CS1100 – Introduction to Programming

Instructor:

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Lecture 27

Sorting algorithms

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  nearly sorted inputs occur in practice many times
- Several other sorting algorithms (Quick-sort, Bubble-sort, Heap-sort) exist and many are implemented in libraries.

Link

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- **(Different) Recursive Thinking**: Divide the array into two halves, recursively sort them, merge the resulting arrays into one array keeping the result to be sorted.
  This is new ! - called **merge sort**.

Recursive version of Insertion Sort

```
#include <stdio.h>
void recursiveInsertionSort(int arr[], int n){
   if (n <= 1)
      return;
   recursiveInsertionSort( arr, n-1 );
   int nth = arr[n-1];
   int j = n-2;
   while (j >= 0 && arr[j] > nth){
      arr[j+1] = arr[j];
      j--;
   }
   arr[j+1] = nth;
}
int main(){
   int array[] = {34, 7, 12, 90, 51};
   int n = sizeof(array)/sizeof(array[0]);
   printf("Unsorted Array:\t");
      for (int i=0; i < n; i++)
   printf("%d ",array[i]);
      recursiveInsertionSort(array, n);
   printf("\nSorted Array:\t");
   for (int i=0; i < n; i++)
      printf("%d ",array[i]);
   return 0;
}
```

Links

- Merge Sort Visualizer (Click on this link).

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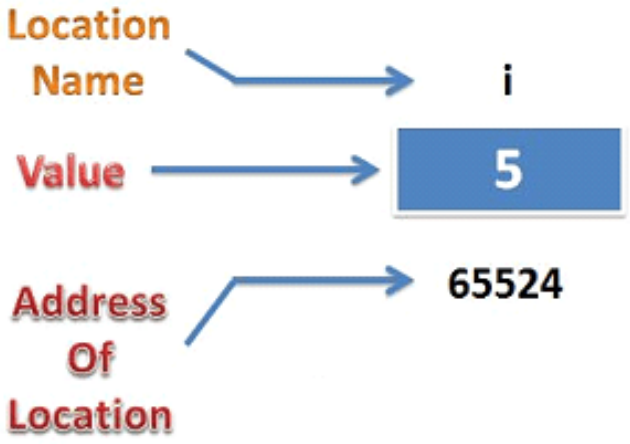

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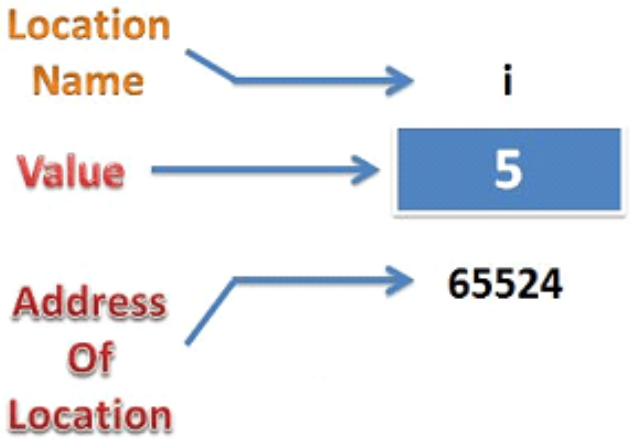

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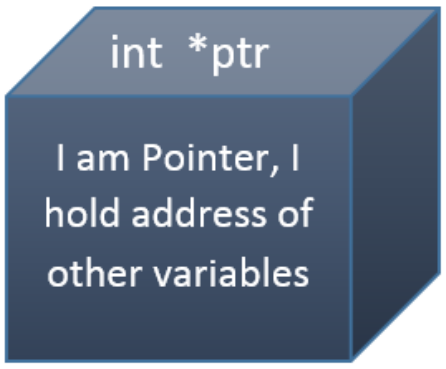

