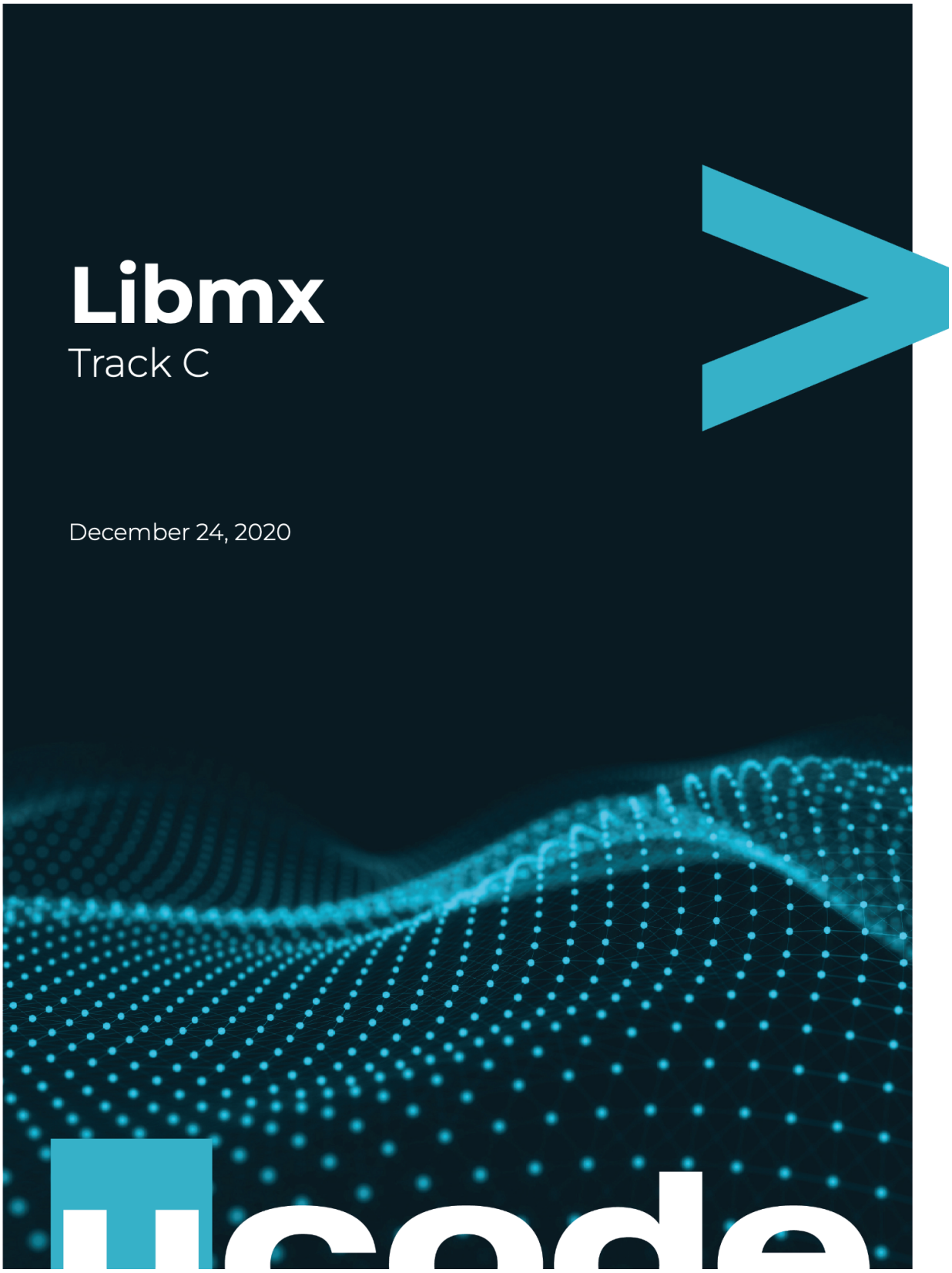
Libmx
Track C
December 24, 2020

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ucode

Engage

DESCRIPTION

Hey there.

The next challenge in Track C is to create your own library of functions.
The implementation of this challenge will help simplify your programming life and save a lot of time in future development. By creating various functions, you can understand even more deeply how they work, why and how they are used, and understand the algorithms of their work.
Of course, you can use the functions from the created library in the next Track C challenges. In addition, you have a great opportunity to expand your library with even more useful functions and make it unique.

Good luck, The Chosen One!

BIG IDEA

Stay DRY. Don't Repeat Yourself.

ESSENTIAL QUESTION

How can I reuse my code, modules, programs, etc.?

CHALLENGE

Create your own library.

Investigate

GUIDING QUESTIONS

We invite you to find answers to the following questions. By researching and answering them, you will gain the knowledge necessary to complete the challenge. To find answers, ask the students around you and search the internet. We encourage you to ask as many questions as possible. Note down your findings and discuss them with your peers.

- What are `libraries` in programming?
- What is the difference between a `framework` and a `library`?
- Why is it useful to create your own library?
- Have you ever developed a library before?
- What is the difference between `static` and `dynamic` libraries?
- What do you know about dynamic libraries?
- What are `static variables`? What is their life span?

GUIDING ACTIVITIES

Complete the following activities. Don't forget that you have a limited time to overcome the challenge. Use it wisely. Distribute tasks correctly.

- Define the terms of the challenge (library, function, solution, product, etc.).
- Ask students who have already begun this challenge about what is best to start with and what problems they have encountered.
- Make a plan where to start. Read the tasks, examine all the functions that you must create.
- Think about the extra functions you would like to have in your library.
- Carefully read the instructions, as well as the `man` for the functions that have similar behavior to the standard libc functions.
- Ask other students to test your solutions. Help each other find mistakes.
- Think about how you can improve your functions.
- Clone your git repository that is issued on the challenge page.
- Push your solutions.

