

## Capitolo 6 - Array

### Outline

- Array
- Definizione degli Array
- Esempi con Array
- Array come parametri a funzioni
- Sorting Arrays
- Esercizi: Calcolo della Media, Mediana e Moda usando Array
- Array Multidimensionali

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## 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 ]`

Nome dell'array  
(Tutti gli elementi  
di questo array  
hanno lo stesso  
nome, c)

c[0]	-45
c[1]	6
c[2]	0
c[3]	72
c[4]	1543
c[5]	-89
c[6]	0
c[7]	62
c[8]	-3
c[9]	1
c[10]	6453
c[11]	78

Numero di posizioni  
dell'elemento  
nell'array c

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## 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 ]
```

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## Array

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

Fig. 6.2 Operator precedence.

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## 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 ];`

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## 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 troppo 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

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```
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( "%d\n", "Element", "Value" );
17
18     /* output contents of array n in tabular format */
19     for ( i = 0; i < 10; i++ ) {
20         printf( "%d\n", i, n[ i ] );
21     } /* end for */
22
23     return 0; /* indicates successful termination */
24 } /* end main */
25
```

Outline  
fig06\_03.c

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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

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## 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

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```
1 /* Fig. 6.4: fig06_04.c
2  Initializing an array with an initializer list */
3 #include <stdio.h>
4
5 /* function main begins program execution */
6 int main()
7 {
8     /* use initializer list to initialize array n */
9     int n[10] = { 85, 27, 64, 18, 95, 14, 90, 70, 60, 37 };
10    int i; /* counter */
11
12    printf( "%s\n", "Element", "Value" );
13
14    /* output contents of array in tabular format */
15    for ( i = 0; i < 10; i++ ) {
16        printf( "%7d\n", n[ i ] );
17    } /* end for */
18
19    return 0; /* indicates successful termination */
20 } /* end main */
```

Outline

fig06\_04.c

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

Outline

Program Output

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```
1 /* Fig. 6.5: fig06_05.c
2  Initialize the elements of array s to the even integers from 2 to 20 */
3 #include <stdio.h>
4 #define SIZE 10
5
6 /* function main begins program execution */
7 int main()
8 {
9     /* symbolic constant SIZE can be used to specify array size */
10    int s[ SIZE ]; /* array s has 10 elements */
11    int j; /* counter */
12
13    for ( j = 0; j < SIZE; j++ ) { /* set the values */
14        s[ j ] = 2 + 2 * j;
15    } /* end for */
16
17    printf( "%s\n", "Element", "Value" );
18
19    /* output contents of array s in tabular format */
20    for ( j = 0; j < SIZE; j++ ) {
21        printf( "%7d\n", j, s[ j ] );
22    } /* end for */
23
24    return 0; /* indicates successful termination */
25 } /* end main */
```

Outline

fig06\_05.c

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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

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```

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 } /* end main */

```

Outline

fig06\_06.c

Program Output

Total of array element values is 383

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```

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)

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```

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\n", "Rating", "Frequency" );
30
31 /* output frequencies in tabular format */
32 for ( rating = 1; rating < FREQUENCY_SIZE; rating++ ) {
33     printf( "%s\n", rating, frequency[ rating ] );
34 } /* end for */
35
36 return 0; /* indicates successful termination */
37
38 } /* end main */

```

Outline

fig06\_07.c (Part 2 of 2)

Program Output

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

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```

1 /* Fig. 6.8: fig06_08.c
2 Histogram printing program */
3 #include <stdio.h>
4 #define SIZE 10
5
6 /* function main begins program execution */
7 int main()
8 {
9     /* use initializer list to initialize array n */
10    int n[ SIZE ] = { 19, 3, 16, 7, 11, 9, 15, 6, 17, 1 };
11    int i; /* outer counter */
12    int j; /* inner counter */
13
14    printf( "%s\n", "Element", "Value", "Histogram" );
15
16    /* for each element of array n, output a bar in histogram */
17    for ( i = 0; i < SIZE; i++ ) {
18        printf( "%10d", i, n[ i ] );
19
20        for ( j = 1; j <= n[ i ]; j++ ) { /* print one bar */
21            printf( "%c", "x" );
22        } /* end inner for */
23

```

Outline

fig06\_08.c (Part 1 of 2)

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```

24    printf( "\n" ); /* start next line of output */
25    } /* end outer for */
26
27    return 0; /* indicates successful termination */
28
29 } /* end main */

