Introduction to Programming (CS 101)

Spring 2024

Lecture 4:

while loops, break/continue, do while, scope

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Based on material developed by Prof. Abhiram Ranade

Recap-I (`if` and logical operators)

What is the output from the following piece of code?

1 1 -1

1 2 -1

2 1 -1

2 2 -1

```
#include <simplecpp>
main_program{

  int i = 1, j = 1, k = -1;

  if(!i || j && k)
    i += 1;
  else
    j += 1;

  cout << i << " " << j << " " << k;
}
```

Recap-II (`switch` statement)

What is the output from the following piece of code?

`1 1 0`

`0 2 0`

`1 2 1`

`1 2 0`

```
#include <simplecpp>
main_program{

  int i = 0, j = 1, k = -1;

  switch(!i * j - k) {
    case 2:
    case 1:
      j += 1; k += 1;
    case 0:
      i += 1;
      break;
    default:
      k += 1;
  }

  cout << i << " " << j << " " << k;
}
```

Recap-III (ternary operator)

What is the output from the following piece of code?

0

1

-1

```
#include <simplecpp>
main_program{

  int i = 0, j = 0;

  cout << (i > j ? i-1 : j+1) << endl;
}
```

An aside: `nan` and `inf`

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NaN (Not a Number) vs. inf (Infinity)

- `nan`: Short for *Not a Number*; cannot be defined or represented
- Examples where `nan` appears:
  - Log of a non-positive number
  - Square root of -1
- `inf`: Short for *Infinity*; numbers that are too large (in absolute value)
- Examples where `inf` appears:
  - Divide (non-zero) number by zero
  - *Overflow*: When a number exceeds the maximum representable floating-point number
- Note both these quantities relate to floating point numbers

`while` statement

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Compute average of scores

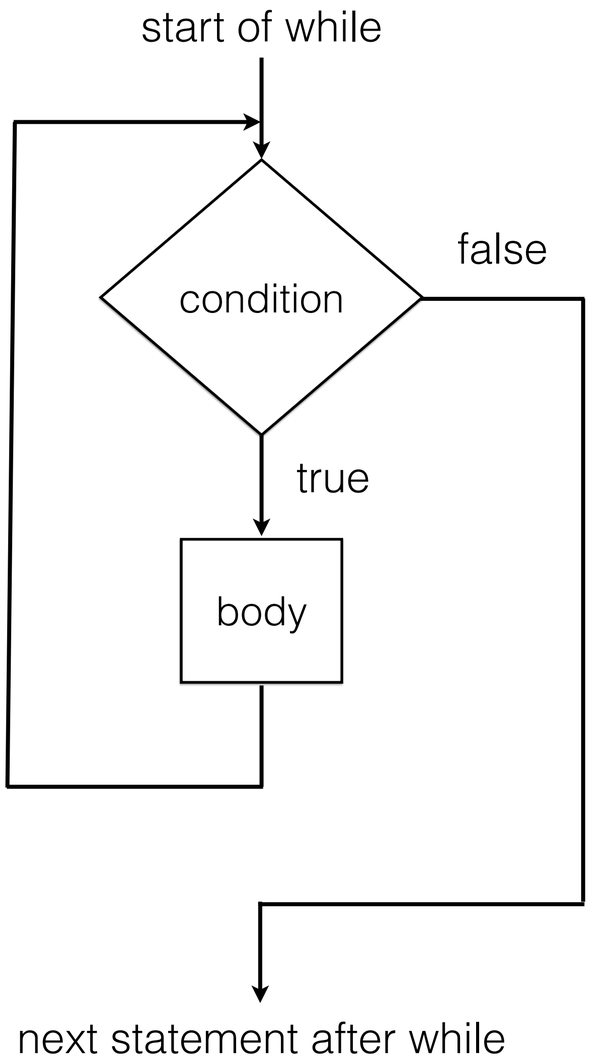
- *Requirement*: Read as input a sequence of student's scores (0 to 100) and print its average
  - Number of students is not known beforehand
  - Assume that at least one positive score will be given
  - Treat a negative number as a signal to end the sequence
- Example:
  - Input: 80,20,-5 Output: 50
- Implement using `repeat`?
  - `repeat` repeats fixed number of times and we do not know the number of students
- New looping constructs (while, do while, for) that naturally support such requirements

`while` statement

- Syntax:

```
while(condition){
    body
}
```

- Semantics:
  1. Evaluate condition
  2. If condition evaluates to `true`, then **`body`** is executed
  3. If condition evaluates to `false`, then skip the `while` block and move to the statement following `while`
  4. Go back to step 1 and repeat

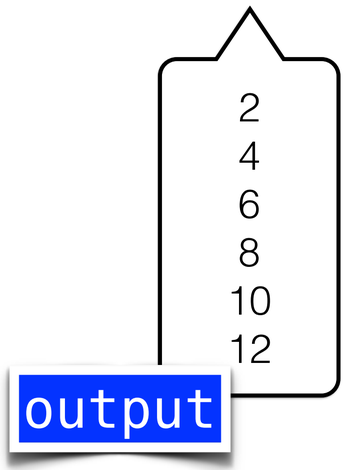


`while` statement (I)

