CLIMATE WINS:
PREDICTING WEATHER PATTERNS WITH MACHINE LEARNING

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OBJECTIVES & OVERVIEW

CLIMATE WINS OBJECTIVES

- Identify weather patterns outside the regional norm in Europe.
- Determine if unusual weather patterns are increasing.
- Generate possibilities for future weather conditions over the next 25 to 50 years based on current trends.
- Determine the safest places for people to live in Europe over the next 25 to 50 years.

THOUGHT EXPERIMENTS

- Classify and distinguish between unusual weather patterns using hierarchical clustering algorithms.
- Identify the most important weather features in order to predict weather patterns using Random Forest model.
- Predict the safest regions for people to live by simulating future weather events using CNNs and GANs

MACHINE LEARNING APPROACHES

HIERARCHICAL CLUSTERING

- Type of unsupervised machine learning algorithm used for grouping similar data points into clusters
- Builds a tree-like hierarchy of clusters, known as a dendrogram

RANDOM FOREST

- Type of supervised machine learning algorithm that is used for both classification and regression tasks
- Builds multiple decision trees and merges their outputs to improve accuracy and reduce overfitting

CNN (Convolutional Neural Network)

- Type of deep learning model designed primarily for processing structured grid-like data
- Widely used in computer vision tasks like image classification, object detection, and facial recognition

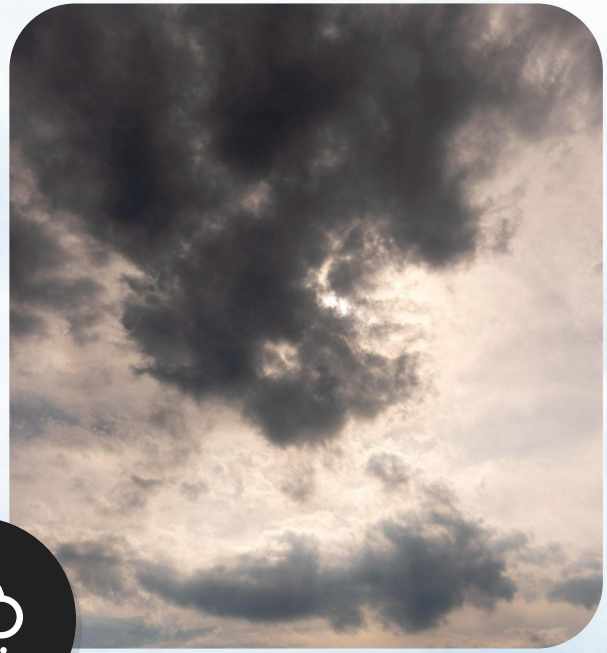
GAN (Generative Adversarial Network)

- Type of deep learning model used for generating new, realistic data samples from a given dataset
- Consists of two neural networks—the Generator and the Discriminator—that compete with each other in a process called adversarial training

ADDITIONAL DATA NEEDED

In addition to historical weather data:

- Weather Event Data - storms, heatwaves, droughts, extreme cold
- Radar Images from weather stations across Europe
- Healthcare Data - records of illness, injury, and death counts caused by extreme weather
- Real-time weather station data to aid in future weather predictions

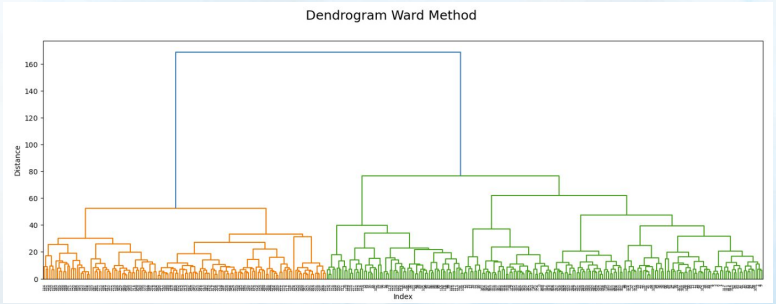


THOUGHT EXPERIMENT 1: CLASSIFYING WEATHER PATTERNS

HYPOTHESIS: Using hierarchical clustering algorithms, we can distinguish between severe/unusual weather patterns.