```

Element	Value	Histogram
0	19	xxxxxxxxxxxx
1	3	xxx
2	16	xxxxxxxxxxxx
3	7	xxxxxxx
4	11	xxxxxxxxx
5	9	xxxxxxxxx
6	13	xxxxxxxxxxx
7	6	xxxxxxx
8	17	xxxxxxxxxxx
9	1	x

Outline

fig06\_08.c (Part 2 of 2)

Program Output

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```

1 /* Fig. 6.9: fig06_09.c
2 Roll a six-sided die 6000 times */
3 #include <stdio.h>
4 #include <stdlib.h>
5 #include <time.h>
6 #define SIZE 7
7
8 /* function main begins program execution */
9 int main()
10 {
11     int face; /* random number with value 1 - 6 */
12     int roll; /* roll counter */
13     int frequency[ SIZE ] = { 0 }; /* initialize array to 0 */
14
15     srand( time( NULL ) ); /* seed random-number generator */
16
17     /* roll die 6000 times */
18     for ( roll = 1; roll <= 6000; roll++ ) {
19         face = rand() % 6 + 1;
20         ++frequency[ face ]; /* replaces 26-line switch of Fig. 5.8 */
21     } /* end for */
22
23     printf( "%s\n", "Face", "Frequency" );
24

```

Outline

fig06\_09.c (Part 1 of 2)

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```

25     /* output frequency elements 1-6 in tabular format */
26     for ( face = 1; face < SIZE; face++ ) {
27         printf( "%4d%17d\n", face, frequency[ face ] );
28     } /* end for */
29
30     return 0; /* indicates successful termination */
31
32 } /* 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

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```

1 /* Fig. 6.10: fig06_10.c
2  Treating character arrays as strings */
3 #include <stdio.h>
4
5 /* function main begins program execution */
6 int main()
7 {
8     char string1[ 20 ]; /* reserves 20 characters */
9     char string2[] = "string literal"; /* reserves 15 characters */
10    int i; /* counter */
11
12    /* read string from user into array string2 */
13    printf("Enter a string: ");
14    scanf("%s", string1);
15
16    /* output strings */
17    printf("string1 is: %s\n", string1);
18    printf("string2 is: %s\n", string2);
19
20    /* output characters until null character is reached */
21    for ( i = 0; string1[ i ] != '\0'; i++ ) {
22        printf("%c", string1[ i ] );
23    } /* end for */
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```

```

46 /* function to demonstrate an automatic local array */
47 void automati cArrayni t( 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 automati cArrayni t:\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( "\n\nValues on exiting automati cArrayni t:\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 automati cArrayni t */

```

Outline

fig06\_11.c (Part 3 of 3)

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First call to each function:

```

Values on entering stati cArrayni t:
array1[ 0 ] = 0 array1[ 1 ] = 0 array1[ 2 ] = 0
Values on exiting stati cArrayni t:
array1[ 0 ] = 5 array1[ 1 ] = 5 array1[ 2 ] = 5

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

```

Second call to each function:

```

Values on entering stati cArrayni t:
array1[ 0 ] = 5 array1[ 1 ] = 5 array1[ 2 ] = 5
Values on exiting stati cArrayni t:
array1[ 0 ] = 10 array1[ 1 ] = 10 array1[ 2 ] = 10

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

```

Outline

Program Output

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### 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

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### 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

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```

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\narray[0] = %p\n"
11           " &array = %p\n",
12           array, &array[ 0 ], &array );
13
14    return 0; /* indicates successful termination */
15 } /* end main */
16 array = 0012FF78
17 &array[0] = 0012FF78
18 &array = 0012FF78

```

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Outline

fig06\_12.c

Program Output

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```

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\n" );
25 }

```

30

Outline

fig06\_13.c (Part 1 of 3)

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```

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\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

```

31

Outline

fig06\_13.c (Part 2 of 3)

