Database Final Report

Group:

05

Member:

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Main Idea

The application aims to analyze Formula 1 race performance and present detailed data on a user-friendly website. It serves F1 enthusiasts by providing race, driver, and circuit information, along with interactive features for data analysis and user engagement.

Data

The dataset contains comprehensive Formula 1 data from 1950 to 2024, organized into 17 tables, including details of circuits, drivers, constructors, races, and standings. All attributes include:

1. **Circuits Table:**

   Contains data about F1 circuits, including location details like latitude, longitude, and altitude.

   - circuits_id: Unique ID for each circuit.
   - circuit_ref: Circuit reference name.
   - circuit_name: Circuit name.
   - city: City or location of the circuit.
   - country: Country where the circuit is located.

- lat, lng: Latitude and longitude of the circuit.
- alt: Altitude of the circuit (in meters).
- wiki_url: Official URL of the circuit.

2. **Constructor Results Table:**

   Performance data of constructors per race, including points and status.

- constructor_result_id: Unique ID for constructor results.
- race_id: Refers to the specific race.
- constructor_id: Constructor's unique identifier.
- points: Points scored by the constructor in that race.
- status_of_result: Performance status (e.g., finished, retired).

3. **Constructor Standings Table:**

   Constructor rankings by points and wins.

- constructor_standings_id: Unique ID for standings.
- race_id: Refers to a particular race.
- Constructor_id: Constructor's unique identifier.
- points: Total points the constructor earned.
- position: Constructor's position in the standings.
- position_text: Text representation of position.
- wins: Number of race wins by the constructor.

4. **Pit Stops Table:**

   Information about pit stops during races, including duration.

- race_id: Refers to a specific race.
- driver_id: Driver's unique identifier.
- stop_num: Number of the pit stop.
- lap_num: Lap during which the pit stop occurred.
- time_of_pit_stop: Pit stop time.
- duration: Duration of the pit stop.
- milliseconds: Duration in milliseconds.

5. **Constructors Table:**

Basic details of constructors like nationality and names.

- constructor_id: Unique ID for the constructor.
- constructor_ref: Reference name for constructor.
- constructor_name: Constructor name.
- nationality: Constructor's nationality.
- wiki_url: Official URL of the constructor.

6. **Driver Standings Table:**

Drivers’ ranking data across races.

- driver_standings_id: Unique ID for the driver standings.
- race_id: Refers to a specific race.
- driver_id: Driver’s unique identifier.
- points: Total points the driver earned.
- position: Driver’s position in the standings.
- position_text: Text representation of position.
- wins: Number of race wins by the driver.

7. **Drivers Table:**

Personal information about drivers including nationality, date of birth, and code.

- driver_id: Unique ID for the driver.
- driver_ref: Reference name for the driver.
- driver_number: Driver’s car number.
- code: Driver’s code (short form).
- f_name: Driver’s first names.
- l_name: Driver’s last names.
- date_of_birth: Date of birth.
- nationality: Driver’s nationality.
- wiki_url: Official URL for more details on the driver.

8. **Lap Times Table:**

Details of lap times for drivers in each race.

- race_id: Refers to a specific race.
- driver_id: Driver’s unique identifier.
- lap_num: Lap number.
- position: Driver's position for the lap.
- finish_time: Lap time.
- finish_time_in_milliseconds: Lap time in milliseconds.

9. **Qualifying Table:**

Qualifying results for each driver per race.

- qualify_id: Unique ID for qualifying data.
- race_id: Refers to a specific race.
- driver_id: Driver’s unique identifier.
- constructor_id: Constructor’s unique identifier.
- car_num: Driver’s car number.
- position: Qualifying position.
- q1, q2, q3: Times for qualifying sessions 1, 2, and 3.

10. **Races Table:**

Information about races, including dates, circuits, and race names.

- race_id: Unique ID for the race.
- year_of_race: Year the race was held.
- round: Round number in the season.
- circuits_id: Refers to the circuit.
- circuit_name: Name of the race.
- race_date: Date of the race.
- race_time: Time the race started.
- wiki_url: Official race URL.
- fp1_date, fp1_time: Date and time of Free Practice 1.

