ClimateWins: Weather Prediction and Climate Change Analysis

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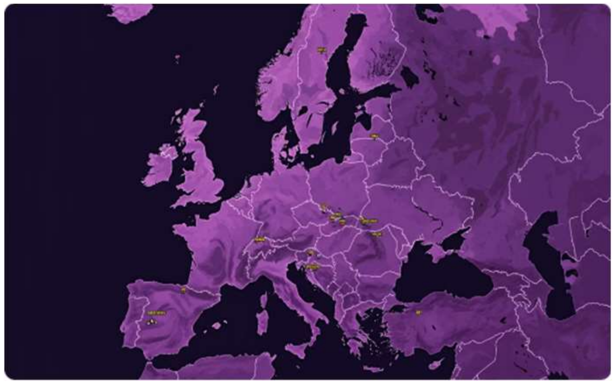
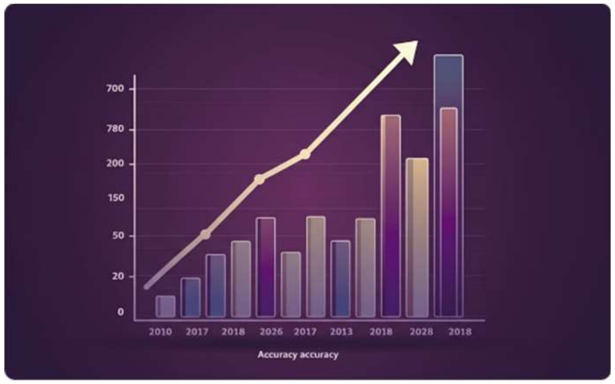
Machine Learning in Climate Modeling



European Weather Stations

This report analyzes ClimateWins' weather prediction model performance across multiple European weather stations, finding an average accuracy of 88%.



Model Accuracy

Key findings include strong performance in stable climates and potential overfitting issues.

Complex Weather Patterns

Challenges arise in predicting complex weather patterns, where the model's accuracy may be lower.

Summary of the Model Performance

1 Overall Accuracy

The weather prediction model achieves an average accuracy of 88% across multiple stations.

2 Stable Climate Performance

Stations like Sonnblick (100%) and Kassel and Oslo (90%) show high accuracy due to stable weather patterns.

3 Complex Climate Challenges

Stations such as Madrid and Belgrade have higher false positive rates, indicating difficulties with complex or variable weather patterns.

4 Potential Overfitting

Sonnblick's perfect accuracy suggests possible overfitting, which may reduce the model's generalizability.

Introduction to Climate Change

Climate change is a global issue, with rising temperatures causing shifts in weather patterns and increasing the frequency and severity of extreme weather events.

ClimateWins is a platform for climate data analysis, providing insights into global weather patterns and helping us understand climate change.

1. **Rising Temperatures**
   Global temperatures are increasing due to human activities.

2. **Shifting Weather Patterns**
   Changes in precipitation, wind, and seasons.

3. **Extreme Weather Events**
   More frequent and severe storms, heatwaves, and droughts.

4. **Data Analysis Importance**
   ClimateWins helps understand and predict climate trends.

Data Sets and Optimization

This analysis uses weather data from 18 European stations, collected from the late 1800s to 2022. The dataset includes daily records of wind, temperature, radiation, and other variables, compiled by the European Climate Assessment & Data Set.

Gradient Descent optimization minimized error by adjusting parameters, improving model accuracy.

1

Data Collection

18 European stations, late 1800s to 2022

2

Optimization

Gradient Descent method

3

Parameter Adjustment

Theta0, theta1, iterations, alpha

4

Error Minimization

Approaching zero

Model Hypotheses

1 **Temperature Increase Prediction**

Can machine learning predict a significant increase in average daily temperatures in Europe in the coming years?

2 **Extreme Weather Forecasting**

Can machine learning effectively predict extreme weather conditions?

3 **Pattern Identification**

Can machine learning identify correlations or patterns between extreme weather conditions and other variables, such as heatwaves?

These hypotheses guide the model analysis, focusing on the potential of machine learning to enhance our understanding and prediction of climate change impacts.

