計算機程式設計

Computer Programming

Functions

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GitHub repo

Outline

- Review
  - Usage of “return”
- Internal properties when passing an array to a function
- Recursion
- Function scope

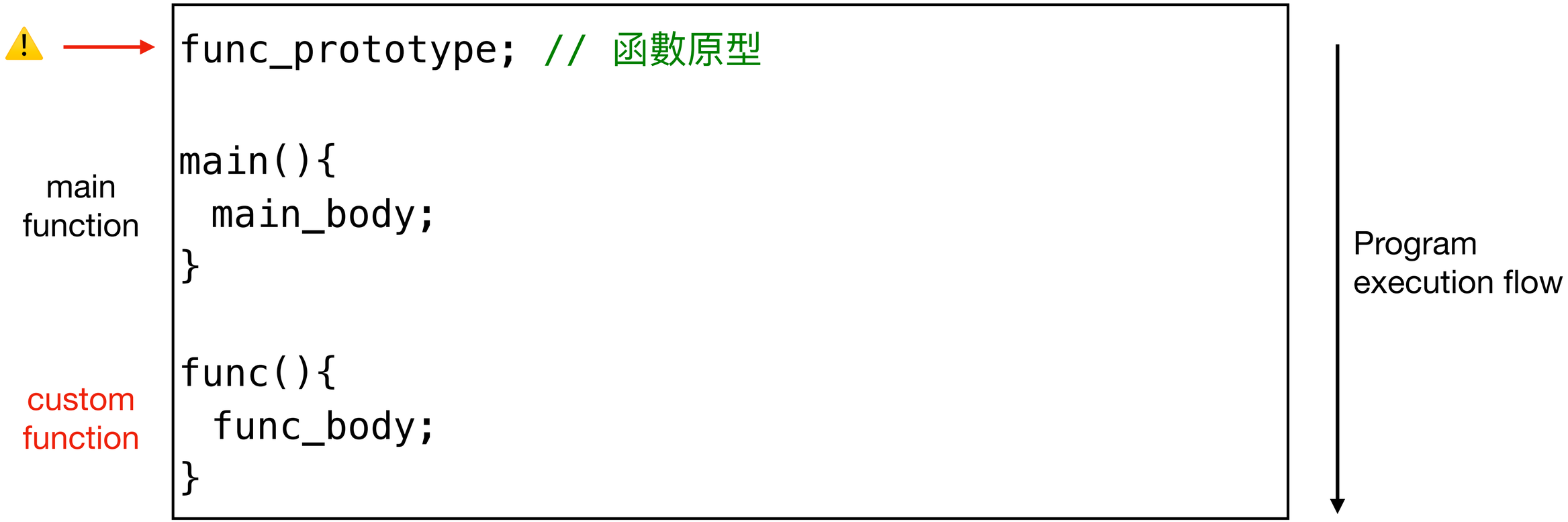
Categories

- [Definition]: 定義 (通常一堆字)
- [Declaration]: 宣告方法 (通常 pseudo code)
- [Usage]: 使用方法 (通常 pseudo code)
- [Illustration]: 我有畫圖
- [Important Notes]: 注意事項 (通常一堆字)
- [Notes]: 注意事項 (通常一堆字)，但重要程度較 Important Notes 低
- 什麼都沒標: 真的 code 且右上角會有灰字告訴你該 code 在 GitHub repo 的位置

Review (Functions)

[Declaration] How to write a function

You can declare a function with a function prototype



- Then, your program will first check the function prototype and use the function you define outside the main function.

[Declaration] Function Prototype (函數原型)

- A function prototype is:

```
return_type func_name(type1, type2, ...);
```

- Purposes:
  1. **Type Checking:** Help the compiler **check the correctness of data types** when you use a function in the main function.
  2. **Function Declaration**: Allows function calls before the function is defined.

- You can also write a function prototype as the following to increase readability:

```
return_type func_name(type1 param1, type2 param2, ...);
```

[Declaration] Input Array to a Function

prototype

```
return_type func_name(type arr[], type2 param2, ...)
```

Not required

main function

```
int main(void){
  array_declaration;
  ...
}
```

custom function

```
return_type func_name(type arr[], type2 param2, ...){
   body;
   return value;
}
```

Not required

Addresses between Parameters and Arguments

C-course-materials/05-Functions/array.c

```c
#include <stdio.h>

void modifyArray(int arr[]) {
    printf("Address of parameter 'arr' inside function: %p\n", arr);
    arr[0] = 999; // Modify the first element
}

int main(void) {
    int score[4] = {80, 85, 90, 100};
    printf("Address of argument 'score' in main: %p\n", score);

    printf("First element before modification: %d\n", score[0]);
    modifyArray(score);
    printf("First element after modification: %d\n", score[0]);
    return 0;
}
```

Print the memory address of an array

C-course-materials/04-Arrays/print_array_addr.c

```c
#include <stdio.h>
int main(){
    int score[4] = {80, 85, 90, 100};
    printf("The address of this array: %p\n", &score);
    for (int i = 0; i < 4; i++){
        printf("The address of score[%d]: %p\n", i, &score[i]);
    }
}
```

Output

```
The address of this array: 0x7fffffffdd80
The address of score[0]: 0x7fffffffdd80
The address of score[1]: 0x7fffffffdd84
The address of score[2]: 0x7fffffffdd88
The address of score[3]: 0x7fffffffdd8c
```

Usage of “return”

[Definition] What is “return”?

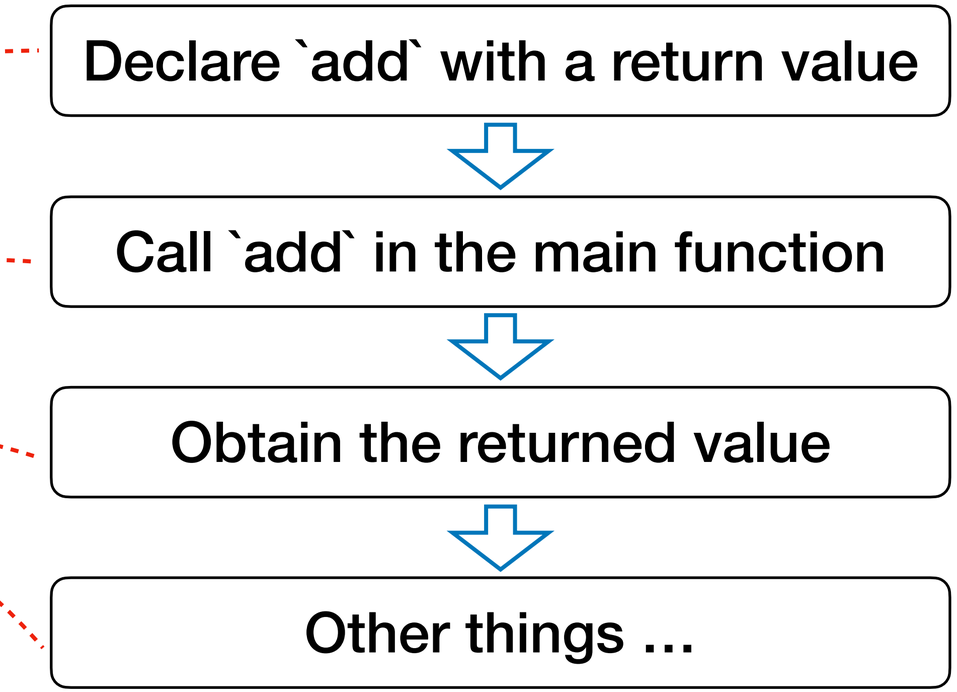
- return (回傳) usually comes with a statement, which is called a return statement.
- A return statement ends the execution of a function, and returns control to the calling function.

This line is a return statement.

```
return_type func_name(type1 param1, type2 param2, ...){
    body;
    return value;
}
```

[Illustration] Usage of “return”

```c
#include <stdio.h>
int add(int a, int b){
    return a + b;
}
int main(void){
    int sum;
    sum = add(5, 6);
    printf("Sum: %d", sum);
    return 0;
}
```



[Notes / Recap] Property of an Array

- The return type of a function is the type of value that the function returns.
- Omitting the return type is not recommended. Placing a return type increases readability and lowers the chance of producing wrong behaviors.

[Notes / Recap] Property of an Array

C-course-materials/05-Functions/return_example.c

- The return type of a function is the type of value that the function returns.
- Omitting the return type is not recommended. Placing a return type increases readability and lowers the chance of producing wrong behaviors.
  - Yes, you can omit the return type. But a function will set the return type as integer in default.
  - If you don’t need to return a value (i.e. just print), omitting the return type (void) does not cause an undesired result.

