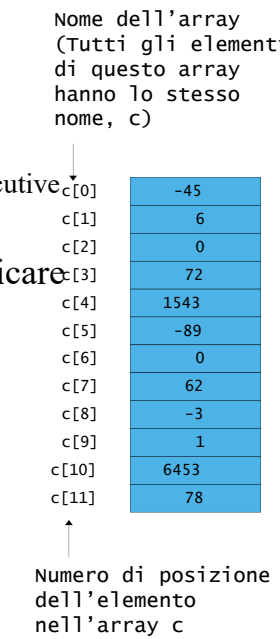
Capitolo 6 - Array

Outline

Array

- Array
  - Gruppo di locazioni di memoria consecutive
  - Stesso nome e tipo
- Per riferirsi a un elemento, specificare
  - Nome dell'array
  - Posizione
- Formato:

  arrayname`[` *position number* `]`
  - Primo elemento a posizione 0
  - array di n elementi di nome `c`:
    - `c[ 0 ], c[ 1 ]...c[ n - 1 ]`



Array

- Gli elementi di un array sono gestiti come normali variabili

```
c[ 0 ] =  3;
printf( "%d", c[ 0 ] );
```

- Operazioni eseguite con un indice.
  - Es. Se x è 3 allora la seguente è corretta

```
c[ 5 - 2 ] == c[ 3 ] == c[ x ]
```


Array

Operatori						Associatività	Tipo
[]	()					left to right	highest
++	--	!	(*type*)			right to left	unary
*	/	%				left to right	multiplicative
+	-					left to right	additive
<	<=	>	>=			left to right	relational
==	!=					left to right	equality
&&						left to right	logical and
||						left to right	logical or
?:						right to left	conditional
=	+=	-=	*=	/=	%=	right to left	assignment
,						left to right	comma

Fig. 6.2 Operator precedence.

Definizione degli Array

- Nella definizione degli array, specificare
  - Tipo dell'array
  - Nome
  - Numero di elementi
    ```
    arrayType arrayName[ numberOfElements ];
    ```
  - Esempi:
    ```
    int c[ 10 ];
    float myArray[ 3284 ];
    ```
- Definizione di array multipli dello stesso tipo
  - Formato simile alle variabili regolari
  - Esempio:
    ```
    int b[ 100 ], x[ 27 ];
    ```


Esempi con Array

- Inizializzazione
  ```
  int n[ 5 ] = { 1, 2, 3, 4, 5 };
  ```
  - Se non ci sono sufficienti valori di inizializzazione, gli elementi più a destra diventano 0
    ```
    int n[ 5 ] = { 1 }
    ```
    - Tutti gli elementi hanno il valore 0, ad eccezione del primo che vale 1
  - Se ci sono troppi valori di inizializzazione, viene prodotto un errore sintattico
  - Gli array in C non hanno il controllo dei limiti
- Se la dimensione è omessa, gli inizializzatori la determinano
  ```
  int n[ ] = { 1, 2, 3, 4, 5 };
  ```
  5 inizializzatori, perciò array di 5 elementi

```
1  /* Fig. 6.3: fig06_03.c
2     initializing an array */
3  #include <stdio.h>
4
5  /* function main begins program execution */
6  int main()
7  {
8     int n[ 10 ]; /* n is an array of 10 integers */
9     int i;       /* counter */
10
11    /* initialize elements of array n to 0 */
12    for ( i = 0; i < 10; i++ ) {
13       n[ i ] = 0; /* set element at location i to 0 */
14    } /* end for */
15
16    printf( "%s%13s\n", "Element", "Value" );
17
18    /* output contents of array n in tabular format */
19    for ( i = 0; i < 10; i++ ) {
20       printf( "%7d%13d\n", i, n[ i ] );
21    } /* end for */
22
23    return 0; /* indicates successful termination */
24
25 } /* end main */
```

Outline

fig06_03.c


```
Element        Value
      0            0
      1            0
      2            0
      3            0
      4            0
      5            0
      6            0
      7            0
      8            0
      9            0
```

Outline

Program Output

Esempi con Array

- Array di caratteri
  - La stringa "`first`" è un array statico di caratteri
  - Gli arrays di caratteri possono essere inizializzati usando stringhe di letterali

```
char string1[] = "first";
```

    - Il carattere Null `'\0'` termina le stringhe
    - `string1` ha 6 elementi
      - E' equivalente a

```
char string1[] = { 'f', 'i', 'r', 's', 't', '\0' };
```

  - E' possibile accedere ai caratteri individuali

```
string1[ 3 ] è il carattere 's'
```

  - Il nome dell'array è l'indirizzo dell'array, dunque & non è richiesto nella scanf

```
scanf( "%s", string2 );
```

