

Week 7: Advanced Loops

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Loops in C++ (review)

- **while**

```
while (expression)
    statement
```

statement may be a
compound statement
(a block: {statements})

▶ if expression is true, statement is executed, repeat

- **for**

```
for (expr1; expr2; expr3)
    statement
```

▶ equivalent to:

```
expr1;
while (expr2) {
    statement
    expr3;
}
```

- **do while**

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

statement is executed.
if expression is true, then repeat

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Counting (review)

- set a counter variable to 0
- increment it inside the loop (each iteration)
- after each iteration of the loop, it stores the # of loop iterations so far

```
int number;
int count = 0;

cout << "Enter a number between 1 and 10: ";
cin >> number;

while (number < 1 || number > 10) {
    count = count + 1;
    cout << "Please enter a number between 1 and 10: ";
    cin >> number;
}

cout << count << " invalid numbers entered " << endl;
// Do something with number here
```

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5.7 Keeping a running total (summing)

- set an accumulator variable to 0
- add the next number to it inside the loop
- after each iteration of the loop, it stores the sum of the numbers added so far (running total)

```
int days; //Counter for count-controlled loop
float total = 0.0; //Accumulator
float miles; //daily miles ridden

cout << "How many days did you ride your bike? ";
cin >> days;

for (int i = 1; i <= days; i++) {
    cout << "Enter the miles for day " << i << ": ";
    cin >> miles;
    total = total + miles;
}

cout << "Total miles ridden: " << total << endl;
```

total is 0 first time through

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Keeping a running total

- Output:

```
How many days did you ride you bike? 3
Enter the miles for day 1: 14.2
Enter the miles for day 2: 25.4
Enter the miles for day 3: 12.2
Total miles ridden: 51.8
```

- How would you calculate the average mileage?

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5.8 Sentinel controlled loop

- sentinel: special value in a list of values that indicates the end of the data
- sentinel value must not be a valid value!
-99 for a test score, -1 for miles ridden
- User does not need to count how many values will be entered
- Requires a “priming read” before the loop starts
 - ▶ so the sentinel is NOT included in the sum
 - ▶ the loop can be skipped (if first value is the sentinel)

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Sentinel example

- Example:

```
float total = 0.0; //Accumulator
float miles;      //daily miles ridden

cout << "Enter the miles you rode on your bike each day, ";
cout << "then enter -1 when finished. " << endl;

cin >> miles;          //priming read
while (miles != -1) {
    total = total + miles; //skipped when miles== -1
    cin >> miles;        //get the next one
}

cout << "Total miles ridden: " << total << endl;
```

- Output:

```
Enter the miles you rode on your bike each day,
then enter -1 when finished.
14.2
25.4
12.2
-1
Total miles ridden: 51.8
```

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5.9 Which Loop to use?

- Any loop can work for any given problem
- while loop:
 - ▶ test at start of loop
 - ▶ validating input, sentinel controlled loops, etc.
- for loop:
 - ▶ initialize/test/update
 - ▶ count-controlled loops
- do-while loop
 - ▶ always do at least once
 - ▶ good for repeating, simple menu processing

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5.10 Nested loops

- When one loop appears in the body of another
- For every iteration of the outer loop, we do all the iterations of the inner loop
- Example from “real life”:
- A clock. For each hour in a day (24), we iterate over 60 minutes.

12:00	1:00	2:00	3:00
12:01	1:01	2:01	.
12:02	1:02	2:02	.
...
12:59	1:59	2:59	.