Internal properties when passing an array to a function
將陣列輸入到函數時的內部行為

[Usage] Calling a Function with an array

```
void modifyArray(int arr[]) {
    arr[0] = 999; // Modify the first element
}
```

✅ **This is correct for calling `modifyArray` in the main function.**

```
int main(void) {
    int score[4] = {80, 85, 90, 100};
    modifyArray(score);
}
```

❌ **This is not correct for calling `modifyArray` in the main function.**

```
int main(void) {
    int score[4] = {80, 85, 90, 100};
    modifyArray(score[0]);
}
```

[Illustration] 1D Array as a Argument

```
//Input score
modifyArray(score);
```

- Input an array as an argument to a function is actually **passing its memory address**.


```
void modifyArray(int arr[])
```

Sub-Array as a Argument

C-course-materials/05-Functions/func_pass_array.c

```c
#include <stdio.h>
void print_array(int arr[]) {
    for (int i = 0; i < 4; i++) {
        printf("%d ", arr[i]);
    }
    printf("\nFinish printing an array\n");
}
void modifyArray(int arr[]) {
    printf("Address of parameter 'arr' inside function: %p\n", arr);
    arr[0] = 999; // Modify the first element
}
int main(void) {
    int score[4] = {80, 85, 90, 100};
    print_array(score);
    modifyArray(score);
    print_array(score);
    modifyArray(&score[1]);
    print_array(score);
}
```

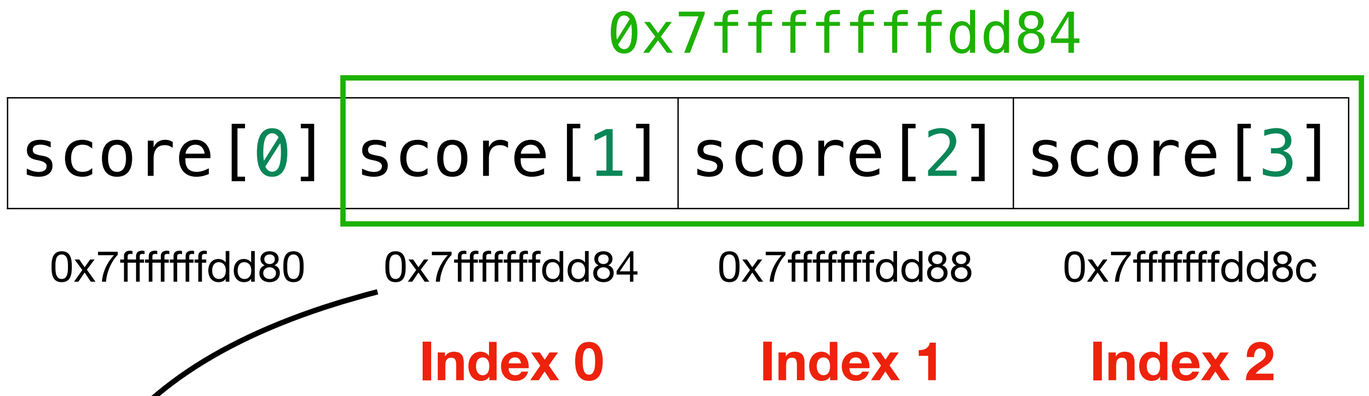
[Important Notes / Recap] Property of an Array

- An array itself is a memory address. (陣列名稱本身就是存放陣列位址的變數)
  - Example: printf(“%p”, score); will show the address of `score`.
- Array subscripting gets the value of an element in an array.
  - Example: score[0] will get a value of 80.
- Using the address operator (&) returns with array subscripting gets the address of an element in an array.
  - Example: printf(“%p”, &score[0]); will show the address of `score[0]`.

[Illustration] 2D Array as a Argument

```
//Input a sub-array
modifyArray(&score[1]);
```

- Input an array as an argument to a function is actually passing its memory address.




```
void modifyArray(int arr[])
```

[Declaration] Input a 2D Array to a Function

- Example: pass `score[2][4]` to a function

You can only leave the leftmost index empty!

prototype

```
return_type func_name(type arr[][4], type2 param2, ...)
```

Not required

Required

main function

```
int main(void){
  array_declaration;
  ...
}
```

custom function

```
return_type func_name(type arr[][4], type2 param2, ...){
   body;
   return value;
}
```

Not required

Required

Passing a 2D array to a function

C-course-materials/05-Functions/func_pass_2Darray.c

```c
#include <stdio.h>
void print_array(int arr[][4]) {
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 4; j++) {
            printf("%d ", arr[i][j]);
        }
        printf("\n");
    }
    printf("Finish printing an array\n");
}
void modifyArray(int arr[][4]) {
    printf("Address of parameter 'arr' inside function: %p\n", arr);
    arr[0][3] = 999; // Modify the first element
}
int main(void) {
    int score[][4] = {
        {80, 85, 90, 100},
        {60, 65, 70, 100}
    };
    print_array(score);
    modifyArray(score);
    print_array(score);
}
```

[Declaration] Pass Array to a Function with length

- For a 1D array:

custom function

```
return_type func_name(type arr[], int n){
   for (int i = 0; i < n; i++){
      ...
   }
}
```

- For a 2D array (Example: `score[2][4]`):

custom function

```
return_type func_name(type arr[][4], int num_rows){
   for (int i = 0; i < num_rows; i++){
      for (int j = 0; j < 4; j++){
         ...
      }
   }
}
```

Pass an array with a length parameter

Length parameter

C-course-materials/05-Functions/func_pass_array_with_length.c

```c
#include <stdio.h>
void print_array(int arr[], int n) {
    for (int i = 0; i < n; i++) {
        printf("%d ", arr[i]);
    }
    printf("\nFinish printing an array\n");
}
void modifyArray(int arr[]) {
    printf("Address of parameter 'arr' inside function: %p\n", arr);
    arr[0] = 999; // Modify the first element
}
int main(void) {
    int score[4] = {80, 85, 90, 100};
    print_array(score, 4);
    modifyArray(score);
    print_array(score, 4);
}
```

Recursion (遞迴)

[Definition] What is recursion?

- We are now talking about “**recursion** in a function”.
- Recursion is to call the same function inside a function. (自己呼叫自己)

```
int do_func(int n){
    ...;
    do_func(n);
}

int main(void){
    int var_a;
    do_func(var_a);
}
```

[Illustration] Recursion

C-course-materials/05-Functions-2/infinite_recursion.c

Start →

```c
#include <stdio.h>
void do_print(void){
    printf("Hello, World!\n");
    do_print();
}
int main(void){
    do_print();
    return 0;
}
```

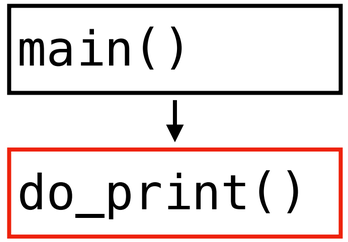
```
main()
```

[Illustration] Recursion

C-course-materials/05-Functions-2/infinite_recursion.c

```c
#include <stdio.h>
void do_print(void){
    printf("Hello, World!\n");
    do_print();
}
int main(void){
    do_print();
    return 0;
}
```

Now

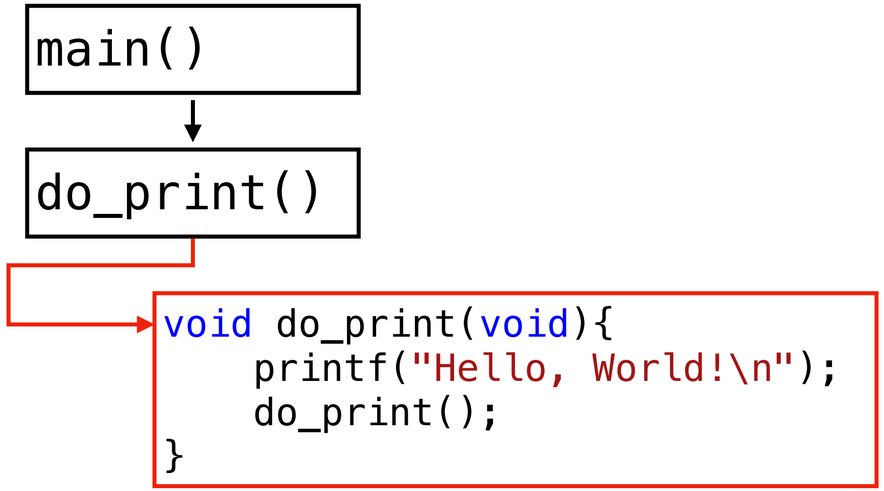


[Illustration] Recursion

C-course-materials/05-Functions-2/infinite_recursion.c

Now

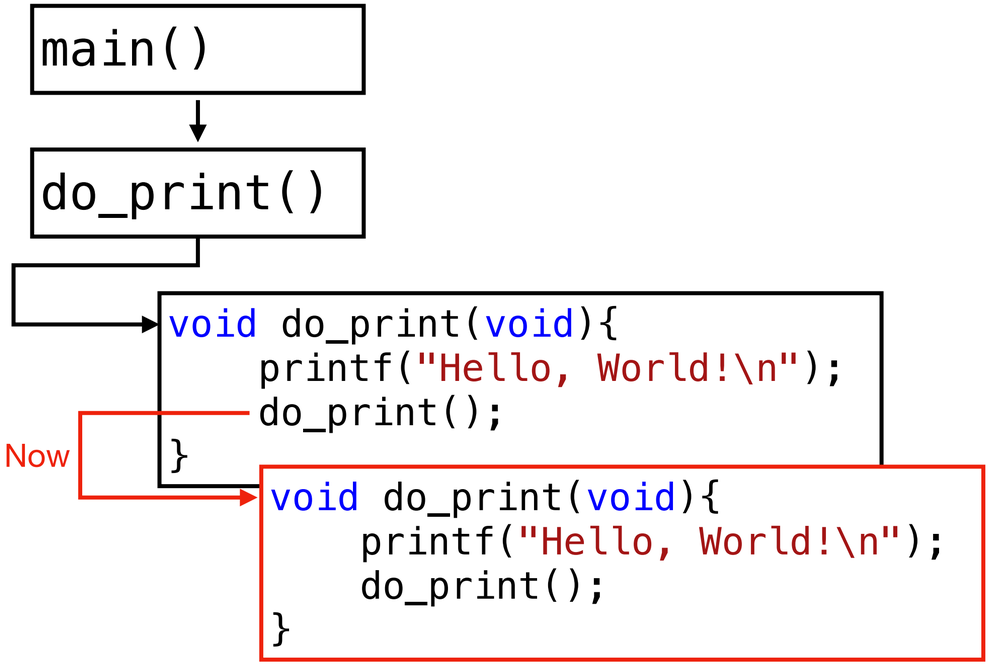
```c
#include <stdio.h>
void do_print(void){
    printf("Hello, World!\n");
    do_print();
}
int main(void){
    do_print();
    return 0;
}
```



