Object Oriented Programming

Structures

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- Also known as records
- The data items in structure are called members
- A struct is heterogeneous as its data members can be of different types
- Whereas, array is homogeneous as it can only store items of same data types

Syntax of a Structure

1 Structure Definition

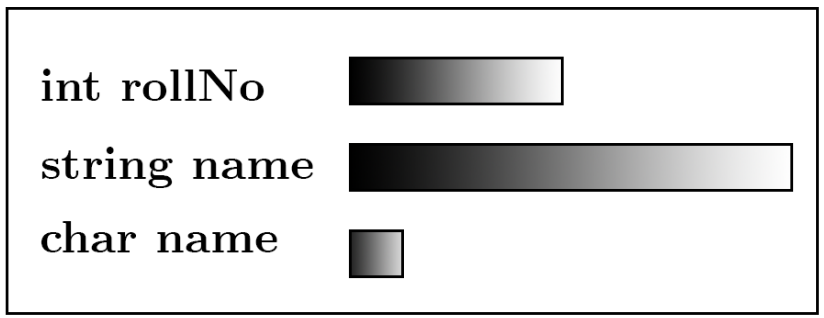
```
struct <identifier>{
<data-type> <identifier_list>;
<data-type> <identifier_list>;
......
};
```

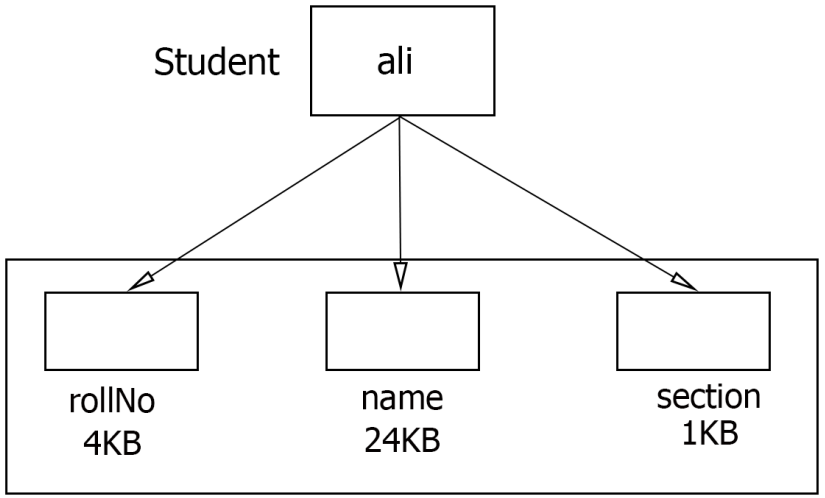
- structure definition acts like a blueprint and doesn't hold any space in memory

Structure Example

```
struct Student{
        int rollNo;
        string name;
        char section;
};

Student ali;
```

- When a struct type variable is declared, a space in memory is reserved just like variable of other data types
- The memory structure for the above structure variable, i.e., ali is depicted below