Machine Learning in Climate Modeling

K-Nearest Neighbor (KNN)

Classifies weather conditions based on proximity.

Decision Tree

Makes weather predictions based on multiple criteria.

Artificial Neural Network (ANN)

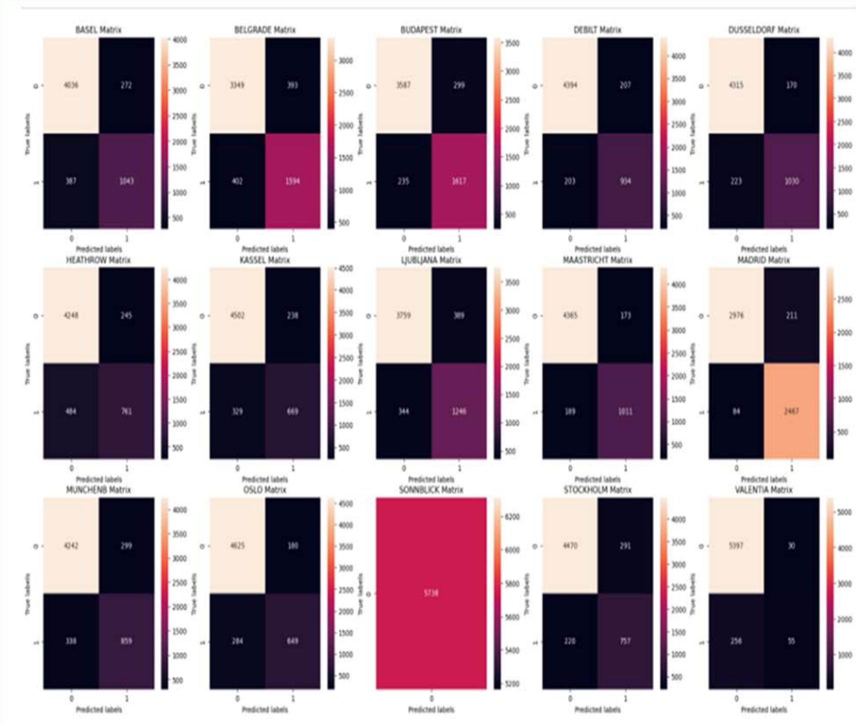
Detects complex weather patterns.

These machine learning methods help in forecasting and climate modeling by recognizing and predicting weather trends, enabling more accurate long-term climate predictions and enhancing our understanding of climate change dynamics.

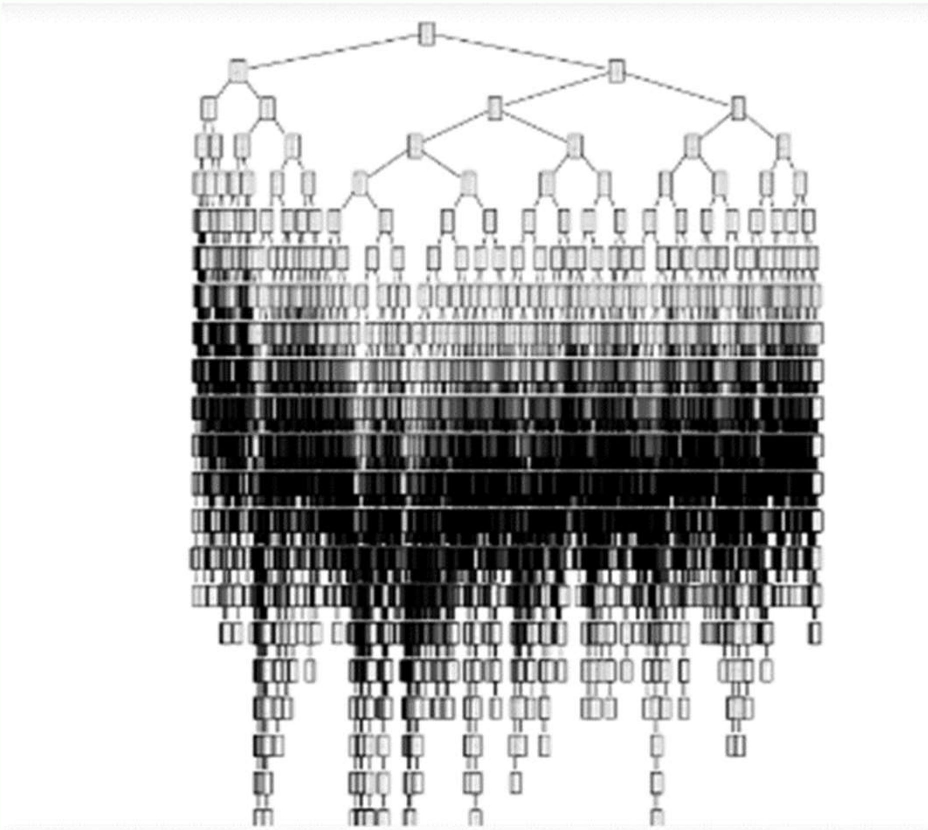
K-Nearest Neighbor algorithm that finds its category by its distance toward its neighbour

