A job ready bootcamp in C++, DSA and IOT

Pointers

Saurabh Shukla (MySirG)

Agenda

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2. Referencing and Dereferencing operators
3. What is pointer?
4. Size of pointer
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7. Extended concept of pointers
8. Pointer's Arithmetic
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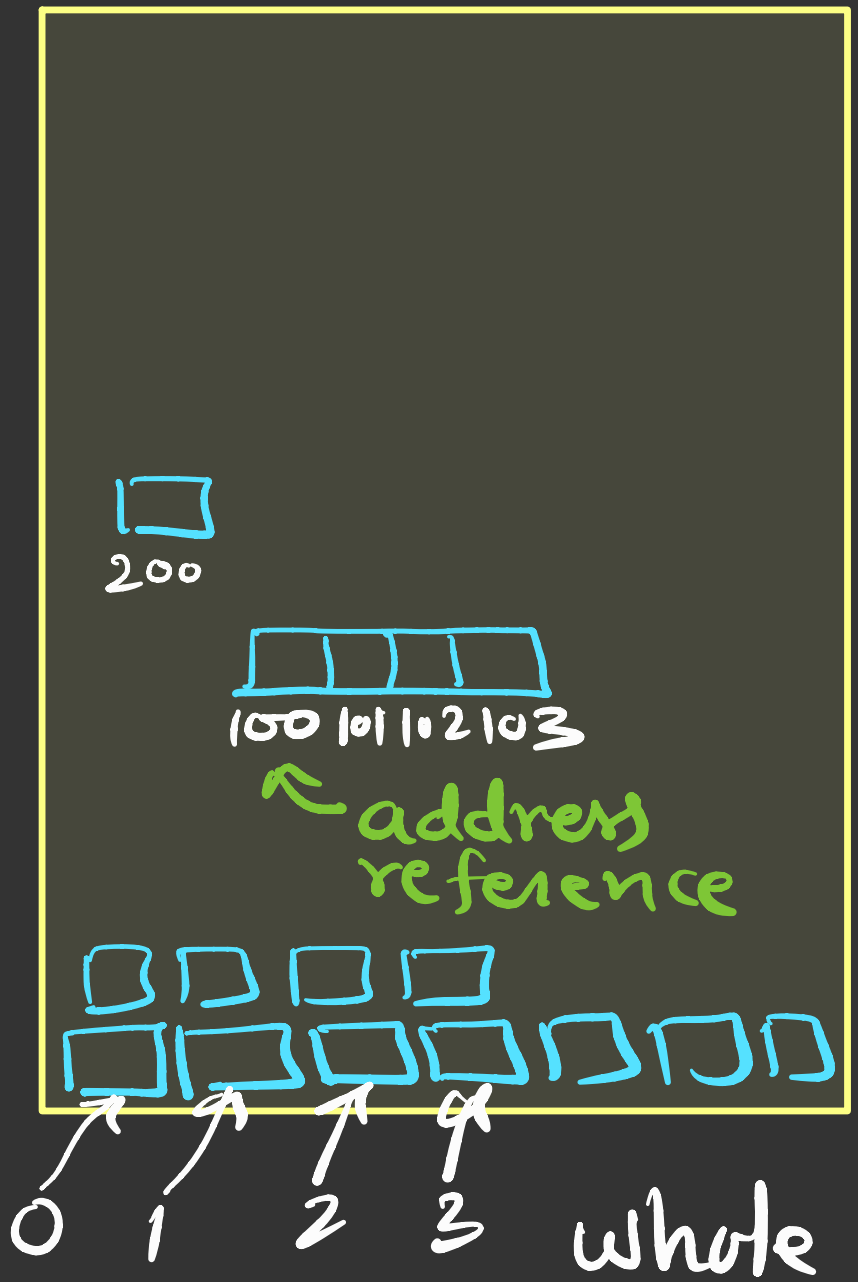
14. Wild pointer
15. NULL pointer
16. Dangling pointer
17. Void pointer

Introduction to Memory Address

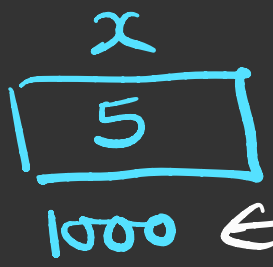
```
int x = 5;
char m = 'A';
```

logical address



Referencing and Dereferencing operators

```
int x=5;
printf("%d",&x); 1000
printf("%d", *&x ); 5
```



address
Reference
whole number
OS will decide

*&x ≈ x

&

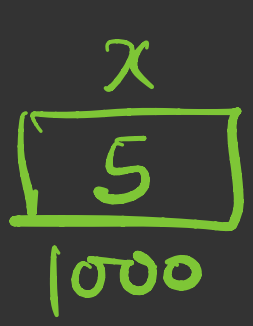
- Address of operator
- Referencing operator
- Unary operator
- & ___ ← variable