ANALYSIS

Analyze your findings. What conclusions have you made after completing guiding questions and activities? In addition to your thoughts and conclusions, here are some more analysis results.

- Be attentive to all statements of the story.
- All packs of functions are divided into Act: Basic and Act: Advanced. You need to complete all basic functions to validate the challenge. But to achieve maximum points, consider accomplishing advanced functions also.
- The challenge must have the following structure:
  - `src` directory contains files with extension `.c`

  - `obj` directory contains files with extension `.o` (you must not push this directory in your repository, only `Makefile` creates it during compilation)
  - `inc` directory contains header `libmx.h`
  - `Makefile` that compiles and builds `libmx.a`
- All tasks are divided into Act Basic and Act Advanced. You need to complete all basic tasks to validate the challenge. But to achieve maximum points, benefit, and more knowledge, consider accomplishing advanced tasks also.
- Complete the challenge according to the rules specified in the `Auditor`.
- Submit your files using the layout described in the story. Only useful files allowed, garbage shall not pass!
- Compile C-files with clang compiler and use these flags: `clang -std=c11 -Wall -Wextra -Werror -Wpedantic`.
- You are allowed to use such functions: `malloc, malloc_size/malloc_usable_size, free, open, read, write, close, exit`.
- Pay attention to what is allowed. Use of forbidden stuff is considered a cheat and your challenge will be failed.
- Your program must manage memory allocations correctly. A memory that is no longer needed must be freed, otherwise, the task is considered incomplete.
- Oracle will check the memory leaks with the `leaks tool` on the macOS.
- Oracle will check the memory leaks with the `valgrind tool` on the Ubuntu.
- All functions that are given in all parts of the story must be done in separate files.
- It is recommended to reuse already written functions for writing new ones.
- You can add some custom functions if you need it.
- The solution will be checked and graded by students like you. `Peer-to-Peer learning`.
- Also, the challenge will pass automatic evaluation which is called `Oracle`.
- If you have any questions or don't understand something, ask other students or just Google it.

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Act: Basic. Utils pack

In this pack, you must create util functions that make your work easier. Find the prototypes for every function below.

NAME

Print character

DESCRIPTION

Create a function that outputs a single character to the standard output.

SYNOPSIS

```
void mx_printchar(char c);
```

NAME

Print string

DESCRIPTION

Create a function that outputs a string of characters to the standard output.

SYNOPSIS

```
void mx_printstr(const char *s);
```

NAME

Print array of strings

DESCRIPTION

Create a function that outputs:

- an array of strings `arr` to the standard output with a delimiter `delim` between the elements of an array
- nothing if `arr` or `delim` do not exist
- a newline at the end of the output

`arr` must be `NULL`-terminated, in other cases the behavior is undefined.

SYNOPSIS

```
void mx_print_strarr(char **arr, const char *delim);
```

NAME

Print integer

DESCRIPTION

Create a function that outputs integer values to the standard output.

SYNOPSIS

```
void mx_printint(int n);
```

EXAMPLE

```
mx_printint(25); //prints 25
mx_printint(2147483647); //prints 2147483647
```

NAME

Decimal to hex

DESCRIPTION

Create a function that converts an `unsigned long` number into a hexadecimal string.

RETURN

Returns the number converted to a hexadecimal string.

SYNOPSIS

```
char *mx_nbr_to_hex(unsigned long nbr);
```

EXAMPLE

```
mx_nbr_to_hex(52); //returns "34"
mx_nbr_to_hex(1000); //returns "3e8"
```

NAME

Bubble sort

DESCRIPTION

Create a function that:

- sorts an array of integers in place in ascending order
- uses the `bubble sort` algorithm

RETURN

Returns the number of swap operations.

SYNOPSIS

```
int mx_bubble_sort(int *arr, int size);
```

EXAMPLE

```
// arr = { 68 -20 2 -6 8 53 79 -30 -25 }
mx_bubble_sort(arr, 9); // returns 20
// arr = { -30 -25 -20 -6 2 8 53 68 79 }

// arr = { -7 -23 }
mx_bubble_sort(arr, 2); // returns 1
// arr = { -23 -7 }

// arr = { 33 19 39 47 10 63 69 48 26 25 67 -4 2 }
mx_bubble_sort(arr, 13); // returns 43
// arr = { -4 2 10 19 25 26 33 39 47 48 63 67 69 }

// arr = { -11 79 69 -9 -23 2 43 66 -25 35 38 61 84 7 11 }
mx_bubble_sort(arr, 15); // returns 48
// arr = { -25 -23 -11 -9 2 7 11 35 38 43 61 66 69 79 84 }

// arr = { -2 20 54 86 60 73 52 }
mx_bubble_sort(arr, 7); // returns 6
// arr = { -2 20 52 54 60 73 86 }
```

NAME

Quick sort

DESCRIPTION

Create a function that:

- sorts an array of integers in ascending order
- uses the `quick sort` algorithm
- performs the sorting in-place (swap values, DON'T create additional arrays)
- returns the number of swap operations

Requirements:

- always take the rightmost value as the pivot
- after an iteration of swapping values compared to a pivot, the pivot must then be swapped with a certain value in a way that it will have smaller (or equal) values on the left, and larger values on the right

Don't check the validity of `left` and `right`.

There are different ways to implement the quick sort algorithm. Each decision will influence the speed and/or the number of swaps. In this case, we ask you to implement a particular variation of it.

So, follow closely the requirements and see the EXAMPLE for various cases. Test your solution to make sure it works properly and returns the exact same values.

