Modeling Climate Change & Predicting the Trend

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Background Information

Global Warming & Climate Change- what is it?

- Global warming: increase in surface temperature of the Earth
- Climate change: change in climate for more factors than just temperature

Why does it matter?

- Devastation to food sources for humans and other species
- Unlivable conditions

Significant aspects we looked at:

- Global Surface Temperature
- CO2 emissions

Questions

1. *What will global warming and climate change look like in the future?*
    a. *Current state?*

2. *What is the current trend with CO2 emissions and is it correlated to global temperature increase?*

Data

Two major contributing factors to global warming/climate change:

1. CO2 emissions
2. Land Temperature

Data obtained from NASA

Coding in Python- Packages

1. Numpy/pandas
2. Sklearn
    a. For predictions of trends, linear regression
3. Seaborn, Matplotlib
4. Datetime and calendar
5. For correlation: scipy.stats Spearman
6. Installed the following:
    a. Prophet Library by Facebook
        i. Regression visualization chart
    b. Plotly offline, chart studio, cufflinks
        i. Interactive visualizations

Methods (Example Code)

- Data Cleaning- indexing and working with dates (resample)

```
In [27]: #data range
         date_rng = pd.date_range(start='1/1/1880', end='1/03/2019', freq='M')
         t = pd.DataFrame(date_rng, columns=['date'])
         # Create a column for the anomoly values
         t['Avg_Anomaly_deg_C'] = None
         # Set the index of the DataFrame to the date column (DateTime index)
         t.set_index('date', inplace=True)
         t.head()
```

```
t.resample('A').mean().head()
# https://pandas.pydata.org/par
```

date	Avg_Anomaly_deg_C
1880-12-31	-0.187500
1881-12-31	-0.100833
1882-12-31	-0.110000
1883-12-31	-0.191667
1884-12-31	-0.294167

Filling in NA data:

```
e.fillna(method='ffill', inplace=True)
e[e.index.year>2011]
```

Preparing packages:

```
pip install plotly --upgrade
```

```
Requirement already up-to-date: p
Requirement already satisfied, sk
packages (from plotly) (1.3.3)
Requirement already satisfied, sk
om plotly) (1.12.0)
```

Methods (Example Code)

Data Analysis:

```
# Create figure, title and plot data
plt.figure(figsize=(10,8))
plt.xlabel('Time (years)')
plt.ylabel('Temperature Anomaly (Celsius)')
plt.plot(t, color='Red', linewidth=1.0)
```

Facebook Trend Predictor

```
# Import Facebook's Prophet forecasting library
from fbprophet import Prophet
# Create a new DataFrame with which we will create/train our Prophet model
t_prophet = pd.DataFrame()
t_prophet['ds'] = t.index
t_prophet['y'] = t['Avg_Anomaly_deg_C'].values

# Instantiate model and fit to data (just like with sklearn model API)
m = Prophet()
m.fit(t_prophet)

# Generate future dataframe containing predictions (we are doing this for 100 y
future = m.make_future_dataframe(freq='m', periods=100*12)
forecast = m.predict(future)

# Plot the resulting forecast
m.plot(forecast)
```

Linear Regression:

```
#Model from online
regressor = LinearRegression()
regressor.fit(X_train, y_train) #training the algorithm
#To retrieve the intercept:
print('the intercept of our model is',regressor.intercept_)
#For retrieving the slope:
print('the slope of our model is',regressor.coef_)
y_pred = regressor.predict(X_test)
df = pd.DataFrame({'Actual': y_test.flatten(), 'Predicted': y_pred.flatten()})
df1 = df.head(25)
df1.plot(kind='bar',figsize=(8,8))
plt.grid(which='major', linestyle='-', linewidth='0.5', color='green')
plt.grid(which='minor', linestyle=':', linewidth='0.5', color='black')
plt.show()
plt.scatter(X_test, y_test,  color='gray')
plt.plot(X_test, y_pred, color='red', linewidth=2)
plt.show()
```

