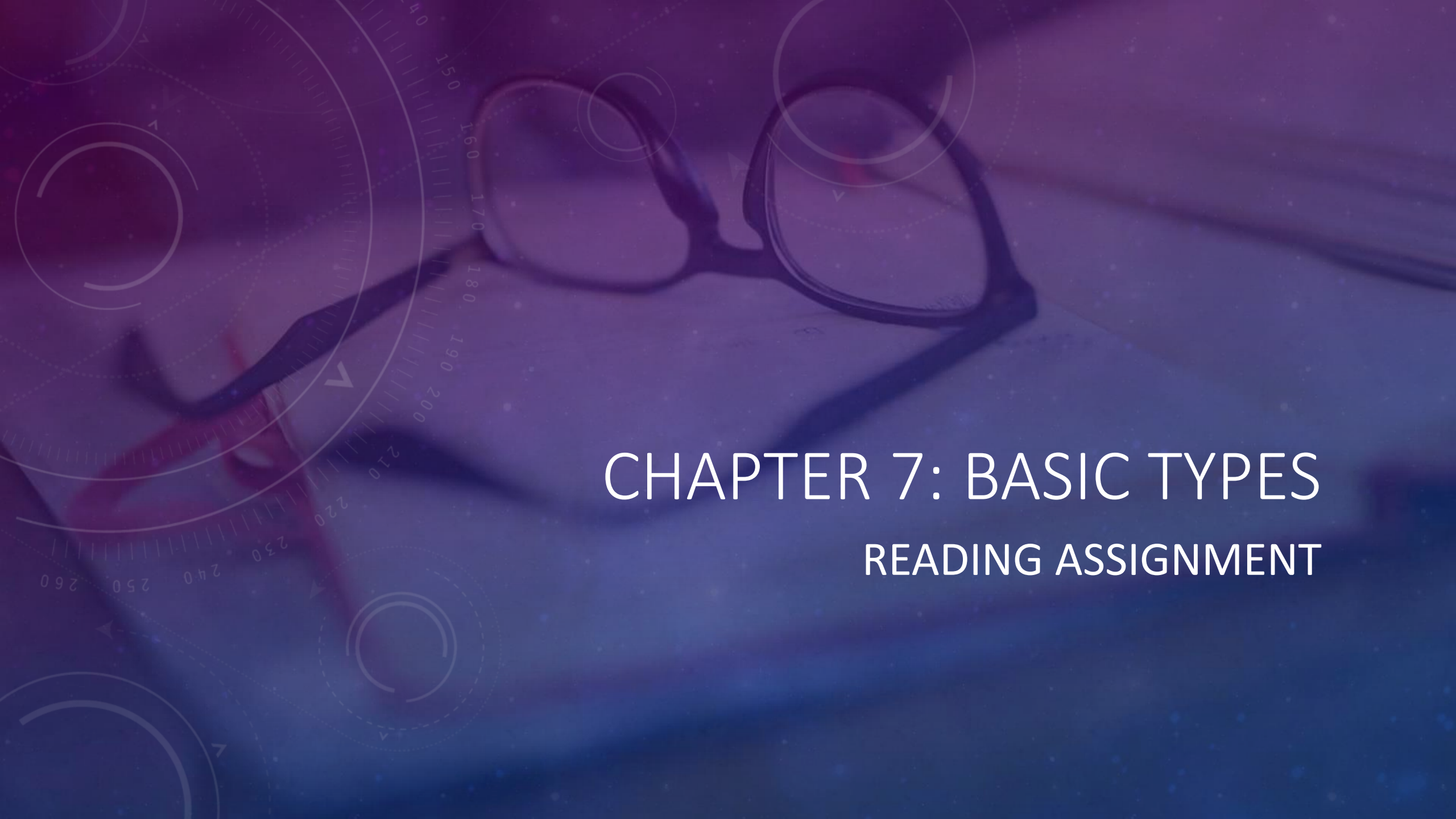


CHAPTER 7: BASIC TYPES

READING ASSIGNMENT

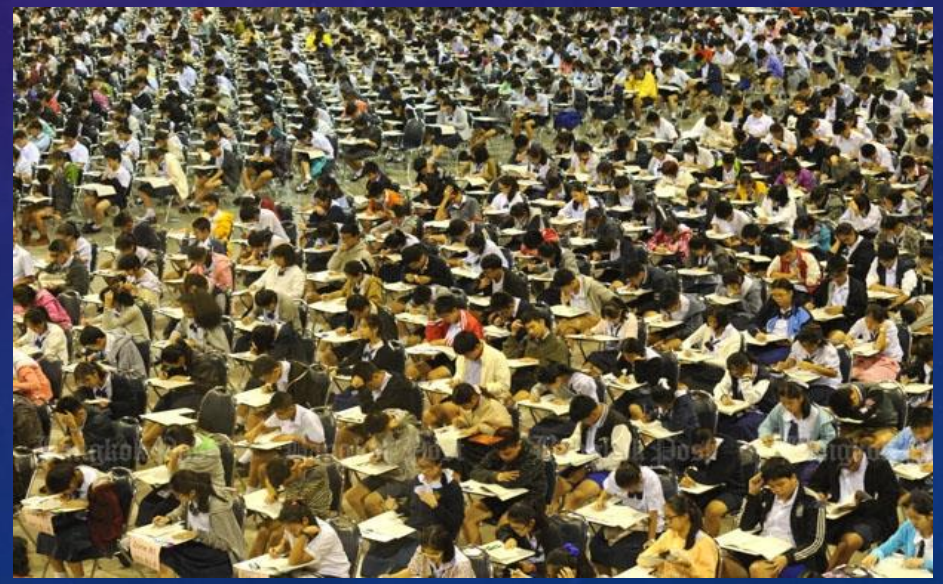
ARRAYS

HK RANA

WHY ARRAYS

- Need to store a large number of values of an identical data types
- For instance:
  - To store the marks of all the students of a university, you need to declare thousands of variables. In addition, all of them must be unique.

- Is this Convenient?



ONE DIMENSIONAL ARRAYS

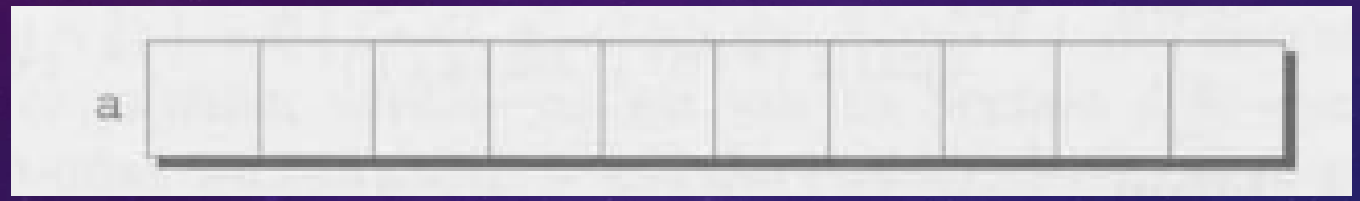
Definition: An array is a data structure containing a number of data values, all of which have the same data type

These values, known as elements, can be individually selected by their position within the array.

Simplest kind of array is One-Dimensional Array

Generally, size of the array is fixed

ARRAY DECLARATION




```
#define N 10
…
int a[N];
```

ARRAY SUBSCRIPTING


```
a[0] = 1;
printf("%d\n", a[5]);
++a[i];
```

```
idiom   for (i = 0; i < N; i++)
          a[i] = 0;                 /* clears a */

idiom   for (i = 0; i < N; i++)
          scanf("%d", &a[i]);       /* reads data into a */

idiom   for (i = 0; i < N; i++)
          sum += a[i];              /* sums the elements of a */
```

Note:

Combination of an Array name and its Index works like a variable

ATTENTION