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```

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 } /* end function modifyArray */
60
61 /* In function modifyElement, "e" is a local copy of array element
62 a[ 3 ] passed from main */
63 void modifyElement( int e )
64 {
65     /* multiply parameter by 2 */
66     printf( "Value in modifyElement is %d\n", e * 2 );
67 } /* end function modifyElement */

```

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Outline

fig06\_13.c (Part 3 of 3)

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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

Program Output

Outline

35

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```

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

```

fig06\_14.c (Part 1 of 2)

Outline

34

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```

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 ] /* error */
25     b[ 1 ] /* error */
26     b[ 2 ] /* error */
27 } /* end function tryToModifyArray */

```

fig06\_14.c (Part 2 of 2)

Program Output

Outline

35

```

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

```

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### 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 occorre più spesso
  - 1, 1, 1, 2, 3, 3, 4, 5
  - 1 è la moda

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```

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
19
20
21
22
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24
25
26
27
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30
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97
98
99

```

Outline

fig06\_16.c (Part 1 of 8)

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```

19 /* initialize array response */
20 int response[ SIZE ] =
21 { 4, 7, 8, 9, 8, 7, 8, 9, 8, 9,
22   7, 8, 9, 5, 9, 6, 7, 8, 7, 8,
23   6, 7, 8, 9, 3, 9, 8, 7, 8, 7,
24   7, 8, 9, 8, 9, 6, 9, 7, 8, 9,
25   6, 7, 8, 7, 8, 7, 9, 8, 9, 2,
26   7, 8, 9, 8, 9, 6, 9, 7, 5, 3,
27   5, 6, 7, 2, 5, 5, 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, 6, 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 2 of 8)

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```

61 /* calculate average of all response values */
62 void mean( const int answer[] )
63 {
64     int j; /* counter */
65     int total = 0; /* variable to hold sum of array elements */
66
67     printf( "%s\n%s\n%s\n", "*****", " Mean", "*****" );
68
69     /* total response values */
70     for ( j = 0; j < SIZE; j++ ) {
71         total += answer[ j ];
72     } /* end for */
73
74     printf( "The mean is the average value of the data\n"
75            "items. The mean is equal to the total of\n"
76            "all the data items divided by the number\n"
77            "of data items ( %d ). The mean value for\n"
78            "this run is: %d / %d = %.4f\n",
79            SIZE, total, SIZE, ( double ) total / SIZE );
80 } /* end function mean */
81

```

Outline

fig06\_16.c (Part 3 of 8)

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```

62 /* sort array and determine median element's value */
63 void median( int answer[] )
64 {
65     printf( "\n\n%s\n%s\n",
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",
80            SIZE / 2, SIZE, answer[ SIZE / 2 ] );
81 } /* end function median */
82

```

Outline

fig06\_16.c (Part 4 of 8)

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```

123 /* determine most frequent response */
124 void mode( int freq[], const int answer[] )
125 {
126     int rating; /* counter */
127     int j; /* counter */
128     int h; /* counter */
129     int largest = 0; /* represents largest frequency */
130     int modeValue = 0; /* represents most frequent response */
131
132     printf( "\n\n\n\n\n\n",
133            "*****", " mode", "*****" );
134
135     /* initialize frequencies to 0 */
136     for ( rating = 1; rating <= 9; rating++ ) {
137         freq[ rating ] = 0;
138     } /* end for */
139
140     /* summarize frequencies */
141     for ( j = 0; j < SIZE; j++ ) {
142         ++freq[ answer[ j ] ];
143     } /* end for */
144
145     /* display the mode value */
146     printf( "The mode is the most frequent value.\n"
147            "For this run the mode is %d which occurred\n"
148            "%d times.\n", modeValue, largest );
149 } /* end function mode */
150
151 /* function that sorts an array with bubble sort algorithm */
152 void bubbleSort( int a[] )
153 {
154     int pass; /* counter */
155     int j; /* counter */
156     int hold; /* temporary location used to swap elements */
157
158     /* loop to control number of passes */
159     for ( pass = 1; pass < SIZE; pass++ ) {
160
161         /* loop to control number of comparisons per pass */
162         for ( j = 0; j < SIZE - 1; j++ ) {
163
164             /* swap elements if out of order */
165             if ( a[ j ] > a[ j + 1 ] ) {
166                 hold = a[ j ];
167                 a[ j ] = a[ j + 1 ];
168                 a[ j + 1 ] = hold;
169             } /* end if */
170         }
171     }
172 }

```

Outline 41

fig06\_16.c (Part 5 of 8)

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```

155 /* output headers for result columns */
156 printf( "%d\t%d\t%d\t%d\t%d\t%d\t",
157         "Response", "Frequency", "Histogram",
158         "1 1 2 2", "5 0 5 0 5" );
159
160 /* output results */
161 for ( rating = 1; rating <= 9; rating++ ) {
162     printf( "%d\t", rating, freq[ rating ] );
163
164     /* keep track of mode value and largest frequency value */
165     if ( freq[ rating ] > largest ) {
166         largest = freq[ rating ];
167         modeValue = rating;
168     } /* end if */
169
170     /* output histogram bar representing frequency value */
171     for ( h = 1; h <= freq[ rating ]; h++ ) {
172         printf( "x" );
173     } /* end inner for */
174
175     printf( "\n" ); /* being new line of output */
176 } /* end outer for */
177
178 } /* and inner for */
179 } /* end outer for */
180
181 /* end function bubbleSort */
182
183 /* output array contents (20 values per row) */
184 void printArray( const int a[] )
185 {
186     int j; /* counter */
187
188     /* output array contents */
189     for ( j = 0; j < SIZE; j++ ) {
190
191         if ( j % 20 == 0 ) { /* begin new line every 20 values */
192             printf( "\n" );
193         } /* end if */
194
195         printf( "%3d", a[ j ] );
196     } /* end for */
197 } /* end function printArray */

