# Week 4 - Lecture 3
# Pointers

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UK | CHINA | MALAYSIA

# Overview

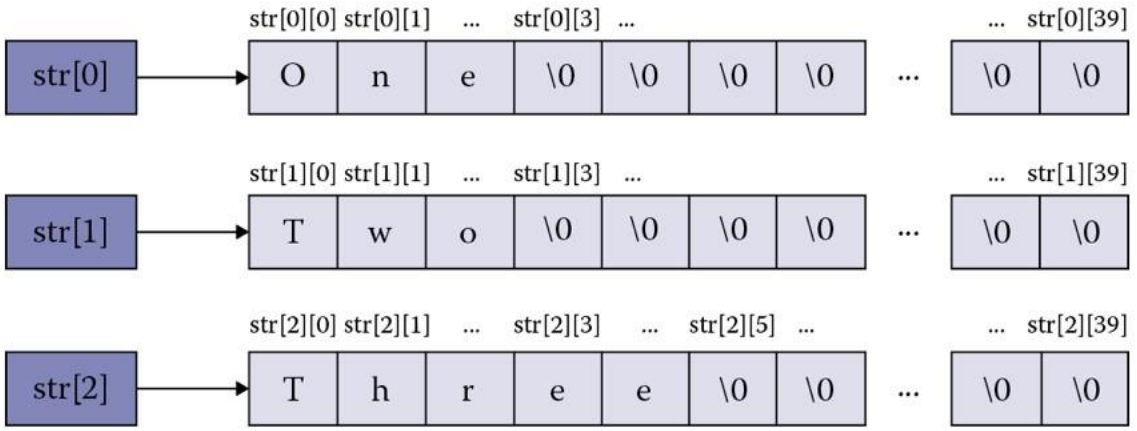
- Declaration and initialisation
- Pointer to Constant vs. const Pointer
- Pointers and arrays
  - String literals
- **Array of pointers**
- **Pointer arithmetic (e.g. subtracting, comparing)**

# Arrays of Pointers

- Every element in the array is a pointer to the same data type
- char *arr[3]; array of 3 pointers to arrays of characters
  - Common use i.e. array of strings

char str[3][40];

a waste of memory

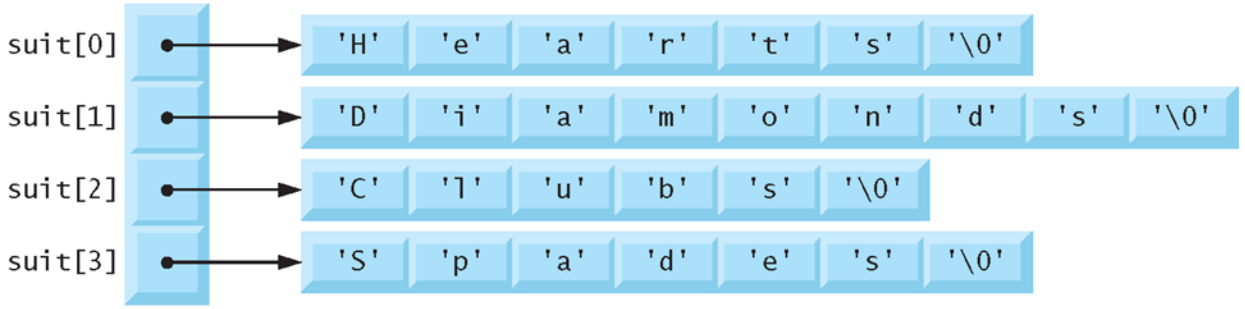


# Arrays of Pointers (2)

- A common use of an array of pointers is to form an array of strings, referred to simply as a string array.

- Consider the definition of string array **suit**, which might be useful in representing a deck of cards. 

- const char ***suit**[ 4 ] = { "Hearts", "Diamonds", "Clubs", "Spades" };




