COMPUTER SYSTEMS AND ORGANIZATION

Function Pointers II

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ENGINEERING

1. Function Pointers (Review)
2. Writing functions that return function pointers
3. Type Def Function Pointers
4. Structs And Function Pointers
5. Places where function pointers show up all the time.

FUNCTION POINTERS REVIEW

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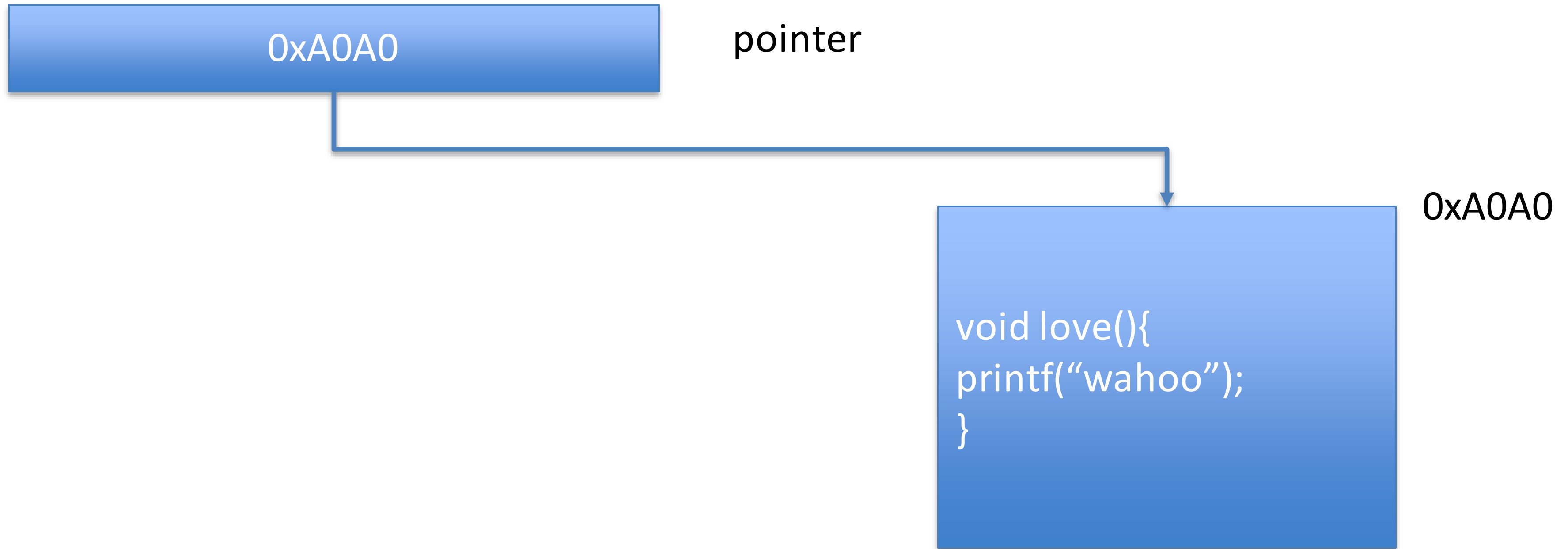
WHAT IS A FUNCTION POINTER



