Programming Fundamental

Week 13 –
Pointer and Array in the C Programming Language

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Weekly Learning Outcomes for Subjects (Sub-CPMK):

Sub-CPMK 0614: Students are able to create simple programs with elements of selection control, repetition control, functions, or procedures, as well as implementing arrays and pointers in the C programming language (C6).

Review

1. Introduction
2. Standard Library
3. Programmer-Defined Functions
4. Recursion

Outline

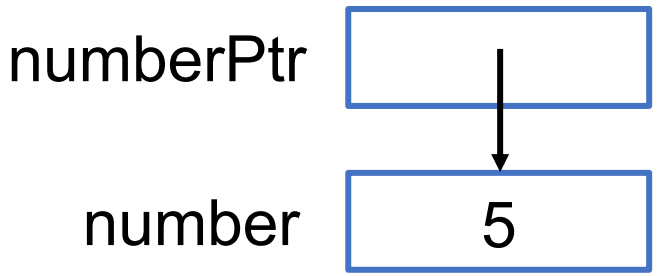
1. Pointer
2. Pointer Operators
3. Array Declaration
4. Array Access

Pointer Variable Definitions & Initialization

- Pointers are variables whose **values are memory addresses**
- A pointer contains **an address of a variable** that contains a specific value
- A variable name directly references a value, but a pointer indirectly references a value

Pointer **numberPtr** indirectly references the value 5

Variable **number** directly contains the value 5



Pointer Variable Definitions & Initialization

- Pointers **must be defined** before they can be used

```
data_type *pointer_name;
```

- Example

```
int *iPtr;
```

- What is the data type of **iPtr** ?

```
int *iPtr;
```

- What is the data type of ***iPtr** ?

```
int *iPtr;
```

Pointer Variable Definitions & Initialization

- Pointers **should be initialized** either when they are defined or in an assignment statement

- A pointer may be initialized to NULL or an address

- **A pointer with the value NULL points to nothing**

Pointer Operators

```
int number = 5;
int *numberPtr;

numberPtr = &number;

printf("%d",*numberPtr);
```

numberPtr	0xFF08	0xFF04
number	5	0xFF08

- The address operator (**&**) returns the address of its operand (variable)
- The **indirection operator**/dereferencing operator (*) **returns the value of the object** to which its operand (pointer) points

Examples

```c
#include <stdio.h>

int main()
{
    int number = 8;
    int *numberPtr;

    numberPtr = &number;

    printf("The address of number is %p\n",&number);
    printf("The value of numberPtr is %p\n",numberPtr);

    return 0;
}
```

F:\pointer.exe

```
The address of number is 0060FF08
The value of numberPtr is 0060FF08

Process returned 0 (0x0)   execution time : 0.001 s
Press any key to continue.
```

Examples

```c
#include <stdio.h>

int main()
{
    int number = 8;
    int *numberPtr;

    numberPtr = &number;

    printf("The value of number is %d\n",number);
    printf("The value of *numberPtr is %d\n",*numberPtr);

    return 0;
}
```

F:\pointer.exe

```
The value of number is 8
The value of *numberPtr is 8

Process returned 0 (0x0)   execution time : 0.016 s
Press any key to continue.
```

Examples

```c
#include <stdio.h>

int main()
{
    int number = 8;
    int *numberPtr;

    numberPtr = &number;

    printf("* and & are complements of each other\n\n");
    printf("&*numberPtr = %p\n",&*numberPtr);
    printf("*&numberPtr = %p\n",*&numberPtr);

    return 0;
}
```

F:\pointer.exe

```
* and & are complements of each other

&*numberPtr = 0060FF0C
*&numberPtr = 0060FF0C

Process returned 0 (0x0)   execution time : 0.016 s
Press any key to continue.
```

Examples

```c
#include <stdio.h>

int main()
{
    int number = 8;
    int *numberPtr;

    numberPtr = &number;

    *numberPtr = number + 7;
    printf("number = %d\n",number);

    return 0;
}
```

F:\pointer.exe

```
number = 15

Process returned 0 (0x0)
execution time : 0.017 s
Press any key to continue.
```

Call by Pointer

```
F:\callbypointer.exe

5! = 120

Process returned 0 (0x0)
execution time : 0.010 s
Press any key to continue.
```

```c
#include <stdio.h>

void factorial(int *n)
{
    int i;

    for(i = *n - 1;i > 1;i--)
    {
        *n *= i;
    }
}

int main()
{
    int number = 5;

    factorial(&number);
    printf("5! = %d\n",number);

    return 0;
}
```

Array Definition

- Array: a group of memory locations → **same name & same type**
- To refer to a particular location or element in the array, we specify the **name** of the array and the **position number** of the particular element in the array
- The first element in every array is the **zeroth (0th) element**
- The position number contained within square brackets ([ ]) is more formally called a **subscript** or **index** → must be an integer or integer expression

