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Ecoscore : Ai-Powered Sustainability Assessment And Carbon Footprint Visualization For Eco-Friendly Lifestyles

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Abstract: Eco-Score is an innovative web-based platform that combines artificial intelligence (AI), machine learning, and user-centric design to provide personalized sustainability assessments and actionable recommendations. The platform includes features such as a sustainability rating system, a carbon footprint calculator, and an AI-powered chatbot, guiding users towards more eco-friendly practices. By leveraging advanced analytics and real-time insights, Eco-Score aims to empower individuals to make informed decisions, driving positive behavioral changes and contributing to global sustainability goals.

Index Terms - Sustainability, Carbon Footprint, AI Chatbot, Machine Learning, Personalized Recommendations, Eco-Friendly Practices

I. INTRODUCTION

The global environmental crisis, fueled by overconsumption of resources, unsustainable practices, and rising carbon emissions, presents urgent challenges for individuals and societies. Reducing carbon footprints and adopting sustainable practices is critical to mitigating these challenges. However, many individuals are unaware of how their actions impact the environment and lack accessible tools to make informed, eco-friendly decisions.

Traditional methods of tracking sustainability, such as manual calculations or generic advice, often lack personalization and fail to motivate consistent action. In response to these challenges, Eco-Score is designed to be an intelligent, data-driven platform that helps users assess their environmental impact and adopt sustainable practices.

To address these limitations, there is a growing need for innovative, user-friendly platforms that combine accurate, data-driven insights with personalized guidance. Such platforms can help bridge the gap between environmental awareness and actionable steps, empowering individuals to reduce their carbon footprints and make informed, eco-conscious decisions. However, this shift requires not only awareness but also a change in behavior—people need to be motivated and equipped with the knowledge to take concrete actions toward sustainability.

Eco-Score is designed as an intelligent, data-driven platform that provides users with an accessible and personalized tool for evaluating their environmental impact. By integrating cutting-edge technologies like machine learning, AI-powered chatbots, and comprehensive sustainability rating systems, Eco-Score aims to simplify the process of reducing one's ecological footprint and adopting sustainable habits. The platform is equipped with three core features: a personalized sustainability rating system, a carbon footprint calculator, and a conversational AI chatbot that offers real-time advice and tailored suggestions based on user behavior.

By leveraging these technologies, Eco-Score aims to offer a solution that is both highly personalized and accessible to a broad audience. The platform not only educates users about their environmental impact but also motivates them to make long-term, sustainable changes in their daily lives. Through continuous tracking, feedback, and personalized advice, Eco-Score empowers individuals to take ownership of their role in protecting the planet and building a more sustainable future. This paper presents the design, development, and implementation of the Eco-Score platform. It outlines the technological framework behind each of the platform's features, evaluates the effectiveness of these tools in promoting sustainable behavior.

