Scope

2025 Winter APS105: Computer Fundamentals
Jon Eyolfson

Lecture 11
1.1.2

When We Use a Function, We Say “Function Call”

Given the previous code snippet:

```
int main(void) {
    /* Get the input. */
    printTriangle(n);
    return 0;
}
```

We would say `main` calls `printTriangle`,
C copies the arguments and jumps there

When We Use a Function, We Say “Function Call”

Given the previous code snippet:

```
int main(void) {
    /* Get the input. */
    printTriangle(n);
    return 0;
}
```

We would say `main` calls `printTriangle`,
C copies the arguments and jumps there

In this case `main` is the caller, and `printTriangle` is the callee

When We Use a Function, We Say “Function Call”

Given the previous code snippet:

```
int main(void) {
    /* Get the input. */
    printTriangle(n);
    return 0;
}
```

We would say `main` calls `printTriangle`,
  C copies the arguments and jumps there

In this case `main` is the caller, and `printTriangle` is the callee

A `return` stops the callee, and the caller resumes
  The caller gets a copy of the return value

The Scope is Part of the Program You Can Use a Variable

You can use a variable declaration within a { until the matching }

C declares function arguments, and `for` loop initializers in the next {

Variables Exist Within a Function

```
int main(void) {
    int i = 42;
    printf("i: %d\n", i);
    return 0;
}
```

main

Variables Exist Within a Function

```
int main(void) {
    int i = 42;
    printf("i: %d\n", i);
    return 0;
}
```

`i` is valid here

Variables Exist Within a Function

```
int main(void) {
    int i = 42;
    printf("i: %d\n", i);
    return 0;
}
```

`i` is valid here

A For Loop Creates an Inner Scope

```
int main(void) {
    int i = 42;
    for (int j = 0; j < 1; ++j) {
        printf("j: %d\n", j);
    }
    return 0;
}
```

main

A For Loop Creates an Inner Scope

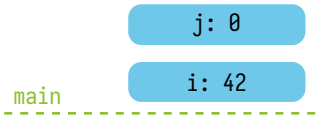
```
int main(void) {
    int i = 42;
    for (int j = 0; j < 1; ++j) {
        printf("j: %d\n", j);
    }
    return 0;
}
```

i is valid here

A For Loop Creates an Inner Scope

```
int main(void) {
    int i = 42;
    for (int j = 0; j < 1; ++j) {
        printf("j: %d\n", j);
    }
    return 0;
}
```

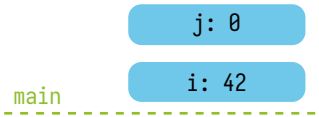
j is valid here



A For Loop Creates an Inner Scope

```
int main(void) {
    int i = 42;
    for (int j = 0; j < 1; ++j) {
        printf("j: %d\n", j);
    }
    return 0;
}
```

j is valid here



A For Loop Creates an Inner Scope

```
int main(void) {
    int i = 42;
    for (int j = 0; j < 1; ++j) {
        printf("j: %d\n", j);
    }
→   return 0;
}
```

You Can “Shadow” A Variable with the Same Name

```
int main(void) {
    int i = 42;
    for (int i = 0; i < 1; ++i) {
        printf("i: %d\n", i);
    }
    return 0;
}
```

main

You Can “Shadow” A Variable with the Same Name

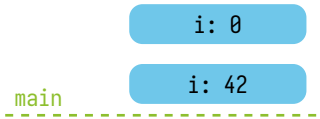
```
int main(void) {
    int i = 42;
    for (int i = 0; i < 1; ++i) {
        printf("i: %d\n", i);
    }
    return 0;
}
```

`i` is valid here

You Can “Shadow” A Variable with the Same Name

```
int main(void) {
    int i = 42;
    for (int i = 0; i < 1; ++i) {
        printf("i: %d\n", i);
    }
    return 0;
}
```

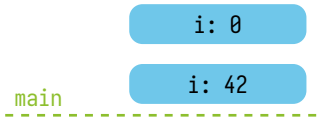
`i` is valid here (C always uses the most recent)



You Can "Shadow" A Variable with the Same Name

```
int main(void) {
    int i = 42;
    for (int i = 0; i < 1; ++i) {
        printf("i: %d\n", i);
    }
    return 0;
}
```

