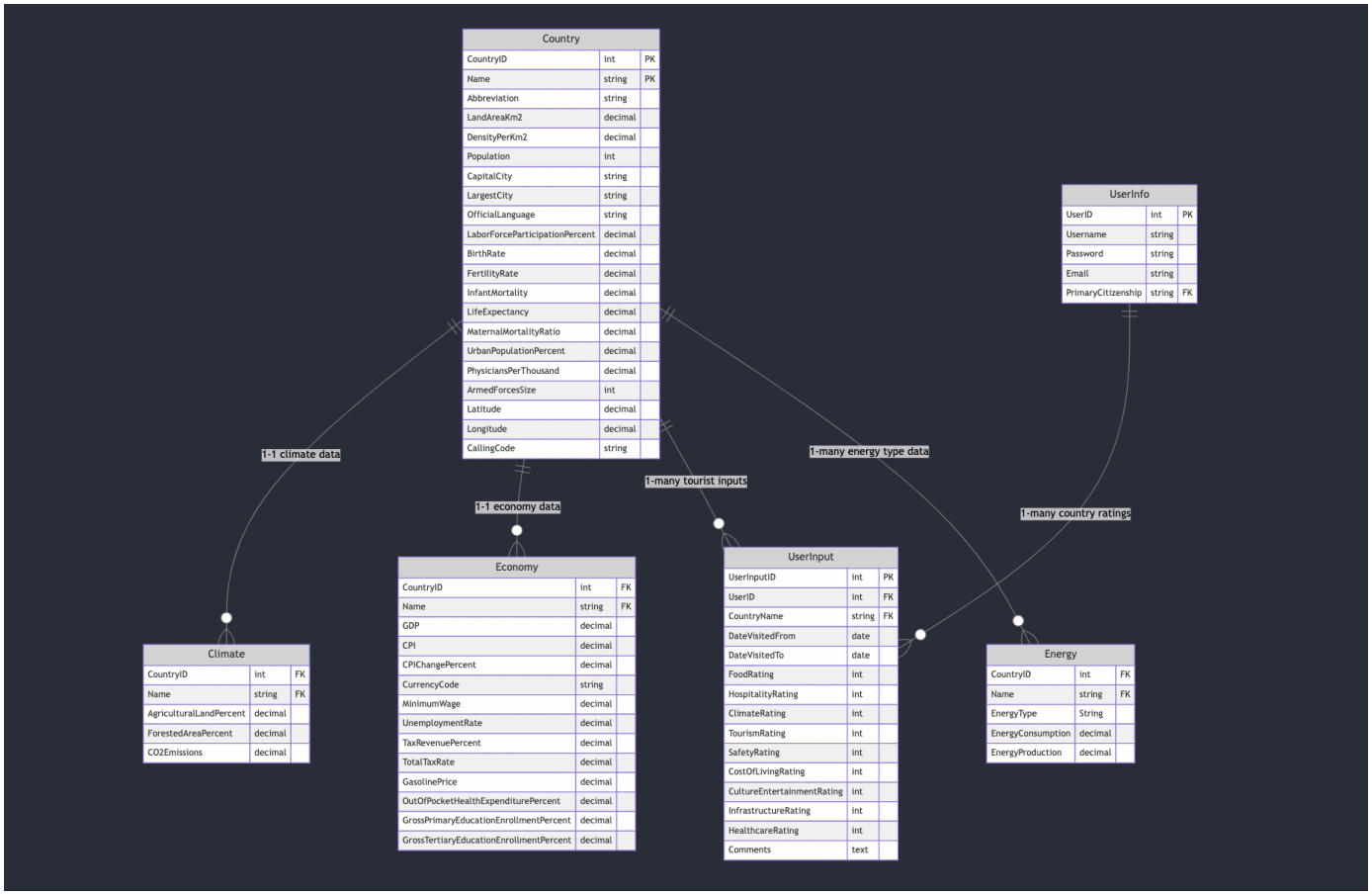
Country Pollution App Conceptual and Logical Database Design

Entity-Relationship Diagram (ERD)



ER Diagram Description

The Entity-Relationship Diagram (ERD) for the Country Pollution App consists of six entities:

1. **Country**
2. **Climate**
3. **Economy**
4. **Energy**
5. **UserInfo**
6. **UserInput**

There are 5 total relationships between these entities (between 2 types):

- **Country** has a **1-to-1** relationship with **Climate**.
- **Country** has a **1-to-1** relationship with **Economy**.
- **Country** has a **1-to-many** relationship with **Energy**.
- **UserInfo** has a **1-to-many** relationship with **UserInput**.
- **Country** has a **1-to-many** relationship with **UserInput**.

