Sustainable Smart City Assistant Using IBM Granite LLM

Project Documentation

1. Introduction

- **Project Title:** Sustainable Smart City Assistant Using IBM Granite LLM
- **Team Members:**
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  - Member 2: Ariharan R
  - Member 3: Gangeshwaran M
  - Member 4: Hariharasudhan S

Introduction:

The rise of climate change, pollution, and unsustainable practices has created an urgent need for **eco-conscious technologies**. At the same time, governments are publishing lengthy policy documents that are often inaccessible to citizens due to their complexity. This creates a gap between **policy makers** and **citizens**, making it difficult to translate sustainability goals into practical action.

The **Eco Assistant & Policy Analyzer** project leverages **Artificial Intelligence (AI)** and **Large Language Models (LLMs)** to address these issues. It has two main objectives:

1. Help **individuals and communities** adopt sustainable practices through **AI-generated eco tips**.
2. Help **citizens, researchers, and policymakers** understand lengthy environmental and governance-related policies by generating **summaries with key points and implications**.

By combining **natural language processing, summarization, and real-time AI interaction**, the system bridges the gap between **policy creation and public understanding**, empowering individuals and governments to collaborate on sustainability goals.

2. Project Overview

Purpose

- Assist users in understanding complex policy documents through AI-driven summarization.
- Generate practical eco-friendly solutions for everyday problems.
- Promote sustainability awareness and eco-friendly decision-making.

Objectives

1. Build an **intelligent assistant** that can provide eco-tips on demand.
2. Enable **policy simplification** through AI-based summarization.

3. Provide an easy-to-use **interactive web interface** for non-technical users.
4. Support **education and awareness** in both environmental studies and public administration.

Features

1. **Eco Tips Generator**
    - *Key Point:* Practical guidance for sustainability
    - *Functionality:* Generates actionable eco tips for given environmental keywords (e.g., *plastic waste, solar energy, water saving*).
    - *Example:* If user inputs "plastic", system might suggest:
        - Replace single-use plastics with biodegradable alternatives
        - Use cloth bags instead of plastic shopping bags
2. **Policy Summarization**
    - *Key Point:* Simplified understanding of lengthy policies
    - *Functionality:* Summarizes uploaded PDF policies or text-based input into short, clear summaries with key provisions and implications.
    - *Example:* Uploading a 50-page water conservation policy results in a 1-page concise summary with the main objectives, challenges, and citizen duties.
3. **PDF Processing**
    - *Key Point:* Automated document handling
    - *Functionality:* Extracts raw text from PDFs using **PyPDF2**, enabling AI-based summarization without manual copy-pasting.
4. **Gradio Web Interface**
    - *Key Point:* Accessibility for all users
    - *Functionality:* Provides a tab-based interactive platform where users can:
        - Enter keywords for eco tips
        - Upload/paste policies for summarization
        - Receive outputs in real-time

3. Architecture

The project follows a **modular architecture** with clear separation between frontend and backend.

Frontend (Gradio)

- Built using gr.Blocks() for modular UI design
- Provides tab-based navigation
- Handles:
    - File upload (PDFs)
    - Textbox inputs (keywords, policies)
    - Real-time AI outputs

Backend (Hugging Face Transformers + PyTorch)

- Uses the **ibm-granite/granite-3.2-2b-instruct** model
- Handles both summarization and text generation tasks
- Leverages **GPU acceleration in Google Colab** for faster inference

PDF Processing (PyPDF2)

- Extracts plain text from uploaded policy PDFs
- Handles multi-page documents

Core Modules

- generate_response() → Core AI inference function
- extract_text_from_pdf() → Extracts text from PDFs
- eco_tips_generator() → Generates sustainability tips
- policy_summarization() → Produces simplified summaries

Data Flow Diagram

1. **Input** → User uploads PDF / enters keywords or text
2. **Preprocessing** → Tokenization / text extraction
3. **Model Processing** → IBM Granite model generates tips/summaries
4. **Output** → Gradio UI displays results