`i` is valid here (C always uses the most recent)



You Can “Shadow” A Variable with the Same Name

```
int main(void) {
    int i = 42;
    for (int i = 0; i < 1; ++i) {
        printf("i: %d\n", i);
    }
→   return 0;
}
```

A Set of Curly Brackets Is Also a New Inner Scope

```
int main(void) {
    int i = 42;
    {
        int j = 0;

    }
    return 0;
}
```

main

A Set of Curly Brackets Is Also a New Inner Scope

```
int main(void) {
    int i = 42;
    {
        int j = 0;
    }
    return 0;
}
```

i valid

A Set of Curly Brackets Is Also a New Inner Scope

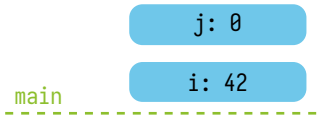
```
int main(void) {
    int i = 42;
    {
        int j = 0;

    }
    return 0;
}
```

i valid

A Set of Curly Brackets Is Also a New Inner Scope

```
int main(void) {
    int i = 42;
    {
        int j = 0;
                    } j valid
    }
    return 0;
}
```



A Set of Curly Brackets Is Also a New Inner Scope

```
int main(void) {
    int i = 42;
    {
        int j = 0;

→   }
    return 0;
}
```

A Set of Curly Brackets Is Also a New Inner Scope

```
int main(void) {
    int i = 42;
    {
        int j = 0;

    }
    return 0;
}
```

Functions Create Their Own Scope

```
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

main

Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

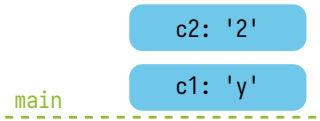
c1 and c2 valid

Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

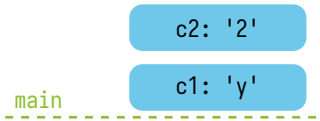


Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

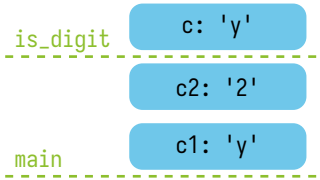


Functions Create Their Own Scope

```
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

only c valid

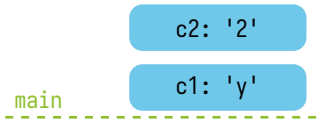


Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

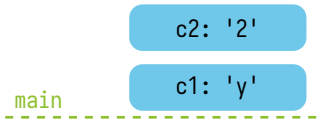


Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

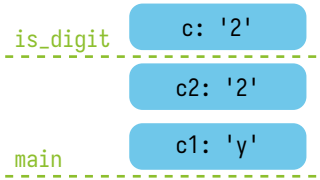


Functions Create Their Own Scope

```
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

only c valid

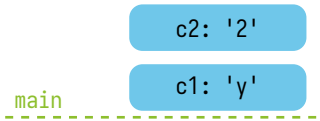


Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

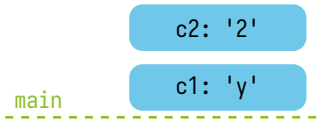


Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

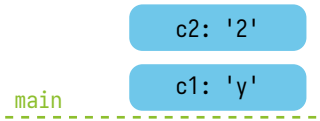


Functions Create Their Own Scope

```c
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

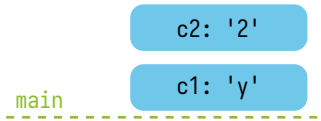


Functions Create Their Own Scope

```
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid

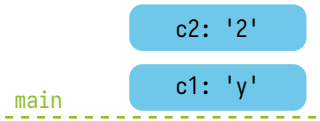


Functions Create Their Own Scope

