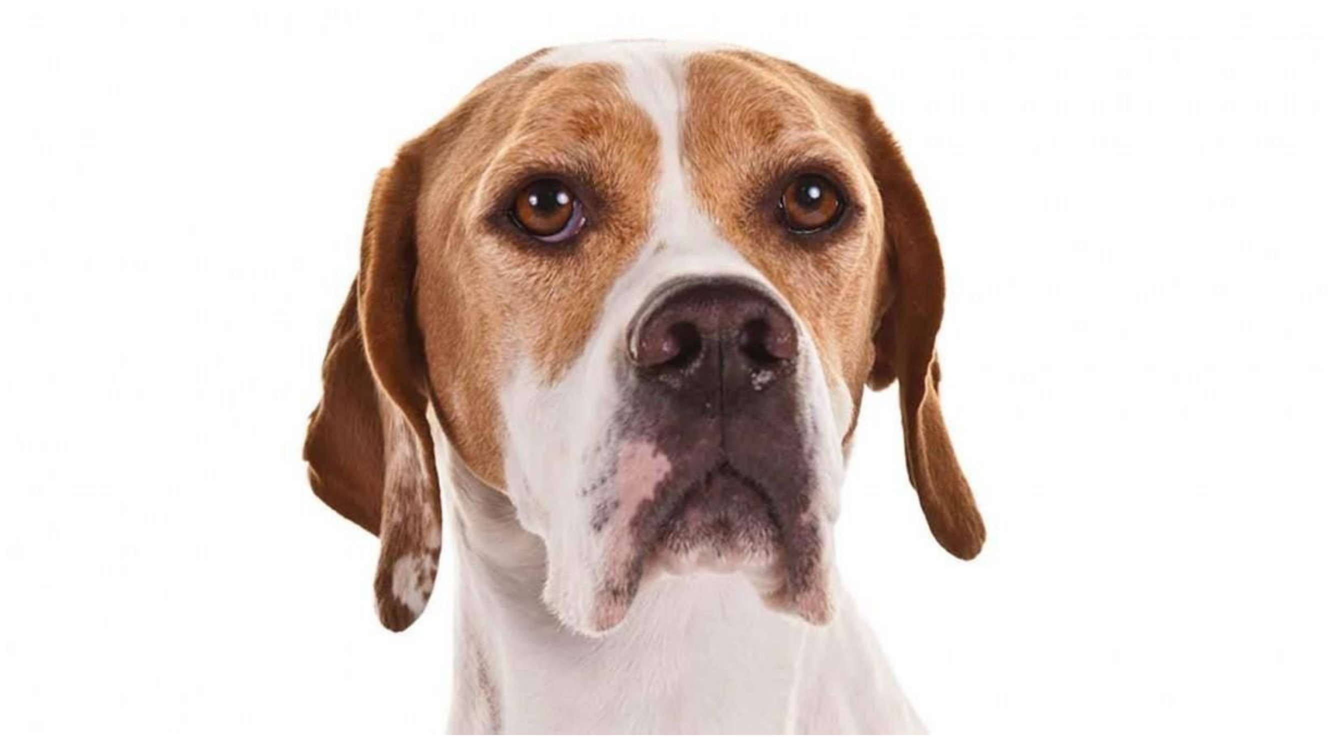


Week 4 - Lecture 3
Pointers

Edited by: Heshan Du

Autumn 2023

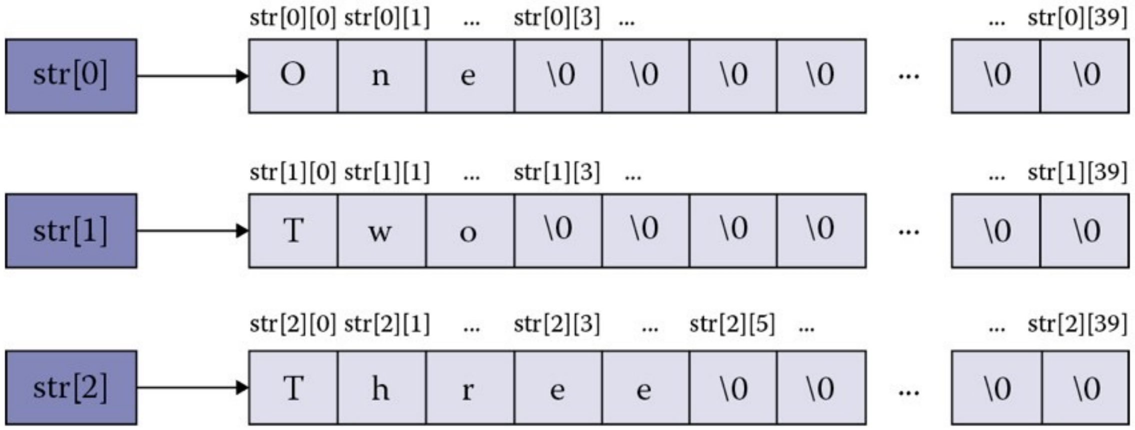
Overview

- 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

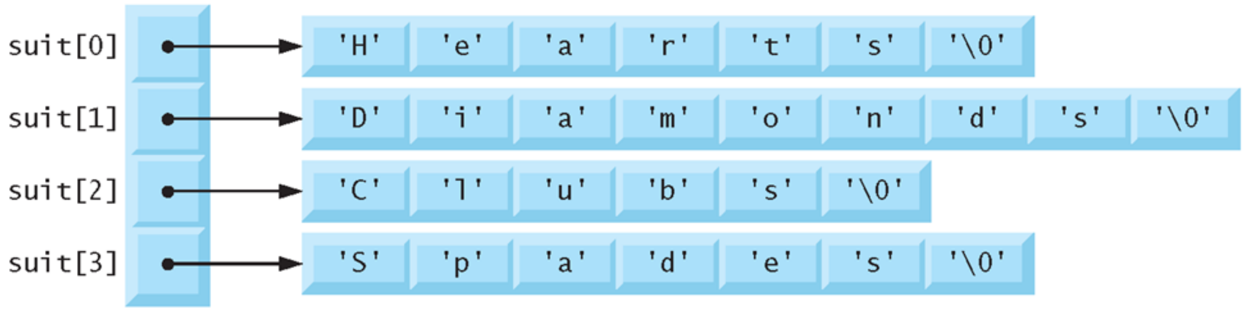
- Every element in the array is a pointer to the same data type
- char *arr[3]; array of 3 pointers to arrays of characters
  - Common use i.e., array of strings

char str[3][40];


str[0]
str[1]
str[2]
str[0][0] str[0][1] ... str[0][3] ... ... str[0][39]
O n e \0 \0 \0 \0 ... \0 \0
str[1][0] str[1][1] ... str[1][3] ... ... str[1][39]
T w o \0 \0 \0 \0 ... \0 \0