Assumptions and Explanations

1. Country

- **Assumptions:**
  - Each country is uniquely identified by a CountryID.
  - A country's Name is also unique and can serve as another primary key.
  - Attributes like Population, CapitalCity, and OfficialLanguage are properties that describe the demographics and geographic information about the country.
- **Explanation:**
  - The Country entity is central to the application as it represents the primary subject of analysis.
  - We modeled Country as an entity to encapsulate all country-specific data in one place.
  - Attributes are chosen based on the need to provide comprehensive information about each country.

2. Climate

- **Assumptions:**
  - Each country has one set of climate data.
  - Climate data includes metrics like AgriculturalLandPercent, ForestedAreaPercent, and CO2Emissions.
- **Explanation:**
  - Climate is modeled as a separate entity to manage the most up-to-date climate-related attributes, which are substantial and may change over time.
  - The 1-to-1 relationship with Country reflects that each country has a unique climate profile.

3. Economy

- **Assumptions:**
  - Each country has one set of economic data.
  - Economic data includes indicators like GDP, CPI, and UnemploymentRate.
- **Explanation:**
  - Similar to Climate, Economy is a separate entity to handle economic attributes efficiently.
  - The 1-to-1 relationship ensures that each country's economic data is directly linked to it.

4. Energy

- **Assumptions:**
  - A country can have multiple energy sources (natural gas, coal, solar, hydro, etc.).
  - Each energy source has specific data like EnergyType, EnergyConsumption, and EnergyProduction.
- **Explanation:**
  - Energy is modeled as an entity to accommodate multiple energy records per country.
  - This design avoids data redundancy and allows for detailed energy data management.
  - The 1-to-many relationship with Country signifies that a country can have multiple energy types.

5. UserInfo

- **Assumptions:**
  - Each user is uniquely identified by a UserID.
  - Users have attributes like Username, Email, and PrimaryCitizenship.
- **Explanation:**
  - UserInfo is the sole entity representing user accounts, adhering to the project requirement of having at most one user entity.
  - It stores essential user information for authentication and personalization.

6. UserInput

- **Assumptions:**
  - Users can provide multiple inputs or ratings for different countries.
  - Each input includes ratings on various aspects like FoodRating, SafetyRating, and Comments.
- **Explanation:**
  - UserInput captures user-generated content, crucial for the application's interactive features.
  - The 1-to-many relationship with UserInfo allows users to submit multiple inputs.
  - The 1-to-many relationship with Country enables aggregation of inputs for each country.

Relationships and Cardinality

Country to Climate (1-to-1)

- **Assumptions:**
  - Each country has one unique set of climate data.
- **Explanation:**
  - This relationship ensures that climate data is directly associated with its respective country without duplication.

Country to Economy (1-to-1)

- **Assumptions:**
  - Each country has one unique set of economic data.
- **Explanation:**
  - Economic data is specific to a country and doesn't vary per user, justifying the 1-to-1 relationship.

Country to Energy (1-to-many)

- **Assumptions:**
  - A country can have multiple energy sources.
- **Explanation:**
  - The 1-to-many relationship allows for multiple energy records (different energy types) linked to a single country.

UserInfo to UserInput (1-to-many)

- **Assumptions:**
  - A user can submit multiple inputs for the same or different countries.
- **Explanation:**
  - This relationship enables users to provide numerous ratings and feedback entries over time.

Country to UserInput (1-to-many)

- **Assumptions:**
  - A country can have multiple inputs from different users.
- **Explanation:**
  - Aggregates user inputs for a country, facilitating collective analysis and display of user feedback.

Normalization

First Normal Form (1NF)

- **All attributes are atomic:**
  - Each field contains only indivisible values.
  - There are no repeating groups or arrays.

