C Structures

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Structures

- A Structure is a collection of related data items, possibly of different types.
- A structure type in C++ is called struct.
- A struct is heterogeneous in that it can be composed of data of different types.
- In contrast, array is homogeneous since it can contain only data of the same type.

Structures

- Structures hold data that belong **together**.
- Examples:
  - Student record: student id, name, major, gender, start year, …
  - Bank account: account number, name, currency, balance, …
  - Address book: name, address, telephone number, …
- In database applications, structures are called records.

Structures

- Individual components of a struct type are called members (or fields).
- Members can be of different types (simple, array or struct).
- A struct is named as a whole while individual members are named using field identifiers.
- Complex data structures can be formed by defining arrays of structs.

struct basics

- Definition of a structure:

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

Each identifier defines a <u>member</u> of the structure.

- Example:

```
struct Date {
    int day;
    int month;
    int year;
} ;
```

The “Date” structure has 3 members, day, month & year.

struct examples

- Example:

```
struct StudentInfo{
    int Id;
    int age;
    char Gender;
    double CGA;
};
```

The “StudentInfo” structure has 4 members of different types.

- Example:

```
struct StudentGrade{
    char Name[15];
    char Course[9];
    int Lab[5];
    int Homework[3];
    int Exam[2];
};
```

The “StudentGrade” structure has 5 members of different array types.

struct examples

- Example:

```
struct BankAccount{
    char Name[15];
    int AcountNo[10];
    double balance;
    Date Birthday;
};
```

The “BankAcount” structure has simple, array and structure types as members.

- Example:

```
struct StudentRecord{
    char Name[15];
    int Id;
    char Dept[5];
    char Gender;
};
```

The “StudentRecord” structure has 4 members.

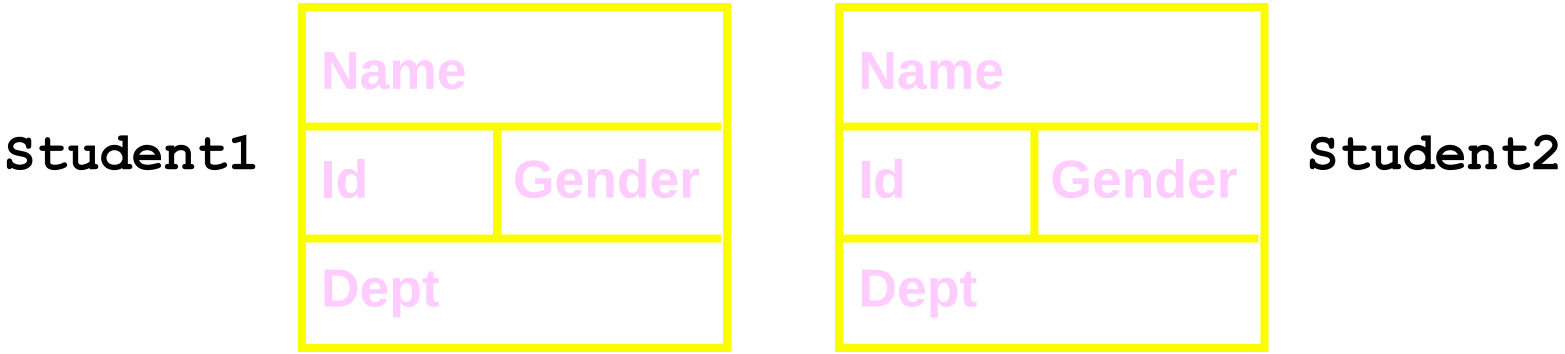
struct basics

- Declaration of a variable of struct type:

```
<struct-type> <identifier_list>;
```

- Example:

```
struct StudentRecord Student1, Student2;
```



`Student1` and **`Student2`** are variables of **`StudentRecord`** type.

