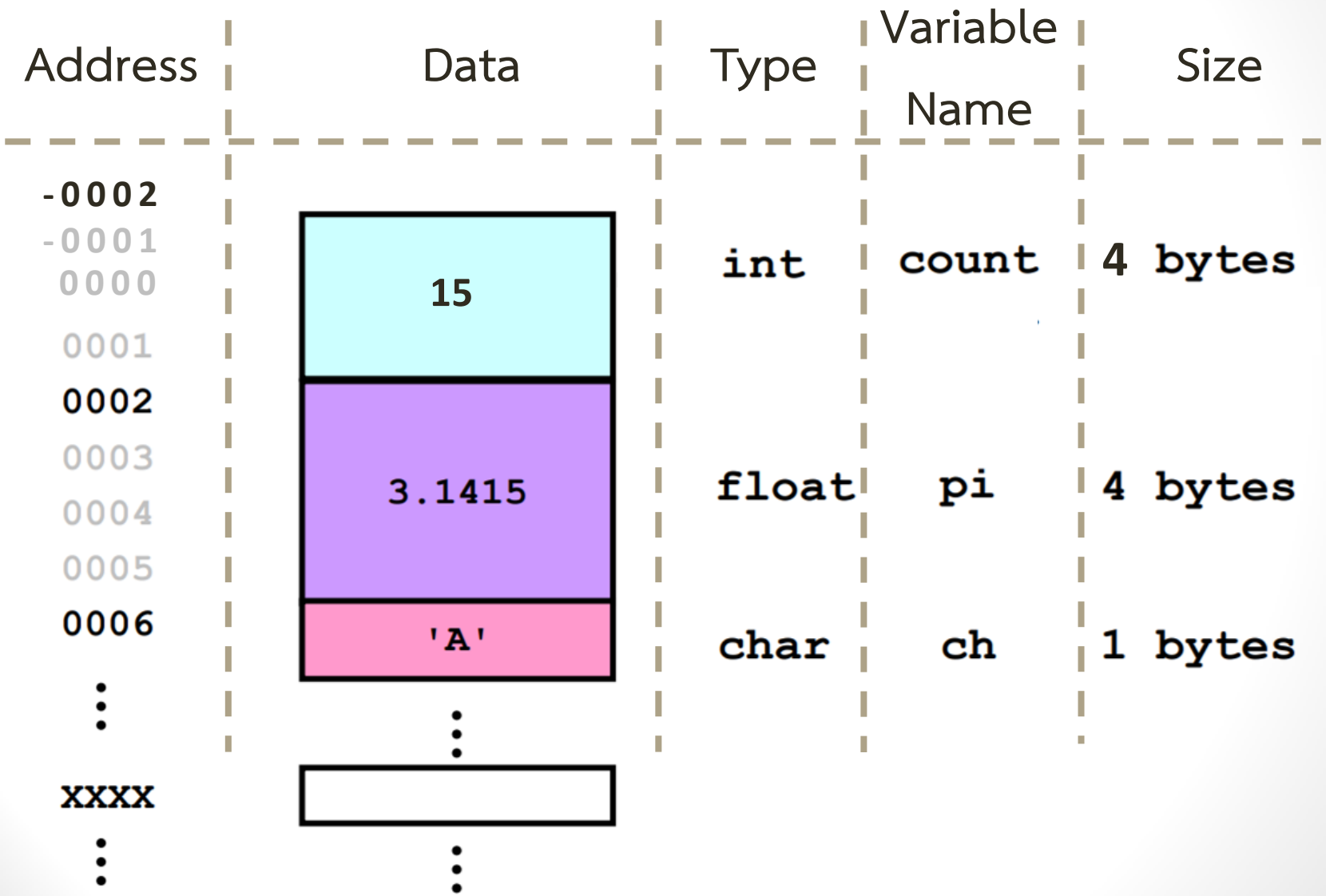
Chapter 8

Pointers 1

Faculty of Engineering KMITL
King Mongkut's Institute of Technology Ladkrabang

Memory and Pointer Structure



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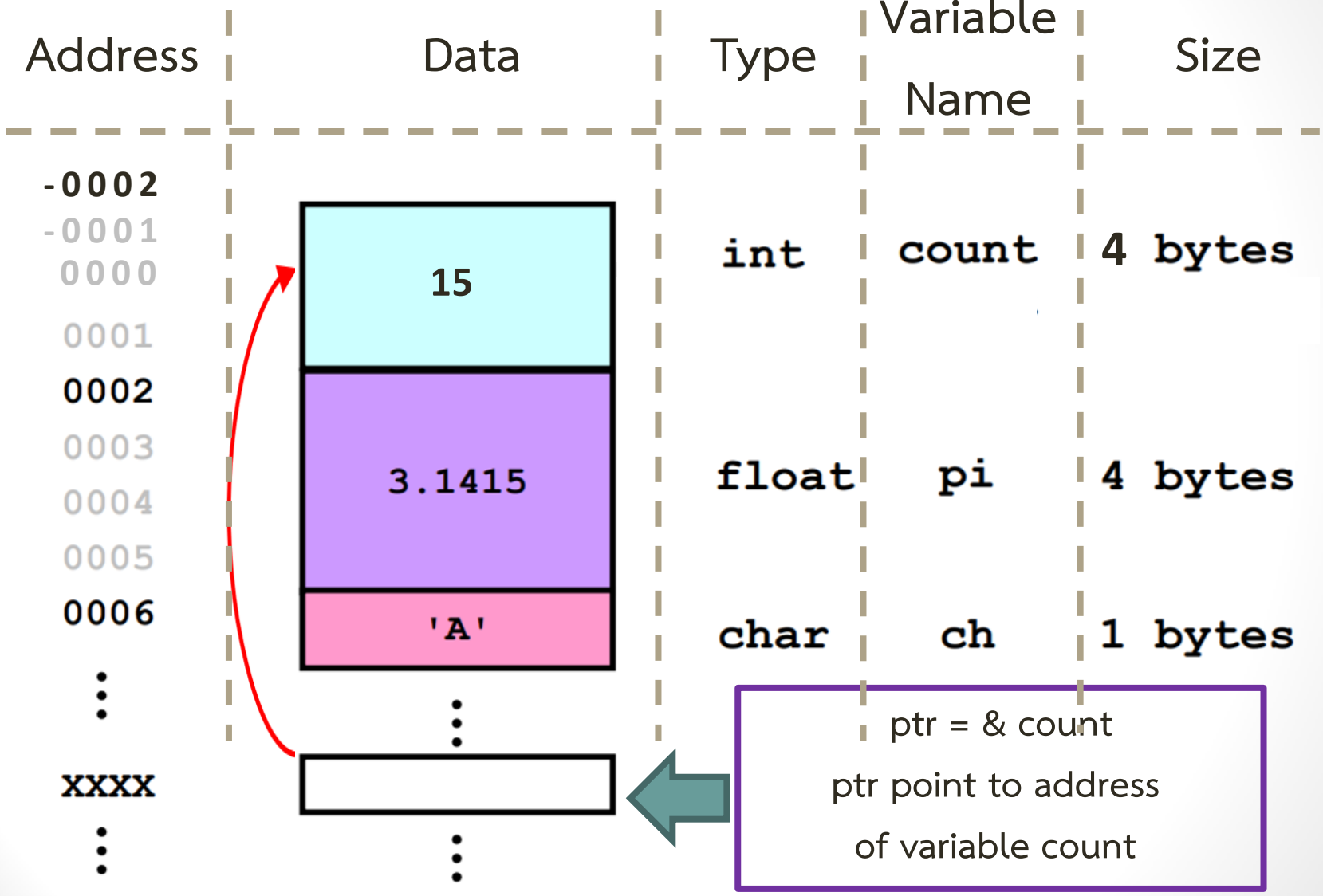
Memory and Pointer Structure



