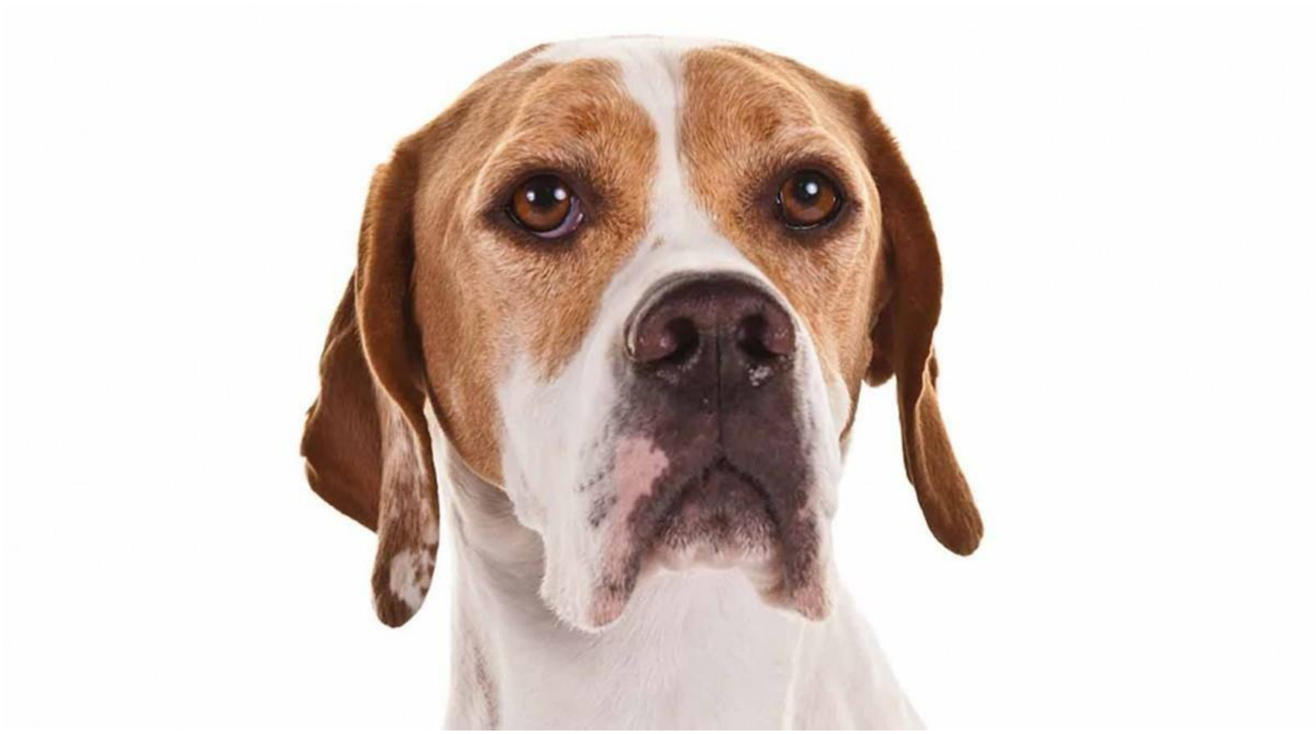

Week 4- lecture 3
Pointers

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Autumn 2021

https://www.vectorstock.com/royalty-free-vector/smiling-donkey-head-vector-1217480

Quiz
What is arr[0] + arr[3]?

```
int arr[] = {10, 20, 30, 40, 50};
int *const ptr;
ptr = arr;
*ptr = 1;
ptr += 3;
*ptr = 3;
printf("Val = %d\n", arr[0]+arr[3]);
```