- fp2_date, fp2_time: Date and time of Free Practice 2.
- fp3_date, fp3_time: Date and time of Free Practice 3.
- quali_date, quali_time: Date and time of qualifying.
- sprint_date, sprint_time: Date and time of sprint race.

11. **Sprint Results Table:**

    Results of sprint races, including fastest laps and positions.

- result_id: Unique ID for the sprint result.
- race_id: Refers to a specific sprint race.
- driver_id: Driver’s unique identifier.
- constructor_id: Constructor’s unique identifier.
- car_num: Driver’s car number.
- position_grid: Starting grid position for the sprint.
- position: Final position.
- position_text: Text for the position.
- position_order: Order of position.
- points: Points scored in the sprint.
- laps: Number of laps completed in the sprint.
- time: Finishing time.
- time_in_milliseconds: Time in milliseconds.
- fastest_lap: Number of the fastest lap.
- fastest_lap_time: Time for the fastest lap.
- status_id: Status of the driver.

12. **Results Table:**

    Detailed race results for each driver, including position, points, and laps.

- result_id: Unique ID for the result.
- race_id: Refers to a specific race.
- driver_id: Driver’s unique identifier.
- constructor_id: Constructor’s unique identifier.
- car_num: Driver’s car number.
- position_grid: Starting grid position.

- position: Finishing position.
- position_text: Text for the position.
- position_order: Order of position (numerical).
- points: Points scored in the race.
- laps: Number of laps completed.
- time: Finishing time.
- time_in_milliseconds: Time in milliseconds.
- fastest_lap: Number of the fastest lap.
- rank_of_fastest_lap: Rank for fastest lap.
- fastest_lap_time: Time for the fastest lap.
- fastest_lap_speed: Speed during the fastest lap.
- status_id: Status of the driver (finished, retired, etc.).

13. Seasons Table:

Seasons data, including year and corresponding URLs.

- year_of_race: Season year.
- wiki_url: Official URL for the season overview.

14. Status Table: Status codes for race outcomes such as "Finished" or "Retired."

- status_id: Unique ID for the status.
- status_name: Status description (e.g., "Finished," "Retired," etc.).

15. Users Table: Used to manage user accounts, facilitate login/logout operations, and associate user activity (like comments) with specific accounts.

- id: A unique identifier for each user.
- username: The name chosen by the user for their account. It must be unique for each user.
- password: A hashed and securely stored password to authenticate the user.

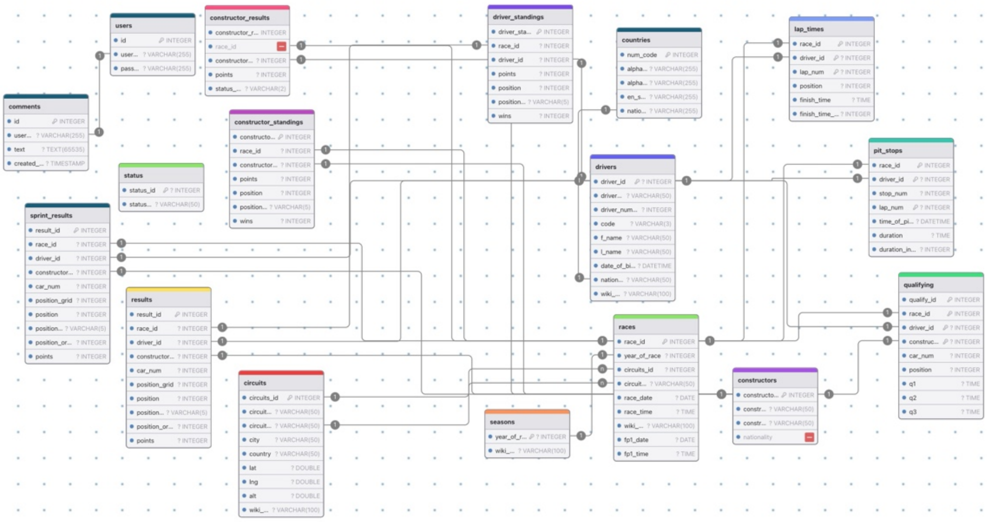
16. Comments Table: Enables users to share feedback, insights, or opinions about various aspects of Formula 1 data on the application.

- id: A unique identifier for each comment.

