NWEN 241 Assignment 2

(Weeks 3–5 Topics)

Release Date: **28 March 2022**

Submission Deadline: **20 April 2022, 23:59**

In this assignment, you will be asked to implement C functions, the specifications of which are presented in each of the tasks. To be submitted in file named `dbms.c`.

You must submit the required file to the Assessment System (`https://apps.ecs.vuw.ac.nz/submit/NWEN241/Assignment_2`). Any assignment submitted up to 24 hours after the deadline will be penalised by 20%, and any assignment submitted between 24 and 48 hours after the deadline will be penalised by 40%. Any assignment submitted 48 hours or more after the deadline will not be marked and will get 0 marks.

Important: The Assessment System is configured **not to accept submissions that do not compile.** So please test that your code compiles using a C compiler before submitting it.

Full marks is 100. The following table shows the overall marks distribution:

Criteria	**Marks**	**Expectations for Full Marks**
Compilation	5	Compiles without warnings
Comments	10	Sufficient and appropriate comments
Code Quality	15	Efficient code and use of consistent coding style
Correctness	70	Handles all test cases correctly (see marks distribution below)
Total	**100**	

For the **Correctness** criteria, the following table shows the marks distribution over the different task types:

Task Type	**Marks**
Core	45
Completion	15
Challenge	10
Total	**70**

Introduction

This assignment will test whether you can apply the conceptual knowledge you have learned in Weeks 3–5 to solve practical programming tasks. You must only use the Standard C Library to perform the tasks in this part.

You will implement a simple database management system (DBMS). DBMS is a systems program that performs storage, retrieval, and updating of data in a computer system. DBMS addresses two major problems in conventional file-based systems: data redundancy and data dependence.

Sample code showing an example on how you can test your code are provided under the `files` directory in the archive that contains this file.

Commenting

You should provide appropriate comments to make your source code readable. If your code does not work and there are no comments, you may lose all marks.

Code Quality

Code quality refers to (*i*) the use of efficient coding techniques and (*ii*) use of consistent coding style or standard.

When writing your source code, strive for *coding efficiency* which covers the following aspects: (*i*) elimination of unessential operations and variables; (*ii*) creation of functions to contain blocks of code that are used repeatedly; (*iii*) minimization of loop iteration; and (*iv*) avoiding the use of global variables (i.e. variables that are declared outside any function.)

In addition, you should follow a consistent coding style when writing your source code. Coding style (aka coding standard) refers to the use of appropriate indentation, proper placement of braces, proper formatting of control constructs, and many others. Following a particular coding style consistently will make your source code more readable. There are many coding standards available (search "C coding style"), but we suggest you consult the *lightweight* Linux kernel coding style (see `https://www.kernel.org/doc/html/v4.10/process/coding-style.html`). The relevant sections are Sections 1, 2, 3, 4, 6, and 8. Note that you do not have to follow every recommendation you can find in a coding style document, you just have to apply that style consistently.

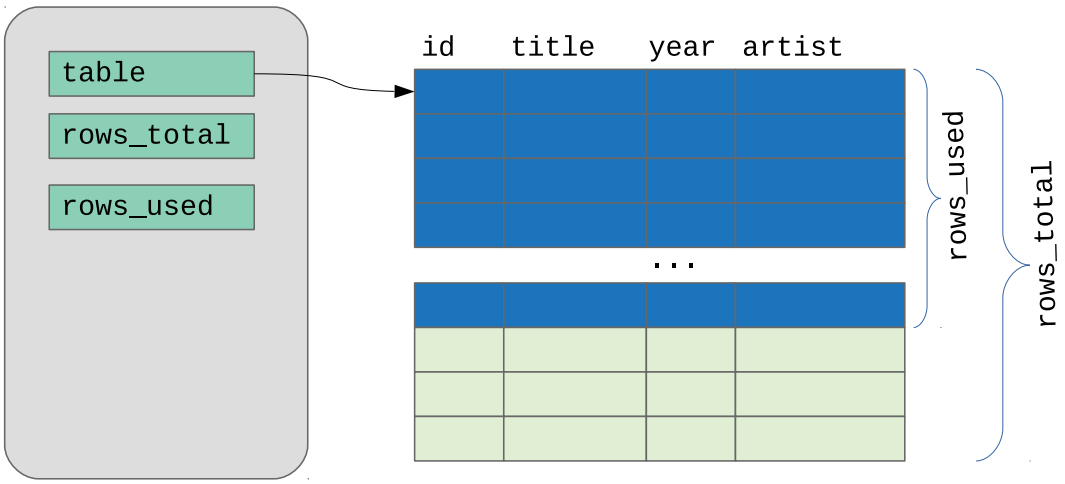
Program Design

A fundamental concept in DBMS is the *table*. A table consists of zero or more *records* or entries, and each record can have one or more *fields* or columns. An example of a table that stores information about music albums is shown below:

id	title	year	artist
10	The Dark Side of the Moon	1973	Pink Floyd
14	Back in Black	1980	AC/DC
23	Their Greatest Hits	1976	Eagles
37	Falling into You	1996	Celine Dion
43	Come Away With Me	2002	Norah Jones
55	21	2011	Adele

This table contains 6 records. Each record has 4 fields, namely, `id`, `title`, `year`, and `artist`.