Weather Station	Accurate predictions		False positive	False negative	Accuracy rate
Basel	3917	961	421	439	85%
Belgrade	3252	1544	524	418	84%
Budapest	3424	1462	476	376	85%
Debilt	4320	723	317	378	88%
Desseldorf	4164	810	343	421	87%
Heathrow	4138	744	432	424	85%
Kassel	4563	614	252	309	90%
Ljubljana	3740	1180	455	363	86%
Maastricht	4253	824	309	352	88%
Madrid	2750	2261	418	309	87%
Munchenb	4237	792	309	400	88%
Oslo	4637	512	242	347	90%
Sonnblick	5738	0	0	0	100%
Stockholm	4483	607	283	365	89%
Valentia	5404	74	50	202	96%
				Average	88%

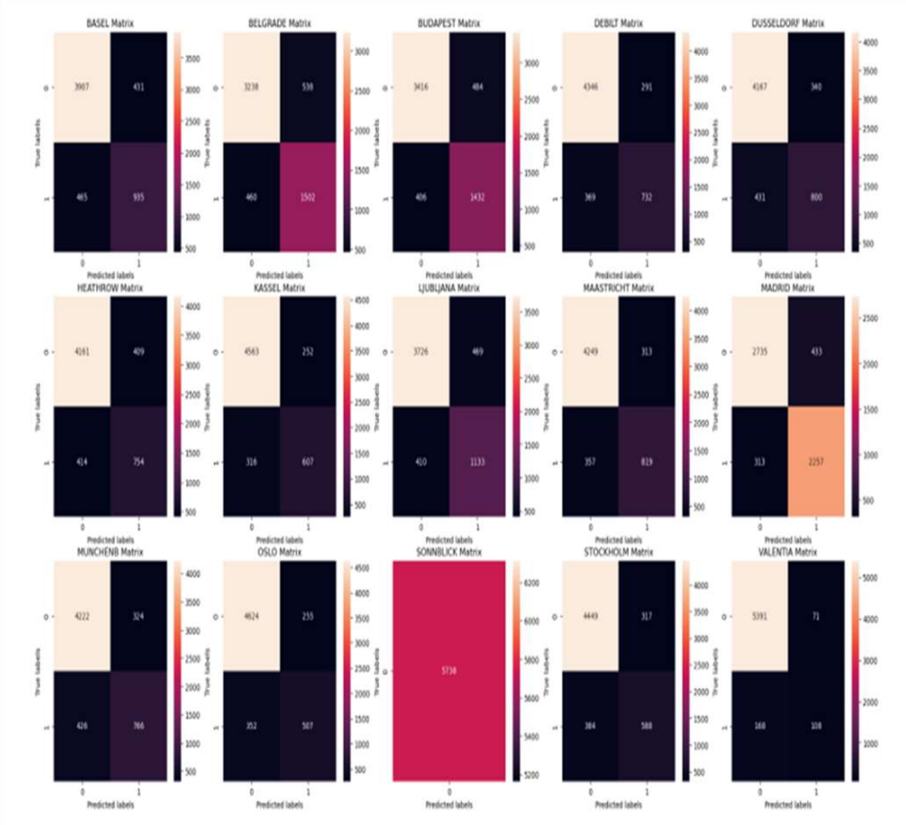
ANN - Training Data using confusion matrix:
Training and testing data were performed.