*

- Indirection operator
- Dereferencing operator
- Unary operator
- * ___ ← address

```
int x=5;
&x=7;
```

error




```
char str[20];
str = "MySirG";
```

address

```
strcpy(str, "MySirG");
```

&x is not a variable.
&x is just a way to represent address of variable x.
&x ⇒ 1000
&x is considered as a constant value

Constant =

error

```
int x = 5;
int *j;
j = &x;
```

j is a pointer variable

```
printf("%d %d %d", &x, j, *&x);
```

1000 1000 5

```
printf("%d %d %d", *j, x, &j);
```

5 5 2000

*j ≅ x

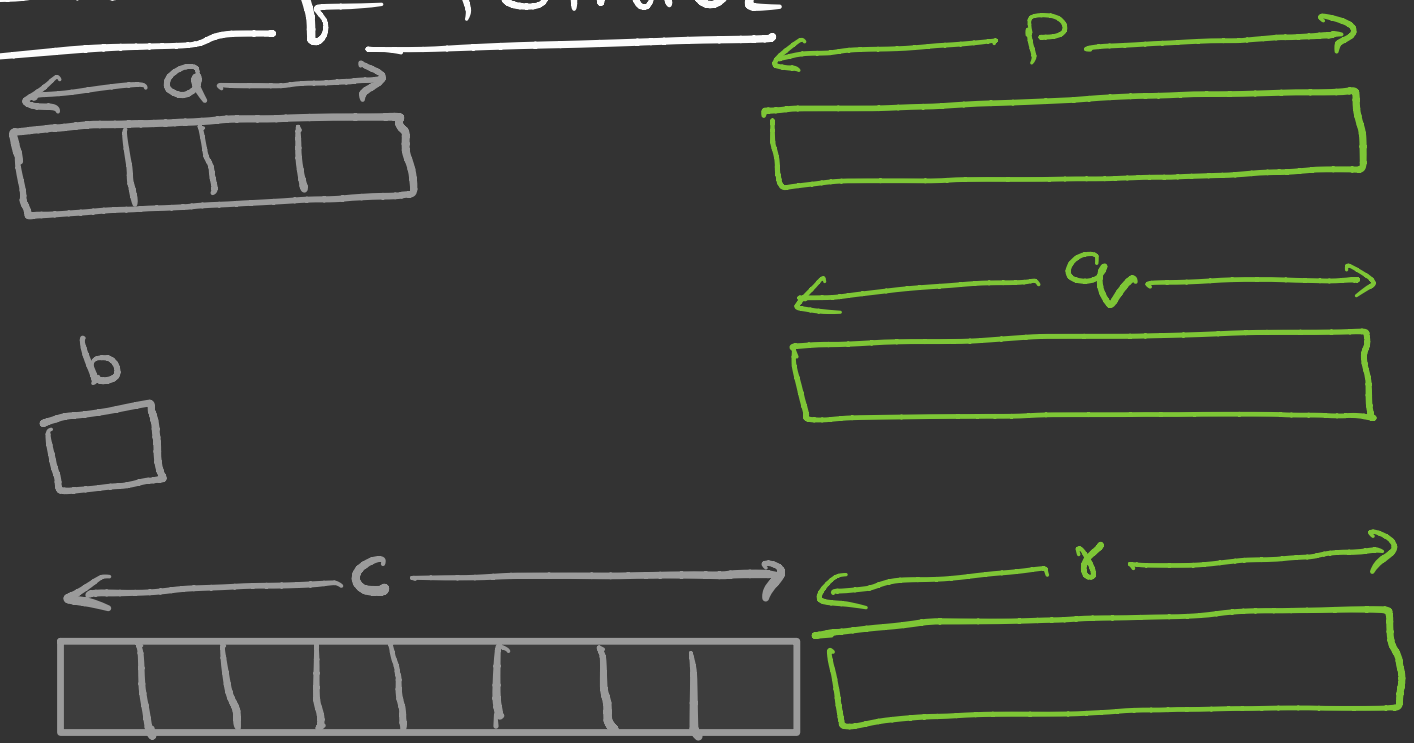
*j
*1000
x

What is a Pointer?

Pointer is variable, which contains address of another variable.