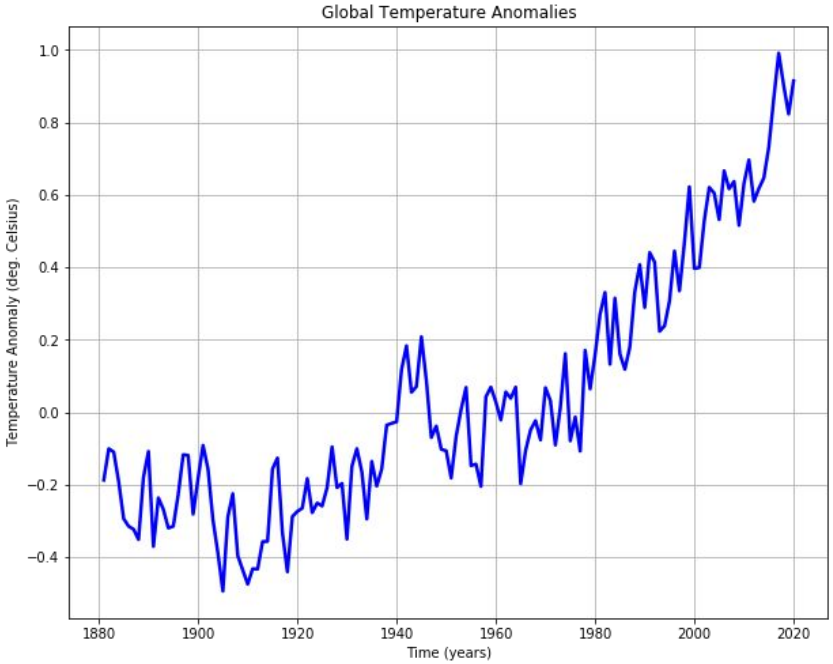
Correlation

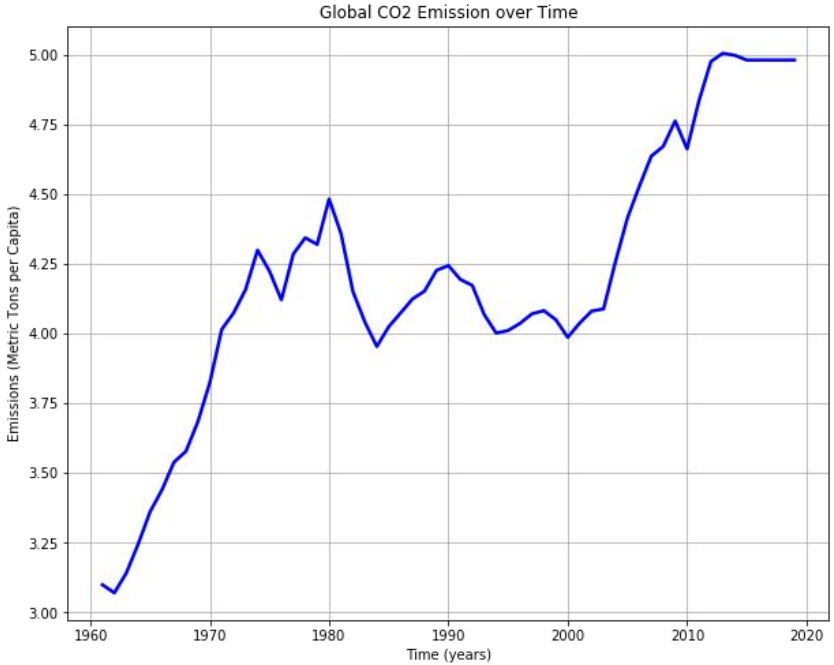
```
#Correlation model: using scipy.stats Spearman
from numpy.random import randn
from numpy.random import seed
from scipy.stats import spearmanr
# seed random number generator
seed(1)
# calculate spearman's correlation
corr, _ = spearmanr(t_final, e)
print('Spearmans correlation: %.3f' % corr)
```

Results

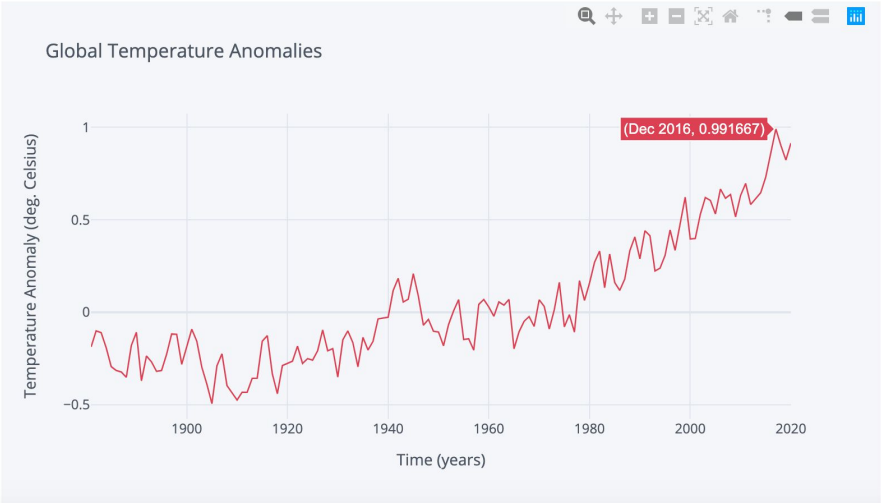
- Prophet Regression Technique:
  - By 2124 CO2 will increase by about 7 metrics tons/capita
  - By 2124 Temperature will increase about 2 degrees celsius
- Correlation (CO2 and Temperature)
  - Weak positive correlation of value:
    - Spearman’s correlation: 0.685
- SkLearn Linear Regression
  - the intercept of our model is [3.80886063]
  - the slope of our model is [1.28785762]
- Data-fitting is displayed in our Prophet Regression Line

