CS113: Lecture 2

Topics:

• Relational, Equality, and Logical operators

• Decision and Control statements (e.g. if-else, switch, while, etc.)
if statement

• Basic form:

\[
\text{if( condition )} \\
\quad \text{statement;}
\]

(Statement executed if, and only if, the condition is “true”)

• Example (fragment):

\[
\text{if( 5 > 3 )} \\
\quad \text{printf( "5 is strictly greater than 3.\n" );}
\]

• The statement can be a block of code containing more than one statement - enclosed in curly braces:

\[
\text{if( a > 0 )} \\
\quad \text{printf( "a is positive.\n" );} \\
\quad \text{printf( "In case you didn’t hear me, I said that a is positive.\n" );}
\]

• Be careful! What happens here?

\[
a = -5; \\
\text{if( a > 0 )} \\
\quad \text{printf( "a is positive.\n" );} \\
\quad \text{printf( "In case you didn’t hear me, I said that a is positive.\n" );}
\]
Relational and Equality operators

• In actuality, expressions like "5 > 3" are evaluated to integer values: 1 for true, 0 for false. Thus the program

```c
void main() {
    printf( "Result of 1 > 2: %d\n", 1 > 2 );
    printf( "Result of 6 < 8: %d\n", 6 < 8 );
}
```

gives as output:

Result of 1 > 2: 0
Result of 6 < 8: 1

• Relational operators: >, >=, <, <=

• Equality operators: ==, !=

  – IMPORTANT! == (two equals) versus = (one equal) is an extremely common source of programmer errors in C. One equal, =, is an assignment operator.
More on our friend if

- if executes the statement (or statement block) after it when the specified condition is non-zero.

- Thus, the following fragment prints: Hi!

  if( 18 )
  	printf( "Hi!\n" );
  if( 0 )
  	printf( "Bye.\n" );

- What does the following fragment do?

  int a;
  
  printf( "Enter a number:" );
  
  scanf( "%d", &a );
  
  if( a = 3 )
  	printf( "You typed 3.\n" );

- Notice that there is no semicolon after the condition of an if statement.
Conditional Expressions

Consider the following code:

```c
if (a < 13)
    b = 3;
else
    b = 18;
```

C has a construct that lets you encapsulate the choice as part of the expression assigned to the variable `b`. The following code is equivalent:

```c
b = (a < 13) ? 3 : 18;
```

The general form is `test ? expr1 : expr2`. The test `test` is evaluated first. If it is nonzero, the entire expression evaluates to `expr1`, otherwise it evaluates to `expr2`.

Since the whole term is itself an expression, we can nest conditional expressions:

```c
grade = (percent > 80) ? 'A' :
        ((percent > 70) ? 'B' : 'C');
```
Logical Operators

• \&\&, || (logical AND, logical OR) are binary operators: two arguments.

• expression1 \&\& expression2 evaluates to 1 ("true") if both expressions are non-zero, otherwise evaluates to 0 ("false").

• expression1 || expression2 evaluates to 1 ("true") if either or both expressions are non-zero, otherwise evaluates to 0 ("false").

• !expression evaluates to 1 ("true") if the expression is zero, otherwise evaluates to 0 ("false").

• A XOR B: ((!A \&\& B) || (A \&\& !B))

• Example

```c
if(( 3 >= 5 ) || !(2 > 4)) {
    printf( "The OR is true.\n" );
}
if(( 3 >= 5 ) \&\& !(2 > 4)) {
    printf( "The AND is true.\n" );
}
```

• "Short-circuit evaluation" used.
  (The !(2 > 4) in second if not evaluated.)
if-else

• Basic form:

```c
if( condition )
    statement1;
else
    statement2;
```

• As before, each statement can be either a single command (terminated with a semicolon), or a block of commands delimited by curly braces.