4. Setup Instructions

Prerequisites

- **Platform:** Google Colab or local Python environment
- **Python:** 3.9+
- **Libraries Required:**
- pip install gradio torch transformers PyPDF2

Installation Steps (Google Colab)

1. Open Google Colab notebook
2. Copy-paste the full project code
3. Run the notebook → Installs dependencies and loads the model
4. Gradio generates a **public link**
5. Open the link in your browser and use the app

5. Folder Structure

eco-assistant/

├── app.ipynb # Main project notebook (Colab)

├── requirements.txt # Optional dependency list

├── README.md # Documentation

├── /data # Optional folder for sample PDFs

6. Running the Application

1. Run the Colab notebook
2. Wait for model initialization (~500MB download)
3. Gradio launches with a **shareable link**
4. Navigate tabs:
    - **Eco Tips Generator:** Enter keywords → AI generates sustainability tips
    - **Policy Summarization:** Upload PDF or paste text → AI produces a concise summary

7. API Documentation (Internal Functions)

- **generate_response(prompt, max_length)**
    - Input: Prompt string
    - Output: AI-generated text response
- **extract_text_from_pdf(pdf_file)**
    - Input: PDF file
    - Output: Extracted plain text
- **eco_tips_generator(problem_keywords)**
    - Input: Environmental keyword(s)
    - Output: Eco-friendly tips

- **policy_summarization(pdf_file, policy_text)**
    - Input: Policy (PDF or text)
    - Output: Concise summary with key provisions

8. Authentication

- **Current Version:** Open access
- **Planned Security Features:**
    - Token-based authentication (JWT)
    - API key integration
    - Role-based access for citizens, researchers, and policymakers