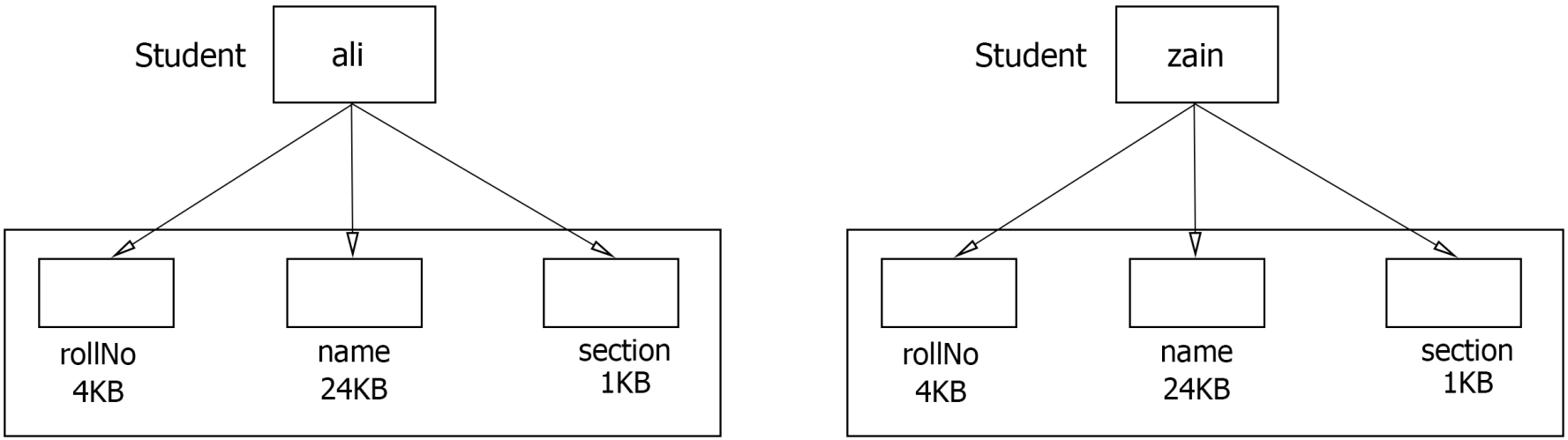




Declaration of a variable of struct type

- Example continued,

```
Student ali, zain;
```

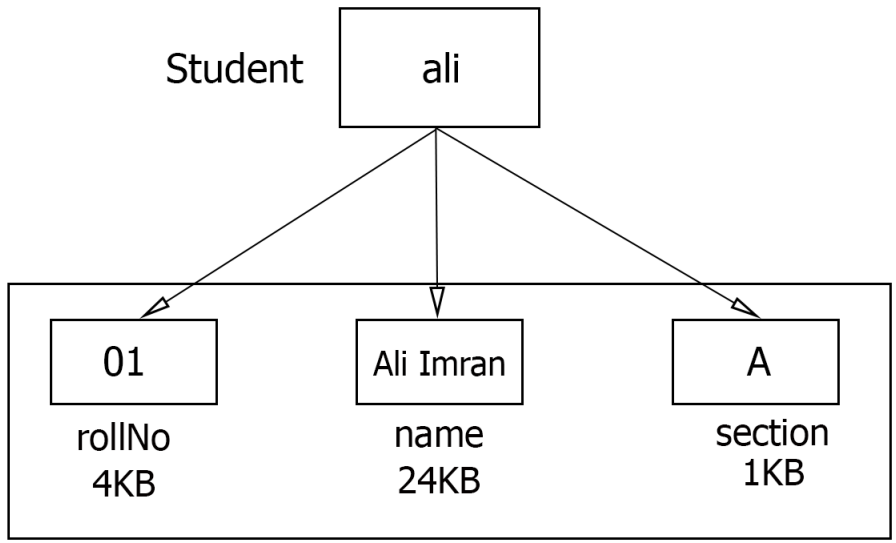


Acessing `struct` members

- The member of a `struct` type variable are accessed with the dot (.) operator
- Syntax,

```
<struct-variable>.<member_name>;
```

```
#include <iostream>
using namespace std;
struct Student{
        int rollNo;
        string name;
        char section;
};
Student ali;
int main(){
        ali.rollNo = 01;
        ali.name = "Ali Imran";
        ali.section = 'A';

        cout<<"Roll no: "<<ali.rollNo<<
             endl;
        cout<<"Name: "<<ali.name<<endl;
        cout<<"Section: "<<ali.section<<
             endl<<endl;
}
```