Decision Tree

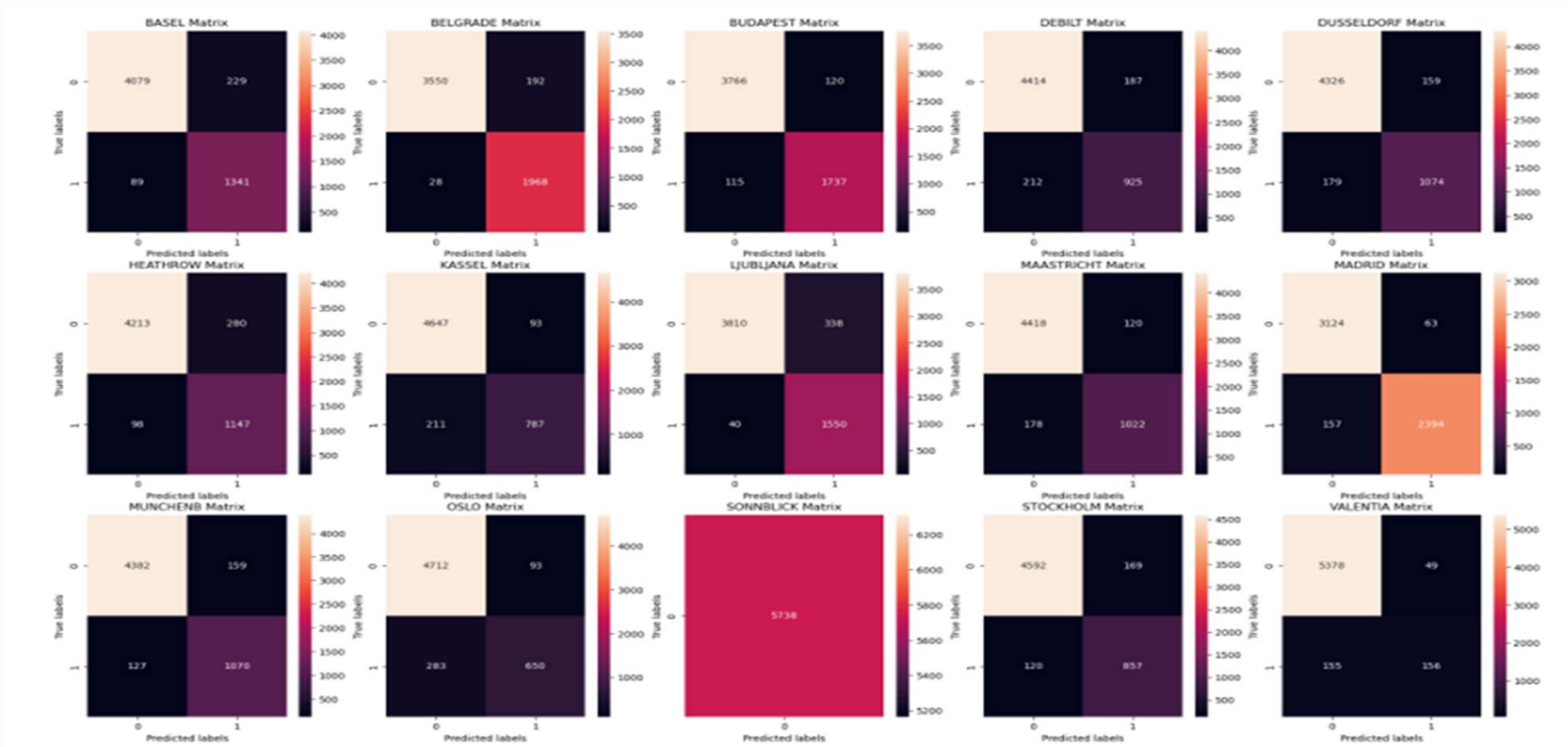


ANN - Testing and training data Table: whether using the confusion matrix of the weather stations that show good weather



Artificial Neural Network (ANN)

Testing Data using confusion matrix: training and testing data were performed.



