Climate Change: Prediction of Future Temperature

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***Abstract*— Scientists attribute the global warming trend observed since the mid-20th century to the human expansion of the "greenhouse effect" warming that results when the atmosphere traps heat radiating from Earth toward space. Certain gases in the atmosphere block heat from escaping. Long-lived gases that remain semi-permanently in the atmosphere and do not respond physically or chemically to changes in temperature are described as "forcing" climate change. Gases, such as water vapor, which respond physically or chemically to changes in temperature are seen as "feedbacks" [1]. Our project had two main objectives. First, we wanted to use historical average temperature data for every month of some countries to see how did global warming effect the average air temperature and predict the outcomes of future average temperature. Next, we wanted to use the ice extent data to see that if it is slowly decreasing because of global warming.**

Keywords— Global Warming, Climate Change, Temperature, Ice Extent, Machine Learning,

I. Introduction

Two global coupled climate models show that even if the concentrations of greenhouse gases in the atmosphere had been stabilized in the year 2000, we are already committed to further global warming of about another half degree and an additional 320% sea level rise caused by thermal expansion by the end of the 21st century. Projected weakening of the meridional overturning circulation in the North Atlantic Ocean does not lead to a net cooling in Europe. At any given point in time, even if concentrations are stabilized, there is a commitment to future climate changes that will be greater than those we have already observed [2]. Arctic sea ice reaches its minimum each September. September Arctic sea ice is now declining at a rate of 12.85 percent per decade, relative to the 1981 to 2010 average. Annual Arctic sea ice minimum since 1979, based on satellite observations. The 2012 sea ice extent is the lowest in the satellite record [3]. Therefore, in this project, we will use machine learning algorithms.to see the rising of the average temperature for some countries such as Brazil, Greenland, Antartica, Russia, Norway, Iceland, and Turkey. We wrote a code which can predict the future average temperature for these countries. Besides, our second aim is to see decline of the north pole ice extent.

II. Data and Preprocessing

We used several datasets in this study. Some of them are about average temperature of the countries and others are about ice extent in North Pole. We used Kaggle, National Centers for Environmental Information (NCEI), and The National Snow and Ice Data Center (NSIDC) for datasets. We spent about 70% of the time in this project for data analysis, cleaning and retrieving data. Because, datasets which we got from these websites were not suitable for our models and we had to make arrangements. After all, we were ready to apply datasets to our models.

III. Methods

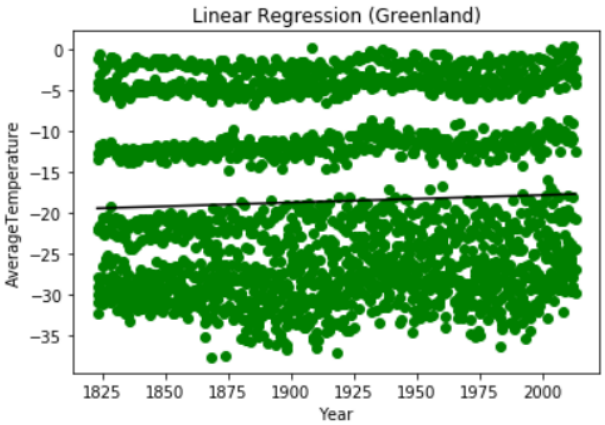
We decided to try several machine learning algorithms. We briefly summarize how each works below

A. Linear Regression

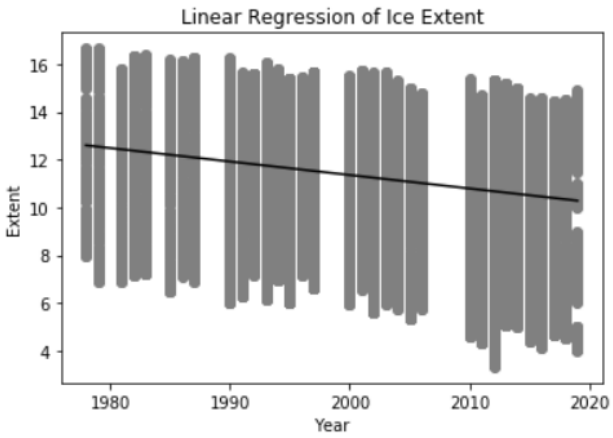
Linear Regression is a machine learning algorithm based on supervised learning. It performs a regression task. Regression models a target prediction value based on independent variables. It is mostly used for finding out the relationship between variables and forecasting. Different regression models differ based on – the kind of relationship between dependent and independent variables, they are considering and the number of independent variables being used. Hypothesis function for Linear Regression :

$$y = \theta_1 + \theta_2 . x$$

For our dataset, our features are average temperature value for every month, year and month. You can see our linear regression model graph below.