[Illustration] Recursion

C-course-materials/05-Functions-2/infinite_recursion.c

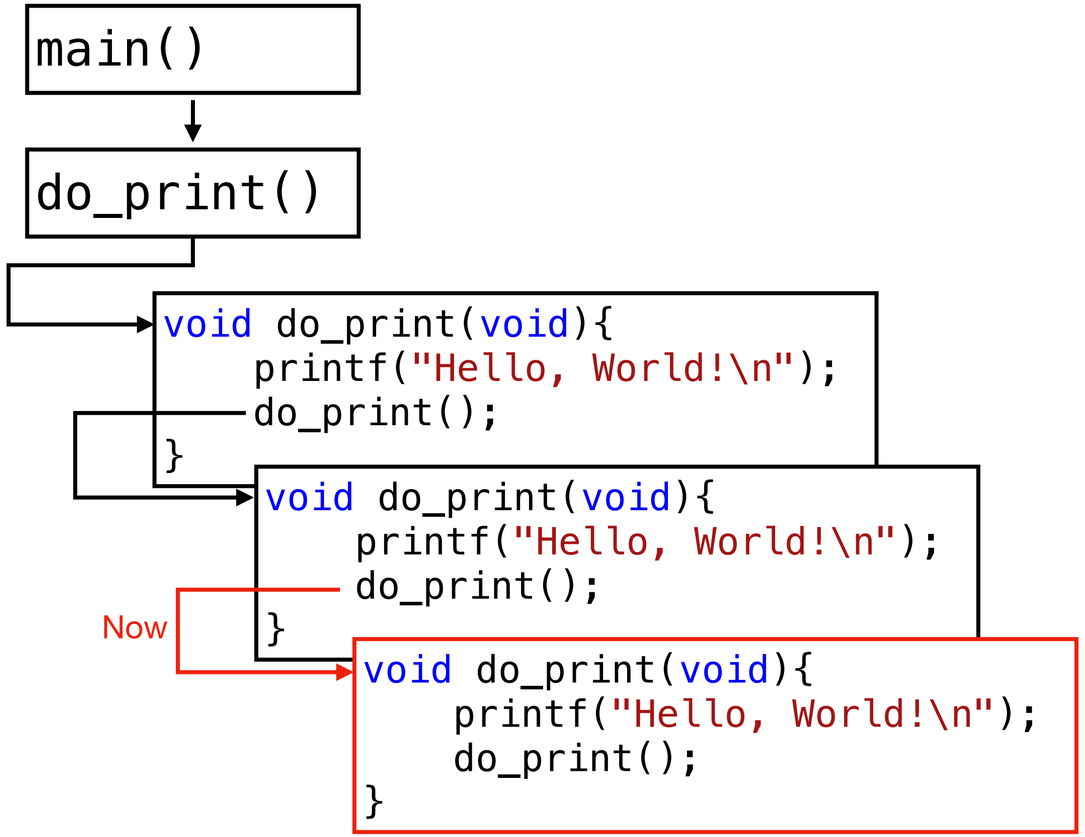
```c
#include <stdio.h>
void do_print(void){
    printf("Hello, World!\n");
    do_print();
}
int main(void){
    do_print();
    return 0;
}
```



[Illustration] Recursion

C-course-materials/05-Functions-2/infinite_recursion.c

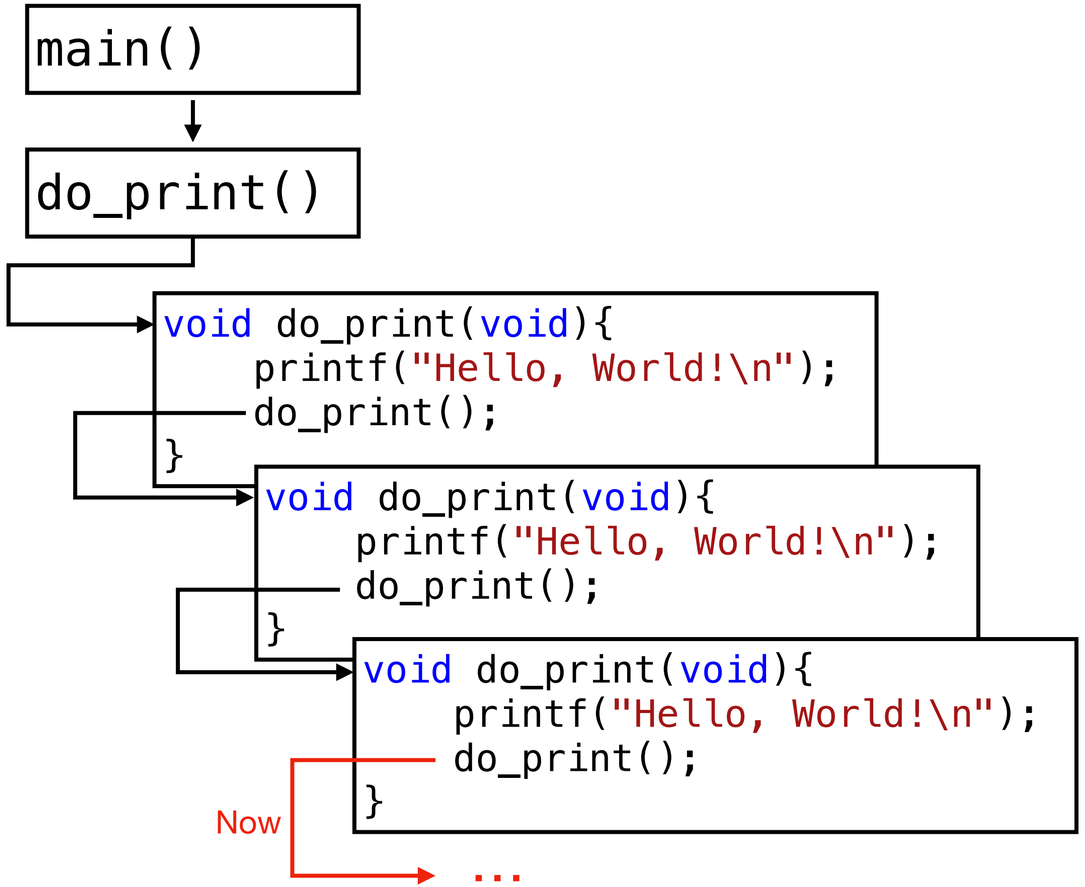
```c
#include <stdio.h>
void do_print(void){
    printf("Hello, World!\n");
    do_print();
}
int main(void){
    do_print();
    return 0;
}
```



[Illustration] Recursion

C-course-materials/05-Functions-2/infinite_recursion.c

```c
#include <stdio.h>
void do_print(void){
    printf("Hello, World!\n");
    do_print();
}
int main(void){
    do_print();
    return 0;
}
```

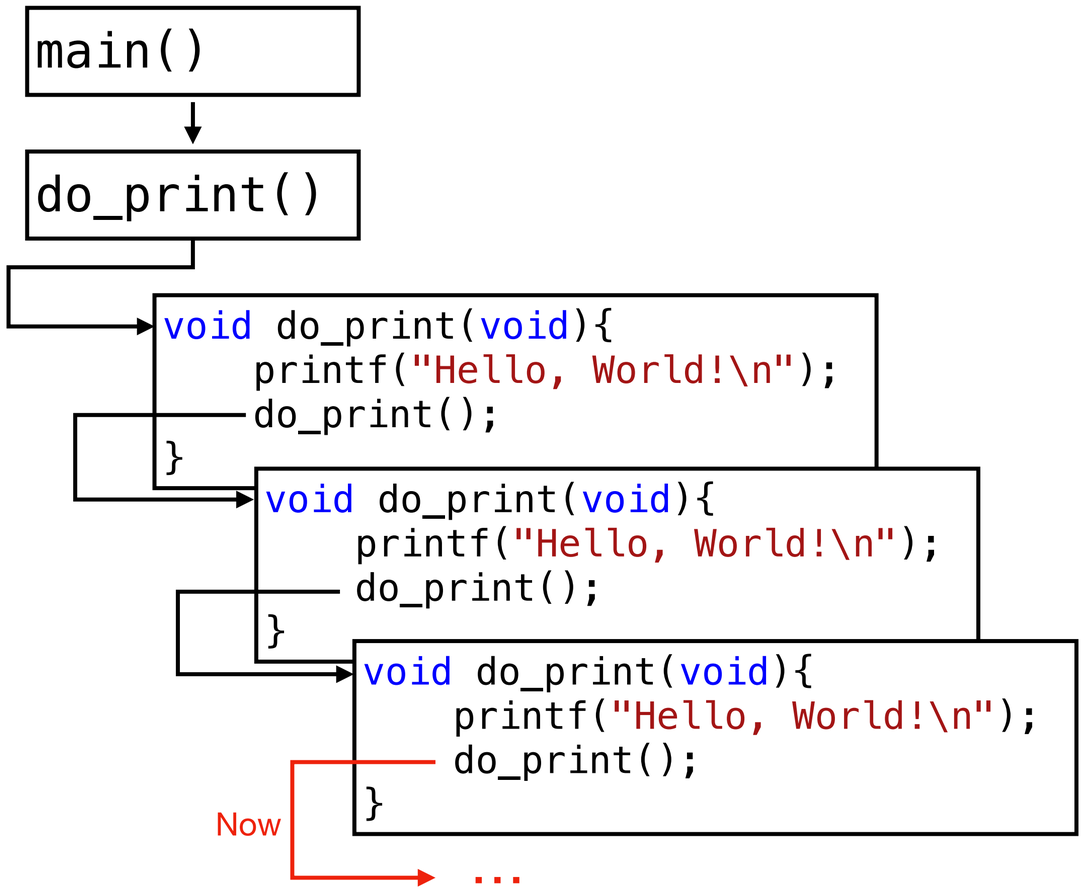


This program will not end!

[Illustration] Recursion

C-course-materials/05-Functions-2/infinite_recursion.c

Figure source: https://x.com/ProductHunt/status/1013695862508097536



This program will not end!

