

# Submit design document (ERD, DDL, task division)

Group 11 - Pokemon Database  
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## 1 Conceptual & Logical Design

### a. Functional and non-functional requirements

*Functional requirements:*

- Store region details, including unique region names.
- Manage trainer information, including name and level, associated with a region.
- Track abilities for Pokemon, with unique ability names and descriptions.
- Record battle outcomes, linking Pokemon, trainers, and regions, with timestamps and winner identification.
- Support queries to retrieve trainers and their Pokemon by region or battle history.
- Target 89.9% database uptime.

*Functional requirements:*

- Ensure data consistency with unique constraints (e.g., region names, ability names) and referential integrity.
- Achieve query response times under 1 second for common operations (e.g., retrieving Pokemon by trainer).
- Support scalability for up to 5,000 trainers and 10,000 Pokemon.
- Ensure maintainability with clear schema definitions and documentation.
- Support queries to retrieve trainers and their Pokemon by region or battle history.
- Allow updates to trainer levels and Pokemon stats.

## b. Entity Relationship Diagram

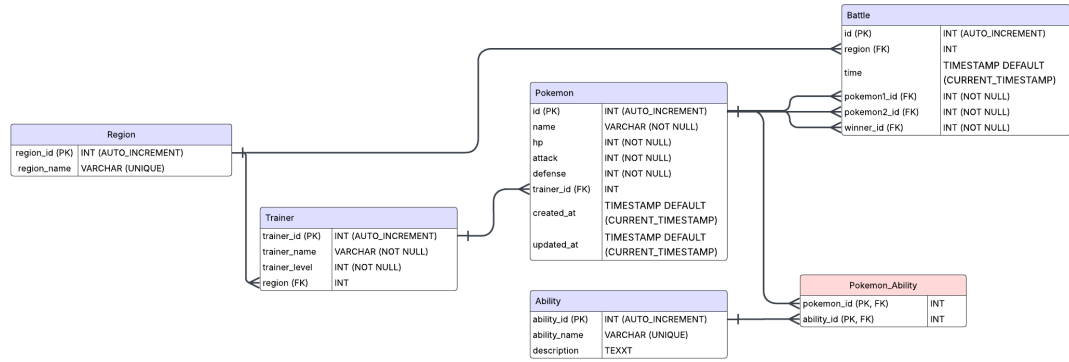


Figure 1: Pokemon entity relationship diagram

*Region:*

- One-to-many relationship with Trainer (one region can have many trainers)
- One-to-many relationship with Battle (one region can host many battles)

*Trainer:*

- Many-to-one relationship with Region (many trainers can be from one region)
- One-to-many relationship with Pokemon (one trainer can own many Pokemon)

*Ability:*

- Many-to-many relationship with Pokemon through Pokemon\_Ability junction table

*Pokemon:*

- Many-to-one relationship with Trainer (many Pokemon can be owned by one trainer)
- Many-to-many relationship with Ability through Pokemon\_Ability junction table
- One-to-many relationship with Battle (one Pokemon can participate in many battles)

*Battle:*

- Many-to-one relationship with Region (many battles can occur in one region)
- Many-to-one relationship with Pokemon for trainer1\_id, trainer2\_id, and winner\_id

### c. Normalization Proof up to Third Normal Form (3NF)

*First Normal Form:*

- All tables have a primary key
- No repeating groups
- All attributes are atomic

*Second Normal Form:*

- Non-key attributes depend fully on the primary key.
- Example: In Trainer, *trainer\_level* depends on *trainer\_id*, not a subset of a composite key.
- Junction table *Pokemon\_Ability* uses composite key (*id*, *ability\_id*) with no non-key attributes.

*Third Normal Form:*

- No transitive dependencies exist. Example: In Pokemon, hp, attack, etc., depend only on id, not on *trainer\_id*.
- Region table has *region\_name* dependent on *region\_id*, with no other dependencies.
- All tables are verified to have no transitive dependencies.