As you see that the average temperature in Greenland has rised almost 2° Celcius degree since nearly 150 years. In 1850, the average temperature was -19.21° Celcius degree. However, according to our code in 2050 the average temperature will have been -17.37° Celcius degree.

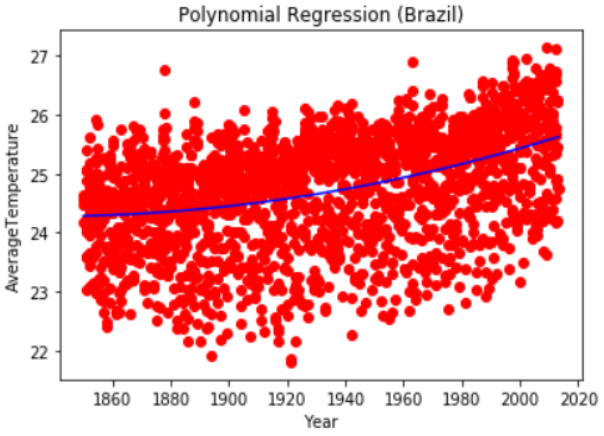


This dataset provides the total extent for each day in north pole for the entire time period (1978-2019). Extent of ice value has unit of 10^6 sq km. As you see that in 40 years, the extent value has declined about 1.5 x 10^6 sq km in north pole. According to our code in 2200, there will be no ice in north pole.

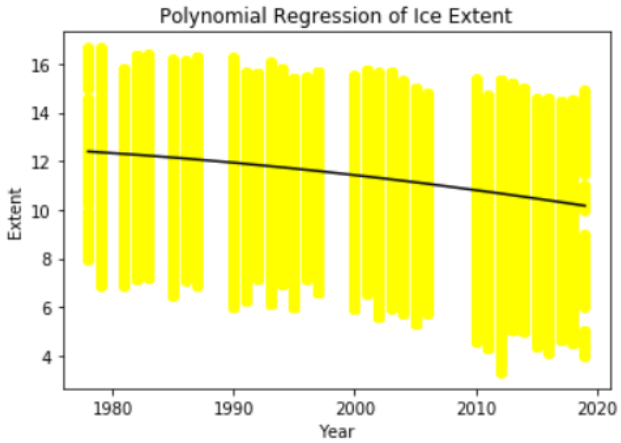
B. *Polynomial Regression*

Polynomial Regression is a form of linear regression in which the relationship between the independent variable x and dependent variable y is modeled as an nth degree polynomial. Polynomial regression fits a nonlinear relationship between the value of x and the corresponding conditional mean of y, denoted E(y |x).

$$y = \theta_1 + \theta_2.x + \theta_3.x^2$$



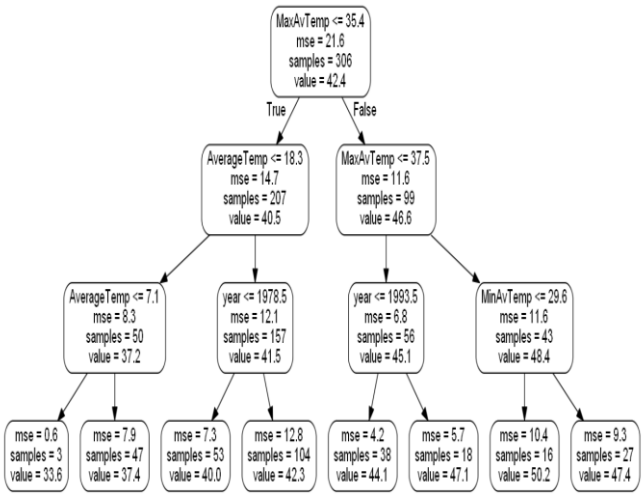
As you see that the average temperature in Brazil has rised almost 1° Celcius degree since nearly 150 years. Easily, you can see the difference between Linear and Polynomial Regression from the graphs. In 1850, the average temperature was 24.28° Celcius degree. However, according to our code in 2050 the average temperature will have been 25.73° Celcius degree.