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Pointer Declaration

```
type        *pointer_name;
```

type is type of pointer variable

***** is operator that identify pointer

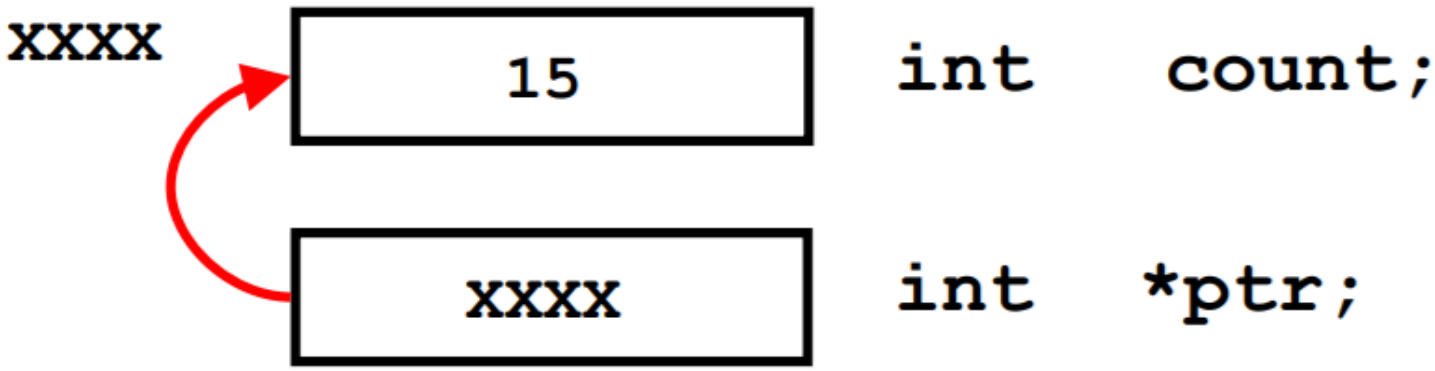
pointer_name is name of pointer variable

<u>Example</u>

```
int     * ptr_int;      /* pointer to integer */
float   * ptr_float;    /* pointer to float */
char    * ptr_char;     /* pointer to char */
```

Reference Operator “&”

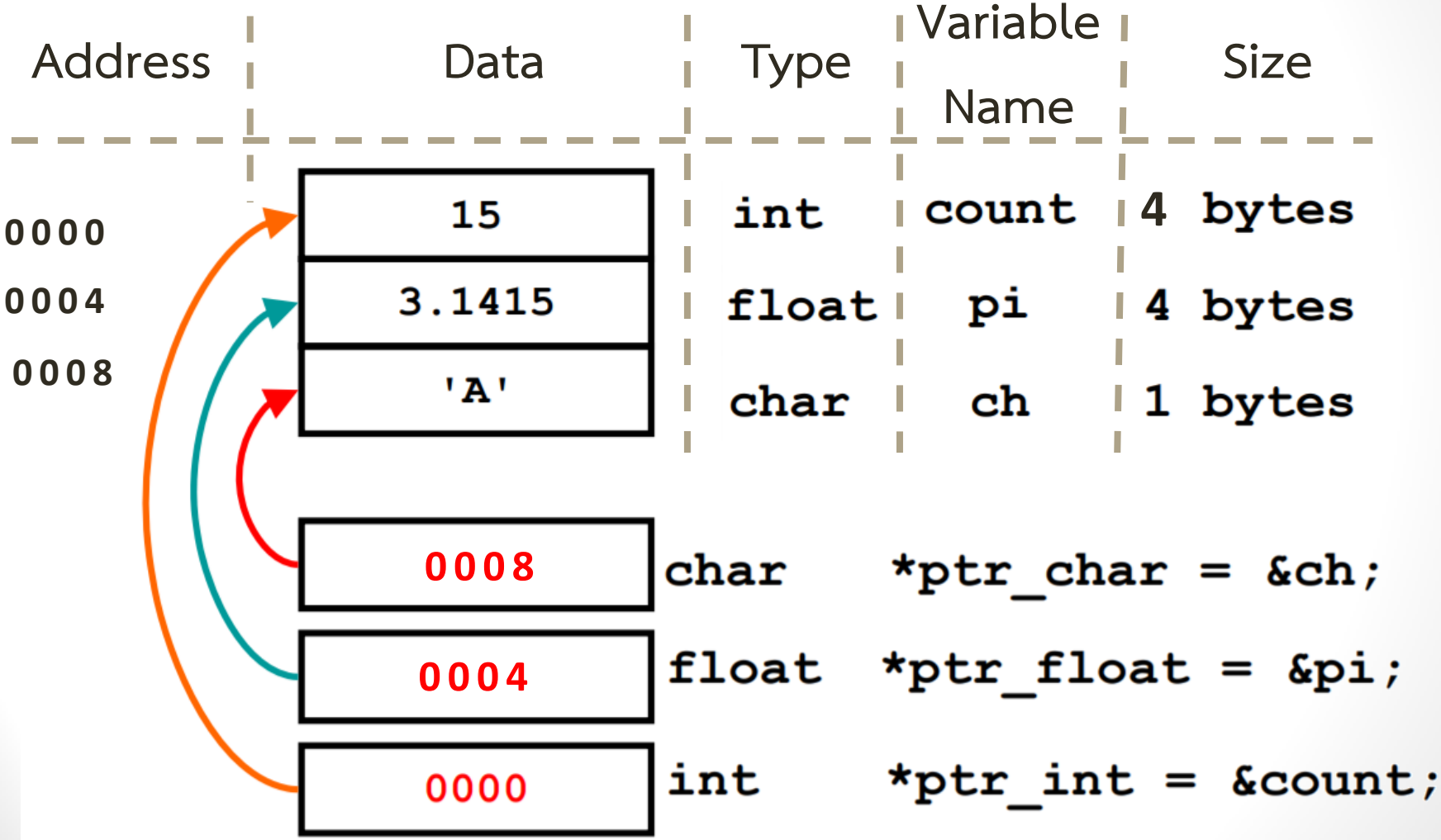
Reference Operator gives you the address of a variable.




```
int    count;
int    *ptr;
```

```
ptr = &count;          /* ptr is XXXX */
```