str[2][0] str[2][1] ... str[2][3] ... str[2][5] ... ... str[2][39]
T h r e e \0 \0 ... \0 \0

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]
'H' 'e' 'a' 'r' 't' 's' '\0'
suit[1]
'D' 'i' 'a' 'm' 'o' 'n' 'd' 's' '\0'
suit[2]
'C' 'l' 'u' 'b' 's' '\0'
suit[3]
'S' 'p' 'a' 'd' 'e' 's' '\0'

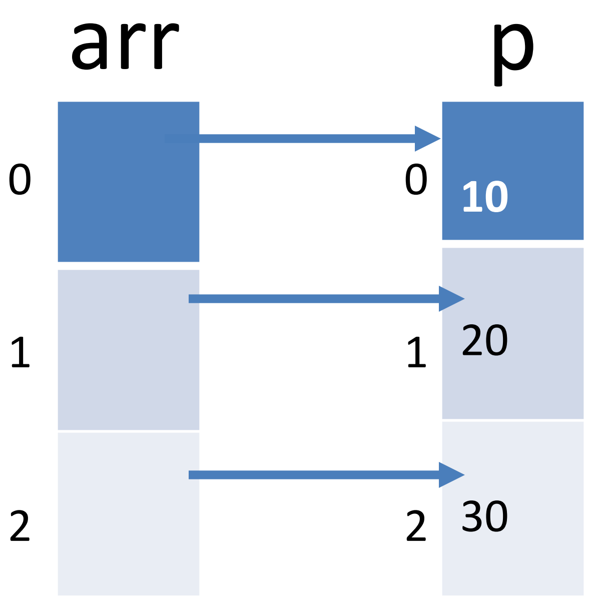
Arrays of Pointers (3)

- 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]);
  ```

Overview

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

Pointer Arithmetic

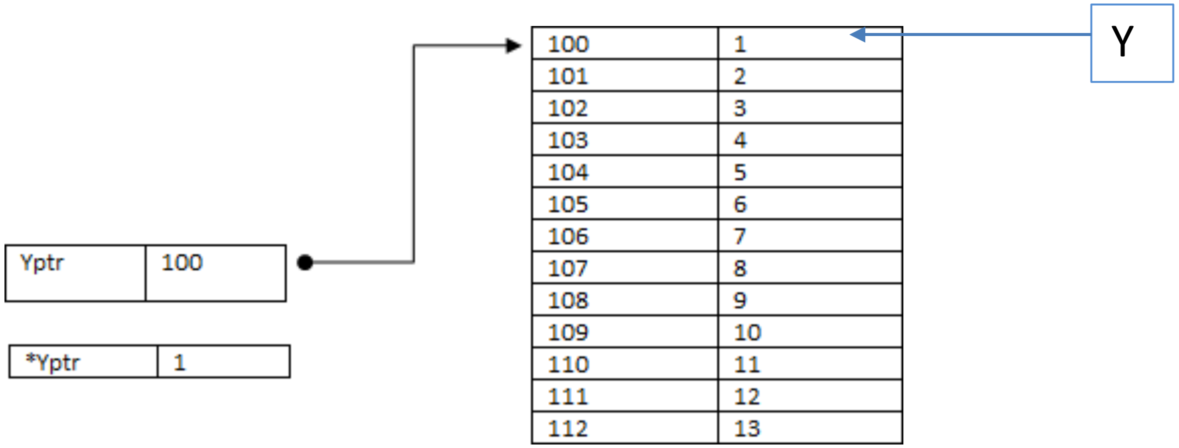
ptr = ptr + n;

- **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;
```