    - Legge i caratteri fino a quando non si incontra uno spazio bianco
    - Attenzione: si può scrivere anche oltre i limiti di un array

```c
/* Fig. 6.4: fig06_04.c
   Initializing an array with an initializer list */
#include <stdio.h>

/* function main begins program execution */
int main()
{
   /* use initializer list to initialize array n */
   int n[ 10 ] = { 32, 27, 64, 18, 95, 14, 90, 70, 60, 37 };
   int i; /* counter */

   printf( "%s%13s\n", "Element", "Value" );

   /* output contents of array in tabular format */
   for ( i = 0; i < 10; i++ ) {
      printf( "%7d%13d\n", i, n[ i ] );
   } /* end for */

   return 0; /* indicates successful termination */

} /* end main */
```

fig06_04.c


```
Element         Value
      0            32
      1            27
      2            64
      3            18
      4            95
      5            14
      6            90
      7            70
      8            60
      9            37
```

Program Output


```c
/* Fig. 6.5: fig06_05.c
   Initialize the elements of array s to the even integers from 2 to 20 */
#include <stdio.h>
#define SIZE 10

/* function main begins program execution */
int main()
{
   /* symbolic constant SIZE can be used to specify array size */
   int s[ SIZE ]; /* array s has 10 elements */
   int j;         /* counter */

   for ( j = 0; j < SIZE; j++ ) { /* set the values */
      s[ j ] = 2 + 2 * j;
   } /* end for */

   printf( "%s%13s\n", "Element", "Value" );

   /* output contents of array s in tabular format */
   for ( j = 0; j < SIZE; j++ ) {
      printf( "%7d%13d\n", j, s[ j ] );
   } /* end for */

   return 0; /* indicates successful termination */

} /* end main */
```

fig06_05.c

```
Element         Value
      0             2
      1             4
      2             6
      3             8
      4            10
      5            12
      6            14
      7            16
      8            18
      9            20
```

Outline

Program Output


```
1  /* Fig. 6.6: fig06_06.c
2     Compute the sum of the elements of the array */
3  #include <stdio.h>
4  #define SIZE 12
5
6  /* function main begins program execution */
7  int main()
8  {
9     /* use initializer list to initialize array */
10    int a[ SIZE ] = { 1, 3, 5, 4, 7, 2, 99, 16, 45, 67, 89, 45 };
11    int i;          /* counter */
12    int total = 0; /* sum of array */
13
14    /* sum contents of array a */
15    for ( i = 0; i < SIZE; i++ ) {
16       total += a[ i ];
17    } /* end for */
18
19    printf( "Total of array element values is %d\n", total );
20
21    return 0; /* indicates successful termination */
22
23 } /* end main */
```

```
Total of array element values is 383
```

Outline

fig06_06.c

Program Output


```
1  /* Fig. 6.7: fig06_07.c
2     Student poll program */
3  #include <stdio.h>
4  #define RESPONSE_SIZE 40 /* define array sizes */
5  #define FREQUENCY_SIZE 11
6
7  /* function main begins program execution */
8  int main()
9  {
10    int answer; /* counter */
11    int rating; /* counter */
12
13    /* initialize frequency counters to 0 */
14    int frequency[ FREQUENCY_SIZE ] = { 0 };
15
16    /* place survey responses in array responses */
17    int responses[ RESPONSE_SIZE ] = { 1, 2, 6, 4, 8, 5, 9, 7, 8, 10,
18          1, 6, 3, 8, 6, 10, 3, 8, 2, 7, 6, 5, 7, 6, 8, 6, 7, 5, 6, 6,
19          5, 6, 7, 5, 6, 4, 8, 6, 8, 10 };
20
```

Outline

fig06_07.c (Part 1 of 2)


```
21    /* for each answer, select value of an element of array responses
22          and use that value as subscript in array frequency to
23          determine element to increment */
24    for ( answer = 0; answer < RESPONSE_SIZE; answer++ ) {
25       ++frequency[ responses [ answer ] ];
26    } /* end for */
27
28    /* display results */
29    printf( "%s%17s\n", "Rating", "Frequency" );
30
31    /* output frequencies in tabular format */
32    for ( rating = 1; rating < FREQUENCY_SIZE; rating++ ) {
33       printf( "%6d%17d\n", rating, frequency[ rating ] );
34    } /* end for */
35
36    return 0; /* indicates successful termination */
37
38 } /* end main */
```

```
Rating        Frequency
     1                2
     2                2
     3                2
     4                2
     5                5
     6               11
     7                5
     8                7
     9                1
    10                3
```

Outline

fig06_07.c (Part 2 of 2)