*suit[0]只指向第一个字母，其他字母可以通过suit[0]++

# Arrays of Pointers (3)

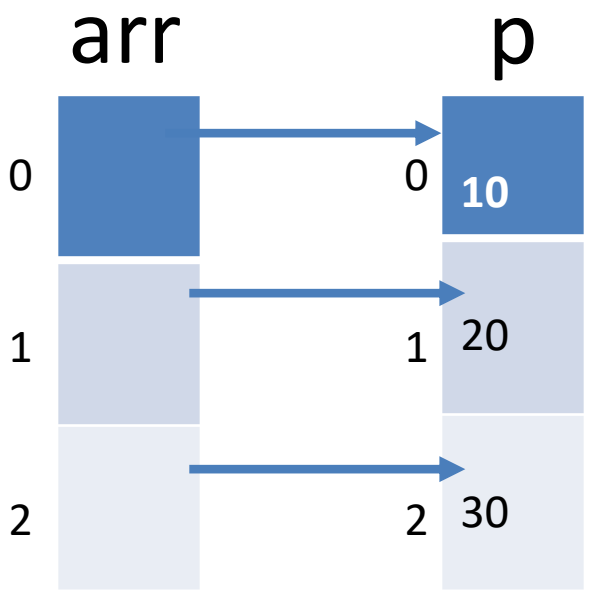
- The **suits** could have been placed in a two-dimensional array.
  - Such a data structure would have to have a fixed number of columns per row, and that number would have to be as large as the largest string.

  - Therefore, considerable memory could be wasted when storing a large number of strings of which most were shorter than the longest string.
- **Because of this, we use arrays of pointers!**

# Q1: What will be shown here?

- int *arr[3], i, p[3] = {10, 20, 30};

```
for(i = 0; i < 3; i++){
        arr[i] = &p[i];
        printf("%d", *arr[i]);
}
```



# Q2: What are first chars?

- char *arr[3];
  int i;
  arr[0] = "This is”;
  arr[1] = "a new”;
  arr[2] = "message”;
  for(i = 0; i < 3; i++)
  printf("Text: %s\tFirst char: %c\n", arr[i], *arr[i]);

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- **Pointer arithmetic (e.g. subtracting, comparing)**

# Pointer Arithmetic

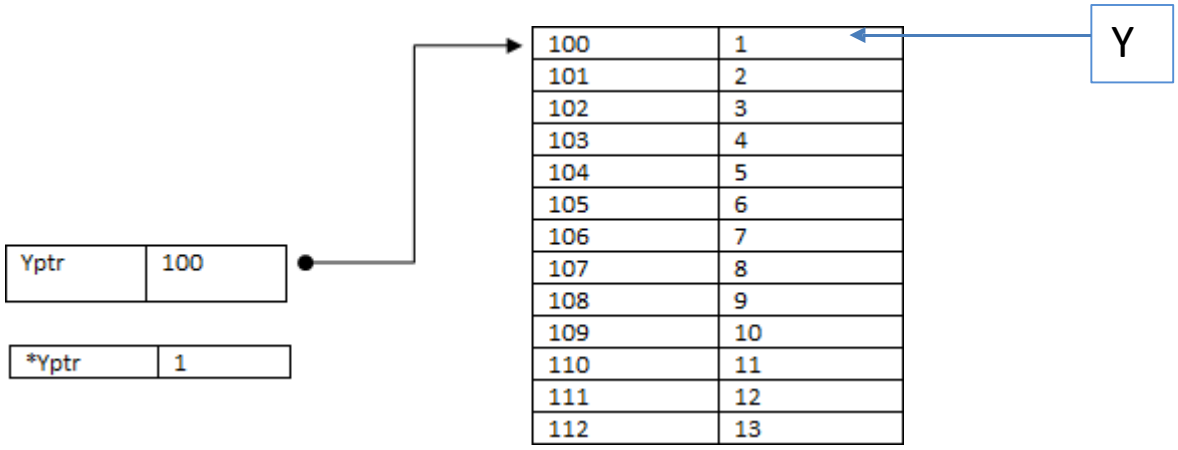
ptr = ptr + n;

- **char: ptr** is  increased by n;  char size is 1 byte.
- **int or** float: ptr is  increased by n * 4, int and float size is 4 bytes.
- **double: ptr** is increased by n * 8; double size is 8 bytes.

# Remember this?!

- A variable name *directly* references a value, a pointer ***indirectly*** references a value.

```
int Y = 1;
int *Yptr;
Yptr = &Y;
```




Source: http://www.exforsys.com/tutorials/c-language/c-pointers.html

# Pointer Arithmetic: Example

- int *ptr, i;
  ptr = &i;
  printf("Address = %p\n", ptr);
  ptr++;
  printf("Address = %p\n", ptr);

The second address will be 4 bytes higher than the first one

ptr永远是int类型，占4bytes

# Subtracting Pointers

- Only if both pointers refer to the **same data type**, Indicates **the number of data items between them**
- Suppose ptr1 and ptr2 point to two integer variables store in addresses 1000 and 1040 respectively
- **(ptr2 - ptr1) != (1040 – 1000) != 40**
- **(ptr2 - ptr1) == (40 / 4) == 10**