100	1
101	2
102	3
103	4
104	5
105	6
106	7
107	8
108	9
109	10
110	11
111	12
112	13

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

Subtracting Pointers

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

University of Nottingham
UK | CHINA | MALAYSIA

Comparing Pointers

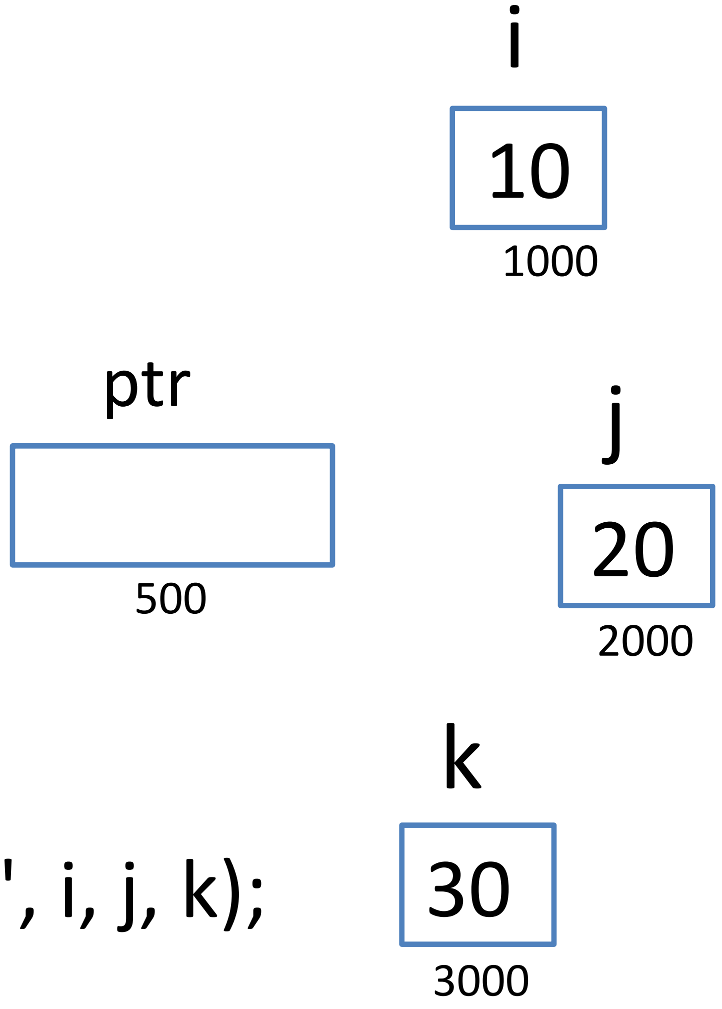
- Only if both point to members of the **same data structure**
- Operators: ==, !=, >, <, >= and <=
- To check if two pointers point to **the same address**
  - if(ptr1 == ptr2) or if(ptr1 != ptr2)

Q3: explain how this Pointer works?