Program Output

```c
/* Fig. 6.8: fig06_08.c
   Histogram printing program */
#include <stdio.h>
#define SIZE 10

/* function main begins program execution */
int main()
{
   /* use initializer list to initialize array n */
   int n[ SIZE ] = { 19, 3, 15, 7, 11, 9, 13, 5, 17, 1 };
   int i; /* outer counter */
   int j; /* inner counter */

   printf( "%s%13s%17s\n", "Element", "Value", "Histogram" );

   /* for each element of array n, output a bar in histogram */
   for ( i = 0; i < SIZE; i++ ) {
      printf( "%7d%13d          ", i, n[ i ]) ;

      for ( j = 1; j <= n[ i ]; j++ ) { /* print one bar */
         printf( "%c", '*' );
       } /* end inner for */

```

Outline

fig06_08.c (Part 1 of 2)


```c
      printf( "\n" ); /* start next line of output */
   } /* end outer for */

   return 0; /* indicates successful termination */

} /* end main */
```

```
Element         Value         Histogram
      0            19          *******************
      1             3          ***
      2            15          ***************
      3             7          *******
      4            11          ***********
      5             9          *********
      6            13          *************
      7             5          *****
      8            17          *****************
      9             1          *
```

Outline

fig06_08.c (Part 2 of 2)

Program Output


```c
/* Fig. 6.9: fig06_09.c
   Roll a six-sided die 6000 times */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#define SIZE 7

/* function main begins program execution */
int main()
{
   int face;                    /* random number with value 1 - 6 */
   int roll;                    /* roll counter */
   int frequency[ SIZE ] = { 0 }; /* initialize array to 0 */

   srand( time( NULL ) ); /* seed random-number generator */

   /* roll die 6000 times */
   for ( roll = 1; roll <= 6000; roll++ ) {
      face = rand() % 6 + 1;
      ++frequency[ face ]; /* replaces 26-line switch of Fig. 5.8 */
   } /* end for */

   printf( "%s%17s\n", "Face", "Frequency" );

```

Outline

fig06_09.c (Part 1 of 2)


```c
   /* output frequency elements 1-6 in tabular format */
   for ( face = 1; face < SIZE; face++ ) {
      printf( "%4d%17d\n", face, frequency[ face ] );
   } /* end for */

   return 0; /* indicates successful termination */

} /* end main */
```

```
Face        Frequency
   1             1029
   2              951
   3              987
   4             1033
   5             1010
   6              990
```

Outline

fig06_09.c (Part 2 of 2)

Program Output

```c
/* Fig. 6.10: fig06_10.c
   Treating character arrays as strings */
#include <stdio.h>

/* function main begins program execution */
int main()
{
   char string1[ 20 ];               /* reserves 20 characters */
   char string2[] = "string literal"; /* reserves 15 characters */
   int i;                            /* counter */

   /* read string from user into array string2 */
   printf("Enter a string: ");
   scanf( "%s", string1 );

   /* output strings */
   printf( "string1 is: %s\nstring2 is: %s\n"
           "string1 with spaces between characters is:\n",
           string1, string2 );

   /* output characters until null character is reached */
   for ( i = 0; string1[ i ] != '\0'; i++ ) {
      printf( "%c ", string1[ i ] );
   } /* end for */

```

Outline

fig06_10.c (Part 1 of 2)


```c
   printf( "\n" );

   return 0; /* indicates successful termination */

} /* end main */
```

```
Enter a string: Hello there
string1 is: Hello
string2 is: string literal
string1 with spaces between characters is:
H e l l o
```

Outline

fig06_10.c (Part 2 of 2)


```c
/* Fig. 6.11: fig06_11.c
   Static arrays are initialized to zero */
#include <stdio.h>

void staticArrayInit( void );    /* function prototype */
void automaticArrayInit( void ); /* function prototype */

/* function main begins program execution */
int main()
{
   printf( "First call to each function:\n" );
   staticArrayInit();
   automaticArrayInit();

   printf( "\n\nSecond call to each function:\n" );
   staticArrayInit();
   automaticArrayInit();

   return 0; /* indicates successful termination */

} /* end main */
```

Outline

fig06_11.c (Part 1 of 3)


```c
/* function to demonstrate a static local array */
void staticArrayInit( void )
{
   /* initializes elements to 0 first time function is called */
   static int array1[ 3 ];
   int i; /* counter */

   printf( "\nValues on entering staticArrayInit:\n" );

   /* output contents of array1 */
   for ( i = 0; i <= 2; i++ ) {
      printf( "array1[ %d ] = %d  ", i, array1[ i ] );
   } /* end for */

   printf( "\nValues on exiting staticArrayInit:\n" );

   /* modify and output contents of array1 */
   for ( i = 0; i <= 2; i++ ) {
      printf( "array1[ %d ] = %d  ", i, array1[ i ] += 5 );
   } /* end for */

} /* end function staticArrayInit */
```