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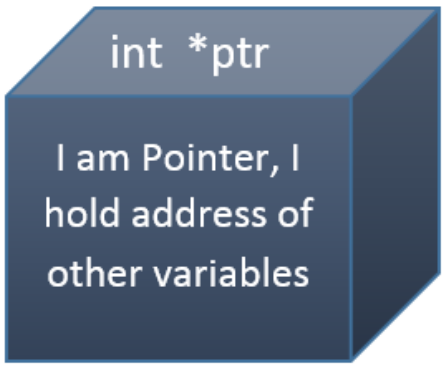

Example :

```
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For instance, it can hold the address 65524 which will be the address of the variable `i`.

Initializing and dereferencing a pointer

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int *ptr1; // ptr1 is the address of an integer variable.
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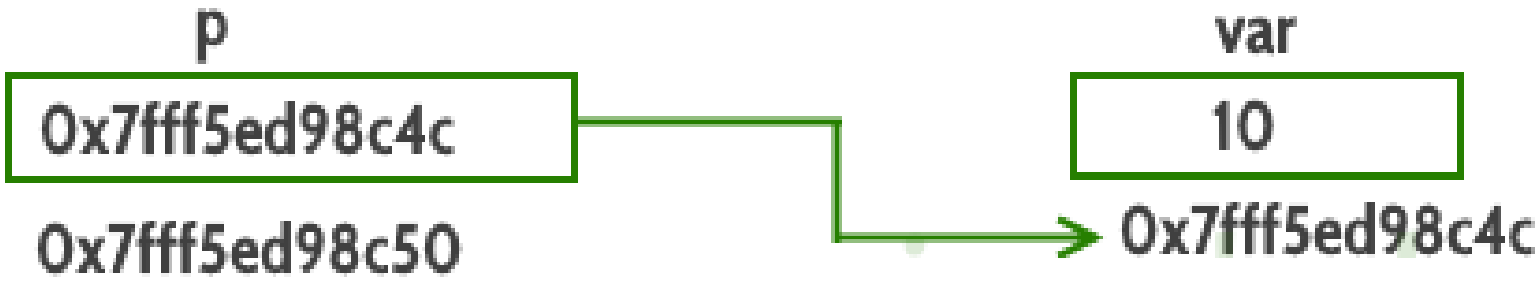
  Example : `ptr1 = &x` assigns the address of the location where variable x is stored to the pointer variable `ptr1`.
- **Dereferencing a pointer** : Accessing the variable pointed to by a pointer. Use the * operator.
  Example : `*ptr1` gives the value stored in the memory location that the `ptr1` points to (if it does !).

Demo 1 : Initializing and dereferencing

```
int var = 10;
int *p;
p = &var;
```



P is a pointer that stores the address of variable var.
The data type of pointer p and variable var should match because an integer pointer can only hold the address of integer variable.

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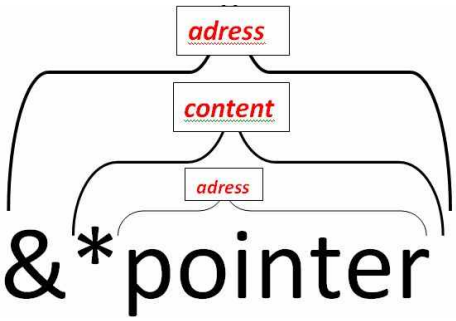

- Example :

```
int x, y, *ptr1;
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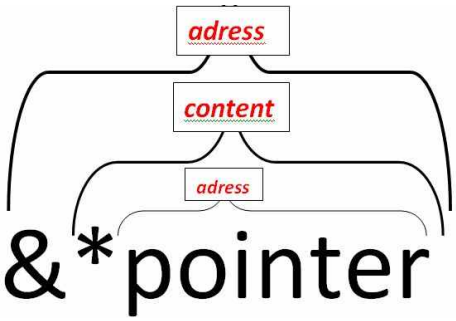