```
bool is_digit(char c) {
    return c >= '0' && c <= '9';
}

int main(void) {
    char c1, c2;
    printf("Input 2 characters: ");
    scanf(" %c %c", &c1, &c2);
    printf("Digits:");
    if (is_digit(c1)) {
        printf(" %c", c1);
    }
    if (is_digit(c2)) {
        printf(" %c", c2);
    }
    printf("\n");
    return 0;
}
```

c1 and c2 valid



Beware: `scanf` Behaves Strangely with Characters

If we write: `scanf("%c %c", &c1, &c2);`
and our input is: `" A B"`
then `c1 = ' '`; and `c2 = 'A'`;

Beware: `scanf` Behaves Strangely with Characters

If we write: `scanf("%c %c", &c1, &c2);`
and our input is: `" A B"`
then `c1 = ' '`; and `c2 = 'A'`;

If we write: `scanf("%c%c", &c1, &c2);`
and our input is: `"  A B"`
then `c1 = ' '`; and `c2 = ' '`;

Beware: `scanf` Behaves Strangely with Characters

If we write: `scanf("%c %c", &c1, &c2);`
and our input is: `" A B"`
then `c1 = ' '`; and `c2 = 'A'`;

If we write: `scanf("%c%c", &c1, &c2);`
and our input is: `"  A B"`
then `c1 = ' '`; and `c2 = ' '`;

Unless you really want to capture a space character,
always put a space before %c and,
never put a space after a format specifier

Beware: `scanf` Behaves Strangely with Characters

If we write: `scanf("%c %c", &c1, &c2);`
and our input is: `" A B"`
then `c1 = ' '`; and `c2 = 'A'`;

If we write: `scanf("%c%c", &c1, &c2);`
and our input is: `"  A B"`
then `c1 = ' '`; and `c2 = ' '`;

Unless you really want to capture a space character,
always put a space before %c and,
never put a space after a format specifier

From the real documentation:
"It is very difficult to use these functions correctly"...

Just In Case: , in an Expression is an Operator

The , operator will evaluate the expression on the left-hand side, and throw the result away, then it evaluates the right-hand side, and the result of the expression is the result of the right-hand side

You may see things like: `for (int x = 0, y = 10; x < y; ++x, --y)`

What Do We See Printed?

```c
#include <stdio.h>

void swap(int a, int b) {
    int temp = a;
    a = b;
    b = temp;
    printf("swap a: %d, b: %d\n", a, b);
}

int main(void) {
    int a = 1;
    int b = 2;
    printf("main (before swap) a: %d, b: %d\n", a, b);
    swap(a, b);
    printf("main (after swap)  a: %d, b: %d\n", a, b);
    return 0;
}
```

The Output of the Previous Program

```
main (before swap) a: 1, b: 2
swap a: 2, b: 1
main (after swap)  a: 1, b: 2
```

We Can Create Global Variables

A global variable is always in scope (valid) below its declaration

They're created before `main` runs

We Can Create Global Variables

A global variable is always in scope (valid) below its declaration

They're created before `main` runs

They are not advised for this course, and you should avoid them

If you absolutely have to make globals, declare them as `static`
(so they can't accidentally be used in other C files)

Any Function Can Change Global Variables

```c
#include <stdio.h>

static int a = 1;
static int b = 2;

void swap(void) {
    int temp = a;
    a = b;
    b = temp;
    printf("swap a: %d, b: %d\n", a, b);
}

int main(void) {
    printf("main (before swap) a: %d, b: %d\n", a, b);
    swap();
    printf("main (after swap)  a: %d, b: %d\n", a, b);
    return 0;
}
```

We've Covered Functions, Now Practice!

We've now completed chapter 5 of the Learning C online book
Try: https://learningc.org/chapters/chapter05-functions/exercises

There's also past (midterm) exams:
https://q.utoronto.ca/courses/330896/pages/past-exams

Please feel free to discuss and ask questions in Discord!

The Real Swap Function (Next Lecture)

```c
#include <stdio.h>
#include <stdlib.h>

void swap(int* a, int* b) {
    int temp = *a;
    *a = *b;
    *b = temp;
}

int main(void) {
    int a = 1;
    int b = 2;
    printf("main (before swap) a: %d, b: %d\n", a, b);
    swap(&a, &b);
    printf("main (after swap)  a: %d, b: %d\n", a, b);
    return EXIT_SUCCESS;
}
```

Bonus Practice: Factorial

Create a function called `factorial` that takes an integer argument, `n`, and returns an integer that's the result of computing n!

Recall: n! is
$n \times (n-1) \times (n-2) \times \cdots \times 1$

The factorial of a negative number is undefined

Example Previous Solution

```
int factorial(int n) {
    if (n < 0) {
        return 0;
    }
    int product = 1;
    for (int x = 1; x <= n; ++x) {
        product *= x;
    }
    return product;
}
```