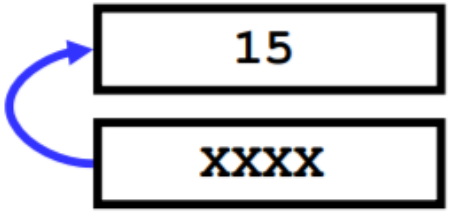
Reference Operator “&”



Indirect Operator "*"

Indirection or Dereferencing gets you the value from the address

Address XXXX




```
int   count;
int   * ptr;
```

```
int     count = 15, y, z[10];
int    *ptr;          /* ptr is int pointer   */

ptr   = &count;       /* ptr point to count */
y     = *ptr;         /*  y = 15              */
*ptr  =  0;           /*  count = 0           */
ptr   = &z[0];        /* ptr point to z [0]   */
```

Shows pointer by printf function

Function printf can show address by using this operator.

- %p show address in hexadecimal
- %u show address in decimal format

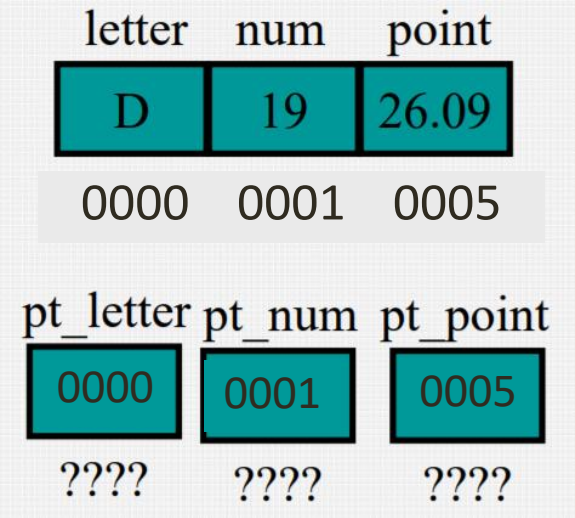
The result will show in format XXXX:YYYY or XXXX depend on memory model

```
1  #include <stdio.h>
2  int main()
3  {
4      int i = 10;
5      int *p;
6      p = &i;
7      printf("%p  %d\n",&i, i);
8      printf("%p  %p  %d\n",&p, p, *p);
9      printf("--------------\n");
10     printf("%u  %d\n",&i, i);
11     printf("%u  %u  %d\n",&p, p, *p);
12     return 0;
13 }
```

```
C:\WINDOWS\system32\cmd.exe
0012FF60  10
0012FF54  0012FF60  10
--------------
1245024  10
1245012  1245024  10
Press any key to continue .
```

Example : Program shows address by pointer

```
#include<stdio.h>
#include<conio.h>
int main()
{
    char    letter = 'D';
    int     num = 19;
    float   point = 26.09;
    char    *pt_letter;
    int     *pt_num;
    float   *pt_point;
    pt_letter  =   &letter;
    pt_num     =   &num;
    pt_point   =   &point;
    printf("Address of letter = %p \n",pt_letter);
    printf("Address of num = %p \n",pt_num);
    printf("Address of point = %p \n",pt_point);
  return 0;
}
```

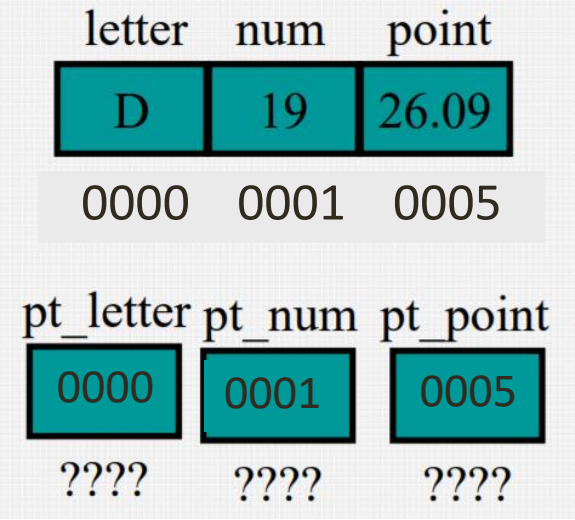


Example : Program shows address by pointer

Address of letter = 0000

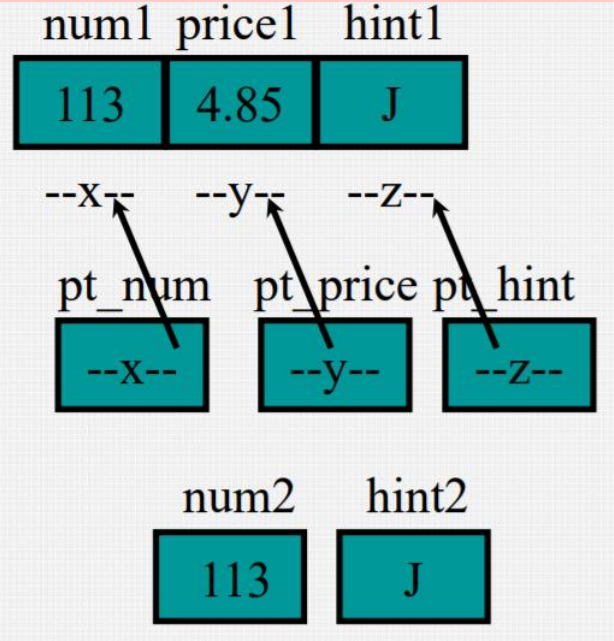
Address of num = 0002

Address of point = 0004



Example : Program shows referencing and dereferencing

```
int main()
{
        int    num1 = 113,num2;
        float  price1 = 4.85;
        char   hint1 = 'J',hint2;
        int    *pt_num;
        float  *pt_price;
        char   *pt_hint;
        pt_num    =  &num1;
        pt_price  =  &price1;
        pt_hint   =  &hint1;
        num2      =  *pt_num;
        hint2     =  *pt_hint;
        printf ("Variable num1 = %d \n", num2);
        printf ("Variable price1 = %f \n",*pt_price);
        printf ("Variable hint2 = %c \n", hint2);
    return 0;
}
```

