CSE 142
Programming I

Arrays of Structures

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Structures and Arrays

- A *struct* represents a single record
- Typically, computer applications have to deal with collections of such records
  - Examples: student records, employee records, customer records, parts records
  - In each case we will have multiple instances of one record (struct) type

Arrays of structs are the natural way to do this

Recall These *struct* Examples

```
#define MAX_NAME  40
typedef struct {
    char name [MAX_NAME+1] ;
    int id ;
    double  score ;
} student_record ;
```

```
typedef struct {
    int hours, minutes ;
    double  seconds ;
}  time ;

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

Arrays of *structs*

Each declaration below declares an array, where each array element is a structure:

```
point corner_points[10];

time meeting_times[MAX_MEETINGS];

student_record cse_142[MAX_STUDENTS];
```

Using arrays of *structs* is a natural extension of principles we're already learned.

Using Arrays of *structs*

- We access a field of a *struct* in an array by specifying the array element and then the field:

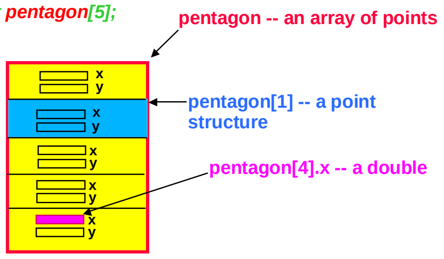
```
cse_142[i].name

corner_points[j+1].x

meeting_times[4].hours
```

Naming in *struct* Arrays

```
point pentagon[5];
```


pentagon -- an array of points
x
y
x
y
pentagon[1] -- a point structure
x
y
x
y
pentagon[4].x -- a double
x
y

Using Arrays of *structs*

```
student_record  class[MAX_STUDENTS] ;
...
for ( i = 0 ;  i < nstudents ;  i = i + 1 )
{
    scanf("%d %d", &class[i].hw, &class[i].exams) ;
    class[i].grade =
        (double) (class[i].hw + class[i].exams) / 50.0 ;
}
```

struct Array Elements as Parameters

```
void draw_line ( point p1, point p2) {.....}
...
point pentagon[5] ;
...
for ( i = 0 ;  i < 4 ;  i = i + 1) {
    draw_line (pentagon[i], pentagon[i+1]) ;
    }
draw_line (pentagon[4], pentagon[0]) ;
```

Review: *structs* as Parameters

- A single *struct* is passed by value
  - all of its components are copied from the argument (actual parameter) to initialize the (formal) parameter.

```
point midpoint (point a; point b) {...}

int main (void) {
    point p1, p2, m;          /* declare 3 points */
    ...
    m = midpoint ( p1, p2);
}
```

Passing Arrays of *structs*

- An array of *structs* is an array.
- When *any* array is an argument (actual parameter), it is passed by reference (not copied).]
  - The parameter is an alias of the actual array argument

```
int avg (student_rec class_db[MAX_N]) {...}
int  main (void) {
    student_rec cse_142[MAX_N];
    int average;
    ....
    average = avg ( cse_142 ); /* by reference */
}
```

Sorting Arrays of *structs*

David 920915 2.9	Kathryn 901028 4.0	Sarah 900317 3.9	Phil 920914 2.8	Casey 910607 3.6

Phil 920914 2.8	David 920915 2.9	Casey 910607 3.6	Sarah 900317 3.9	Kathryn 901028 4.0

```
typedef struct  {
    char      name [MAX_NAME + 1] ;
    int       id ;
    double  score ;
} StudentRecord ;
```

Review: Selection Sort for Array of ints

```
int min_loc (int a[ ], int k, int n)
    {
    int j, pos;
    pos = k;
    for ( j = k + 1; j < n; j = j + 1)
     if (a[j] < a[pos])
        pos = j;
  return pos;
}

void swap (int * x, int * y);
```

```
void sel_sort (int a[ ], int n)
  {
  int k, m;
  for (k = 0; k < n - 1; k = k
  + 1) {
     m = min_loc(a,k,n);
     swap(&a[k], &a[m]);
  }
}
```

Modifying For Array of StudentRecord

- Decide which field to sort by: the “sort key”
  - Let’s sort by *score*
- Change array types to StudentRecord
- Change comparison to pull out sort key from the structs
- Write a “swap” for StudentRecord

Modified For Array of StudentRecord

