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This report delves into the storage of data for the esteemed group endeavor, namely the ***Course Management System,*** which has been meticulously crafted as part of the ***Programming Techniques*** course.

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**Data Storage Report**

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# ENUMERATIONS AND STRUCTURES

## Enumerations

An enumeration is a data type that allows programmers to define a collection of named values.

|  |  |
| --- | --- |
| **enum Program { APCS, CLC, VP };** | An enumeration used for representing the program that a student attending in. |
| **enum WeekDay {**  **MON, TUE, WED, THU, FRI, SAT, SUN**  **};** | Represents weekday in the program, used for day performance of a course. |
| **enum Session { S1, S2, S3, S4 };** | Represents the shift that a course performs in the program. |
| **enum Type { Staff, Student };** | Represents type of the user. |

## Structures

### Linked list

|  |  |
| --- | --- |
| **template <typename data\_type>**  **struct SLL {**  **// to declare a node of a singly linked list of integers: SLL<int> \*head;**  **data\_type data;**  **SLL<data\_type> \*next = nullptr;**  **};** | A node of a singly linked list that encapsulates three components:   * data: the data type of data will be passed to the declaration of the instance as a template argument when this structure is called. * next: a pointer that points to the next node. |
| **template <typename data\_type>**  **struct DLL {**  **// to declare a node of a doubly linked list of integers: DLL<int> \*head;**  **data\_type data;**  **SLL<data\_type> \*prev = nullptr;**  **SLL<data\_type> \*next = nullptr;**  **};** | A node of a doubly linked list that encapsulates three components:   * data: the data type of data will be passed to the declaration of the instance as a template argument when this structure is called. * prev: a pointer that points to the previous node. * next: a pointer that points to the next node. |
| **template <template <typename> list\_type, typename data\_type>**  **struct LIST {**  **// to declare a doubly linked list `DLL` of integers: LIST<DLL, int> list;**  **list\_type<data\_type> \*head = nullptr;**  **list\_type <data\_type> \*tail = nullptr;**  **};** | A structure that keeps the first and the last node of the corresponding linked list.   * head: the first node of the list * tail: the last node of the list |

### User

|  |  |
| --- | --- |
| **struct USER {  std::string username = “”;**  **std::string password = “”;**  **};** | Represents a user account, including username and password. |
| **struct STUDENT {**  **unsigned int yearIn = 0;**  **std::string firstname = “”,**  **lastname = “”,**  **studentID = “”,**  **socialID = “”;  const Type type = Student;**  **USER user;**  **DATE dateOfBirth;**  **bool gender = 0; // 0: male && 1: female**  **CLASS\* Class;**  **LIST<DLL, COURSE\*> courses; // list of courses that the student enroll in in the current semester**  **};** | Represents a student in the school.  The struct has several member variables with different data types, including:   * An unsigned integer named yearIn: the enrollment year of this student. * A std::string named firstname / lastname / studentID / socialID: firstname / lastname / student ID / social ID of this student. * A constant variable of Type named type: to tell the system that this is a student or a staff. This component is unchangable. * A USER variable named user: represents for the user account (including username and password only) associated with the student. * A DATE variable named dateOfBirth: represents the student’s date of birth. * A boolean named gender: represents the gender of this student (1 for male, 0 for female). * A pointer of CLASS named Class: contains the address of the data member inside the node of list the L\_Class ([*II – 3*](#L_Class_definition)) in which this student is participating. |
| **struct STAFF {**  **std::string firstname = “”, lastname = “”;**  **const Type type = Staff;**  **USER user;**  **};** | Represents a staff in the school.  Consists of 4 components: first name, last name, type of user (constant, set to Staff) and user account information. |

### Date time – Scholastic year – Semester

|  |  |
| --- | --- |
| **struct DATE {**  **unsigned int year = 0;**  **unsigned short day = 0, month = 0;**  **};** | Represents a semester in the school year.  Encapsulates 4 components:   * A unsigned integer named year is used to store the year of the date * Two unsigned short integers named day and month are used to store the day and month of the date. |
| **struct SCHOOLYEAR {**  **unsigned int begin = 0, end = 0;**  **SEMESTER \*sem1 = nullptr, \*sem2 = nullptr, \*sem3 = nullptr;**  **};** | Represents a scholastic year in the school.  Consists of 5 components:   * Two unsigned integers named begin and end represent for starting year and ending year of this school year. * Three pointer of SEMESTER named sem1, sem2 and sem3 pointing to the corresponding semester of this school year. |
| **struct SEMESTER {**  **int No = 0;**  **DATE startdate, enddate;**  **LIST<DLL, COURSE\*> courses;**  **};** | Represents a semester in the school year.  Encapsulates 4 components:   * No: ordinal number of this semester (1, 2 or 3 only). * Two variables of DATE named startdate and enddate represent the starting date and ending date of this semester * A doubly linked list of pointers of COURSE which contains the list of the courses performing in this semester. |