Size of Pointer

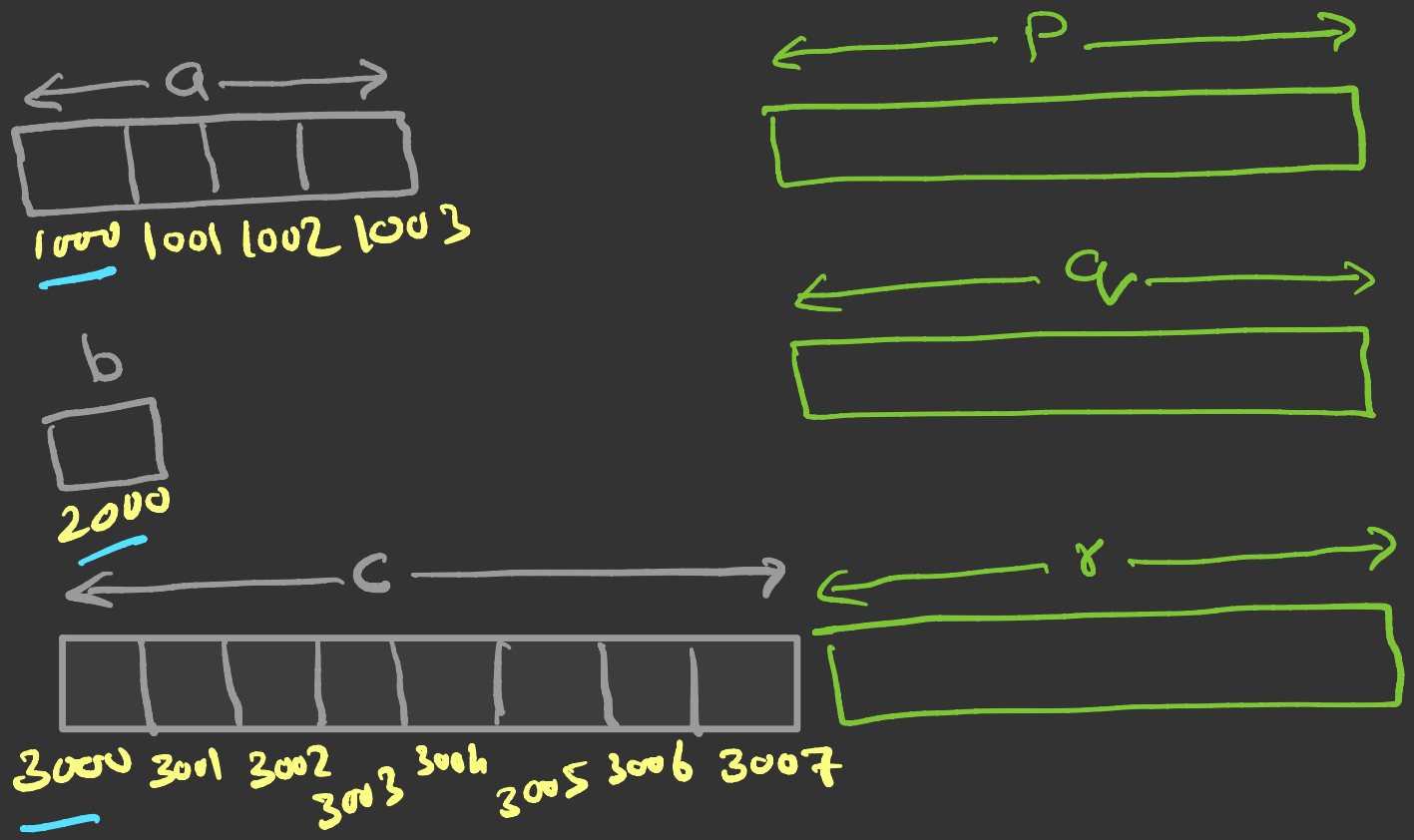
```
int a, *p;
char b, *q;
double c, *r;
```



- ordinary variables का size उसके data type पर depend करता है।
- size of pointer variable does not depend on it's data type

