ClimateWins: Predicting Weather Patterns With Machine Learning

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Date: April 3rd, 2025

Introduction

- With the introduction of climate change, extreme weather events are becoming more common place. To better predict these events machine learning techniques are being used.

Goals

PREDICTING EXTREME WEATHER EVENTS FURTHER IN ADVANCE

DETERMINE THE SAFETY OF ALL REGIONS IN MAINLAND EUROPE

PROJECT THE NEXT 50 YEARS OF WEATHER CONDITIONS IN MAINLAND EUROPE

Recommended Machine Learning Techniques

Random Forest: an ensemble learning algorithm that combines several decision trees to create a "forest" for a more accurate final prediction.

Excels at: classification with complex inputs.

CNN: Convolution neural networks consists of hidden layers alternating between convolution layers and pooling layers. In the convolution layers data is processed into matrixes for algorithmic manipulation. In the pooling layers data is compressed using maximums and averages.

Excels at: image processing and numerical data.

GAN: General adversarial networks a generative algorithm based on real data points. Trains on real data to create fake data, then iterates till the fakes more resemble the real.

Excels at: processing images and creating new images

New Data Required

- Past extreme events in mainland Europe
  - To create an index of where is experiencing the weather events and their category

- Damage reports from extreme weather events
  - To compare the with the above data set, used to determine intensity and impact on the locations

- Radar/Satellite imaging
  - Used to train the CNN model to predict weather through image patterns

- Lidar records for cloud cover
  - To create an accurate idea of how precipitation moves across mainland Europe.

- Thermal imaging over mainland Europe
  - To track the movements of warm and cold fronts, which predict weather events

Goal
## Predicting extreme weather events further in advance

- Method
  - Using CNNs trained on extreme weather event data to isolate the start of an event
- Data needed
  - Satellite and radar imaging from the before and after extreme weather events to train the CNN to recognize patterns
- Data Bais
  - Climate change is causing what are known as super storms that may present differently than previous examples. Leading to older data perhaps being less useful

Goal
Determine the safety of all regions in mainland Europe

- Method
    - Using Random forest with data from extreme weather events and the damage recorded in the aftermath.

- Data needed
    - Past records of extreme weather events and events classification and intensity
    - The damage in loss of life and monetary expense, also time to recover from event

- Data Bais
    - Data taken per country is going to be prone to misrepresentation due to things like insurance fraud or simple human error. Also applying numbers to human suffering such as this will be prone to human error due to emotional investment.
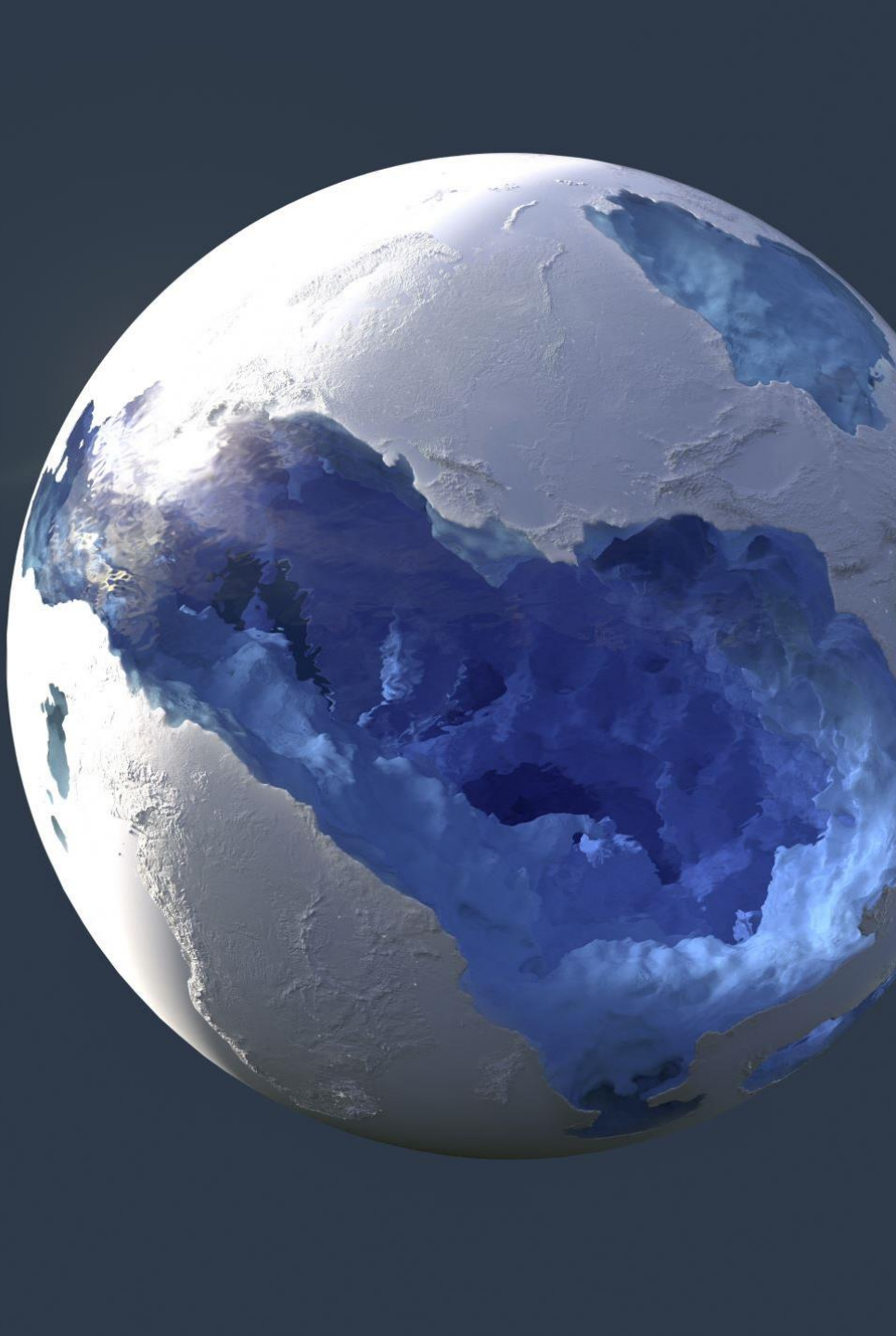
Goal
Project the next 50 years of weather conditions in mainland Europe

- Method
  - Using a GAN model trained on previous weather data, a "fake" data base of future weather can be created to predict the future trends.

- Data needed
  - Lidar for mapping the cloud cover and movement of precipitation over Europe
  - Thermal imaging for tracking hot and cold fronts which in turn tracks things like changes in pressure

- Data Bais
  - As previously mentioned, climate change has cause recent data to be more important than ever. It's possible the model suffers from too small a sample size of the newer climate we now inhabit.

Recommendations and Next Steps

- Recommendation: Of all goals, goal two is the most feasible. It requires the least prediction of future weather events and deals entirely in measurable past data. Using Random forests to determine the most evaluate, areas will also have the most immediate effect in safety and comfort levels.

- Next Steps: Large scale data collection must begin before any other step in the process. Currently the data is immensely lacking for making good predictions. After that all models must be monitored and improved over the life span of use. Weather is a complex system to evaluate and any lack of continuous improvement could be disastrous

Thank You

- For questions or discussion please email me

- See my GitHub page for the detailed analysis

- Please see YouTube for recorded presentation