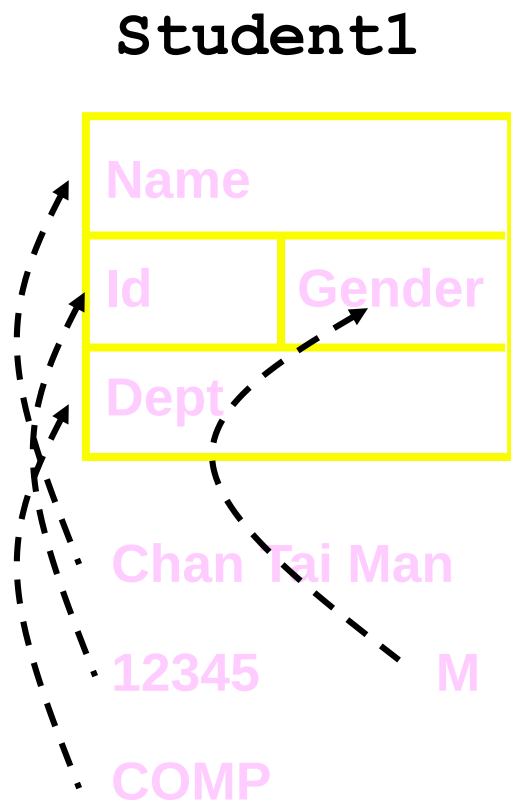
Ex. 1: struct basics

- The members of a struct type variable are accessed with the dot (.) operator:

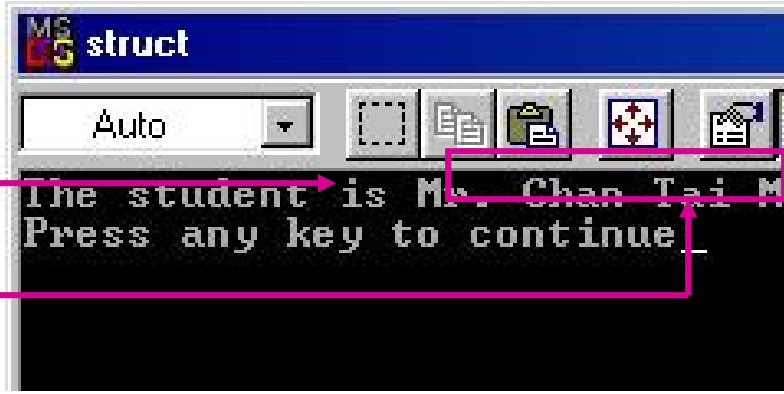
```
<struct-variable>.<member_name>;
```

- Example:

```
strcpy(Student1.Name, "Chan Tai Man");
Student1.Id = 12345;
strcpy(Student1.Dept, "COMP");
Student1.gender = 'M';
cout << "The student is ";
switch (Student1.gender){
    case 'F': cout << "Ms. "; break;
    case 'M': cout << "Mr. "; break;
}
cout << Student1.Name << endl;
```