# Comparing Pointers

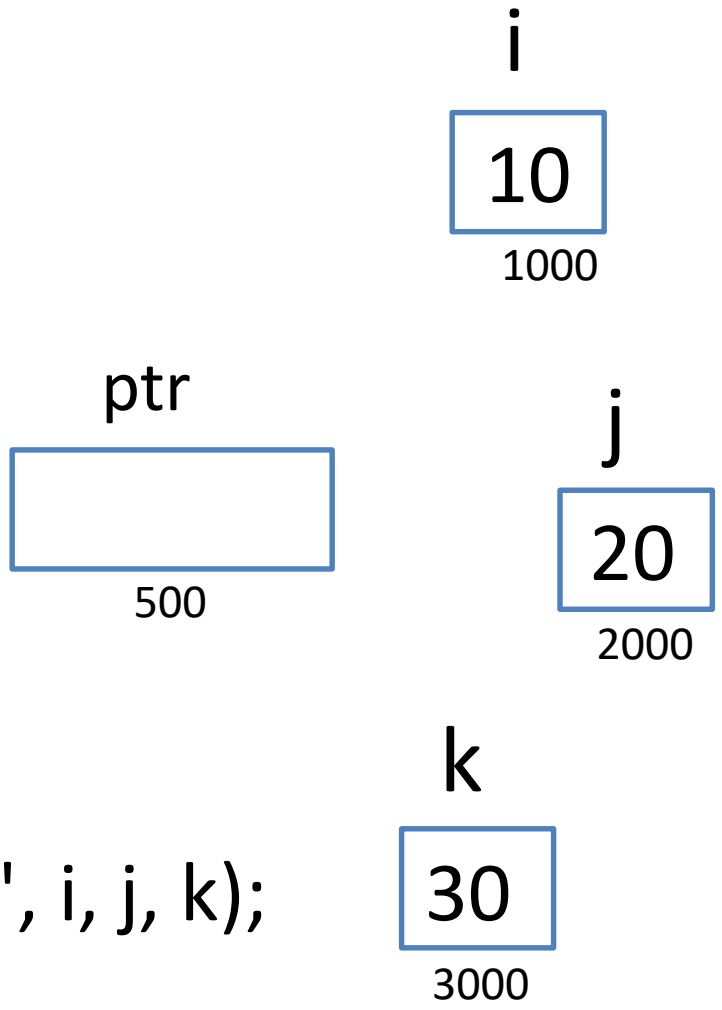
- Only if both point to members of the **same data structure**
- Operators: ==, !=, >, <, >= and <=
- To check if two pointers point to **the same address**
  - if(ptr1 == ptr2) or if(ptr1 != ptr2)

# Q3: explain how this Pointer works?

```
int *ptr, i;
ptr = &i;
printf("Address = %p\n", ptr);
ptr -= 10;
printf("Address = %p\n", ptr);
```

# Q4: What is the value of i, j and k?

```
int *ptr, i = 10, j = 20, k = 30;
ptr = &i;
*ptr = 40;
ptr = &j;
*ptr += i;
ptr = &k;
*ptr += i + j ;
printf("i = %d j = %d k = %d\n", i, j, k);
```



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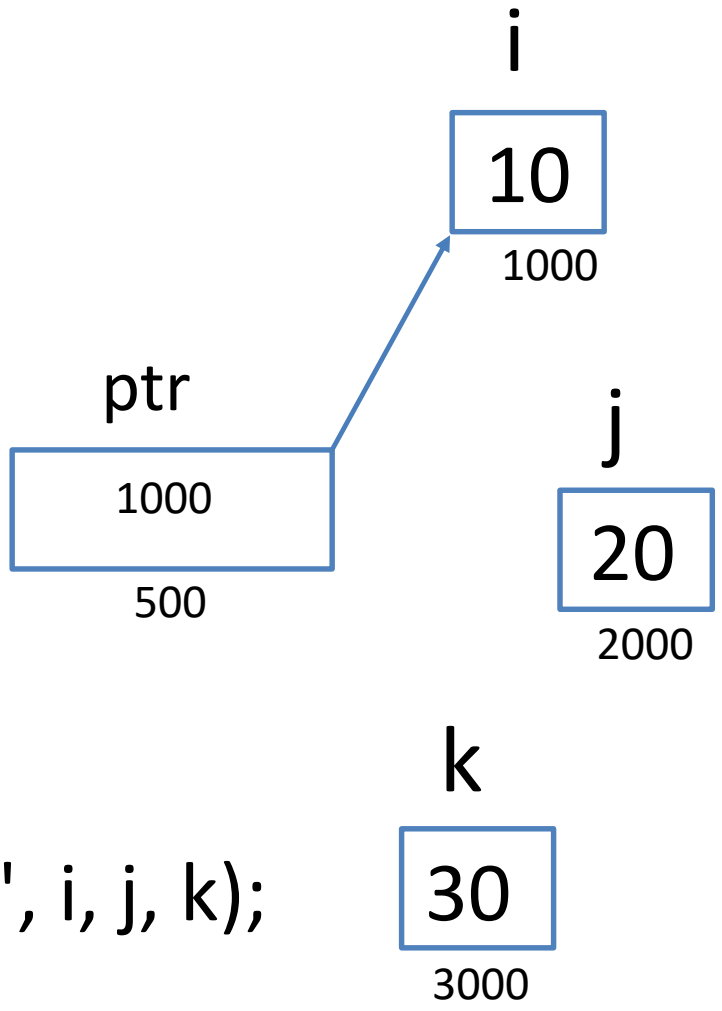