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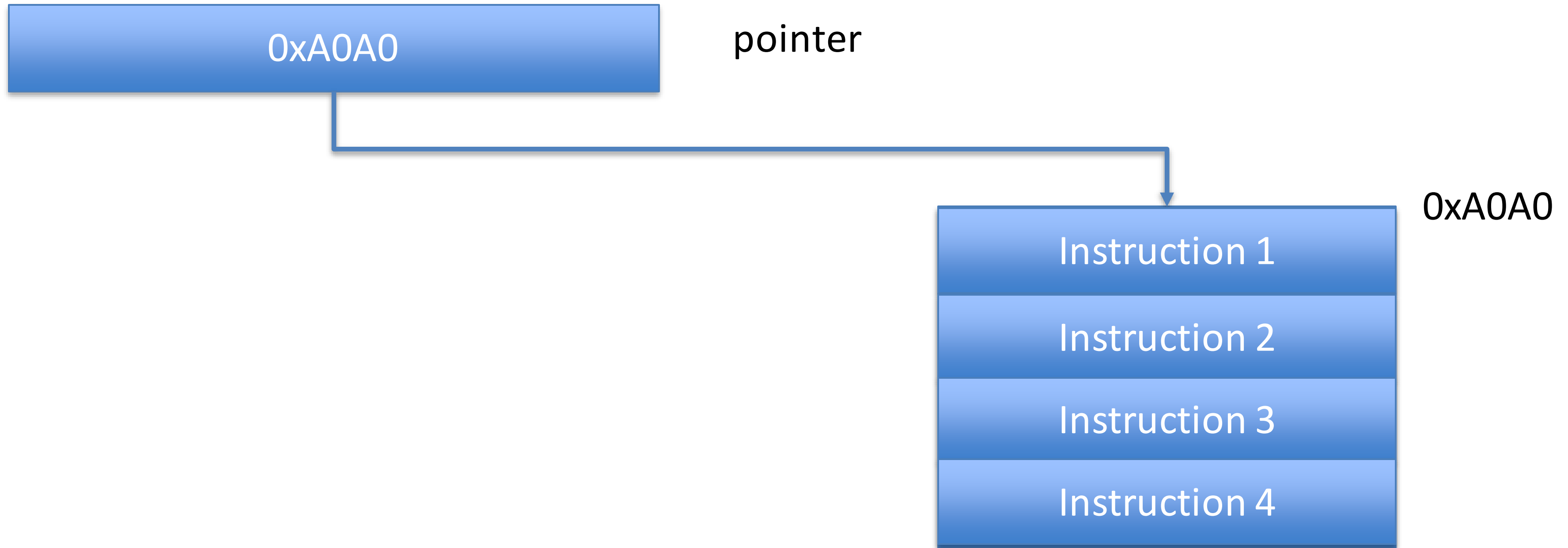
WHAT IS A FUNCTION POINTER



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GENERAL FORM

```
[return type] (*[name])([parameters])
```


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ASSIGNING A FUNCTION POINTER

```
float div(int a, int b){
    return (float)a/(float)b;
}
int main(){
    float (*ptr) ( int, int);
    ptr = &div;
}
```


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USING FUNCTION PTR

```
float div(int a, int b)
{
    return ((float)a)/b;
}
```

```
int main(){
    float (*ptr) ( int, int);
    ptr = &div;
    float result = (*ptr)(10,20);
    printf(“%f”, result);
}
```


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USING FUNCTION PTR

```
float div(int a, int b)
{
    return ((float)a)/b;
}
```

```
int main(){
    float (*ptr) ( int, int);
    ptr = &div;
    float result = (*ptr)(10,20);
    printf(“%f”, result);
}
```

We don't need &. It is optional for function names since names already represent address.

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USING FUNCTION PTR

```
float div(int a, int b)
{
    return ((float)a)/b;
}
```

```
int main(){
    float (*ptr) ( int, int);
    ptr = div;
    float result = (*ptr)(10,20);
    printf(“%f”, result);
}
```

This is valid C code

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USING FUNCTION PTR

```
float div(int a, int b)
{
    return ((float)a)/(b;
}
```

```
int main(){
    float (*ptr) ( int, int);
    ptr = div;
    float result = (*ptr)(10,20);
    printf("%f", result);
}
```

We don't need * or the parentheses. They are also optional.

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USING FUNCTION PTR

```
float div(int a, int b)
{
    return ((float)a)/b;
}
```

```
int main(){
    float (*ptr) ( int, int);
    ptr = div;
    float result = ptr(10,20);
    printf("%f", result);
}
```

This is also valid c

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ALTERNATIVE

```
float div(int a, int b)
{
    return ((float)a)/b;
}
```

```
int main(){
    float (*ptr) ( int, int);
    ptr = div;
    float result = ptr(10,20);
    printf(“%f”, result);
}
```


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REVIEW OF RIGHT-LEFT RULE

Write an “English” description of the following declaration.

```
int (*(*fun_one)(char *,double))[9][20];
```

Removed parameters to make it easier to read

```
int (*(*fun_one)())[9][20];
```

"fun_one is pointer to function expecting (char *,double) and returning pointer to array (size 9) of array (size 20) of int."