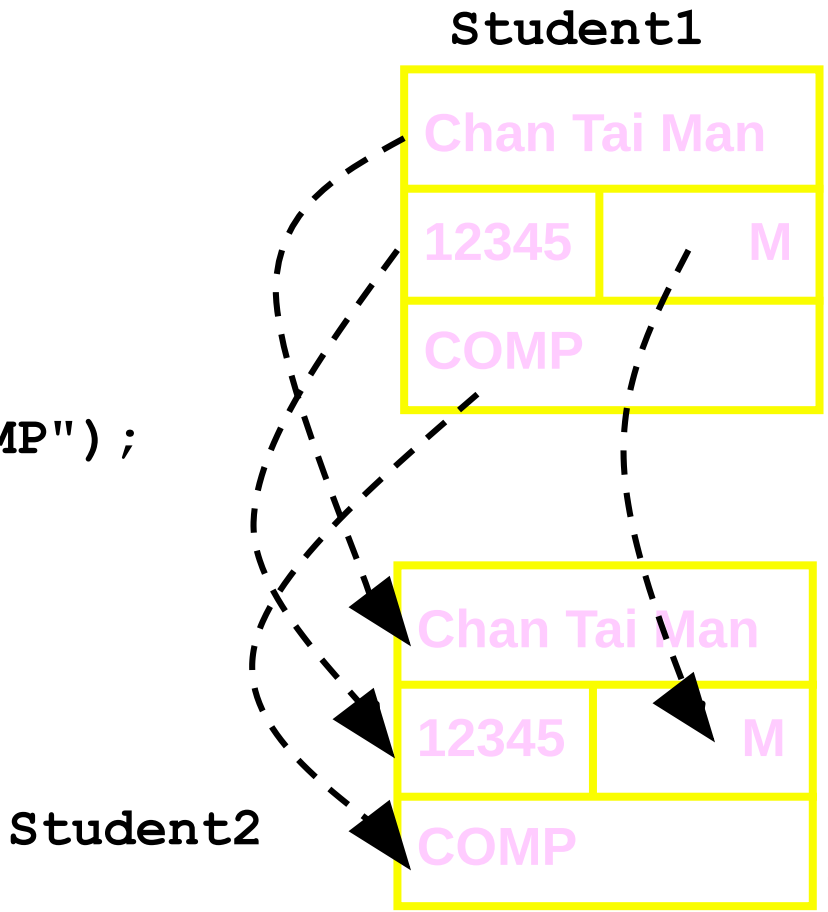
```
#include <string.h>

struct StudentRecord {
        char Name[22];
        int Id;
        char Dept[22];
        char gender;
};

int main()  {
    StudentRecord Student1;

    strcpy(Student1.Name, "Chan Tai Man");
    Student1.Id = 12345;
    strcpy(Student1.Dept, "COMP");
    Student1.gender = 'M';

    cout << "The student is ";
    switch (Student1.gender){
        case 'F': cout << "Ms. "; break;
        case 'M': cout << "Mr. "; break;
    }
    cout << Student1.Name << endl;
    return 0;
}
```



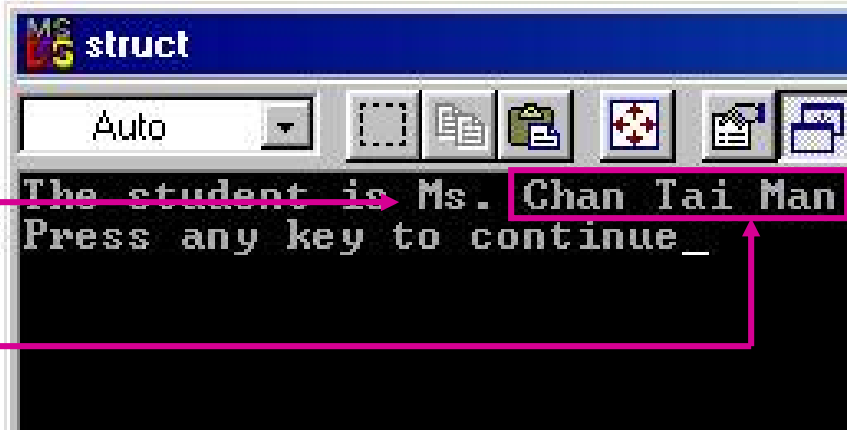
Ex. 2: struct-to-struct assignment

- The values contained in one struct type variable can be assigned to another variable of the same struct type.
- Example:

```
strcpy(Student1.Name,
       "Chan Tai Man");
Student1.Id = 12345;
strcpy(Student1.Dept, "COMP");
Student1.gender = 'M';

Student2 = Student1;
```



