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

ECE 220: Computer Systems & Programming

Control Constructs in C (Partially a Review)

Learn Four More Kinds of C Statements

We'll learn about statements for* …

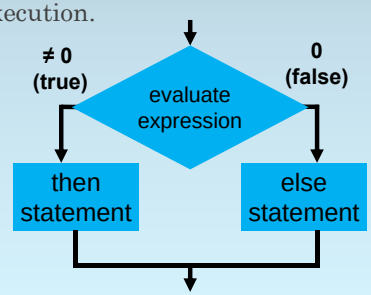
- conditional decomposition:
  `if` and **`switch`**;
- iterative decomposition:
  `for`, **`while`**, and **`do/while`**;
- iteration control:
  `continue`, and **`break`**; and
- function control:
  `return`.

*Minor review: **`if`** and **`for`** covered in ECE120.

Statements Can Introduce Conditions

Simple statements in **C** can introduce **conditional** execution.

Based on an expression, the computer executes one of two statements.



C's **`if`** Statement Enables Conditional Execution

Conditional execution uses the **`if` statement**:

```
if ( <expression> ) {
    /* <expression> != 0:
       execute "then" block */
} else {
    /* <expression> == 0:
       execute "else" block */
}
```

`<expression>` can be replaced with any expression, and **"else { … }" can be omitted**.

Examples of the `if` Statement

For example,

```
/* Calculate inverse of number. */
if (0 != number) {
    inverse = 1 / number;
} else {
    printf ("Error!\n");
}
```


Examples of the `if` Statement

Or,

```
/* Limit size to 42. */
if (42 < size) {
    printf ("Size set to 42.\n");
    size = 42;
}
```


switch Specifies Code Based on Expression Values

What if we have more than two choices?

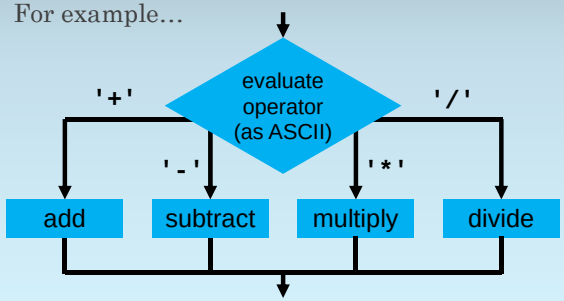
For example, an operation in a simple calculator: +, - , ×, or ÷ (divide).

One answer: use
- a sequence of conditional constructs, or
- nested conditionals.

Another answer: **if choice based on values of an expression, use a `switch` statement**.

A Flow Chart with Multiple Choices

For example…



Multiple Choices Implemented with `switch`

In C, we write

```
switch (operator) {
    case '+':     // add
          break;
    case '-':     // subtract
          break;
    case '*':     // multiply
          break;
    case '/':     // divide
          break;
}
```

an expression

constant values

leave the switch

Constant Values, Break after Each Block of Code

Switch allows any expression,
but **values must be constant**.

Normally, **use `break` at end of each case**.

- **No `break`** means keep going, such as
- **when two values require the same code**.

```
case 1:
case 2:
    // code for both 1 and 2
    break;
```


Pitfall: Be Sure Others Know Your Intent

Leaving out `break` is usually an error.

```
case 1:
    // do this first
    // code continues with next case
case 2:
    // both cases execute this code!
    break;
```

People may "fix" the code. **Always comment!**

Use `default` to Catch All Remaining Values

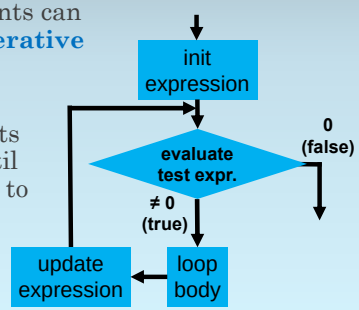
```
switch (<expression>) {
    case <value1>:
        break;
    ...
    default:
        // code for other values
        break;
}
```

`default` catches any other values (and should be the last case)

Simple Statements Can Also Be Iterations

Simple statements can also describe **iterative** execution.

This type of execution repeats a statement until a test evaluates to false (0).



C's `for` Loop Enables Iterative Execution

The following is called a **`for` loop**:

```
for (<init>; <test>; <update>) {
    /* loop body */
}
```

As shown on the previous slide, the computer:

1. Evaluates `<init>`.
2. Evaluates `<test>`, and stops if it is false (0).
3. Executes the **`loop body`**.
4. Evaluates `<update>` and returns to Step 2.