RETURN

- returns the number of swaps
- returns `-1` if `arr` does not exist

SYNOPSIS

```c
int mx_quicksort(int *arr, int left, int right);
```

EXAMPLE

```c
// arr = { 19 83 68 -20 2 -6 }
mx_quicksort(arr, 0, 5); // returns 3
// arr = { -20 -6 2 19 68 83 }

// arr = { 53 79 -30 -25 -18 -28 -3 }
mx_quicksort(arr, 0, 6); // returns 6
// arr = { -30 -28 -25 -18 -3 53 79 }

// arr = { -23 19 10 22 33 19 39 }
mx_quicksort(arr, 0, 6); // returns 3
```

```
// arr = { -23 10 19 19 22 33 39 }

// arr = { 10 }
mx_quicksort(arr, 0, 0); // returns 0
// arr = { 10 }

// arr = { 69 48 }
mx_quicksort(arr, 0, 1); // returns 1
// arr = { 48 69 }

// arr = { 25 67 -4 2 37 20 3 -11 79 69 }
mx_quicksort(arr, 0, 9); // returns 8
// arr = { -11 -4 2 3 20 25 37 67 69 79 }

// arr = { -23 2 43 66 -25 }
mx_quicksort(arr, 0, 4); // returns 4
// arr = { -25 -23 2 43 66 }

// arr = { 38 61 84 7 }
mx_quicksort(arr, 0, 3); // returns 3
// arr = { 7 38 61 84 }

// arr = { 83 -2 34 -2 20 54 86 60 73 52 }
mx_quicksort(arr, 0, 9); // returns 8
// arr = { -2 -2 20 34 52 54 60 73 83 86 }

// arr = { 25 67 -4 2 37 20 3 -11 79 69 }
mx_quicksort(arr, 0, 9); // returns 8
// arr = { -11 -4 2 3 20 25 37 67 69 79 }

// arr = { 33 19 39 47 10 63 69 48 26 25 67 -4 2 }
mx_quicksort(arr, 4, 11); // returns 5
// arr = { 33 19 39 47 -4 10 25 26 48 63 67 69 2 }

// arr = { -6 -9 27 41 38 -13 8 67 }
mx_quicksort(arr, 5, 6); // returns 0
// arr = { -6 -9 27 41 38 -13 8 67 }
```

NAME

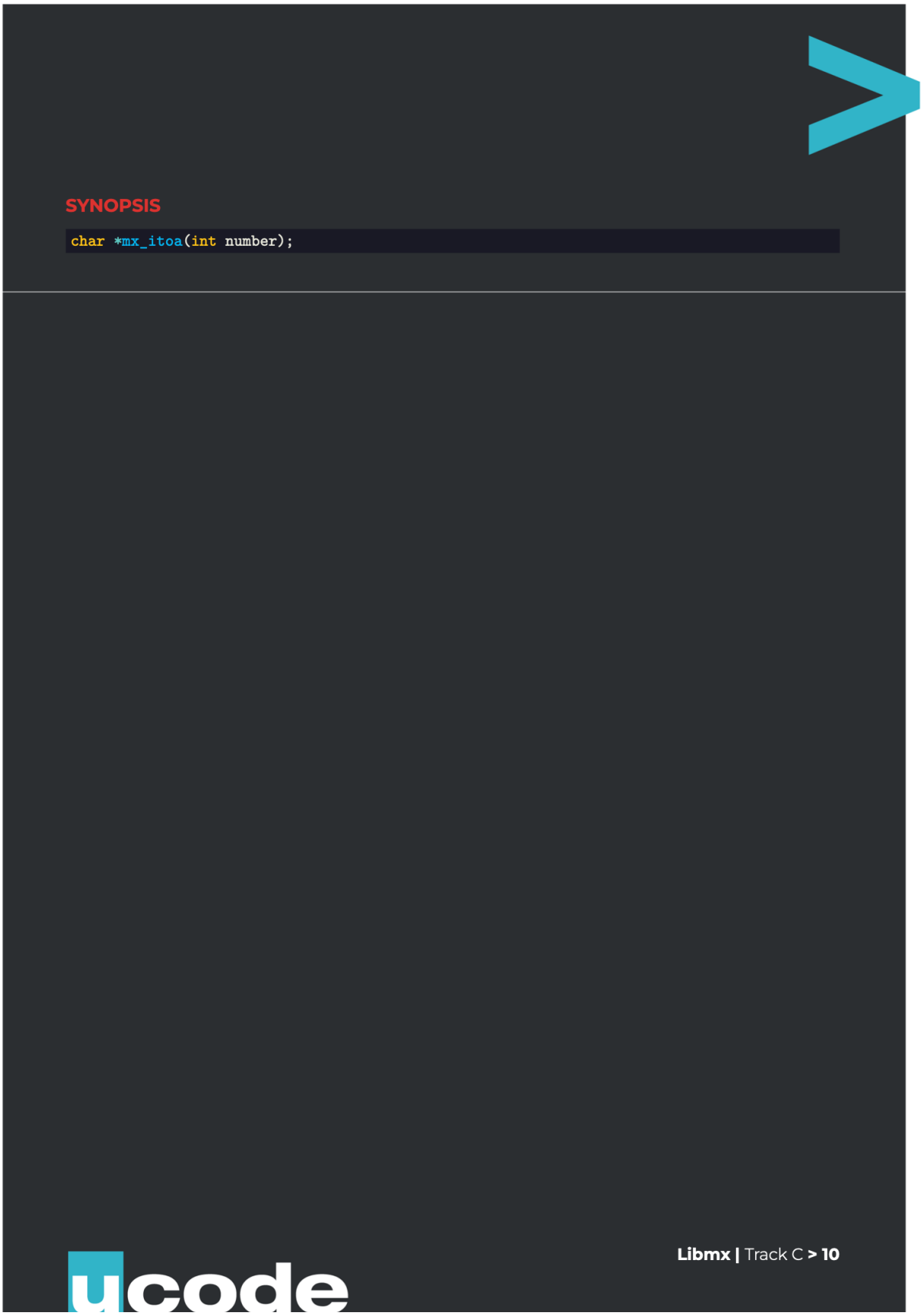
Integer to ASCII

DESCRIPTION

Create a function that takes an integer and converts it to a string.