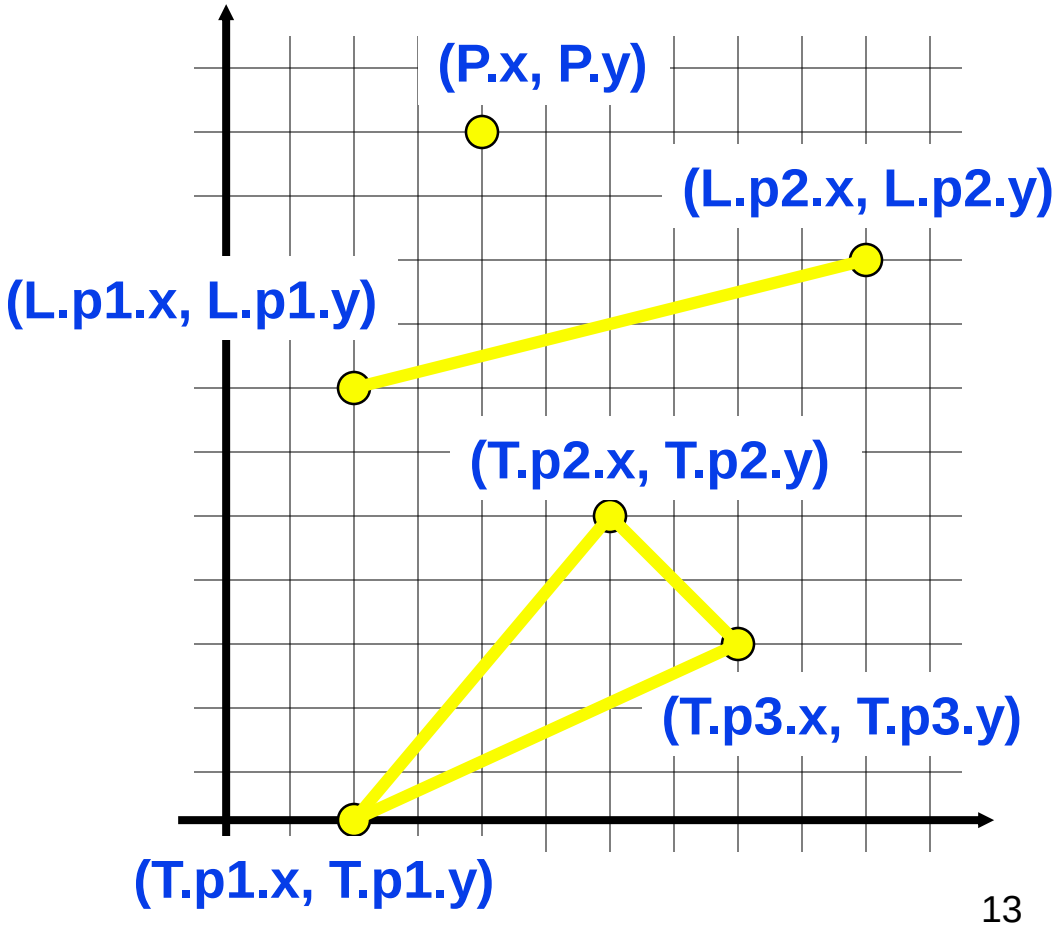
```
struct StudentRecord {
        char Name[22];
        int Id;
        char Dept[22];
        char gender;
};

int main()  {
    StudentRecord Student1, Student2;

    strcpy(Student1.Name, "Chan Tai Man");
    Student1.Id = 12345;
    strcpy(Student1.Dept, "COMP");
    Student1.gender = 'M';

    Student2 = Student1;
    Student2.gender = 'F';

    cout << "The student is ";
    switch (Student2.gender){
        case 'F': cout << "Ms. "; break;
        case 'M': cout << "Mr. "; break;
    }
    cout << Student2.Name << endl;
    return 0;
}
```



Ex. 3-5: Nested structures

- We can nest structures inside structures.
- Examples:

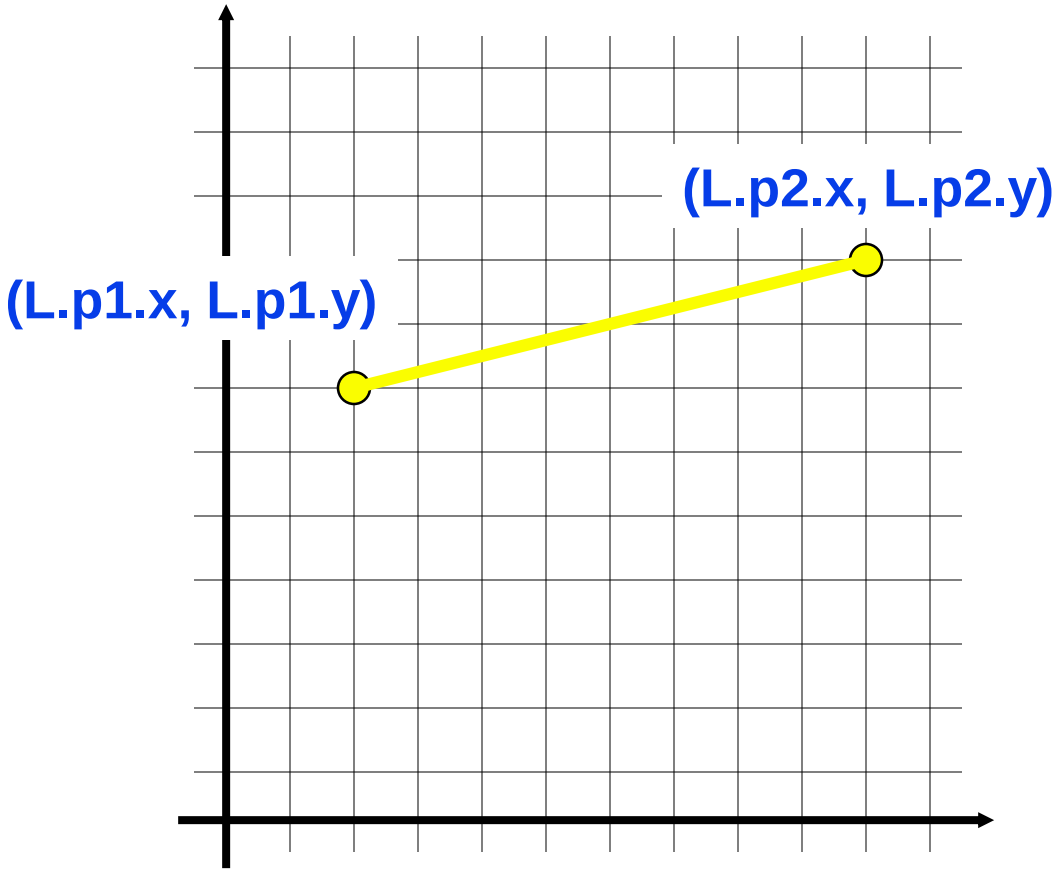
```
struct point{
    double x, y;
};
point P;

struct line{
    point p1, p2;
};
line L;

struct triangle{
    point p1, p2, p3;
};
triangle T;
```



Ex. 3-5: Nested structures

- We can nest structures inside structures.