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

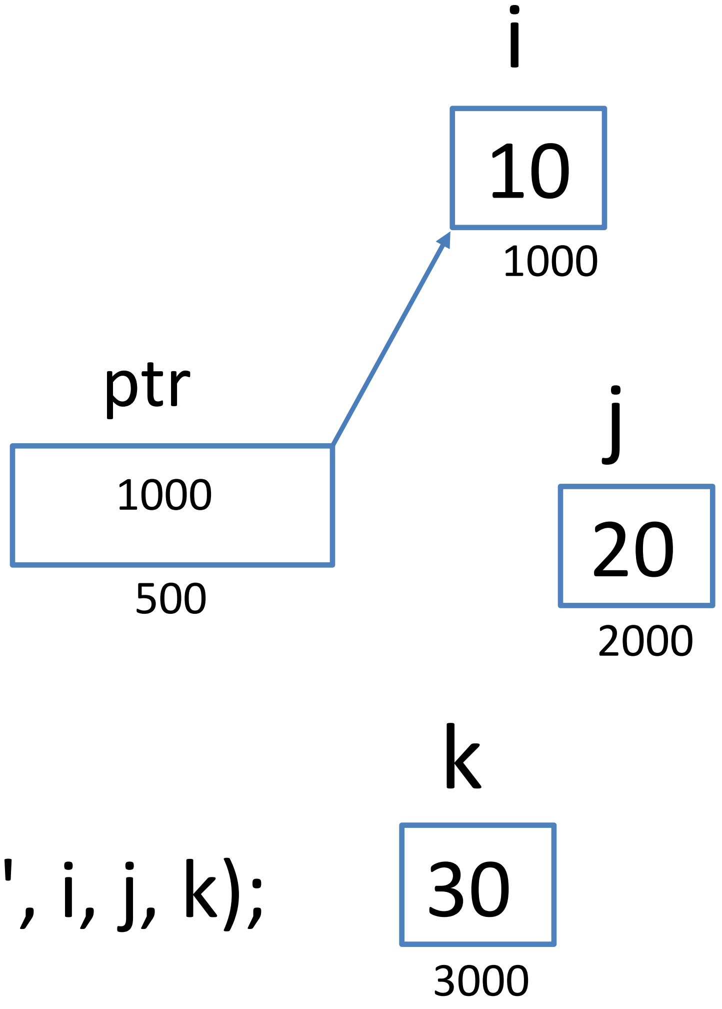
Q4: What is the value of i, j and k?

```
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);
```



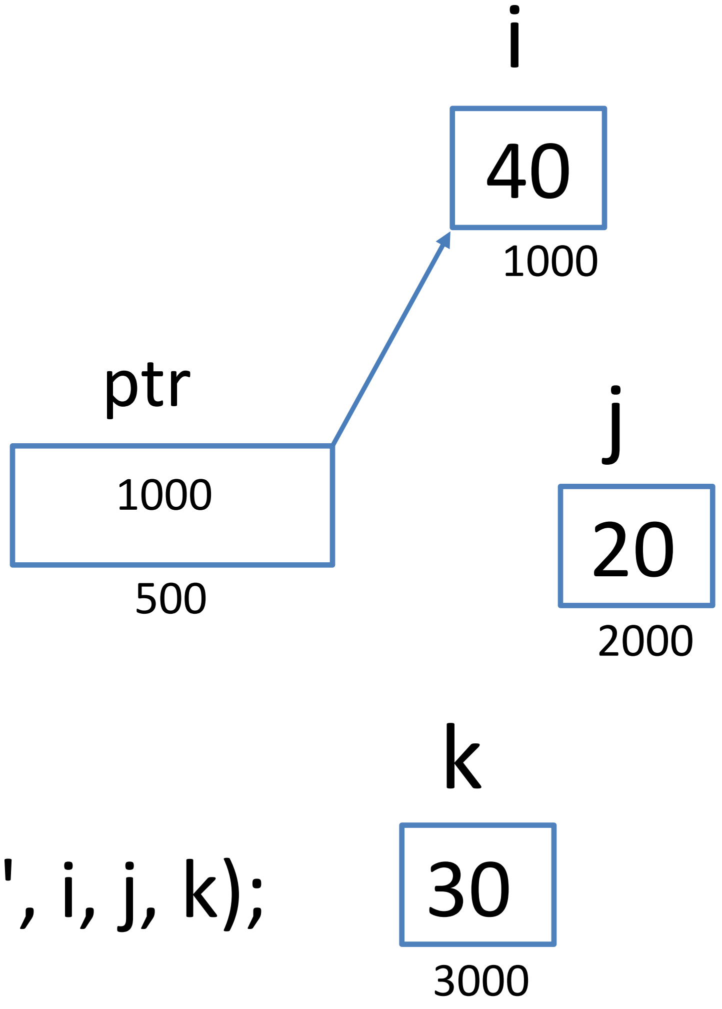
Q4: What is the value of i, j and k?

```
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);
```