### Class – Course – Scoreboard

|  |  |
| --- | --- |
| **struct CLASS {**  **unsigned int yearIn;**  **unsigned short K = 0, No = 0;**  **Program program;**  **// for example: 22CLC2, K = 22, No = 2, Program = CLC (an enumeration)**  **LIST<DLL, STUDENT\*> students;**  **// member function**  **std::string convertToString();**  **};** | Represents for a class of students in the school.  Consists of 5 components and 1 member function:   * A unsigned integer named yearIn represents the enrollment year of the students in this class. * Two unsigned short integers named K and No:   + K = yearIn % ((yearIn / 1000) \* 1000).  + No is the ordinal number of this class in the year it was created.   * A Program variable named program represents the program that the students in this class study in (including CLC, VP and APCS). * A doubly linked list of pointers of STUDENT named students contains students that attend in this class. This list does not contain any new nodes but uses the same node with the L\_Student. * Function convertToString() is a member function which converts a class to a std::string that represents the name of that class. It needs to be accessed using dot operator. |
| **struct COURSE {**  **std::string ID = “”,**  **name = “”,**  **teacher = “”;**  **unsigned short credit = 0, maxStudents = 50;**  **WeekDay day = MON;**  **Session session = S1;**  **LIST<DLL, SCOREBOARD\*> students;**  **// member function**  **void add1Student(SCOREBOARD\* student);**  **};** | Represents a course a certain semester.  Encapsulates 8 components and 1 member function:   * Three std::string named ID, name and teacher represent the course ID / course name the teacher who teaches this course. * Two unsigned short integers named credit and maxStudents which represent for number of credits of this course and the maximum students (or the capacity) of the course. * A WeekDay variable named day represents the day on which this course will perform. * A Session variable named session represents the session on which this course will perform * A doubly linked list of pointers of SCOREBOARD named students which contain all the nodes of student enrolling in this course and their scores. * Function add1Student(SCOREBOARD\* student) is a member function that add a new student with his/her score to the list students. |
| **struct SCOREBOARD {**  **double totalMark = 0, finalMark = 0, midtermMark = 0, otherMark = 0;**  **STUDENT\* student = nullptr;**  **};** | Represents a score board of a certain student in a certain course.  Encapsulates 5 members:   * Four double variables named totalMark, finalMark, midtermMark and otherMark for marks. * A pointer of STUDENT named student, which is set to nullptr by default, points to the student that got these scores. |

# GLOBAL LISTS AND GLOBAL VARIABLES

## Why is it essential to set the scope of these lists and variables to global?

* To ensure that these lists and variables can be accessed or modified without having to pass them as arguments to multiple functions.
* To facilitate communication and data sharing between different parts of the program.

## Global variables used in the source code

|  |  |
| --- | --- |
| **SCHOOLYEAR\* g\_currentSchoolYear = nullptr;** | Keeps the pointer that points to the current school year. |
| **SEMESTER\* g\_currentSemester = nullptr;** | Keeps the pointer that points to the current semester. |
| **STUDENT\* g\_currentStudent = nullptr;** | Keeps the pointer that points to the current student (the user that is logging in the system; otherwise, this pointer will point to **nullptr**) . |
| **STAFF\* g\_currentStaff = nullptr;** | Keeps the pointer that points to the current staff (the user that is logging in the system; otherwise, this pointer will point to **nullptr**) . |
| **std::string lastestUsername = “”;** | If `*remember*` check box is selected, the system will assign the user name of the most recent user who logged in to it. |
| **std::string latestPassword = “”;** | If `*remember*` check box is selected, the system will assign the password of the most recent user who logged in to it. |
| **bool latestCheckRememberLogin = false;** | When `*remember*` check box is checked, it itself will be set to **true**. |