a) 50
b) 40
c) 4
d) Error

Quiz
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int arr[] = {10, 20, 30, 40, 50};
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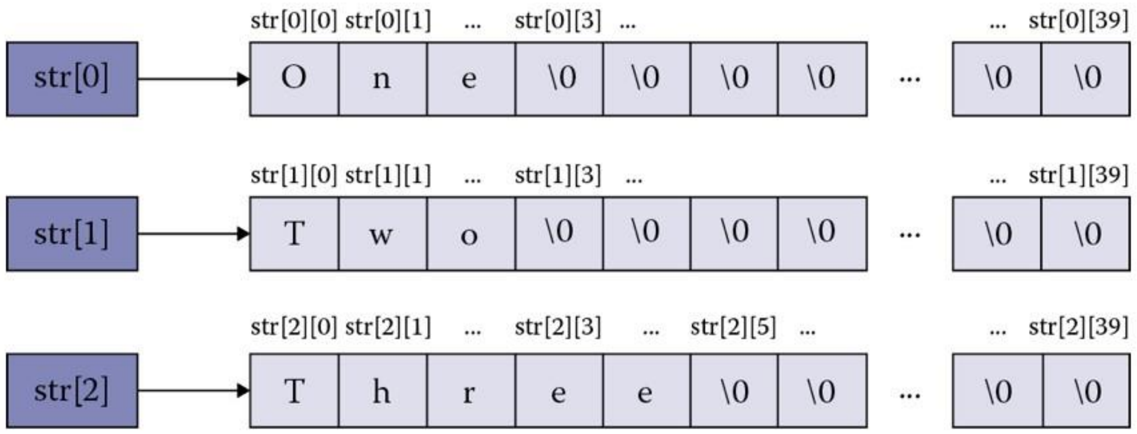
a) 50
b) 40
c) 4
d) Error

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

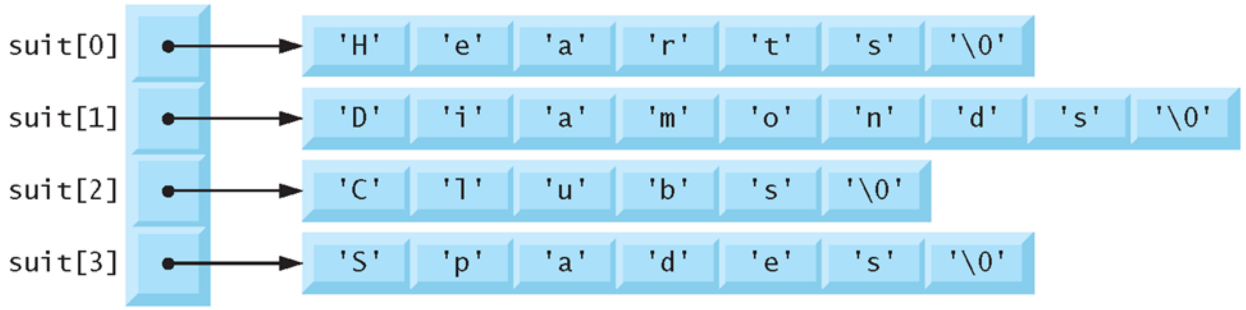
- Every element in the array is a pointer to the same data type
- char *arr[3]; array of 3 pointers to arrays of characters
  - Common use i.e. array of strings



str[0]
str[0][0] str[0][1] ... str[0][3] ... ... str[0][39]
O n e \0 \0 \0 \0 ... \0 \0
str[1]
str[1][0] str[1][1] ... str[1][3] ... ... str[1][39]
T w o \0 \0 \0 \0 ... \0 \0
str[2]
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]
suit[1]
suit[2]
suit[3]
'H' 'e' 'a' 'r' 't' 's' '\0'
'D' 'i' 'a' 'm' 'o' 'n' 'd' 's' '\0'
'C' 'l' 'u' 'b' 's' '\0'
'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]);
  }
  ```

  a) 0, 0, 0
  b) 1, 2, 3
  c) 10, 20, 30
  d) 0, 1, 2

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]);
  }
  ```

  a) 0, 0, 0
  b) 1, 2, 3
  c) 10, 20, 30
  d) 0, 1, 2

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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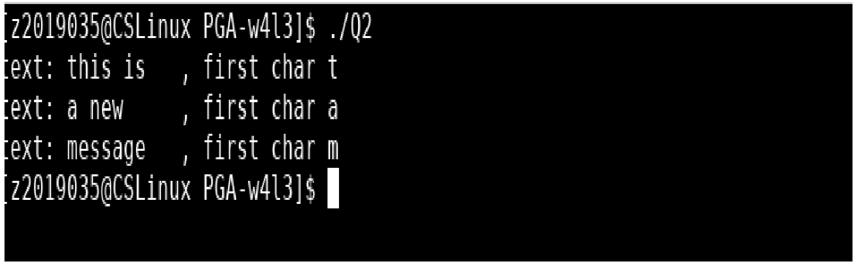
Q2: What are first chars?