[Illustration] Recursion (finite version)

C-course-materials/05-Functions-2/finite_recursion.c

```c
#include <stdio.h>
void do_print(int i){
    if (i < 3){
        printf("Hello, World!\n");
        do_print(i + 1);
    }
}
int main(void){
    int i = 0;
    do_print(i);
    return 0;
}
```

[Illustration] Recursion (finite version)

C-course-materials/05-Functions-2/finite_recursion.c

Start →

```c
#include <stdio.h>
void do_print(int i){
    if (i < 3){
        printf("Hello, World!\n");
        do_print(i + 1);
    }
}
int main(void){
    int i = 0;
    do_print(i);
    return 0;
}
```

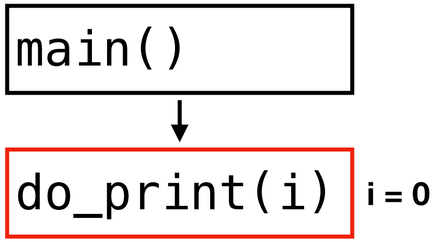
```
main()
```

[Illustration] Recursion (finite version)

C-course-materials/05-Functions-2/finite_recursion.c

```c
#include <stdio.h>
void do_print(int i){
    if (i < 3){
        printf("Hello, World!\n");
        do_print(i + 1);
    }
}
int main(void){
    int i = 0;
    do_print(i);
    return 0;
}
```

Now

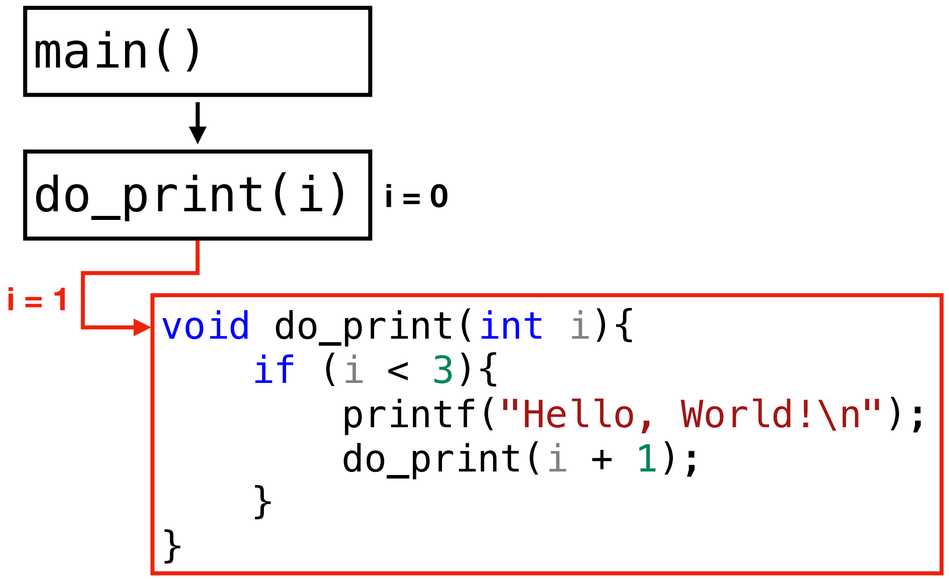


[Illustration] Recursion (finite version)

C-course-materials/05-Functions-2/finite_recursion.c

Now

```c
#include <stdio.h>
void do_print(int i){
    if (i < 3){
        printf("Hello, World!\n");
        do_print(i + 1);
    }
}
int main(void){
    int i = 0;
    do_print(i);
    return 0;
}
```



[Illustration] Recursion (finite version)

C-course-materials/05-Functions-2/finite_recursion.c

```c
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    if (i < 3){
        printf("Hello, World!\n");
        do_print(i + 1);
    }
}
int main(void){
    int i = 0;
    do_print(i);
    return 0;
}
```
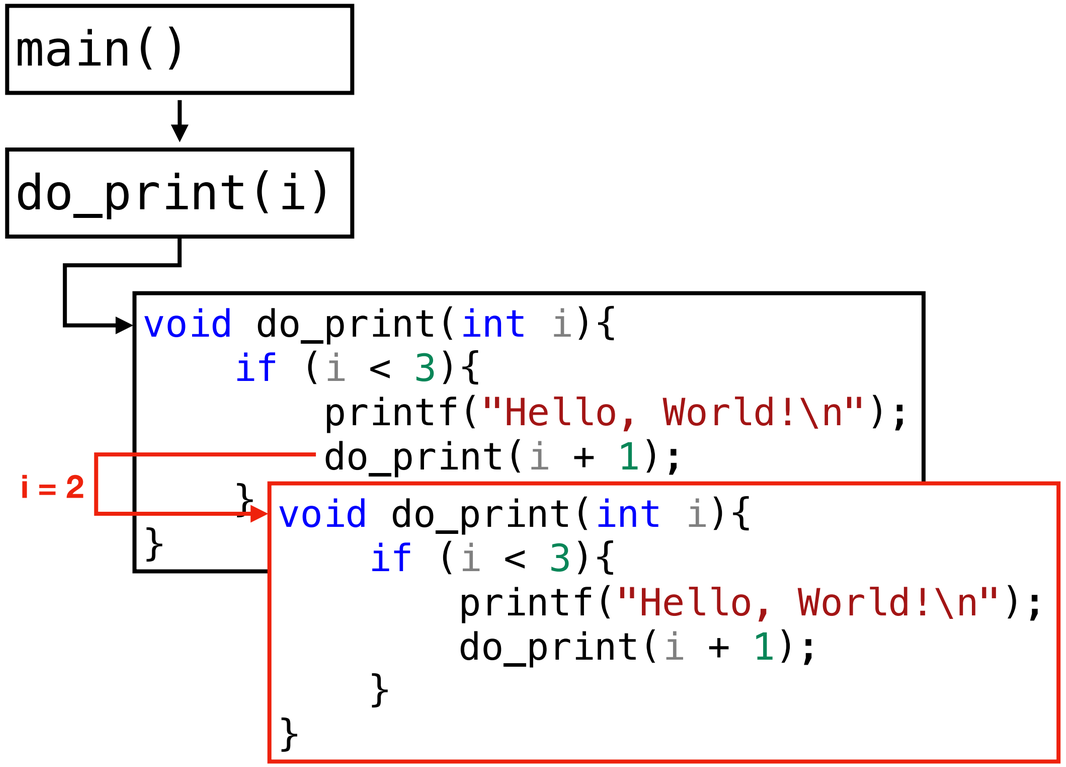
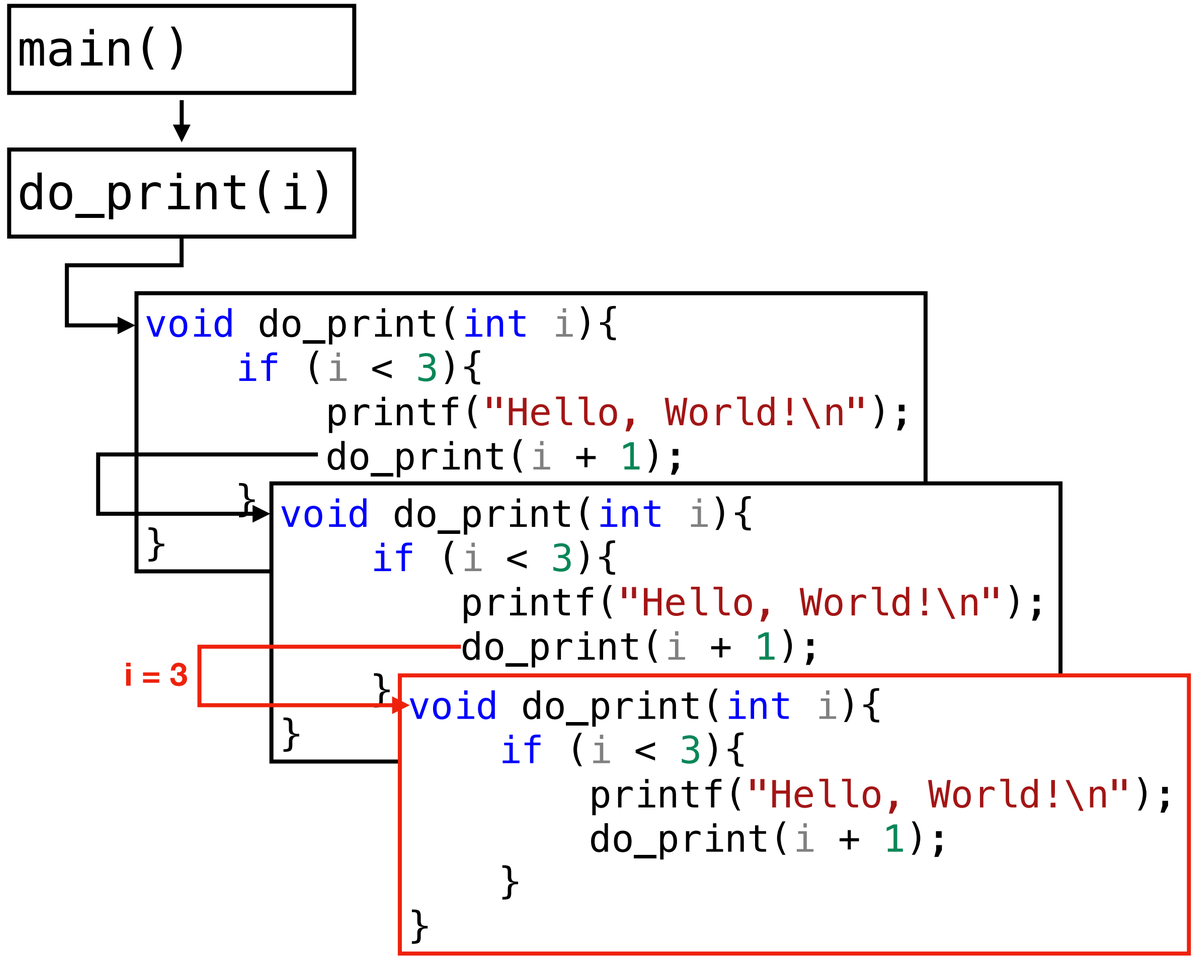