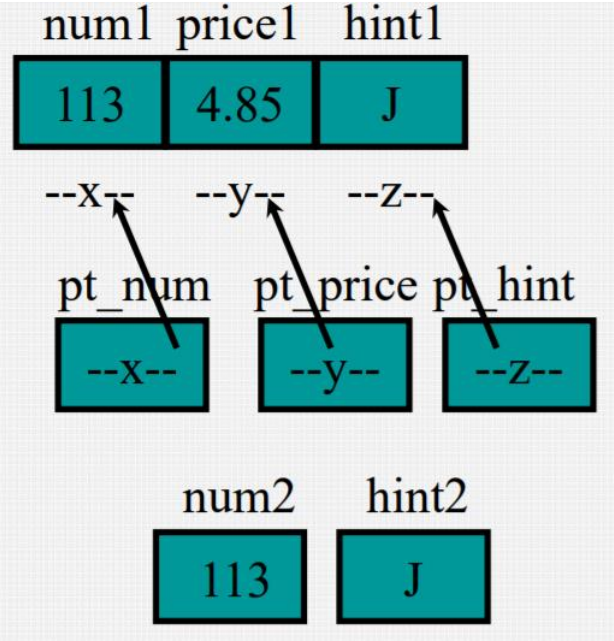


Example : Program shows address by pointer

Variable num1 = 113

Variable price1 = 4.850000

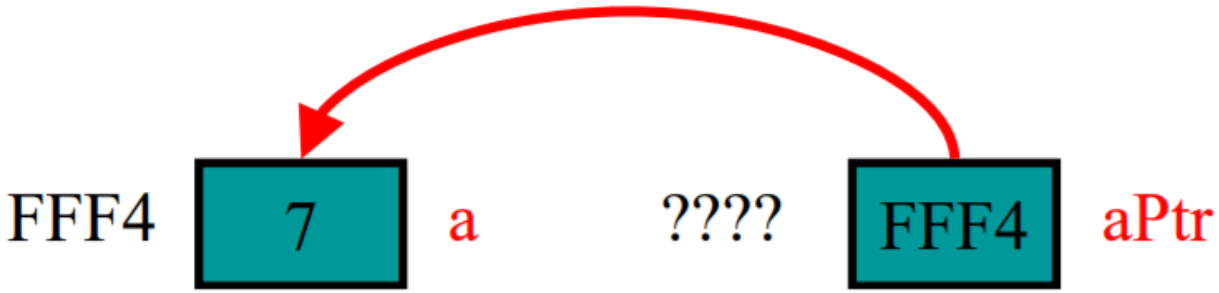
Variable hint2 = J



Example : Program shows referencing and dereferencing 2

```
#include<stdio.h>
#include<conio.h>
int main()
{
        int a;              /* a is an integer */
        int *aPtr;          /* aPtr is a pointer to an integer */
        a = 7;
        aPtr = &a;          /* aPtr set to address of a */
printf ("The address of a is %p\n"
         "The value of aPtr is %p\n\n", &a, aPtr);
printf ("The value of a is %d\n"
         "The value of *aPtr is %d\n\n", a, *aPtr);
printf ("Proving that * and & are complements of "
         "each other.\n&*aPtr = %p\n*&aPtr = %p\n",
         &*aPtr, *&aPtr);
return 0;
}
```

Example : Program shows referencing and dereferencing 2



The address of a is FFF4

The value of aPtr is FFF4

The value of a is 7

The value of *aPtr is 7

Proving that * and & are complements of each other.

&*aPtr = FFF4

*&aPtr = FFF4

Example : Pointer Conclusion

Pointer Declaration

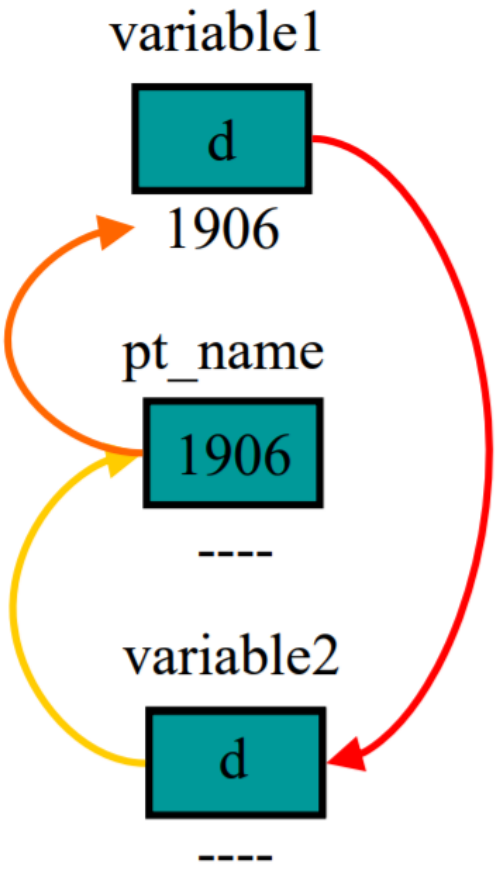
```
type          *pointer_name;
```

Show address by using “&”

```
pt_name  =  &variable1;
```

Show value by using “*”

```
variable2  =  *pt_name;
```



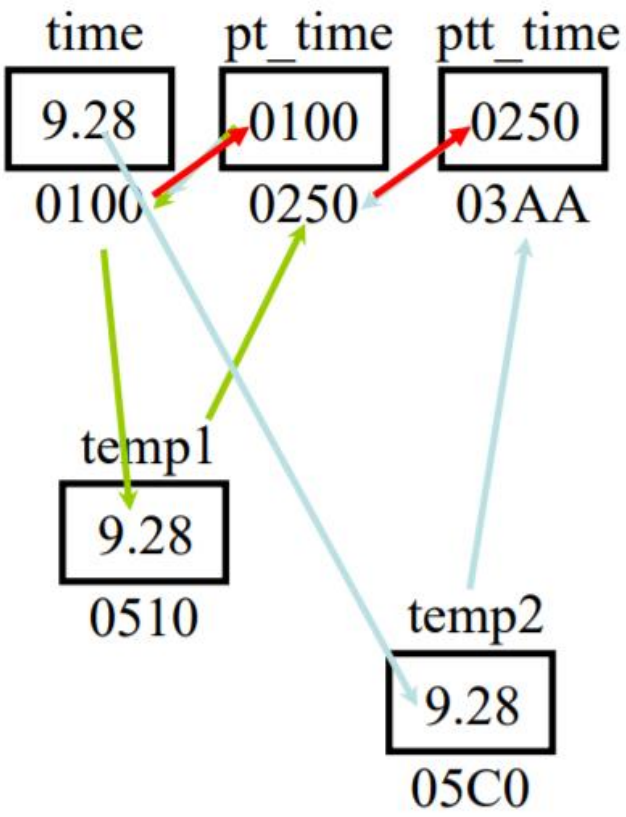
Pointer to Pointer

```
type        **ptt_name;
```

type	is type of pointer variable
****	is operator that identify pointer to pointer
ptt_name	is name of pointer to pointer variable