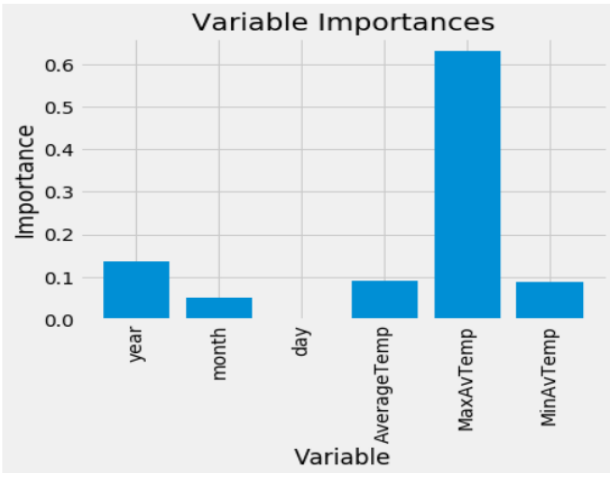
According to our code in 2120, there will be no ice in north pole. Therefore, we can see that Polynomial Regression model is more accurate. When we analyze the research, scientists say that before this century, there will be no ice in north pole.

C. *Random Forest*

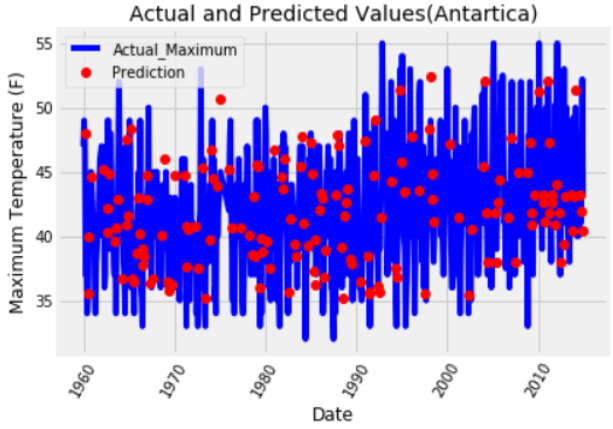
Random forest, like its name implies, consists of a large number of individual decision trees that operate as an ensemble. Each individual tree in the random forest spits out a class prediction and the class with the most votes becomes our model's prediction.



Based solely on this tree, we can make a prediction for any new data point.



In order to quantify the usefulness of all the variables in the entire random forest, we can look at the relative importances of the variables. This tells us that we actually do not need all the data we collected to make accurate predictions.

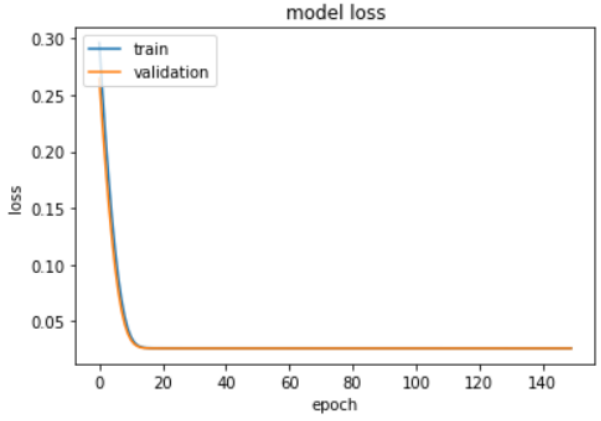


We plotted the entire dataset for Antartica with predictions highlighted this time our temperature value is in terms of Fahrenheit degree and we got 2.08 mean absolute error and 95.01 % accuracy. That looks well. Our model has learned how to predict the temperature for the future day in Antartica with 95.01 accuracy.

D. Neural Network

Neural Network is a set of mathematical expressions that are really good at recognizing patterns in information, or data. A NN accomplishes this through a kind of human emulated perception, but instead of seeing, say an image, like a human would, the NN expresses this information numerically contained within a Vector or Scalar.

