for Loop Lesson 3 Outline

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for Loop with a float Counter: BAD!

All of the examples of for loops that we’ve seen so far have used int counters.

In principle, C also allows float counters.

But, using a float counter is BAD BAD BAD BAD.
```c
#include <stdio.h>

int main ()
{ /* main */
    const int program_success_code = 0;
    float real_count;
    float sum = 0.0;

    for (real_count = 1.0;
         real_count <= 10.0; real_count++) {
        sum = sum + real_count;
    } /* for real_count */
    printf("After the loop:\n");
    printf(" real_count = %f, sum = %f\n", 
           real_count, sum);
    return program_success_code;
} /* main */
```
float Counter Example #2

% gcc -o forreal forreal.c
% forreal

After the loop:
real_count = 11.000000, sum = 55.000000

This is BAD BAD BAD. Why?
Why float Counters are BAD BAD BAD

float counters are generally considered to be BAD BAD BAD programming practice, because:

- a float counter is an approximation, and
- therefore a loop with lots of iterations will accumulate a lot of error in the counter variable, as the error from each approximation adds up.
BAD float Counter Example #1

#include <stdio.h>

int main ()
{ /* main */
    const float pi = 3.1415926;
    const int program_success_code = 0;
    float radians;

    for (radians = 0;
        radians <= 100.0 * pi;
        radians = radians + pi / 5.0) {
        printf("radians = %19.15f\n", radians);
    } /* for radians */
    printf("After the loop:\n");
    printf("  100 * pi = %19.15f\n", 100.0 * pi);
    printf("  radians  = %19.15f\n", radians);
    return program_success_code;
} /* main */
BAD float Counter Example #2

% gcc -o forreal2 forreal2.c
% forreal2

radians = 0.0000000000000000
radians = 0.628318488597870
radians = 1.256636977195740
radians = 1.884955525398254
radians = 2.513273954391479
...

radians = 312.901885986328125
radians = 313.530212402343750
radians = 314.158538818359375

After the loop:
    100 * pi = 314.159250259399414
    radians = 314.786865234375000

This has been a deadly problem in real life. See:
http://www.ma.utexas.edu/users/arbogast/misc/disasters.html
Replace float Counter with int #1

#include <stdio.h>

int main ()
{ /* main */
    const int program_success_code = 0;
    const float pi = 3.1415926;
    float radians;
    int radians_counter;

    for (radians_counter = 0;
        radians_counter <= 500;
        radians_counter++) {
        radians = radians_counter * pi / 5.0;
        printf("radians =%19.15f\n", radians);
    } /* for radians */
    printf("After the loop:\n");
    printf("  100.0 * pi = %19.15f\n", 100.0 * pi);
    printf("  radians = %19.15f\n", radians);
    printf("  radians_counter = %3d\n", radians_counter);
    return program_success_code;
} /* main */
Replace `float` Counter with `int` #2

```
gcc -o forreal2int forreal2int.c
forreal2int
radians = 0.000000000000000
radians = 0.628318488597870
radians = 1.256636977195740
radians = 1.884955644607544
radians = 2.513273954391479
...
radians = 312.902618408203125
radians = 313.530944824218750
radians = 314.159240722656250
After the loop:
  100.0 * pi = 314.159250259399414
  radians = 314.159240722656250
  radians_counter = 501
```

Notice that there’s no **accumulated** error from approximating `float` quantities, because each approximation is independent of the others.
Debugging a for Loop #1

Suppose you have a program that has a for loop, and it looks like the for loop has a bug in it.

Assuming that the bug isn’t obvious just from looking, how do we figure out where the bug is?

One thing we can try is to put some printf statements inside the loop body.

Often, the output of the loop body printf statements will tell us where to find the bug.

When we’ve made a change, we can check to make sure things are going well using the same printf statements inside the loop body.

