University of Dundee

**Mentorship Management and Monitoring system (MMMS)**

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1.Introduction

Mentorship plays a vital role in supporting students academically, emotionally, and professionally. This is especially true for students who simultaneously juggle responsibilities at **universities and in companies** — having two mentors: one academic and one industrial. However, traditional mentorship management methods such as emails, informal meetings, or scattered logbooks are **inefficient, non-scalable, and lack actionable insights**.

To solve this, the **Mentor-Mentee Monitoring System (MMMS)** is designed as a smart, data-driven platform that streamlines the mentorship experience in **dual-mentorship environments**. It enables seamless coordination between students, university mentors, and company mentors by offering structured **student progress tracking**, centralized **communication**, and early **conflict detection** between academic and industrial obligations.

The core goals of MMMS include:

* Facilitating effective **mentor-mentee management** for students with dual responsibilities
* Systematically monitoring **academic performance** (attendance, assignments, etc.) alongside work commitments
* Gathering **feedback** from both academic and industry mentors
* Detecting potential conflicts (e.g., class attendance impacted by work schedules)
* Using **predictive analytics** to flag early signs of disengagement or mentorship breakdown based on data such as:
  + Communication frequency
  + Sentiment in feedback
  + Missed milestones or low academic activity

MMMS is more than just a digital tracker. It’s a **smart coordination tool** that empowers institutions and companies to provide **cohesive, proactive, and personalized mentorship support**. By making mentorship data **centralized, interpretable, and actionable**, it allows mentors and administrators to replace guesswork with **data-driven insights** — enabling more responsive decisions and stronger mentorship outcomes for students balancing both academia and industry.

This project also demonstrates how a **realistic synthetic dataset** combined with **machine learning** can be used to simulate real-world scenarios and test scalable solutions for mentorship challenges in modern educational systems.

2.Overview of MMMS

The **Mentorship Management and Monitoring System (MMMS)** is a comprehensive **platform** designed to transform how mentorship programs are managed within educational institutions — especially for students balancing **academic study and professional work**. These students often have **two mentors**: one from their **university** and another from their **company**, which introduces unique challenges in coordination, engagement, and progress tracking.

MMMS provides a centralized, data-driven, and intelligent solution that supports **continuous mentorship**, **dual-role engagement**, and **early conflict detection**, ultimately enhancing the overall mentorship experience for all stakeholders.

### **Key Features**

#### **Mentor-Mentee**

* Supports **dual-mentor assignments** (academic + industry).

#### **Progress Tracking**

* Each mentor-mentee pair (academic and industry) gets a shared digital space to:
  + Log meetings
  + Track milestone completions
* Enables **transparent accountability** and helps mentors monitor progress over time.
* The system will track student progress using quantifiable indicators such as attendance, assignment completion, and mentor engagement logs. These will serve as inputs for future ML-based risk predictions.

#### **Feedback Mechanism**

* Collected feedback feeds into **analytics models** to highlight.

#### **Conflict & Disengagement Detection**

* Employs **machine learning models** (e.g., Naive Bayes, Random Forest) to detect:
  + Missed meetings or unlogged sessions
  + Negative feedback sentiment
  + Scheduling conflicts between academic and work commitments
  + Reduced academic activity or low mentor engagement

#### **Administrative Dashboard**

* Program coordinators and academic administrators can:
  + Monitor system usage and engagement metrics
  + Identify at-risk students or ineffective mentor matches
  + Intervene early based on real-time data insights

### **Key Stakeholders**

* **Students** – Seek personalized academic and professional guidance while balancing university and work life.
* **Faculty Mentors** – Provide academic support, research supervision, and study tracking.
* **Industry Mentors** – Offer real-world exposure, soft skill development, and career coaching.
* **Program Administrators** – Oversee mentorship program health, engagement trends, and outcomes.

3.Literature Review

**Why Dual Mentorship Needs a Smarter Approach**

As more students balance **university education with industry roles**, they interact with two mentors—one academic and one professional. While this dual-mentorship model enhances real-world readiness, it also introduces challenges like **scheduling conflicts**, **misaligned expectations**, and **difficulty in tracking overall progress**.

Traditional mentorship practices—emails, spreadsheets, informal logs—are **fragmented, hard to scale, and reactive**. Without a centralized system, institutions often miss early signs of disengagement or conflict.