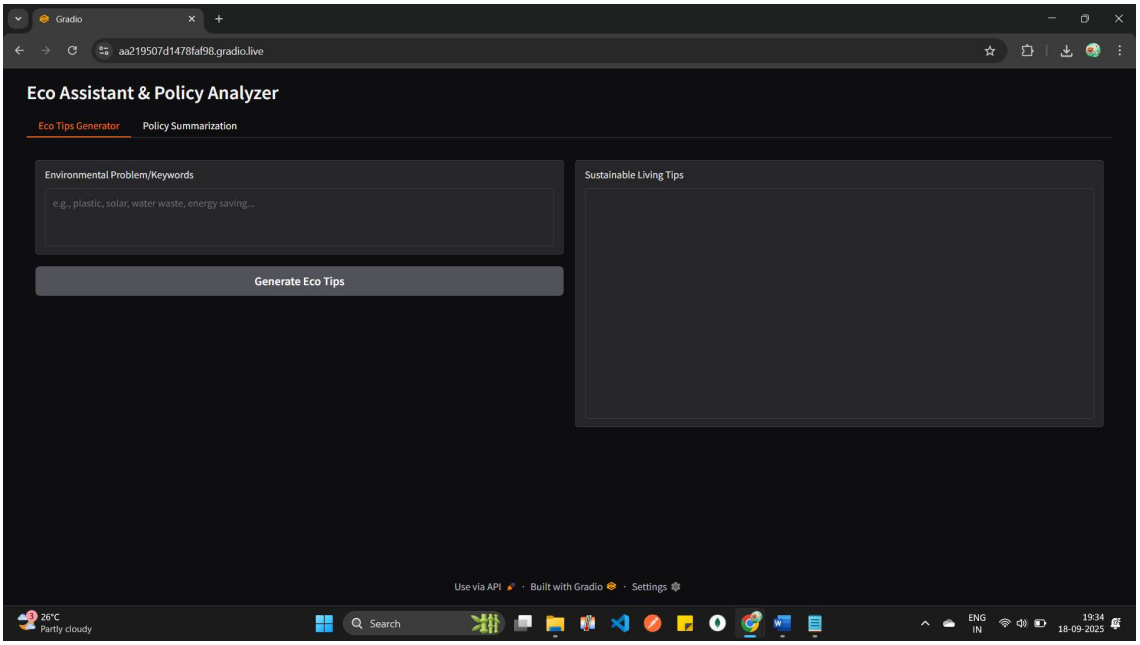
9. User Interface

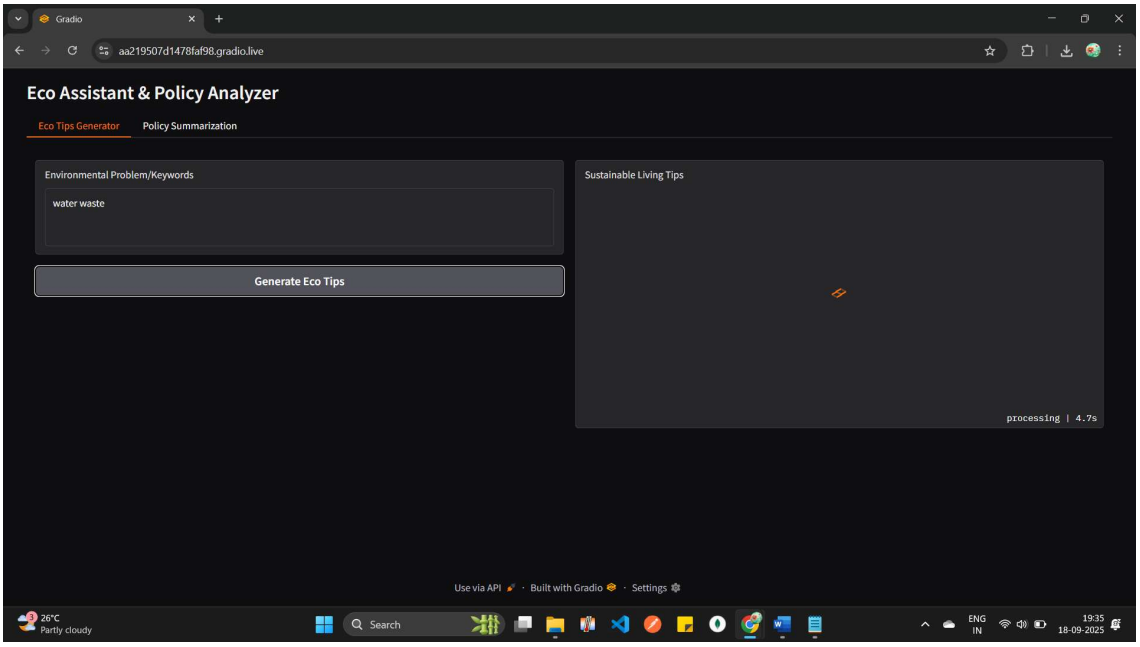
- **Tabs:**
    - *Eco Tips Generator* → Keywords → Tips
    - *Policy Summarization* → PDF/Text → Summary
- **Inputs:**
    - Textbox (eco keywords, policy text)
    - File upload (PDFs)
- **Outputs:**
    - Sustainable living tips
    - Summarized policies with key points