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NORMAL FUNCTIONS

Return type

```
float div(int x, int y ){
    return ((float)x)/y;
}
```


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NORMAL FUNCTIONS

Identifier

```
float div(int x, int y ){
    return ((float)x)/y;
}
```


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BUT FUNCTION POINTERS HAVE THE IDENTIFIER IN THE "MIDDLE"

Identifier

```
float (*return_func)(int, int)
```

Return type

Parameter info

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WRITING FUNCTIONS THAT RETURN FUNCTION POINTERS

```
float div(int x, int y ){
    return ((float)x)/y;
}

float (*return_func())(int, int) {
    return div;
}
```

Here is example of function that returns function pointer.

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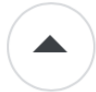
FUNCTION TYPE

Returning function pointer type

Asked 9 years, 11 months ago Modified 1 year, 5 months ago Viewed 69k times



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Often I find the need to write functions which return function pointers. Whenever I do, the basic format I use is:

```
typedef int (*function_type)(int,int);

function_type getFunc()
{
   function_type test;
   test /* = ...*/;
   return test;
}
```

They go on to ask the format that we discussed in the previous slides.

LET'S TALK ABOUT TYPEDEF WITH FUNCTION POINTERS

```
typedef float (*function_type)(int, int);

function_type returnDivider(){
    return div;
}
```


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LET'S TALK ABOUT TYPEDEF WITH FUNCTION POINTERS

```
typedef float (*divfunc)(int, int);
```

Identifier

Identifier

```
divfunc returnDivider(){
    return div;
}
```


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WE CAN ALSO TYPE FUNCTION

```
typedef float (*divfunc)(int, int);
```

Identifier

Identifier

```
divfunc returnDivider(){
    return div;
}
```


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```
#include <stdio.h>
void myfunction(); //Function prototype

struct MyStruct{
     void (*funcPtr)();
};

void myFunction(){
     printf("Hello from the inside");
}
int main(){
     struct MyStruct example;
     example.funcPtr = myFunction;
     example.funcPtr();
     return 0;
}
```

EXAMPLE 1

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EXAMPLE 2

```
#include <stdio.h>

void onSuccess();
void onError();

struct MyStruct{
	void(*successCallback)();
	void(*errorCallback)();
}

void onSuccess(){
	printf(“Success operation Completed\n”);
}
void onError(){
	printf(“An error occurred. \n”);
}
```

```
void performOperation(struct MyStruct
callbacks, int fail){
	if (!fail){
		callbacks.successCallback();
	}else{
		callbacks.errorCallback();
	}

}

int main(){
	struct MyStruct callbacks;
	callbacks.successCallback = onSuccess;
	callbacks.errorCallback = onError;
	performOperation(callbacks, 1);
	return 0;
}
```


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ENUMS

In C, an enum (short for "enumeration") is a user-defined data type that consists of a set of named integer constants. Enums are used to define a list of named values that represent a finite set of possible values for a variable.

```
enum Name{
    Constant 1,
    Constant 2,
    …
}
```


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ENUMS

```
#include <stdio.h>

enum Day {SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, SATURDAY};

int main() {
     enum Day today;
     today = WEDNESDAY;

    if (today == WEDNESDAY) {
        printf("It's the middle of the week.\n");
    }

    return 0;
}
```

The first element in the array is implicitly assigned the value 0

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ENUMS

```
enum Month {
    January = 1,
    February,
    March,
    April,
    May,
    June,
    July,
    August,
    September,
    October,
    November,
    December
};

int main() {
    enum Month birthMonth;
    birthMonth = April;
    return 0;
}
```

The value of January is explicitly set to 1, and the subsequent months are automatically assigned values incrementing by 1. birth Month is set to April, which would have the value 4

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ENUMS