Base Address

```
int a, *p;
char b, *q;
double c, *r;
```

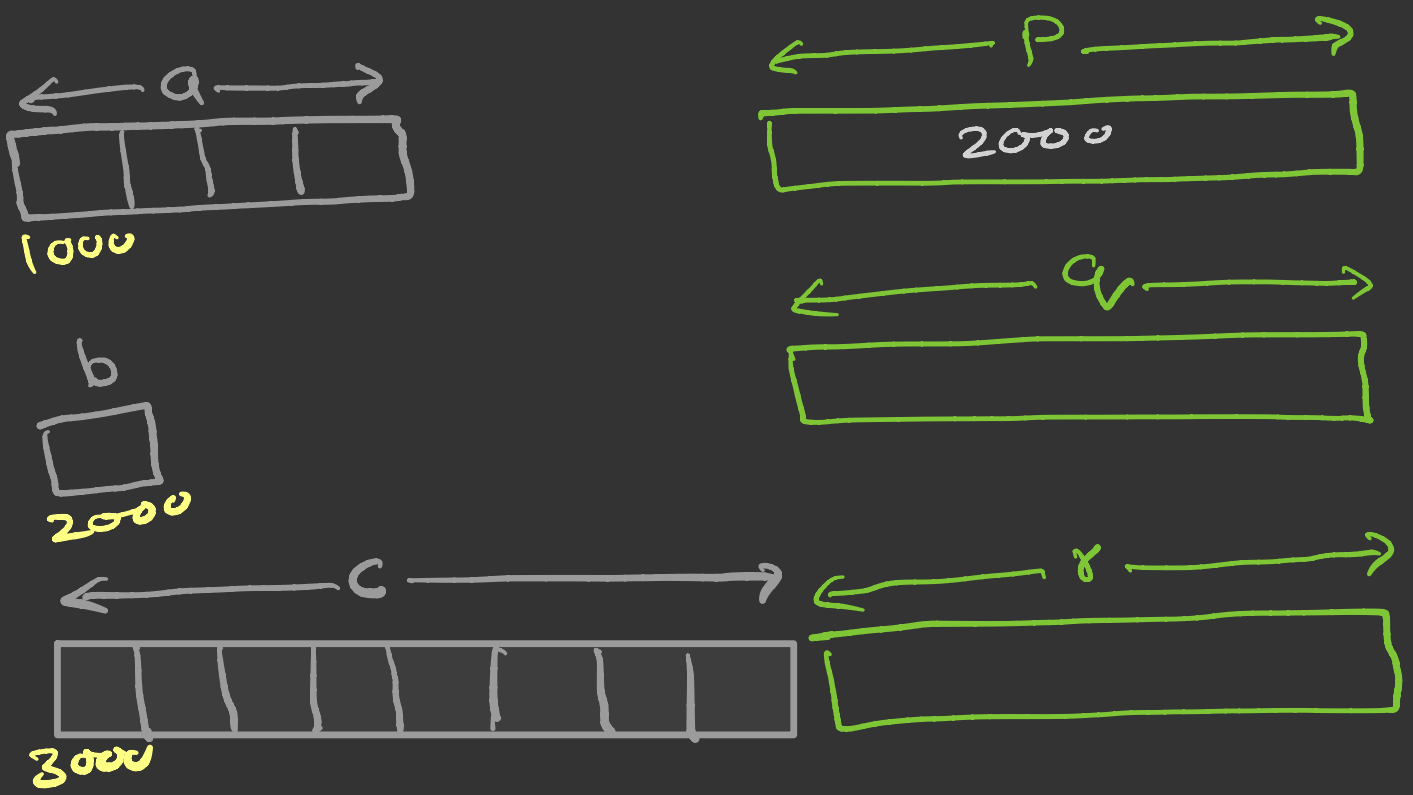


Base address

pointer variable always contains base address

Data Type of Pointer

```
int a, *p;
char b, *q;
double c, *r;
```

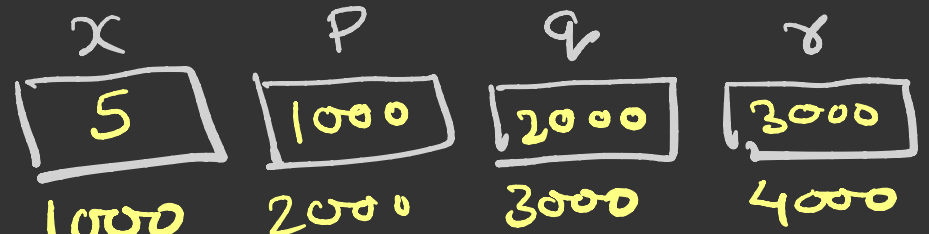


p = &b ; *p ≃ b

char *q ; q is not going to store character constant, but it is going to store address of char variable.