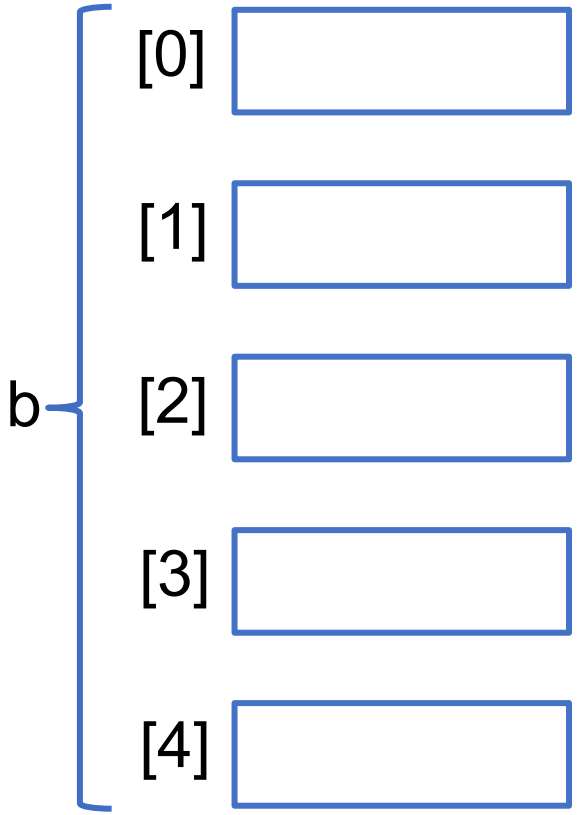
Array Declaration

- Syntax

```
element_data_type array_name[size];
```

- Example

```
int a[100];
int b[5];
```



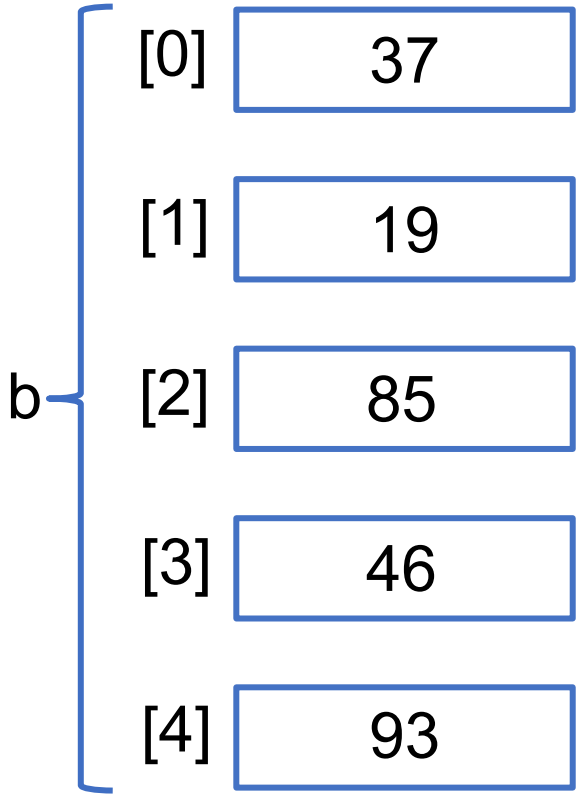
Array Initialization

- Initialization using **for statements**

```
int a[100], i;

for(i = 0;i < 100;i++)
{
      a[i] = 0;
}
```

- Initialization using an **initializer list**

```
int b[5] = {37,19,85,46,93};
```



Array Initialization

- If there are **fewer initializers than elements in the array**, the remaining elements are initialized to zero

```
int a[100] = {0};
```

  - This explicitly initializes the first element to zero and initializes the remaining 99 elements to zero

- If the array size is omitted from a definition with an initializer list, the number of elements in the array will be the number of elements in the initializer list

```
int b[] = {37,19,85,46,93};
```

  - This would **create a five-element array**

Array Access

- Syntax

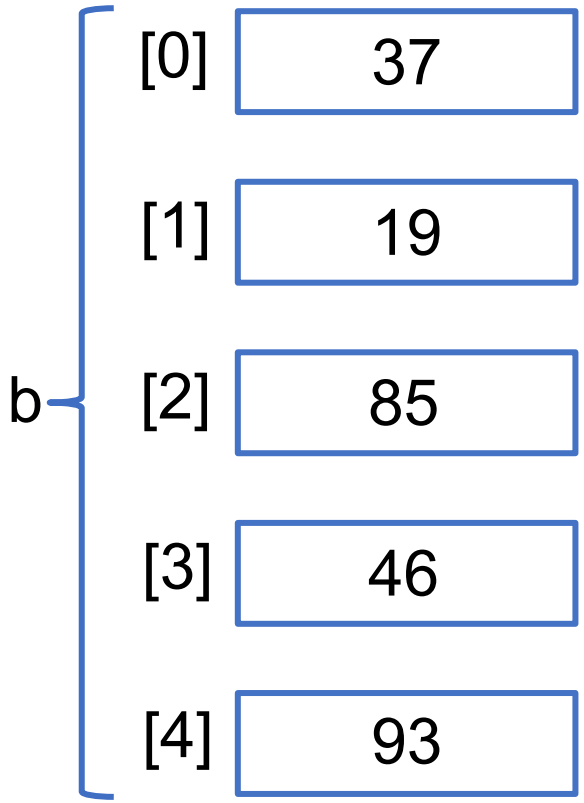
```
array_name[index]
```

- Example
  - How to print 46 ?

```
printf("%d",b[3]);
```

  - How to print 37 ?

