

Arrays and Strings in C

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Introduction to Arrays

What is an Array?

- An **array** is a collection of elements of the *same* type stored in contiguous memory
- Each element is accessed by an **index** (zero-based in C, meaning that the first element is at index 0): `arr[0], arr[1], ...`
- Example: list of student marks
- Arrays let us group related values under one name

1D Array: Declaration and Initialization

Declaration:

```
int arr[5];      // declares an array of 5 integers
```

Declaration and Initialization:

```
int a[5] = {10, 20, 30, 40, 50};  
int b[] = {1, 2, 3};      // size inferred: 3
```

Accessing Individual Elements

- Use square brackets with index: arr[index]
- Example: arr[2] accesses the third element

Example: print elements

```
1 #include <stdio.h>
2
3 int main() {
4     int a[5] = {10, 20, 30, 40, 50};
5     printf("%d\n", a[2]);    // prints 30
6     return 0;
7 }
```

Example: Take User Input Into an Array

```
1 #include <stdio.h>
2
3 int main() {
4     int n, i;
5     printf("How many numbers? ");
6     scanf("%d", &n);
7     int arr[100]; // assume max 100 for simplicity
8     for(i = 0; i < n; i++){
9         scanf("%d", &arr[i]);
10    }
11    for(i = 0; i < n; i++) { // printing the values
12        printf("arr[%d] = %d\n", i, arr[i]);
13    }
14 }
```

Example: Summing the Elements of an Array

```
1 #include <stdio.h>
2
3 int main() {
4     int i, sum = 0, arr[5] = {10, 20, 30, 40, 50};
5
6     for(i = 0; i < 5; i++){
7         sum += arr[i];
8     }
9     printf("Sum = %d\n", sum);
10 }
```

Multidimensional Arrays

Multidimensional Array

- An array with more than one dimension
- Real-life analogies:
 - 2D: matrix or spreadsheet (rows and columns), indices are written as `arr[row][col]`
 - 3D: a stack of matrices
- C supports arrays with any number of dimensions

2D Array: Declaration and Initialization

```
int mat[3][4]; // 3 rows, 4 columns

int mat2[2][3] = {
    {1, 2, 3},
    {4, 5, 6}
};

// or flattened initialization:
int mat3[2][3] = {1,2,3,4,5,6};
```

Accessing Values in 2D Arrays

- Access element at row r, column c by `mat[r][c]`
- Example: `mat[1][2]` refers to second row, third column

Example: print a 2×3 matrix

```
1 #include <stdio.h>
2
3 int main(){
4     int mat[2][3] = {{1,2,3},{4,5,6}};
5     printf("%d\n", mat[1][2]); // prints 6
6     return 0;
7 }
```

Example: Input and Print a 2D Array

```
1 #include <stdio.h>
2
3 int main() {
4     int r = 2, c = 3, i, j, mat[2][3];
5
6     printf("Please input a 2 by 3 matrix:\n");
7
8     for(i = 0; i < r; i++){
9         for (j = 0; j < c; j++){
10             scanf("%d", &mat[i][j]);
11         }
12     }
13
14     printf("\nYou entered:\n");
```

Continued in next slide

Example: Input and Print a 2D Array (cont.)

```
14     printf("\nYou entered:\n");
15
16     for(i = 0; i < r; i++){
17         for (j = 0; j < c; j++){
18             printf("%d ", mat[i][j]);
19         }
20         printf("\n");
21     }
22 }
```

3D and Higher Dimensions

- A 3D array `int arr[2][3][4];` can be thought of as 2 blocks, each block is a 3×4 matrix
- Real-life: for example, **block x row x column** measurements (temperature map over multiple days)
- Indexing: `a[block][row][col]`

Strings in C

What is a String in C?

- In C, a **string** is an array of **char** terminated by the null character '\0'
- Example: `char s[] = "hello";` actually creates 6 chars:
`'h', 'e', 'l', 'l', 'o', '\0'`
- Strings are manipulated through arrays and standard library functions in `<string.h>`
- You can access individual characters with `s[i]`

Declare and Initialize Strings

```
char c1 = 'a';      // a single character  
  
char s1[] = "Hello";  
char s2[10] = "Hi";   // remaining bytes unused  
  
char s3[6] = {'H', 'i', '!', '\0'};    // explicit
```

Note: individual characters denoted by single quotes, whereas strings are denoted by double quotes.