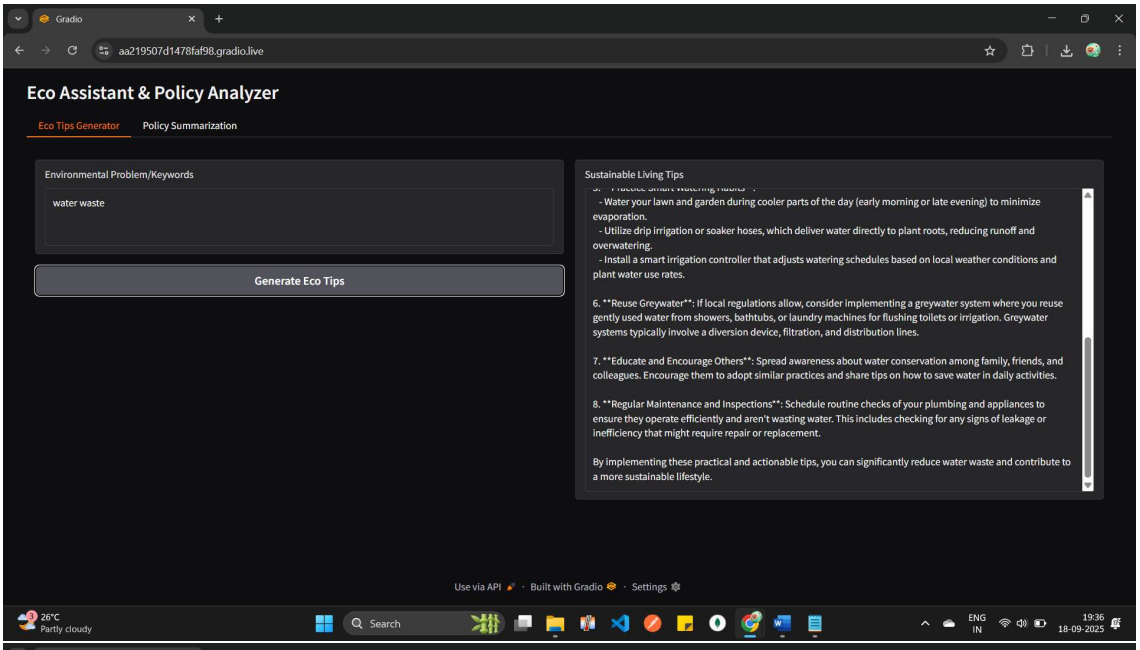
10. Testing

- **Unit Testing:**
    - PDF extraction
    - AI summarization accuracy
    - Eco tips relevance
- **Manual Testing:**
    - Gradio UI usability
    - Output clarity
- **Edge Case Handling:**
    - Empty inputs
    - Corrupted/blank PDFs
    - Extremely long documents