[Illustration] Recursion (finite version)

C-course-materials/05-Functions-2/finite_recursion.c

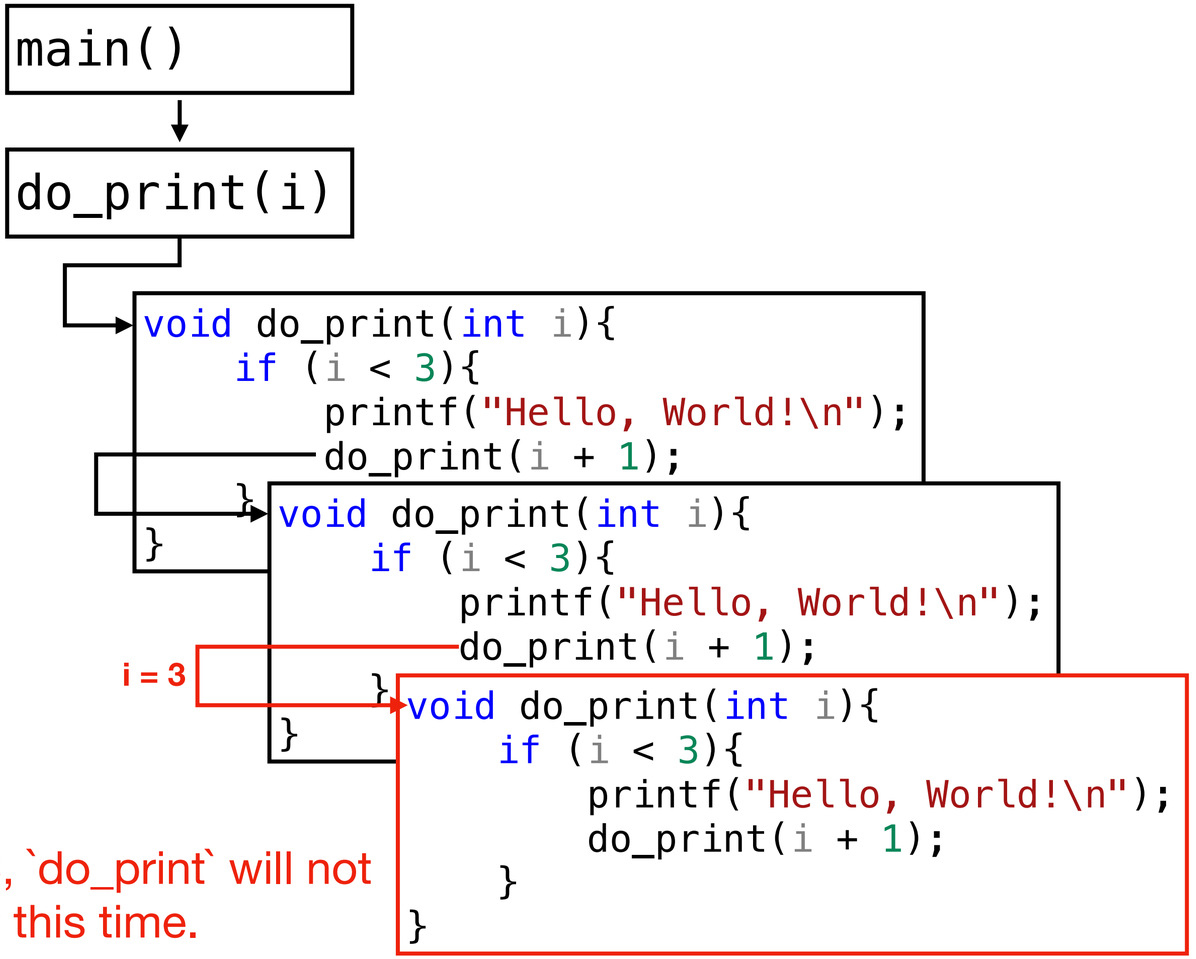
```c
#include <stdio.h>
void do_print(int i){
    if (i < 3){
        printf("Hello, World!\n");
        do_print(i + 1);
    }
}
int main(void){
    int i = 0;
    do_print(i);
    return 0;
}
```



[Illustration] Recursion (finite version)

C-course-materials/05-Functions-2/finite_recursion.c

```c
#include <stdio.h>
void do_print(int i){
    if (i < 3){
        printf("Hello, World!\n");
        do_print(i + 1);
    }
}
int main(void){
    int i = 0;
    do_print(i);
    return 0;
}
```



Because i == 3, `do_print` will not be executed at this time.

Practical Examples of Recursion

[Example Problem] Factorial

Write a program that takes a positive integer n and outputs its factorial:

$$n! = n \times (n-1) \times (n-2) \times \ldots \times 2 \times 1$$

- Input

```
5
```

- Output

```
120
```

Factorial with while

C-course-materials/05-Functions-2/factorial_while.c

```c
#include <stdio.h>
int do_factorial(int n){
    int ans = 1;
    while (n > 0){
        ans *= n;
        n--;
    }
    return ans;
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
}
```

[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c

```
main()
```

Start →

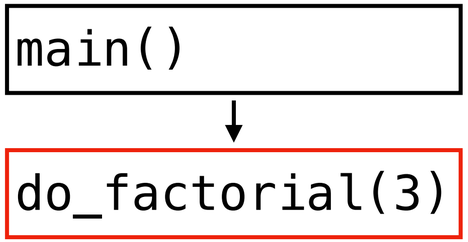
```c
#include <stdio.h>
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
    return 0;
}
```

[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c

```c
#include <stdio.h>
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
    return 0;
}
```

Now

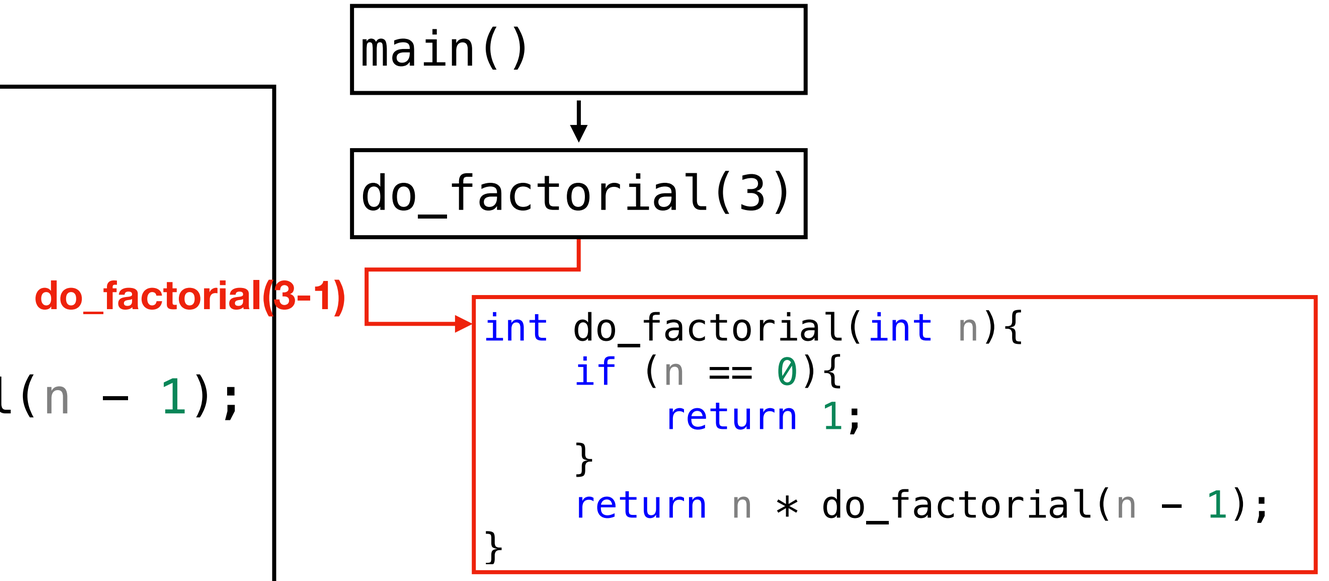


[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c

```c
#include <stdio.h>
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
    return 0;
}
```