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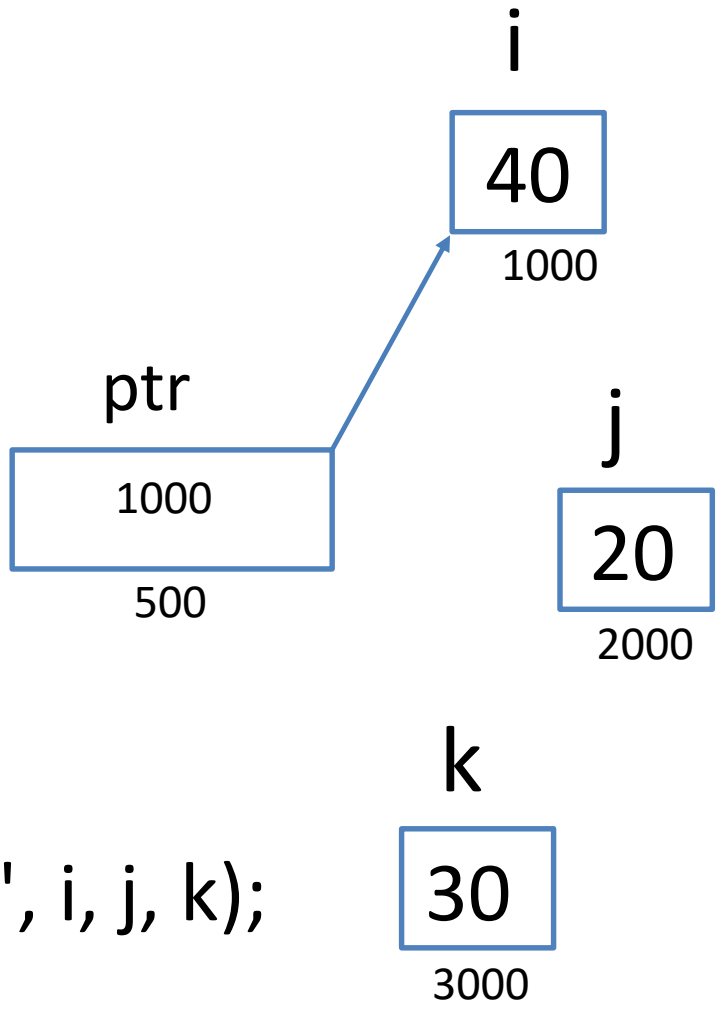

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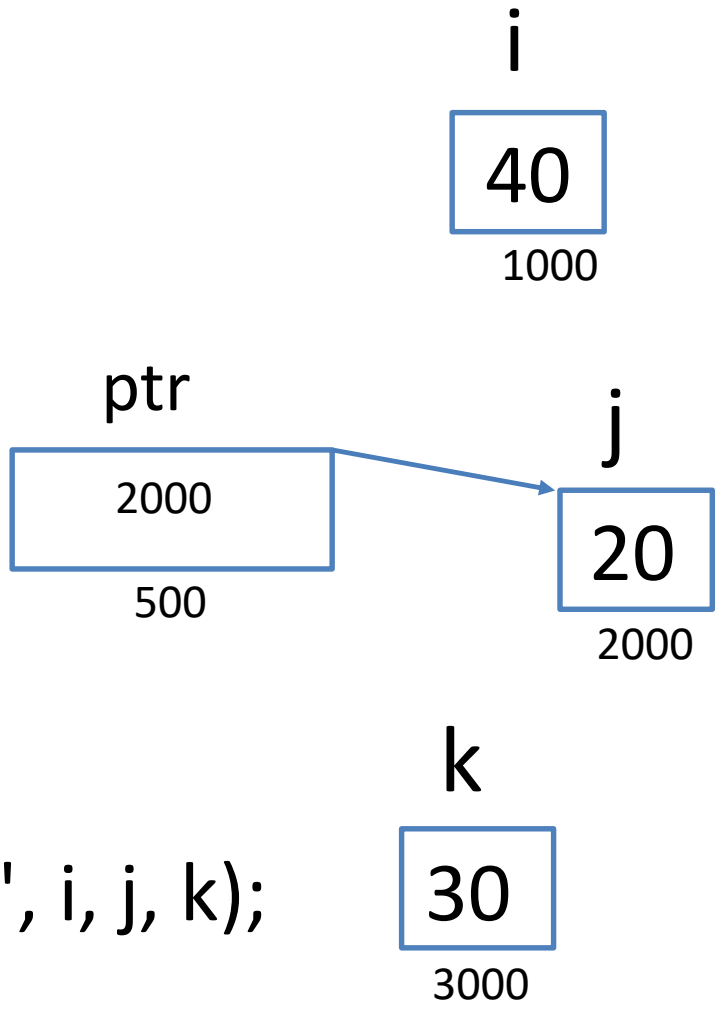

