SMR3821: C and Linux for Science Engineering:

Introduction to C Programming

Pointers

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Outline

where are we?

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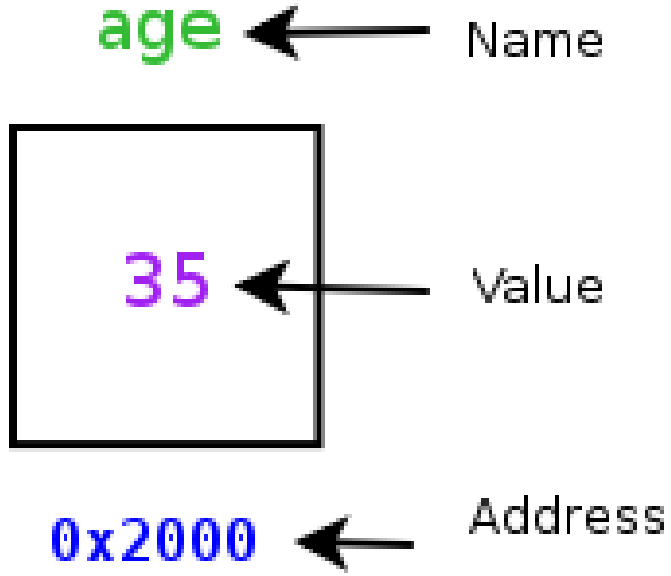
Variables Revisited

Recall that a variable has the following characteristics

1. name
2. address
3. value
4. type



How can we obtain the address of a variable?

By using the 'Address Of' operator **&**

ILLUSTRATION:

```c
#include<stdio.h>

int main()
{
        float X = 302.45;

        printf("Value of X = %f\n",X);
        //Use of Address Of operator &
        printf("Memory Address of X = %p\n",&X);

}
```

Given a memory address, how do we determine the value at that location?

By using the 'Value At Address' Or Indirection operator *

ILLUSTRATION:

```
1 #include<stdio.h>
2
3 int main()
4 {
5         float X = 302.45;
6         //The usual way
7         printf("Value of X = %f\n",X);
8         //The use of the 'Value At Address' operato
9         printf("Value of X = %f\n", *(&X)   );
10
11
12 }
```

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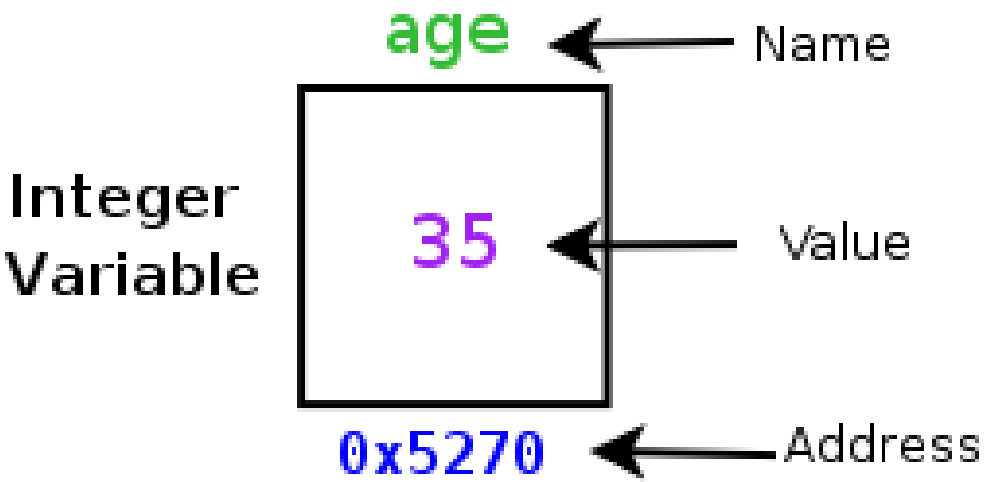
What is a Pointer?

