Detailed Report

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The proposed solution for the Pale Blue Dot Challenge serves as a comprehensive, interactive platform that allows users to engage with the wealth of data we have collected, analyzed, and generated. This dynamic environment allows users to dive into visualizations and predictive models that illuminate climate patterns and future projections. By allowing users to interact with the data, we empower them to gain a deeper understanding of the complex dynamics of climate change and global warming. This interactive exploration not only demystifies the abstract concepts often associated with these phenomena but also highlights their tangible, real-world impacts. In addition, our solution underscores the importance of data-driven decision-making in addressing the pressing issue of climate change. By providing a platform that translates rich climate data into actionable insights, we aim to facilitate informed discussions and decisions about sustainable practices and policies.

The World Temperature Viewer, as the authors call it, is more than just a data visualization tool; it is a conduit for knowledge transfer, fostering a greater understanding of the far-reaching impacts of global warming and climate change. We hope that this understanding will inspire action toward a more sustainable future.

At the core of our solution is a set of predictive models, powered by Meta AI's robust Prophet framework, that have been meticulously designed to predict average monthly temperatures for cities across the United States. The data on which these models are based has undergone a series of rigorous processes, including data preprocessing, exploratory data analysis, feature engineering, model building, and model evaluation. Python, a versatile programming language, was used as the primary tool for these processes within a Jupyter Notebook environment. A variety of libraries and frameworks such as Scikit-learn, NumPy, Pandas, Seaborn, and Matplotlib were used, with Git and GitHub serving as version control systems.

In addition to the above processes, a thorough analysis of the data was conducted to gain in-depth knowledge and insights. This included the use of multiple charts, geographic maps, and descriptive statistics to visualize and understand the data. The culmination of this effort was the integration of all results into the World Temperature Viewer. This Streamlit application provides users with a streamlined interface to understand the historical state of global temperatures and explore potential future scenarios.

The software allows users to compare temperature trends from 1970 to 2013. It also allows users to forecast U.S. temperatures using powerful models. These models have demonstrated their effectiveness with a Mean Absolute Error (MAE) of 1.7 and a Mean Squared Error (MSE) of 7.3, providing reliable and accurate predictions of future temperature trends. This effort underscores our commitment to using advanced scientific methods to address pressing environmental issues. The subsequent images illustrate a comparative analysis between the observed and forecasted

monthly average temperature of the test set (2010 - 2013), evaluated specifically for the cities of New York and Miami.

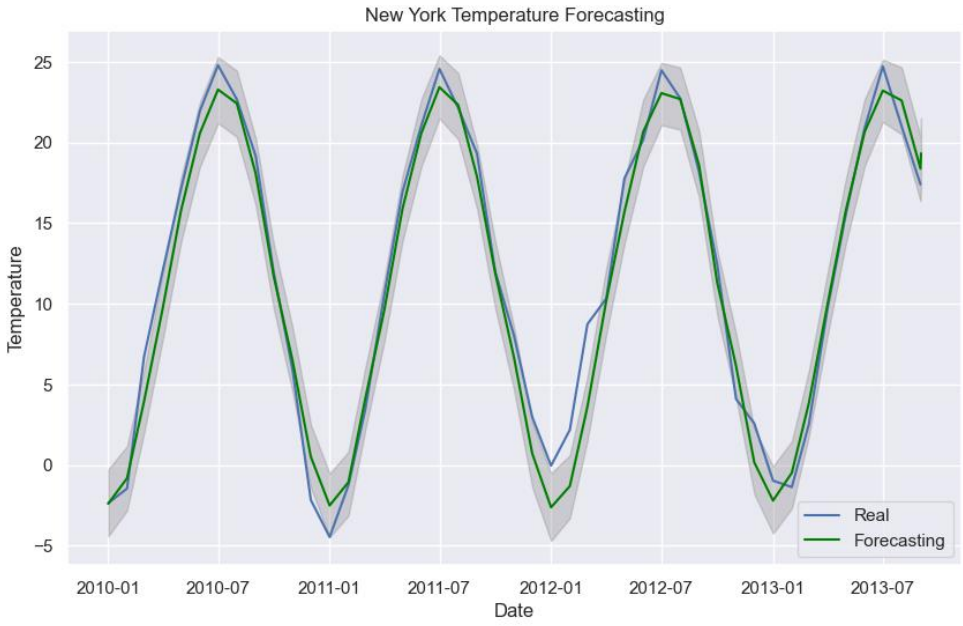

Figure 1: Comparison between real and forecasted temperatures in New York.

