COMP1511/1911 Programming Fundamentals

Week 4 Lecture 2

Strings, Arrays of Strings
Command Line Arguments

Last Lecture

- Recap Arrays
- Arrays of structs
- 2D Arrays

Today’s Lecture

- 2D Arrays recap
- Strings
- Arrays of strings
- Command Line Arguments

Note: Anything we don’t finish can be covered in the next lecture.

Link to Week 4 Live Lecture Code

https://cgi.cse.unsw.edu.au/~cs1511/24T3/live/week_4/

Assignment 1

- Assignment 1 has been released
- Assignment 1 live stream recording is available
- Get started soon!

Revision Sessions (Not recorded)

Week 4: Fri 12-2pm Online

You can **sign up** for the revision sessions by following the link Select tickets – COMP1511 Revision Sessions – UNSW or Online (tickettailor.com)

Keep your eye out on more revision sessions coming up in week 6

Also don’t forget about Help Sessions too!

Public Holiday

Monday Lecture

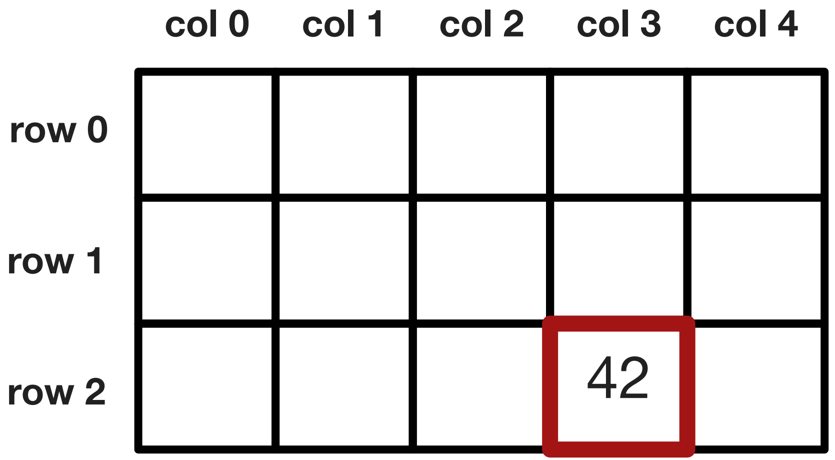
- Pre-recorded video
- Recap of strings, arrays of strings, command line arguments
- A larger 2D array of structs example to help with skills needed in the assignment
- New content: Multi-file projects

Tuts/labs

- Students in monday classes please book and attend another class for week 5. Link to book here   timetable
- Lab week 4 deadline: Week 5 Tuesday 8pm

Recap: 2D Arrays: Accessing Indexes

```c
// A 2D array with 3 rows and 5 columns of int
int number_grid[3][5];
// To access an element you need to give 2 indexes
number_grid[2][3] = 42;
```



Recap of 2D Arrays Coding

2D_array.c

copy array

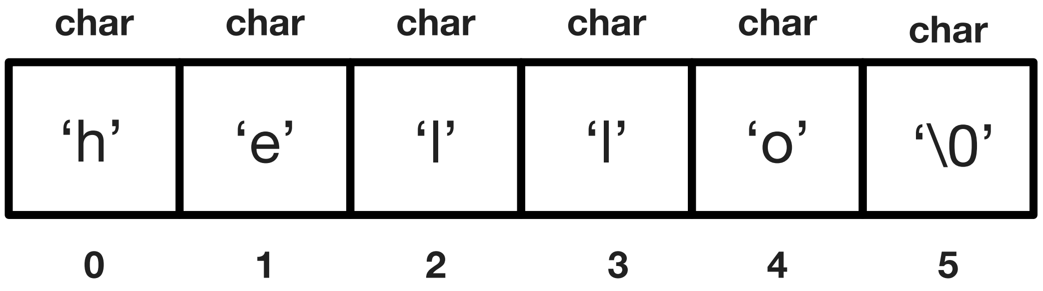
diagonals.c

sum_diagonal_top_right

Strings

Strings: What are they?