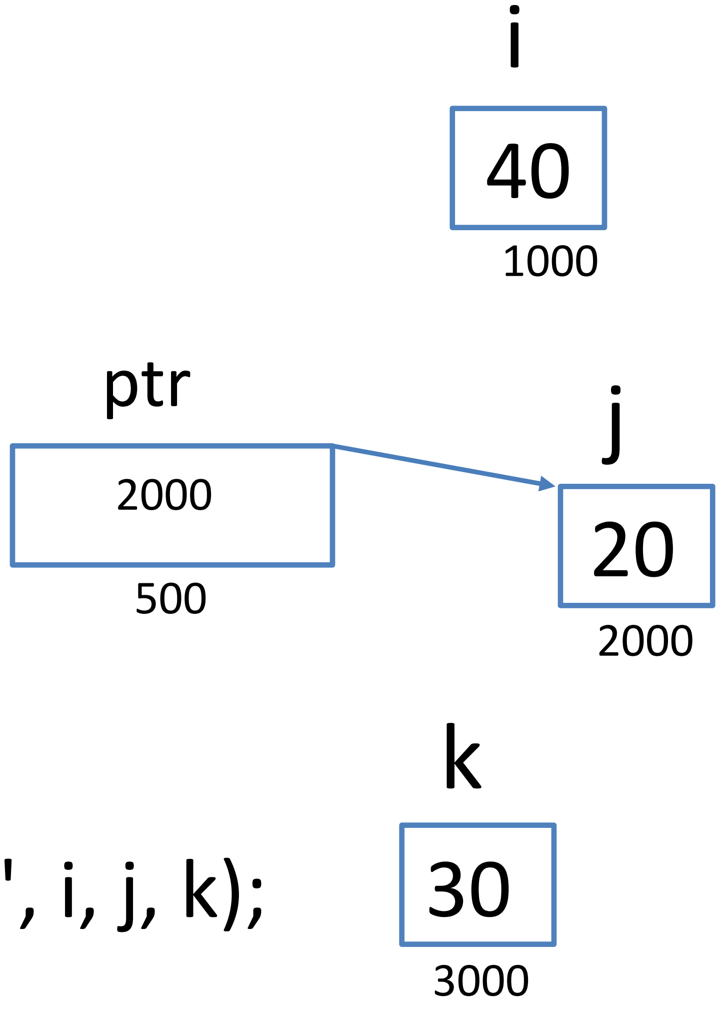
Q4: What is the value of i, j and k?

```
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);
```



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);
```

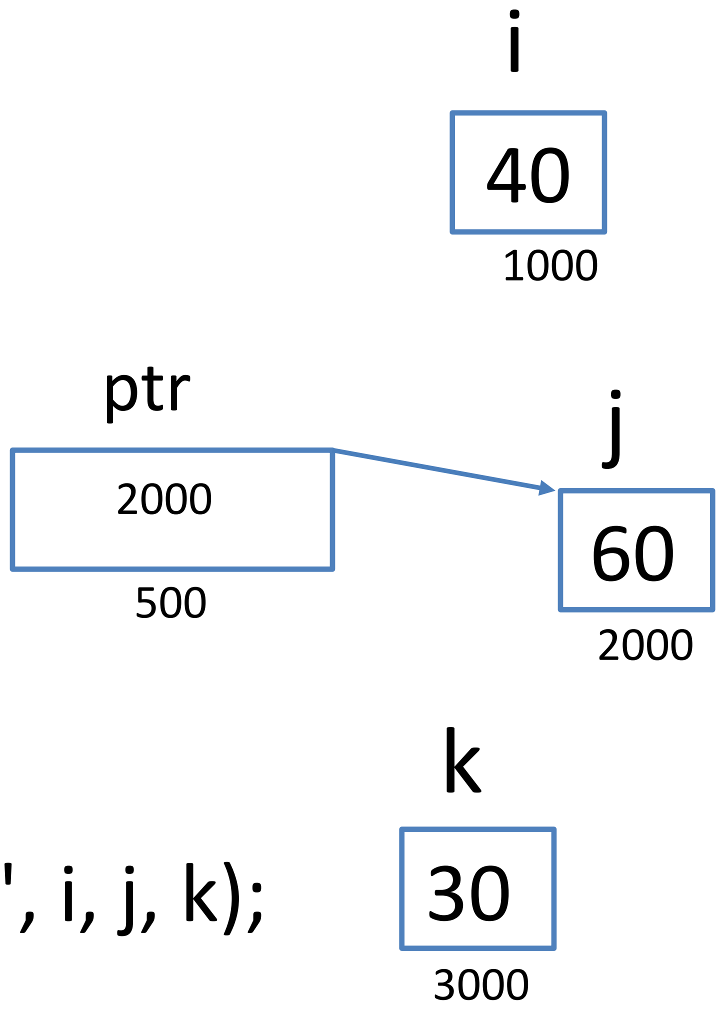


Q4: What is the value of i, j and k?