- username: Links the comment to the user who made it, referencing the username field in the Users table.
- text: The content of the comment provided by the user.
- created_at: A timestamp indicating when the comment was created.

17. countries Table: This table provides standardized information about countries, which could be used for attributes like race locations, driver nationalities, or constructor origins.

- num_code: A numeric code assigned to the country as per ISO standards.
- alpha_2_code: The two-letter country code (e.g., "US" for the United States).
- alpha_3_code: The three-letter country code (e.g., "USA" for the United States).
- en_short_name: The official English short name of the country.
- nationality: The term used to describe a person from that country (e.g., "American" for the United States).



Database

Database System Used

- Type: MySQL
  - Relational database management system (RDBMS) that is well-suited for structured data with relationships.
  - Supports ACID compliance, ensuring reliable transactions and data integrity.

Database Maintenance

1. Data Updates:

   - New data is inserted via CRUD operations.
   - Functions like 「insertDriver」 and 「insertResult」 allow real-time data addition.

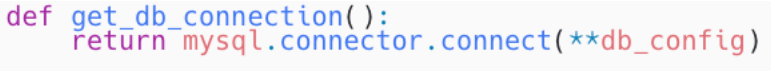
2. Data Deletion:

   - Outdated or erroneous entries can be deleted via functions like 「deleteDriver」.

Database Connection

1. Configuration:

   - 「db_config」 stores the connection details: host, user, password, and database name.
   - A reusable function 「get_db_connection()」 creates and returns a connection to the database using 「mysql.connector」.



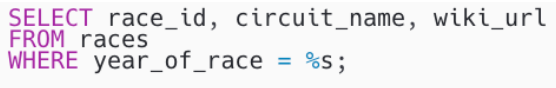
```
def get_db_connection():
    return mysql.connector.connect(**db_config)
```

2. Connection Lifecycle:

   - Connections are opened when executing queries and closed promptly afterward to avoid resource leakage.

Backend Query Processing

1. Example Query: To fetch race details:



```
SELECT race_id, circuit_name, wiki_url
FROM races
WHERE year_of_race = %s;
```

   - The parameterized query prevents SQL injection by using placeholders (%s) for user inputs.

2. Flow:

   - Input validation occurs at the application level.
   - Queries are executed using a cursor obtained from the database connection.

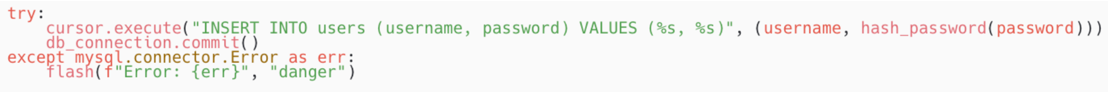
- Results are fetched and structured as Python dictionaries.

Exception Handling

1. Database Errors:

    - Common issues like missing data or unique constraint violations are caught using 「try-except」 blocks.

- Example:



```
try:
    cursor.execute("INSERT INTO users (username, password) VALUES (%s, %s)", (username, hash_password(password)))
    db_connection.commit()
except mysql.connector.Error as err:
    flash(f"Error: {err}", "danger")
```

2. Unexpected Inputs:

    - Missing or invalid inputs are handled gracefully.
    - Users are shown appropriate error messages (e.g., "All fields are required").

3. SQL Injection Prevention:

    - All queries use parameterized placeholders to prevent malicious input from being executed.

Graphical Representation

The flow from the frontend to the database is as follows:

1. Frontend: User actions (e.g., form submission, button clicks).

2. Backend:

    - Validates input.
    - Constructs parameterized SQL queries.
    - Executes queries using MySQL cursor.

3. Database:

    - Executes the query and returns results.

4. Frontend: Displays the results or error messages.

Application

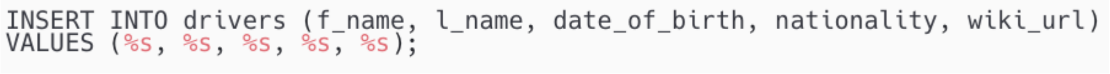
Interface

- Homepage: Displays recent comments and a list of countries.
- Login/Register: Secure user authentication with a user-friendly interface.
- Search Bar: Allows users to search drivers or races dynamically.
- Filter Controls: Enables filtering and sorting by attributes like nationality or race year.
- CRUD Buttons: Provide options to create, update, and delete data interactively.