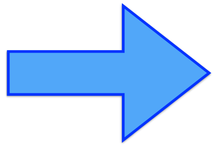
- What does this program do?

```
#include <simplecpp>

main_program {
    int i = 0;
    while(i <= 10) {
      i = i + 2;
      cout << i << endl;
    }
}
```



equivalent to



```
#include <simplecpp>

main_program {
    int i = 0;
    while(i <= 10) {
     cout << (i+=2) << endl;
    }
}
```

`while` statement (II)

- What does this program do?

```
#include <simplecpp>

main_program {
    int i = 0;
    while(false) {
      i = i + 2;
      cout << i << endl;
    }
}
```

What if this was `true`?

Infinite loop!

Nothing will be printed

`output`

- The `while` condition must eventually become `false`, otherwise the program will never halt.

Code to average student's scores

Demo in class and code shared on Moodle

`break`/`continue` statements

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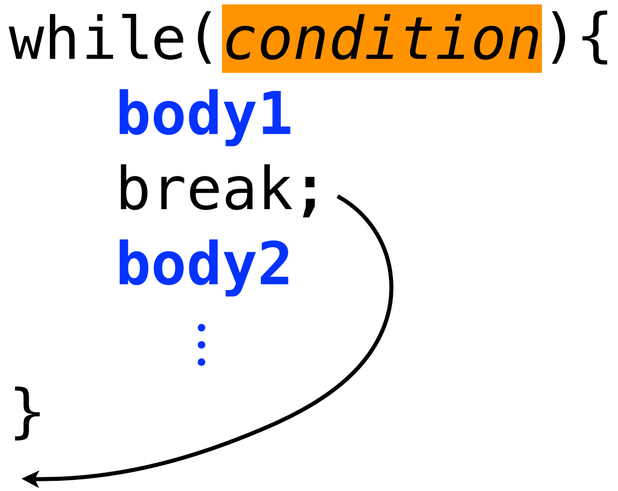
`break` statement within `while` loop

- Syntax of `break` within a `while` loop:



- Semantics:
  - if *condition* is satisfied, **body1** is executed and when control reaches `break`, the execution of the `while` statement is terminated.
  - That is, **body2** is not executed if `break` appears right before it.
  - Execution continues from the next statement following the `while` block.

`break` in code to average student's scores

- Consider `break` in the following piece of code that implements averaging student's scores:

```
main_program {
     float next, sum = 0;
     int count = 0;
     while(true) {
       cin >> next;
       if(next < 0) break;
       sum += next;
       count += 1;
     }
     cout << sum/count << endl;
}
```

if `next < 0`, then the while loop execution terminates

Execution continues from the statement after `while`, i.e., `cout <<` ...

`break` in code to average student's scores

- Consider `break` in the following piece of code that implements averaging student's scores:

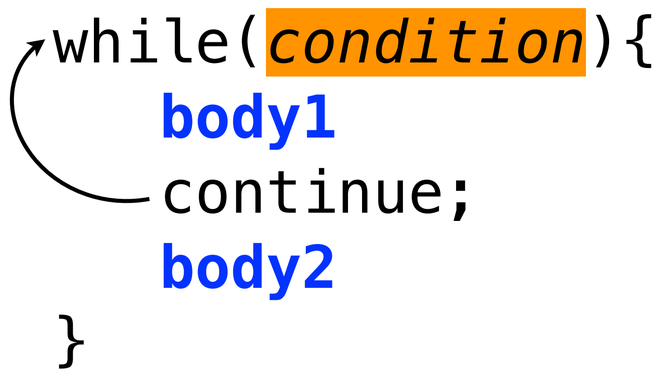
```
main_program {
    float next, sum = 0;
    int count = 0;
    while(true) {
      cin >> next;
      if(next < 0) break;
      sum += next;
      count += 1;
    }
    cout << sum/count << endl;
}
```

Note how break is written. Since `{}` is omitted, the single statement after `if` can appear on the same line.

- If `break` appears inside a `while` which is itself nested inside another `while`, then the inner `while` statement is terminated

`continue` statement within `while` loop

- Syntax of `continue` within a `while` loop:



- Semantics:
  - if *condition* is satisfied, **body1** is executed and when control reaches `continue`, it goes to the `while` loop for the next iteration.
  - **body2** i.e., statements from `continue` to the end of the loop are skipped.