Pointer to Pointer

```
float time = 9.28;
float *pt_time;
float **ptt_time;
pt_time = &time;
ptt_time = &pt_time;
float temp1;
temp1 = *pt_time;
float temp2;
temp2 = **ptt_time;
```



Pointer and Array

Arrays are closely related to pointers in C programming but the important difference between them is that, a pointer variable takes different addresses as value where as, in case of array it is fixed.

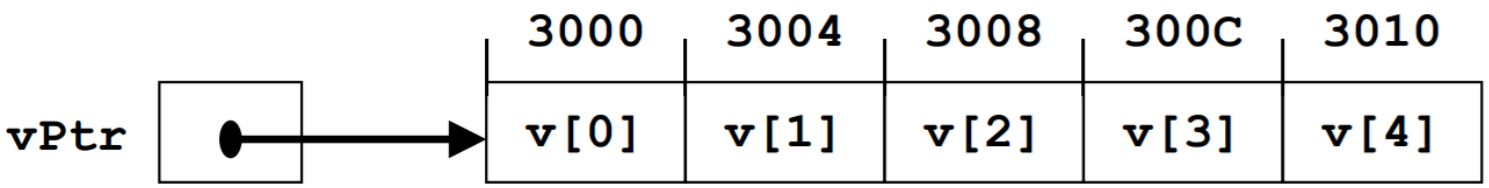
<u>Example</u>

float v[5]

Definition Array **v** size **5** which mean group of continuous object. Name are **v[0], v[1], v[2], v[3], v[4].**

3000	3004	3008	300C	3010
v[0]	v[1]	v[2]	v[3]	v[4]

Pointer and Array



Declaration **float *vPtr** and define **vPtr** point to Array address **v** can do by 2 methods.

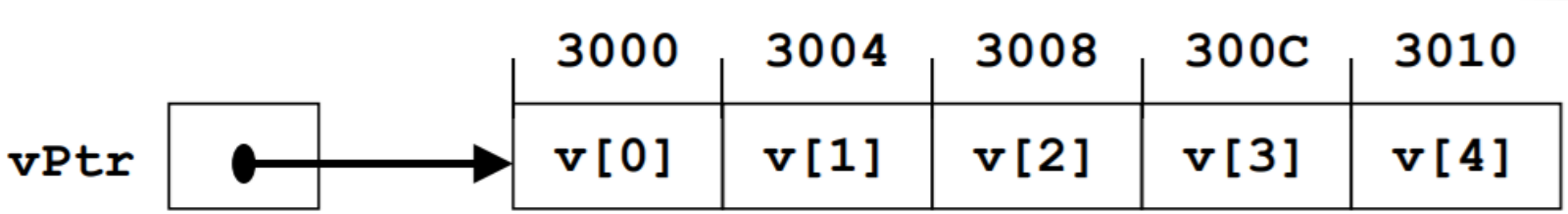
<u>Method 1</u>

vPtr = v;

<u>Method 2</u>

vPtr = &v[0];

Pointer and Array



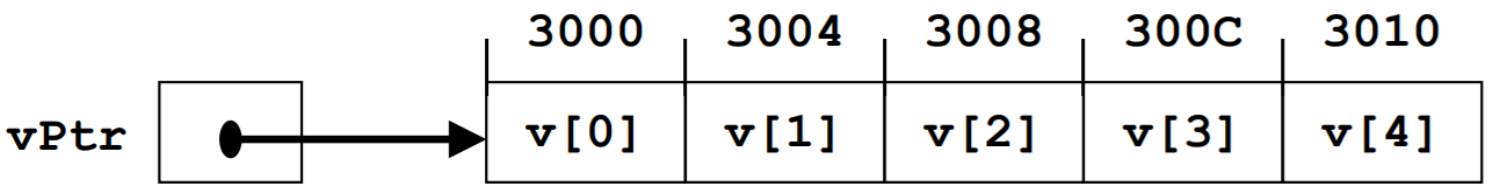
Meaning of definition **x = *vPtr** is copy value of **v[0]** to **x**

Move Array Pointer by += and -=

Pointer can be used as Arithmetic Operator as below.

- Increment (++) or Decrement (--)
- Integer can add or minus with pointer (+, +=) or (-, -=)
- Pointer can minus with another Pointer.

Move Array Pointer by += and -=



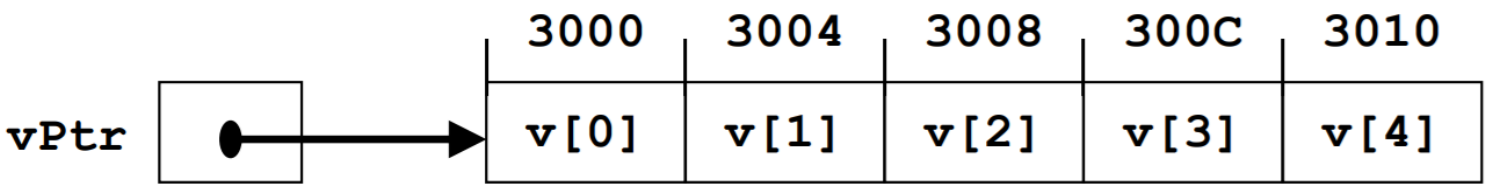
When add or minus Pointer and integer then

- Value of pointer not increase or decrease by that number.
- Value of pointer will increase or decrease by that number multiply with size of object pointed.
- Size (byte) depend on type of object.