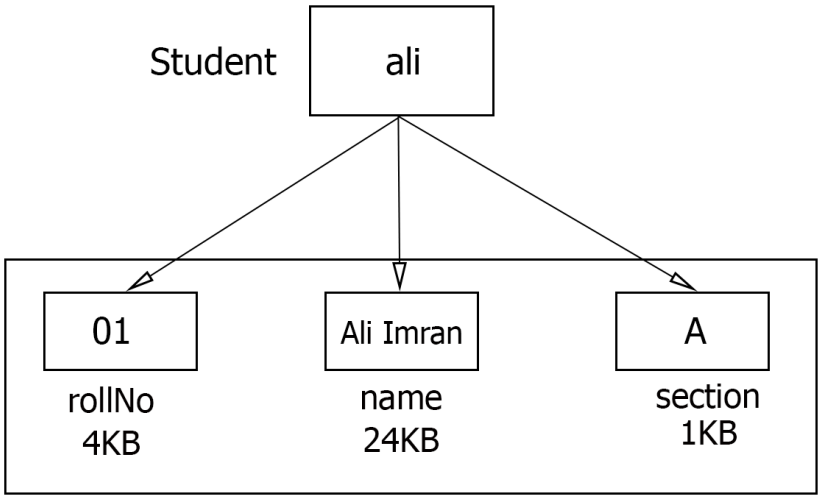


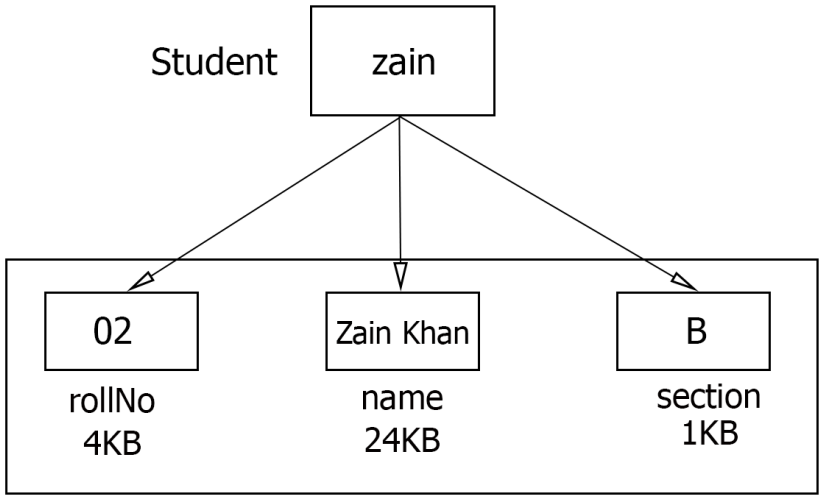
Initializing an object of `struct` variable

- An object of a `struct` variable can be initialized at once by using curly braces
- The sequence of member types must the same as declared in the `struct` definition
- Example,

```
struct Student{
        int rollNo ;
        string name;
        char section;
};

Student ali;

int main(){
        ali = {01, "Ali Imran", 'A'};
        Student zain = {02, "Zain Khan", 'B'};
}
```

Initialization of `struct` variables





`struct` with default values

- assigning values to variables while defining structure member variables refers to default values
- while declaring structure variable, the default values will be automatically assigned to its members
- Syntax,

```
<struct> <identifier>{
        int <identifer> = 00 ;
        string <identifier> = "N/A";
        char <identifier> = '-';
};
```

`struct` default values example

```
#include <iostream>
using namespace std;
struct Student{
        int rollNo = 0;
        string name = "N/A" ;
        char section = '-';
};
Student ali;
void displayMembers(Student x){
        cout<<"Roll no: "<<x.rollNo<<endl
            ;
        cout<<"Name: "<<x.name<<endl;
        cout<<"section: "<<x.section<<
            endl<<endl;
}
int main(){

        ali = {1, "Ali Imran", 'A'};
        Student zain;

        displayMembers(ali);
        displayMembers(zain);
}
```

```
PS C:\Users\p18-0405\Documents\structures> ./a
Roll no: 1
Name: Ali Imran
section: A

Roll no: 0
Name: N/A
section: -

PS C:\Users\p18-0405\Documents\structures>
```

copying `struct` variable object

- The `struct` variable object can be initialized by copying from other `struct` variable object. Example,

```
struct Student{
        int rollNo = 00;
        string name = "N/A" ;
        char section = '-';
};

Student ali;

void displayMembers(Student x){
        cout<<"Roll no: "<<x.rollNo<<
            endl;
        cout<<"Name: "<<x.name<<endl;
        cout<<"section: "<<x.section<<
            endl<<endl;
}

int main(){

        ali = {01, "Ali Imran", 'A'};
        Student zain = ali;

        displayMembers(ali);
        displayMembers(zain);
}
```