Reading Strings from User

- Avoid `gets()` (unsafe). Use `fgets()` or `scanf("%s", ...)`
- `scanf("%s", s);` reads until whitespace, does not read spaces
- `fgets(s, size, stdin);` reads a whole line (including spaces)
- However, the string from `fgets()` includes newline (`\n`)
- May want to trim this newline (trimming it, is often not required, depends on use case)

Example: String Input Using `scanf()`

```
1 #include <stdio.h>
2
3 int main(){
4     char username[20];
5     printf("Enter your name: ");
6     scanf("%s", username);
7     printf("Good day to you, %s!", username);
8 }
```

Note that in `scanf()`, we provided `username` as the second argument and not `&username`.

This is because `username` itself holds the memory address of the character array.

Recall that the `&var` returns the memory address of the variable named `var`.

Example: String Input Using fgets()

```
1 #include <stdio.h>
2 #include <string.h>
3
4 int main() {
5     char s[100];
6     printf("Enter a line: ");
7
8     fgets(s, sizeof(s), stdin);
9
10    printf("You wrote: %s\n", s);
11    return 0;
12 }
```

Example: String Input Using `fgets()` (cont.)

```
1 #include <stdio.h>
2 #include <string.h>
3
4 int main() {
5     char s[100];
6     printf("Enter a line: ");
7     fgets(s, sizeof(s), stdin);
8
9     // remove trailing newline
10    // search for "\n" and replace with "\0"
11    s[strcspn(s, "\n")] = '\0';
12    printf("You wrote: %s\n", s);
13
14 }
```

Example: String Input Using **fgets()** (cont.)

```
9     // remove trailing newline  
10    // search for "\n" and replace with "\0"  
11    s[strcspn(s, "\n")] = '\0';
```

In the above code, `strcspn(s, "\n")` searches for and returns the index of the newline character ("\"n") in the string named s.

`s[strcspn(s, "\n")] = '\0';` replaces the newline character with the null terminator character ('\"0').

Common String Functions (from <string.h>)

- `strlen(s)` — length of string (not counting '\0')
- `strcmp(s1, s2)` — compare strings (returns 0 if equal)
- `strcpy(dest, src)` — copy string
- `strcat(dest, src)` — concatenate

Example: Comparing Two Strings: `strcmp()`

```
1 #include <stdio.h>
2 #include <string.h>
3
4 int main() {
5     char a[20], b[20];
6     scanf("%s", a);
7     scanf("%s", b);
8     if (strcmp(a, b) == 0)
9         printf("Same\n");
10    else
11        printf("Not same\n");
12    return 0;
13 }
```

`strcmp()` returns 0 if the two strings are same.

Example: Copying a String: `strcpy()`

```
1 #include <stdio.h>
2 #include <string.h>
3
4 int main() {
5     char a[20], b[20];
6     scanf("%s", a);
7
8     // copying the contents of a into b:
9     strcpy(b, a);    // 2nd argument is the source
10    printf("%s", b);
11    return 0;
12 }
```

Example: Concatenate Strings (strcat)

```
1 #include <stdio.h>
2 #include <string.h>
3
4 int main() {
5     char a[] = "Hello";
6     char b[] = " World";
7     strcat(a, b);
8     printf("\%s\n", a); // prints "Hello World"
9
10 }
```

Summary

Summary

- **Array:** contiguous collection of same-type elements, accessed by indices `arr[i]`
- **1D/2D/3D:** use `arr[i]`, `arr[i][j]`, `arr[i][j][k]` respectively
- **Strings:** arrays of `char` ending with '`\0`'
- `<string.h>` contains functions that operate on strings
- **Input:** `scanf` or `fgets` (preferred for whole lines)

Array Variable and Memory

- **Important note:** In many contexts (for example, when passing to a function), the array name (say, arr) is a pointer to the first element (details on pointers in upcoming lectures)
- Meaning that, arr actually holds the memory address in which the first element of the array is stored
- To summarize: the array name points to a contiguous block of memory starting at the first element of the array

Exercises

Exercises

- ① Write a program to read n integers into an array and print them in reverse order
- ② Write a program to find the maximum and minimum values in an integer array
- ③ Write a program to remove duplicate elements from a small integer array (keep first occurrences)
- ④ Write a program to multiply two 2×2 matrices and print the result
- ⑤ Write a program to read a line of text and print its length (without using `strlen`)

Exercises (cont.)

- ⑥ Write a program to check if a given string is a palindrome (ignore case and spaces)
- ⑦ Write a program to count frequency of each digit (0 - 9) in an array of integers
- ⑧ Write a program to concatenate two strings without using `strcat`
- ⑨ Write a program to rotate the elements of an array to the right by k positions
- ⑩ Write a program to read a 3D array of size $2 \times 2 \times 2$ and compute the sum of all elements