## 2 Physical Schema Definition

### a. Data Definition Language

```
-- Drop tables if they exist
DROP TABLE IF EXISTS Battle;
DROP TABLE IF EXISTS Pokemon_Ability;
DROP TABLE IF EXISTS Pokemon;
DROP TABLE IF EXISTS Ability;
DROP TABLE IF EXISTS Trainer;
DROP TABLE IF EXISTS Region;
```

```

-- Initialize tables
CREATE TABLE Region (
    region_id INT PRIMARY KEY AUTO_INCREMENT,
    region_name VARCHAR(100) UNIQUE NOT NULL
);

CREATE TABLE Trainer (
    trainer_id INT PRIMARY KEY AUTO_INCREMENT,
    trainer_name VARCHAR(100) NOT NULL,
    trainer_level INT NOT NULL CHECK (trainer_level >= 1),
    region_id INT,
    FOREIGN KEY (region_id) REFERENCES Region(region_id)
);

CREATE TABLE Ability (
    ability_id INT PRIMARY KEY AUTO_INCREMENT,
    ability_name VARCHAR(100) UNIQUE NOT NULL,
    description TEXT
);

CREATE TABLE Pokemon (
    id INT PRIMARY KEY AUTO_INCREMENT,
    name VARCHAR(100) NOT NULL UNIQUE,
    hp INT NOT NULL CHECK (hp >= 1),
    attack INT NOT NULL CHECK (attack >= 1),
    defense INT NOT NULL CHECK (defense >= 1),
    trainer_id INT,
    created_at TIMESTAMP DEFAULT CURRENT_TIMESTAMP,
    updated_at TIMESTAMP DEFAULT CURRENT_TIMESTAMP ON UPDATE
        CURRENT_TIMESTAMP,
    FOREIGN KEY (trainer_id) REFERENCES Trainer(trainer_id)
);

CREATE TABLE Pokemon_Ability (
    pokemon_id INT,
    ability_id INT,
    PRIMARY KEY (pokemon_id, ability_id),
    FOREIGN KEY (pokemon_id) REFERENCES Pokemon(id),
    FOREIGN KEY (ability_id) REFERENCES Ability(ability_id)
);

CREATE TABLE Battle (
    battle_id INT PRIMARY KEY AUTO_INCREMENT,
    battle_time TIMESTAMP DEFAULT CURRENT_TIMESTAMP,
    trainer1_id INT NOT NULL,
    trainer2_id INT NOT NULL,
    winner_id INT NOT NULL,
    region_id INT,
    FOREIGN KEY (trainer1_id) REFERENCES Pokemon(id),

```

```

FOREIGN KEY (trainer2_id) REFERENCES Pokemon(id),
FOREIGN KEY (winner_id) REFERENCES Pokemon(id),
FOREIGN KEY (region_id) REFERENCES Region(region_id),
CONSTRAINT CHK_Different_Pokemon CHECK (pokemon1_id != pokemon2_id),
CONSTRAINT CHK_Valid_Winner CHECK (winner_id IN (pokemon1_id,
pokemon2_id))
);

```

## b. Definitions of views, indexes, and any partitioning strategy

*Views:* Simplify retrieval of trainers, Pokémon, region, battle.

```

-- View for Pokemon with their trainers and regions
CREATE VIEW v_pokemon_details AS
SELECT
    p.id,
    p.name AS pokemon_name,
    p.hp,
    p.attack,
    p.defense,
    t.trainer_id,
    t.trainer_name,
    t.trainer_level,
    r.region_id,
    r.region_name
FROM
    Pokemon p
LEFT JOIN
    Trainer t ON p.trainer_id = t.trainer_id
LEFT JOIN
    Region r ON t.region_id = r.region_id;

-- View for Pokemon with their abilities
CREATE VIEW v_pokemon_abilities AS
SELECT
    p.id,
    p.name AS pokemon_name,
    GROUP_CONCAT(a.ability_name SEPARATOR ', ') AS abilities
FROM
    Pokemon p
LEFT JOIN
    Pokemon_Ability pa ON p.id = pa.pokemon_id
LEFT JOIN
    Ability a ON pa.ability_id = a.ability_id
GROUP BY
    p.id, p.name;

-- View for Battle details

