Programming Language Lab

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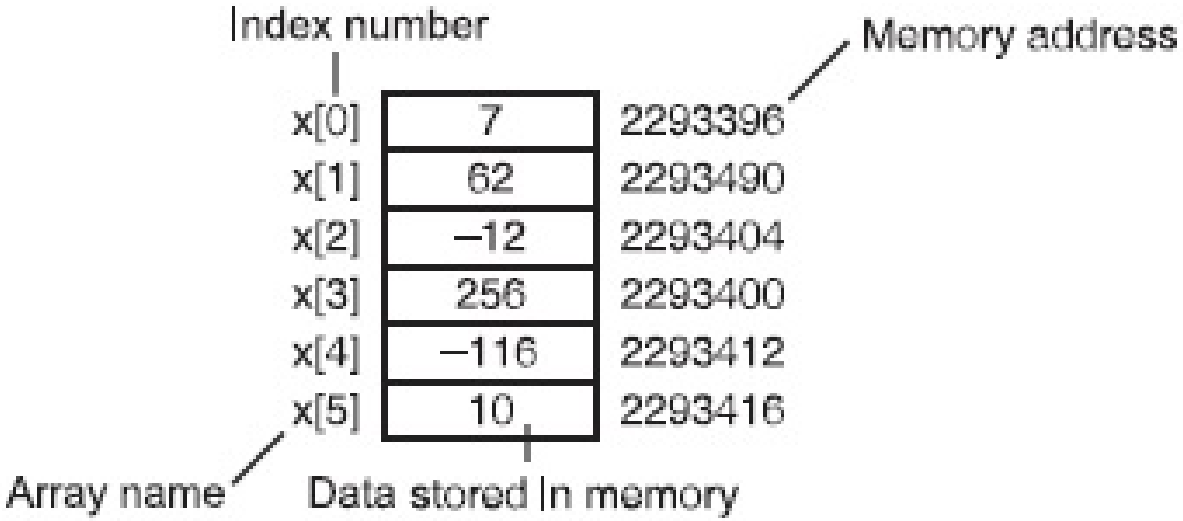
Arrays

A programming construct which facilitates to group like variables for easy access during coding:

- Variables in an array share the same name
- Variables in an array share the same data type
- Individual variables in an array are called elements
- Elements in an array are accessed with an index number



- off-by-one error

One-dimensional array

Example

- The number of pages in each chapter of a book
- A list of students' CGPAs
- A list of phone numbers

Creating one-dimensional arrays

```
int iArray[10]; //Integer data type array with 10 elements
float fArray[10]; //Float data type array with 10 elements
double dArray[3]; //Double data type array with 3 elements
short sSalaries[9]; //Short data type array with 9 elements
char cName[19]; //Char array - 18 character elements and one null character
```

Floating point number system

A floating point number system $F \subset \mathbb{R}$ is a subset of real numbers whose elements are of the form

$$y = \pm m \times \beta^{e-t}.$$

The system F is characterized by four integer parameters:

- the base β (sometimes called the radix)
- the precision t, and
- the exponent range $e_{\text{min}} < e < e_{\text{max}}$.

- The significand/mantissa m is an integer satisfying $0 \leq m \leq \beta^t - 1$
- To ensure a unique representation for each nonzero $y \in F$ it is assumed that $m \geq \beta^{t-1}$ so that the system is normalized
- The number 0 is a special case in that it does not have a normalized representation
- The range of the nonzero floating point numbers in F is given by $\beta^{e_{\text{min}}-1} \leq |y| \leq \beta^{e_{\text{max}}-1}$

Floating point number system

An alternative (and more common) way of expressing y is

$$y = \pm\beta^e \left(\frac{d_1}{\beta} + \frac{d_2}{\beta^2} + \ldots + \frac{d_t}{\beta^t} \right) = \pm\beta^e \times .d_1 d_2 \ldots d_t.$$

where each digit d_i satisfies $0 < d_i < \beta - 1$, and $d_1 \neq 0$ for normalized numbers. d_1 is called the most significant digit and d_t the least significant digit.

Floating point arithmetic parameters.

Machine and arithmetic	β	t	$e_{\min}$	$e_{\max}$
Cray-1 single	2	48	−8192	8191
Cray-1 double	2	96	−8192	8191
DEC VAX G format, double	2	53	−1023	1023
DEC VAX D format, double	2	56	−127	127
HP 28 and 48G calculators	10	12	−499	499
IBM 3090 single	16	6	−64	63
IBM 3090 double	16	14	−64	63
IBM 3090 extended	16	28	−64	63
IEEE single	2	24	−125	128
IEEE double	2	53	−1021	1024
IEEE extended (typical)	2	64	−16381	16384

IEEE 754 precision

- Single Precision: It occupies 32$(1 + 23 + 8)$ (sign, mantissa, exponent) bits in computer memory
- Double Precision: It occupies 64$(1 + 52 + 11)$ (sign, mantissa, exponent) bits in computer memory

Initializing One-Dimensional Arrays

There are two ways:

- within the array declaration:
  `int iArray[5] = {0, 1, 2, 3, 4};` or
  `int iArray[5] = {0};`
- outside of the array declaration: initialize your array elements is to use looping structures such as the for loop

```
int x;
int iArray[5];

for ( x = 0; x < 5; x++ )
iArray[x] = 0;

//print array element contents
for ( x = 0; x < 5; x++ )
printf("\n The value of iArray index %d is %d\n", x, x);
```