Averaging student's scores, with a constraint

- Ignore if a score > 100, and move on to the next score in the input

```
main_program {
    float next, sum = 0;
    int count = 0;
    while(true) {
      cin >> next;
      if(next < 0) break;
      sum += next;
      count += 1;
    }
    cout << sum/count << endl;
}
```

Averaging student's scores, with a constraint

- Ignore if a score > 100, and move on to the next score in the input

```
main_program {
     float next, sum = 0;
     int count = 0;
     while(true) {
       cin >> next;
       if(next > 100) continue;
       if(next < 0) break;
       sum += next;
       count += 1;
     }
     cout << sum/count << endl;
}
```

if `next > 100`, then control is transferred to the beginning of the while loop

`do while` statement

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`do while` statement

- Syntax:

```
do{
    body
}while(condition)
```

- Semantics: Equivalent to

```
{ body }
while(condition){
    body
}
```

- Note: The above equivalence holds only when **`body`** does not contain a `continue` statement. `continue` is only used within loop bodies.
- Compared to `while`, can avoid one condition evaluation, if it holds anyway in the beginning
- Compared to `while`, `do while` is less commonly used

Blocks and scope

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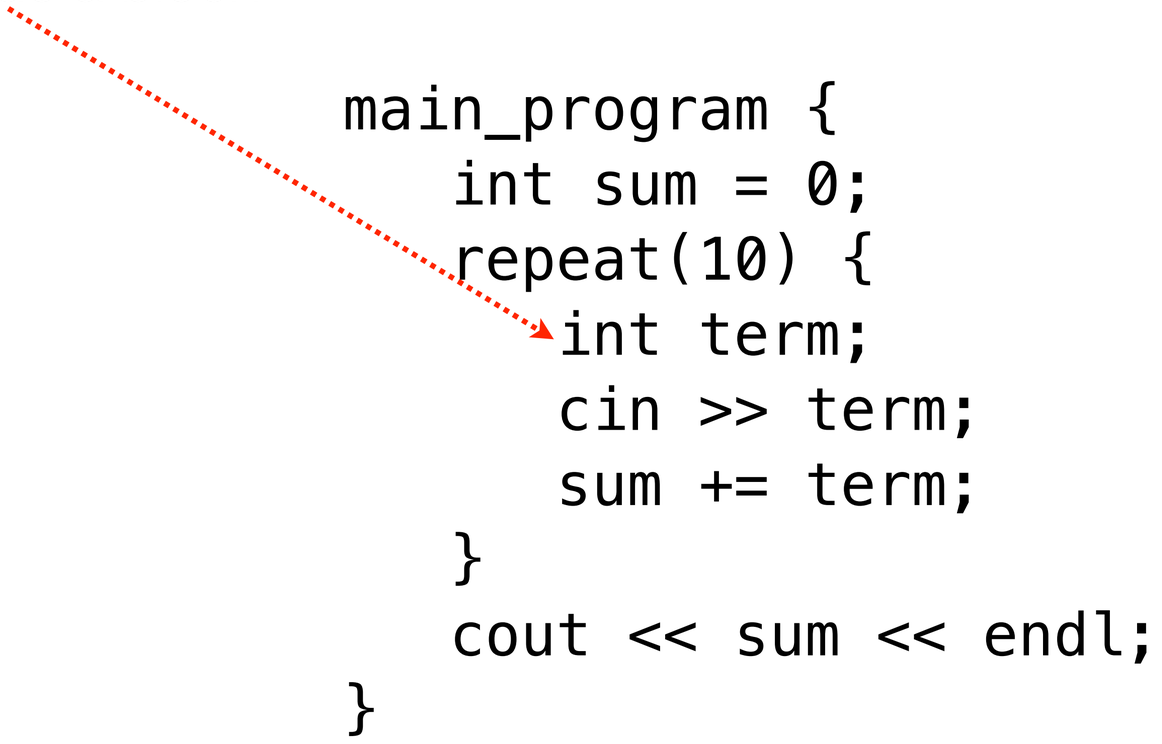
Blocks and scope

- Code inside `{}` is referred to as a ***block***
- `repeat`, `if`, etc. typically consists of blocks; one could create them otherwise too by just adding `{}`
- Variables can be declared inside a block



```
main_program {
    int sum = 0;
    repeat(10) {
        int term;
        cin >> term;
        sum += term;
    }
    cout << sum << endl;
}
```

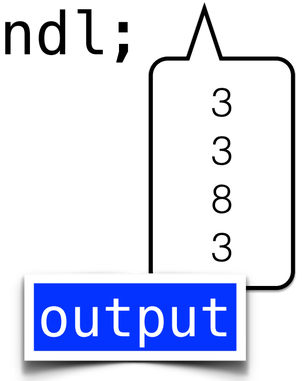
How definitions in a block execute

- A variable is defined/created every time control reaches the definition.
- All variables defined in a block are destroyed every time control reaches the end of the block.
- “Creating” a variable is only notional; the compiler simply starts using that region of memory from then on.
- Likewise “destroying” a variable is notional.

Scope and shadowing

- Variables defined outside a block can be used inside the block, if no variable of the same name is defined inside the block.
- If a variable of the same name is defined, then from the point of definition to the end of the block, the newly defined variable gets used.
- The new variable is said to “***shadow***” the old variable.
- The region of the program where a variable defined in a particular definition can be used is said to be the "***scope***" of the definition.

```
main_program {
    int i = 3;
    cout << i << endl;
    {
        cout << i << endl;
        int i = 8;
        cout << i << endl;
    }
    cout << i << endl;
}
```



Next class: Looping construct "`for`"

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