

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** \times **row** \times **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", 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", s);
13     return 0;
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");
10     else
11         printf("Not same");
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", a); // prints "Hello World"
9      return 0;
10 }
```

Example: Upper-case and Lower-case Conversion (Manual)

```
1  #include <stdio.h>
2  #include <string.h>    // for strlen()
3  #include <ctype.h>     // for toupper(), tolower()
4
5  int main(){
6      char s[] = "Hello World!";
7      for(int i = 0; i < strlen(s); i++){
8          s[i] = toupper((unsigned char)s[i]);
9      }
10     printf("%s", s);    // HELLO WORLD!
11     return 0;
12 }
```

Example: Count Vowels in a String

```
1  #include <stdio.h>
2  #include <string.h>
3  #include <ctype.h>
4  int main(){
5      char s[100];
6      fgets(s, sizeof(s), stdin);
7      int count = 0;
8      for(int i = 0; i < strlen(s); i++){
9          char ch = tolower((unsigned char)s[i]);
10         if (ch=='a' || ch=='e' || ch=='i' || ch=='o' || ch=='u'){
11             count++;
12         }
13     }
14     printf("Vowels = %d", count);
15 }
```

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 count frequency of each digit (0 - 9) in an array of integers
- ⑤ Write a program to multiply two 2×2 matrices and print the result

Exercises (cont.)

- ⑥ Write a program to rotate the elements of an array to the right by `k` positions
- ⑦ Write a program to read a line of text and print its length (without using `strlen`)
- ⑧ Write a program to concatenate two strings without using `strcat`
- ⑨ Write a program to check if a given string is a palindrome (ignore case and spaces)