Now

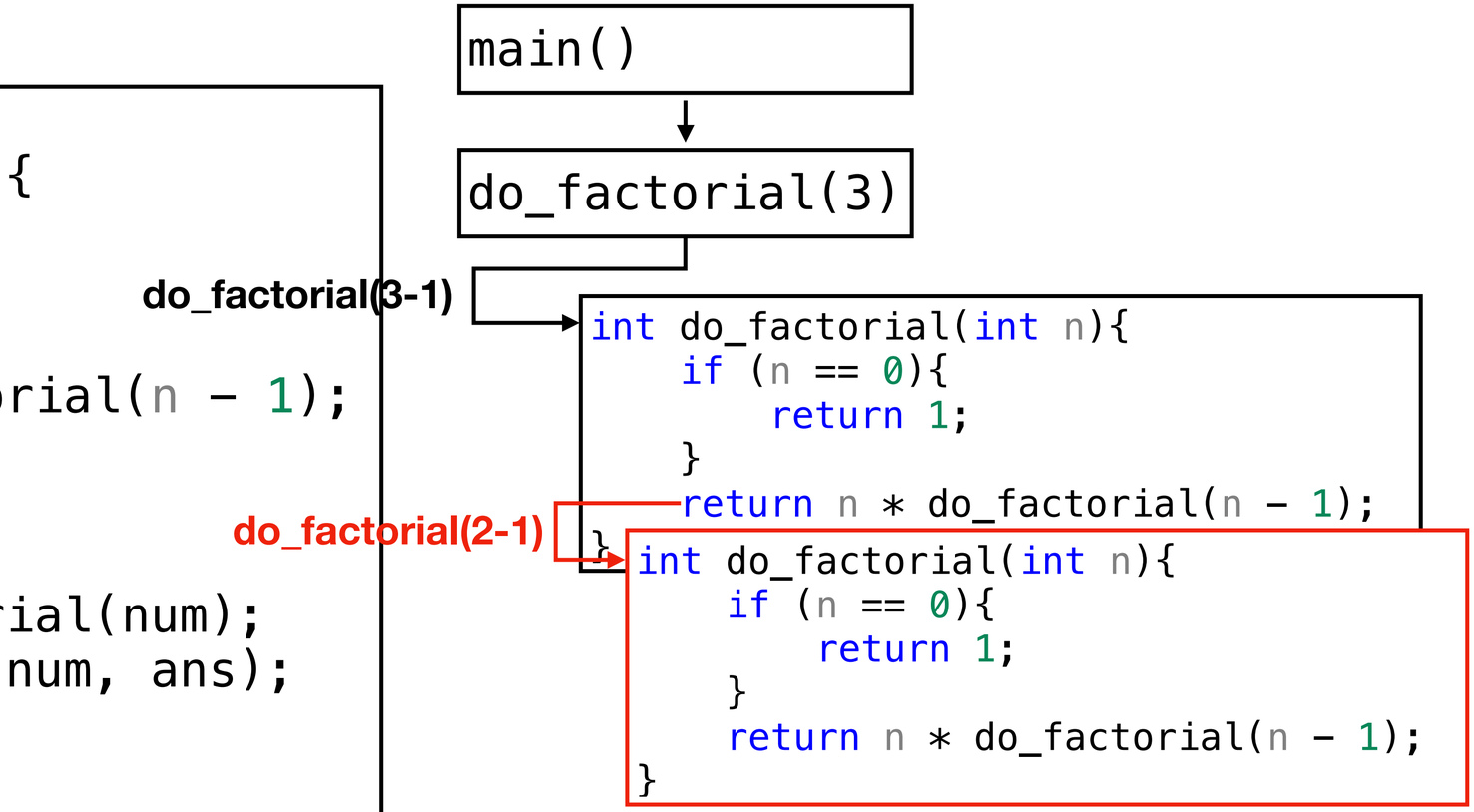


[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c

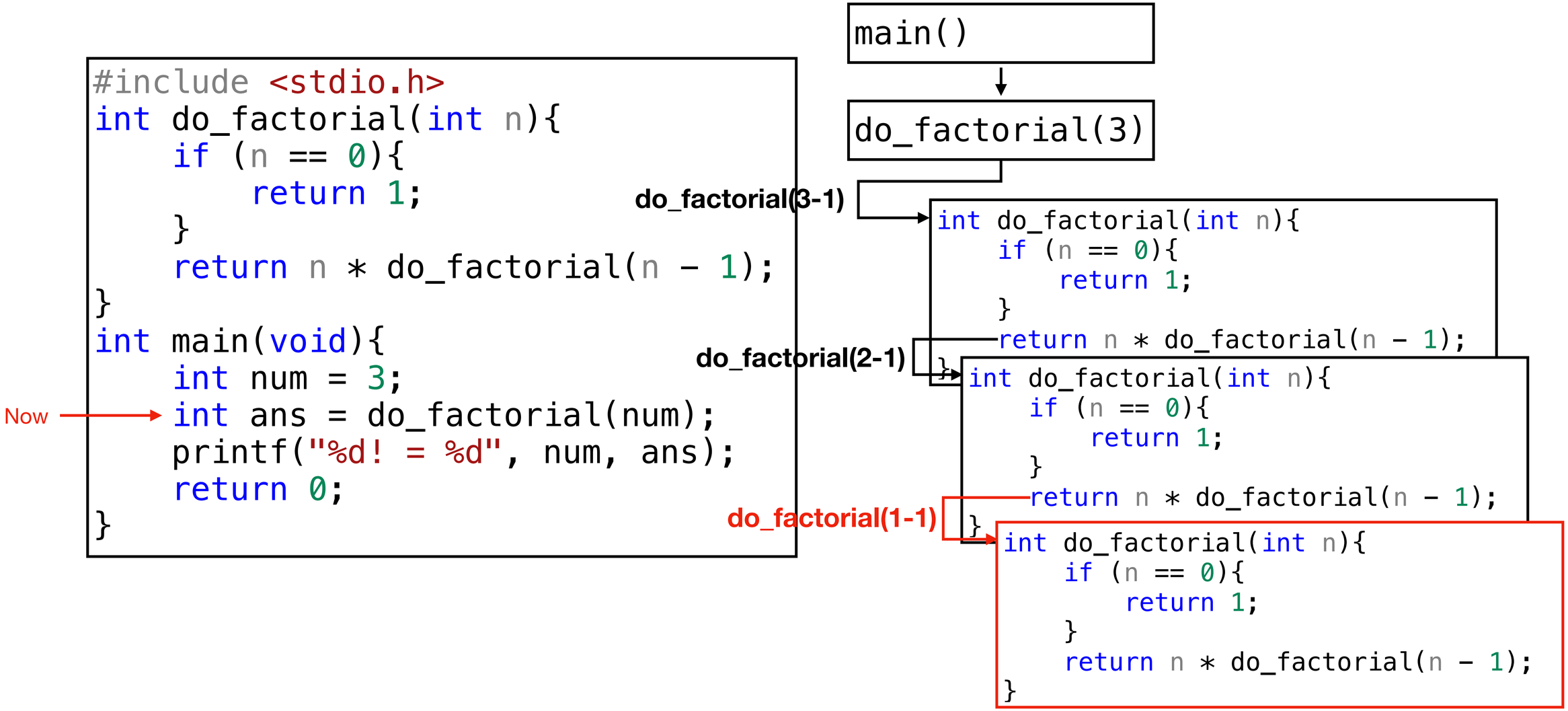
```c
#include <stdio.h>
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
    return 0;
}
```

Now



[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c



[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c

```c
#include <stdio.h>
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
    return 0;
}
```

Now

main()

do_factorial(3)

do_factorial(3-1)

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

do_factorial(2-1)

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

do_factorial(1-1)

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c

```c
#include <stdio.h>
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
    return 0;
}
```

Now

main()

do_factorial(3)

do_factorial(3-1)

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

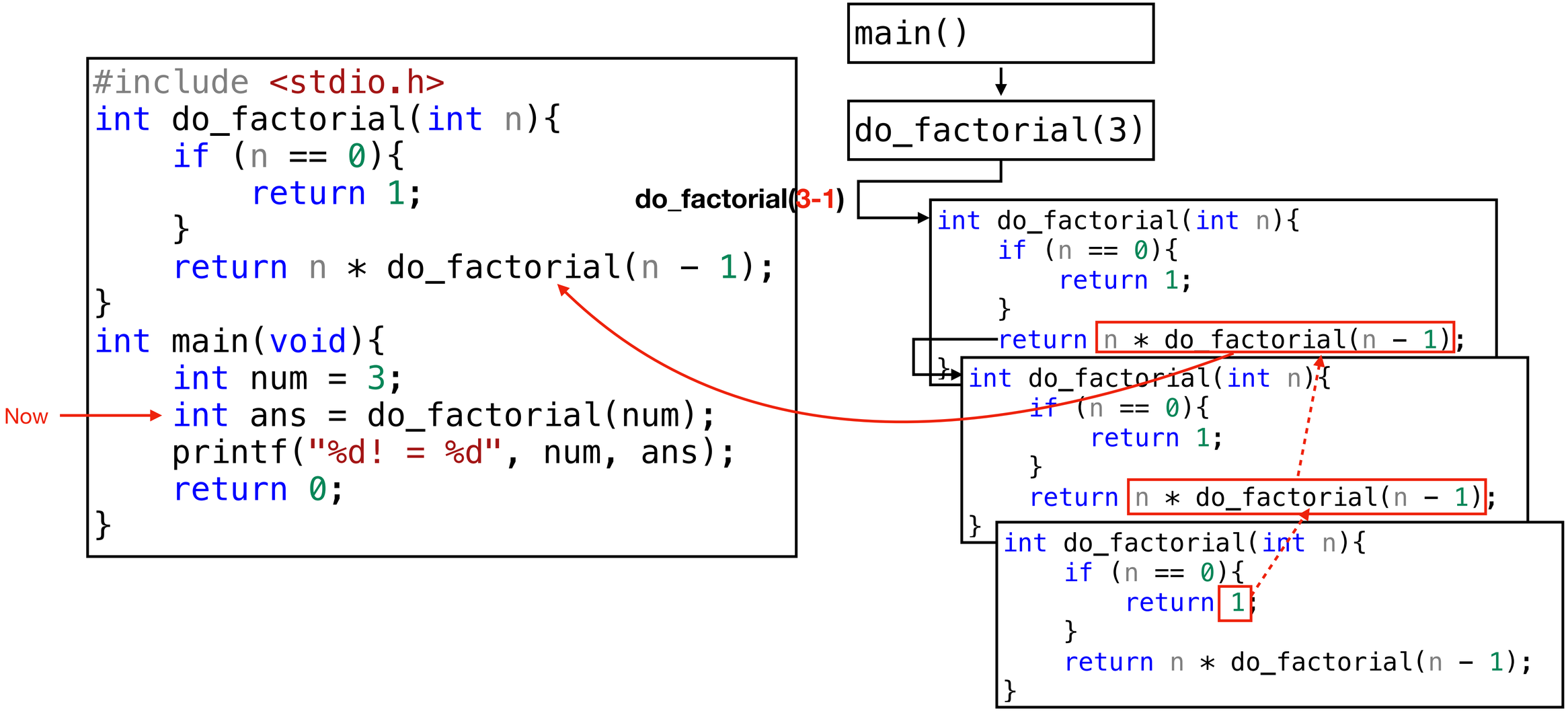
do_factorial(2-1)