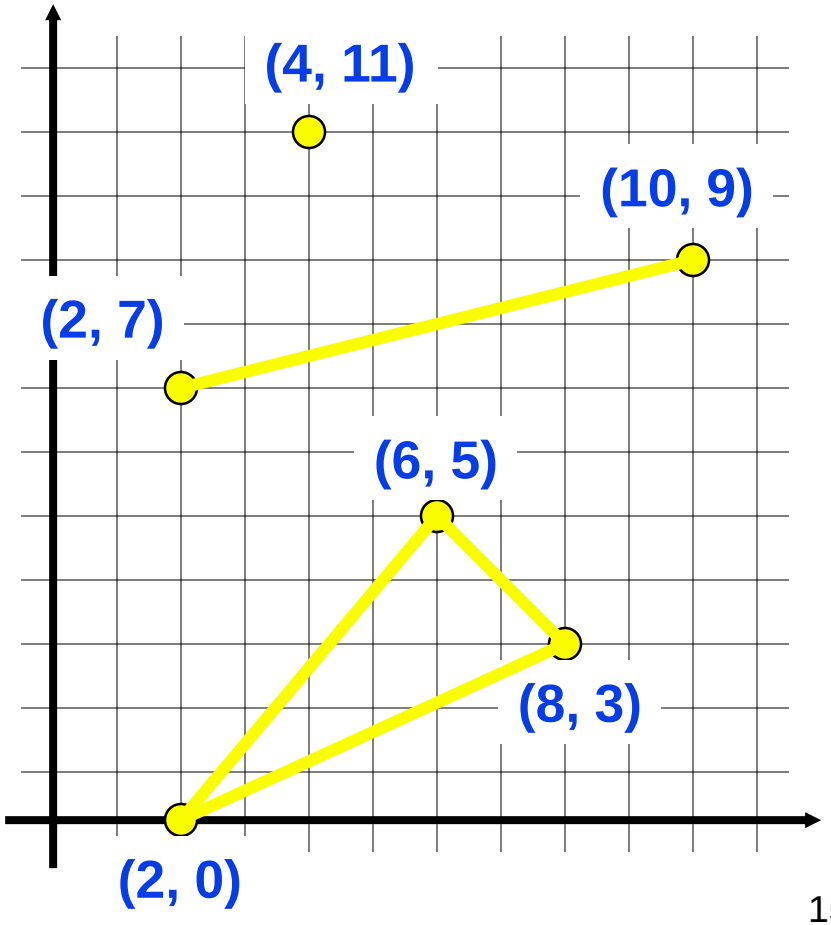
```
struct line{
    point p1, p2;
};
line L;
```

Ex. 3-5: Nested structures

- Assign values to the variables **`P`**, **`L`**, and **`T`** using the picture:

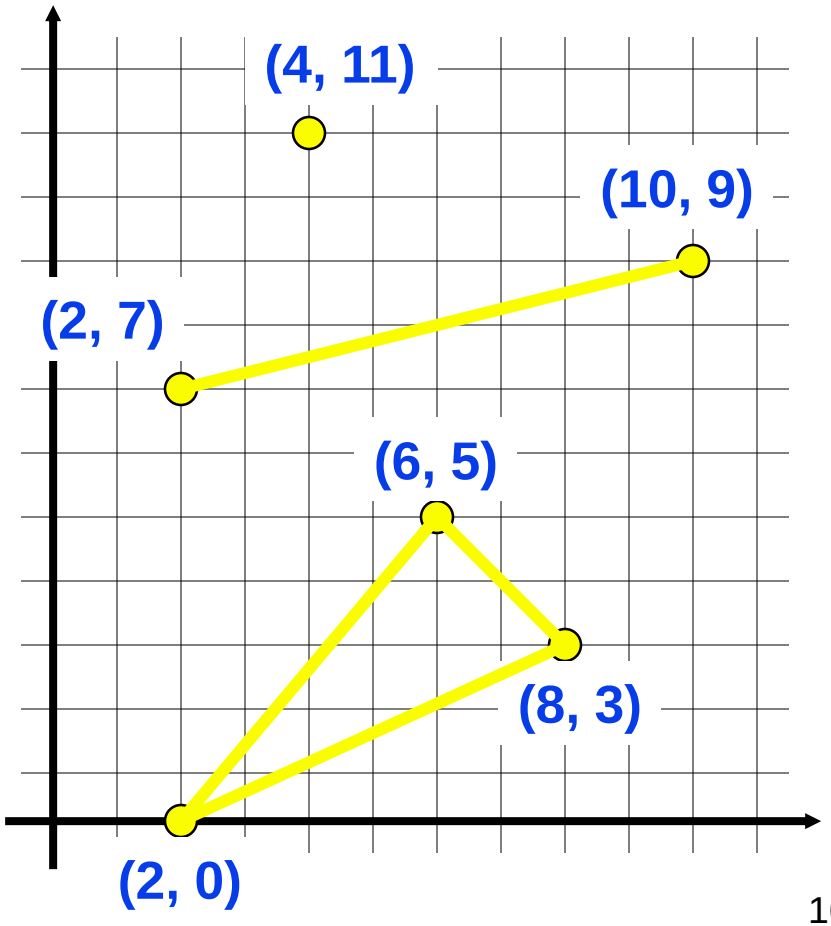
```
point P;
line L;
triangle T;
```



- Ex. 3: Graph a point
- Ex. 4: Graph a line
- Ex. 5: Graph a triangle

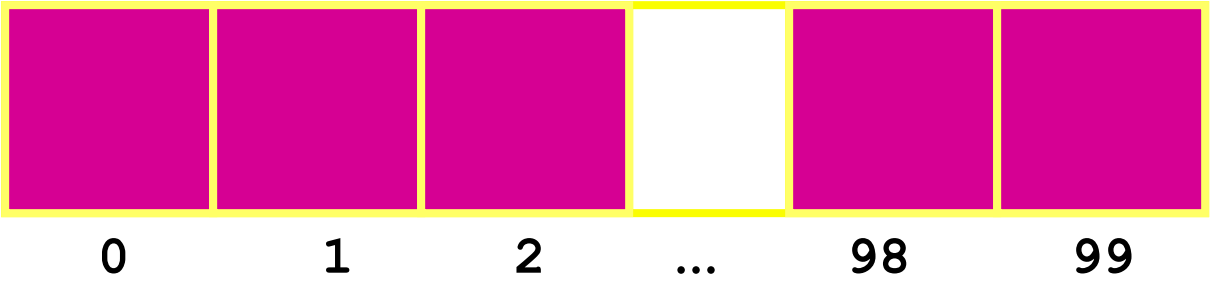
Ex. 3-5: Nested structures

```
point P;
line L;
triangle T;
P.x = 4;
P.y = 11;
L.p1.x = 2;
L.p1.y = 7;
L.p2.x = 10;
L.p2.y = 9;
T.p1.x = 2;
T.p1.y = 0;
T.p2.x = 6;
T.p2.y = 5;
T.p3.x = 8;
T.p3.y = 3;
```