Once we know that the loop is debugged, we can delete the printf statements inside the loop body.
Debugging a for Loop #2

```c
#include <stdio.h>

int main ()
{
    int initial_value, final_value, count;
    int sum = 0;

    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    for (count = initial_value;
        count <= final_value; count++)
        { sum = sum * count;
        } /* for count */
    printf("The sum from %d to %d is %d.\n", initial_value, final_value, sum);
    return 0;
} /* main */
```

```
gcc -o sumbad sumbad.c
% sumbad
What are the summation limits?
1 5
The sum from 1 to 5 is 0.
```
Debugging a for Loop #3

#include <stdio.h>

int main ()
{ /* main */
    int initial_value, final_value, count;
    int sum = 0;
    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    for (count = initial_value;
        count <= final_value; count++) {
        sum = sum * count;
        printf("count = %d, sum = %d\n", count, sum);
    } /* for count */
    printf("The sum from %d to %d is %d.\n", 
            initial_value, final_value, sum);
    return 0;
} /* main */

% gcc -o sumbad sumbad.c
% sumbad
What are the summation limits?
1 5
count = 1, sum = 0
count = 2, sum = 0
count = 3, sum = 0
count = 4, sum = 0
count = 5, sum = 0
The sum from 1 to 5 is 0.
Debugging a for Loop #4

```c
#include <stdio.h>

int main ()
{ /* main */
    int initial_value, final_value, count;
    int sum = 0;
    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    for (count = initial_value;
        count <= final_value; count++) {
        sum = sum + count;
        printf("count = %d, sum = %d\n", count, sum);
    } /* for count */
    printf("The sum from %d to %d is %d.\n", initial_value, final_value, sum);
    return 0;
} /* main */
```

```
gcc -o sumbad sumbad.c

What are the summation limits?
1 5
count = 1, sum = 1
count = 2, sum = 3
count = 3, sum = 6
count = 4, sum = 10
count = 5, sum = 15
The sum from 1 to 5 is 15.
```
```c
#include <stdio.h>

int main ()
{
    int initial_value, final_value, count;
    int sum = 0;

    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    for (count = initial_value;
        count <= final_value; count++) {
        sum = sum + count;
    } /* for count */
    printf("The sum from %d to %d is %d.\n", initial_value, final_value, sum);
    return 0;
} /* main */
```

`gcc -o sumbad sumbad.c`

`sumbad`

What are the summation limits?
1 5

The sum from 1 to 5 is 15.
#include <stdio.h>

int main ()
{ /* main */
    int initial_value, final_value, maximum_value, count;
    int sum = 0;

    printf("What are the initial, final and ");
    printf("maximum values?\n");
    scanf("%d %d %d",
    &initial_value, &final_value, &maximum_value);
    for (count = initial_value;
        count <= final_value; count++) {
        sum = sum + count;
        if (sum > maximum_value) {
            final_value = final_value - 1; ← BAD!
        } /* if (sum > maximum_value) */
        printf("count = %d, sum = %d, final_value = %d\n",
            count, sum, final_value);
    } /* for count */
    return 0;
} /* main */
Changing Loop Bounds Inside Loop #2: BAD

```
gcc -o loopbndschg loopbndschg.c
```
```
% loopbndschg
```

What are the initial, final and maximum values?

1 5 3

- count = 1, sum = 1, final_value = 5
- count = 2, sum = 3, final_value = 5
- count = 3, sum = 6, final_value = 4
- count = 4, sum = 10, final_value = 3
Changing Loop Index Inside Loop #1: BAD

#include <stdio.h>

int main ()
{
    int initial_value, final_value, maximum_value, count;
    int sum = 0;

    printf("What are the initial, final and ");
    printf("maximum values?
");
    scanf("%d %d %d",
        &initial_value, &final_value, &maximum_value);
    for (count = initial_value;
        count <= final_value; count++) {
        sum = sum + count;
        if (sum > maximum_value) {
            count = count + 1;
        } /* if (sum > maximum_value) */
        printf("count = %d, sum = %d, final_value = %d
", count, sum, final_value);
    } /* for count */
    return 0;
} /* main */

BAD!
Changing Loop Index Inside Loop #2: BAD

```bash
% gcc -o loopidxchg loopidxchg.c
% loopidxchg
```

What are the initial, final and maximum values?

<table>
<thead>
<tr>
<th>count</th>
<th>sum</th>
<th>final_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>5</td>
</tr>
</tbody>
</table>

```bash
```