Application Functions

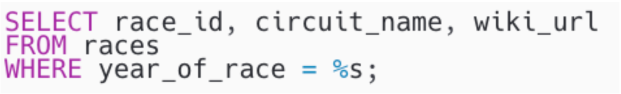
1. CRUD Implementation

1. Create:
    1. Function: insertDriver/ insertResult/ insertUser
    2. Adds a new driver to the database with required attributes.
    3. Query:

        ```
        INSERT INTO drivers (f_name, l_name, date_of_birth, nationality, wiki_url)
        VALUES (%s, %s, %s, %s, %s);
        ```

        - The query uses placeholders for secure and dynamic data insertion.
    4. Exception Handling:
        - Checks for missing fields.
        - Rolls back the transaction if an error occurs.
2. Read:
    - Function: getRace/ getDriver/ get_teams
    - Fetches details of races in a specific year.
    - Query:

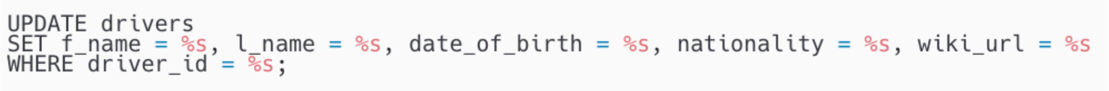
        

        ```
        SELECT race_id, circuit_name, wiki_url
        FROM races
        WHERE year_of_race = %s;
        ```

        - Filters results to improve performance by narrowing the scope using 『WHERE』.

    - Error Handling:
        - Returns an empty list if no races are found.

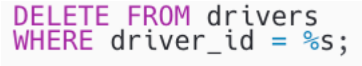
3. Update:
    - Function: modifyDriver
    - Updates details of a specific driver identified by `driver_id`.
    - Query:



```sql
UPDATE drivers
SET f_name = %s, l_name = %s, date_of_birth = %s, nationality = %s, wiki_url = %s
WHERE driver_id = %s;
```

        - Uses 「SET」 to modify specific columns.
        - The 「WHERE」 clause ensures only the targeted driver record is updated, preventing unintended modifications.
    - Error Handling:
        - Rolls back the transaction if any database error occurs.
        - Returns an error message if the provided `driver_id` does not exist or the query fails.

4. Delete:
    - Function: deleteDriver
    - Query:



```sql
DELETE FROM drivers
WHERE driver_id = %s;
```

        - Removes a driver by driver_id.
    - Error Handling:
        - Verifies the existence of the driver before deletion.
        - Prevents accidental deletions by using specific `WHERE` clauses.

2. Detailed Function Descriptions

1. Login/Authentication:

- Validates user credentials using hashed passwords.
- Maintains session state for logged-in users.

2. Driver Search:

- Dynamically builds SQL queries based on input parameters.

- Query:

  ```
  SELECT driver_id, f_name, l_name, date_of_birth, nationality, wiki_url
  FROM drivers
  WHERE LOWER(f_name) LIKE %s AND LOWER(l_name) LIKE %s;
  ```

  - Rationale: Allows flexible, case-insensitive searching.
- Exception Handling:
  - Ensures empty fields don’t cause errors.

3. **Race Details by Year:**
   - Fetches race details for a given year.
   - Returns data in JSON format for easy frontend integration.
4. **Comment System:**
   - Users can add comments linked to their accounts.
   - Query: `INSERT INTO comments (username, text) VALUES (%s, %s);`
     - Includes feedback for invalid input or missing session.
5. **Inspect Driver:**
   1. Fetches detailed information about a specific driver by 「driver_id」 and allows actions like modify or delete.
   2. Query:

      ```
      SELECT * FROM drivers WHERE driver_id = %s;
      ```

      - Rationale: Retrieves all driver details, ensuring precise identification using 「driver_id」.
      - Parameterized Query: Protects against SQL injection.
   3. Additional Actions:
      1. Delete Driver:
         - Rationale: Safely removes the driver identified by 「driver_id」.
         - Error Handling:
           - Rolls back the transaction if an error occurs and flashes an error message.
      2. Modify Driver:
         - Rationale: Allows updating specific details while maintaining data integrity.
         - Error Handling:
           - Checks if the driver exists (` if not driver`)

and provides user feedback if not found.