11. Screenshots






Gradio
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Eco Assistant & Policy Analyzer
Eco Tips Generator
Policy Summarization
Environmental Problem/Keywords
water waste
Generate Eco Tips
Sustainable Living Tips
- Water your lawn and garden during cooler parts of the day (early morning or late evening) to minimize evaporation.
- Utilize drip irrigation or soaker hoses, which deliver water directly to plant roots, reducing runoff and overwatering.
- Install a smart irrigation controller that adjusts watering schedules based on local weather conditions and plant water use rates.
6. **Reuse Greywater**: If local regulations allow, consider implementing a greywater system where you reuse gently used water from showers, bathtubs, or laundry machines for flushing toilets or irrigation. Greywater systems typically involve a diversion device, filtration, and distribution lines.
7. **Educate and Encourage Others**: Spread awareness about water conservation among family, friends, and colleagues. Encourage them to adopt similar practices and share tips on how to save water in daily activities.
8. **Regular Maintenance and Inspections**: Schedule routine checks of your plumbing and appliances to ensure they operate efficiently and aren't wasting water. This includes checking for any signs of leakage or inefficiency that might require repair or replacement.
By implementing these practical and actionable tips, you can significantly reduce water waste and contribute to a more sustainable lifestyle.
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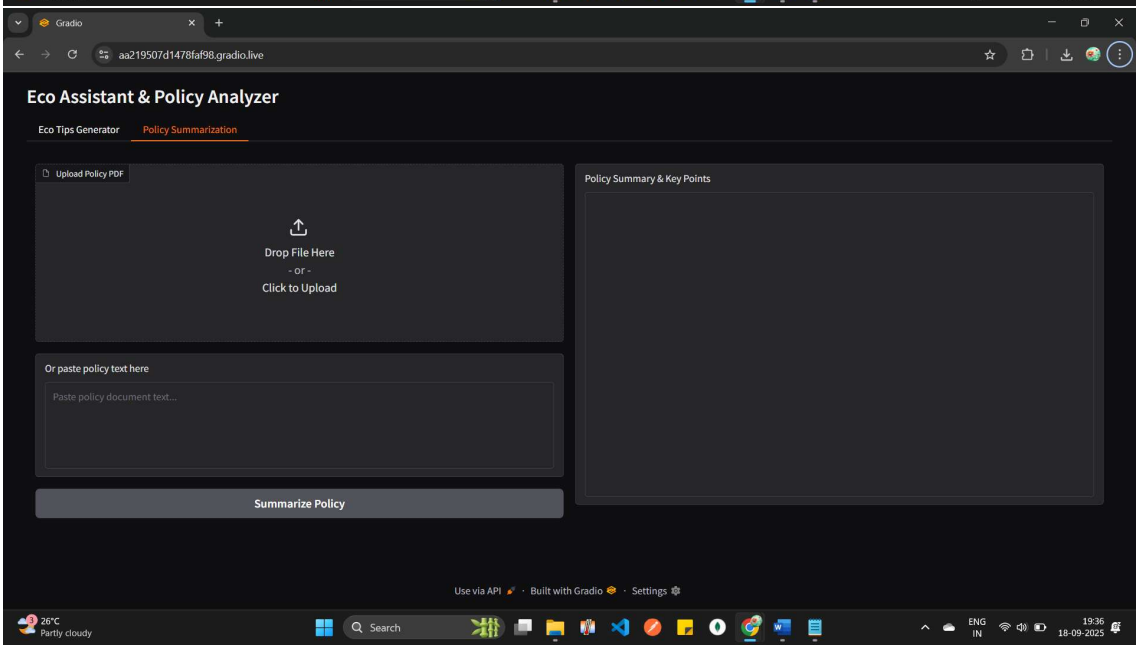
Gradio
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Eco Assistant & Policy Analyzer
Eco Tips Generator
Policy Summarization
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Summarize Policy
Policy Summary & Key Points
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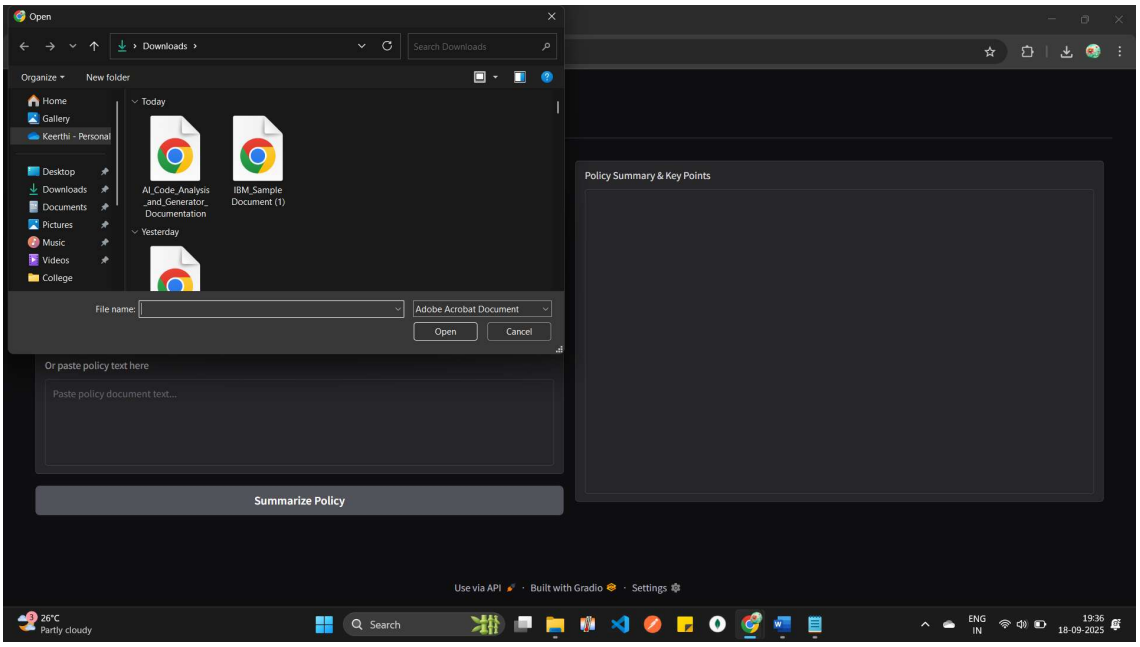
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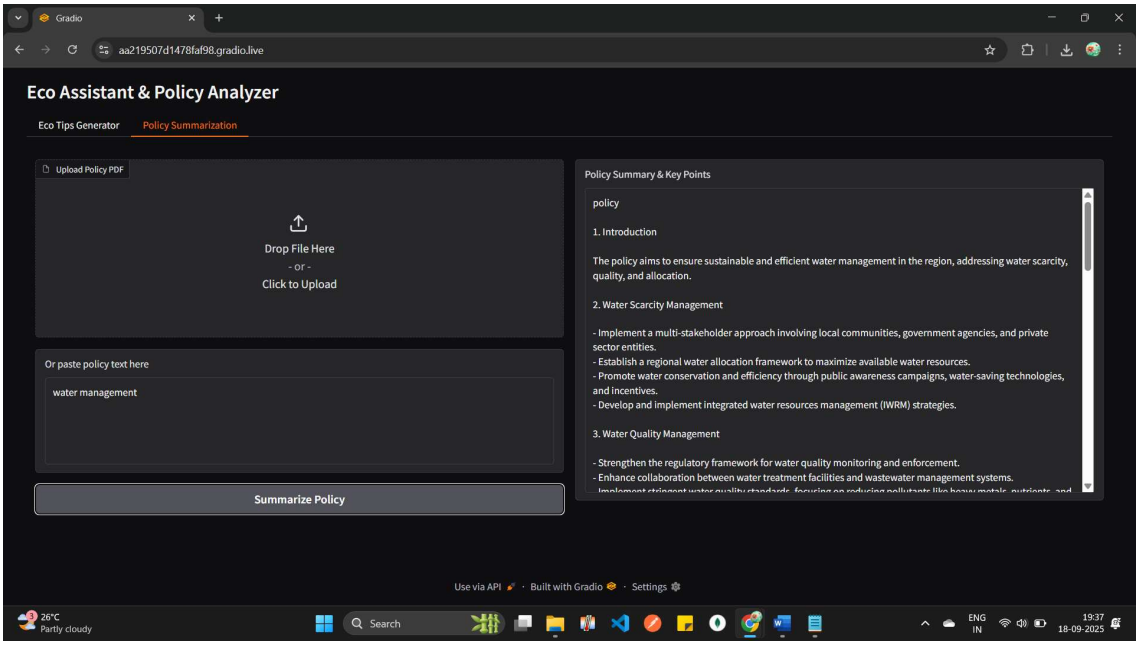
Gradio