### **Gaps in Current Mentorship Solutions**

**Commercial platforms** (e.g., Chronus, Mentorloop) offer mentorship matching and communication tools but are geared toward corporate use. They lack:

* Support for **dual mentor structures**
* Academic data integration (e.g., attendance, assignment tracking)
* Predictive capabilities to identify issues early

**Manual systems** in academia are equally limited—inefficient, error-prone, and incapable of scaling. As noted by Crisp & Cruz (2009) and Eby et al. (2008), mentorship programs suffer when they lack structure, alignment, and continuous evaluation.

### **How AI/ML Can Transform Mentorship**

AI and machine learning enable **early detection and proactive support** in mentorship programs by:

* Analyzing **communication frequency** and **feedback sentiment**
* Predicting potential conflict using models like **Naive Bayes** and **Random Forest**
* Scoring engagement through task completion, surveys, and academic data

NLP tools can detect emotional tone in written feedback, while predictive models flag at-risk mentor-mentee pairs. Studies by Guo et al. (2019) and Sezer & Gurdal (2020) support these methods as effective in improving educational outcomes.

### **MMMS: A Data-Driven, Dual-Mentor Solution**

The **Mentorship Management and Monitoring System (MMMS)** fills a critical gap by offering:

* Unified tracking across both academic and industry mentorship
* Early conflict detection and intervention
* Personalized, data-informed support for students

By combining structured mentorship processes with AI analytics, MMMS supports a scalable, proactive, and student-centered approach to modern mentorship.

4. Creation of Synthetic Datasets

To effectively simulate the dual-mentorship environment, a collection of interconnected datasets was generated. This modular approach allows for a realistic representation of how different data points (e.g., academic performance, industry logs, meeting schedules) would be captured in a real-world system.

The following individual datasets were created as .csv files:

* **students.csv**: Contains profiles for 100 students, including their student\_id, name, email, course, and assigned academic\_mentor\_id and industry\_mentor\_id.
* **academic\_mentors.csv & industry\_mentors.csv**: These files contain profile information for 20 academic and 20 industry mentors, respectively, including their mentor\_id, name, and professional details (university or employer).
* **assignment.csv**: Tracks assignment submissions for each student, detailing the total assignments for their course, the number submitted, and a derived assignment\_grade (e.g., 'A1', 'B1', 'Fail').
* **academic\_progress.csv**: A log of each student's academic performance, including attendance percentage, the grade from the assignment.csv file, and the date of the last update.
* **industry\_progress.csv**: A log of each student's industry engagement, tracking their attendance and the number of projects they are involved in.
* **meetings.csv**: Records scheduled meetings between students and one of their mentors, capturing the meeting\_id, student\_id, mentor\_id, and date.
* **request.csv**: Logs special requests made by students, such as extensions or leave, detailing the reason and category (e.g., attendance, assignment).

#### **Master Dataset (master\_mmms.csv)**

The individual files were then merged into a single, denormalized **master dataset**. This file, master\_mmms.csv, consolidates all information for each student into a single row, providing a comprehensive view. This master file is the primary input for the data analysis and machine learning phases. It includes detailed information from student profiles, both mentor profiles, academic grades, industry logs, meeting details, and any special requests.

5. Database Schema Design

Based on the structure of the generated datasets, a relational database schema has been designed. A **PostgreSQL** database is proposed for its reliability and ability to enforce data integrity through relationships. The schema normalizes the data to reduce redundancy and ensure consistency.

The core tables in the schema are as follows:

* **Students Table**
  + student\_id (Primary Key)
  + name
  + email
  + course
  + current\_year
  + academic\_mentor\_id (Foreign Key)
  + industry\_mentor\_id (Foreign Key)
* **Mentors Table**
  + mentor\_id (Primary Key)
  + name
  + email
  + mentor\_type ('Academic' or 'Industry')
  + affiliation (University or Employer)
* **Assignments Table**
  + assignment\_id (Primary Key)
  + student\_id (Foreign Key)
  + total\_assignments
  + submitted\_assignments
  + assignment\_grade
* **Academic\_Progress Table**
  + academic\_progress\_id (Primary Key)
  + student\_id (Foreign Key)
  + attendance\_percentage
  + last\_update
* **Industry\_Progress Table**
  + industry\_id (Primary Key)
  + student\_id (Foreign Key)
  + attendance
  + project\_count
* **Meetings Table**
  + meeting\_id (Primary Key)
  + student\_id (Foreign Key)
  + mentor\_id (Foreign Key)
  + meeting\_date
* **Requests Table**
  + request\_id (Primary Key)
  + student\_id (Foreign Key)
  + reason
  + category