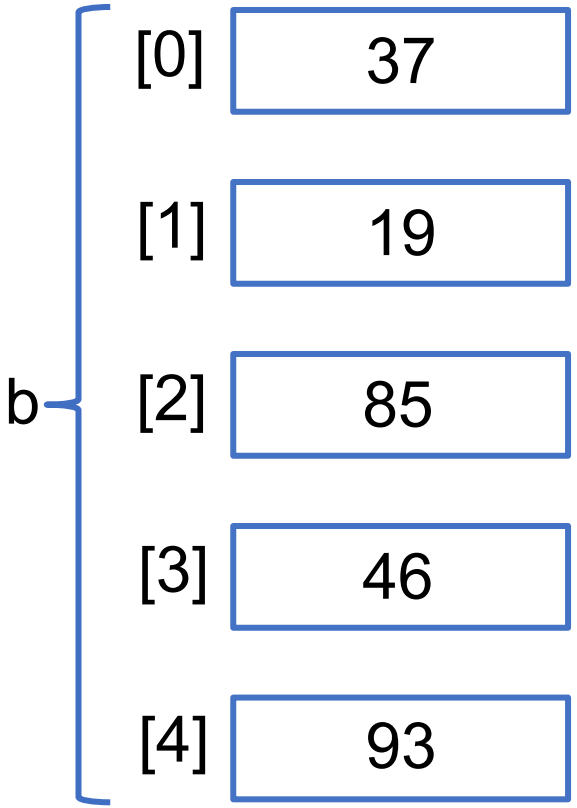
```
printf("%d",b[0]);
```



Array Access

- Using for loops for sequential access

```
int i;

for(i = 0;i < 5;i++)
{
        printf("%d\n",b[i]);
}
```



Practice 1

- What does the following code print?

```c
#include <stdio.h>

void f(int *x, int *y)
{
    *x *= 2;
    *y *= 3;
}

int main()
{
    int a = 25, b = 30;

    f(&a,&b);
    printf("%d %d",a,b);

    return 0;
}
```

Practice 2

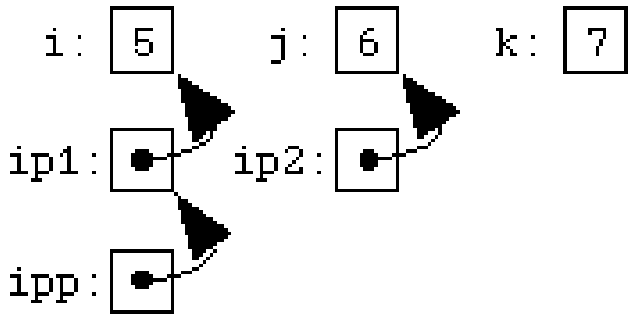
- What does the following code print?

```c
#include <stdio.h>

void swap(int *x, int *y)
{
    int *z;

    z = x;
    x = y;
    y = z;
}

int main()
{
    int a = 25, b = 30;

    swap(&a,&b);
    printf("%d %d",a,b);

    return 0;
}
```

Practice 3

- What does the following code print?

```
int i = 5, j = 6; k = 7;
int *ip1 = &i, *ip2 = &j;
int **ipp = &ip1;
```




```c
#include <stdio.h>

void f(int **x, int **y)
{
    **y *= **x;
}

int main()
{
    int a = 25, b = 30;
    int *aPtr = &a, *bPtr = &b;

    f(&aPtr,&bPtr);
    printf("%d %d",a,b);

    return 0;
}
```

Practice 4

- Write a function
  void sigma(int *n)
  that calculates 1 + 2 + … + n.

```
#include <stdio.h>

void sigma(int *n)
{
    ?
}

int main()
{
    int a = 10;

    sigma(&a);
    printf("Result = %d",a);

    return 0;
}
```

Practice 5

- Write a C program to **display the index of the smallest and the largest numbers in an array** x of **10 integers.** Array x need to be assign values first to each element.

REFERENCES

- Hanly, Jeri R. and Koffman, Elliot B., 2013, Problem Solving and Program Design in C, Seventh Edition, Pearson Education, Inc.
- Deitel, Paul and Deitel, Harvey, 2016, C How to Program, Eighth Edition, Pearson Education, Inc.

Visi

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