```
int min_loc (StudentRecord a[ ],
    int k, int n) {
    int j, pos;
   pos = k;
   for ( j = k + 1; j < n; j = j + 1)
    if (a[j].score < a[pos].score)
      pos = j;
  return pos;
}

void swap (StudentRecord * x,
    StudentRecord * y);
```

```
void sel_sort (StudentRecord
   a[ ], int n) {
   int k, m;
  for (k = 0; k < n - 1; k = k
   + 1) {
     m = min_loc(a,k,n);
     swap(&a[k], &a[m]);
   }
}
```

Alphabetical Order

David 920915 2.9	Casey 910607 3.6	Sarah 900317 3.9	Phil 920914 2.8	Kathryn 901028 4.0

Casey 910607 3.6	David 920915 2.9	Kathryn 901028 4.0	Phil 920914 2.8	Sarah 900317 3.9

```
typedef struct  {
    char    name[MAX_NAME + 1];
    int      id;
    doublescore;
} student_record;
```

Need a function to compare two strings!

Review: String Comparison

“Alice”	is less than	“Bob”
“Dave”	is less than	“David”
“Rob”	is less than	“Robert”

```
#include <string.h>
int  strcmp (char str1[ ], char str2[ ])
```

returns	negative integer	if str1 is less than str2
	0	if str1 equals str2
	positive integer	if str1 is greater than str2

Modified to Sort By Name

```
int min_loc (StudentRecord a[ ],
    int k, int n) {
    int j, pos;
   pos = k;
   for ( j = k + 1; j < n; j = j + 1)
    if (0 > strcmp(a[j].name,
    a[pos].name))
      pos = j;
  return pos;
}

void swap (StudentRecord * x,
    StudentRecord * y);
```

```
void sel_sort (StudentRecord
   a[ ], int n) {
   int k, m;
  for (k = 0; k < n - 1; k = k
   + 1) {
     m = min_loc(a,k,n);
     swap(&a[k], &a[m]);
   }
}
```

Type Quiz

```
StudentRecord a [MAX_STUDENTS];
/*What is the type of each?*/
a
a[0]
a[5].name
a[4].id
&a[6].score
a[2].name[1]
a.score[0]
StudentRecord[1]
```

```
typedef struct {
    char name [MAX_NAME+1] ;
    int id ;
    double  score ;
} StudentRecord ;
```

Data Structures: What If...

- ...you wanted to keep information about one song on the computer.
  - What pieces of data would you want?
  - How would you organize them?
  - How would it look in C?
- And then…
  - What if you wanted information about an entire CD of songs?
  - And then… how about a whole collection of CD's?

Insertion Sort for *student_record*

```
/* sort student records a[0..size-1] in */
/* ascending order by score */
void sort (student_record a[ ],  int size)
{
    int j ;
    for ( j = 1 ;  j < size ;  j = j + 1 )
      insert (a, j) ;
}
```

Insert for sorting records

```
/* given that a[0..j-1] is sorted, move a[j] to the correct */
/* location so that that a[0..j] is sorted by score */
void insert ( student_record a[ ] , int j )
{    int i;
     student_record temp ;

     temp = a[j] ;
     for ( i = j;
             i > 0  && a[i-1].score > temp.score;
             i = i - 1 ) {
        a[i] = a[i-1];
     }
     a[i] = temp ;
}
```

Insert for Alphabetic Sorting

```
/* given that a[0..j-1] is sorted, move a[j] to the correct */
/* location so that that a[0..j] is sorted by name */
void insert ( student_record a[ ], int j )
{    int i;
     student_record temp ;
     temp = a[j] ;
     for ( i = j ;
             i > 0  && strcmp (a[i-1].name, temp.name) > 0 ;
             i = i - 1 ){
        a[i] = a[i-1];
     }
     a[i] = temp ;
}
```