```

```

CREATE VIEW v_battle_details AS
SELECT
    b.battle_id,
    b.battle_time,
    p1.name AS pokemon1_name,
    p2.name AS pokemon2_name,
    pw.name AS winner_name,
    r.region_name,
    t1.trainer_name AS trainer1_name,
    t2.trainer_name AS trainer2_name
FROM
    Battle b
JOIN
    Pokemon p1 ON b.trainer1_id = p1.id
JOIN
    Pokemon p2 ON b.trainer2_id = p2.id
JOIN
    Pokemon pw ON b.winner_id = pw.id
LEFT JOIN
    Region r ON b.region_id = r.region_id
LEFT JOIN
    Trainer t1 ON p1.trainer_id = t1.trainer_id
LEFT JOIN
    Trainer t2 ON p2.trainer_id = t2.trainer_id;

-- View for Region statistics
CREATE VIEW v_region_stats AS
SELECT
    r.region_id,
    r.region_name,
    COUNT(DISTINCT t.trainer_id) AS trainer_count,
    COUNT(DISTINCT p.id) AS pokemon_count,
    COUNT(DISTINCT b.battle_id) AS battle_count
FROM
    Region r
LEFT JOIN
    Trainer t ON r.region_id = t.region_id
LEFT JOIN
    Pokemon p ON t.trainer_id = p.trainer_id
LEFT JOIN
    Battle b ON r.region_id = b.region_id
GROUP BY
    r.region_id, r.region_name;

```

*Indexes:* Enhance performance for searches.

```

-- Indexes for Region table
CREATE INDEX idx_region_name ON Region(region_name);

-- Indexes for Trainer table

```

```

CREATE INDEX idx_trainer_name ON Trainer(trainer_name);
CREATE INDEX idx_trainer_region ON Trainer(region_id);

-- Indexes for Ability table
CREATE INDEX idx_ability_name ON Ability(ability_name);

-- Indexes for Pokemon table
CREATE INDEX idx_pokemon_name ON Pokemon(name);
CREATE INDEX idx_pokemon_trainer ON Pokemon(trainer_id);
CREATE INDEX idx_pokemon_stats ON Pokemon(hp, attack, defense);

-- Indexes for Battle table
CREATE INDEX idx_battle_region ON Battle(region_id);
CREATE INDEX idx_battle_pokemon1 ON Battle(trainer1_id);
CREATE INDEX idx_battle_pokemon2 ON Battle(trainer2_id);
CREATE INDEX idx_battle_winner ON Battle(winner_id);
CREATE INDEX idx_battle_time ON Battle(battle_time);

```

*Strategy:* Battles are time-sensitive queries, and partitioning improves performance for historical data analysis.

```

ALTER TABLE Battle
PARTITION BY RANGE (UNIX_TIMESTAMP(battle_time)) (
    PARTITION p0 VALUES LESS THAN (UNIX_TIMESTAMP('2024-01-01 00:00:00'))
    ,
    PARTITION p1 VALUES LESS THAN (UNIX_TIMESTAMP('2025-01-01 00:00:00'))
    ,
    PARTITION p2 VALUES LESS THAN (UNIX_TIMESTAMP('2026-01-01 00:00:00'))
    ,
    PARTITION p3 VALUES LESS THAN (UNIX_TIMESTAMP('2027-01-01 00:00:00'))
    ,
    PARTITION p4 VALUES LESS THAN MAXVALUE
);

```

### 3 Task Division & Project Plan

#### a. Task Division - Pham Minh Hieu, Cao Lam Huy

##### Planning and Requirements

- Clarify requirements for the Pokémon database web app – *Hieu*
- Design application structure – *Huy*
- Write README.md – *Hieu, Huy*

## Application Setup

– *Hieu, Huy*

- Create Flask application structure
- Set up MySQL database connection
- Create database schema, data definition language, entity relation diagram
- Set up virtual environment and install dependencies

## Database Models

– *Hieu*

- Implement Region model
- Implement Trainer model
- Implement Ability model
- Implement Pokémon model
- Implement `Pokemon.Ability` relationship model
- Implement Battle model

## Core Features

– *Hieu*

- Implement CRUD operations for Region
- Implement CRUD operations for Trainer
- Implement CRUD operations for Ability
- Implement CRUD operations for Pokémon
- Implement CRUD operations for `Pokemon.Ability` relationships
- Implement CRUD operations for Battle

## Frontend

– *Huy*

- Create base templates and layout
- Implement Region management pages
- Implement Trainer management pages



- Implement Ability management pages
- Implement Pokémon management pages
- Implement Battle management pages
- Add search functionality for all entities

## Testing

– *Hieu, Huy*

- Test database connections and models
- Test CRUD operations for all entities
- Test search functionality
- Perform end-to-end testing

## Deployment

– *Huy*

- Prepare application for deployment
- Create final documentation
- Package and deliver the application to the user