Extended Concept of Pointers

```
int x=5, *p, **q, ***r;
```




```
p=&x;
q=&p;
r=&q;
```

*p

*(*r)
*q
p

1000 4000 1000 1000

```
printf("%d %d %d %d", p, &r, *q, &x);
```

1000 3000 5 5

```
printf("%d %d %d %d", **r, &q, **&p, x);
```

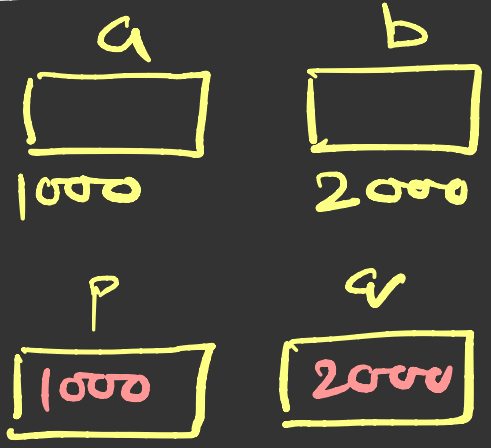
5 5 5 5

```
printf("%d %d %d %d", ***r, **q, *p, **&p);
```

```
int *p;
p = &p;   X
```

Pointer's Arithmetic

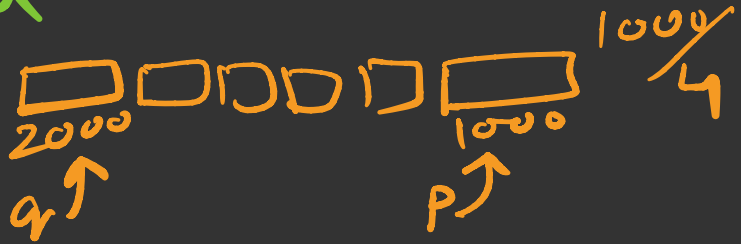
```
int a, b, *p, *q;
p = &a;
q = &b;
```



P+1 1004
P+2 1008
P+5 1020
q-1 1996
P-2 992
q-P 250

errors:
- P+q
- P*q
- P/q
- P*5
- P/4

valid:
- P+2
- P-5
- q-P



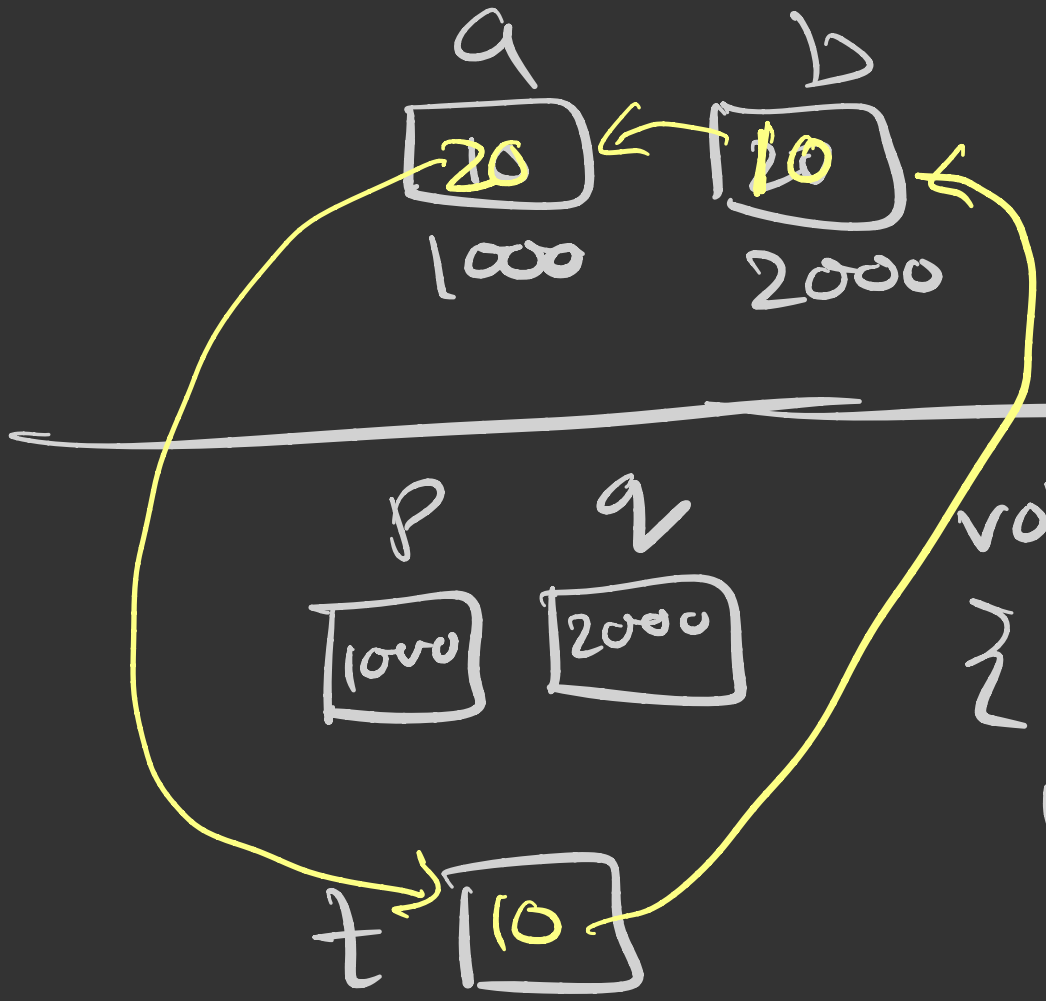
P+i => Address in P + sizeof(type of pointer) * i

