Array

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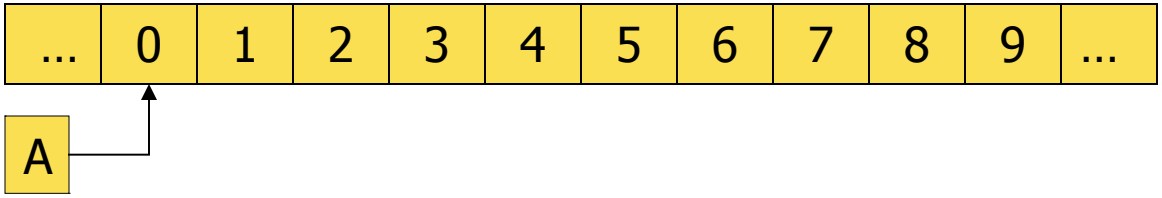
Array

- Array can declare any data type
  - Example, `int A[10]` creates an array of 10 integers
- The total elements of an array is a constant

Memory of an array

- A group of continuous memory locations used to store a series of related values
- All values have the same type
- Array's name is the address of the first element in the memory.
- Example:

  int A[10];



- Individual elements of an array are accessed via an integer index.
- Element indices start at 0 (index of the first element).

Program

- Read in a series of integer numbers (10 numbers at maximum) to store in an array and print the array in reverse order.

Program

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```
#include <stdio.h>
int main(void)
{
   int i, n, A[10];
   printf("Nhap so phan tu trong day (n<=10):");
   scanf("%d",&n);

   printf("Nhap cac phan tu trong day:\n");
   for(i=0; i<n; i++) {
      printf("Phan tu thu %d:", i+1);
      scanf("%d",&A[i]);
   }

   printf("Day so sau khi dao lai:\n");
   for(i=n-1; i>=0; i--)
      printf("%5d",A[i]);

   return 0;
}
```

Exercise

- Read in a series of integer numbers to store in an array and calculate their sum.
- Find min, max elements of the array.

Initialize an array

- Arrays may be initialized with a list of suitable values
  - int a[3] = {1, 2, 3};
- The number of elements that are initialized cannot be more than array's size.
  - But it can be smaller
  - At that time, the other elements are initiated with 0.
- Array's size can be induced from the number of elements whose value is initialized.

```
int A[8] = {2, 4, 6, 8, 10, 12, 14, 16};
```

or

```
int A[] = {2, 4, 6, 8, 10, 12, 14, 16};
```

Example

```
int    month;
int table[12] = { 30, 40, 45, 95, 130, 220, 210,
   185, 135, 80, 40, 45 };

printf("Enter a month: ");
scanf("%d", &month);

if (1 <= month && month <= 12)
   printf("Average rainfall for month %d is %d
   mm.\n", month, table[month-1]);
else
   printf("Invalid month\n");
```

Sorting elements in an array

- We iterate the elements from left to right in the array to exchange them with the smallest element on the right side.
  - A[i] is the element to be exchanged
  - A[j] is an element on the right side of A[i]
  - A[i] must be exchanged with A[j] if A[i] < A[j]
  - To exchange two elements, use a temporary memory

Program

```
#include <stdio.h>
int main(void)
{
   int A[10], n, i, j, tmp;
   /* enter numbers into array */
   for(i=0; i<n-1; i++)
     for(j=i+1; j<n; j++)
       if (a[i]<a[j]) {
         tmp = A[i];
         A[i] = A[j];
         A[j] = tmp;
       }
   printf("Achieved array:\n");
   for(i=0; i<n-1; i++)
      printf("%5d", A[i]);
   return 0;
}
```

Array index

- Arrays have a fixed size.
- There is no built-in way of checking if the supplied index is within range.
- We must check for valid indices ourselves.

Example:

```
int i, n=5;
int A[n];
int B[5];
for (i=1; i<=n; i++)
    B[i] = 0;
```

Array's size is a constant

Error: index is out of array's scope

Passing arrays to a function

- The array is passed as an array of unspecified size (int array[]) and the total number of elements.
  - `f (int array[], int n)`
- Array's elements can be changed

Passing arrays to a function

```
#include <stdio.h>

void inputArray(int array[], int num)
{
    int i;
    for(i=0; i<num; i++) {
        printf("i-th element %d:", i+1);
        scanf("%d", &array[i]);
    }
}

void reverse(int array[], int num)
{
    int i;
    for(i=num-1; i>=0; i--)
        printf("%5d", array[i]);
}
```

Passing arrays to a function

```
int main(void)
{
    int n, A[10];
    printf("Enter number of array elements(n<=10):");
    scanf("%d",&n);

    printf("Enter each element:\n");
    inputArray(A, n);

    printf("Reverse array:\n");
    reverse(A, n);

    return 0;
}
```

2D array:

- An array's element has a specific data type
- An array can be considered as data type for an array's element.
  - An element of an array can be another array
- A 2D array is: an "array-of-arrays"

Example:

```
int A[5][3];
for (i=0; i<=5; i++)
   for (j=0; j<=3; j++)
      A[i][j] = 10;
```

Example

```
#define  NYEARS   5
#define  NMONTHS  12
int table[NYEARS][NMONTHS] ={
     {30,40,75,95,130,220,210,185,135,80,40,45},
     {25,25,80,75,115,270,200,165, 85, 5,10, 0},
     {35,45,90,80,100,205,135,140,170,75,60,95},
     {30,40,70,70, 90,180,180,210,145,35,85,80},
     {30,35,30,90,150,230,305,295, 60,95,80,30}
};
```

table[i][j] allows to access rainfall in month (j+1) and year (2000+i)

Example

```
printf("Enter a year: ");
sscanf("%d", &year);
if (year < 2000 && year > 2004) {
   printf("Year between 2000 and 2004\n");
   return 1;
}
printf("Enter a month: ");
scanf("%d", &month);
if (month < 1 && month > 12) {
   printf("Invalid month\n");
   return 1;
}
printf("Average rainfall is mm.\n", table[year-2000]
   [month-1]);
```

Example

```
#include <stdio.h>

void main()
{
   /* bảng cửu chương cho cả số 0 */
   int cuuchuong[10][10];
   int i, j;

   /* tạo giá trị cho bảng cửu chương */
   for (i=0; i<=9; i++)
      for (j=0; j<=9; j++)
         cuuchuong[i][j] = i*j;

   printf("Nhap hai so cua bang cuu chuong\n");
   printf("So 1: "); scanf("%d", &i);
   printf("So 2: "); scanf("%d", &j);

   printf("Giá trị trong bang la %d", cuuchuong[i][j]);
}
```

Exercise 1

- Given function's prototypes:

```
int Enter_ Number_Element(int a[]);
int Find_Max(int a[], int n);
```

- The function **`Enter_ Number_Element`**() allows to input the number of elements and their values. It returns the number of elements of the array. The function Find_Max() find the maximum value in the input array.
- Write functions' definition and the main function that allows to input two different arrays and find the maximum value in both arrays

Exercise 2

Solve the following set of equations:

a11*x + a12*y = c1

a21*x + a22*y = c2

1. Input values for the 2D array **a**.
2. Input values for the array **c**.
3. Compute and display values for x and y.

Exercise 3

- Read in a series of integer numbers to store in a 2D array
- Sort elements of the array in increasing order by two ways:
  - Using an extra array
  - Without using an extra array