<u>Example</u> (Define size of float object is 4 byte)

```
vPtr += 2;        //        vPtr = vPtr+(2*4)
                  //   or   vPtr = 3000+(2*4)
```

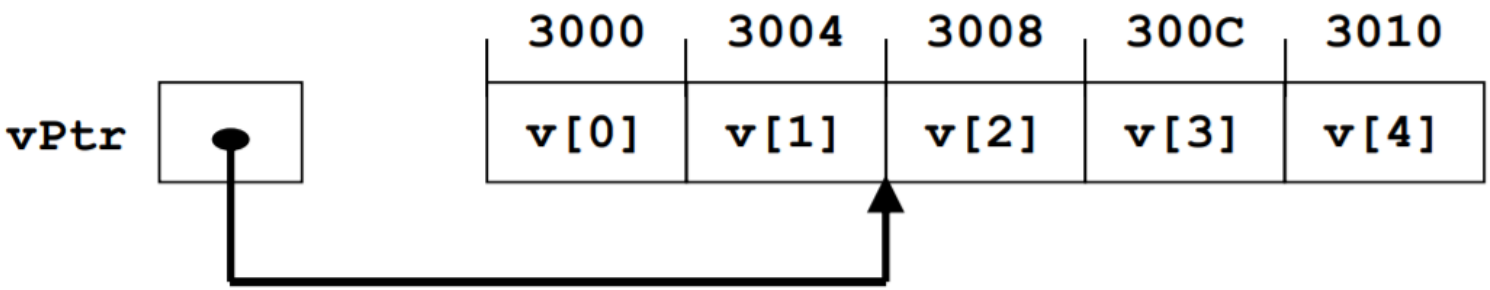
Move Array Pointer by += and -=



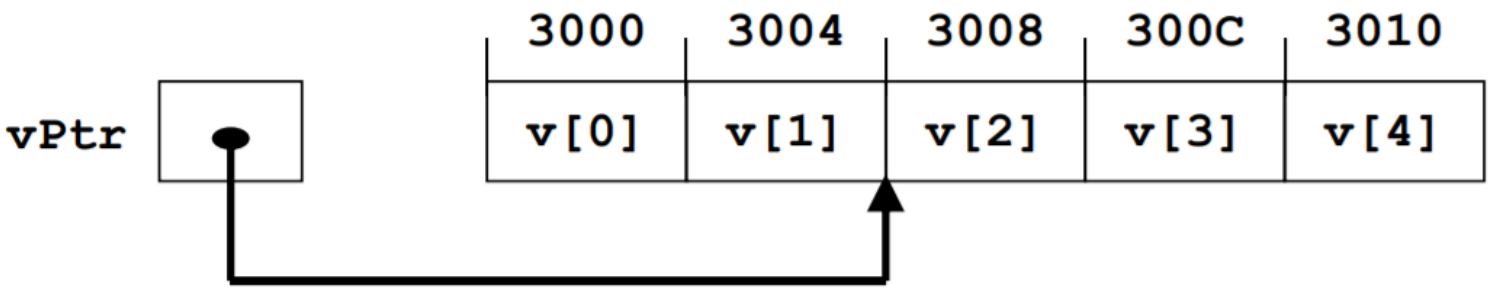
vPtr += 2; // vPtr = vPtr+(2*4)

// or vPtr = 3000+(2*4)

After above method **vPtr** will point to **v[2]**



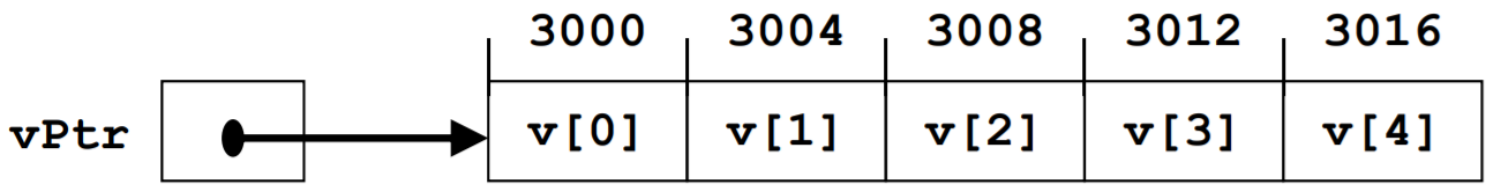
Move Array Pointer by += and -=



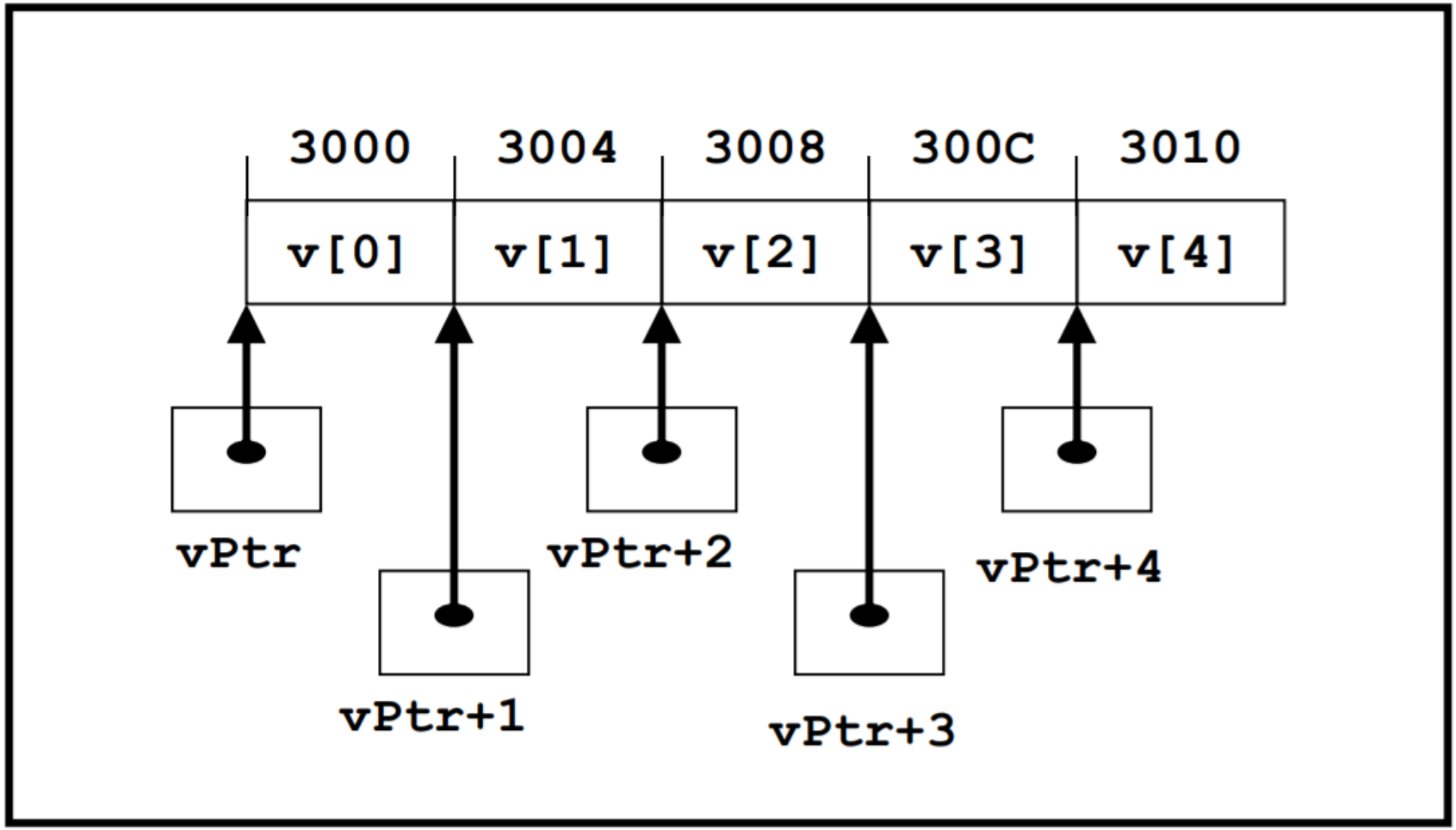
vPtr -= 2; // vPtr = vPtr-(2*4)