C doesn't require that subscript bounds be checked; if a subscript goes out of range, the program's behavior is undefined. One cause of a subscript going out of bounds: forgetting that an array with n elements is indexed from 0 to $n - 1$, not 1 to n. (As one of my professors liked to say, "In this business, you're always off by one." He was right, of course.) The following example illustrates a bizarre effect that can be caused by this common blunder:

```
int a[10], i;

for (i = 1; i <= 10; i++)
  a[i] = 0;
```

With some compilers, this innocent-looking `for` statement causes an infinite loop! When `i` reaches 10, the program stores 0 into `a[10]`. But `a[10]` doesn't exist, so 0 goes into memory immediately after `a[9]`. If the variable `i` happens to follow `a[9]` in memory—as might be the case—then `i` will be reset to 0, causing the loop to start over.

SOME MORE DISCUSSIONS

An array subscript may be any integer expression:

```
a[i+j*10] = 0;
```

The expression can even have side effects:

```
i = 0;
while (i < N)
  a[i++] = 0;
```

Let's trace this code. After `i` is set to 0, the `while` statement checks whether `i` is less than `N`. If it is, 0 is assigned to `a[0]`, `i` is incremented, and the loop repeats. Note that `a[++i]` wouldn't be right, because 0 would be assigned to `a[1]` during the first loop iteration.