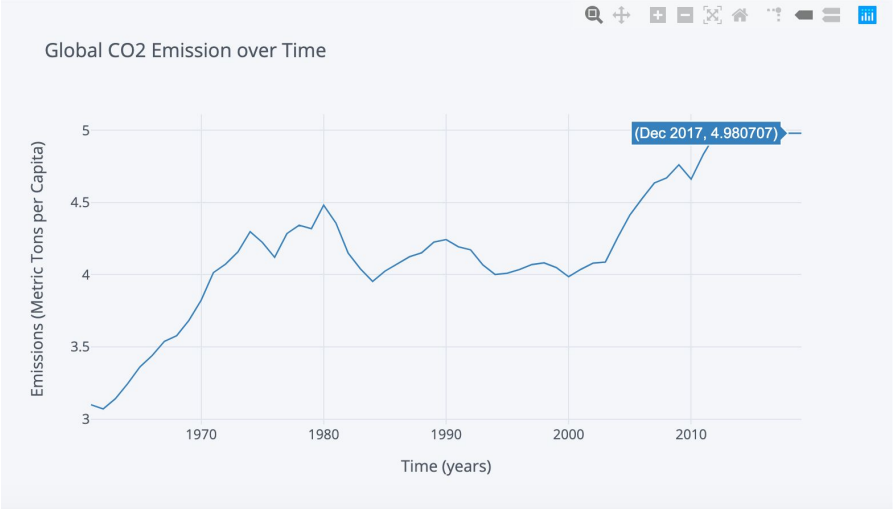
Visualizations: Analysis (matplotlib)





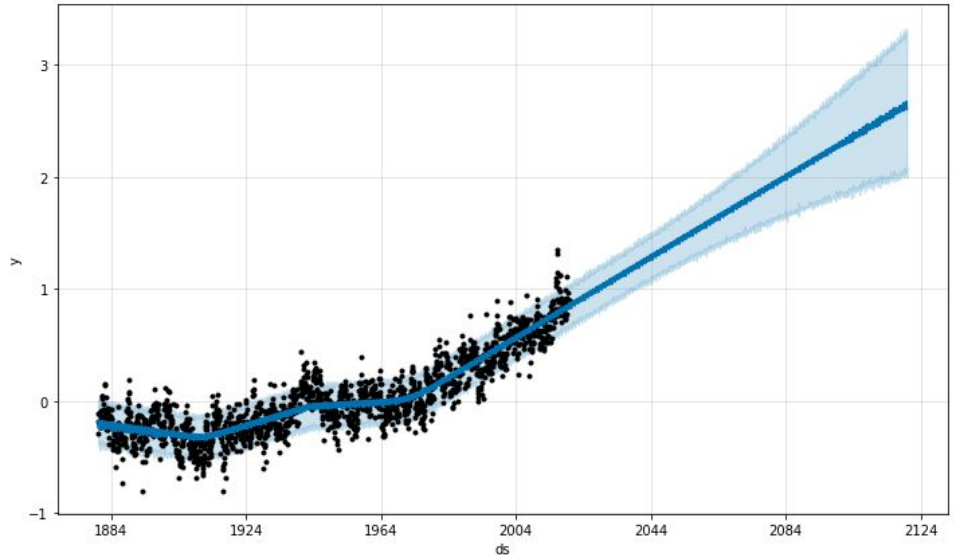
Visualizations: Analysis (online plot.ly)