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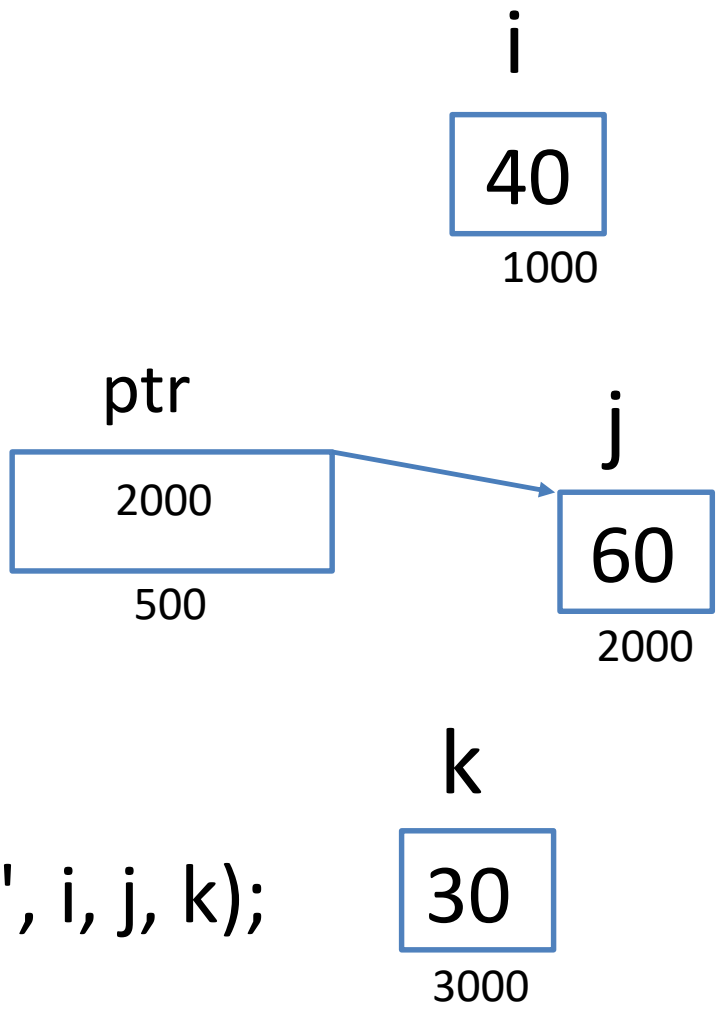
```

***ptr = *ptr + i;**
**= 20 + 40**



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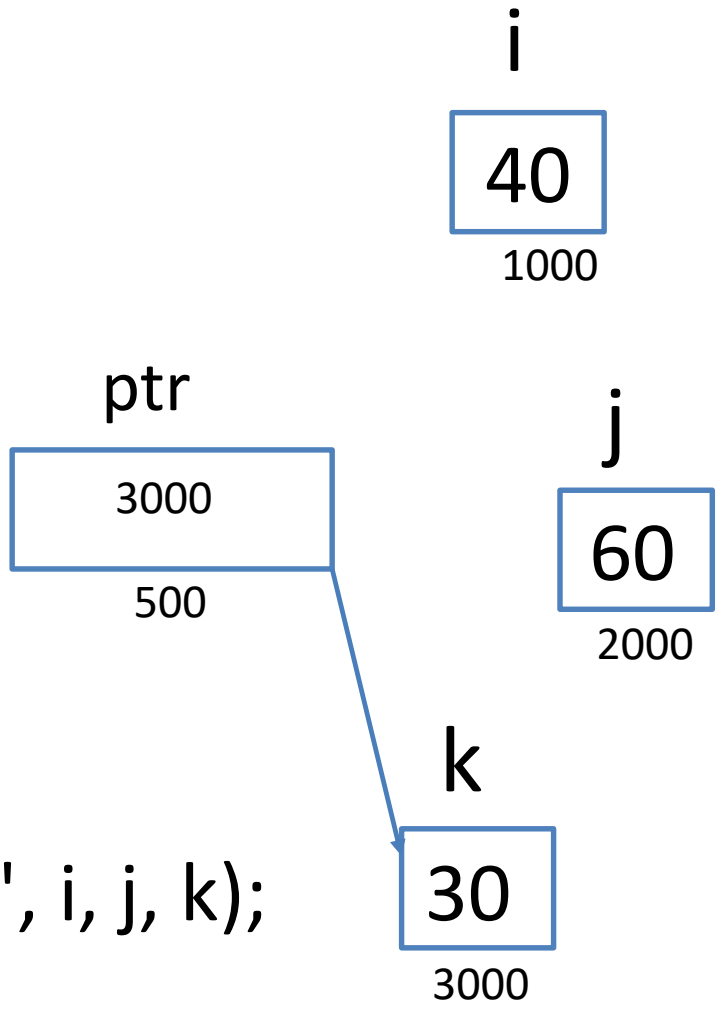

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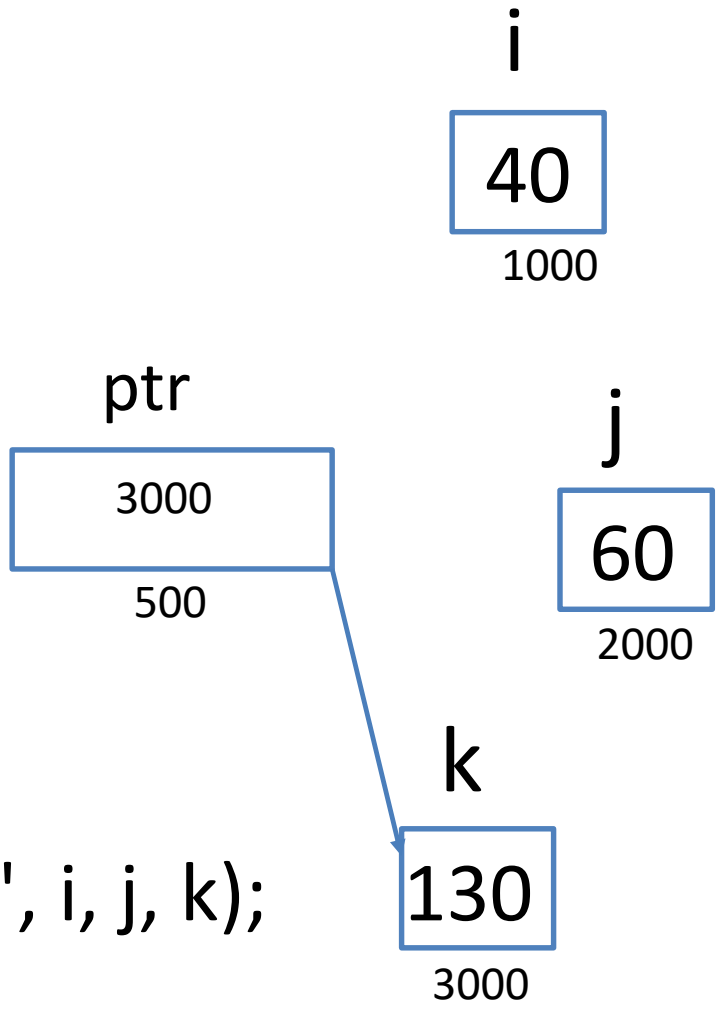