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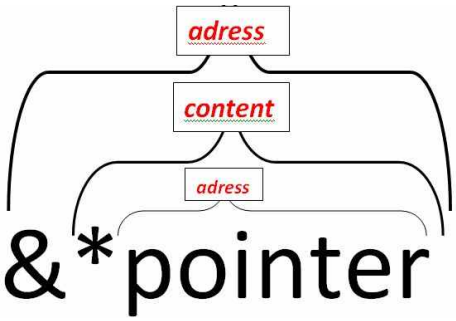

- Example :

```
int x, y, *ptr1;
ptr1 = &x; Initializing ptr1
x = 10;
y = *ptr1; Dereferencing ptr1
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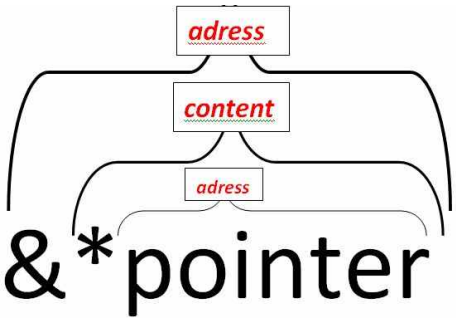

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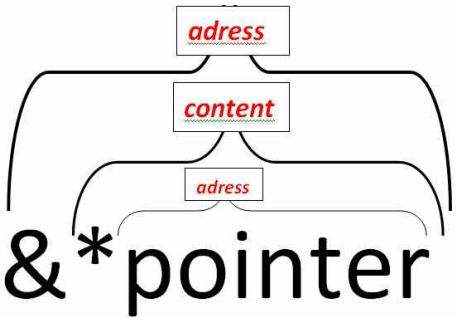

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- What are the values of `x, y, *ptr1`?
- after this, in the same program ...
  suppose we add :

```
ptr1 = &y;
(*ptr1)++;
```

- What are the values of `x, y, *ptr1`?

Example 2 : First programs using pointer manipulation

```
#include<stdio.h>
int main() {
    int count;
    int *countPtr;

    count = 10;
    countPtr = &count;
    printf("count = %d\n", count);
    printf("count via countPtr = %d\n",  *countPtr);
    printf("address of count = %p\n", &count);
    printf("value of countPtr = %x\n", countPtr);
}
```

Example 3 : Second program using pointers

```
#include <stdio.h>
int main(){
   int* pc;
   int c;
   c=22;
   printf("Address of c:%p\n",&c);
   printf("Value of c:%d\n\n",c);
   pc=&c;
   printf("Address stored in the pointer pc:%p\n",pc);
   printf("Content of location pointed to by pc:%d\n\n",*pc);
   c=11;
   printf("Address stored in the pointer pc:%p\n",pc);
   printf("Content of location pointed to by pc:%d\n\n",*pc);
   *pc=2;
   printf("Address of c:%p\n",&c);
   printf("Value of c:%d\n\n",c);
   return 0;
}
```

An Application : Passing Parameters to Functions

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void swap(int x, int y)
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int main()
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- **Error** : No swapping happens.
- **Our usual solution :** Make a and b global variables.
- This is convenient but dangerous - because there may be other functions which uses these variables.
- Here is a more elegant solution : pass pointers holding the addresses of a and b to the function.

An Application : Passing Parameters to Functions (a review of Swap)

Fixing the error:

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Original Version :

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    x = y;
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- This is achieved by passing the address of the variable.
  - The caller uses &var-name to pass it to the function.
  - The function prototype must accept a pointer to the appropriate data type.

Another Swap function

```
#include<stdio.h>
void swap(int *p1, int *p2)
{
     int *temp;
     printf ("before (in function) %p %p\n", p1, p2);
     temp = p1;
     p1 = p2;
     p2 = temp;
     printf ("(after (in function) %p %p\n", p1, p2);
}

int main()
{
    int a = 10, b = 20;
    printf ("in main (before swap) %d %d %p %p\n", a, b, &a, &b);
    swap(&a, &b);
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    printf ("in main (after swap) %d %d %p %p\n", a, b, &a, &b);
}
```

Why does this function not achieve the desired swap?