RETURN

Returns the number as a `NULL`-terminated string.


SYNOPSIS
char *mx_itoa(int number);
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Act: Advanced. Utils pack

NAME

Print multibyte characters

DESCRIPTION

Create a function that outputs ASCII and multibyte characters to the standard output.

SYNOPSIS

```
void mx_print_unicode(wchar_t c);
```

NAME

Exponentiation

DESCRIPTION

Create a function that computes `n` raised to the power of zero or a positive integer `pow`.

RETURN

Returns the result of `n` to the power of `pow`.

SYNOPSIS

```
double mx_pow(double n, unsigned int pow);
```

EXAMPLE

```
mx_pow(3, 3); //returns 27
mx_pow(2.5, 3); //returns 15.625
mx_pow(2, 0); //returns 1
```

NAME

Square root

DESCRIPTION

Create a function that computes the non-negative square root of `x`.
The function must compute square root in less than 2 seconds.

RETURN

Returns the square root of the number `x` if it is natural, and `0` otherwise.

SYNOPSIS

```
int mx_sqrt(int x);
```

EXAMPLE

```
mx_sqrt(3); //returns 0
mx_sqrt(4); //returns 2
```

NAME

Hex to decimal

DESCRIPTION

Create a function that converts a hexadecimal string into an `unsigned long` number.

RETURN

Returns the `unsigned long` number.

SYNOPSIS

```
unsigned long mx_hex_to_nbr(const char *hex);
```

EXAMPLE

```
mx_hex_to_nbr("C4"); //returns 196
mx_hex_to_nbr("FADE"); //returns 64222
mx_hex_to_nbr("fffffffffff"); //returns 281474976710655
mx_hex_to_nbr(NULL); //returns 0
```

NAME

For each

DESCRIPTION

Create a function that applies the function `f` for each element of the array `arr` given `size`.

SYNOPSIS

```
void mx_foreach(int *arr, int size, void (*f)(int));
```

NAME

Binary search

DESCRIPTION

Create a function that:

- searches the string `s` in the array `arr` with the given `size` of array
- uses the binary search algorithm assuming that the input array has already been sorted in a lexicographical order

RETURN

- returns the `index` of the found string in the array
- returns `-1` in case of errors or if the string has not been found
- assigns the number of required iterations to the `count` pointer

SYNOPSIS

```
int mx_binary_search(char **arr, int size, const char *s, int *count);
```

EXAMPLE

```
arr = {"222", "Abcd", "aBc", "ab", "az", "z"};
count = 0;
mx_binary_search(arr, 6, "ab", &count); //returns 3 and count = 3
count = 0;
mx_binary_search(arr, 6, "aBc", &count); //returns 2 and count = 1
count = 0;
mx_binary_search(arr, 6, "aBz", &count); //returns -1 and count = 0
```

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Act: Basic. Strings pack

In this pack, you must create functions to operate with strings. Find prototypes for each function below.

NAME

String length

DESCRIPTION

Create a function that has the same behavior as the corresponding standard libc function `strlen`.

SYNOPSIS

```
int mx_strlen(const char *s);
```

NAME

Swap characters

DESCRIPTION

Create a function that swaps the characters of a string using pointers. Do nothing if `s1` or `s2` does not exist.

SYNOPSIS

```
void mx_swap_char(char *s1, char *s2);
```

EXAMPLE

```
str = "ONE";
mx_swap_char(&str[0], &str[1]); //'str' now is "NOE"
mx_swap_char(&str[1], &str[2]); //'str' now is "NEO"
```

NAME

Copy string

DESCRIPTION

Create a function that has the same behavior as the standard libc function `strcpy`.

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SYNOPSIS

```
char *mx_strcpy(char *dst, const char *src);
```

NAME

Compare strings

DESCRIPTION

Create a function that has the same behavior as the standard libc function `strcmp`.

SYNOPSIS

```
int mx_strcmp(const char *s1, const char *s2);
```

NAME

Concatenate strings

DESCRIPTION

Create a function that has the same behavior as the standard libc function `strcat`.

SYNOPSIS

```
char *mx_strcat(char *restrict s1, const char *restrict s2);
```

NAME

New string

DESCRIPTION

Create a function that:

- allocates memory for a string of a specific `size` and one additional byte for the terminating `'\0'`
- initializes each character with `'\0'`

RETURN

- returns the string of a specific `size` and terminated by `'\0'`
- returns `NULL` if creation fails