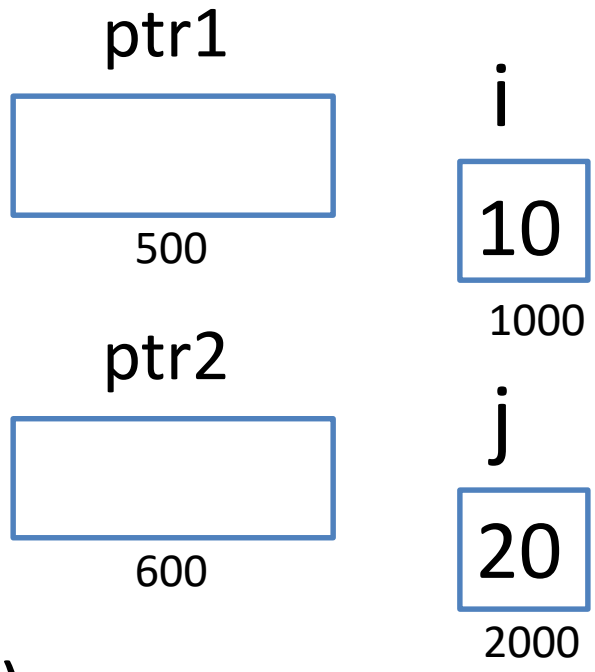
***ptr = *ptr + i + j;**
**= 30 + 40 + 60**



# Q5: What is the value of j?

- int *ptr1, *ptr2, i = 10, j = 20;
  ptr1 = &i;
  *ptr1 = 150;
  ptr2 = &j;
  *ptr2 = 50;
  ptr2 = ptr1;
  *ptr2 = 250;
  ptr2 = &j;
  *ptr2 += *ptr1;
  printf("Val = %d\n", j);



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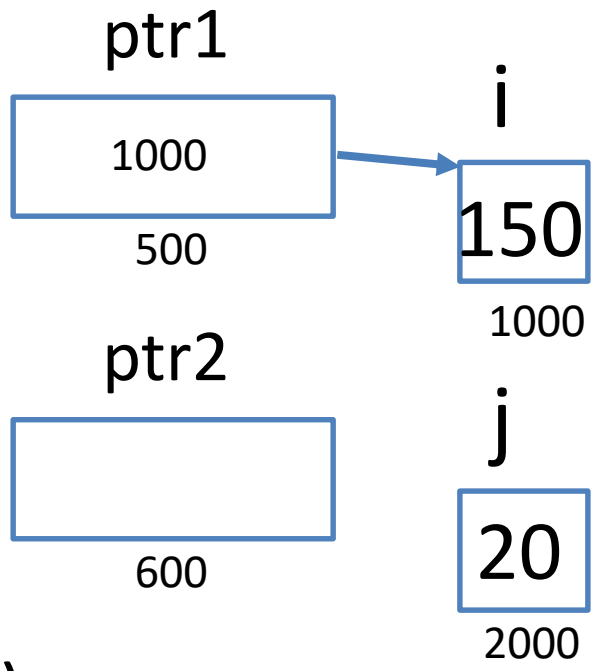