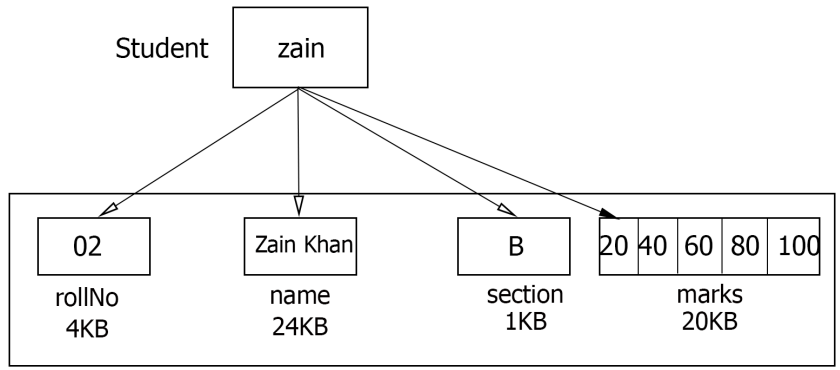
```
PS C:\Users\p18-0405\Documents\structures> ./a
Roll no: 1
Name: Ali Imran
section: A

Roll no: 1
Name: Ali Imran
section: A

PS C:\Users\p18-0405\Documents\structures>
```

Array in Structures

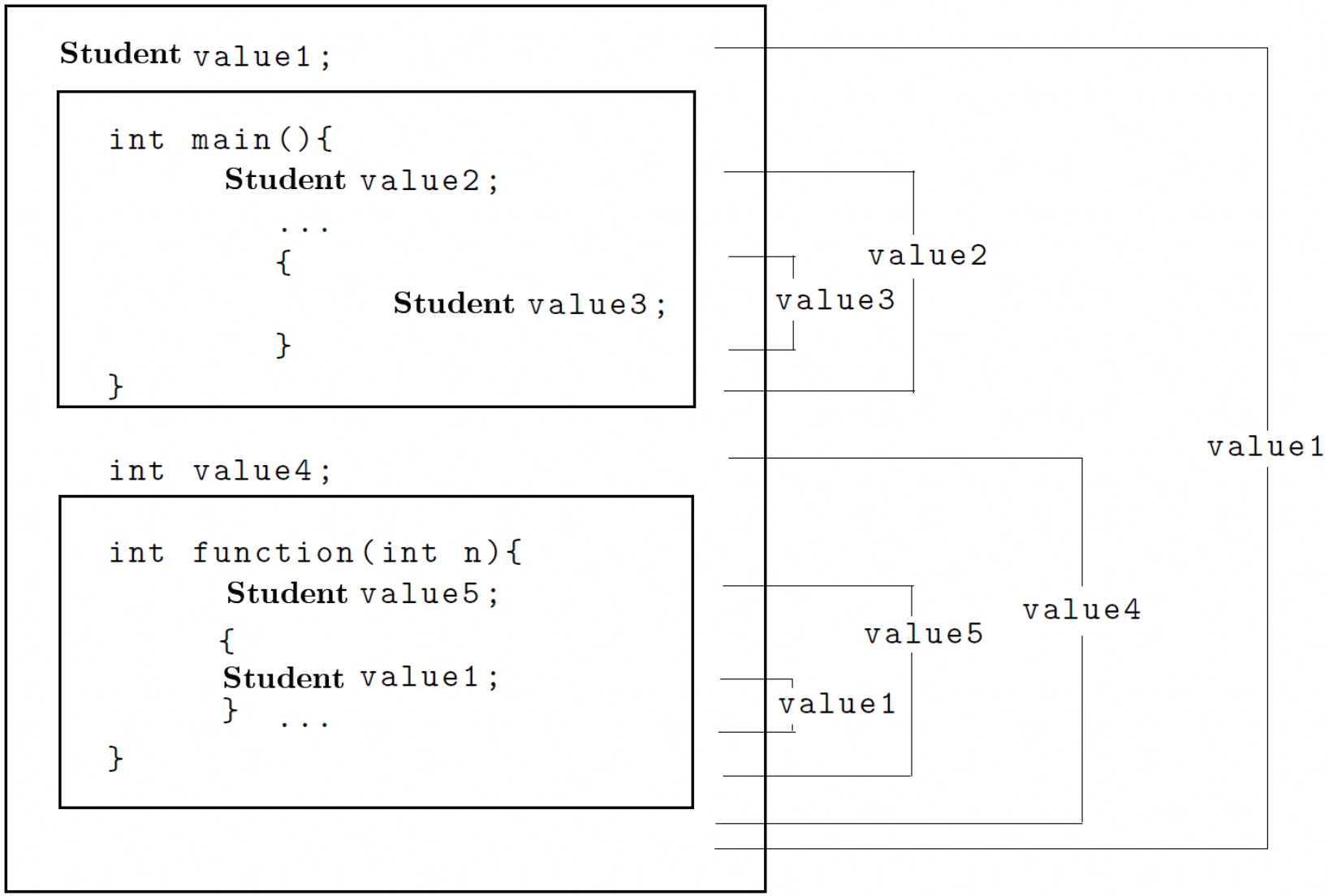
```
struct Student{
        int rollNo = 0;
        string name = "N/A";
        char section = '-';
        int marks[5]={0,0,0,0,0};
};
Student ali;
void displayMembers(Student x){
        cout<<"Roll no: "<<x.rollNo<<endl;
        cout<<"Name: "<<x.name<<endl;
        cout<<"section: "<<x.section<<endl;
        for (int count = 0; count < sizeof(x.marks)/sizeof(int); count++)
                cout<<"marks in subject["<<count<<"] = "<<x.marks[count]<<endl;
}
int main(){
        ali.rollNo = 01;
        ali.name = "Ali Imran";
        ali.section = 'A';
        ali.marks[0] = 10;
        ali.marks[1] = 20;
        ali.marks[2] = 30;
        ali.marks[3] = 40;
        ali.marks[4] = 50;
        Student zain = {2, "Zain Khan", 'B', {20, 40, 60, 80, 100}};
        displayMembers(ali); cout<<endl;
        displayMembers(zain);
}
```