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Eco Assistant & Policy Analyzer
Eco Tips Generator
Policy Summarization
Upload Policy PDF
Drop File Here
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Click to Upload
Or paste policy text here
water management
Summarize Policy
Policy Summary & Key Points
policy
1. Introduction
The policy aims to ensure sustainable and efficient water management in the region, addressing water scarcity, quality, and allocation.
2. Water Scarcity Management
- Implement a multi-stakeholder approach involving local communities, government agencies, and private sector entities.
- Establish a regional water allocation framework to maximize available water resources.
- Promote water conservation and efficiency through public awareness campaigns, water-saving technologies, and incentives.
- Develop and implement integrated water resources management (IWRM) strategies.
3. Water Quality Management
- Strengthen the regulatory framework for water quality monitoring and enforcement.
- Enhance collaboration between water treatment facilities and wastewater management systems.
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12. Known Issues

- Slow model loading on first run
- Summarization may miss minor details in very complex policies
- Generated eco tips may sometimes be general instead of highly specific
- Requires GPU for fast performance

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13. Future Enhancements

- Add **multilingual support** (e.g., Hindi, Tamil, Spanish)
- Provide **impact score visualization** (e.g., estimated CO_2 reduction)
- Extend to **other document formats** (.docx, .xlsx)
- Store **user history and feedback** for better personalization
- Integrate with **smart city dashboards** for real-time policy updates

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14. Societal Impact

- Helps **citizens** adopt sustainable practices with ease
- Supports **students and researchers** studying policy impacts
- Assists **policymakers** in making documents more accessible
- Encourages **community-level environmental awareness**