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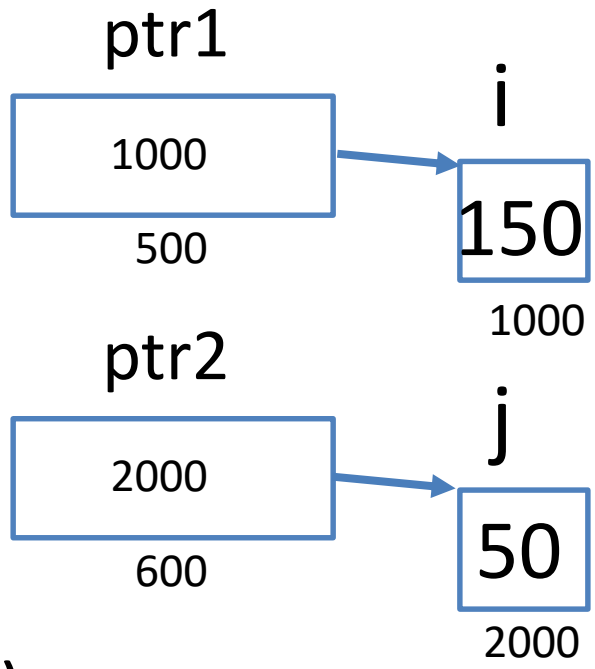

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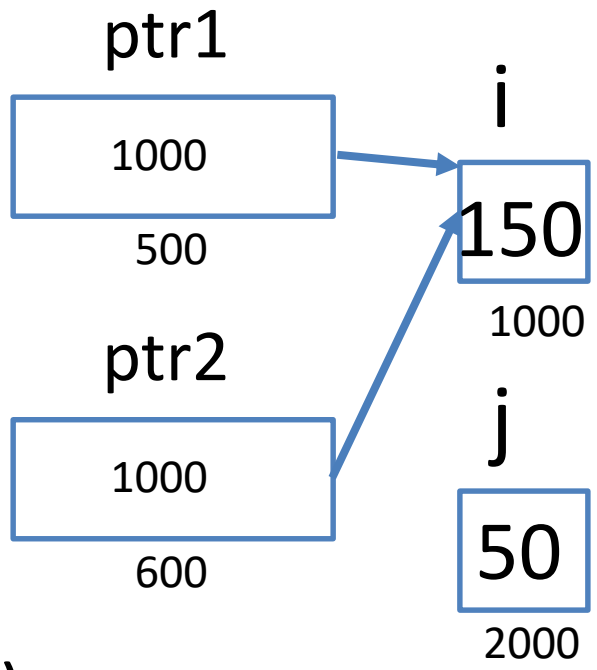

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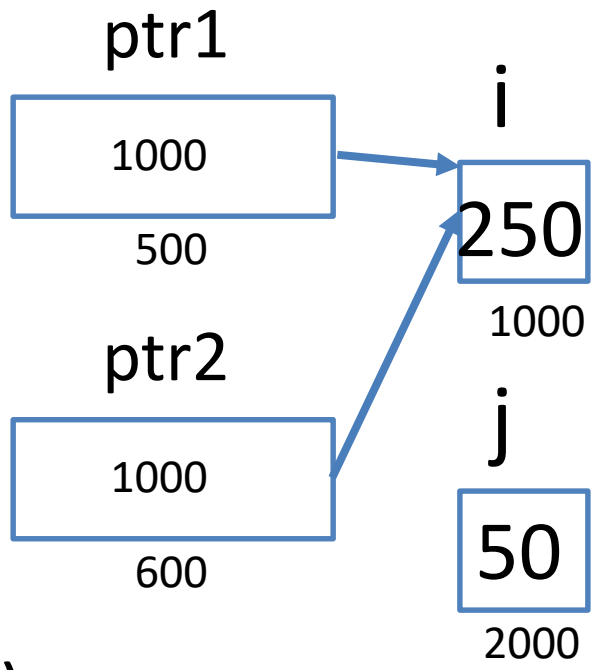