```
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);
```

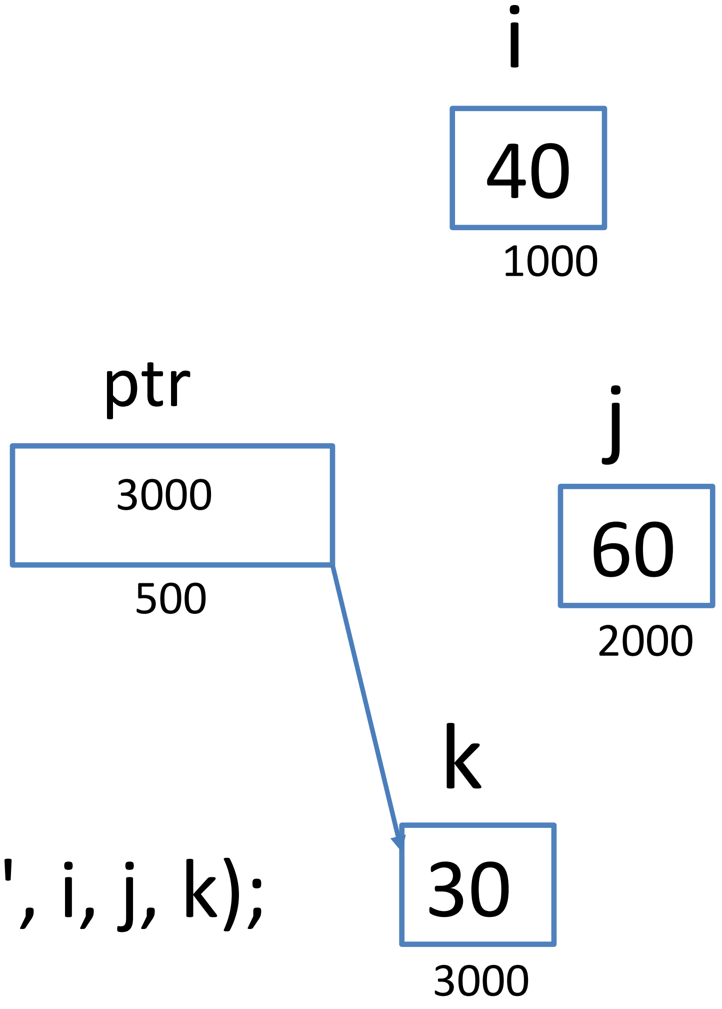
***ptr = *ptr + i;**

= 20 + 40



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

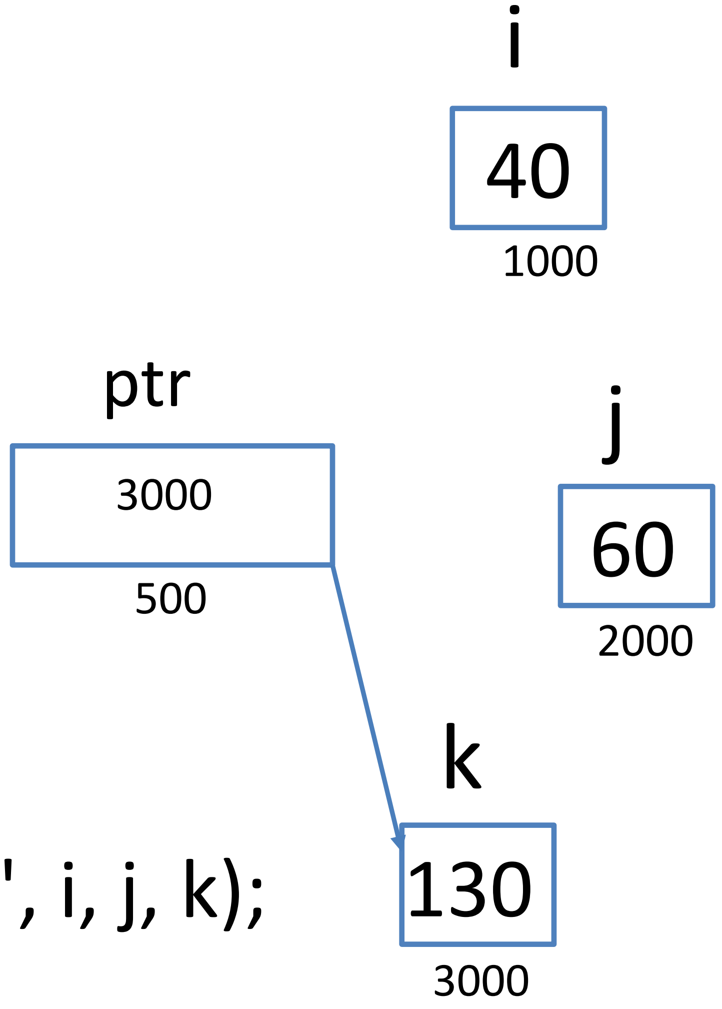
```
int *ptr, i = 10, j = 20, k = 30;
ptr = &i;
*ptr = 40;
ptr = &j;
*ptr += i;
ptr = &k;
*ptr += i + j ;
printf("i = %d j = %d k = %d\n", i, j, k);
```



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

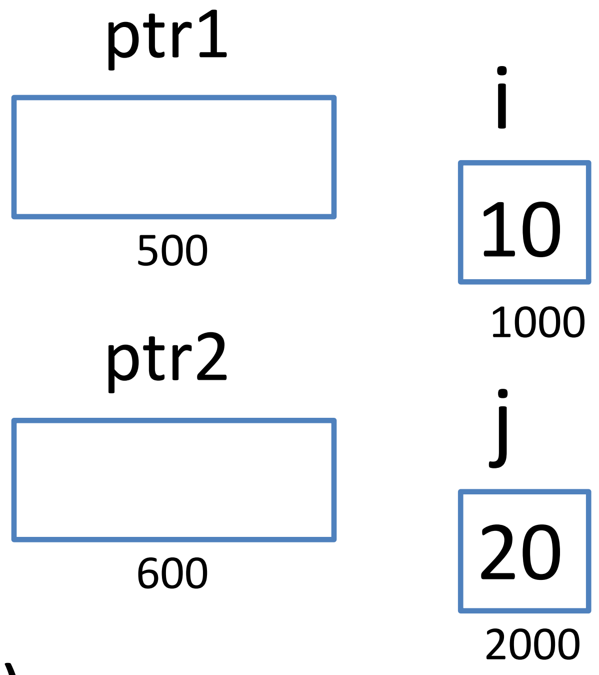
```
int *ptr, i = 10, j = 20, k = 30;
ptr = &i;
*ptr = 40;
ptr = &j;
*ptr += i;
ptr = &k;
*ptr += i + j ;
printf("i = %d j = %d k = %d\n", i, j, k);
```

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



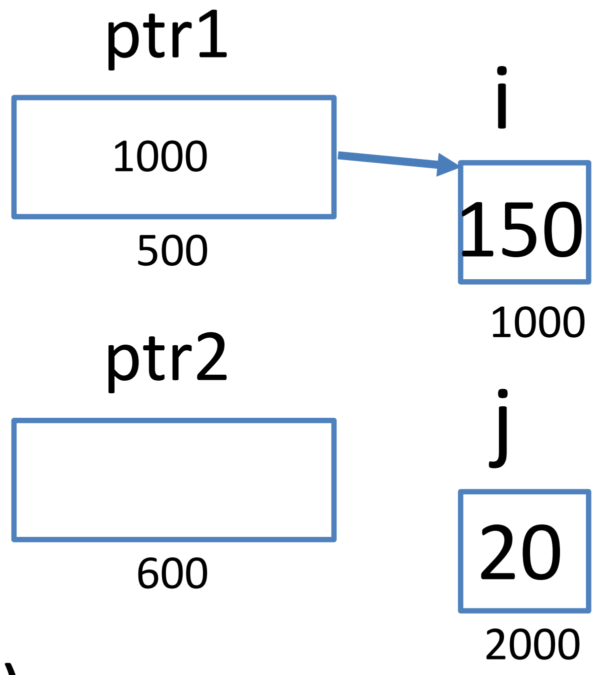
Q5: What is the value of j?