Outline

fig06_11.c (Part 2 of 3)

```
46 /* function to demonstrate an automatic local array */
47 void automaticArrayInit( void )
48 {
49    /* initializes elements each time function is called */
50    int array2[ 3 ] = { 1, 2, 3 };
51    int i; /* counter */
52
53    printf( "\n\nValues on entering automaticArrayInit:\n" );
54
55    /* output contents of array2 */
56    for ( i = 0; i <= 2; i++ ) {
57       printf("array2[ %d ] = %d  ", i, array2[ i ] );
58    } /* end for */
59
60    printf( "\nValues on exiting automaticArrayInit:\n" );
61
62    /* modify and output contents of array2 */
63    for ( i = 0; i <= 2; i++ ) {
64       printf( "array2[ %d ] = %d  ", i, array2[ i ] += 5 );
65    } /* end for */
66
67 } /* end function automaticArrayInit */
```

Outline

fig06_11.c (Part 3 of 3)


```
First call to each function:

Values on entering staticArrayInit:
array1[ 0 ] = 0  array1[ 1 ] = 0  array1[ 2 ] = 0
Values on exiting staticArrayInit:
array1[ 0 ] = 5  array1[ 1 ] = 5  array1[ 2 ] = 5

Values on entering automaticArrayInit:
array2[ 0 ] = 1  array2[ 1 ] = 2  array2[ 2 ] = 3
Values on exiting automaticArrayInit:
array2[ 0 ] = 6  array2[ 1 ] = 7  array2[ 2 ] = 8

Second call to each function:

Values on entering staticArrayInit:
array1[ 0 ] = 5  array1[ 1 ] = 5  array1[ 2 ] = 5
Values on exiting staticArrayInit:
array1[ 0 ] = 10  array1[ 1 ] = 10  array1[ 2 ] = 10

Values on entering automaticArrayInit:
array2[ 0 ] = 1  array2[ 1 ] = 2  array2[ 2 ] = 3
Values on exiting automaticArrayInit:
array2[ 0 ] = 6  array2[ 1 ] = 7  array2[ 2 ] = 8
```

Outline

Program Output

Array come parametri a funzioni

- Passaggio di array
  - Per passare un array come argomento a una funzione, specificare il nome dell'array senza parentesi quadre

```
int myArray[ 24 ];
myFunction( myArray, 24 );
```

    - La dimensione dell'array è in genere passata come ulteriore parametro
  - Gli array sono passati per riferimento
  - Il nome dell'array è l'indirizzo del suo primo elemento
  - La funzione conosce dove l'array è memorizzato
    - Vengono modificate le posizioni originali in memoria
- Passaggio di elementi singoli dell'array
  - Passaggio per valore
  - Passare il nome con l'indice (i.e., `myArray[ 3 ]`) alla funzione

Array come parametri a funzioni

- Prototipo di funzione

```
void modifyArray( int b[], int arraySize );
```

  - I nomi dei parametri sono opzionali nel prototipo
    - `int b[]` potrebbe essere scritto `int []`
    - `int arraySize` potrebbe essere semplicemente `int`

Outline

fig06_12.c

```
1  /* Fig. 6.12: fig06_12.c
2     The name of an array is the same as &array[ 0 ] */
3  #include <stdio.h>
4
5  /* function main begins program execution */
6  int main()
7  {
8     char array[ 5 ]; /* define an array of size 5 */
9
10    printf( "    array = %p\n&array[0] = %p\n"
11       "   &array = %p\n",
12       array, &array[ 0 ], &array );
13
14    return 0; /* indicates successful termination */
15
16 } /* end main */
```

Program Output

```
    array = 0012FF78
&array[0] = 0012FF78
   &array = 0012FF78
```


Outline

fig06_13.c (Part 1 of 3)

```
1  /* Fig. 6.13: fig06_13.c
2     Passing arrays and individual array elements to functions */
3  #include <stdio.h>
4  #define SIZE 5
5
6  /* function prototypes */
7  void modifyArray( int b[], int size );
8  void modifyElement( int e );
9
10 /* function main begins program execution */
11 int main()
12 {
13    int a[ SIZE ] = { 0, 1, 2, 3, 4 }; /* initialize a */
14    int i; /* counter */
15
16    printf( "Effects of passing entire array by reference:\n\nThe "
17          "values of the original array are:\n" );
18
19    /* output original array */
20    for ( i = 0; i < SIZE; i++ ) {
21       printf( "%3d", a[ i ] );
22    } /* end for */
23
24    printf( "\n" );
25
```


