islesselse
Pick an integer:
4
That’s unbelievable! Your number is less than mine!
Well, okay, maybe it’s believable.
And now I’m sick of you.
Bye!
```
printf("Pick an integer:\n");
    scanf("%d", &users_number);
if (users_number < computers_number) {
    printf("That’s unbelievable! Your number is\n");
    printf(" less than mine!\n");
    printf("Well, okay, maybe it’s believable.\n");
} /* if (users_number < computers_number) */
else {
    printf("Wow, you picked a number that isn’t\n");
    printf(" less than mine. Good work!\n");
} /* if (users_number < ...else */
printf("And now I’m sick of you.\n");
printf("Bye!\n");
if-else Indentation #1

if (condition) {
    statement_true1;
    statement_true2;
    ...
} ... 
else {
    statement_false2;
    statement_false2;
}

Statements inside the if clause are indented additionally, beyond the indentation of the if statement and its associated block close.

Statements inside the else clause are indented the same amount as statements inside the if clause.
if-else Indentation #2

```java
if (condition) {
    statement1;
    statement2;
    ...
}
else {
    statement_false2;
    statement_false2;
}
```

In CS1313, the statements inside the `if` clause are indented an additional 4 spaces beyond the `if` statement and its associated block close, and likewise for the `else` clause.

In CS1313, you are **ABSOLUTELY FORBIDDEN** to use tabs for indenting in your source code.
Examples of if-else

```c
if (a > b) {
    printf("Wow, a is greater than b!\n");
} /* if (a > b) */
else {
    printf("Loser, a is not greater than b!\n");
} /* if (a > b)...else */

if (my_height < your_height) {
    shortest_height = my_height;
} /* if (my_height < your_height) */
else {
    shortest_height = your_height;
} /* if (my_height < your_height)...else */
```