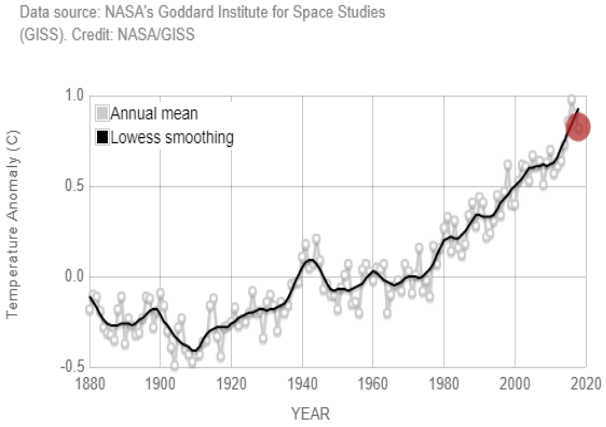
We applied Neural Network to our dataset. we have specified 250 epochs for our model. This means that we are essentially training our model over 250 forward and backward passes, with the expectation that our loss will decrease with each epoch, meaning that our model is predicting the value of y more accurately as we continue to train the model.



Both the training and validation loss decrease in an exponential fashion as the number of epochs is increased, suggesting that the model gains a high degree of accuracy as our epochs (or number of forward and backward passes) is increased. In 1800 predicted temperature value is 23.6° fahrenheit degree and in 2060 the predicted temperature value will be 25.85° fahrenheit degree this mean the temperature will be increased nearly 2 degrees celcius. 2 degree looks like not too much but its enough to make ice melt if the conditions are appropriate. It is really close to degree of 0° celcius degree. As you know ice start melt if the degree past 0° celcius degree. If we consider these informations nearly in 100 years ice will be started to melt faster.

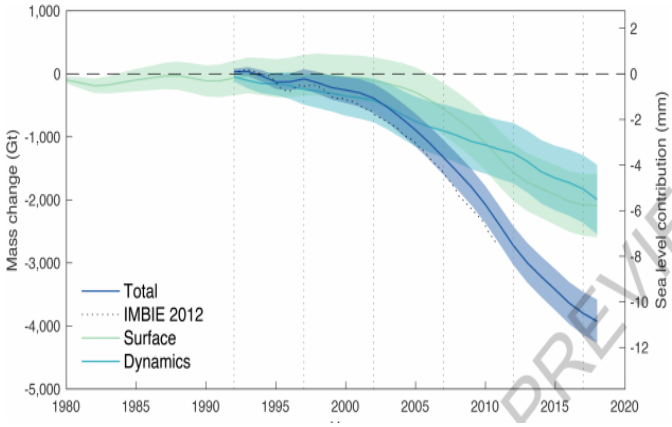
IV. CONCLUSION

Global warming is one of the most important situation in the World and every year temperature rises. If we don't be carefull in 100 years there will be no ice in the World and global warming will have been dangerous. If we consider of machine learning algorithms which have been applied to temperatures of countries global warming will have come up in close time. The alghorithms which we used on temperature datasets say that temperature will rise about 2° celcius in 100 years. This mean end of the World is really close [4].



Our regression models also really close with this graph and our results and predictions say that temperature will have been rised 2° celcius degree in 100 years. We have to be carefull from now to later or in 100 years maybe we won't have the World to live.

The other situation which we observed mass of ice in the World. Ice sheet was close to a state of balance in the 1990s, annual losses have risen since then, peaking at 335 ± 62 billion tonnes per year in 2011. In all, Greenland lost 3,800 ± 339 billion tonnes of ice between 1992 and 2018, causing the mean sea level to rise by 10.6 ± 0.9 millimeters. Using three regional climate models, we show that reduced surface mass balance has driven 1,971 ± 555 billion tonnes (52%) of the ice loss owing to increased meltwater run of. The remaining 1,827 ± 538 billion tonnes (48%) of ice loss was due to increased glacier discharge, which rose from 41 ± 37 billion tonnes per year in the 1990s to 87 ± 25 billion tonnes per year. This mean there will be no ice in 100 years in the World. This couse rising of water level therefore living areas, farming areas will reduce [5].



Our models also give information about mass of ice lose and our prediction say that there will be no ice in close years. Global warming is becoming dangerous our regression model also say that the same thing.

If we consider all of these things we have to take prevention to stop the global warming or we will have had to change the World. This mean we have to find new World to live.

ACKNOWLEDGMENT

We would like to thank Assoc. Prof. Dr. Aytuğ Onan for giving this lecture and helping us with the project.

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