Web Application for Quantifying Carbon Footprint in Indian Coal Mines Using MERN Stack

Objectives:

- Quantify carbon emissions from coal mining activities.
- Estimate carbon sinks and calculate gaps.
- Provide pathways to achieve carbon neutrality.

Features:

- Emission Estimation Module
- Carbon Neutrality Pathways Module
- Data Visualization
- Scalability for different mine sizes and types.

Technologies:

Frontend Development

- **Technologies**: React.js, Redux (for state management), Chart.js/D3.js (for data visualization)
- **Components**:
    - **Dashboard**: Overview of carbon footprint, emission trends, and pathways to neutrality.
    - **Data Input Forms**: Forms for users to input mining activity data (e.g., equipment usage, excavation volumes).
    - **Results Visualization**: Charts/graphs to display emission estimates, carbon sinks, and potential reduction strategies.
    - **Pathway Simulator**: UI to simulate different carbon neutrality strategies (clean technologies, afforestation, etc.).

3. Backend Development

- **Technologies**: Node.js, Express.js
- **API Endpoints**:
    - **/api/emission-calculate**: Calculate carbon emissions based on input data.
    - **/api/carbon-sink**: Estimate current carbon sinks based on land area and tree density.
    - **/api/pathways**: Provide pathways for carbon neutrality based on user input and simulation data.
    - **/api/carbon-credits**: Estimate potential carbon credits based on emission reduction and market rates.

Algorithms:

- **Emission Estimation**:
  - Formula: `Total Emissions = ∑ (Activity Data × Emission Factor)`
  - **Activity Data**: Input from users about mining activities (e.g., diesel consumption, electricity usage).
  - **Emission Factors**: Pre-defined constants based on established guidelines for each activity.
- **Carbon Sink Estimation**:
  - Formula: `Carbon Sequestration = Area of Land × Tree Density × Sequestration Rate`
  - **Sequestration Rate**: Pre-defined values based on tree species and age.
- **Carbon Neutrality Pathways**:
  - **Clean Technologies**: Calculate emission reduction from electric vehicles, methane capture, etc.
  - **Afforestation**: Estimate land required for offsetting emissions through tree planting.
  - **Alternative Energy**: Assess the impact of using renewable energy (solar, wind) on emissions.