// or vPtr = 3008-(2*4)

After above method **vPtr** will point to **v[0]**



Move Array Pointer by += and -=



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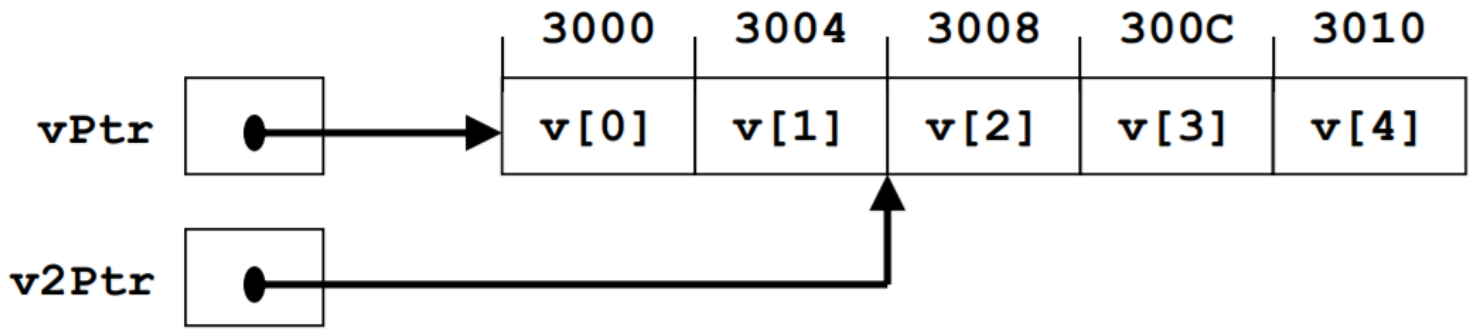
Calculate number of element by Pointer

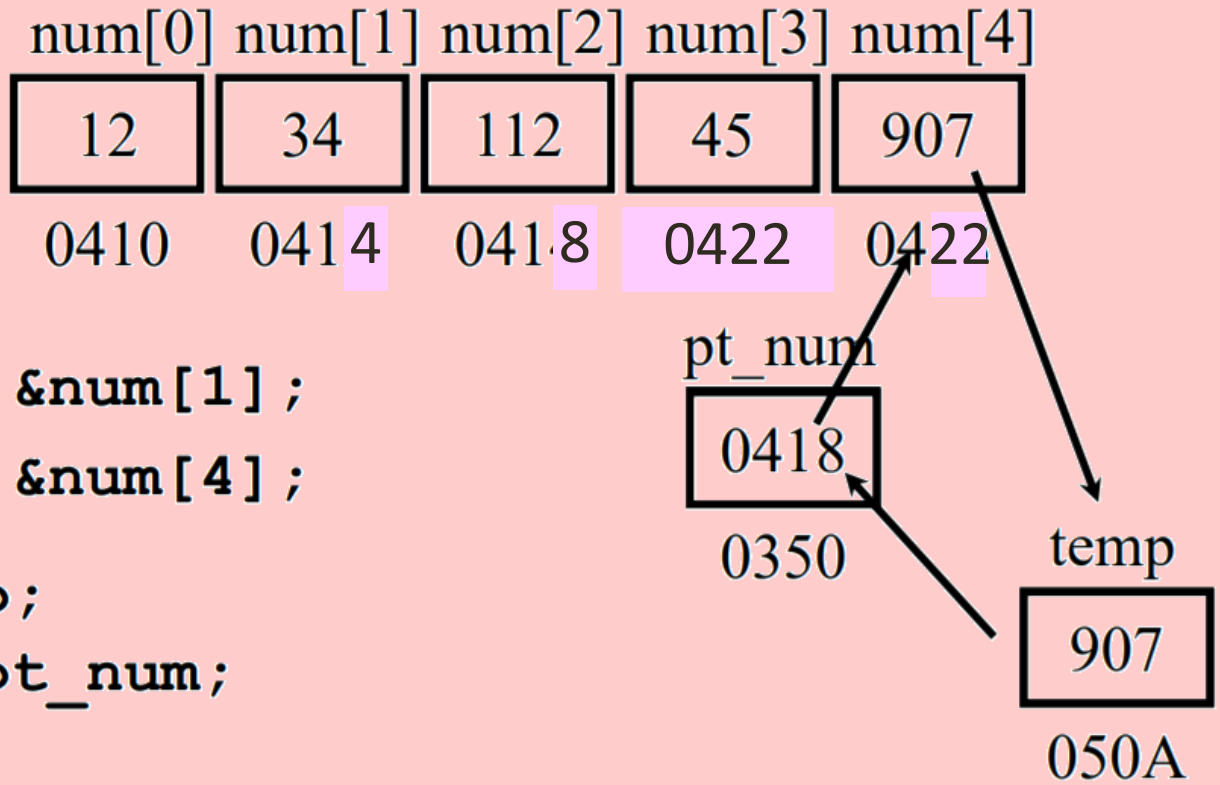



```
• vPtr = &v[0];          //      vPtr = 3000
• v2Ptr = &v[2];         // or v2Ptr = 3008
• x = v2Ptr - vPtr;      // x = ?
```

Value of **x** is number of element of Array variable from **vPtr** to **vPtr2** in this case is **2**