ucode

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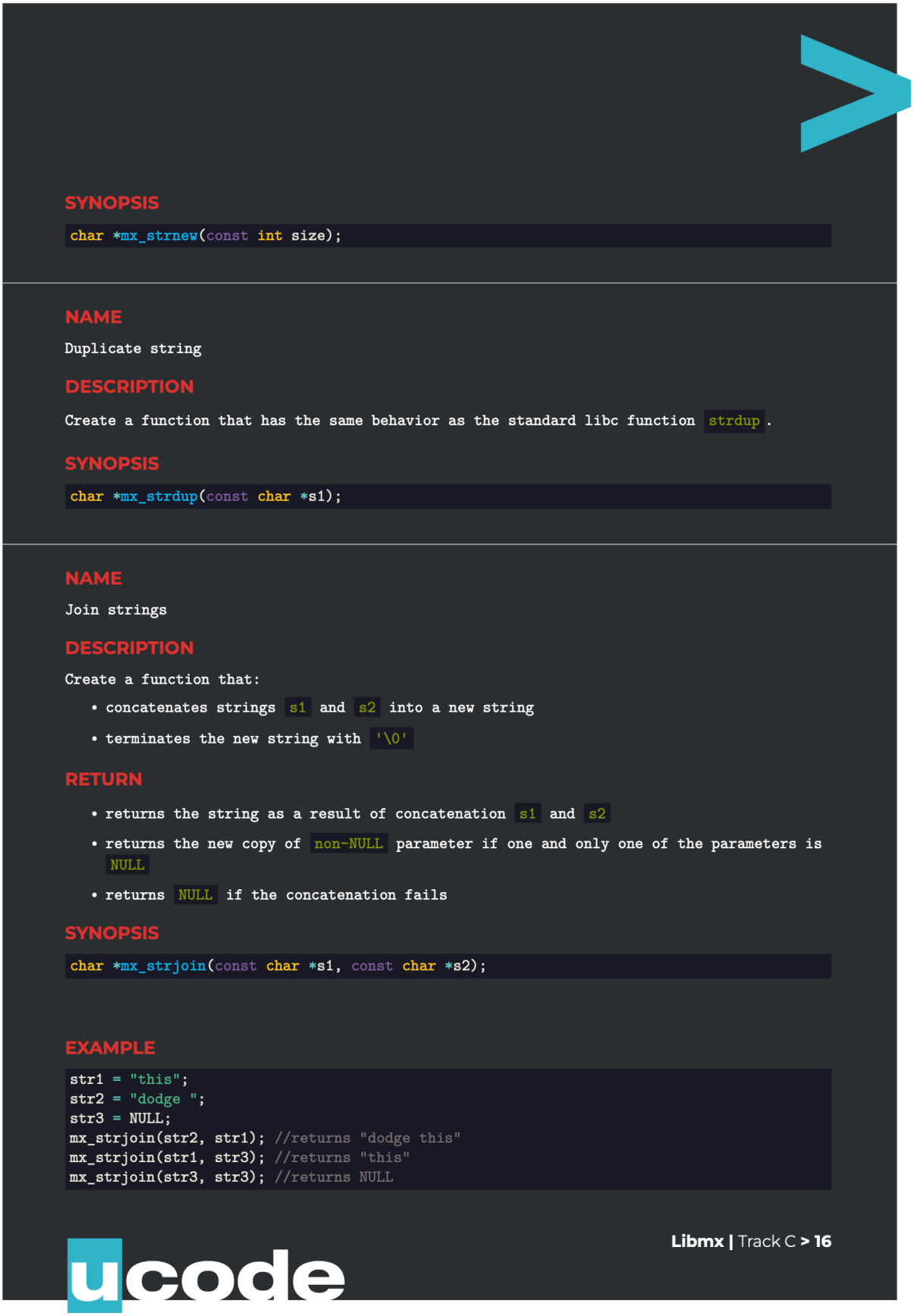

SYNOPSIS

```
char *mx_strnew(const int size);
```

NAME

Duplicate string

DESCRIPTION

Create a function that has the same behavior as the standard libc function `strdup`.

SYNOPSIS

```
char *mx_strdup(const char *s1);
```

NAME

Join strings

DESCRIPTION

Create a function that:

- concatenates strings `s1` and `s2` into a new string
- terminates the new string with `'\0'`

RETURN

- returns the string as a result of concatenation `s1` and `s2`
- returns the new copy of `non-NULL` parameter if one and only one of the parameters is `NULL`
- returns `NULL` if the concatenation fails

SYNOPSIS

```
char *mx_strjoin(const char *s1, const char *s2);
```

EXAMPLE

```
str1 = "this";
str2 = "dodge ";
str3 = NULL;
mx_strjoin(str2, str1); //returns "dodge this"
mx_strjoin(str1, str3); //returns "this"
mx_strjoin(str3, str3); //returns NULL
```

ucode

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NAME

Delete string

DESCRIPTION

Create a function that:

- takes a pointer to a string
- frees string memory with `free`
- sets the string to `NULL`

SYNOPSIS

```
void mx_strdel(char **str);
```

NAME

Delete array of strings

DESCRIPTION

Create a function that:

- takes a pointer to a `NULL`-terminated array of strings
- deletes the contents of the array
- frees array memory with `free`
- sets a pointer to `NULL`

SYNOPSIS

```
void mx_del_strarr(char ***arr);
```

NAME

File to string

DESCRIPTION

Create a function that:

- takes a filename as a parameter
- reads data from the file into a string

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RETURN

- returns a `NULL`-terminated string
- returns `NULL` in case of any errors

SYNOPSIS

```
char *mx_file_to_str(const char *file);
```

NAME

Read line a.k.a. Mr. Big

DESCRIPTION

Create a function that reads the line from the given `fd` into the `lineptr` until it:

- reaches a `delim` character. The delimiter must not be returned with `lineptr`
- reaches the End Of File (EOF)

A line is a sequence of characters before a delimiter.

The function:

- works correctly with any file descriptor `fd`
- works correctly with any positive integer `buf_size`. `buf_size` must be passed to the function `read` as a parameter `nbytes`
- can read all data from the given `fd` until the EOF, one line per call
- may contain a single static variable while global variables are still forbidden
- may have undefined behavior while reading from a binary file

RETURN

- returns the number of bytes that are written into `lineptr`
- returns `-1` if EOF is reached and there is nothing to write in `lineptr`
- returns `-2` in case of errors or `fd` is invalid

SYNOPSIS

```
int mx_read_line(char **lineptr, size_t buf_size, char delim, const int fd);
```

EXAMPLE

ucode

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```
/* lets imagine that there is a file 'fragment' and it contains:
FADE IN:

ON COMPUTER SCREEN

so close it has no boundaries.