Outline

fig06_13.c (Part 2 of 3)

```
26    /* pass array a to modifyArray by reference */
27    modifyArray( a, SIZE );
28
29    printf( "The values of the modified array are:\n" );
30
31    /* output modified array */
32    for ( i = 0; i < SIZE; i++ ) {
33       printf( "%3d", a[ i ] );
34    } /* end for */
35
36    /* output value of a[ 3 ] */
37    printf( "\n\n\nEffects of passing array element "
38          "by value:\n\nThe value of a[3] is %d\n", a[ 3 ] );
39
40    modifyElement( a[ 3 ] ); /* pass array element a[ 3 ] by value */
41
42    /* output value of a[ 3 ] */
43    printf( "The value of a[ 3 ] is %d\n", a[ 3 ] );
44
45    return 0; /* indicates successful termination */
46
47 } /* end main */
48
```


Outline

fig06_13.c (Part 3 of 3)

```
49 /* in function modifyArray, "b" points to the original array "a"
50    in memory */
51 void modifyArray( int b[], int size )
52 {
53    int j; /* counter */
54
55    /* multiply each array element by 2 */
56    for ( j = 0; j < size; j++ ) {
57       b[ j ] *= 2;
58    } /* end for */
59
60 } /* end function modifyArray */
61
62 /* in function modifyElement, "e" is a local copy of array element
63    a[ 3 ] passed from main */
64 void modifyElement( int e )
65 {
66    /* multiply parameter by 2 */
67    printf( "Value in modifyElement is %d\n", e *= 2 );
68 } /* end function modifyElement */
```

```
Effects of passing entire array by reference:

The values of the original array are:
  0  1  2  3  4
The values of the modified array are:
  0  2  4  6  8


Effects of passing array element by value:

The value of a[3] is 6
Value in modifyElement is 12
The value of a[ 3 ] is 6
```

Outline

Program Output


```
1  /* Fig. 6.14: fig06_14.c
2     Demonstrating the const type qualifier with arrays */
3  #include <stdio.h>
4
5  void tryToModifyArray( const int b[] ); /* function prototype */
6
7  /* function main begins program execution */
8  int main()
9  {
10    int a[] = { 10, 20, 30 }; /* initialize a */
11
12    tryToModifyArray( a );
13
14    printf("%d %d %d\n", a[ 0 ], a[ 1 ], a[ 2 ] );
15
16    return 0; /* indicates successful termination */
17
18 } /* end main */
19
```

Outline

fig06_14.c (Part 1 of 2)


```
20 /* in function tryToModifyArray, array b is const, so it cannot be
21    used to modify the original array a in main. */
22 void tryToModifyArray( const int b[] )
23 {
24    b[ 0 ] /= 2;    /* error */
25    b[ 1 ] /= 2;    /* error */
26    b[ 2 ] /= 2;    /* error */
27 } /* end function tryToModifyArray */
```

```
Compiling...
FIG06_14.C
fig06_14.c(24) : error C2166: l-value specifies const object
fig06_14.c(25) : error C2166: l-value specifies const object
fig06_14.c(26) : error C2166: l-value specifies const object
```

Outline

fig06_14.c (Part 2 of 2)

Program Output

Esercizi: Calcolo della Media, Mediana e Moda usando array

- Media
- Mediana – punto medio tra il max e il min di un insieme di valori
  - 1, 2, 3, 4, 5
  - 3 è la mediana
- Moda – numero che occore più spesso
  - 1, 1, 1, 2, 3, 3, 4, 5
  - 1 è la moda

Outline

fig06_16.c (Part 1 of 8)

```
1  /* Fig. 6.16: fig06_16.c
2     This program introduces the topic of survey data analysis.
3     It computes the mean, median, and  mode of the data */
4  #include <stdio.h>
5  #define SIZE 99
6
7  /* function prototypes */
8  void mean( const int answer[] );
9  void median( int answer[] );
10 void mode( int freq[], const int answer[] ) ;
11 void bubbleSort( int a[] );
12 void printArray( const int a[] );
13
14 /* function main begins program execution */
15 int main()
16 {
17    int frequency[ 10 ] = { 0 }; /* initialize array frequency */
18
```


Outline

fig06_16.c (Part 2 of 8)

```
19    /* initialize array response */
20    int response[ SIZE ] =
21       { 6, 7, 8, 9, 8, 7, 8, 9, 8, 9,
22         7, 8, 9, 5, 9, 8, 7, 8, 7, 8,
23         6, 7, 8, 9, 3, 9, 8, 7, 8, 7,
24         7, 8, 9, 8, 9, 8, 9, 7, 8, 9,
25         6, 7, 8, 7, 8, 7, 9, 8, 9, 2,
26         7, 8, 9, 8, 9, 8, 9, 7, 5, 3,
27         5, 6, 7, 2, 5, 3, 9, 4, 6, 4,
28         7, 8, 9, 6, 8, 7, 8, 9, 7, 8,
29         7, 4, 4, 2, 5, 3, 8, 7, 5, 6,
30         4, 5, 6, 1, 6, 5, 7, 8, 7 };
31
32    /* process responses */
33    mean( response );
34    median( response );
35    mode( frequency, response );
36
37    return 0; /* indicates successful termination */
38
39 } /* end main */
40
```