Example: Program show how to use pointer and array

```
int  num[5] = {12, 34, 112, 45, 907};
int  *pt_num;
```




```
pt_num = &num[1];
pt_num = &num[4];

int  temp;
temp = *pt_num;
```

Example: Program show how to use pointer and array

```
type name[10];
type *pt_name;
pt_name = name;      //pt_name = &name[0]
-----------------------------------------

 float num[] = {19.01, 26.09, -4.23, -4.24, -13.12}
```

num[0]	num[1]	num[2]	num[3]	num[4]
19.01	26.09	-4.23	-4.24	-13.12
0300	0304	0308	030C	0310

Example: Program show how to use pointer and array

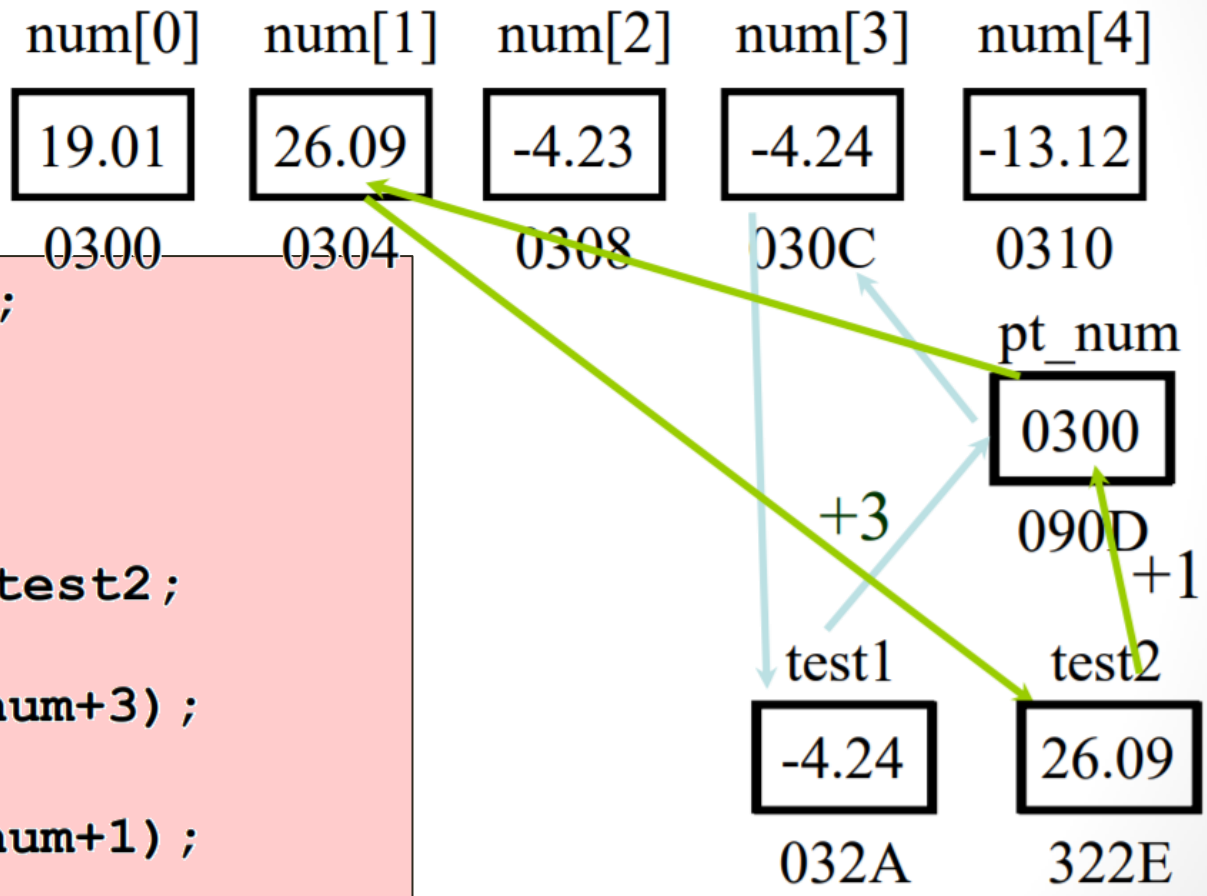
```
float  *pt_num;

pt_num = num;

float  test1, test2;

test1 = *(pt_num+3);

test2 = *(pt_num+1);
```



Relation between Array and Pointers

Arrays are closely related to pointers which almost use in every case.

```
int b[5];
int *bPtr;
bPtr = b;          //equivalent to   bPtr = &b[0];
&b[3] equivalent to bPtr+3
b[3] equivalent to *(bPtr+3)
```

Case 1 : Normal Array

```
int main()
{
        int i, offset, b[] = {10, 20, 30, 40};
        int *bPtr = b;        /* set bPtr to point to array b */
        printf("Array b printed with:\n"
                "Array subscript notation\n");
        for (i=0; i<=3; i++)
                printf("b[%d] = %d\n", i, b[i]);
        return 0;
}
```

```
Array b printed with:
Array subscript notation
b[0] = 10
b[1] = 20
b[2] = 30
b[3] = 40
```

Case 2 : Array in Pointer format

```
int main()
{
        int i, offset, b[] = {10, 20, 30, 40};
        int *bPtr = b;              /* set bPtr to point to array b */
        printf("Pointer/offset notation where\n"
                "the pointer is the array name\n");
        for (offset = 0; offset<=3 ; offset++)
                printf("*(b + %d) = %d\n", offset, *(b + offset));
        return 0;
}
```

Pointer/offset notation where

The pointer is the array name

*(b + 0) = 10

*(b + 1) = 20

*(b + 2) = 30

*(b + 3) = 40

Case 3 : Pointer in Array format

```
int main()
{
    int i, offset, b[] = {10, 20, 30, 40};
    int *bPtr = b;        /* set bPtr to point to array b */
    printf("Pointer subscript notation\n");
    for (i=0 ; i<=3 ; i++)
        printf("bPtr[%d] = %d\n", i, bPtr[i]);
    return 0;
}
```

Pointer subscript notation

bPtr[0] = 10

bPtr[1] = 20

bPtr[2] = 30

bPtr[3] = 40

Case 4 : Normal Pointer

```
int main()
{
    int i, offset, b[] = {10, 20, 30, 40};
    int *bPtr = b;     /* set bPtr to point to array b */
    printf("Pointer/offset notation\n");
    for (offset=0; offset<=3; offset++)
        printf("*(bPtr + %d) = %d\n", offset, *(bPtr + offset));
    return 0;
}
```

Pointer/offset notation

*(bPtr + 0) = 10

*(bPtr + 1) = 20

*(bPtr + 2) = 30

*(bPtr + 3) = 40