P+5 => 1000 + 4*5
1000 + 20
1020

*p + *q

a + b

```
int main()
{
    int a, b;
    printf("Enter two numbers");
    scanf("%d %d", &a, &b);
    // call a function swap
    printf("%d %d", a, b);
    return 0;
}
```



swap (&a, &b)

```
void swap (int *p, int *q)
{
  int t ;
   t = *p ;
  *p = *q ;
  *q = t ;

}
```

Call by Reference

```
void swap(int *, int*);
int main()
{
    int a,b;
    printf("Enter two numbers");
    scanf("%d %d",&a,&b);
    swap(&a,&b);
    printf("%d %d", a, b);
    return 0;
}
void swap(int *p, int *q)
{
    int t;
    t = *p;
   *p = *q;
   *q = t;
}
```

call by reference

Formal argument

1. ordinary variable
2. pointer variable

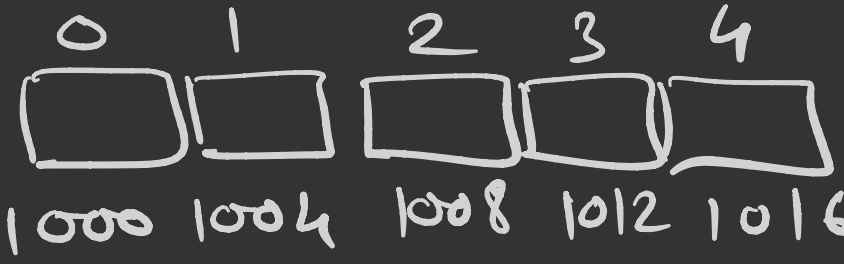
Why we use & in scanf() ?

```
scanf("%d", &x);
```

```
scanf( , *p)
```

Pointers and Arrays

```
int a[5];
```




```
int *p;
p = &a[0];
```

p+0	1000	&a[0]
p+1	1004	&a[1]
p+2	1008	&a[2]
p+i		&a[i]

```
fun(a);
```

*(p+0)	a[0]
*(p+1)	a[1]
*(p+i)	a[i]

```
fun(int *p)
```

a, p

a[i] ⟶ *(a+i) → *(i+a) → i[a]

a is a constant a= ✗

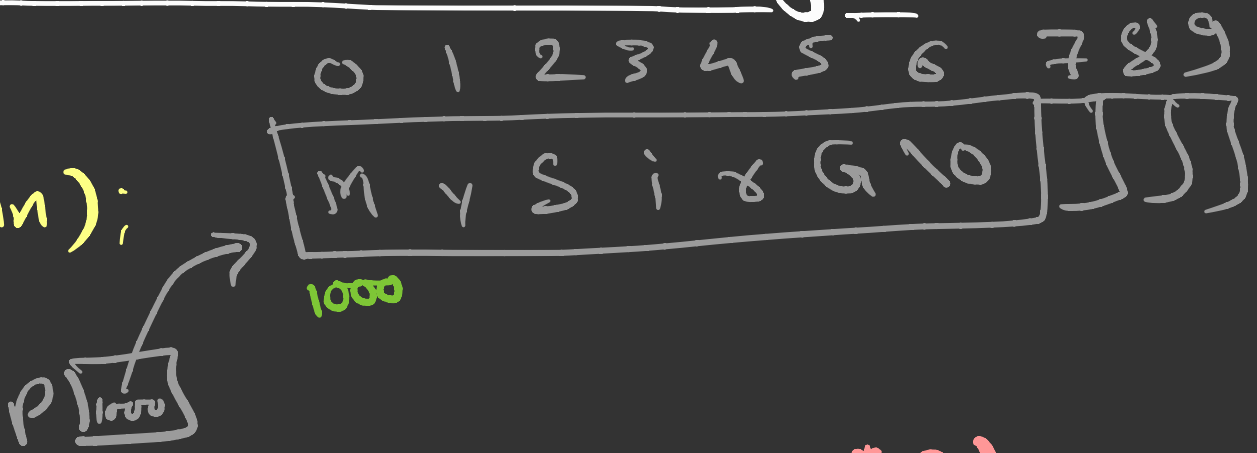
p is a variable p= ✓

a+i p+i ✓

p[i] → *(p+i) ⟶ *(i+p) → i[p]