```
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);
```



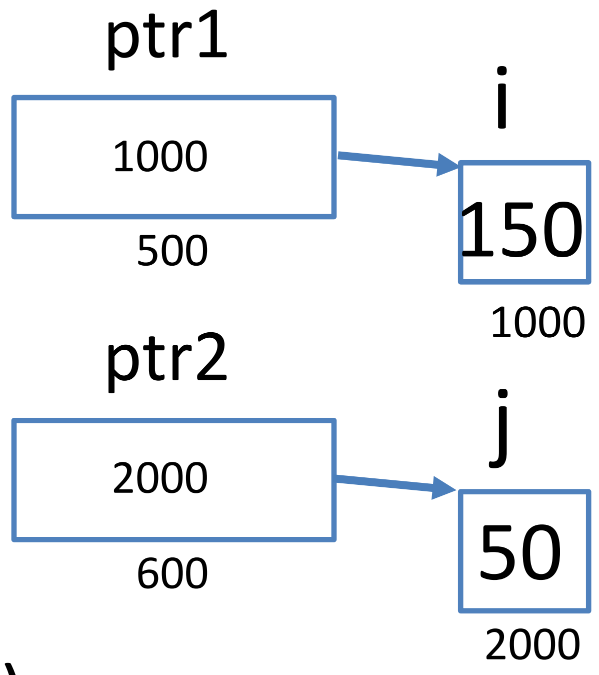
Q5: What is the value of j?

```
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);
```



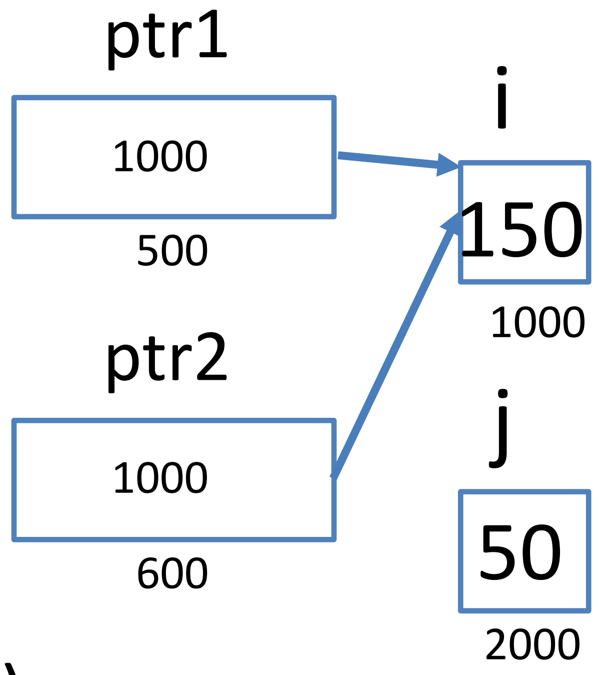
Q5: What is the value of j?