Weather Conditions Overview

Weather varies globally due to location, circulation, and currents. Key factors like temperature, precipitation, and wind drive local patterns. Climate change increases unpredictability, with extremes in some regions.

Geographic Factors

Location, altitude, proximity to water bodies

Atmospheric Factors

Circulation patterns, pressure systems

Climate Change Effects

Increased unpredictability, extreme events

Temperature Variability Findings

ClimateWins data analysis reveals significant temperature variability across regions, with cities like Madrid and Belgrade showing more extreme temperatures, while regions with historically stable climates, such as Oslo and Kassel, show less variation but are beginning to display subtle signs of temperature increases.

High Variability Regions

Madrid and Belgrade show significant temperature fluctuations.

Stable Climate Regions

Oslo and Kassel show less variation but are warming gradually.

Climate Change Impact

Increasing temperature extremes and seasonal transition intensity are observed.

Extreme Weather Frequency

ClimateWins data analysis reveals increased frequency of extreme weather events, such as heatwaves, floods, and storms. While some regions remain relatively stable, others experience significant variability, impacting long-term forecast accuracy.

1. **Heatwaves**

   Frequency and intensity are increasing in many regions.

2. **Floods**

   Occurrences are more frequent in certain areas.

3. **Storms**

   Intensity and unpredictability are increasing.

4. **Model Adaptation**

   Prediction models require continuous refinement.

Model Accuracy and Challenges

Weather prediction accuracy varies by location. Stable climates like Kassel and Oslo achieve 90% accuracy, while unpredictable regions like Madrid face challenges. Adjustments may be needed for less predictable stations.

Station	Accuracy	Challenge
Sonnblick	100%	Potential overfitting
Kassel/Oslo	90%	Stable performance
Madrid	Lower	Unpredictable patterns

Overfitting and Model Adjustments

Sonnblick's 100% accuracy rate may indicate overfitting, meaning the model is too specific to its training data. To address this, ClimateWins should diversify its data and refine the model using techniques like cross-validation and regularization. This will enhance adaptability and reduce overfitting.

1

Identify Overfitting

Recognize high accuracy rates, potentially indicating overfitting

2

Diversify Data

Incorporate datasets from diverse climate regions

3

Apply Techniques

Implement cross-validation and regularization to improve adaptability

4

Continuous Refinement

Regularly update and adjust models for ongoing accuracy

Algorithm Performance Analysis

KNN model achieves 63% accuracy, outperforming initial 60% ANN. Adjusted ANN reaches 60%, with potential 85% through testing. No station perfect, SONNBLICK overfits. Unique dataset challenges overall accuracy.

KNN Performance

63% accuracy, currently outperforming ANN.

ANN Potential

60% initial accuracy, potential for 85% with tuning.

Challenges

Unpredictable fluctuations and overfitting issues.

Ethical Considerations

Climate AI raises ethical concerns. Data privacy, bias risks exist, but current dataset avoids personal info. Transparency, unbiased data key for ethical AI use.

Privacy Concerns

Potential monitoring of private property or activities.

Bias in Data

Influence of personal or political beliefs on data collection and analysis.

Ethical AI Use

Ensuring responsible and transparent AI applications in climate research.

Conclusions and Future Potential

ANN model shows most potential for accurate forecasting. Insights valuable, but predicting future weather remains challenging due to climate complexity.

Advanced Prediction Tools

Next-generation interfaces for climate analysis and forecasting

Expanded Data Collection

Comprehensive global network for more accurate climate data

Enhanced Collaboration

International cooperation for improved climate understanding and mitigation strategies

Recommendations for ClimateWins

1 Model Enhancements

Use expanded datasets and experiment with algorithms to improve predictions.

2 Climate Change Mitigation

Use improved forecasting for proactive climate change mitigation and early warning systems.

3 Research Collaboration

Collaborate with global weather agencies to refine the platform and climate change adaptation strategies.

4 Continuous Improvement

Regularly update and refine prediction models for informed decisions on climate change.

Thank you