• Example.

```c
if(( year % 4 == 0 && year % 100 != 0 ) ||
    ( year % 400 == 0 )) {
    printf( "%d is a leap year\n", year );
} else {
    printf( "%d is not a leap year\n", year );
}
```
More on if-else

• Is there a difference between

```c
if( condition )
    statement1;
else
    statement2;
```

and

```c
if( !condition )
    statement2;
else
    statement1;
```

• Common usage for a series of if-elses:

```c
if( expression1 )
    statement1;
else if( expression2 )
    statement2;
else if( expression3 )
    statement3;
...
else
    statement;
```

The temptation is to continually indent.
Under what conditions is `statement3` executed?
An example

- Example.

```c
void main() {
    int num;
    printf( "Please enter a positive integer:\n" );
    scanf( "%d", &num );

    if( num % 3 == 0 )
        printf( "%d is divisible by 3.\n", num );
    else if( num % 2 == 0 )
        printf( "%d is divisible by 2, but not 3.\n", num );
    else
        printf( "%d is not divisible by 3 nor 2.\n", num );
}
```
The “dangling else problem”

- The following code is ambiguous. Never write anything like this!

```
if( a == 3 )
if( a == 5 )
    printf( "a is 5.\n" );
else
    printf( "Doh!\n" );
```

- Instead, use braces:

```
if( a == 3 ) {
    if( a == 5 )
        printf( "a is 5.\n" );
    else
        printf( "Doh!\n" );
}
```
switch statement

• Similar to a chain of if/else statements, but more restricted in terms of functionality.

• Useful when one wants to branch based on the value of an expression.

• General form:

```java
switch( expression ) {
    case constant1:
        statement1;
        [break;]
    case constant2:
        statement2;
        [break;]
    ...
    default:
        statement;
        [break;]
}
```
The fall-through property

• Use breaks! What happens if the breaks are removed?

```c
switch( num ) {
    case 1:
        printf( "Behind Door 1 is nothing.\n" );
        break;
    case 2:
        printf( "Behind Door 2 is a goat.\n" );
        break;
    case 3:
        printf( "Behind Door 3 is a pot of gold.\n" );
        break;
}
```

• Sometimes we can exploit the fall-through property:

```c
switch( month ) {
    case 1: case 3: case 5: case 7:
    case 8: case 10: case 12:
        printf( "31 days.\n" );
        break;
    case 2:
        printf( "28 or 29 days.\n" );
        break;
    default:
        printf( "30 days.\n" );
}
```
while statement

- Nice and simple:

```
while( condition )
    statement;
```

- A break statement inside the statement block causes the loop to be stopped.

- A variant:

```
do
    statement;
while( expression );
```

- The statement is always executed at least once. Equivalent to:

```
statement;
while( expression )
    statement;
```
while example

• Keeping a running sum.

    void main() {
        int sum = 0, number = 0;
        while( number != -1 ) {
            sum += number;
            printf( "The running sum is: %d\n", sum );
            printf( "Enter a pos. integer (-1 quits):" );
            scanf( "%d", &number );
        }
    }

• Another way to do it.

    void main() {
        int sum = 0, number;
        while( 1 ) {
            printf( "The running sum is: %d\n", sum );
            printf( "Enter a pos. integer (-1 quits):" );
            scanf( "%d", &number );
            if( number == -1 ) break;
            sum += number;
        }
    }

Note: while( 1 ) is conventional for “infinite” loops
for statement

- General form:

  ```
  for( initial-stmt; condition; iteration-stmt )
  body-stmt;
  ```

- Equivalent to:

  ```
  initial-stmt;
  while( condition ) {
  body-stmt;
  iteration-stmt;
  }
  ```

- **break** can also be used, within the **body-stmt**.

- **break** in general applies to innermost loop (while, do/while, for) or switch statement.

- **continue** statement (not frequently used) causes the next iteration to be executed - jumps to condition-test of innermost loop (while, do/while) or next increment statement (for).
for example

- Summing the first ten positive even numbers (2, 4, 6, ..., 20).

```c
void main() {
    int i, sum = 0;
    for( i = 1; i <= 10; i++ )
        sum += 2 * i;
    printf( "The sum is %d\n", sum );
}
```

- Another way to do it.

```c
void main() {
    int i, sum = 0;
    for( i = 2; i <= 20; i += 2 )
        sum += i;
    printf( "The sum is %d\n", sum );
}
```

- Notice: no semicolon after the condition of the for.
Something new: goto statement

• General form:

    statements;
    ...
    goto label;
    ...
    label:
        code ...

• Never necessary. Almost always bad programming practice, except ...

    for( ... ) {
        for( ... ) {
            ... /* 50th nested loop/if statement */
            if( disaster )
                goto error;
        }
        ...
    } ...

    error:
        clean up stuff