- Strings are a collection of characters
- In C a string is
  - an array of `char`
  - that ends with a special character `'\0'` (null terminator)

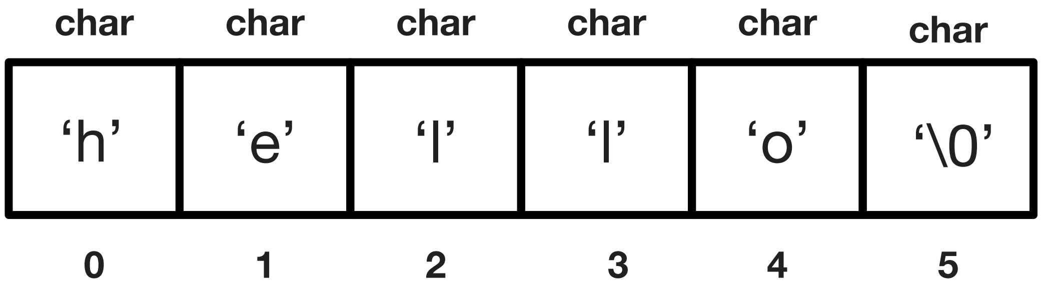


Null Terminator

- The null terminator ‘\0’ must be at the end of every string
    - If it does not have one it is not a string! Just an array of char
- The array must be big enough to store the extra character
- It is not displayed as part of the string
- It is very useful to know when our string has come to an end, when we loop through the array of characters
- Anything in the array after the ‘\0’ is not part of the string

Strings: How do we initialise them?

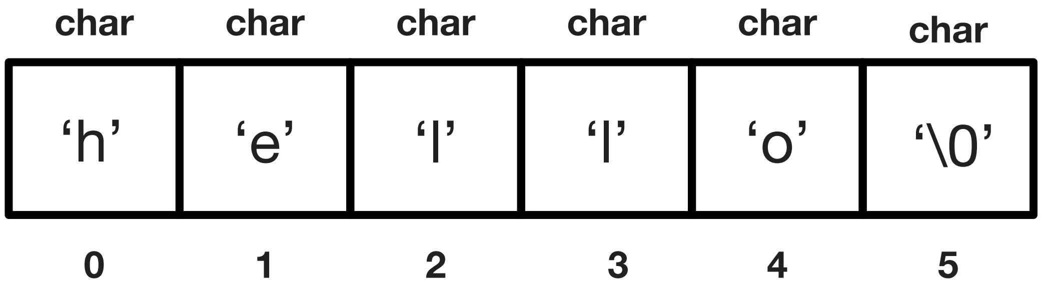
```
// the painful way
char word[] = {'h','e','l','l','o','\0'};
// the more convenient way which does the same thing
char word[] = "hello";
```



Strings: How do we print them?

```
char word[] = "hello";
int i = 0;
while (word[i] != '\0') {
    printf("%c", word[i]);
    i++;
}
```

```
// the easy way
// using printf with %s
char word[] = "hello";
printf("%s", word);
```



Code Demo

simple_strings.c

- declaring,
- initialising,
- modifying,
- printing strings,
- writing our own printing function

Strings: Can I read them in with scanf %s?

- No. Please don't. It can read strings that are too long to fit in the array
  - Overwrite other memory - **buffer overflow**
  - Security Vulnerability
  - Hackers can exploit this
  - You will see more about this in COMP1521
- It may not do what you expect/want anyway
  - Stops when it encounters whitespace
- It is forbidden in the style guide. You will lose marks for using it

Strings: How do we read them in?

We fgets them: `fgets(array, size, stream);`

`fgets` needs three inputs:

- array - the array that the string will be stored into
- size - the size of the array
  - fgets will only read in and store a max of `size - 1` characters
- stream - this is where this string is coming from
  - For this course it will always be `stdin` (standard input: by default the input will always be from terminal)

Strings: How do we read them in?