II. RESEARCH METHODOLOGY

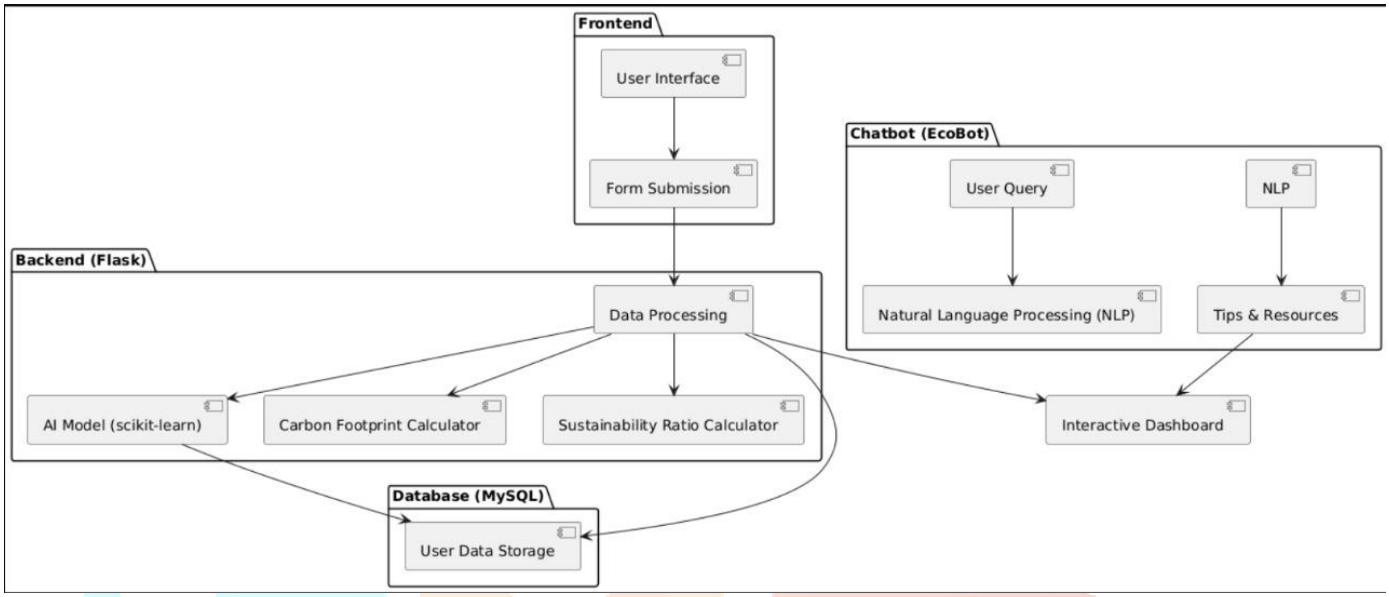

Fig 1.1 : System Architecture

Main functional modules:

- **Sustainability Lifestyle Rating**: This module assesses the sustainability of users' lifestyle choices based on their actions, such as energy usage, waste management, and eco-friendly habits. The system assigns a sustainability rating to users, encouraging them to adopt more sustainable practices. The rating is dynamically updated as users track and adjust their behaviors.
- **Carbon Footprint Calculator**: This module calculates the carbon footprint of users based on their daily activities, such as transportation, energy consumption, and waste production. It provides a comprehensive overview of users' environmental impacts and offers tailored recommendations to reduce emissions. This tool ensures accurate and localized tracking to make sustainability accessible to users worldwide.
- **Sustainability Chatbot (EcoBot)**: The EcoBot serves as a real-time assistant, helping users by answering sustainability-related questions and guiding them through the platform. It provides instant feedback on sustainability practices, offering personalized recommendations for reducing carbon footprints. The EcoBot helps engage users by fostering a deeper understanding of their environmental impact and offering practical tips for improvement.
- **User Interface(UI):** : The platform features an intuitive web-based interface, built using ReactJS, ensuring a seamless and user-friendly experience. The UI allows users to easily input their data, track their carbon footprint, view their sustainability rating, and receive real-time feedback on their environmental practices.

Software Components of our web:

- **Backend Framework:** The app is developed using Flask, a lightweight Python framework that handles user authentication, data processing for the carbon footprint calculator, and user interactions with the sustainability tools.
- **Frontend Technologies: HTML5** & **CSS3** for structuring and styling the web pages. **JavaScript** adds interactivity to the platform, such as form validation and dynamic updates..
- **Database Management System (DBMS): MySQL** is used for storing user data, sustainability scores, and embedded messages, ensuring data persistence and integrity.
- **Machine Learning Libraries: scikit-learn**, for building and training the sustainability prediction model. **pandas & NumPy**, for data manipulation and preprocessing.
- **Chatbot Integration(Botpress):** Used for real-time user assistance and answering sustainability-related queries.
- **Streamlit:** Used for implementing the carbon footprint calculator with an intuitive interface.

