CSE 142
Programming I

Multidimensional Arrays

Textbook 8.7

Arrays as Data Structures

- Review: *An array is an ordered collection of values of identical type*
  - Name the collection; number the elements
- Arrays are the natural choice for organizing a large number of values, all of identical type
- Sometimes the values already have some additional regular pattern or structure
- One common such structure is the “matrix” or two-dimensional array

2-Dimensional Arrays

- *An ordered collection of values of identical type*
- Name the collection; number the elements
  - Like 1-D arrays, but a more complicated numbering scheme
- Example: scores for 7 students on 4 homeworks

score	hw 0	1	2	3
student 0	22	15	25	25
student 1	12	12	25	20
student 2	5	17	25	24
student 3	15	19	25	13
student 4	2	0	25	25
student 5	25	22	24	21
student 6	8	4	25	12

C expressions:

score[0][0] is 22

score[6][3] is 12

*2*score[3][0]* is 30

Declaring a 2D Array

```
#define MAX_STUDENTS    80
#define MAX_HWS         6
...

int score [MAX_STUDENTS] [MAX_HWS] ;
int nstudents, nhws, i, j ;
```

2D Arrays: Two Views

type name[#rows][#columns]

int score[80][6]

score is a *two-dimensional array of int* of size 80 by 6

or… score is an array of size 80 of type array of size 6 of int

score[0][0], score[0][1], ... , score[79][5] are the elements of the array

or… score[0], score[1], ... , score[79] are the rows of the array and each of the rows is itself an array.

Reading a 2D Array

```
scanf (“%d %d”, &nstudents, &nhws) ;
if (nstudents <= MAX_STUDENTS &&
    nhws <= MAX_HWS) {
    for ( i = 0 ;  i < nstudents ;  i = i + 1 )
        for ( j = 0 ;  j < nhws ;  j =j + 1 )
            scanf(“%d”, &score [i] [j]) ;
}
```

Part of the array is unused; which part?

Array Input Example

Input: 7 4 0 1 2 3 4 5 6 7 8 9 ...

```
score    j= 0  1  2  3  4  5 ...
    i=0 | 0  1  2  3  ?  ? ...
    i=1 | 4  5  6  7  ?  ? ...
    i=2 | 8  9  ...
    ...   ...
    i=6 | ...
    i=7 | ?  ?  ?  ? ...
```

Printing a 2D Array

```
if (nstudents <= MAX_STUDENTS &&
        nhws <= MAX_HWS) {
    for ( i = 0 ;  i < nstudents ;  i = i + 1 ) {
        for ( j = 0 ;  j < nhws ;  j = j + 1 )
            printf("%d", score [i] [j]) ;
        printf("\n") ;
    }
}
```

2D Arrays as Parameters

```
void read_2D (int a [MAX_STUDENTS] [MAX_HWS] ,
                 int nstudents, int nhws)
{
    int i, j ;
    for ( i = 0 ;  i < nstudents ;  i = i + 1 )
        for ( j = 0 ;  j < nhws ;  j = j + 1 )
            scanf("%d", &a[i][j]) ;
}
```

Array Function Arguments

```
int main(void)
{
  int score [MAX_STUDENTS] [MAX_HWS] ;
  int nstudents, nhws ;

  scanf ("%d %d", &nstudents, &nhws) ;
  if (nstudents <= MAX_STUDENTS &&
      nhws <= MAX_HWS)
        read_2D (score, nstudents, nhws) ;
   ...
}
```

no &

2-D Score Averages

```
int score [MAX_STUDENTS] [MAX_HWS],  total [MAX_HWS] ;
int nstudents, nhws, i, j ;
/* Input nstudents and nhws.  Use read_2D to input scores.  [code omitted] */
/* Calculate and print averages for each homework assignment */
for ( j= 0 ;  j < nhws ;  j = j + 1 )   {
      total [ j ] = 0 ;
      for ( i = 0 ;  i < nstudents ;  i = i + 1 )
         total [ j ] = total [ j ] + score [ i]  [ j ] ;
}
printf( "Averages: \n ") ;
for ( j= 0 ;  j < nhws ;  j = j + 1 )
      printf( "HW %d: %f \n",  j, (double) total [ j ] / (double) nstudents) ;
```

2D Array Elements as Parameters

```
/* Interchange rows row1 and row2 of array a */
void swap_rows (int a [ ] [MAX_HWS],
                   int row1, int row2, int ncols)
{
   int j ;
   for ( j = 0 ;  j < ncols ;  j = j + 1 )
      swap(&a[row1][j], &a[row2][j]) ;
}
```

	0	1	2	3	4	5
0	13	15	25	25	?	?
1	12	12	25	20	?	?
2	5	17	25	24	?	?
3	15	19	25	13	?	?
4	2	0	25	25	?	?
5	25	22	24	21	?	?
6	8	4	25	12	?	?
7	?	?	?	?	?	?

Representation of Arrays

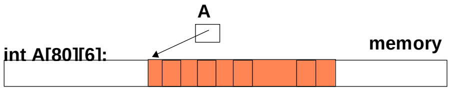
(Or: can you omit dimensions in a formal parameter?)

score	hw 0	1	2	3	4	5
student 0	13	15	25	25	?	?
student 1	12	12	25	20	?	?
student 2	5	17	25	24	?	?
student 3	15	19	25	13	?	?
student 4	2	0	25	25	?	?
student 5	25	22	24	21	?	?
student 6	8	4	25	12	?	?
student 7	?	?	?	?	?	?

13	15	25	25	?	?	12	12	25	20	?	?	5	17	25	24	?	?	15	...

student 0 student 1 student 2

A 2D Array as a Pointer



A[i] equivalent to ***(A + 6 * i)**

A[i][j] equivalent to ***(A + 6 * i + j)**