One call to fgets will read in characters until

- size - 1 characters are read in
- a newline character is read in
    - this newline character is stored in the array
- we get to the end of file
    - which is Ctrl+D on a line of its own for terminal input

Note: There is a matching function that prints strings out

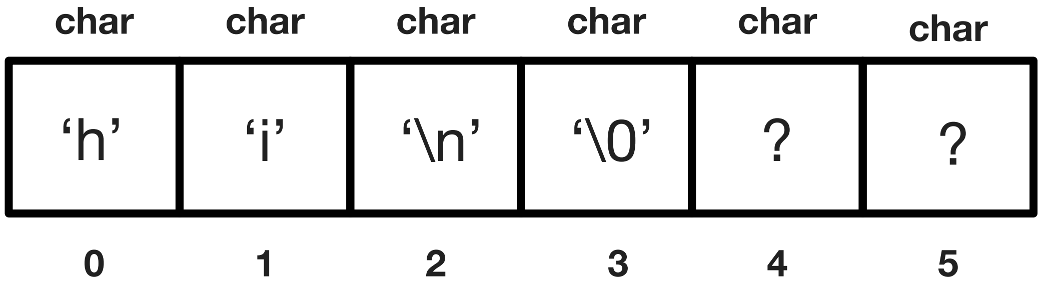
```
fputs(array, stream);
```

- For this course stream will always be **`stdout`** (terminal)

Strings: How do we read them in?

```
char array[MAX_LENGTH];
// Read in the string into array of length MAX_LENGTH
// from standard input - which by default is the terminal
fgets(array, MAX_LENGTH, stdin);
```

Assume **`MAX_LENGTH`** is 6 and the user types in **hi** then presses **enter** we would get an array like:



Strings: How do we read in many of them?

```
// Declare an array to store your string
char array[MAX_LENGTH];

printf("Type in a string to echo: ");
// Read a string into array again and again
// until Ctrl+D is pressed (indicated by fgets returning NULL)
while (fgets(array, MAX_LENGTH, stdin) != NULL) {
    printf("The string is:\n");
    printf("%s", array);
    printf("Type in a string to echo: ");
}
```

Note: We are only ever storing 1 string at a time with this code

ctype.h library functions

You can use these to make your life easier when working with characters!

`toupper()`	convert a character to uppercase
`tolower()`	convert a character to lowercase
`isupper()`	test whether a character is uppercase
`islower()`	test whether a character is lowercase

Find more here: https://www.tutorialspoint.com/c_standard_library/ctype_h.htm

Code Demo: Reading in Strings

read_strings.c

- Read in a string
- Try reading in a string that is too long
- Repeatedly read in a string
- Convert string to all capitals

string.h library functions

Some other useful functions for strings:

`strlen()`	gives us the length of the string excluding the '\0'
`strncpy()`	copy the contents of one string to another
`strcmp()`	compare two strings
`strncat()`	append one string to the end of another (concatenate)
`strchr()`	find the first occurance of a character in a string

Find more here: https://www.tutorialspoint.com/c_standard_library/string_h.htm

String Functions: strncpy strlen

```
// Declare an array to store a string
char puppy[MAX_LENGTH] = "Boots";

// Copy the string "Finn" into the word array
// strncpy will truncate the string if it is too long
// this is safer than using strcpy which can cause buffer overflow
strncpy(puppy, "Finn", MAX_LENGTH - 1);
puppy[MAX_LENGTH - 1] = '\0';
printf("%s\n", puppy);
// Find string length. It does NOT include '\0' in the length
int len = strlen(puppy);
printf("%s has length %d\n", puppy, len);
```

String Functions: strcmp

```c
// Declare an array to store a string
char name[] = "Oscar";

// Use strcmp to compare 2 strings
// It will return 0 if the strings are equal
// A negative number if the first string < second string
// A positive number if the first string > second string
int comparison = strcmp("Oscar", name);
printf("Are the 2 strings the same? %d\n", comparison);

comparison = strcmp(name, "Edgar");
printf("Are the 2 strings the same? %d\n", comparison);
```

String Functions: fgets and strcmp

```
// Declare an array to store a string
char city[MAX_LENGTH];
printf("Type in the name of a city: ");

// Read in a string
fgets(city, MAX_LENGTH, stdin);

// Use strcmp to compare 2 strings
if (strcmp("Sydney", city) == 0) {
    printf("I live in Sydney!\n");
}
```

What is the issue with this code?