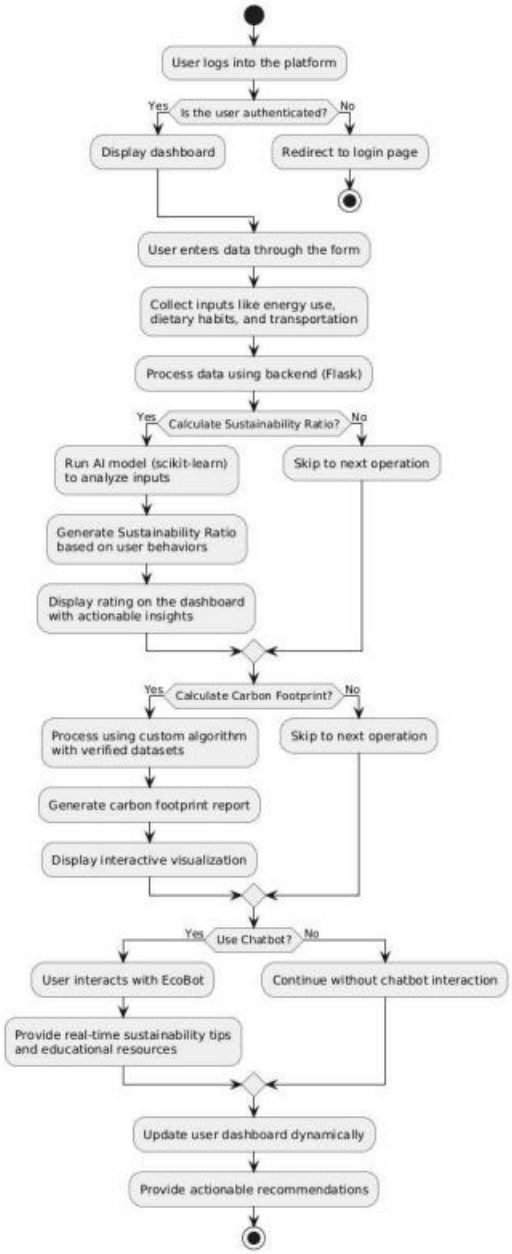

Fig 1.2 : Workflow Diagram

1. **Sustainability Lifestyle Rating:**

- This module continuously collects data from user activities, such as recycling habits, energy efficiency, and eco-friendly purchases.
- Using a scoring algorithm, the system generates a personalized sustainability rating that reflects the user's environmental impact.
- Ratings are updated dynamically, encouraging users to improve their behaviors.

Visual dashboards provide insights into the factors influencing their scores and offer actionable recommendations to achieve better ratings.

2. **Carbon Footprint Calculator:**

- Users begin by entering activity data such as transportation methods, energy consumption, and waste generation through a user-friendly form.
- The system processes this input using a custom-built algorithm to calculate the user's carbon footprint, based on emissions factors from verified datasets.
- Results are displayed via interactive visualizations, showing detailed breakdowns of emissions by category.
- Users receive tailored suggestions to reduce their carbon footprint and can track progress over time through stored historical data.

3. **Sustainability Chatbot (EcoBot):**

- The EcoBot serves as an AI-driven chatbot that provides real-time answers to sustainability-related queries.
- Users can ask questions about reducing carbon footprints, making eco-friendly choices, or understanding environmental concepts.
- The chatbot uses natural language processing (NLP) to offer personalized advice and sustainability tips, improving user engagement.
- EcoBot also connects users to additional resources, such as guides, articles, and local eco-friendly initiatives.

The platform's modular design allows seamless integration of future features, such as renewable energy calculators or gamification elements. Scalability ensures the app can handle growing user traffic while maintaining performance.
The app serves as a learning platform, promoting awareness of environmental challenges and actionable strategies to address them.

IV. RESULTS AND DISCUSSION

1. Results

The testing phase of EcoScore demonstrated its capability to engage users effectively and drive measurable improvements in sustainability practices. Key outcomes are summarized below:

1. User Adoption:

A pilot test involving 100 users over three months revealed an 89% user satisfaction rate, with most users highlighting the Sustainability Lifestyle Rating and Carbon Footprint Calculator as the most impactful features.
About 86% of participants found the platform's design intuitive, particularly appreciating the real-time updates and personalized recommendations provided by the tools.

2. Behavioral Impact:

More than 70% of users reported adopting at least two new eco-friendly habits based on the platform's recommendations, such as reducing energy consumption and switching to sustainable transportation options.

Participants experienced an average 15% improvement in their Sustainability Lifestyle Ratings, with consistent use of the system over the trial period.

3. Environmental Impact:

The recommendations provided by the Carbon Footprint Calculator helped users achieve a combined reduction of approximately 18% in their carbon emissions, particularly through optimized household energy use and decreased reliance on single-use plastics.

Users who engaged with the EcoBot frequently showed a 12% higher likelihood of implementing sustainability tips compared to those who used the feature sparingly.

4. Performance Metrics:

The system maintained robust uptime (99.6%), ensuring reliable access to all functionalities throughout the testing period.

Processing times for tools like the Carbon Footprint Calculator and Sustainability Lifestyle Rating System averaged under 1.4 seconds per user interaction.

The platform successfully handled over 2,500 active sessions without encountering significant technical disruptions.

5. User Feedback:

A post-pilot survey showed that 84% of users would recommend EcoScore to others, with many praising its focus on actionable insights and ease of use.

Nearly 80% of users appreciated the EcoBot's ability to answer complex sustainability queries effectively and provide instant, tailored advice.

2. Discussion

The results of EcoScore testing underscore its ability to effectively promote sustainable living by providing users with data-driven insights and practical tools for environmental impact reduction.

The Carbon Footprint Calculator proved essential for helping users identify and quantify their contributions to carbon emissions, while the Sustainability Lifestyle Rating System motivated consistent behavioral improvements. The EcoBot chatbot further enhanced the user experience by simplifying complex environmental concepts and offering immediate guidance.

These findings indicate that EcoScore is not only user-friendly but also impactful in driving meaningful changes in sustainability practices. The platform's integration of real-time feedback, personalized recommendations, and intuitive features ensures broad appeal and usability. Future enhancements, such as localized datasets and collaborative sustainability challenges, could further expand its impact and user engagement.

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