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Print a bar graph

- Input numbers from a file. For each number, output that many asterisks (*) in a row.

```
int number;
ifstream inputFile;
inputFile.open("numbers.txt");
inputFile >> number; //priming read
while (number!=-1) {
    for (int i = 1; i <= number; i++)
        cout << '*';
    cout << endl;
    inputFile >> number;
}
```

- numbers.txt:

```
8
3
6
10
-1
```

- Output:

```
*****
***
*****
*****
```

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Calculate grades for a class

For each student, input the test scores from the user and output the average.

```
int numStudents, numTests;
cout << "How many students? ";
cin >> numStudents;
cout << "How many test scores? ";
cin >> numTests;
for (int student=1; student <= numStudents; student++) {
    float total = 0, score;
    cout << "Enter the " << numTests
         << " test scores for student " << student << endl;
    for (int test=1; test <= numTests; test++) {
        cin >> score;
        total = total + score;
    }
    float avgScore = total/numTests;
    cout << "Average for student" << student
         << " is: " << avgScore << endl;
}
```

Inner loop

Outer loop

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Calculate grades for a class

- Output:

```
How many students? 3
How many test scores? 4
Enter the 4 test scores for student 1
88 90.5 92 77.5
Average for student1 is: 87.0
Enter the 4 test scores for student 2
66.5 70.5 80 86
Average for student2 is: 75.8
Enter the 4 test scores for student 3
99 93.5 80 79
Average for student3 is: 87.9
```

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5.11 More File I/O

- Can test a file stream object as if it were a boolean variable to check for various errors.
- After opening a file, if the open operation failed, the value of file stream variable is `false`.

```
ifstream infile;
infile.open("test.txt");

if (!infile) {
    cout << "File open failure!";
    return 1;
}
```

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Reading data from a file

- Use `fin>>x;` in a loop
- Problem: when to stop the loop?
- First entry in file could be count of number of items
 - problems: maintenance, large files
- Could use sentinel value
 - problem: may not be one, maintenance
- Want to automatically detect end of file

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Using >> to detect end of file

- stream extraction operation (>>) returns `true` when a value was successfully read, `false` otherwise

```
int number;
ifstream inputFile;
inputFile.open("numbers.txt");

bool foundValue = (inputFile >> number);
```

- `inputFile >> number`:
 - tries to read a value into `number`
 - if it was successful, value is `true`
 - if it failed (nothing left to input), value is `false` (and the value in the variable does not change!)

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Using the result of >>

- Example:

```
int number;
ifstream inputFile;
inputFile.open("numbers.txt");

bool foundValue = (inputFile >> number);

if (foundValue)
    cout << "The data read in was: " << number << endl;
else
    cout << "Could not read data from file." << endl;
```

- Can also use directly as relational expression:

```
if (inputFile >> number)
    ...
```

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Sum all the values in the file

- Code:

```
int number;
ifstream inputFile;
inputFile.open("numbers.txt");

int total = 0;
while (inputFile >> number) {
    total = total + number;
}

cout << "The sum of the numbers in the file: " << total
<< endl;
```

- numbers.txt:

```
84
32
99
77
52
```

- Output:

```
The sum of the numbers in the file: 344
```

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5.12 Breaking and Continuing

- Sometimes we want to abort (exit) a loop before it has completed.
- The `break` statement can be used to terminate the loop from within:

```
cout << "Guess a number between 1 and 10" << endl;
int number;
while (true) {
    cin >> number;
    if (number == 8)
        break;
}
cout << "You got it." << endl;
```

- Don't do this. It makes your code hard to read and debug.

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Stopping a single iteration

- Sometimes we want to abort an iteration (skip to the end of loop body) before it is done.
- The `continue` statement can be used to terminate the current iteration:

```
for (int i=1; i <= 6; i++) {
    if (i == 4)
        continue;
    cout << i << " ";
}
```

- Output:

```
1 2 3 5 6
```

- Don't do this either. It makes your code hard to read and debug.

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Programming Assignment 4.5 Practice

- Rewrite PA3, Prepare a Lab Report, so that it uses a loop to enter the data for any number of rats (ask the user to specify the number of rats before the loop starts).
 - ▶ Then rewrite it to take the input from a file (do not input the number of rats, just loop until the end of the file).
- Rewrite PA4, Calculate a Cell Phone Bill, to ask the user if they want to repeat the program after the bill and savings are output. Also put the input validation in a loop.

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