`for` Loop Lesson 3 Outline

`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**.

float Counter Example #1

```
#include <stdio.h>

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

    sum = initial_sum;
    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 =   0.000000000000000
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.cs.toronto.edu/~krj/courses/2307/disasters/disasters.html
http://www.ma.utexas.edu/users/arbogast/misc/disasters.html

Replace `float` Counter with `int` #1

```
#include <stdio.h>

int main ()
{ /* main */
    const float pi                   = 3.1415926;
    const int   program_success_code = 0;
    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 that things are going well, using the same `printf` statements inside the loop body.

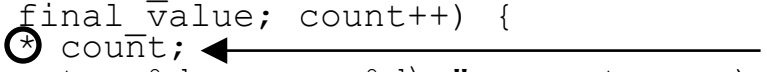
Once we know that the loop is debugged, we can delete the `printf` statements from inside the loop body.

Debugging a `for` Loop #2

```
#include <stdio.h>

int main ()
{ /* main */
    const int initial_sum          = 0;
    const int program_success_code = 0;
    int initial_value, final_value, count;
    int sum;

    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    sum = initial_sum;
    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 program_success_code;
} /* 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 */
    const int initial_sum          = 0;
    const int program_success_code = 0;
    int initial_value, final_value, count;
    int sum;
    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    sum = initial_sum;
    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 program_success_code;
} /* 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.
```



NOTICE!

Debugging a `for` Loop #4

```
#include <stdio.h>
int main ()
{ /* main */
    const int initial_sum          = 0;
    const int program_success_code = 0;
    int initial_value, final_value, count;
    int sum;
    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    sum = initial_sum;
    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 program_success_code;
} /* main */
% gcc -o sumbad sumbad.c
% sumbad
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.
```

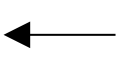
NOTICE!

Debugging a `for` Loop #5

```
#include <stdio.h>

int main ()
{ /* main */
    const int initial_sum          = 0;
    const int program_success_code = 0;
    int initial_value, final_value, count;
    int sum;

    printf("What are the summation limits?\n");
    scanf("%d %d", &initial_value, &final_value);
    sum = initial_sum;
    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 program_success_code;
} /* main */
% gcc -o sumbad sumbad.c
% sumbad
What are the summation limits?
1 5
The sum from 1 to 5 is 15.
```

Changing Loop Bounds Inside Loop #1: BAD

```
#include <stdio.h>

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

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



BAD!

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

    printf("What are the initial, final and ");
    printf("maximum values?\n");
    scanf("%d %d %d",
        &initial_value, &final_value, &maximum_value);
    sum = initial_sum;
    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\n",
            count, sum, final_value);
    } /* for count */
    return program_success_code;
} /* main */
```

BAD!

Changing Loop Index Inside Loop #2: BAD

```
% gcc -o loopidxchg loopidxchg.c
% loopidxchg
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 = 4, sum = 6, final_value = 5
count = 6, sum = 11, final_value = 5
```