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c



[Illustration] Factorial with recursion

C-course-materials/05-Functions-2/factorial.c

```c
#include <stdio.h>
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
int main(void){
    int num = 3;
    int ans = do_factorial(num);
    printf("%d! = %d", num, ans);
    return 0;
}
```

Now

3

do_factorial(3-1)

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

2 1

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

```c
int do_factorial(int n){
    if (n == 0){
        return 1;
    }
    return n * do_factorial(n - 1);
}
```

main()

do_factorial(3)

Ans: 3! = 6

[Example Problem] Fibonacci Numbers

Write a program that accepts an input N and prints the N-th Fibonacci number

$$fib(i) = \begin{cases} 0, & i = 0 \\ 1, & i = 1 \\ fib(i-1) + fib(i-2), & i > 1 \end{cases}$$

$fib(i)$	0	1	1	2	3	5	8	…
Index	0	1	2	3	4	5	6	

Fibonacci Numbers with while

C-course-materials/05-Functions-2/fibonacci_while.c

```c
int fibonacci(int n) {
    if (n == 0)
        return 0;
    if (n == 1)
        return 1;

    int a = 0, b = 1; // a = Fib(0), b = Fib(1)
    int fib = 0;
    int count = 2; // start from 2

    while (count <= n) {
        fib = a + b;  // for current n, fib = a + b
        a = b;        // Update a
        b = fib;      // Update b
        count++;
    }
    return fib;
}
```

[Illustration] Fibonacci Numbers with recursion

C-course-materials/05-Functions-2/fibonacci.c

```
#include <stdio.h>

int fib(int n) {
    if (n == 0) {
        return 0;
    } else if (n == 1) {
        return 1;
    } else {
        return fib(n - 1) + fib(n - 2);
    }
}
int main() {
    int n = 3;
    printf("Fib is: %d", n, fib(n));
    return 0;
}
```

Start

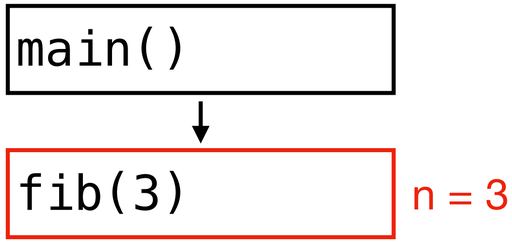
```
main()
```

[Illustration] Fibonacci Numbers with recursion

C-course-materials/05-Functions-2/fibonacci.c

```c
#include <stdio.h>

int fib(int n) {
    if (n == 0) {
        return 0;
    } else if (n == 1) {
        return 1;
    } else {
        return fib(n - 1) + fib(n - 2);
    }
}
int main() {
    int n = 3;
    printf("Fib is: %d", n, fib(n));
    return 0;
}
```

Now →



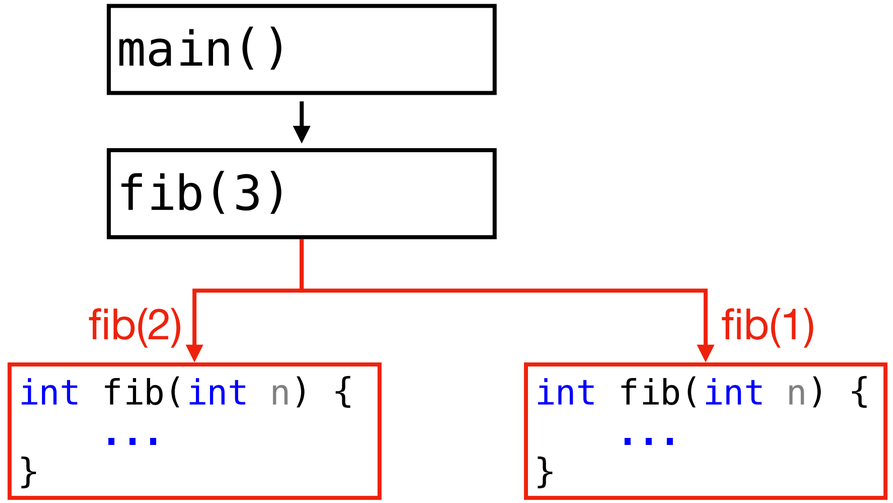
[Illustration] Fibonacci Numbers with recursion

C-course-materials/05-Functions-2/fibonacci.c

```c
#include <stdio.h>

int fib(int n) {
    if (n == 0) {
        return 0;
    } else if (n == 1) {
        return 1;
    } else {
        return fib(n - 1) + fib(n - 2);
    }
}
int main() {
    int n = 3;
    printf("Fib is: %d", n, fib(n));
    return 0;
}
```

Now → `return fib(n - 1) + fib(n - 2);`

Now → `printf("Fib is: %d", n, fib(n));`



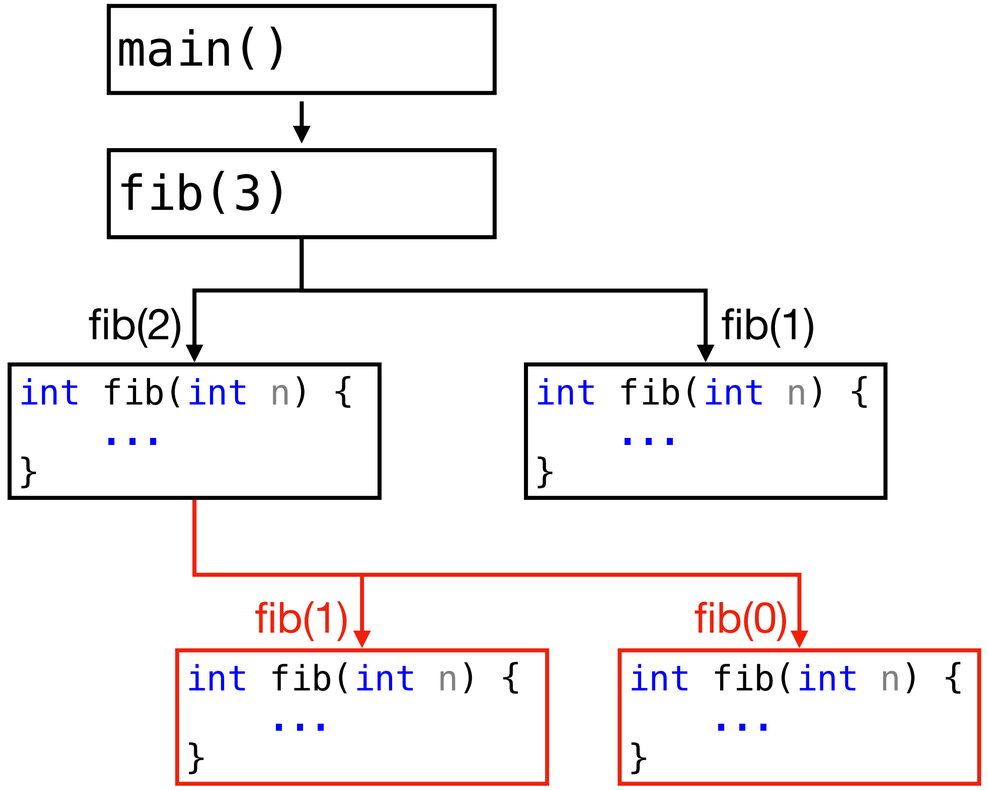
[Illustration] Fibonacci Numbers with recursion

C-course-materials/05-Functions-2/fibonacci.c

```c
#include <stdio.h>

int fib(int n) {
    if (n == 0) {
        return 0;
    } else if (n == 1) {
        return 1;
    } else {
        return fib(n - 1) + fib(n - 2);
    }
}
int main() {
    int n = 3;
    printf("Fib is: %d", n, fib(n));
    return 0;
}
```

Now

Now



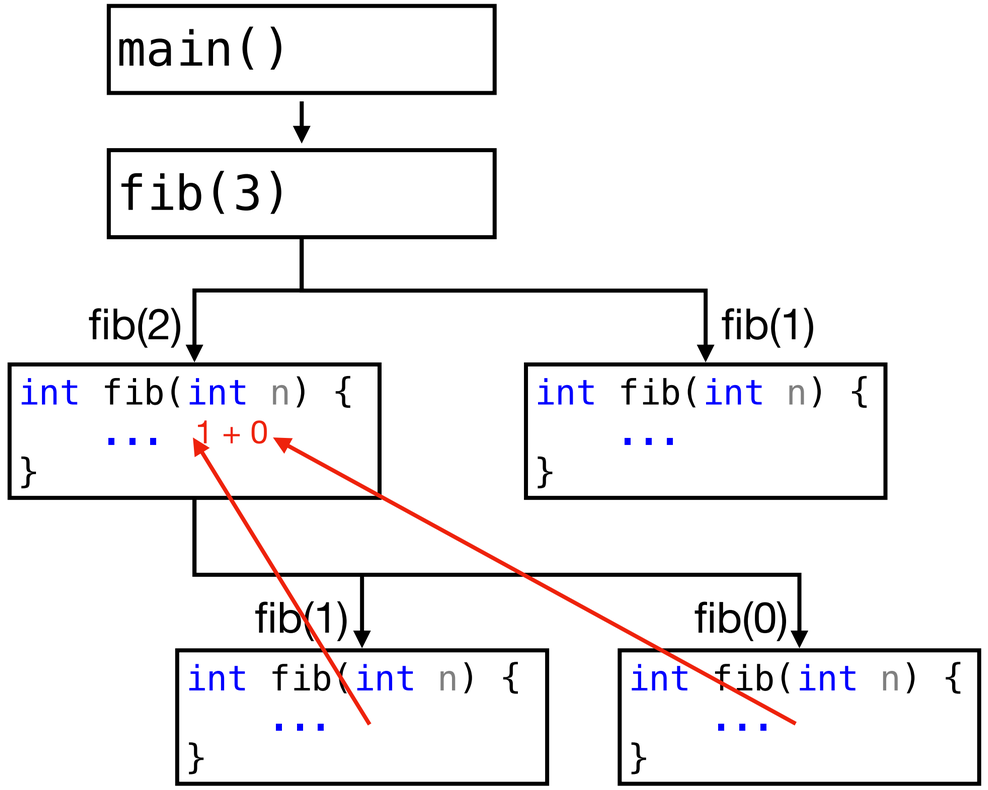
[Illustration] Fibonacci Numbers with recursion