Iterations are Used for Repeated Behavior

```
/* Print multiples of 42 from
   1 to 1000. */
int N;
for (N = 1; 1000 >= N; N = N + 1) {
    if (0 == (N % 42)) {
        printf ("%d\n", N);
    }
}
```


Let's See How This Loop Works

```
/* Print 20 Fibonacci numbers. */
int A = 1; int B = 1; int C; int D;
for (D = 0; 20 > D; D = D + 1) {
    printf ("%d\n", A);
    C = A + B;
    A = B;
    B = C;
}
```


Another Iterative Construct: the `while` Loop

A `while` loop
- **only specifies a `<test>` and a `loop body`**, but is
- **otherwise equivalent to a `for` loop**.

```
while (<test>) {
    /* loop body */
}
```


Easy to Map `while` Loop into `for` Loop

```
while (<test>) {
    /* loop body */
}
```

is completely equivalent to
(with empty `<init>` and `<update>`):

```
for ( ; <test>; ) {
    /* loop body */
}
```


Execution of a `while` Loop

How does the computer execute a `while` loop?

```
while (<test>) {
    /* loop body */
}
```

We can simplify the rules for a `for` loop…

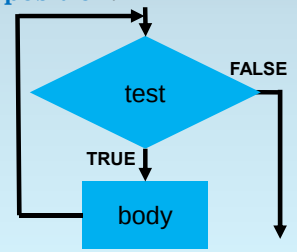
1. ~~Evaluates `<init>`~~. Skip this step.
2. Evaluates `<test>`, and stops if it is false (0).
3. Executes the `loop body`.
4. ~~Evaluates `<update>`~~ and returns to Step 2.

Skip this part.

`while` Loop Performs the Iterative Decomposition

The `while` loop is **identical to the iterative decomposition**.

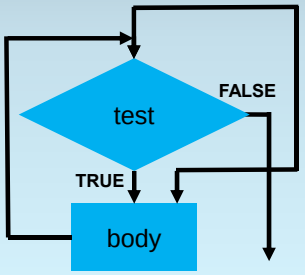
```
while (<test>) {
    /* body */
}
```



Use `do` / `while` to Skip the First Test

What if we want to skip the first test?

```
while (<test>) {
    /* body */
}
do {
    /* body */
} while (<test>);
```



`continue` / `break` Apply to Innermost Iteration

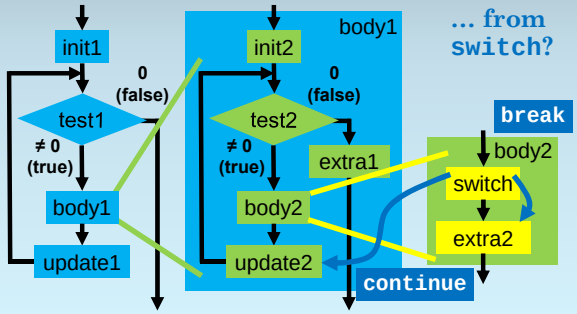
C supports two statements for iteration control:

`continue`:
- current iteration is done, so
- **skip to the update step**.

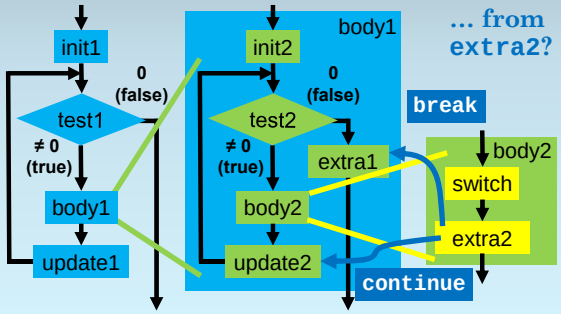
`break`:
- current iterative construct is done, so
- **stop iterating**.

These apply to the innermost loop (or switch).

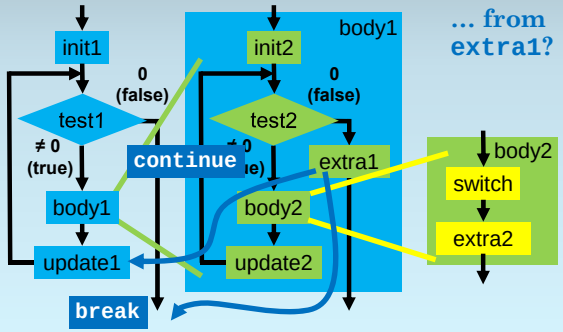
Where Do `continue` / `break` Go …



Where Do `continue` / `break` Go …



Where Do `continue` / `break` Go …



`continue` Goes to Test in `while` and `do` / `while`

Remember that
- `while` and `do` / `while` are like `for` loops
- with no initialization nor update expressions, so
- **`continue` goes to the test**.

`return` Ends the Current Function (with a Return Value)

The `return` statement
- **provides a value** (an expression) to be **returned from the current function**, and
- **terminates function IMMEDIATELY**.

In other words, in LC-3,
- calculate the expression's value
- copy the result into the return value slot
- tear down the stack frame
- RET