PRACTICE PROBLEM 1

PROGRAM **Reversing a Series of Numbers**

Our first array program prompts the user to enter a series of numbers, then writes the numbers in reverse order:

```
Enter 10 numbers: 34 82 49 102 7 94 23 11 50 31
In reverse order: 31 50 11 23 94 7 102 49 82 34
```

Our strategy will be to store the numbers in an array as they're read, then go through the array backwards, printing the elements one by one. In other words, we won't actually reverse the elements in the array, but we'll make the user think we did.

Shifting the Array values to one cell right ….

ARRAY INITIALIZATION

```
int a[10] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
```

```
int a[10] = {1, 2, 3, 4, 5, 6};
  /* initial value of a is {1, 2, 3, 4, 5, 6, 0, 0, 0, 0} */
```

```
int a[10] = {0};
  /* initial value of a is {0, 0, 0, 0, 0, 0, 0, 0, 0, 0} */
```

```
  int a[] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
```

DESIGNATED INITIALIZATION

C99

Designated Initializers

It's often the case that relatively few elements of an array need to be initialized explicitly; the other elements can be given default values. Consider the following example:

```
int a[15] = {0, 0, 29, 0, 0, 0, 0, 0, 0, 7, 0, 0, 0, 0, 48};
```

We want element 2 of the array to be 29, element 9 to be 7, and element 14 to be 48, but the other values are just zero. For a large array, writing an initializer in this fashion is tedious and error-prone (what if there were 200 zeros between two of the nonzero values?).

C99's ***designated initializers*** can be used to solve this problem. Here's how we could redo the previous example using a designated initializer:

```
int a[15] = {[2] = 29, [9] = 7, [14] = 48};
```

Each number in brackets is said to be a ***designator.***

Besides being shorter and easier to read (at least for some arrays), designated initializers have another advantage: the order in which the elements are listed no longer matters. Thus, our previous example could also be written in the following way:

```
int a[15] = {[14] = 48, [9] = 7, [2] = 29};
```

Designators must be integer constant expressions. If the array being initialized has length n, each designator must be between 0 and $n - 1$. However, if the length of the array is omitted, a designator can be any nonnegative integer. In the latter case, the compiler will deduce the length of the array from the largest designator.

PRACTICE PROBLEM 2

PROGRAM **Checking a Number for Repeated Digits**

Our next program checks whether any of the digits in a number appear more than once. After the user enters a number, the program prints either `Repeated digit` or `No repeated digit`:

```
Enter a number: 28212
Repeated digit
```

The number 28212 has a repeated digit (2); a number like 9357 doesn't.

USING THE SIZE OF OPERATOR

The `sizeof` operator can determine the size of an array (in bytes). If `a` is an array of 10 integers, then `sizeof(a)` is typically 40 (assuming that each integer requires four bytes).

We can also use `sizeof` to measure the size of an array element, such as `a[0]`. Dividing the array size by the element size gives the length of the array:

```
sizeof(a) / sizeof(a[0])
```

Some programmers use this expression when the length of the array is needed. To clear the array `a`, for example, we could write

```
for (i = 0; i < sizeof(a) / sizeof(a[0]); i++)
  a[i] = 0;
```