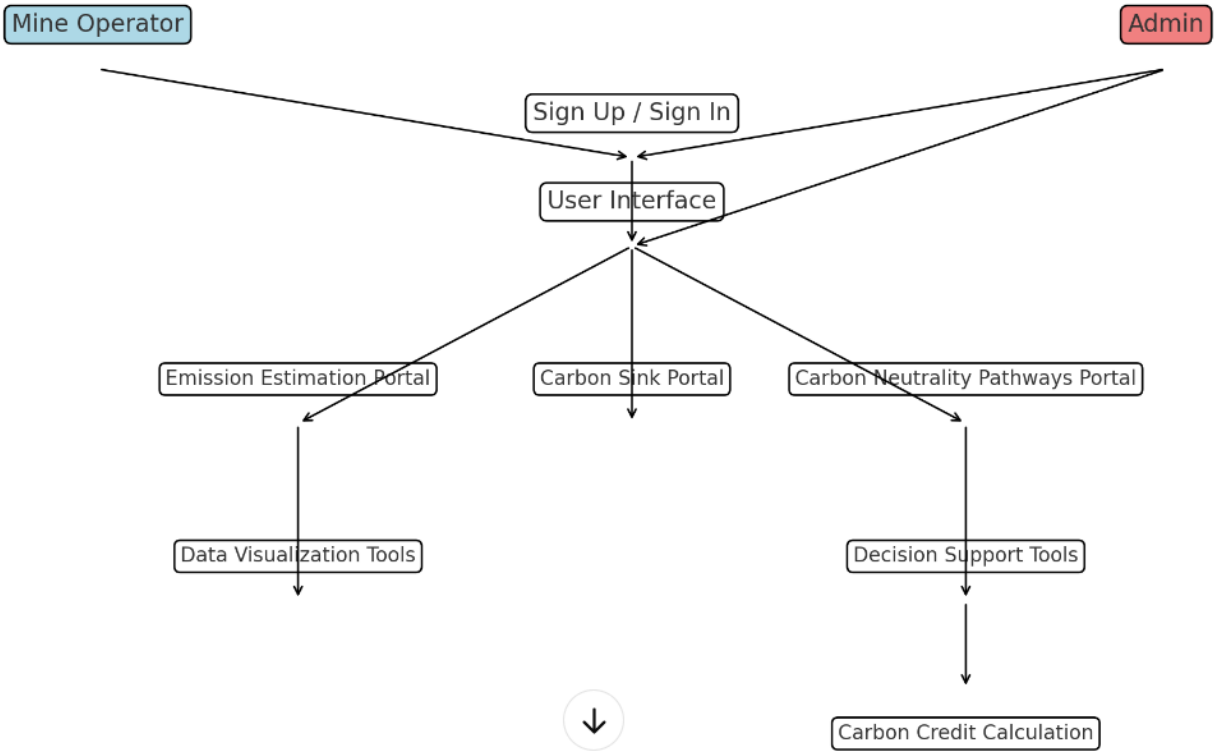
Database Structure

- **Technologies**: MongoDB
- **Schema Design**:
  - **Mines Collection**:
    - `mineId`: Unique identifier
    - `mineType`: Underground or Open-cast
    - `location`: Geographical data
    - `size`: Size of the mine (small, medium, large)
  - **Emissions Collection**:
    - `emissionId`: Unique identifier
    - `mineId`: Reference to Mines collection
    - `activityType`: Type of activity (excavation, transportation, etc.)
    - `activityData`: Data specific to the activity
    - `emissionValue`: Calculated emission
  - **CarbonSinks Collection**:
    - `sinkId`: Unique identifier
    - `mineId`: Reference to Mines collection
    - `landArea`: Area of land available for afforestation
    - `treeDensity`: Number of trees per unit area
    - `sequestrationRate`: Carbon absorption rate
  - **Pathways Collection**:
    - `pathwayId`: Unique identifier
    - `mineId`: Reference to Mines collection

- `strategy`: Type of strategy (clean tech, afforestation, etc.)
- `potentialReduction`: Estimated emission reduction

Layout for Carbon Footprint Application

1. **Top Layer: User Roles**
   - **Mine Operator (User Role)**: Positioned similarly to the "Student" and "Mentor" roles in your provided diagram.
   - **Admin**: Another role, similar to the admin in the provided diagram, responsible for managing the system.
2. **Second Layer: Access Points**
   - **Sign Up/Sign In**: Entry point for users to access the application, just like in your example.
3. **Third Layer: Main Interface**
   - **User Interface**: The main UI for interacting with the system after login.
4. **Fourth Layer: Functional Portals**
   - **Emission Estimation Portal**: Allows users to input data related to mining activities and get emission estimates.
   - **Carbon Sink Portal**: Users input data about existing carbon sinks and land areas.
   - **Carbon Neutrality Pathways Portal**: Simulates different strategies and pathways towards carbon neutrality.
5. **Fifth Layer: Analytical Tools**
   - **Data Visualization Tools**: Similar to "AI Chatbot" in your diagram, this box would show visual charts/graphs.
   - **Decision Support Tools**: A box for automated report generation and decision-making support.
6. **Admin Tasks**
   - **Management and Reporting**: Admin oversees the entire process and handles the reporting and system management tasks.
7. **Monetization Options**
   - **Carbon Credit Calculation**: Option for users to calculate potential carbon credits.


Mine Operator
Admin
Sign Up / Sign In
User Interface
Emission Estimation Portal
Carbon Sink Portal
Carbon Neutrality Pathways Portal
Data Visualization Tools
Decision Support Tools
Carbon Credit Calculation