```
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);
```



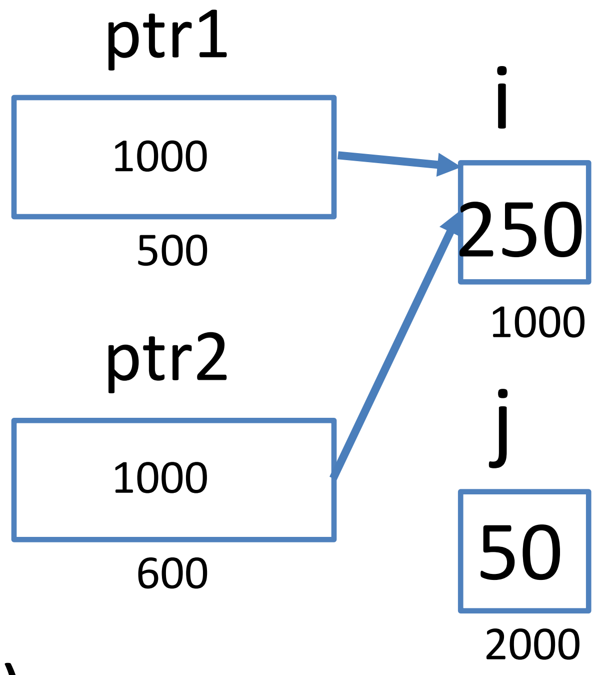
Q5: What is the value of j?

```
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);
```



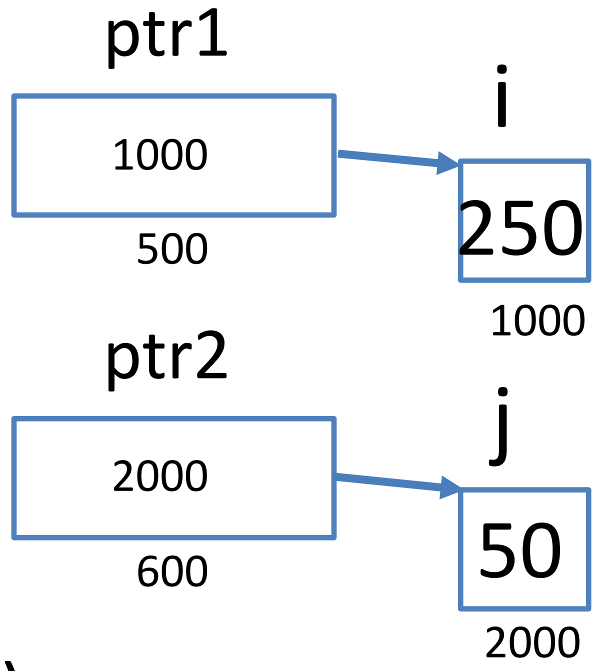
Q5: What is the value of j?

```
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);
```



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);
```

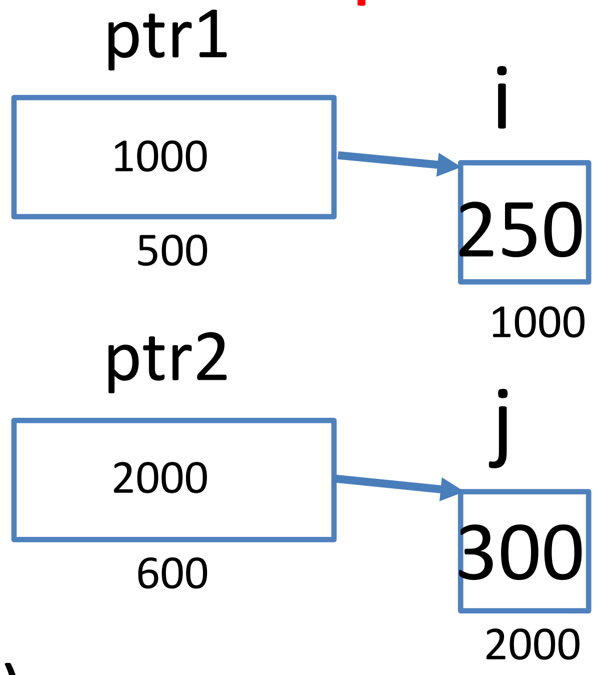


Q5: What is the value of j?

```
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);
```

***ptr2 = *ptr2 + *ptr1;**

***ptr2 = 50 + 250**



Summary

- Array of pointers
- Pointer arithmetic (e.g., subtracting, comparing)