PRACTICE PROBLEM 3

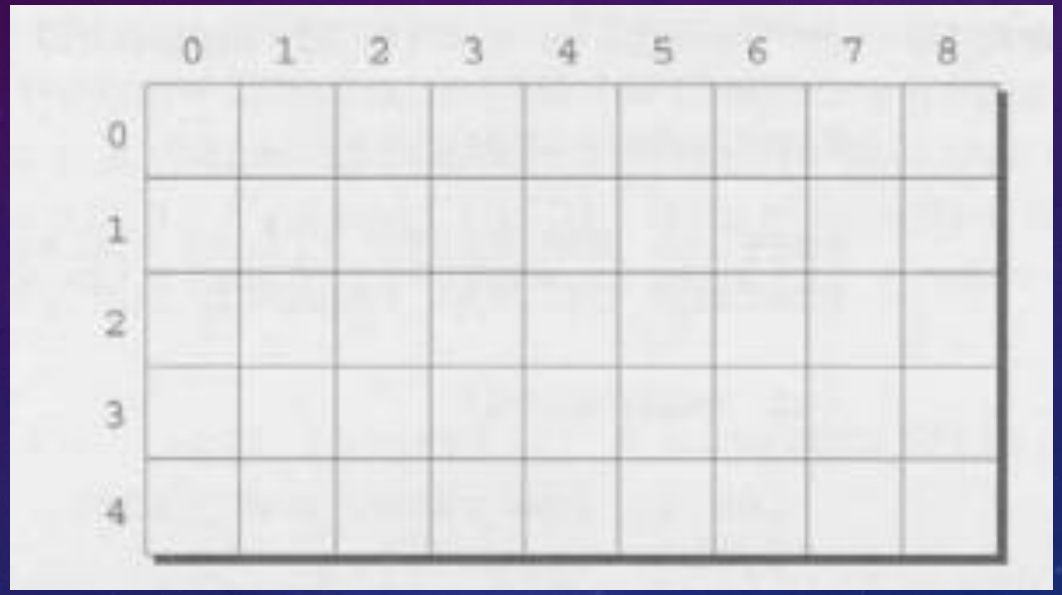
PROGRAM **Computing Interest**

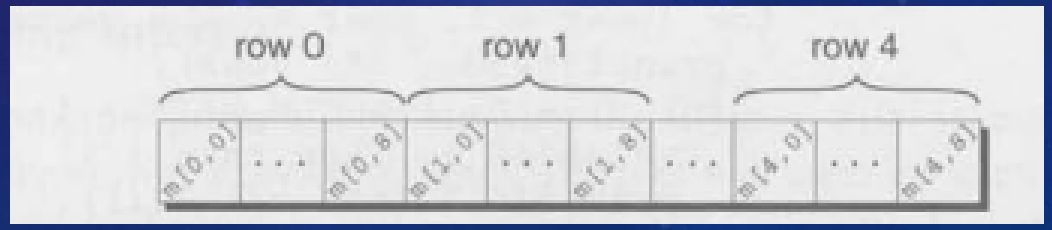
Our next program prints a table showing the value of $100 invested at different rates of interest over a period of years. The user will enter an interest rate and the number of years the money will be invested. The table will show the value of the money at one-year intervals—at that interest rate and the next four higher rates—assuming that interest is compounded once a year. Here's what a session with the program will look like:

```
Enter interest rate: 6
Enter number of years: 5

Years      6%      7%      8%      9%     10%
  1     106.00  107.00  108.00  109.00  110.00
  2     112.36  114.49  116.64  118.81  121.00
  3     119.10  122.50  125.97  129.50  133.10
  4     126.25  131.08  136.05  141.16  146.41
  5     133.82  140.26  146.93  153.86  161.05
```

MULTIDIMENSIONAL ARRAY





INITIALIZING MULTIDIMENSIONAL ARRAY

```
int m[5][9] = {{1, 1, 1, 1, 1, 0, 1, 1, 1},
               {0, 1, 0, 1, 0, 1, 0, 1, 0},
               {0, 1, 0, 1, 1, 0, 0, 1, 0},
               {1, 1, 0, 1, 0, 0, 0, 1, 0},
               {1, 1, 0, 1, 0, 0, 1, 1, 1}};
```

```
int m[5][9] = {{1, 1, 1, 1, 1, 0, 1, 1, 1},
               {0, 1, 0, 1, 0, 1, 0, 1, 0},
               {0, 1, 0, 1, 1, 0, 0, 1, 0}};
```

```
int m[5][9] = {{1, 1, 1, 1, 1, 0, 1, 1, 1},
               {0, 1, 0, 1, 0, 1, 0, 1},
               {0, 1, 0, 1, 1, 0, 0, 1},
               {1, 1, 0, 1, 0, 0, 0, 1},
               {1, 1, 0, 1, 0, 0, 1, 1, 1}};
```

```
int m[5][9] = {1, 1, 1, 1, 1, 0, 1, 1, 1,
               0, 1, 0, 1, 0, 1, 0, 1, 0,
               0, 1, 0, 1, 1, 0, 0, 1, 0,
               1, 1, 0, 1, 0, 0, 0, 1, 0,
               1, 1, 0, 1, 0, 0, 1, 1, 1};
```

```
double ident[2][2] = {[0][0] = 1.0, [1][1] = 1.0};
```

As usual, all elements for which no value is specified will default to zero.

```
const char hex_chars[] =
  {'0', '1', '2', '3', '4', '5', '6', '7', '8', '9',
   'A', 'B', 'C', 'D', 'E', 'F'};
```

PRACTICE PROBLEM 3

PROGRAM **Dealing a Hand of Cards**

Our next program illustrates both two-dimensional arrays and constant arrays. The program deals a random hand from a standard deck of playing cards. (In case you haven't had time to play games recently, each card in a standard deck has a *suit*—clubs, diamonds, hearts, or spades—and a *rank*—two, three, four, five, six, seven, eight, nine, ten, jack, queen, king, or ace.) We'll have the user specify how many cards should be in the hand:

```
Enter number of cards in hand: 5
Your hand: 7c 2s 5d as 2h
```

It's not immediately obvious how we'd write such a program. How do we pick cards randomly from the deck? And how do we avoid picking the same card twice?

VARIABLE LENGTH ARRAY (C99)

```
printf("How many numbers do you want to reverse? ");
scanf("%d", &n);

int a[n];   /* C99 only - length of array depends on n */
```

THE END