A blinking cursor...
*/
fd = open("fragment", O_RDONLY);

res = mx_read_line(&str, 7, '\n', fd); //res = 8, str = "FADE IN:"
res = mx_read_line(&str, 35, 'a', fd); //res = 34, str = "
//ON COMPUTER SCREEN
//
//so close it h"
res = mx_read_line(&str, 1, '.', fd); //res = 15, str = "s no boundaries"
res = mx_read_line(&str, 10, '\n', fd); //res = 0, str = ""
```

TIPS

- Function uses `lineptr` as it is. No changes needed in spite of the file's content.
- Function does nothing with `lineptr` if an input file is empty.
- Your function will be more handy and usefull if it works with multiple descriptors. But it is not neccessary.
- It's okay that your function doesn't work correctly while trying to read from different files with the same descriptor.

FOLLOW THE WHITE RABBIT

`man 2 read`

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Act: Advanced. Strings pack

NAME

Copy them all

DESCRIPTION

Create a function that has the same behavior as the standard libc function `strncpy`.

SYNOPSIS

```
char *mx_strncpy(char *dst, const char *src, int len);
```

NAME

Reverse string

DESCRIPTION

Create a function that reverses a string using pointers. Do nothing if a string does not exist.

SYNOPSIS

```
void mx_str_reverse(char *s);
```

EXAMPLE

```
str = "game over";
mx_str_reverse(str); //'str' now is "revo emag"
```

NAME

Duplicate part of string

DESCRIPTION

Create a function that has the same behavior as the standard libc function `strndup`.

SYNOPSIS

```
char *mx_strndup(const char *s1, size_t n);
```

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NAME

Locate a substring

DESCRIPTION

Create a function that has the same behavior as the standard libc function `strstr`.

SYNOPSIS

```
char *mx_strstr(const char *haystack, const char *needle);
```

NAME

Count words

DESCRIPTION

Create a function that counts words in a string.
Word is a sequence of characters separated by a delimiter.

RETURN

Returns the number of words in the string.

SYNOPSIS

```
int mx_count_words(const char *str, char c);
```

EXAMPLE

```
str = "  follow  *   the  white rabbit ";
mx_count_words(str, '*'); //returns 2
mx_count_words(str, ' '); //returns 5
mx_count_words(NULL, ' '); //returns -1
```

NAME

Count substrings

DESCRIPTION

Create a function that counts the substrings `sub` in the string `str`.

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RETURN

- returns the count of `sub` in `str`
- returns `0` if `sub` is an empty string
- returns `-1` if `str` and / or `sub` do not exist

SYNOPSIS

```
int mx_count_substr(const char *str, const char *sub);
```

EXAMPLE

```
str = "yo, yo, yo Neo";
sub = "yo";
mx_count_substr(str, sub); //returns 3
mx_count_substr(str, NULL); //returns -1
mx_count_substr(NULL, sub); //returns -1
```

NAME

Get character index

DESCRIPTION

Create a function that finds the index of the first occurrence of the character `c` in a string `str`. A string is a sequence of characters, excluding `NULL` in the end.

RETURN

- returns the index of the first occurrence
- returns `-1` if no occurrence is found
- returns `-2` if the string does not exist

SYNOPSIS

```
int mx_get_char_index(const char *str, char c);
```

NAME

Get substring index

DESCRIPTION

Create a function that finds the index of a substring.

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RETURN

- returns the index of the first character of `sub` in `str`
- returns `-1` if `sub` is not found in `str`
- returns `-2` if `str` or `sub` does not exist

SYNOPSIS

```c
int mx_get_substr_index(const char *str, const char *sub);
```

EXAMPLE

```c
mx_get_substr_index("McDonalds", "Don"); //returns 2
mx_get_substr_index("McDonalds Donuts", "on"); //returns 3
mx_get_substr_index("McDonalds", "Donatello"); //returns -1
mx_get_substr_index("McDonalds", NULL); //returns -2
mx_get_substr_index(NULL, "Don"); //returns -2
```

NAME

Trim string

DESCRIPTION

Create a function that:

- takes a string, and creates a new one from it without whitespace characters at the beginning and the end of the string
- frees all unused memory

RETURN

- returns a new trimmed string
- returns `NULL` if the string `str` does not exist or string trim fails

SYNOPSIS

```c
char *mx_strtrim(const char *str);
```

EXAMPLE

```c
name = "\f  My name... is Neo  \t\n ";
mx_strtrim(name); //returns "My name... is Neo"
```

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NAME

Clean string

DESCRIPTION

Create a function that:

- takes a string, and creates a new one from it without whitespace characters in the beginning and/or at the end of the string
- separates words in the new string with exactly one space character
- frees all unused memory

A word is a sequence of characters separated by whitespaces.

RETURN

- returns a new created string
- returns `NULL` if the string `str` does not exist or string creation fails

SYNOPSIS

```
char *mx_del_extra_spaces(const char *str);
```

EXAMPLE

```
name = "\f  My name...     is  \r Neo  \t\n ";
mx_del_extra_spaces(name); //returns "My name... is Neo"
```

NAME

Split string

DESCRIPTION

Create a function that:

- converts a string `s` to a `NULL`-terminated array of words
- frees all unused memory

A word is a sequence of characters separated by the character `c` as a delimiter.

RETURN

- returns the `NULL`-terminated array of strings
- returns `NULL` if the string `s` does not exist or conversion fails

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SYNOPSIS

```
char **mx_strsplit(const char *s, char c);
```

EXAMPLE

```
s = "**Good bye,**Mr.*Anderson.****";
arr = mx_strsplit(s, '*');  // arr = ["Good bye,", "Mr.", "Anderson."]
s = "     Knock, knock,    Neo.   ";
arr = mx_strsplit(s, ' ');  // arr = ["Knock,", "knock,", "Neo."]
```

NAME

Replace substrings

DESCRIPTION

Create a function that replaces all occurrences of `sub` in `str` with `replace`.

RETURN

- returns a new string where substrings are replaced
- returns `NULL` if `sub` or `str` or `replace` does not exist

SYNOPSIS

```
char *mx_replace_substr(const char *str, const char *sub, const char *replace);
```

EXAMPLE

```
mx_replace_substr("McDonalds", "alds", "uts"); //returns "McDonuts"
mx_replace_substr("Ururu turu", "ru", "ta"); //returns "Utata tuta"
```

ucode

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Act: Basic. Memory pack

Correct work with memory is an integral and important part of the interaction of your program with the computer. To do this, we need the following functions.

NAME

Fill memory

DESCRIPTION

Create a function that has the same behavior as the standard libc function `memset`.

SYNOPSIS

