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Article

Predicting the Climate Change in different climate zones using Grammatical Evolution

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Abstract

Climate change is no longer a future or hypothetical issue, but a present reality with tangible consequences and impacts on the well-being not only of the planet itself but also of all living organism that constitute the ecosystem. Since 1969, the global surface temperature has been surpassing its own record almost every year, with NASA's final measurement for 2024 indicating an increase of approximately 2.65° Fahreheit or 1.47° Celsius, in global temperature. These measurements indicate that we have reached the thresholds established by the United Nations, scientists, and member states through Paris Agreement of 2015. Under this accord, countries committed to holding the global temperature increase well below 2° C above pre - industrial levels and pursuing efforts to limit it to 1.5° C, recognizing that achieving this goal would significantly reduce the risk and impacts of climate change. Prior to the Paris Agreement, several other initiatives had been undertaken to address environmental challenges. In 1992, the United Nations Conference of Environment and Development (UNCED) was hold in Rio de Janeiro, Brazil (3 - 14 June), with the ultimate objective of stabilizing greenhouse gas concentrations in the atmosphere. The momentum continued in 1997 with the adoption of the Kyoto Protocol, which ope-rationalized the United Nations Framework Convention on Climate Change (UNFCCC) by committing industrialized nations and economies in transition to limit and reduce greenhouse gas emissions in accordance with agreed individual targets. Although we briefly observed the emergence of more environmentally conscious actions in the past, today, in the year 2025, NASA's data indicate that the debate has shifted to whether humanity will surpass the critical threshold of 1.5°C or 2.7°F global temperature increase. In this study, we seek to gain a comprehensive understanding of climate change, and more specifically of its environmental impacts across five distinct regions located in different climatic zones. Particular emphasis is placed on highlighting the rate at which climate change has altered annual temperature patterns during the period 1995–2025. Furthermore, we aim to project future climate trends by estimating temperature changes over the next 10, 20, and 30 years. To achieve this, we evaluated multiple modeling techniques and propose the use of Grammatical Evolution with rule-based construction as the most suitable approach. The first region is the Congo area, located near the equator and characterized by an equatorial tropical climate. The second is Saudi Arabia, identify as hot desert climate. The thors is Greece which lies within the subtropical zone of the Northern hemisphere. The fourth region is Turkey, characterized by diverse climate zones, overall, the country belongs primarily to the Mediterranean climate zone, while its interior regions exhibit continental conditions and the northern coasts experience humid temperate climates.The fifth region is Iceland, specifically Reykjavik, which is located within the subarctic zone. The sixth one is Svalbard region, in the North Arctic Ocean. The final region is Cape Town in South Africa,

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located in the Southern Hemisphere, which belongs primarily to the Mediterranean climate zone, characterized by warm, dry summers and mild, wet winters.

Keywords: Genetic algorithms; Grammatical Evolution; Machine learning; Climate change

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4.1.1. Subsubsection

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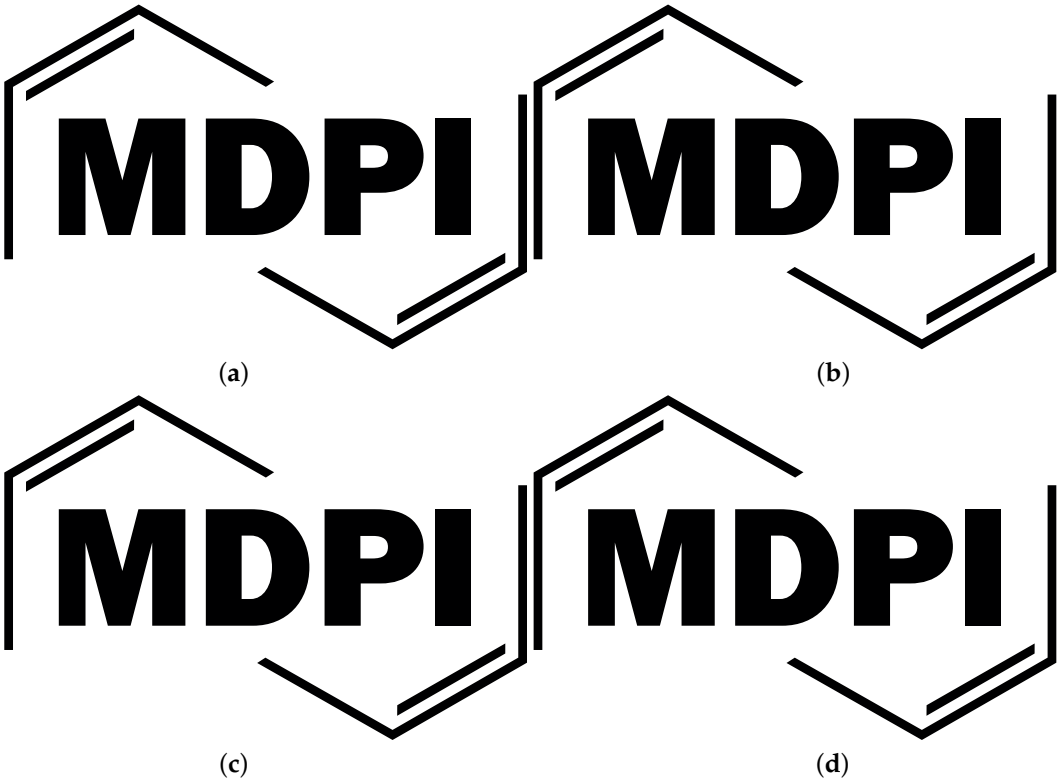

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	Data	Data	Data
	Data	Data	Data
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	Data	Data	Data
	Data	Data	Data

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Text.

Text.

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This is the example 1 of equation:

$$a = 1, \tag{1}$$

the text following an equation need not be a new paragraph. Please punctuate equations as regular text.

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Abbreviations

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TLA	Three letter acronym
LD	Linear dichroism

Appendix A

Appendix A.1

The appendix is an optional section that can contain details and data supplemental to the main text—for example, explanations of experimental details that would disrupt the flow of the main text but nonetheless remain crucial to understanding and reproducing the research shown; figures of replicates for experiments of which representative data are shown in the main text can be added here if brief, or as Supplementary Data. Mathematical proofs of results not central to the paper can be added as an appendix.

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References

1. Author 1, T. The title of the cited article. *Journal Abbreviation* **2008**, *10*, 142–149.
2. Author 2, L. The title of the cited contribution. In *The Book Title*; Editor1, F., Editor2, A., Eds.; Publishing House: City, Country, 2007; pp. 32–58.
3. Author 1, A.; Author 2, B. *Book Title*, 3rd ed.; Publisher: Publisher Location, Country, 2008; pp. 154–196.
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