## b. Timeline/Gantt chart

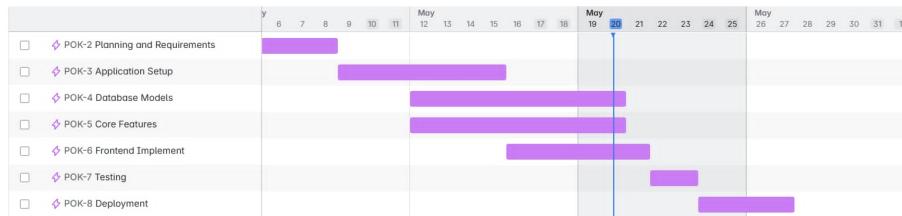


Figure 2: Timeline

## 4 Supporting Document

### a. Database Decision Rationale

*Separation of Region and Trainer Entities:*

- Separating regions from trainers allows for better data organization and reduces redundancy. Multiple trainers can be from the same region, and this design allows for region-based queries and statistics.
- Including region as an attribute of Trainer would have simplified the schema but would have led to data redundancy and made it difficult to maintain region consistency.

*Pokemon-Ability Many-to-Many Relationship:*

- Using a junction table (*Pokemon\_Ability*) allows Pokemon to have multiple abilities and abilities to be shared among multiple Pokemon, reflecting the real-world relationship in the Pokemon universe.
- Limiting Pokemon to a single ability would have simplified the schema but would not have accurately represented the domain.

*Timestamps for Pokemon:*

- Including *created\_at* and *updated\_at* timestamps allows for tracking when Pokemon are added and modified, which can be useful for auditing and sorting.
- Omitting timestamps would have simplified the schema but would have limited the ability to track changes over time.

*Foreign Key Relationships:*

- *ON DELETE SET NULL* vs *CASCADE*: For *trainer\_id* in *Pokemon* and *region\_id* in *Trainer/Battle*, we use *ON DELETE SET NULL* to preserve *Pokemon* and *Trainer* records when their parent entities are deleted. For battle participants and *Pokemon\_Ability* relationships, we use *ON DELETE CASCADE* since these relationships don't make sense without both entities.
- Direct *Pokemon* References in *Battle*: The *Battle* table references *Pokemon* directly (rather than *Trainers*) to simplify battle recording and querying. This design choice prioritizes data integrity and query performance over complex relationship modeling.

### b. Sample data loading

## Data Generation

```
import random
from faker import Faker
import pandas as pd

fake = Faker()

# Generate trainers
trainers = []
for i in range(30):
    trainers.append({
        'trainer_name': fake.name(),
        'trainer_level': random.randint(5, 50),
        'region_id': random.randint(1, 8)
    })

# Generate Pokemon
pokemon = []
for i in range(100):
    pokemon.append({
        'name': f"{fake.word().capitalize()}{fake.word().capitalize()}",
        'hp': random.randint(30, 150),
        'attack': random.randint(20, 130),
        'defense': random.randint(20, 130),
        'trainer_id': random.randint(1, 30) if random.random() > 0.1 else None
    })

# Export to CSV
pd.DataFrame(trainers).to_csv('trainers.csv', index=False)
pd.DataFrame(pokemon).to_csv('pokemon.csv', index=False)
```

## CSV Import

```
LOAD DATA INFILE 'trainers.csv'
INTO TABLE Trainer
FIELDS TERMINATED BY ','
ENCLOSED BY '"'
LINES TERMINATED BY '\n'
IGNORE 1 ROWS
(trainer_name, trainer_level, region_id);

LOAD DATA INFILE 'pokemon.csv'
INTO TABLE Pokemon
FIELDS TERMINATED BY ','
ENCLOSED BY '"'
```

```
LINES TERMINATED BY '\n'  
IGNORE 1 ROWS  
(name, hp, attack, defense, trainer_id);
```

### Data Integrity Considerations

- Foreign Key Constraints: All data loading will respect foreign key constraints, loading parent tables before child tables.
- Unique Constraints: Scripts will check for and handle potential duplicate entries, especially for Pokemon and ability names.
- Realistic Relationships:
  - Most trainers will have 1-6 Pokemon (standard team size in Pokemon games)
  - Pokemon will have 1-4 abilities
  - Battles will only occur between Pokemon that exist in the database
- Data Validation:
  - Pokemon stats will be within reasonable ranges
  - Trainer levels will follow game progression logic
  - Battle winners will be one of the participating Pokemon