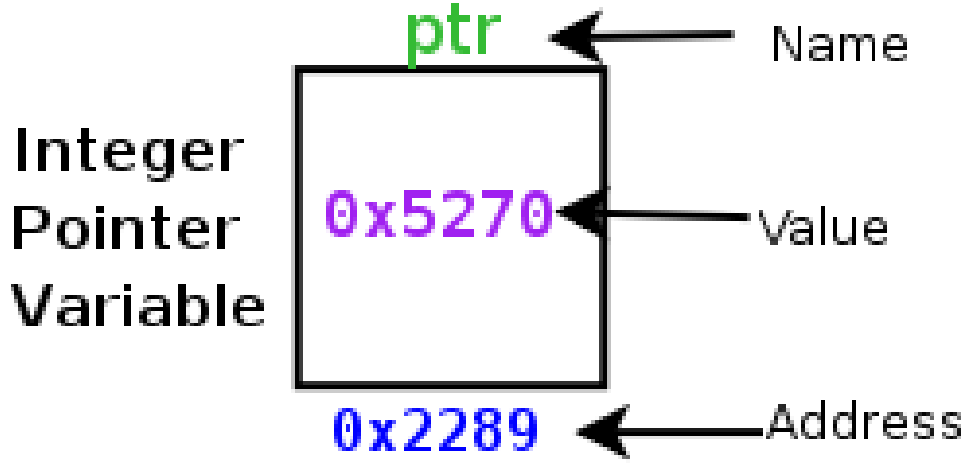
A Pointer is a variable that holds memory address values.

Since a pointer is still a variable, the following characteristics still apply.

1. name
2. address
3. value
4. type

The type a of pointer determines the kind of address it can store. For example, if we say a pointer is of type int, then only the memory address of integer variables can be stored by the pointer.


age
Name
Integer Variable
35
Value
0x5270
Address


ptr
Name
Integer Pointer Variable
0x5270
Value
0x2289
Address

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Syntax: Declaration of a Pointer

```
data_type * pointer_name;

//declare an integer pointer
int*iPtr;

//declare a character pointer
char * pointer;

//declare a float pointer
float *direct;

//declare a pointer to an integer pointer
int ** k;
```

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Syntax: Example Using Pointers

```c
#include<stdio.h>

int main()
{
        int i = 200;      //integer variable
        int * j;          //integer pointer
        int ** k;         //pointer to an integer pointer

        j=&i;             //assign address of i to j
        k=&j;             //assign address of j to k

        printf("Addr. of i = %p\n",&i);
        printf("Addr. of i = %p\n",j);
        printf("Val. of i = %d\n",i);
        printf("Val. of i = %d\n",*(&i));
        printf("Val. of i = %d\n",*j);
        printf("Val. of i = %d\n",**k);

}
```

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Passing Arguments By Value

Pass By Value Copies of values of actual arguments are passed on to their corresponding formal arguments during function invocation.

Example

```c
#include<stdio.h>
void swap(int,int);
int main()
{
   int i=5;
   int j=10;
   printf("\nIn main :: Before swap: i = %d, j = %d",i,j);
   swap(i,j);
   printf("\nIn main :: After swap: i = %d, j = %d\n",i,j);
}

void swap(int a, int b)
{
   int tmp;
   printf("\nIn swap :: Before swap: a = %d, b = %d",a,b);
   tmp=a;
   a=b;
   b=tmp;
   printf("\nIn swap :: After swap: a = %d, b = %d",a,b);
}
```

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Passing Arguments By Reference

Pass By Reference Addresses of actual arguments are passed on to their corresponding formal arguments duing function invocation.

Example

```c
#include<stdio.h>
void swap(int*,int*);
int main()
{
   int i=5;
   int j=10;
   printf("\nIn main :: Before swap: i = %d, j = %d",i,j);
   swap(&i,&j);
   printf("\nIn main :: After swap: i = %d, j = %d\n",i,j);
}

void swap(int * a, int * b)
{
   int tmp;
   printf("\nIn swap :: Before swap: a = %d, b = %d",*a,*b);
   tmp=*a;
   *a=*b;
   *b=tmp;
   printf("\nIn swap :: After swap: a = %d, b = %d",*a,*b);
}
```

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Pointers In Arithmetic Expressions