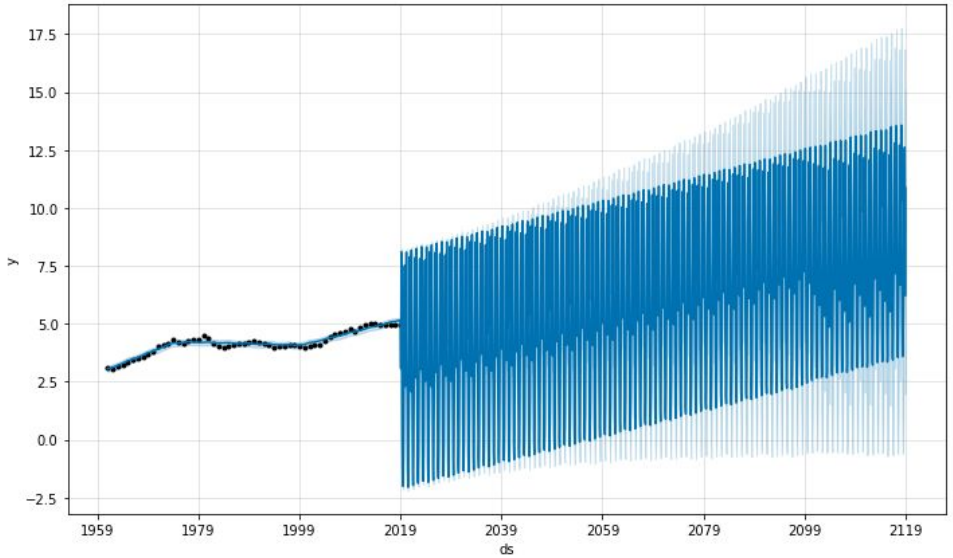


Visualization- Prophet Regression

Temperature Predicted Trend



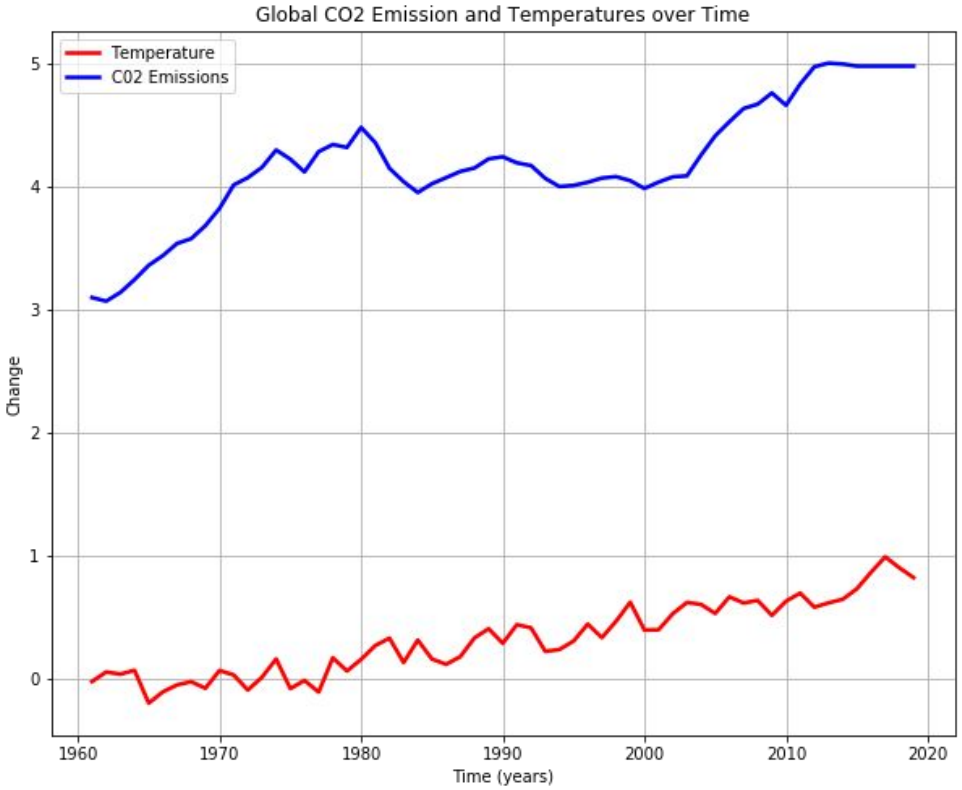
CO2 Predicted Trend



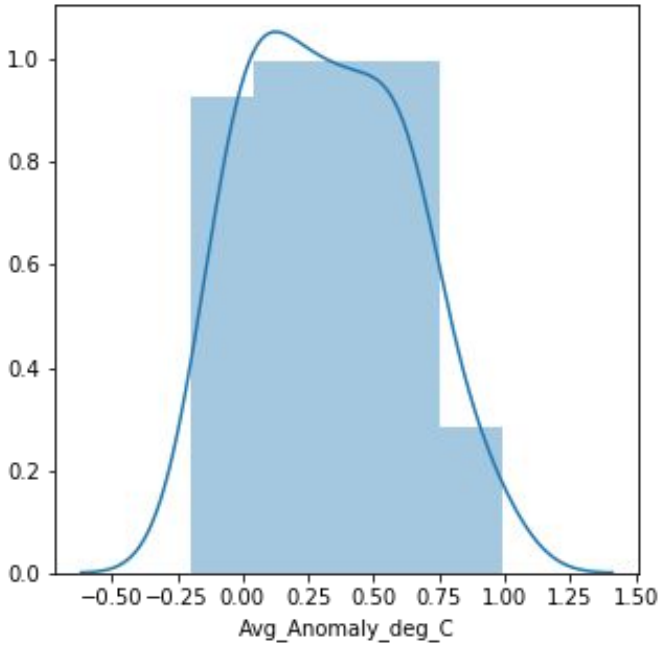
Model overfit & less C02 datapoints

Visualizations: Correlation

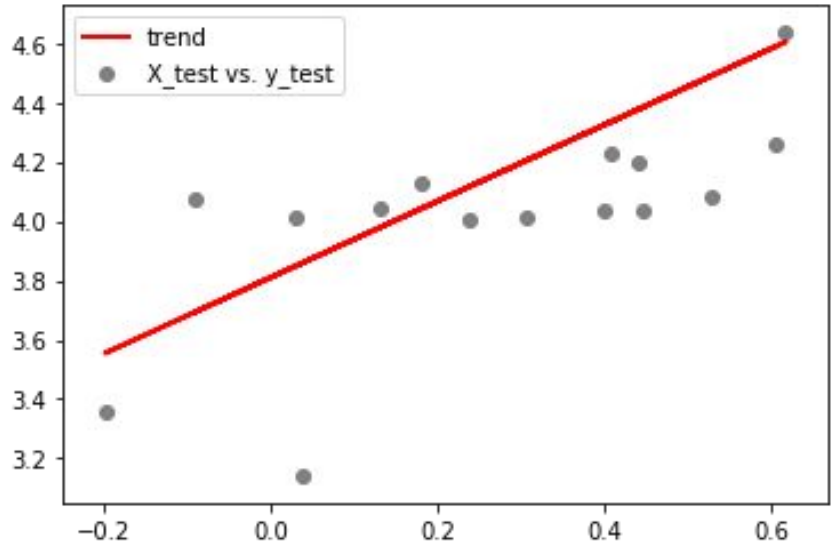
Spearman's Correlation suggests a weak positive correlation between two metrics



Visualizations: SkLearn Linear Regression- Datafit



Data Fitting with Linear Model: CO2 vs Temp Change



Conclusions

- *What will global warming and climate change look like in the future?*
  - *Current state?* Temperature and CO2 levels are increasing as a trend
  - Climate will continue to change as these metrics continue to increase levels
- *What does CO2 look like and is it correlated to global temperature increase?*
  - CO2 emissions are increasing historically over time
  - There is a weak positive correlation with the two features, so as CO2 emissions increase, so will temperature
- We need to be the change to solve this issue!

Sources

GISTEMP Team, 2019: GISS Surface Temperature Analysis (GISTEMP), version 4. NASA Goddard Institute for Space Studies. Dataset accessed 2019-11-25 at https://data.giss.nasa.gov/gistemp/. [data]

Lenssen, N., G. Schmidt, J. Hansen, M. Menne,A. Persin,R. Ruedy, and D. Zyss, 2019: Improvements in the GISTEMP uncertainty model. J. Geophys. Res. Atmos., 124, no. 12, 6307-6326, doi:10.1029/2018JD029522. [data]

Desk, India Today Web. “Climate Change Denial Disorder: 2018 Becomes Earth's Fourth Hottest Year on Record.” India Today, 11 Feb. 2019, www.indiatoday.in/science/story/2018-becomes-earth-fourth-hottest-year-on-record-1451447-2019-02-08. [Photo]

“The Causes of Climate Change.” NASA, NASA, 30 Sept. 2019, climate.nasa.gov/causes/. [background info]

Turner, Peter. “Time Series Analysis and Climate Change.” Medium, Towards Data Science, 10 Sept. 2019, towardsdatascience.com/time-series-analysis-and-climate-change-7bb4371021e.

Thank you for your time- Questions?