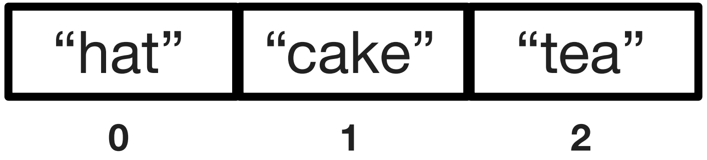
String Functions Demo

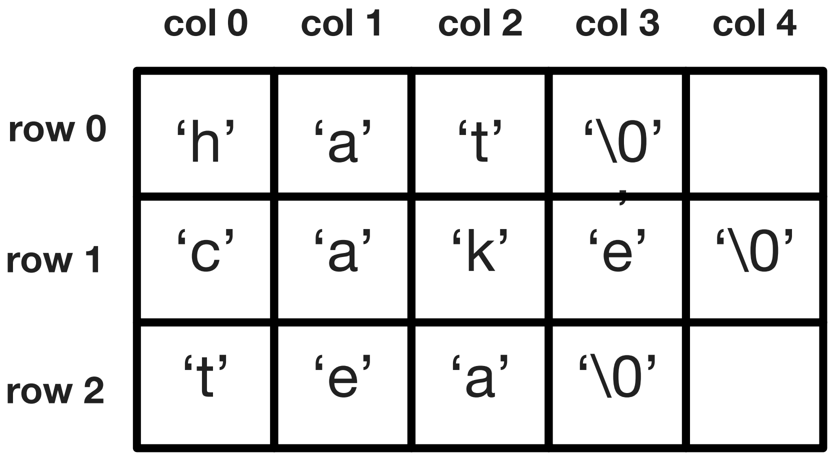
string_functions.c

Array of Strings

```c
// This array can store 3 strings.
// Each string has max size 5, including '\0'
char words[3][5] = {"hat", "cake", "tea"};
```

- You can have an array of strings!
- You can also think of it as a 2D array of characters



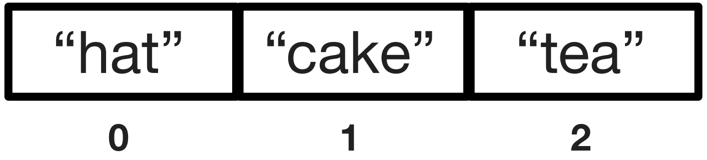


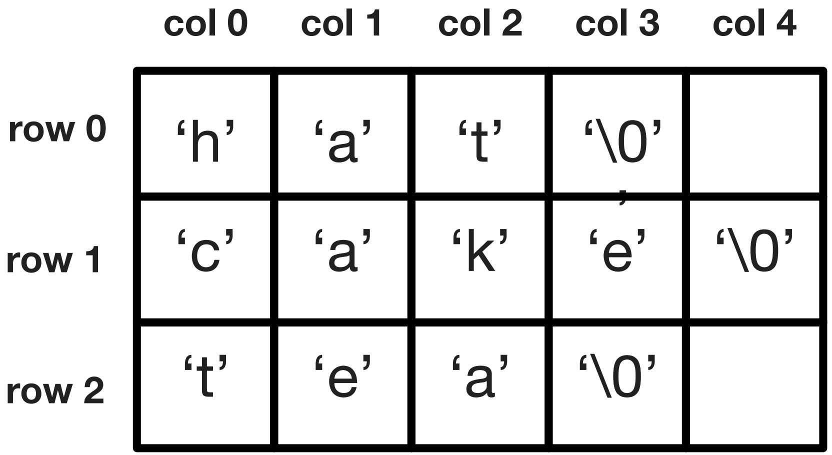
	col 0	col 1	col 2	col 3	col 4
row 0	‘h’	‘a’	‘t’	‘\0’	
row 1	‘c’	‘a’	‘k’	‘e’	‘\0’
row 2	‘t’	‘e’	‘a’	‘\0’	