Pointers can be used in arithmetic expression as illustrated below: Example

```
1 #include<stdio.h>
2
3 int main()
4 {
5         int x=200;
6         int y=400;
7         int * ptrX;
8         int * ptrY;
9
10        ptrX=&x;
11        ptrY=&y;
12
13        printf("\nx + *ptrX = %d",x + *ptrX);
14        printf("\ny - *ptrY = %d",y - *ptrY);
15        printf("\n5 * *ptrX - *ptrY = %d",5* *ptrX - *ptrY);
16        printf("\n*ptrX * *ptrY = %d",*ptrX * *ptrY);
17        printf("\n*ptrY / *ptrX = %d\n",*ptrX/ *ptrY);
18 }
```

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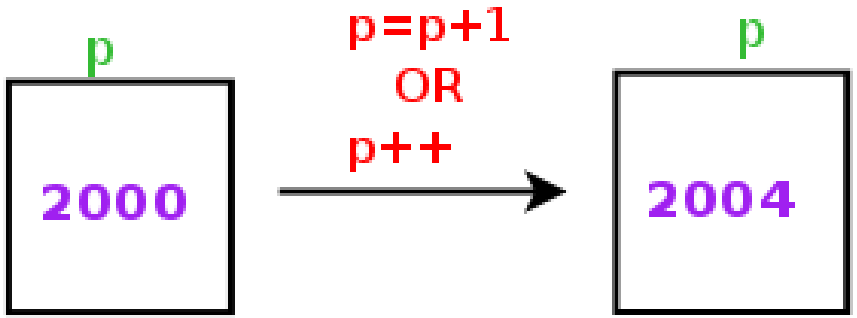
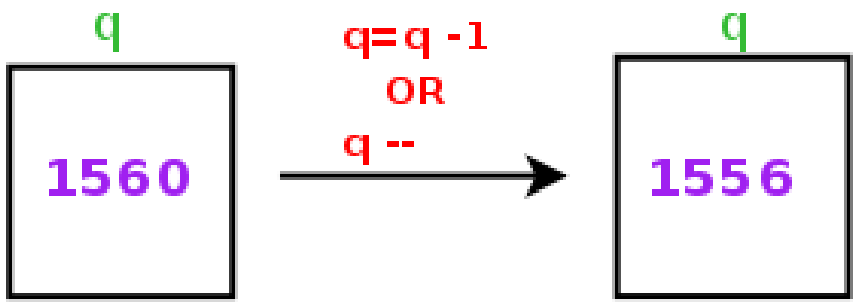
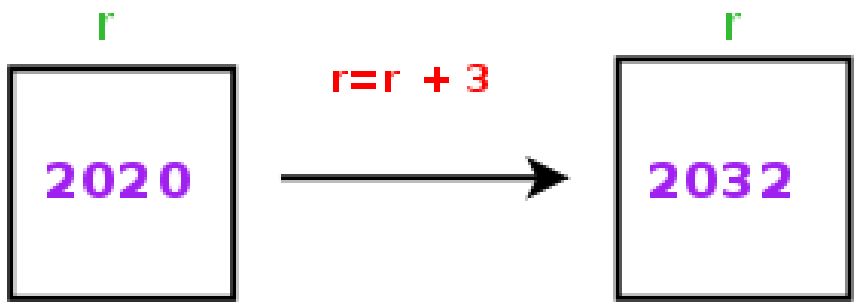
Pointer Arithmetic