APPROACH: Analyzed historical weather data from weather stations in Europe to see what clusters the model was able to generate from the data set.

RESULTS: The model was able to come up with two clusters representing pleasant vs unpleasant weather.



NEXT STEPS: Analyze storm, drought, heatwave, and extreme cold weather events with hierarchical clustering algorithms in order to classify if a weather pattern is severe or unusual, then use a different type of model to determine if unusual weather patterns are increasing.

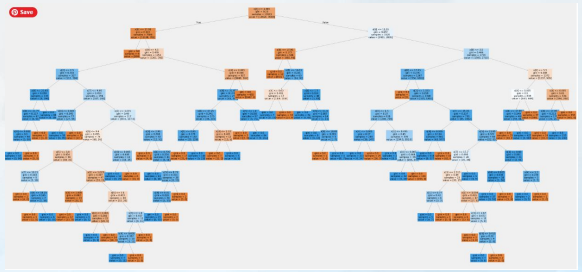
THOUGHT EXPERIMENT 2: IDENTIFYING IMPORTANT WEATHER FEATURES

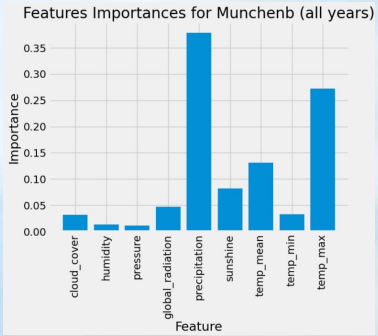
HYPOTHESIS: Identifying important weather features is useful when predicting future weather patterns.

APPROACH: Used random forest model to view important weather features when determining pleasantness of weather.

RESULTS: Precipitation and maximum temperature are the most significant features in determining pleasant versus unpleasant weather.

NEXT STEPS: These variables should be prioritized in forecasting models and equipment development. Trends in extreme temperature fluctuations and shifts in seasonal precipitation patterns can signal changes in climate stability, aiding in the prediction of severe weather events such as heat waves, storms, or droughts.





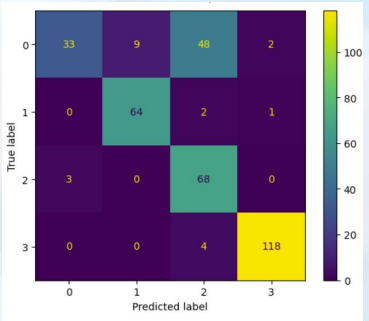
THOUGHT EXPERIMENT 3: PREDICTING FUTURE WEATHER EVENTS

HYPOTHESIS: We can predict the safest regions for people to live by simulating future weather events using GANs and CNNs.

APPROACH: Used a CNN model to classify images of similar weather conditions: cloudy, shine, sunrise, and rain.

RESULTS: The accuracy of the model was ~91% and it correctly predicts most of the weather conditions, however it does seem to have difficulty distinguishing between cloudy and shine.

NEXT STEPS: GANs can be trained on historical weather data to generate simulations of future climate scenarios, aiding in the prediction of increasing frequency and severity of extreme weather events in specific regions. This would aid in determining the safest places to live when it comes to weather.



Correct Prediction - class: Sunrise - predicted: Sunrise

SUMMARY

RECOMMENDATIONS

Based on the accuracy of the CNN model and the possibility of simulating future weather events, I believe that CNNs and GANs should be utilized for the analysis of weather data.

DATA NEEDED

Radar images would be useful in training CNN models to determine weather patterns.

Real-time weather data would be useful in predicting current and future weather patterns.

Healthcare data with records of illness, injury, and deaths by extreme weather conditions would be useful in comparing safe places to live.

NEXT STEPS

Refine the CNN model to make it as accurate as possible when determining weather conditions from radar images.

Use GANs to simulate future weather patterns and predict extreme weather conditions and events.

Compare results of analysis with healthcare data to determine the safest regions to live based on weather.

THANKS!

DO YOU HAVE ANY QUESTIONS?

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GitHub