Pointers and Strings

```
int l;
char str[10];
fgets(str, 10, stdin);
l = length(str);
```




```
int length(char *p)
{
    int i;
    for(i=0; *(p+i) ; i++);
    return i;
}
```

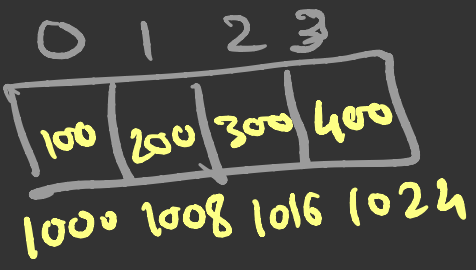
Array of Pointers

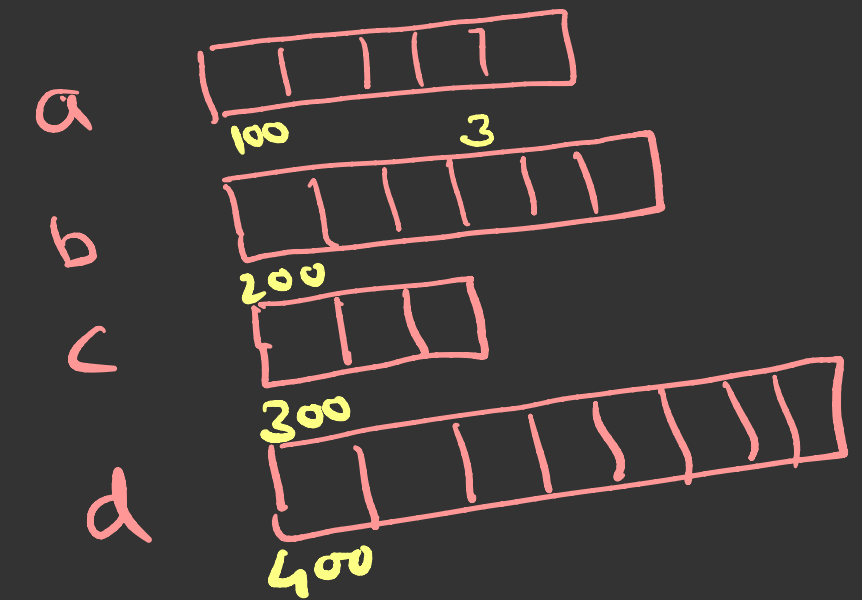
```
int *p[4];

int a[5], b[6], c[3], d[8];

p[0] = &a[0];
p[1] = &b[0];
p[2] = &c[0];
p[3] = &d[0]

input(p)
```





b[3]

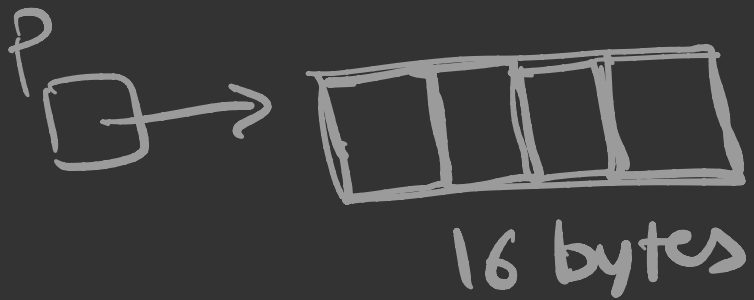
p[1][3]

p[i][j]

```
void input(int **ptr)
```

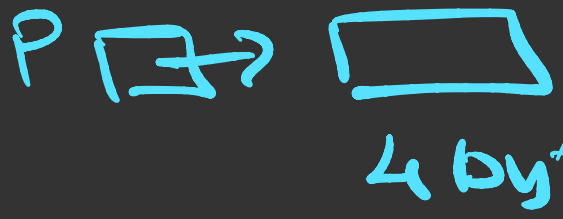
Pointer to Array

`int (*p)[4];` p is a pointer to an array of int type with 4 blocks.