```
enum Direction {
    Up,
    Down,
    Left,
    Right
};

void move(enum Direction dir) {
    switch (dir) {
        case Up:
            // Move up
            break;
        case Down:
            // Move down
            break;
        case Left:
            // Move left
            break;
        case Right:
            // Move right
            break;
    }
}

}
```

```
int main() {
    move(Left);
    return 0;
}
```

Enums make code more readable use them.

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VOLATILE AND EXTERN KEY WORDS

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VOLATILE

```
volatile int flag = 0;

void interrupt_handler() {
    // This could be an interrupt handler
    flag = 1;
}

int main() {
    while (!flag) {
        // Waiting for the flag to be set by
the interrupt
    }
    // Proceed once the flag is set
    return 0;
}
```


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EXTERN

```
// In some other file, let's say 'file1.c'
int count = 5;

// In the current file
extern int count;

int main() {
    // Now count can be used here
    printf("Count is %d\n", count);
    return 0;
}
```

The extern keyword is used to declare a variable or a function that has external linkage, meaning it is defined in another file or later in the same file. It's a way of declaring the existence of a variable or function without actually creating it.

Prints: “Count is 5”

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STYLE GUIDES AND MORE

https://google.github.io/styleguide/cppguide.html

If you are writing in C++ use smart pointers instead of pointers when ever you can.

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DON’T WORRY, POINTERS HAVE BEEN IMPROVED. WE NOW HAVE SMART POINTERS.

USE SMART POINTERS INSTEAD.

ONLY AVAILABLE IN C++

BIT FIELDS IN C

```
struct
{
    data_type member_name : width_of_bit-field;
};
```

data_type: int, signed int, or unsigned int.

member_name: the name of the bit field.

width_of_bit-field: The number of bits in the bit-field. The width must be less than or equal to the bit width of the specified type

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BIT FIELDS

```
struct date {
    unsigned int d;
    unsigned int m;
    unsigned int y;
};

int main()
{
    // printing size of structure
    printf("Size of date is %lu bytes\n", aizeof(struct date));
    struct date dt = { 31, 12, 2014 };
    printf("Date is %d/%d/%d", dt.d, dt.m, dt.y);
}
```

```
Size of date is 12 bytes
Date is 31/12/2014
```

BIT FIELDS

```
struct date {
    unsigned int d;
    unsigned int m;
    unsigned int y;
};

int main()
{
    // printing size of structure
    printf("Size of date is %lu bytes\n",
        sizeof(struct date));
    struct date dt = { 31, 12, 2014 };
    printf("Date is %d/%d/%d", dt.d, dt.m, dt.y);
}
```

```
Size of date is 12 bytes
Date is 31/12/2014
```


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BIT FIELDS

```
/ Space optimized representation of the date
struct date {
   // d has value between 0 and 31, so 5 bits are sufficient
   int d : 5;
   // m has value between 0 and 15, so 4 bit are sufficient
   int m : 4;
   int y;
};
int main(){
   printf("Size of date is %lu bytes\n",
        sizeof(struct date));
   struct date dt = { 31, 12, 2014 };
   printf("Date is %d/%d/%d", dt.d, dt.m, dt.y);
   return 0;
}
```

Oh No :(

Size of date is 8 bytes

Date is -1/-4/2014

11111 – Most significant bit is 1 so we have a negative number. (two complement)

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THE FIX

```
/ Space optimized representation of the date
struct date {
   // d has value between 0 and 31, so 5 bits are sufficient
   unsigned int d : 5;
   // m has value between 0 and 15, so 4 bit are sufficient
   unsigned int m : 4;
   int y;
};
int main(){
   printf("Size of date is %lu bytes\n",
          sizeof(struct date));
   struct date dt = { 31, 12, 2014 };
   printf("Date is %d/%d/%d", dt.d, dt.m, dt.y);
   return 0;
}
```

Size of date is 8 bytes

Date is 31/12/2014

No but 8 bytes instead of 5. Why?

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LIMITATION WITH BIT FIELDS

1. We can't have pointers to pointers to bit fields

REF

https://www.geeksforgeeks.org/bit-fields-c/?ref=lbp

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