Array of Strings

```c
char words[3][5] = {"hat", "cake", "tea"};
// Using 1 index gives us a row/string
// This would print "cake"
printf("%s\n", words[1]);
```

- You can have an array of strings!
- You can also think of it as a 2D array of characters





Array of Strings

```c
char words[3][5] = {"hat", "cake", "tea"};
// Using 2 indexes gives us a character
// This would print the ‘e’ from “tea”
printf("%c\n",words[2][1]);
```

- You can have an array of strings!
- You can also think of it as a 2D array of characters

“hat”	“cake”	“tea”
0	1	2

	col 0	col 1	col 2	col 3	col 4
row 0	‘h’	‘a’	‘t’	‘\0’	
row 1	‘c’	‘a’	‘k’	‘e’	‘\0’
row 2	‘t’	‘e’	‘a’	‘\0’	

Coding Time Array of Strings

array_of_strings.c

- initialise data
- copy in extra data
- fgets extra data
- print out all strings

What are Command Line Arguments?

Command Line Arguments

- So far, we have only given input to our program after we have started running that program (using scanf() or fgets())
- Our main function prototype has always been
  `int main(void);`
- Command line arguments allow us to give inputs to our program at the time that we start running it! E.g.

```
$ dcc prog.c -o prog
$ ./prog argument1 argument2 argument3 argument4
$ ./prog 123 hello
```

Command Line Arguments

- To use command line arguments you need to change your main function prototype to
  `int main(int argc, char *argv[])`
- `argc`
  - a counter for how many command line arguments you have (including the program name)
- `char *argv[]`
  - an array of the different command line arguments
  - each command line argument is a string (an array of char)

Command Line Arguments

- If we ran our program as follows:

```
$ ./prog 123 dog “hello world”
```

- argc would be equal to 4
- argv would be an array of strings we can visualise as follows:

“./prog”	“123”	“dog”	“hello world”
0	**1**	**2**	**3**

Command Line Arguments

```c
int main(int argc, char *argv[]) {
    printf("There are %d command line arguments\n", argc);

    // argv[0] is always the program name
    printf("This program name is %s\n", argv[0]);

    // print out all arguments in the argv array
    for (int i = 0; i < argc; i++) {
        printf("Argument at index %d is %s\n", i, argv[i]);
    }
    return 0;
}
```

Command Line Arguments

```
$ dcc -o command_line_args command_line_args.c
$ ./command_line_args 123 dog "Hello World" COMP1511
This program has 5 command line arguments
This program name is ./command_line_args
Argument at index 0 is ./command_line_args
Argument at index 1 is 123
Argument at index 2 is dog
Argument at index 3 is Hello World
Argument at index 4 is COMP1511
```

Converting Strings to Integers: atoi

- You may want to use your command line arguments to perform calculations, but they are strings!
- There is a function that converts strings to integers:
  - `atoi()` in the standard library: <stdlib.h>
  - E.g. `int x = atoi("952")`
    - Would give us a value of 952 stored in x

Converting Strings to Integers: atoi

```
int main(int argc, char *argv[]) {
    int sum = 0;
    for (int i = 1; i < argc; i++) {
        sum = sum + atoi(argv[i]);
    }
    printf("%d is the sum of all command line args\n", sum);
    return 0;
}
```

Command Line Arguments

- command_line_args.c
- atoi_demo.c

Feedback Please!

Your feedback is valuable!

If you have any feedback from today's lecture, please follow the link below or use the QR Code.

Please remember to keep your feedback constructive, so I can action it and improve your learning experience.

https://forms.office.com/r/Jj5ZE0SNw4

What did we learn today?

- recap 2D arrays
  - 2D_array.c, diagonals.c
- strings
  - simple_strings.c, read_strings.c, string_functions.c
- arrays of strings
  - array_of_strings.c
- command line arguments
  - command_line_args.c, atoi_demo.c

Reach Out

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Forum

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