Array in Structures

```
PS C:\Users\p18-0405\Documents\structures> ./a
Roll no: 1
Name: Ali Imran
section: A
marks in subject[0] = 10
marks in subject[1] = 20
marks in subject[2] = 30
marks in subject[3] = 40
marks in subject[4] = 50

Roll no: 2
Name: Zain Khan
section: B
marks in subject[0] = 20
marks in subject[1] = 40
marks in subject[2] = 60
marks in subject[3] = 80
marks in subject[4] = 100
PS C:\Users\p18-0405\Documents\structures>
```



`struct` variable object scope



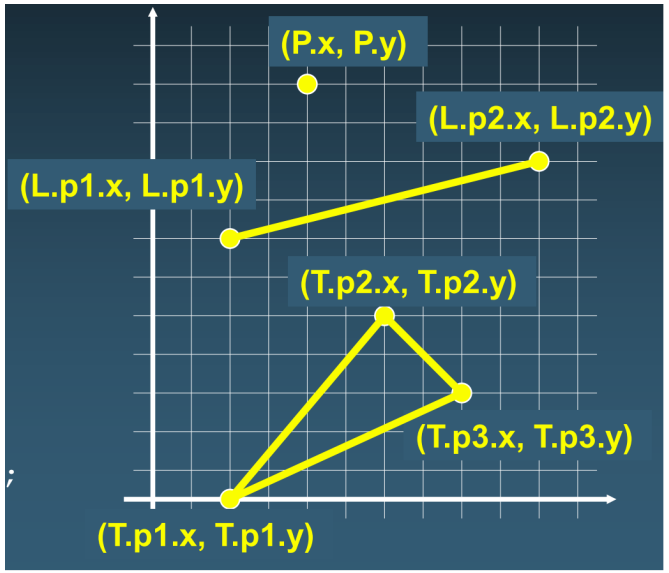
`struct` variable object scope example

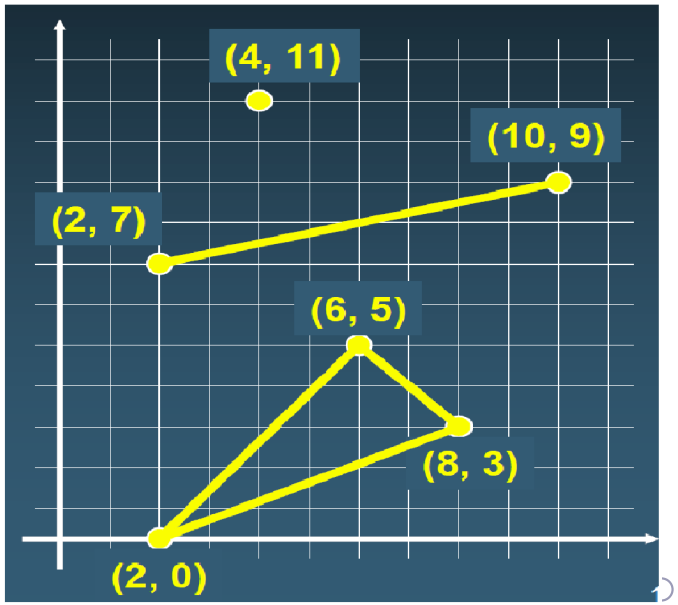
```
struct Student{
        int rollNo ;
        string name;
        char section;
};

Student std1 = {01, "Ali", 'A'};

void displayMembers(Student x){
        cout<<"Roll no: "<<x.rollNo<<endl;
        cout<<"Name: "<<x.name<<endl;
        cout<<"section: "<<x.section<<endl
             <<endl;
}

int main(){