- Validates user inputs for modification, ensuring all fields are completed.
- Includes rollback mechanisms for transactional errors.

6. **Constructor/driver Ranking:**

- Functionality:
    - Fetches and ranks Formula 1 constructors based on their total points and wins.
- Query:

```sql
SELECT
    constructors.constructor_name,
    SUM(points) AS total_points,
    COUNT(wins) AS total_wins
FROM
    constructor_standings
JOIN
    constructors ON constructor_standings.constructor_id = constructors.constructor_id
GROUP BY
    constructor_standings.constructor_id
ORDER BY
    total_points DESC,   -- Ranks by total points first
    total_wins DESC;     -- Breaks ties using total wins
```

- Rationale:
    - Aggregates constructor performance metrics (`total_points` and `total_wins`) to determine rankings.
    - Prioritizes constructors with higher points and, in case of ties, uses the number of wins as a secondary ranking criterion.
- Dynamic Ranking:
    - Iterates through the query results and appends a `rank` field to each constructor, ensuring a user-friendly format.
- Exception Handling:
    - Catches database or query execution errors.
    - Returns an error response (`500 Internal Server Error`) with an appropriate message if the ranking data cannot be retrieved.

Others

1. Repository: GitHub

2. Project Video: YouTube

3. Progress: HackMD

- **the expected progress**

Deadline	Task	Notes
10/23	Final Project Proposal	
10/30	Organizing the data and designing the schema	
11/6	Finishing the basic sql, including create database and the table	
11/13	Finishing the function using on the website by mysql, including searching and filtering	
11/20	Designing the web page interface	
11/27	Finishing the webpage outlook	
12/4	Finishing the function of the website	
12/11	Finishing the final project report	

- **the actual progress**

2024/10/23 First discussion record

- Pick some candidates from kaggle
- Decide the topic of the final project
- Create some collaborative files
- Discuss workflow
- Finish final proposal

2024/11/05 Discussion record

- Finished SQL queries for creating tables

2024/11/13 Discussion record

- setup of website development
- Arrangement of the work

2024/11/25 Discussion record

- Complete the prototype of the website

2024/12/3 Discussion record

- Add GitHub action
- Add function to the website

2024/12/10 Discussion record

- Add function to the website

2024/12/26 Discussion record

- Add function to the website

2024/12/30 Discussion record

- Finish everything

- ## Challenges and Solutions

1. Exams and coursework
   - Challenge: There is no time pressure of mid-term and final weeks, so planning is too optimistic at the beginning.
   - Solution: Finish all the final exams and speed up the progress during the winter vacation.
2. Database Schema Complexity:
   - Challenge: Managing relationships between 14 tables, especially with foreign keys like status_id and nationality.
   - Solution: Used ER diagrams to visualize relationships and ensure consistency in schema design.
3. Frontend-Backend Integration:
   - Challenge: Ensuring seamless data flow and efficient rendering of filtered search results.
   - Solution: Optimized SQL queries and used AJAX calls for dynamic updates.
4. Error Handling:
   - Challenge: Preventing crashes due to unexpected inputs (e.g., missing or incorrect query parameters).

- Solution: Implemented detailed exception handling and validation for both frontend and backend inputs.

6. Reflection

1. Despite encountering challenges with the complexity of the dataset and ensuring smooth user interactions, the project achieved its major milestones.
2. The collaboration between team members significantly improved efficiency, with clear task delegation and regular updates via Trello.
3. The experience provided valuable insights into full-stack development, database management, and the importance of rigorous testing.

4. Team Contributions:

江宸安：查看賽車手跟賽事的頁面還有網頁的架構和登入註冊、create table 和選取特定車隊的車手、特定年份的賽事的 sql

林紹安：新增賽車手、新增賽事結果、國籍選單、一部份修改賽車手資料的功能

林瀚璿：網頁架構、顯示資料、條件篩選功能、留言欄

朱自中：選手的查詢、刪除、部分的修改資料、稍微整理 UI

賴雋樞：新增賽車手的 sql、確認最後功能 debug、做 report 和 slide