Outline

fig06_16.c (Part 3 of 8)

```
41 /* calculate average of all response values */
42 void mean( const int answer[] )
43 {
44    int j;         /* counter */
45    int total = 0; /* variable to hold sum of array elements */
46
47    printf( "%s\n%s\n%s\n", "********", "  Mean", "********" );
48
49    /* total response values */
50    for ( j = 0; j < SIZE; j++ ) {
51       total += answer[  j  ];
52    } /* end for */
53
54    printf( "The mean is the average value of the data\n"
55            "items. The mean is equal to the total of\n"
56            "all the data items divided by the number\n"
57            "of data items ( %d ). The mean value for\n"
58            "this run is: %d / %d = %.4f\n\n",
59            SIZE, total, SIZE, (  double  ) total / SIZE );
60 } /* end function mean */
61
```


Outline

fig06_16.c (Part 4 of 8)

```
62 /* sort array and determine median element's value */
63 void median( int answer[] )
64 {
65    printf( "\n%s\n%s\n%s\n%s",
66            "********", " Median", "********",
67            "The unsorted array of responses is" );
68
69    printArray( answer ); /* output unsorted array */
70
71    bubbleSort( answer ); /* sort array */
72
73    printf( "\n\nThe sorted array is" );
74    printArray( answer ); /* output sorted array */
75
76    /* display median element */
77    printf( "\n\nThe median is element %d of\n"
78            "the sorted %d element array.\n"
79            "For this run the median is %d\n\n",
80            SIZE / 2, SIZE, answer[ SIZE / 2 ] );
81 } /* end function median */
82
```

```
/* determine most frequent response */
void mode( int freq[], const int answer[] )
{
   int rating;        /* counter */
   int j;             /* counter */
   int h;             /* counter */
   int largest = 0;   /* represents largest frequency */
   int modeValue = 0; /* respesents most frequent response */

   printf( "\n%s\n%s\n%s\n",
           "********", "  Mode", "********" );

   /* initialize frequencies to 0 */
   for ( rating = 1; rating <= 9; rating++ ) {
      freq[ rating ] = 0;
   } /* end for */

    /* summarize frequencies */
   for ( j = 0; j < SIZE; j++ ) {
      ++freq[ answer[ j ] ];
   } /* end for */

```

Outline

fig06_16.c (Part 5 of 8)


```
   /* output headers for result columns */
   printf( "%s%11s%19s\n\n%54s\n%54s\n\n",
           "Response", "Frequency", "Histogram",
           "1    1    2    2", "5    0    5    0    5" );

   /* output results */
   for ( rating = 1; rating <= 9; rating++ ) {
      printf( "%8d%11d          ", rating, freq[ rating ] );

      /* keep track of mode value and largest frequency value */
      if ( freq[ rating ] > largest ) {
         largest = freq[ rating ];
         modeValue = rating;
      } /* end if */

      /* output histogram bar representing frequency value */
      for ( h = 1; h <= freq[ rating ]; h++ ) {
         printf( "*" );
      } /* end inner for */

      printf( "\n" ); /* being new line of output */
   } /* end outer for */

```

Outline

fig06_16.c (Part 6 of 8)


```
   /* display the mode value */
   printf( "The mode is the most frequent value.\n"
           "For this run the mode is %d which occurred"
           " %d times.\n", modeValue, largest );
} /* end function mode */

/* function that sorts an array with bubble sort algorithm */
void bubbleSort( int a[] )
{
   int pass; /* counter */
   int j;    /* counter */
   int hold; /* temporary location used to swap elements */

   /* loop to control number of passes */
   for ( pass = 1; pass < SIZE; pass++ ) {

      /* loop to control number of comparisons per pass */
      for ( j = 0; j < SIZE - 1; j++ ) {

         /* swap elements if out of order */
         if ( a[ j ] > a[ j + 1 ] ) {
            hold = a[ j ];
            a[ j ] = a[ j + 1 ];
            a[ j + 1 ] = hold;
         } /* end if */

```

Outline

fig06_16.c (Part 7 of 8)


```
      } /* end inner for */

   } /* end outer for */

} /* end function bubbleSort */

/* output array contents (20 values per row) */
void printArray( const int a[] )
{
   int j; /* counter */

   /* output array contents */
   for ( j = 0; j < SIZE; j++ ) {

      if ( j % 20 == 0 ) { /* begin new line every 20 values */
         printf( "\n" );
      } /* end if */

      printf( "%2d", a[ j ] );
   } /* end for */

} /* end function printArray */
```