        displayMembers(std1);
        Student std1 = {02, "Zain", 'B'};
        displayMembers(std1);
        //displayMembers(std3); // cause
             error

        Student test();
        displayMembers(test());
}
Student std3 = {03, "Umer", 'C'};
Student test(){
        return std3;
}
```

```
PS C:\Users\p18-0405\Documents\structures>
PS C:\Users\p18-0405\Documents\structures> ./a
Roll no: 1
Name: Ali
section: A

Roll no: 2
Name: Zain
section: B

Roll no: 3
Name: Umer
section: C
```

Nested Structures

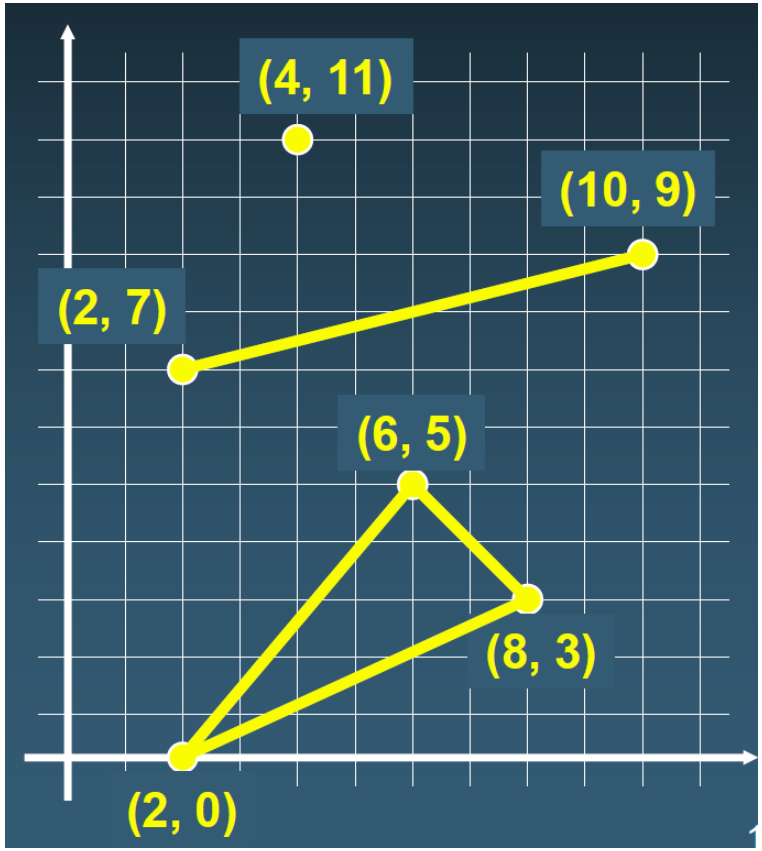
```
struct point{
        int x, y;
};

struct line{
        point p1, p2;
};
struct triangle{
        point p1, p2, p3;
};

int main(){
        point P = {4,11};
        //P.x = 4;
        line L = {{2,7}, {10,9}} ;
        //L.p1.x = 2; L.p1.x=7; L.p2.x=10; L.p2.y
              =0;
        triangle T = {{2,0},{6,5},{8,3}};
        //T.p1.x = 2;
}
```