C-course-materials/05-Functions-2/fibonacci.c

```c
#include <stdio.h>

int fib(int n) {
    if (n == 0) {
        return 0;
    } else if (n == 1) {
        return 1;
    } else {
        return fib(n - 1) + fib(n - 2);
    }
}
int main() {
    int n = 3;
    printf("Fib is: %d", n, fib(n));
    return 0;
}
```

Now

Now



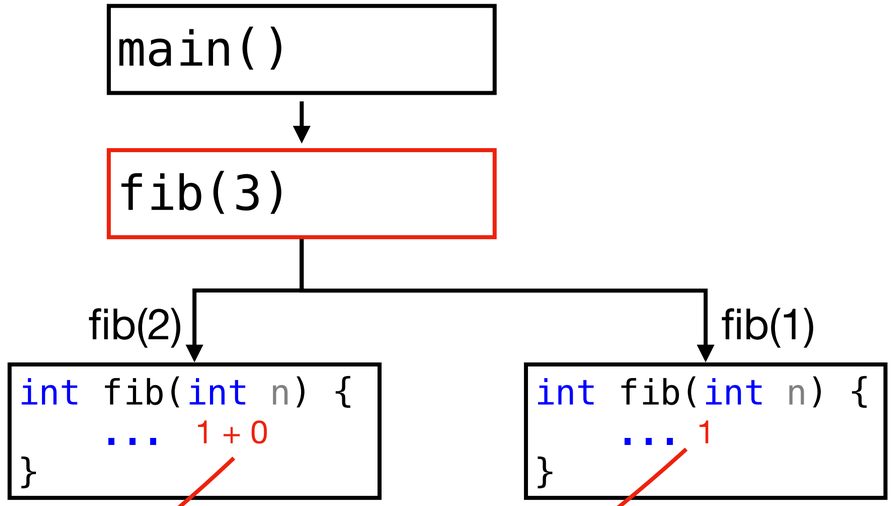
[Illustration] Fibonacci Numbers with recursion

C-course-materials/05-Functions-2/fibonacci_while.c

```c
#include <stdio.h>

int fib(int n) {
    if (n == 0) {
        return 0;
    } else if (n == 1) {
        return 1;
    } else {
        return fib(n - 1) + fib(n - 2);
    }
}
int main() {
    int n = 3;
    printf("Fib is: %d", n, fib(n));
    return 0;
}
```

Now → `return fib(n - 1) + fib(n - 2);`

Now → `printf("Fib is: %d", n, fib(n));`



Ans: fib(3) = 2

Greatest Common Divisor (GCD)

C-course-materials/05-Functions-2/gcd_while.c
C-course-materials/05-Functions-2/gcd.c

```c
int gcd(int a, int b) {
    int temp;
    while (b != 0) {
        temp = a % b;
        a = b;
        b = temp;
    }
    return a;
}
```

```c
int gcd(int a, int b) {
    if (b != 0) {
        return gcd(b, a % b);
    } else {
        return a;
    }
}
```

[Important Notes] Recursion

- Recursion is not an algorithm. Instead, it is a technique to solve a big question from smaller pieces.
- Usually, you can write code using loops instead of recursion, but recursion brings the **simplicity** and an **easier implementation** way for algorithms like Breadth-First Search (BFS), Depth-First Search (DFS), and so on.

[Notes] Recursion LeetCode Problems

- 70. Climbing Stairs
- 1137. N-th Tribonacci Number

Lifetime of C Variables

Outline

- Local variable (區域變數)
- Global variable (全域變數)
- Static variable (靜態變數)

[Illustration] Local vs. Global variables

C-course-materials/compare_local_global.c

Global variable

Local variable

```c
#include <stdio.h>
int globalVar = 100;

void do_print(void){
    printf("Global variable: %d\n", globalVar);
    // printf("Local variable: %d\n", localVar); // will cause an error
}

int main(void){
    int localVar = 0;
    printf("Global variable: %d\n", globalVar);
    do_print();
}
```

[Definition] Global variable

- The declaration of a global variable is outside any function in a program.
- In this way, all functions or code blocks in a program can use the global variable.

Scope of a Global Variable

C-course-materials/compare_local_global.c

Scope:
the whole
program

```c
#include <stdio.h>
int globalVar = 100;

void do_print(void){
    printf("Global variable: %d\n", globalVar);
    // printf("Local variable: %d\n", localVar); // will cause an error
}

int main(void){
    int localVar = 0;
    printf("Global variable: %d\n", globalVar);
    do_print();
}
```

[Definition] Local Variable

- Declaring a variable inside a function definition (including the main function) makes the variable name **local** to the code block.
- Life of a local variable:
  - Each variable's storage exists only from the declaration to the end of the block
  - Execution of the declaration allocates the storage, computes the initial value, and stores it in the variable. The end of the block deallocates the storage.

Scope of a Local Variable (1)

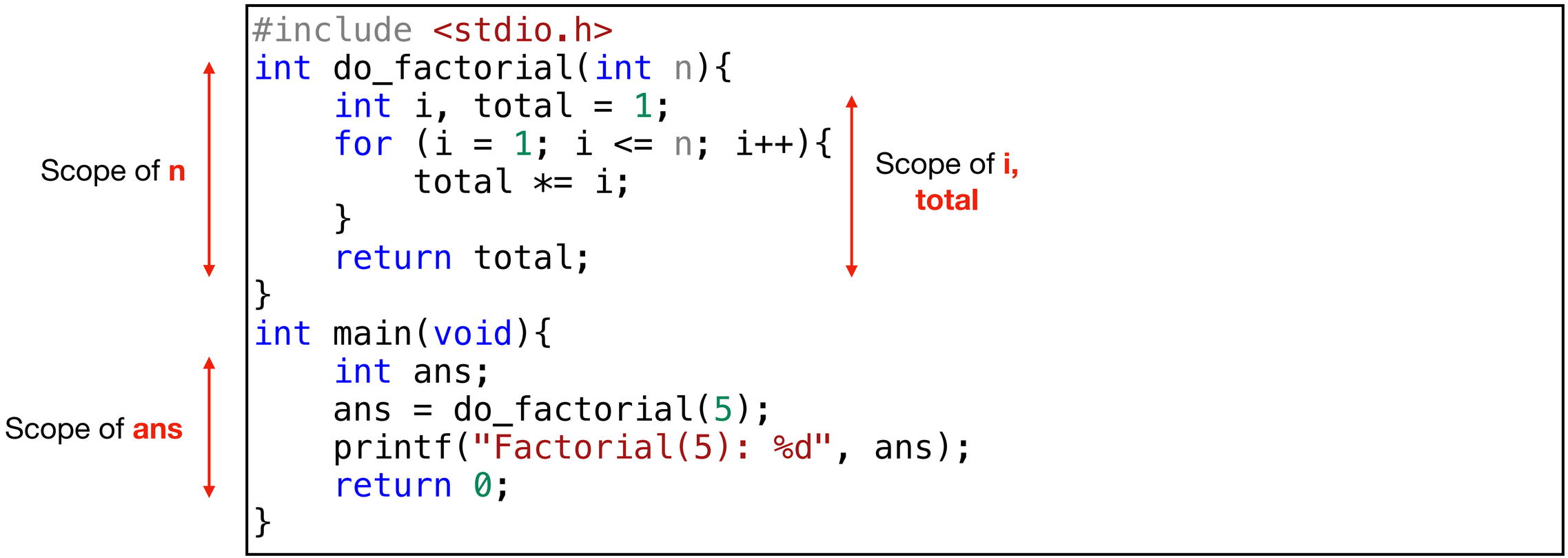
C-course-materials/compare_local_global.c

Scope: within the function

```c
#include <stdio.h>
int globalVar = 100;

void do_print(void){
    printf("Global variable: %d\n", globalVar);
    // printf("Local variable: %d\n", localVar); // will cause an error
}

int main(void){
    int localVar = 0;
    printf("Global variable: %d\n", globalVar);
    do_print();
}
```

Scope of a Local Variable (2)

C-course-materials/local_var_scope.c




```c
#include <stdio.h>
int do_factorial(int n){
    int i, total = 1;
    for (i = 1; i <= n; i++){
        total *= i;
    }
    return total;
}
int main(void){
    int ans;
    ans = do_factorial(5);
    printf("Factorial(5): %d", ans);
    return 0;
}
```

[Definition] static variable

- The declaration of a global variable is outside any function in a program.
- In this way, all functions or code blocks in a program can use the global variable.

Example to use a static local variable

C-course-materials/05-Functions/static_local.c

`sum` is a static local variable.

```c
#include <stdio.h>
int add(int a, int b){
    static int sum = 0;
    sum += (a + b);
    return sum;
}
int main(void){
    int num_a = 5;
    int num_b = 6;
    int result;
    for (int i = 0; i < 5; i++){
        result = add(num_a, num_b);
        printf("Sum: %d\n", result);
    }
}
```

`sum` is a local variable.

```c
#include <stdio.h>
int add(int a, int b){
    int sum = 0;
    sum += (a + b);
    return sum;
}
int main(void){
    int num_a = 5;
    int num_b = 6;
    int result;
    for (int i = 0; i < 5; i++){
        result = add(num_a, num_b);
        printf("Sum: %d\n", result);
    }
}
```

[Notes] static variable

The **static** keyword can control:

1. **Life cycle of a variable**
   - A `static` variable declared inside a function retains its value across function calls and remains in memory until the program ends.
2. **External Linkage**
   - A `static` **global** variable or function is accessible only within the file where it is declared (often called “file scope”).
   - (We will not go into detail on this today.)