## Global lists used in the source code

|  |  |
| --- | --- |
| **LIST<DLL, SCHOOLYEAR\*> L\_SchoolYear;** | A doubly linked list of **SCHOOLYEAR\***.  Encapsulates a comprehensive roster of all the scholastic year that the system has traversed.  Each node of that list consists of:   * data whose data type is **SCHOOLYEAR\***. * next which is a pointer of that node points to the next node. * prev which is a pointer of that node points to the previous node. |
| **LIST<DLL, STAFF\*> L\_Staff;** | A doubly linked list of **STAFF\***.  Encapsulates a comprehensive roster of all staff members. Each node of that list consists of:   * data whose data type is **STAFF\***. * next which is a pointer of that node points to the next node. * prev which is a pointer of that node points to the previous node. |
| **LIST<DLL, STUDENT\*> L\_Student;** | A doubly linked list of **STUDENT\***.  Encapsulates a comprehensive roster of all students in this school. Each node of that list consists of:   * data whose data type is **STUDENT\***. * next which is a pointer of that node points to the next node. * prev which is a pointer of that node points to the previous node. |
| **LIST<DLL, CLASS> L\_Class;** | A doubly linked list of **CLASS**. Encapsulates a comprehensive roster of all classes in this school. Each node of that list consists of:   * data whose data type is **CLASS**. * next which is a pointer of that node points to the next node. * prev which is a pointer of that node points to the previous node. |

# Graphical user interface, application Description automatically generatedDATA STORAGE IN DETAILS

**L\_Schoolyear** includes all school years; each node in the list consists of data stored by data type SCHOOLYEAR and 2 pointers: next and prev pointing to other school years – the year after and the previous year. Each SCHOOLYEAR data encapsulates a total of 3 semesters: sem1, sem2, sem3 which have the data type SEMESTER\*. It also contains the begin and end year of that school year stored by unsigned integer data type.

A screenshot of a computer

Description automatically generated with low confidence

Each SEMESTER in a year will include the start and end date stored in a variable of DATE. It also stores the ordinal number of this semester in a school year. Especially, it includes a list of courses performing in this semester.

A screenshot of a computer

Description automatically generated with low confidence

This list of courses includes nodes that each node contains data stored in the COURSE\* data type. It points to courses which are performed in that semester. Each node of which is a variable of COURSE\* data type has 2 pointers: next and prev, pointing to the previous course and the next course. Each COURSE includes a course’s information, which are consists of course ID, course name, teacher name stored as string data type; number of credits, maximum number of students stored as integer data type, performing date stored as data type WeekDay, shift on which the course will be performed stored as SESSION data type and finally a list of students who enroll in that course.

Graphical user interface

Description automatically generated

The list of students includes nodes that each node contains data stored by SCOREBOARD\*, pointing to related information of each student. In detail, each SCOREBOARD includes the data of different types of score in that course stored as double data type and student’s personal information stored as STUDENT data type.

Diagram

Description automatically generatedEach STUDENT includes student ID, social ID, name (firstname and lastname), username, password; all stored as string data type, gender stored as bool data type, date of birth stored as DATE data type, class stored as CLASS\* point to class student takes part in, courses student participate in stored as a list of COURSE\* point to courses student joins.

Graphical user interface

Description automatically generated

**L\_Student** includes students in the current school year, each node includes data with data type STUDENT and 2 pointers next prev pointing to other students. Each STUDENT data includes student ID, social ID of that student, name, username password stored as string data type, gender stored as bool data type, date of birth stored as DATE data type, courses student participate in stored as a list of COURSE\* point to courses student joins, class stored as CLASS\* point to class student takes part in in **L\_Class**, student of each class are pointed to students in the same class until all students of that class are pointed to then point to students of another class and repeat until the end.

A picture containing diagram

Description automatically generated **L\_Class** includes nodes, each node consists of data with CLASS data type stored a class in this school year and 2 pointers next prev pointing to other classes: the next class and the previous class in that school year. Each CLASS data includes year which students in that class entered school stored as unsigned integer, program of that class stored as Program, class number stored as unsigned short and list students in that class which is a sublist of **L\_Student**, this sublist has head point to first student of class and tail point to last student of class.

**L\_Staff** includes nodes, each node contains difference staff information stored as STAFF data type and 2 pointers next prev pointing to the next staff and the staff before. Each STAFF data includes firstname lastname stored as string and username password stored as string, too.

# STRUCTURE OF SOUCRE CODES

Root directory: **CMS** (stands for Course Management System)