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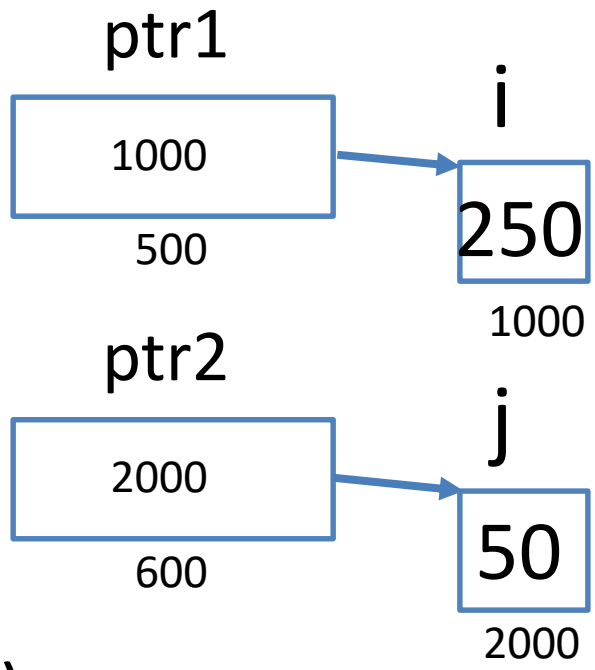

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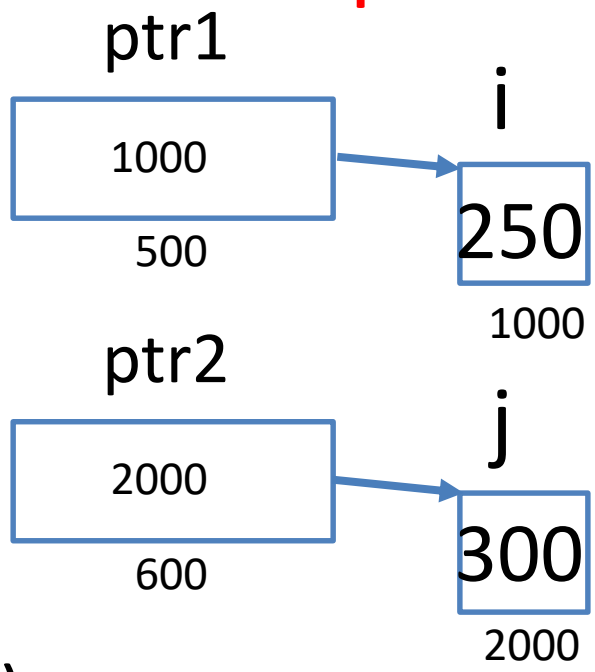
***ptr2 = *ptr2 + *ptr1;**
***ptr2 = 50 + 250**



# Summary

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- Pointer arithmetic (e.g. subtracting, comparing)