In this assignment, you will focus on implementing a single database table with 4 fields (id, title, year, and artist). To guide you in the implementation, a high-level design of the table is shown below:



The design consists of a `db_table` structure and an array of `album` structures that is dynamically allocated. The `db_table` structure should have the following member variables:

- `table`: a pointer to an array of structures that is dynamically allocated,

- `rows_total`: the total number of rows in the array of structures,
- `rows_used`: the number of rows in the array of structures that contains valid records.

The array of `album` structures will hold the records. This array should be dynamically allocated and adjusted using the following scheme:

- Initially, the array should be empty. `rows_total` should be set to 0 and `rows_used` should be set to 0.
- When adding a record and there is unused space in the table (`rows_used` is less than `rows_total`), the record is stored in the next unused row, and `rows_used` is updated accordingly.
- When adding a record and there is no space in the table (`rows_used` is equal to `rows_total`), additional memory for holding 5 records should be allocated. Then, the record is stored in the next unused row, and `rows_used` and `rows_total` are updated accordingly.
- When removing a record, records after the removed record should be moved up by one row so that there will be no gaps in between used rows. When the number of unused rows reaches 5, the unused rows should be released, and `rows_used` and `rows_total` are updated accordingly.

The definition of the `db_table` and `album` structures are given in the header file named `dbms.h` which is provided under the `files` directory.

Task 1.

Core [45 Marks]

Provide an implementation of a function called `db_show_row` for displaying the information stored in a row. The display output should be formatted as follows:

```
id:    title:               artist:year
```

where `id`, `title`, `artist`, and `year` should occupy 6, 20, 20, and 4 spaces, respectively. Shorter values should be padded with space, whereas longer values should be truncated to fit within the space. As an example, for the record with id `10`, title `"The Dark Side of the Moon"`, year `1973`, and artist `"Pink Floyd"`, the output should be

```
␣␣␣␣10:The Dark Side of the:␣␣␣␣␣␣␣␣␣␣Pink Floyd:1973
```

where ␣ represents a single space. There should be newline at the end of line.

The function prototype is given in the header file named `dbms.h` which is provided under the `files` directory.

The function accepts two input parameters:

- Pointer to a `db_table` structure (see definition in `dbms.h`.)
- Unsigned integer indicating the row number of the record to be displayed.

If the record exists, the function should return `1`, otherwise, it should return `0`.

Save the function implementation in a C source file named `dbms.c`.

You can test your function implementation by compiling `dbms.c` together with the file named `t1test.c` which is provided under the `files` directory. Read the contents of `t1test.c` to know how to compile and run the resulting executable file.

Task 2.

Completion [15 Marks]

Provide an implementation of a function called `db_add_row` for adding a record into the database table. The function prototype is given in the header file named `dbms.h` which is provided under the `files` directory.

The function accepts two input parameters:

- Pointer to a `db_table` structure (see definition in `dbms.h`.)
- Pointer to `album` structure (see definition in `dbms.h`) as input parameter containing the record details to be stored in the table.

As mentioned in the *Program Design* section:

- When adding a record and there is unused space in the table (`rows_used` is less than `rows_total`), the record is stored in the next unused row, and `rows_used` is updated accordingly.
- When adding a record and there is no space in the table (`rows_used` is equal to `rows_total`), additional memory for holding 5 records should be allocated. Then, the record is stored in the next unused row, and `rows_used` and `rows_total` are updated accordingly.

The function should always return `1` unless the allocation of additional memory (when needed) fails where it should return `0`.

Save the function implementation in a C source file named `dbms.c`.

You can test your function implementation by compiling `dbms.c` together with the file named `t2test.c` which is provided under the `files` directory. Read the contents of `t2test.c` to know how to compile and run the resulting executable file.

Task 3.

Challenge [10 Marks]

Provide an implementation of a function called `db_remove_row` for removing a record from the database table. The function prototype is given in the header file named `dbms.h` which is provided under the `files` directory.

The function accepts two input parameters:

- Pointer to a `db_table` structure (see definition in `dbms.h`.)
- Unsigned long integer specifying the id of the record to be removed.

As mentioned in the *Program Design* section:

- When removing a record, records after the removed record should be moved up by one row so that there will be no gaps in between used rows. When the number of unused rows reaches 5, the unused rows should be released, and `rows_used` and `rows_total` are updated accordingly.

The function should return `1` if the removal was successful, otherwise, it should return `0`.

Save the function implementation in a C source file named `dbms.c`.

You can test your function implementation by compiling `dbms.c` together with the file named `t3test.c` which is provided under the `files` directory. Read the contents of `t3test.c` to know how to compile and run the resulting executable file.