Suppose p,q and r are integer pointers







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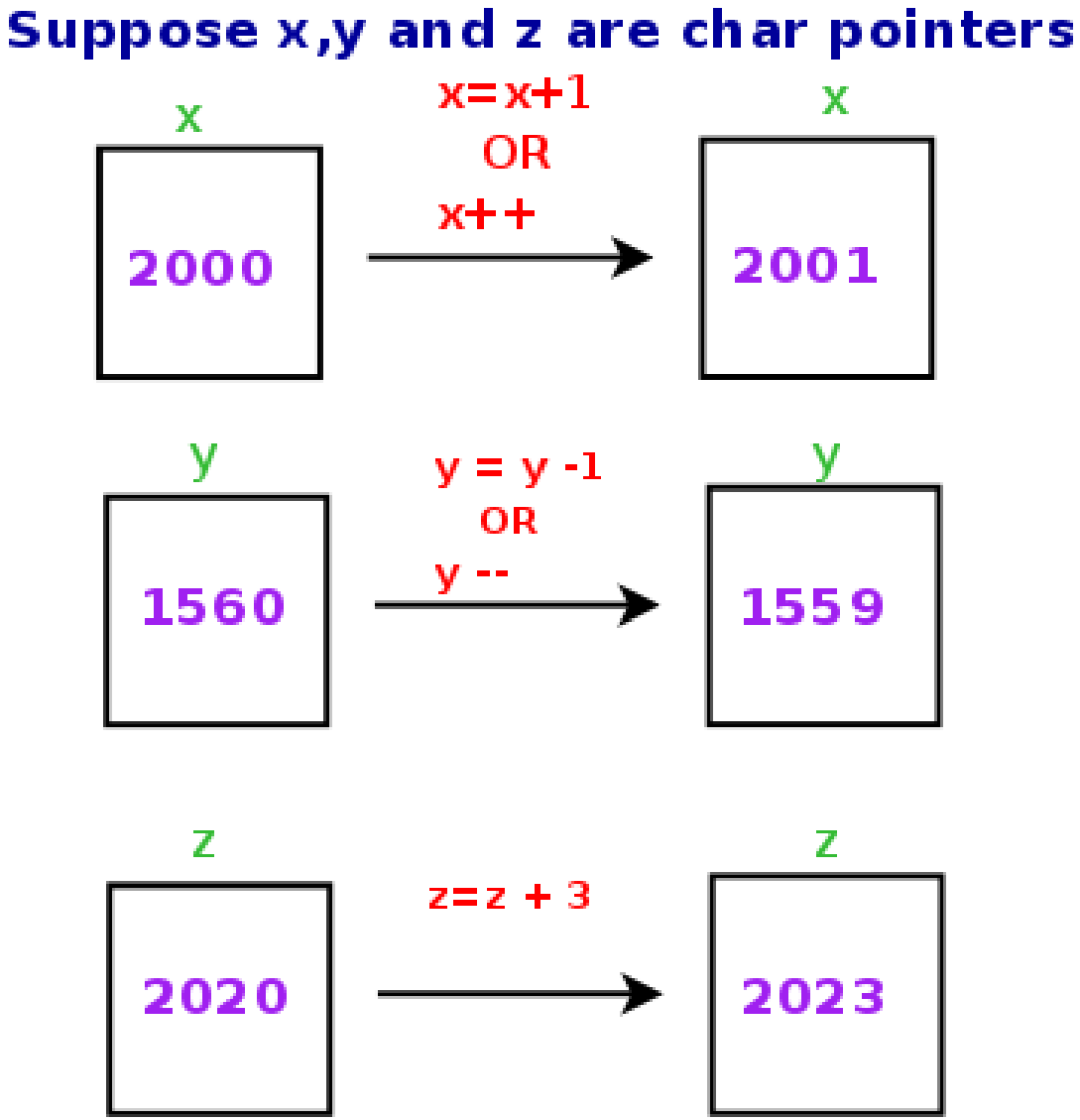
Pointer Arithmetic



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Pointer Arithmetic

1. When we increment a pointer, its value is increased by the length of the data type it points to.
   - char (1 byte)
   - integer (4 bytes) 32 bit word computer
   - float (4 bytes)
   - double (8 bytes)
2. The length is refered to as the scale factor