Nested Structures continued …

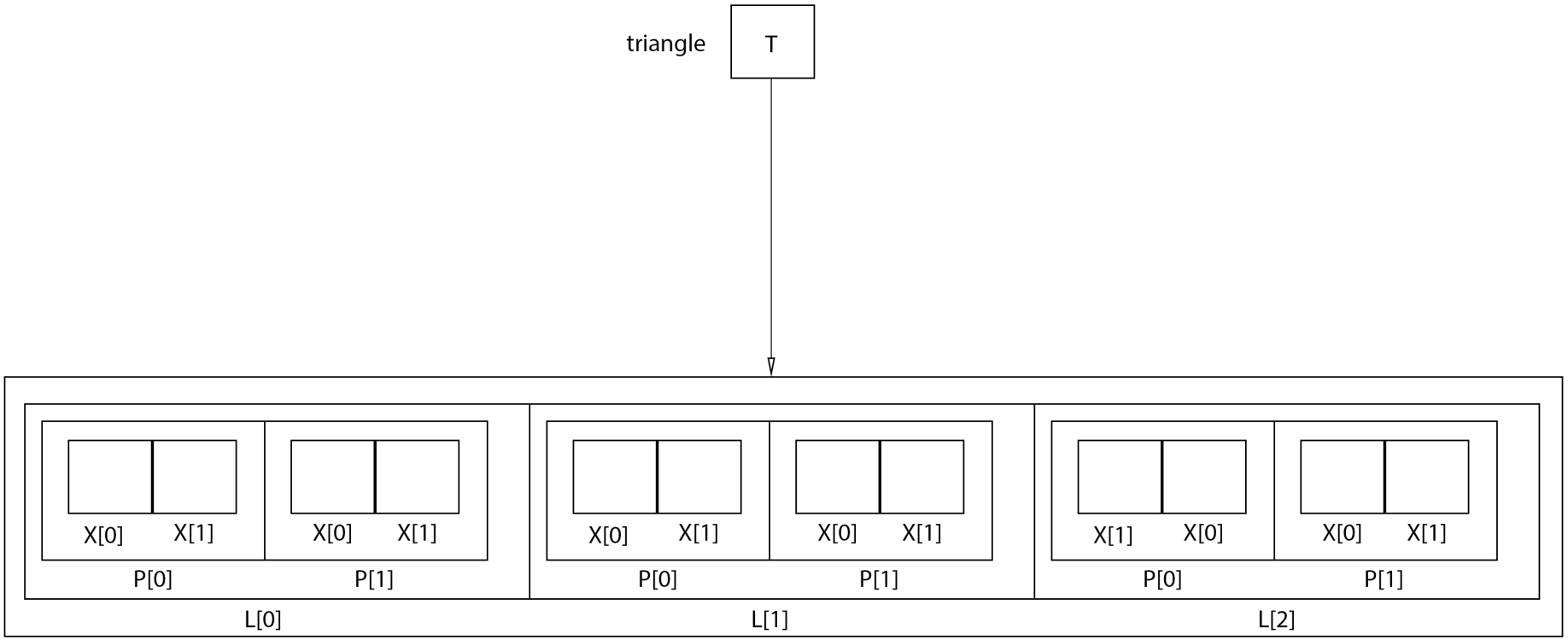
1. Construct the same triangle with `struct` line nested inside `struct` triangle.
2. Construct a square with `struct` line nested inside the `struct` square
3. Construct a rectangle with `struct` line nested inside the `struct` rectangle. Where, the length is double the size of width of the rectangle



