PREDICTION OF FOREST FIRES USING MACHINE LEARNING

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Abstract.

Forest fires are one of the most threatening consequences of climate change. Not only do forest fires cause serious harm to the ecological balance, but they also threaten human lives and property. Predictive tools are essential for early detection and control of such an emergency. Machine Learning tools harness powerful algorithms to analyse and predict the patterns observable in natural calamities like forest fires. This project would implement Regression and Artificial Neural Networks for the prediction of forest fires. Individual machine learning models would be analysed and compared to determine the most accurate model. Since, determination of forest fire susceptibility in specific areas involves factors that have non-linear relationships, regression, and deep learning techniques would be used for prediction purposes. Every instance in our dataset would be mapped a corresponding susceptibility value based on forest fire risk factors by the ML models. Predictions obtained from such algorithms would be compared using ROC-AUC, Mean Absolute Error (MAE), and Root Mean Squared-Error (RMSE) evaluation metrics. The results highlighted would help in efficient control and disaster management by not only pinpointing specific high-risk areas but also allow timely intervention to prevent further spread.

Keywords. Regression, Artificial Neural Network, susceptibility value, ROC-AUC, Mean Absolute Error (MAE), Root Mean Squared-Error (RMSE)

1. INTRODUCTION

Forest fires are one of the most threatening consequences of climate change. Not only do forest fires cause serious harm to the ecological balance, but they also threaten human lives and property. Forest fires are capable of driving species of organisms to extinction if not controlled.

Besides, forest fires are also one of the significant contributors to atmospheric pollution and global warming as a result of different emissions that release harmful gasses into the atmosphere including CO2 and SO2.

We all know about the Amazon Rainforest wildfire back in 2019, and we are all aware of how devastating the fire was, with over 906 thousand hectares of forest within the Amazon biome having been lost to fires in 2019. Similar devastating forest wildfires have occurred across California, USA; British Columbia, Canada; Turkey and many other forests across the globe. The frequency and occurrence of forest-fires have seen a boom over the last decade. Predictive tools based on Machine Learning algorithms are essential for early detection and control of such an emergency. If forest fires can be predicted, then we can take preventive measures to save the environment from a lot of damage by controlling environmental pollution.

2. OBJECTIVE

Machine Learning tools harness powerful algorithms to analyse and predict the patterns observable in natural calamities like forest fires. This model implements logistic regression techniques and other machine learning classification tools as well as artificial neural networks for the prediction of forest fires. Individual machine learning tools would be analysed and compared to determine the most accurate model.

Determination of forest fire susceptibility in specific areas involves factors that have non-linear relationships such as humidity, temperature variance over a period, wind patterns, and so on. Therefore, nonlinear logistic regression, and deep learning techniques would be used for prediction purposes. Every instance in our dataset would be mapped a corresponding susceptibility value based on forest fire risk factors by the ML models.

Predictions obtained from such algorithms would be compared using ROC-AUC, Mean Absolute Error (MAE), and Root Mean Squared-Error (RMSE) evaluation metrics. The results highlighted would help in efficient control and disaster management. It would not only pinpoint specific high-risk areas but also allow timely intervention to prevent further spread.

3. METHODOLOGY

We will use the images captured by the thermal cameras of the satellites for the dataset, which will be fed into the ML models for analysis. By using computer vision libraries like TensorFlow and OpenCV, we will analyse the extent of the red color of a particular portion of the image and then map

that to a corresponding susceptibility value using regression techniques. After the analysis, the model will give us a probability value of the susceptibility of wildfire for a specific latitude and longitude, using which we can predict regions where there are high chances of forest fires. Besides, we will be adding a statistical based approach to our current image-based approach that will include different non-linear factors like wind direction, wind speed, temperature variance and so on.

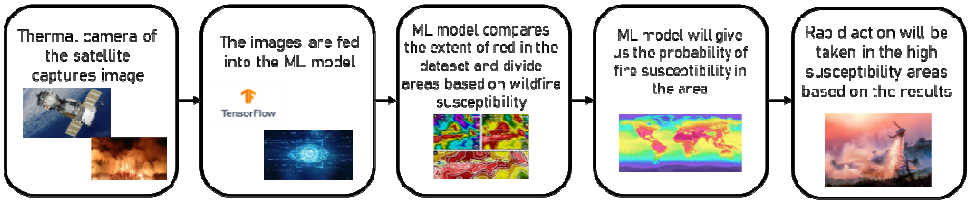

Fig 1. BLOCK DIAGRAM

Our system will operate in five layers, which are shown alongside.

- The 1st level will be the thermal image, which will be captured by the satellites.
- The 2nd level will be the different image datasets that will be formed after accumulating all the pictures from the sources.
- The 3rd level will be the different ML models where the image datasets will be fed into. We will initially train these models with the help of some datasets that we have acquired.
- The 4th level will be the Analysis Level, where using computer vision, the images will be analysed. The different models will be using different ML algorithms, so we will compare them to get the best possible result.
- In the 5th and final levels, the probability values of the susceptibility of wildfires for a particular region will be fed back to the server.

4. RESULTS AND ANALYSIS

For the time being, we have developed a python program that can detect the temperature of each region of a given input image after analysing the extent of redness using different computer vision libraries like OpenCV.

If the following thermal image is given as input to the program, then after analysing, it will give us the temperature of the required regions of the image.

Fig 2. Input image

Fig 3. Output image

The temperature values are shown in degrees Fahrenheit. Each temperature value is mapped to a corresponding susceptibility value using different regression techniques that can be used for the prediction of forest fires. Besides, we will be adding a statistical-based approach to our current image-based approach that will include different non-linear factors like wind direction, wind speed, temperature variance, and so on. Since the factors are non-linear, we'll be using neural networks. By combining both these approaches, the results obtained would be more accurate.

5. CONCLUSION

In this model we have not used a single algorithm but have applied multiple machine learning models using different algorithms to fetch the most accurate and reliable result. The results obtained are more accurate than the models currently in use. A detailed analysis report on the likelihood of wildfires in various forests around the world would be generated. The results highlighted would help in efficient control of environmental pollution and disaster management.

6. REFERENCES

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Biographies

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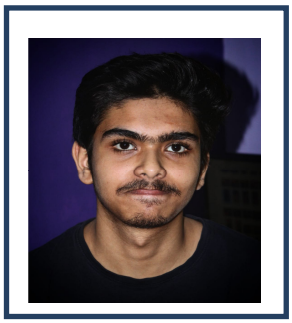
Sayantan Sarkar is currently pursuing his bachelor's degree in electronics and communication engineering from Institute of Engineering and Management, Kolkata. His research areas include machine learning, deep learning, and VLSI systems.



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