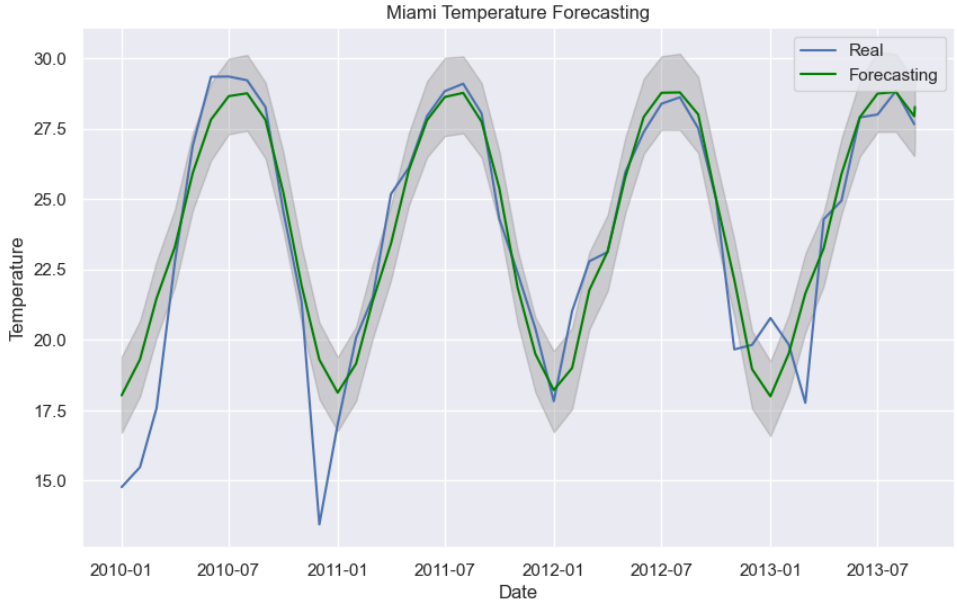

Figure 2: Comparison between real and forecasted temperatures in Miami.

In this day and age, it is of paramount importance that every individual, community, and organization not only recognize but also strongly advocate the intrinsic link between scientific and technological advancement and sustainable development coupled with environmental

stewardship. This conviction has gradually evolved into my primary area of research and development.

While advances in science and technology are laudable, it is the development of sustainable science and technology that deserves special recognition. This approach ensures that we extend our care and concern to our vast green home - the Earth, the only habitat where humanity truly belongs. This belief is the foundation of my motivation for my proposed climate action solution for the Pale Blue Dot Challenge. It is a testament to my commitment to harnessing scientific and technological advances for the betterment of our environment, thereby ensuring a sustainable future for all inhabitants of our Blue Dot.

My academic journey has been greatly influenced by the pressing issue of climate change and global warming, which directly correlates to my chosen area of interest in this challenge. As part of my research, I have conducted an extensive literature review, immersing myself in scholarly articles primarily from Frontiers in Sustainability and Frontiers in Environmental Science and Engineering. I have also consulted relevant books and public data from various sources to expand my knowledge. I have disseminated our preliminary findings on "Advancing Sustainable Agriculture" through a draft published in the TechRxiv preprint. This research underscores the importance of sustainable practices in agriculture, a sector that is critical to both economic development and environmental conservation. In addition, as an undergraduate student, I have had the opportunity to give several talks in which I have shared drafts of my papers. Experiences that not only broadened my knowledge but also sharpened my perspective on this particular topic.

An important milestone in my career was my contribution to the Schneider Electric European Hackathon in the EcoForecast Challenge, where I placed 19th, which strongly influenced my decision to continue my work in this critical field. My regular monitoring of the latest developments in "Environmental News Networks" allows me to extract new sub-areas to work on and possible new methods of presenting and developing solutions in this field.

We are committed to maintaining high ethical standards by using open-source datasets and frameworks; this approach ensures transparency and promotes the democratization of information, which are key ethical considerations in scientific research. In addition, we have released our comprehensive study and code under the MIT Open-Source License to foster an environment of collaboration and shared learning. In this way, we allow others to benefit from our work, just as we have benefited from the tools and resources provided by others. These strategies not only address ethical considerations but also promote equity by ensuring that our work is accessible to all, regardless of resources or background.

The World Temperature Viewer version hosted on the Streamlit cloud is the first iteration to be tested in production. It may contain some typographical and other errors due to its preliminary nature.

After the initial deployment and subsequent testing, we encountered a limitation with the bandwidth allocation of GitHub's Large File System (LFS). This was primarily due to the size of the data and models stored in the repository's LFS. As a result, we are currently unable to update the software to address these issues. However, as soon as the LFS is available again, we plan to update the software to ensure its accuracy and completeness. We ask for the understanding of the organizing committee and the community concerning this matter, as we currently do not have access to another platform to host our data and models. Links to the GitHub repository of the code, the Streamlit application deployed on the Streamlit Cloud, and the dataset used in the study conducted are provided below:

Code Repository	https://github.com/WiseGeorge/NASA-Mission-Pale-Blue-Dot
Interactive Visualization	https://nasa-palebluedot-wtv.streamlit.app
Dataset	https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data

The original concept of the World Temperature Viewer was to include not only temperature forecasts for U.S. cities but also forecasts for major cities worldwide and for all cities within selected countries. However, this approach was deemed excessively expensive in terms of storage and processing requirements. Consequently, a strategic decision was made to refine the scope of the World Temperature Viewer. While it still provides data insights for the entire globe, its forecasting capabilities are specifically tailored to U.S. cities. This decision ensured the feasibility of the project while maintaining a significant portion of its original intent.