



CMSC 106

Lecture Set #6 Loops

Set Started:
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loops also called "repetition statements"

- **The While Statement**

while (condition)
statement;

- **action:**

- 1) condition is tested
- 2) if the condition is true the statement is performed; if the condition is false, continue after the loop
- 3) after completing the loop's body, go back to number 1

- **iteration** = one execution of the subsidiary statement



Trace

```
int var= 1;
while (var < 5) {
    var = var + 1;
    printf("%d\n", var);
}
```



Infinite Loops

- The loop will never terminate on its own.
- In UNIX, to stop a program with an infinite loop
 - Control-c
 - there can be a delay

```
int var= 1;
while (var < 5) {
    printf("%d\n", var);
}
```



The do/while loop

- Format:

do {

statements

} while (condition);

- the curly braces are not required, but good style otherwise the line with "while" can be easily confused with the beginning of a while loop.
- Action:
 - 1) execute the body
 - 2) test the condition
 - 3) if the condition is true, go back to #1; if the condition is false, continue with the line after the loop



Same or Different?

```
sum = 0;
do {
    j--;
    sum += j;
} while (j > 0);
```

```
-----
sum = 0;
while (j > 0){
    j--;
    sum += j;
}
```

- Same or Different?
- Trace both with different starting values for j



Types of repetition:

- counter-controlled repetition
- indefinite repetition

- examples



for loop

- Useful for repeating loop body a fixed number of times
- syntax:

```
for (expr1; expr2; expr3)
    statement;
```
- Each of the three expressions is optional.
- Semicolons and parentheses are required.
- Typically:
 - - expr1 initializes
 - - expr2 is condition
 - - expr3 updates loop control variable
- Action:
 - 1) if present, perform expr1
 - 2) if present, expr2 (condition) tested
 - if false, continue to line after the loop
 - if true (or omitted), continue with step (3)
 - 3) the subsidiary statement, or loop body is executed
 - 4) if present, expr3 executed
 - 5) go back to step (2)



trace examples

- **for (v= 1; v < 5; v++)**
printf("%d %d\n", v, v * v);
- **for (v= 5; v > 0; --v)**
printf("%d %d\n", v, v * v);



More details about the three Expressions

- can initialize to any value
- can do loop control updates other than by one
- can do loop control updates that are negative
- expression 1 and 3 can have multiple expressions
 - connected by the comma operator
- expression 2 can have multiple boolean expressions
 - connected by logical operators therefore building a single boolean expression



The Comma Operator

- to put several expressions in a place where one expression can appear
- Makes a single expression out of any number of individual ones
 - value returned (and its type) is last expression's
 - evaluated left to right
- **`x = y * z, 4.5, 6;`**
- More useful example:
**`for (a= 0, b= 10; a != b; a++, b--)`
`printf("%d %d\n", a, b);`**



One of the for loop expressions missing

- **expression 1 missing**
`for ( ; a != b ; a++, b--)`
`printf("%d %d\n", a, b);`
- **expression 2 missing**
`for (a=1,b=2;; a++,b--)`
`printf("%d %d\n", a, b);`
- **expression 3 missing**
`for (a=1,b=2; a != b ;)`
`printf("%d %d\n", a++, b--);`



Nested Loops

- Follow the same procedure - just view each loop as its own statement following the action rules for that type of loop.

```
for (a= 3; a > 1; a--) {  
    b= 4;  
    while (b > 1) {  
        printf("%d %d\n", b, a);  
        b--;  
    }  
}
```



Not always completely independent

- Inner Loop Dependant On Outer Loop

```
a= 1;  
while (a < 4) {  
    b= a;  
    while (b <= 4) {  
        printf("X");  
        b++;  
    }  
    printf("\n");  
    a++;  
}
```

- inner loop's termination depends on the outer loop control variable

```
a= 1;  
while (a < 4) {  
    b= 1;  
    while (b <= a) {  
        printf("%d\n", b);  
        b++;  
    }  
    a++;  
}
```



break and continue

- **break causes loop to immediately quit**
 - Exits only from innermost nested loop (in which it appears)
- **continue skips rest of a loop body & begins next iteration**
 - **while, do-while**
 - jumps immediately to testing loop termination condition
 - **for loops**
 - jumps to third expression in for loop header
- **VERY IMPORTANT:** break and continue should ONLY be used in loops when they improve a **program's clarity**



Most Common Errors

- Forgetting to modify the variable tested by the condition – result = infinite loop
- Fencepost error – result = one too many or one too few iterations
- The null statement – result = infinite loop

```
int j = 3;
while (j < 3);
    printf("%d\n", j++);
```