- 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]);



```
[z2019035@CSLinux PGA-w4l3]$ ./Q2
ext: this is    , first char t
ext: a new      , first char a
ext: message    , first char m
[z2019035@CSLinux PGA-w4l3]$
```

Overview

- Declaration and initialisation
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  - String literals
- Array of pointers
- **Pointer arithmetic (e.g. subtracting, comparing)**

Pointer Arithmetic

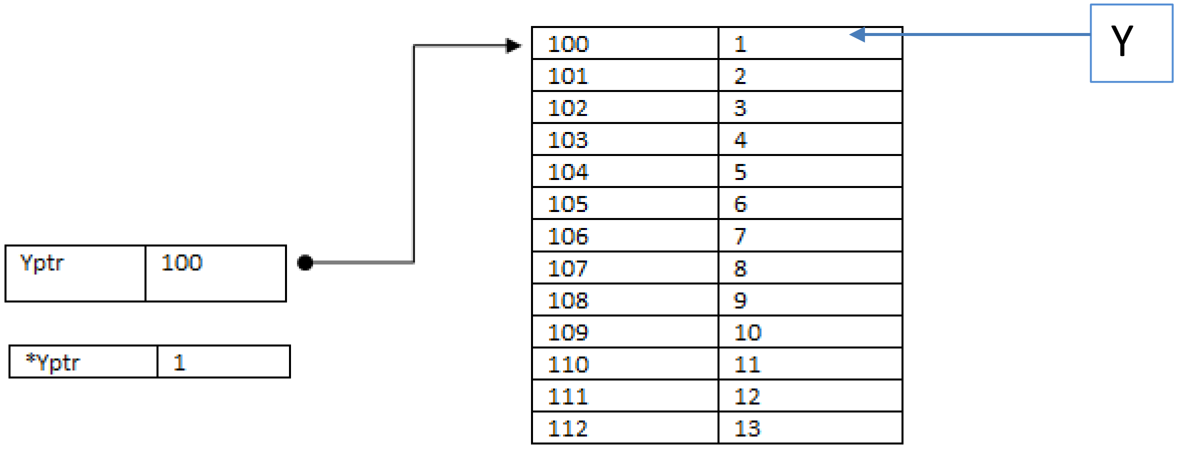
ptr = ptr + n;

- **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 byte.
- **double: ptr** is increased by n * 8; double size is 8 byte.

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 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);
```

a) Reduces the value of i by 10
b) Reduces memory address of i by 40 bytes
c) Reduces memory address of i by 10 bytes
d) Reduces memory address of i by 10

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Q3: explain how this Pointer works?

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

a) Reduces the value of i by 10
b) Reduces memory address of i by 40 bytes
c) Reduces memory address of i by 10 bytes
d) Reduces memory address of i by 10

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);
```

a) i= 20, j= 60, k= 100
b) i= 40, j= 60, k= 130
c) i= 40, j= 60, k= 100
d) i= 40, j= 20, k= 100

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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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a) i= 20, j= 60, k= 100
b) i= 40, j= 60, k= 130
c) i= 40, j= 60, k= 100
d) i= 40, j= 20, k= 100

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);
  ```

a) Val = 500
b) Val = 250
c) Val = 50
d) Val = 300

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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);
  ```

a) Val = 500
b) Val = 250
c) Val = 50
d) Val = 300

Summary

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

Quiz!

Which one is True?

A) Pointers with different data type can be still compared.

B) Array of pointers is declared as same as a pointer of arrays.

C) char ptr++, increases the address of ptr by 4 bytes.

D) Pointer subtracting works only on same data types.

Quiz!

Which one is True?

A) Pointers with different data type can be still compared.

B) Array of pointers is declared as same as a pointer of arrays.

C) char ptr++, increases the address of ptr by 4 bytes.

D) Pointer subtracting works only on same data types.

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