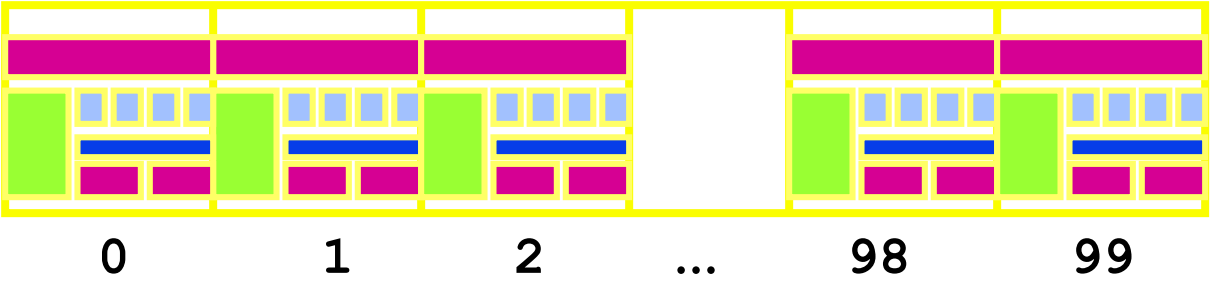


Arrays of structures

- An ordinary array: One type of data



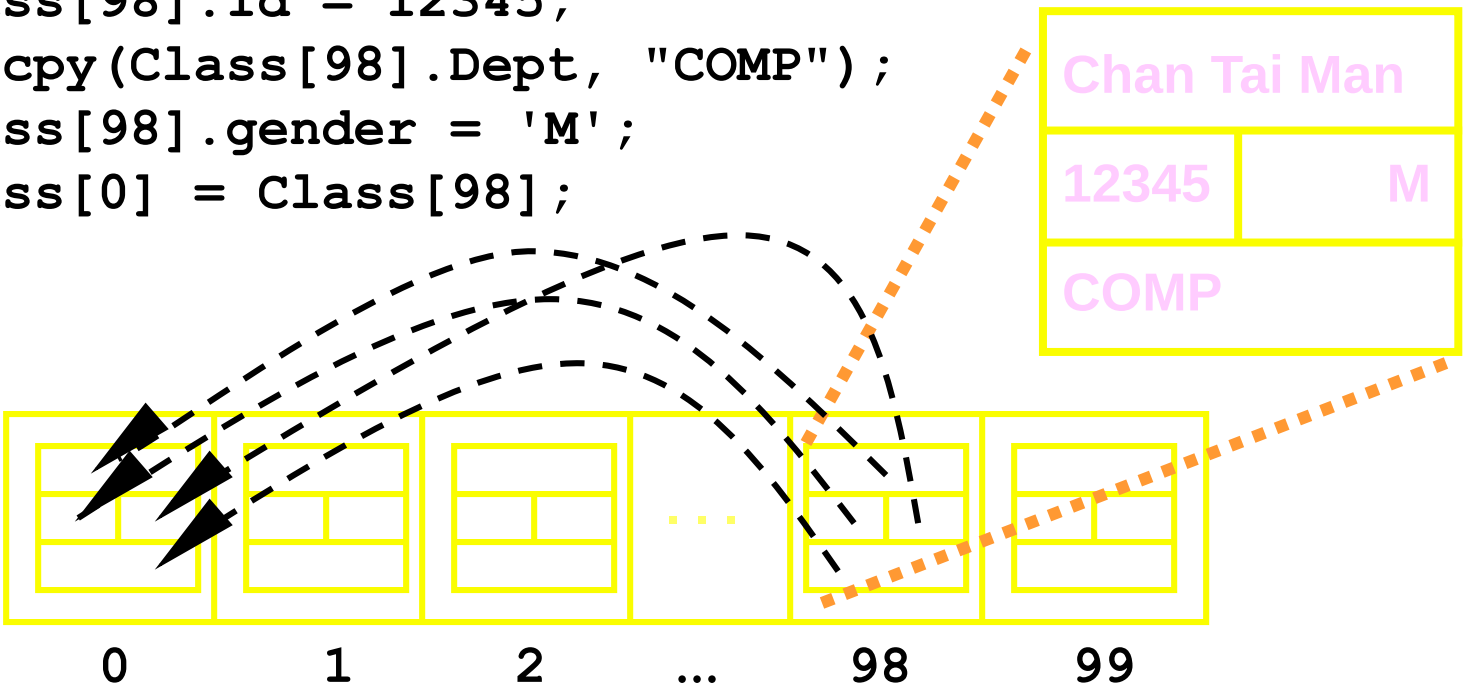
- An array of structs: Multiple types of data in each array element.



Arrays of structures

- We often use arrays of structures.
- Example:

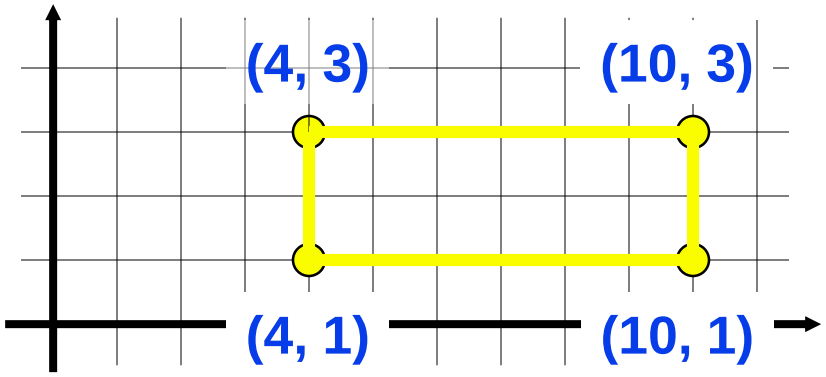
```
StudentRecord Class[100];
strcpy(Class[98].Name, "Chan Tai Man");
Class[98].Id = 12345;
strcpy(Class[98].Dept, "COMP");
Class[98].gender = 'M';
Class[0] = Class[98];
```



Arrays inside structures

- We can use arrays inside structures.
- Example:

```
struct square{
    point vertex[4];
};
square Sq;
```



- Assign values to **`Sq`** using the given square