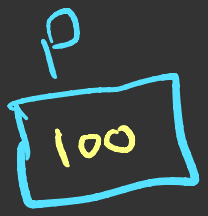
p+1 1016

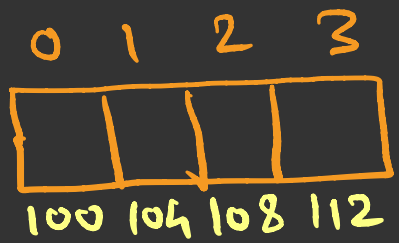
`int *p;`



p+1 1004

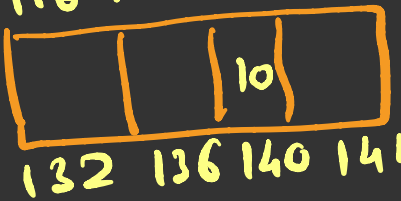
```
int (*p)[4];
int a[5][4];
p = a;
```



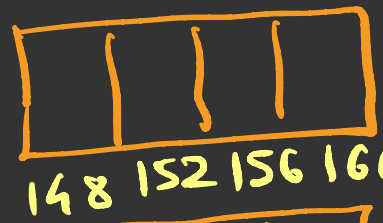


a[2][2]=10 1

*(P+2)[2]=10 2



((P+2)+2)=10 3



*(P[2]+2)=10 4

P[2][2]=10

Wild Pointer

An uninitialized pointer is a wild pointer.

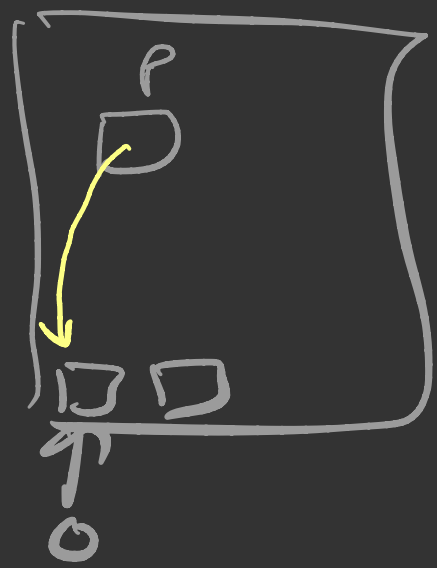
```
void f1()
{
        int *p;   <- wild pointer
        *p = 5;   <- illegal use of pointer
        ....

}
```

NULL Pointer

- A pointer containing NULL (special address) is known as NULL pointer.
- If a pointer containing NULL, we consider it as if it is not pointing to any location.
- As a safe guard to illegal use of pointers you can check for NULL before accessing pointer variable

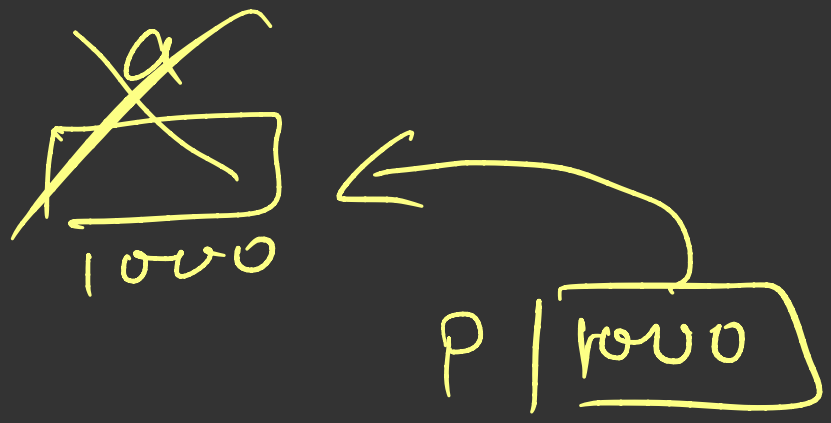
```
int  *p = NULL;
...
if (p != NULL)
{
     *p = 5;
}
```



Dangling Pointer

A pointer pointing to a memory location that has been deleted is called dangling pointer.

```
int * f1()
{
    int a;
    .....
    return &a;
}
void fun()
{
    int *p;
    p = f1();
    *p = 5;
}
```



p is dangling pointer

illegal use of pointer

```
void f1()
{
    int *p;
    {
        int x;
        p=&x;
        ....
    }
    *p=5;
}
```

Scope and life of x is limited to the block

After this line p becomes dangling pointer

illegal use of pointer

```
void f1()
{
    int *p;
    p = (int *) malloc (sizeof(int));
    ...
    ...
    free(p);
    *p = 5;
}
```

← p becomes a dangling pointer

← illegal use of pointer.

Void Pointer

- void pointer is a generic pointer that has no associated data type with it.
- void pointer can hold address of any type.

```
void *p;
int x;
p=&x;
```

```
void *p;
float y;
p=&y;
```

void pointers can not be dereferenced

```
*p=5;
```

```
*p=3.5f;
```

Error

- However void pointer can be dereferenced using typecasting.

```
*(int*)p = 5;
```

```
*(float*)p = 3.5f;
```

(int*)p

(Ram)Vash