```
void *mx_memset(void *b, int c, size_t len);
```

NAME

Copy memory

DESCRIPTION

Create a function that has the same behavior as the standard libc function `memcpy`.

SYNOPSIS

```
void *mx_memcpy(void *restrict dst, const void *restrict src, size_t n);
```

NAME

Compare memory

DESCRIPTION

Create a function that has the same behavior as the standard stdlib function `memcmp`.

SYNOPSIS

```
int mx_memcmp(const void *s1, const void *s2, size_t n);
```

NAME

Reallocate memory

DESCRIPTION

Create a function that has the same behavior as the standard stdlib function `realloc`.

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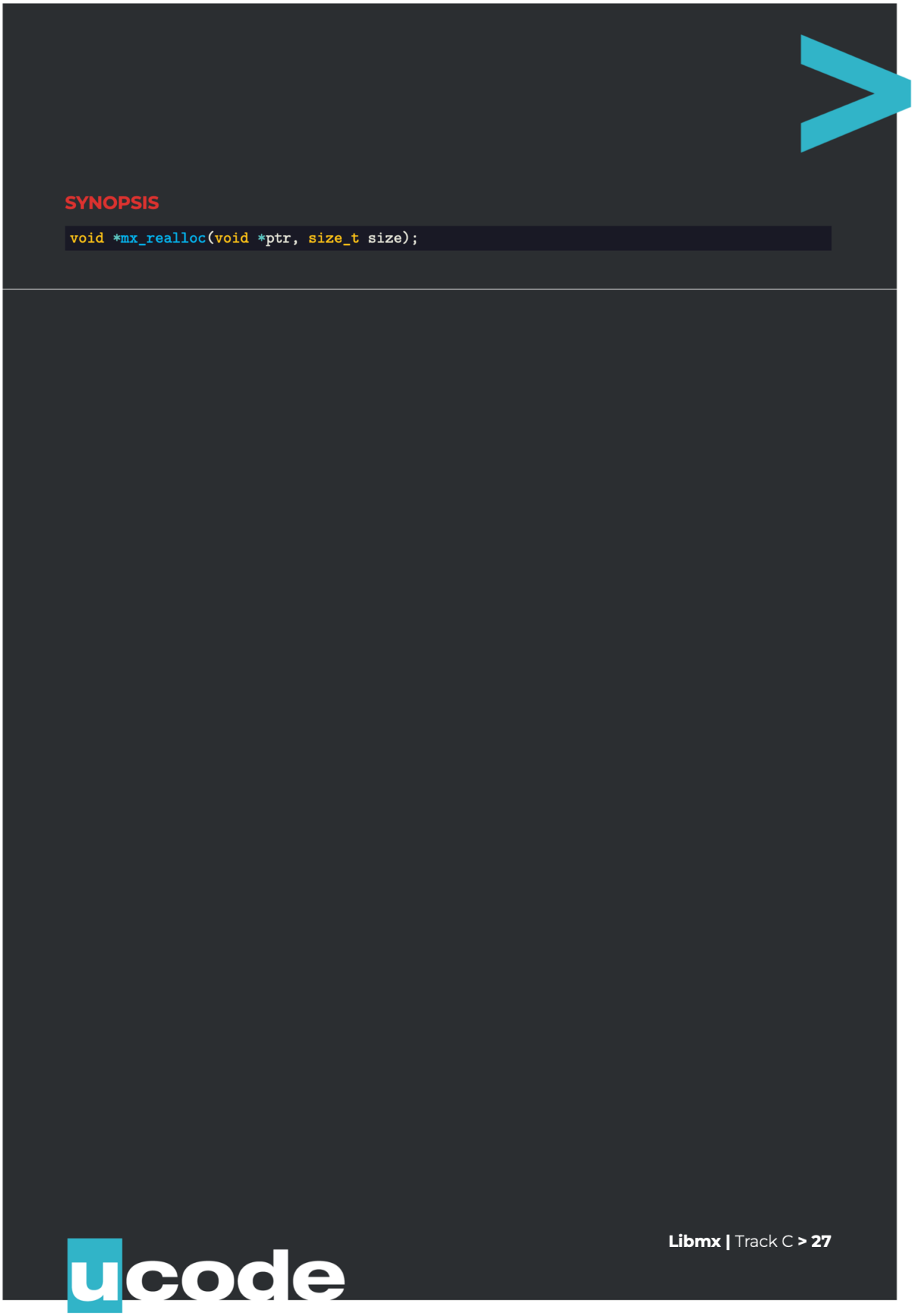
SYNOPSIS
void *mx_realloc(void *ptr, size_t size);
ucode
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Act: Advanced. Memory pack

NAME

Non-overlapping memory copy

DESCRIPTION

Create a function that has the same behavior as the standard libc function `memmove`.

SYNOPSIS

```
void *mx_memmove(void *dst, const void *src, size_t len);
```

NAME

Locate byte from end

DESCRIPTION

Create a function `mx_memrchr`, which is similar to the function `mx_memchr`, except that it searches in the opposite direction from the end of the bytes `n` points to `s` instead of directly from the beginning.

SYNOPSIS

```
void *mx_memrchr(const void *s, int c, size_t n);
```

EXAMPLE

```
mx_memrchr("Trinity", 'i', 7); //returns "ity"
mx_memrchr("Trinity", 'M', 7); //returns NULL
```

NAME

Copy memory to ...

DESCRIPTION

Create a function that has the same behavior as the standard stdlib function `memccpy`.

SYNOPSIS

```
void *mx_memccpy(void *restrict dst, const void *restrict src,
                 int c, size_t n);
```

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NAME

Locate byte from start

DESCRIPTION

Create a function that has the same behavior as the standard stdlib function `memchr`.

SYNOPSIS

```
void *mx_memchr(const void *s, int c, size_t n);
```

NAME

Locate block of bytes

DESCRIPTION

Create a function that has the same behavior as the standard libc function `memmem`.

SYNOPSIS

```
void *mx_memmem(const void *big, size_t big_len, const void *little,
                size_t little_len);
```

Act: Basic. List pack

So, now we come to an important and convenient data structure. You will use it in the future. You can find prototypes for every function in the list of tasks and `s_list` structure below. Your library header must contain the structure `s_list` and the required includes and prototypes to compile the functions successfully.