Second Normal Form (2NF)

- **All entities meet 1NF.**
- **Non-key attributes are fully functionally dependent on the primary key:**
  - **Country:** All attributes depend solely on CountryID.
  - **Climate:** Attributes depend on CountryID.

    - **Economy:** Attributes depend on CountryID.
    - **Energy:** Attributes depend on the composite key (CountryID, EnergyType).
    - **UserInfo:** Attributes depend on UserID.
    - **UserInput:** Attributes depend on UserInputID.

Third Normal Form (3NF)

- **No transitive dependencies exist:**
    - All attributes are dependent only on the primary key, not on other non-key attributes.

Boyce-Codd Normal Form (BCNF)

- **Every determinant is a candidate key:**
    - The schema adheres to BCNF as all functional dependencies have determinants that are superkeys.

Relational Schema

Country

```
Country(
   CountryID: INT [PK],
   Name: VARCHAR(100),
   Abbreviation: VARCHAR(10),
   LandAreaKm2: DECIMAL,
   DensityPerKm2: DECIMAL,
   Population: INT,
   CapitalCity: VARCHAR(100),
   LargestCity: VARCHAR(100),
   OfficialLanguage: VARCHAR(100),
   LaborForceParticipationPercent: DECIMAL,
   BirthRate: DECIMAL,
   FertilityRate: DECIMAL,
   InfantMortality: DECIMAL,
   LifeExpectancy: DECIMAL,
   MaternalMortalityRatio: DECIMAL,
   UrbanPopulationPercent: DECIMAL,
   PhysiciansPerThousand: DECIMAL,
   ArmedForcesSize: INT,
   Latitude: DECIMAL,
   Longitude: DECIMAL,
   CallingCode: VARCHAR(10)
)
```

Climate

Climate(
  CountryID: INT [PK, FK to Country.CountryID],
  AgriculturalLandPercent: DECIMAL,
  ForestedAreaPercent: DECIMAL,
  CO2Emissions: DECIMAL
)

Economy

Economy(
  CountryID: INT [PK, FK to Country.CountryID],
  GDP: DECIMAL,
  CPI: DECIMAL,
  CPIChangePercent: DECIMAL,
  CurrencyCode: VARCHAR(10),
  MinimumWage: DECIMAL,
  UnemploymentRate: DECIMAL,
  TaxRevenuePercent: DECIMAL,
  TotalTaxRate: DECIMAL,
  GasolinePrice: DECIMAL,
  OutOfPocketHealthExpenditurePercent: DECIMAL,
  GrossPrimaryEducationEnrollmentPercent: DECIMAL,
  GrossTertiaryEducationEnrollmentPercent: DECIMAL
)

Energy

Energy(
  CountryID: INT [FK to Country.CountryID],
  EnergyType: VARCHAR(50),
  EnergyConsumption: DECIMAL,
  EnergyProduction: DECIMAL,
  [PK: CountryID, EnergyType]
)

UserInfo

UserInfo(
  UserID: INT [PK],
  Username: VARCHAR(50),
  Password: VARCHAR(50),

Email: VARCHAR(100),
PrimaryCitizenshipID: INT [FK to Country.CountryID]
)

UserInput

UserInput(
UserInputID: INT [PK],
UserID: INT [FK to UserInfo.UserID],
CountryID: INT [FK to Country.CountryID],
DateVisitedFrom: DATE,
DateVisitedTo: DATE,
FoodRating: INT,
HospitalityRating: INT,
ClimateRating: INT,
TourismRating: INT,
SafetyRating: INT,
CostOfLivingRating: INT,
CultureEntertainmentRating: INT,
InfrastructureRating: INT,
HealthcareRating: INT,
Comments: TEXT
)

Summary

- **Entities:** The database includes six entities—Country, Climate, Economy, Energy, UserInfo, and UserInput—each serving a specific purpose in the application.
- **Relationships:** The schema includes various relationships with cardinalities such as 1-to-1 and 1-to-many, satisfying the requirement of having at least two types of relationships.
- **Normalization:** The database schema is normalized to BCNF, ensuring minimal redundancy and optimal data integrity.
- **Relational Schema:** The logical design translates the conceptual ERD into a relational schema, formatted as per the specified guidelines.