Array of structures

Array of Structure

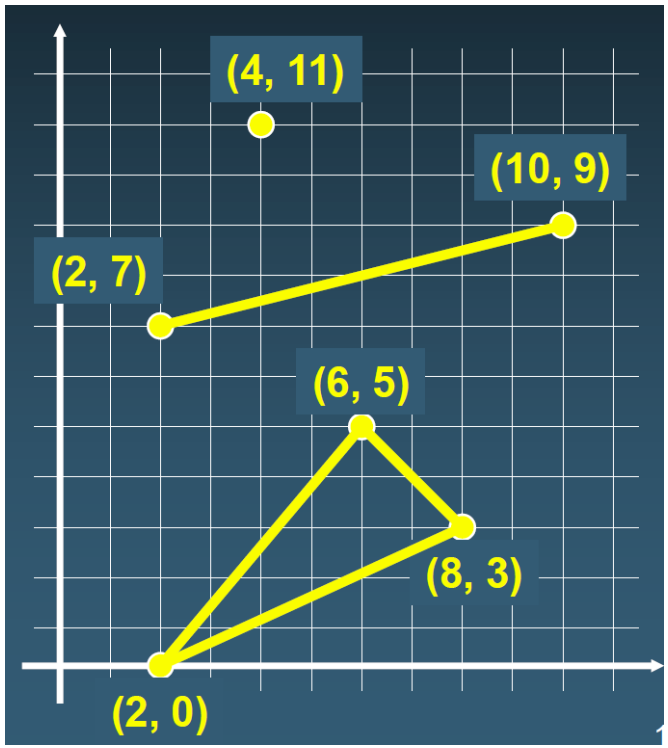
It is an array of a `struct` variable, where each index is an object and holds an address to the location of a structure in memory



Array of Structures continued …

- Re-constructing the triangle using the nested array of structures

```
struct point{
        int x[2];
};

struct line{
        point p[2];
};
struct triangle{
        line l[3];
};

int main(){

triangle T= { {     {{{2, 0}, {6, 5}}} ,
                    {{{6, 5}, {8, 3}}} ,
                    {{{8, 3}, {2, 0}}}  } };

}
```



`struct` Pointers

1. **Pointing to Existing Object**

```
Student ali = {1, "Ali Imran", 'A'};
Student *ptr = &ali;
```

2. **Pointing to new Object**

```
Student *ptr = new Student;
```

struct Pointers Example

```
struct Student{
        int rollNo = 0;
        string name = "N/A";
        char section = '-';
};

int main(){

        Student ali = {1, "Ali Imran", 'A'};

        Student *ptr;
        ptr = &ali;

        cout<<"\nrollNo: "<<ptr->rollNo<<endl;
        cout<<"Name: "<<ptr->name<<endl;
        cout<<"Section"<<ptr->section<<endl;

        Student *ptr1 = new Student;

        cout<<"\n\nrollNo: "<<ptr1->rollNo<<endl;
        cout<<"Name: "<<ptr1->name<<endl;
        cout<<"Section"<<ptr1->section<<endl;

}
```

`struct` Pointers Applications

1. **Single linklist:**

```
struct Node{
        int val = 0;
        Node *nextNode;
};
```

2. **Double linklist:**

```
struct Node{
        int val = 0;
        Node *nextNode;
        Node *previousNode:
};
```