```
typedef struct s_list {
    void *data;
    struct s_list *next;
}              t_list;
```

NAME

Create node

DESCRIPTION

Create a function that creates a new node of a linked list `t_list`. The function assigns a parameter `data` to the list variable `data` and assigns `next` to `NULL`.

SYNOPSIS

```
t_list  *mx_create_node(void *data);
```

NAME

Push front

DESCRIPTION

Create a function that inserts a new node of `t_list` type with the given parameter `data` at the beginning of the linked list.

SYNOPSIS

```
void mx_push_front(t_list **list, void *data);
```

NAME

Push back

DESCRIPTION

Create a function that inserts a node of `t_list` type with the given parameter `data` at the end of the linked list.

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SYNOPSIS

```
void mx_push_back(t_list **list, void *data);
```

NAME

Pop front

DESCRIPTION

Create a function that removes the first node of the linked list and frees the memory allocated for the node.

SYNOPSIS

```
void mx_pop_front(t_list **head);
```

NAME

Pop back

DESCRIPTION

Create a function that removes the last node of the linked list and frees the memory allocated for the node.

SYNOPSIS

```
void mx_pop_back(t_list **head);
```

Act: Advanced. List pack

NAME

Size of list

DESCRIPTION

Create a function that calculates the number of nodes in a linked list.

RETURN

Returns the amount of nodes in the linked list.

SYNOPSIS

```
int mx_list_size(t_list *list);
```

NAME

Sort list

DESCRIPTION

Create a function that sorts a list's contents in ascending order. The function `cmp` returns `true` if `a > b` and `false` in other cases.

RETURN

Returns a pointer to the first element of the sorted list.

SYNOPSIS

```
t_list *mx_sort_list(t_list *lst, bool (*cmp)(void *, void *));
```

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Document

DOCUMENTATION

One of the attributes of Challenge Based Learning is documentation of the learning experience from challenge to solution. Throughout the challenge, you document your work using text and images, and reflect on the process. These artifacts are useful for ongoing reflection, informative assessment, evidence of learning, portfolios, and telling the story of challenge. The end of each phase (Engage, Investigate, Act) of the challenge offers an opportunity to document the process.

Much of the deepest learning takes place by considering the process, thinking about one's own learning, analyzing ongoing relationships with the content and between concepts, interacting with other people, and developing a solution. During learning, documentation of all processes will help you analyze your work, approaches, thoughts, implementation options, code, etc. In the future, this will help you understand your mistakes, improve your work, and read the code.

At the learning stage, it is important to understand and do this, as this is one of the skills that you will need in your future job. Naturally, the documentation should not be voluminous, it should be drawn up in an accessible, logical, and connected form.

So, what must be done?

- a nice-looking and helpful README file. In order for people to want to use your product, their first introduction must be through the README on the project's git page. Your README file must contain:
  - Short description. This means, that there must be some info about what your project actually is. For example, what your program does.
  - Screenshots of your solution. This point is about screenshots of your project "in use".
  - Requirements and dependencies. List of any stuff that must be installed on any machine to build your project.
  - How to run your solution. Describe the steps from cloning your repository to the first launch of your program.
- a full-fledged documentation in any forms convenient for you. By writing this, you will get some benefits:
  - you have an opportunity to think through implementation without the overhead of changing code every time you change your mind about how something should be organized. You will have very good documentation available for you to know what you need to implement
  - if you work with a development team and they have access to this information before you complete the project, they can confidently start working on another part of projects that will interact with your code
  - everyone can find how your project works
- your documentation must contain:
  - Description of progress after every competed CBL stage.
  - Description of the algotithm of your whole program.

Keep in mind that the implementation of this stage will be checked by peers at the assessment!

Also, there are several links that can help you:

- Make a README
- How to write a readme.md file?
- A Beginners Guide to writing a README
- Google Tools - a good way to journal your phases and processes:
  - Google Docs
  - Google Sheets
- Dropbox Paper - a tool for internally developing and creating documentation
- Git Wiki - a section for hosting documentation on Git-repository
- Haroopad - a markdown enabled document processor for creating web-friendly documents
- Canva - a good way to visualize your data
- QuickTime - an easy way to capture your screen, record video or audio
- code commenting - source code clarification method. The syntax of comments is determined by the programming language
- and others to your taste

Share

PUBLISHING

Last but not least, the final stage of your work is to publish it. This allows you to share your challenges, solutions, and reflections with local and global audiences. During this stage, you will discover ways of getting external evaluation and feedback on your work. As a result, you will get the most out of the challenge, and get a better understanding of both your achievements and missteps.

To share your work, you can create:

- a text post, as a summary of your reflection
- charts, infographics or other ways to visualize your information
- a video, either of your work, or a reflection video
- an audio podcast. Record a story about your experience
- a photo report with a small post

Helpful tools:

- Canva - a good way to visualize your data
- QuickTime - an easy way to capture your screen, record video or audio

Examples of ways to share your experience:

- Facebook - create and share a post that will inspire your friends
- YouTube - upload an exciting video
- GitHub - share and describe your solution
- Telegraph - create a post that you can easily share on Telegram
- Instagram - share photos and stories from ucode. Don't forget to tag us :)

Share what you've learned and accomplished with your local community and the world. Use #ucode and #CBLWorld on social media.