Outline

fig06_16.c (Part 8 of 8)

Outline

Program Output

```
********
  Mean
********
The mean is the average value of the data
items. The mean is equal to the total of
all the data items divided by the number
of data items ( 99 ). The mean value for
this run is: 681 / 99 = 6.8788


********
 Median
********
The unsorted array of responses is
 6 7 8 9 8 7 8 9 8 9 7 8 9 5 9 8 7 8 7 8
 6 7 8 9 3 9 8 7 8 7 7 8 9 8 9 8 9 7 8 9
 6 7 8 7 8 7 9 8 9 2 7 8 9 8 9 8 9 7 5 3
 5 6 7 2 5 3 9 4 6 4 7 8 9 6 8 7 8 9 7 8
 7 4 4 2 5 3 8 7 5 6 4 5 6 1 6 5 7 8 7

The sorted array is
 1 2 2 2 3 3 3 3 4 4 4 4 4 5 5 5 5 5 5 5
 5 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7 7
 7 7 7 7 7 7 7 7 7 7 7 7 7 8 8 8 8 8 8 8
 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
```

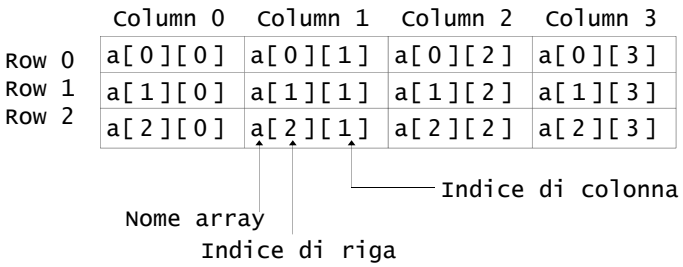

Outline

Program Output (continued)

```
The median is element 49 of
the sorted 99 element array.
For this run the median is 7


********
  Mode
********
Response  Frequency          Histogram

                                    1    1    2    2
                               5    0    5    0    5

      1         1         *
      2         3         ***
      3         4         ****
      4         5         *****
      5         8         ********
      6         9         *********
      7        23         ***********************
      8        27         ***************************
      9        19         *******************
The mode is the most frequent value.
For this run the mode is 8 which occurred 27 times.
```


Array Multidimensionali

- Array multidimensionali
  - Tabelle con righe e colonne (m x n array)
  - Come le matrici: specificare le righe, poi le colonne



Array Multidimensionali

- Inizializzazione
  - `int b[2][2]={{1,2},{3,4}};`
  - Inizializzatori raggruppati per righe tra parentesi graffe
  - Se non sufficienti, gli elementi non specificati sono settati a zero

1	2
3	4

```
int b[2][2]={{1},{3,4}};
```

1	0
3	4

- Referenziazione degli elementi
  - Specificare la riga, poi la colonna

```
printf("%d",b[0][1]);
```


```
1  /* Fig. 6.21: fig06_21.c
2     Initializing multidimensional arrays */
3  #include <stdio.h>
4
5  void printArray( const int a[][ 3 ] ); /* function prototype */
6
7  /* function main begins program execution */
8  int main()
9  {
10    /* initialize array1, array2, array3 */
11    int array1[ 2 ][ 3 ] = { { 1, 2, 3 }, { 4, 5, 6 } };
12    int array2[ 2 ][ 3 ] = { 1, 2, 3, 4, 5 };
13    int array3[ 2 ][ 3 ] = { { 1, 2 }, { 4 } };
14
15    printf( "Values in array1 by row are:\n" );
16    printArray( array1 );
17
18    printf( "Values in array2 by row are:\n" );
19    printArray( array2 );
20
21    printf( "Values in array3 by row are:\n" );
22    printArray( array3 );
23
24    return 0; /* indicates successful termination */
25
26 } /* end main */
27
```


Outline

fig06_21.c (Part 1 of 2)


```
28 /* function to output array with two rows and three columns */
29 void printArray( const int a[][ 3 ] )
30 {
31    int i; /* counter */
32    int j; /* counter */
33
34    /* loop through rows */
35    for ( i = 0; i <= 1; i++ ) {
36
37       /* output column values */
38       for ( j = 0; j <= 2; j++ ) {
39          printf( "%d ", a[ i ][ j ] );
40       } /* end inner for */
41
42       printf( "\n" ); /* start new line of output */
43    } /* end outer for */
44
45 } /* end function printArray */
```

Program Output

```
Values in array1 by row are:
1 2 3
4 5 6
Values in array2 by row are:
1 2 3
4 5 0
Values in array3 by row are:
1 2 0
4 0 0
```