```

Outline 42

fig06\_16.c (Part 6 of 8)

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```

154 } /* and inner for */
155 } /* end outer for */
156
157 /* end function bubbleSort */
158
159 /* output array contents (20 values per row) */
160 void printArray( const int a[] )
161 {
162     int j; /* counter */
163
164     /* output array contents */
165     for ( j = 0; j < SIZE; j++ ) {
166
167         if ( j % 20 == 0 ) { /* begin new line every 20 values */
168             printf( "\n" );
169         } /* end if */
170
171         printf( "%3d", a[ j ] );
172     } /* end for */
173 } /* end function printArray */

```

Outline 43

fig06\_16.c (Part 7 of 8)

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```

174 } /* end function printArray */
175
176 } /* and inner for */
177 } /* end outer for */
178
179 /* end function bubbleSort */
180
181 /* output array contents (20 values per row) */
182 void printArray( const int a[] )
183 {
184     int j; /* counter */
185
186     /* output array contents */
187     for ( j = 0; j < SIZE; j++ ) {
188
189         if ( j % 20 == 0 ) { /* begin new line every 20 values */
190             printf( "\n" );
191         } /* end if */
192
193         printf( "%3d", a[ j ] );
194     } /* end for */
195 } /* end function printArray */

```

Outline 44

fig06\_16.c (Part 8 of 8)

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45

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 8 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 3 3 3 3 4 4 4 4 4 4 5 5 5 5 5 5 5
5 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 8 8 8
9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9

```

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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.

```

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### Array Multidimensionali

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

	Column 0	Column 1	Column 2	Column 3
Row 0	a[0][0]	a[0][1]	a[0][2]	a[0][3]
Row 1	a[1][0]	a[1][1]	a[1][2]	a[1][3]
Row 2	a[2][0]	a[2][1]	a[2][2]	a[2][3]

Nome array      Indice di riga      Indice di colonna

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48

### 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
  - `int b[2][2] = { { 1 }, { 3, 4 } };`
- Referenziazione degli elementi
  - Specificare la riga, poi la colonna
  - `printf( "%d", b[0][1] );`

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```

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, 3, 5, 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)

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```

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\t", 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 */

```

Outline

fig06\_21.c (Part 2 of 2)

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

```

50

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```

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 1 of 6)

51

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```

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( "minimum 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

```

Outline

fig06\_22.c (Part 2 of 6)

52

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```

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

```

Outline 53  
fig06\_22.c (Part 3 of 6)

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```

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

```

Outline 54  
fig06\_22.c (Part 4 of 6)

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```

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 } /* end function average */
106
107
108 /* Print the array */
109 void 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

```

Outline 55  
fig06\_22.c (Part 5 of 6)

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```

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

Outline 56  
fig06\_22.c (Part 6 of 6)

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