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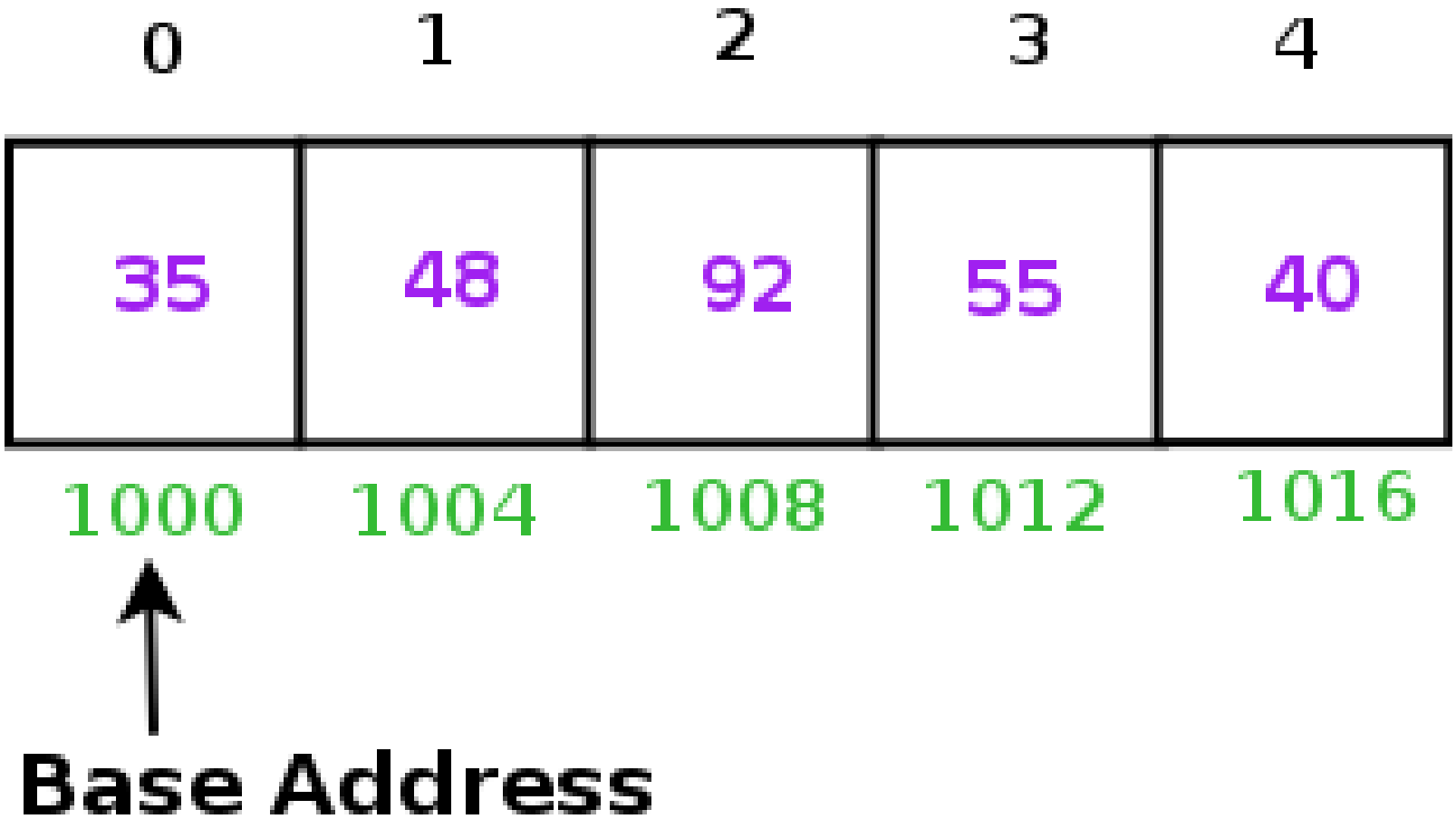
Pointers & Arrays



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Pointers & Arrays

The address of the first element of an array is called the Base Address

The base address of an array may be assigned to a pointer in two way:

```
1 int marks[5];
2 int * ptr;
3
4 //Assign base address of marks to ptr
5 ptr=&marks[0];
6
7 //Alternatively, assign base address of marks to pt
8 ptr=marks;
```

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Example of Pointers and Arrays

```c
#include<stdio.h>

int main()
{
        int marks[5]={30,20,70,25,55};
        int * ptr;
        int i=0;

        //assign base address of marks to ptr
        ptr=marks;

        for(i=0;i<5;i++)
        {
                printf("@ %u: marks[%d] = %d\n",(ptr+i), i,

        }
}
```

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Speed Byte

Question 1 :

With reference to question 1 on arrays, previously discussed, where you find fx values for given x, write a C code that has a void function called swap that uses pointer(s) to swap the values of x and fx and prints the results to screen.
The swap function should take two arguments:

swap(int * a, int * b)

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