Outline

fig06_22.c (Part 1 of 6)


```
1  /* Fig. 6.22: fig06_22.c
2     Double-subscripted array example */
3  #include <stdio.h>
4  #define STUDENTS 3
5  #define EXAMS 4
6
7  /* function prototypes */
8  int minimum( const int grades[][ EXAMS ], int pupils, int tests );
9  int maximum( const int grades[][ EXAMS ], int pupils, int tests );
10 double average( const int setOfGrades[], int tests );
11 void printArray( const int grades[][ EXAMS ], int pupils, int tests );
12
13 /* function main begins program execution */
14 int main()
15 {
16    int student; /* counter */
17
18    /* initialize student grades for three students (rows) */
19    const int studentGrades[ STUDENTS ][ EXAMS ] =
20       { { 77, 68, 86, 73 },
21         { 96, 87, 89, 78 },
22         { 70, 90, 86, 81 } };
23
```


Outline

fig06_22.c (Part 2 of 6)


```
24    /* output array studentGrades */
25    printf( "The array is:\n" );
26    printArray( studentGrades, STUDENTS, EXAMS );
27
28    /* determine smallest and largest grade values */
29    printf( "\n\nLowest grade: %d\nHighest grade: %d\n",
30       minimum( studentGrades, STUDENTS, EXAMS ),
31       maximum( studentGrades, STUDENTS, EXAMS ) );
32
33    /* calculate average grade for each student */
34    for ( student = 0; student <= STUDENTS - 1; student++ ) {
35       printf( "The average grade for student %d is %.2f\n",
36          student, average( studentGrades[ student ], EXAMS ) );
37    } /* end for */
38
39    return 0; /* indicates successful termination */
40
41 } /* end main */
42
43 /* Find the minimum grade */
44 int minimum( const int grades[][ EXAMS ], int pupils, int tests )
45 {
46    int i;              /* counter */
47    int j;              /* counter */
48    int lowGrade = 100; /* initialize to highest possible grade */
49
```

```
50    /* loop through rows of grades */
51    for ( i = 0; i < pupils; i++ ) {
52
53       /* loop through columns of grades */
54       for ( j = 0; j < tests; j++ ) {
55
56          if ( grades[ i ][ j ] < lowGrade ) {
57             lowGrade = grades[ i ][ j ];
58          } /* end if */
59
60       } /* end inner for */
61
62    } /* end outer for */
63
64    return lowGrade; /* return minimum grade */
65
66 } /* end function minimum */
67
68 /* Find the maximum grade */
69 int maximum( const int grades[][ EXAMS ], int pupils, int tests )
70 {
71    int i;            /* counter */
72    int j;            /* counter */
73    int highGrade = 0; /* initialize to lowest possible grade */
74
```


fig06_22.c (Part 3 of 6)


```
75    /* loop through rows of grades */
76    for ( i = 0; i < pupils; i++ ) {
77
78       /* loop through columns of grades */
79       for ( j = 0; j < tests; j++ ) {
80
81          if ( grades[ i ][ j ] > highGrade ) {
82             highGrade = grades[ i ][ j ];
83          } /* end if */
84
85       } /* end inner for */
86
87    } /* end outer for */
88
89    return highGrade; /* return maximum grade */
90
91 } /* end function maximum */
92
93 /* Determine the average grade for a particular student */
94 double average( const int setOfGrades[], int tests )
95 {
96    int i;         /* counter */
97    int total = 0; /* sum of test grades */
98
```


fig06_22.c (Part 4 of 6)


```
99    /* total all grades for one student */
100   for ( i = 0; i < tests; i++ ) {
101      total += setOfGrades[ i ];
102   } /* end for */
103
104   return ( double ) total / tests; /* average */
105
106} /* end function average */
107
108/* Print the array */
109void printArray( const int grades[][ EXAMS ], int pupils, int tests )
110{
111   int i; /* counter */
112   int j; /* counter */
113
114   /* output column heads */
115   printf( "               [0]  [1]  [2]  [3]" );
116
117   /* output grades in tabular format */
118   for ( i = 0; i < pupils; i++ ) {
119
120      /* output label for row */
121      printf( "\nstudentGrades[%d] ", i );
122
```


fig06_22.c (Part 5 of 6)


```
123      /* output grades for one student */
124      for ( j = 0; j < tests; j++ ) {
125         printf( "%-5d", grades[ i ][ j ] );
126      } /* end inner for */
127
128   } /* end outer for */
129
130} /* end function printArray */
```

```
The array is:
               [0]  [1]  [2]  [3]
studentGrades[0] 77   68   86   73
studentGrades[1] 96   87   89   78
studentGrades[2] 70   90   86   81

Lowest grade: 68
Highest grade: 96
The average grade for student 0 is 76.00
The average grade for student 1 is 87.50
The average grade for student 2 is 81.75
```


fig06_22.c (Part 6 of 6)