Algeria Forest Fire Dataset Analysis

ITEC 2600 C Project

Introduction

The data set we chose is the Algerian Forest Fires Dataset. The dataset includes two regions of Algeria, namely the Bejaia region in the northeast and the Sidi Bel-Abbes region in the northwest of Algeria. Each region's data is recorded from June to September in 2012, so 4 months for each region (122 days for each region). The dataset is a CSV file. The attributes were recorded in 2012, and the attributes included in this dataset include the date (in months and years), temperature, relative humidity (RH), wind speed (WS), rain, and FWI components like fine fuel moisture code (FFMC), duff moisture code (DMC), drought code (DC), initial spread index (ISI), buildup index (BUI), and fire weather index (FWI).

Let us introduce some basic information about Algeria's forest fires. Algeria is affected by forest fires that occur every summer, but the rate of being affected by fires increases from year to year due to climate change that causes drought and heat waves. From 1985 to 2010, Algeria recorded 42,555 fires that burned a total area of 9106.4 square kilometers. Attributes shown above are some of the major components to compute the danger rating scale for a forest fire. The FFMC indicates the litter for the ignition and spread of the fire, the DMC and DC indicate fire intensity, and ISI indicates the correlation to the fire velocity spread.[1].

[1] "Ask the Scientist: How Can the Weather Spark and Spread Wildfires?" *National Oceanic and Atmospheric Administration*, https://www.noaa.gov/stories/ask-scientist-how-can-weather-spark-and-spread-wildfires.

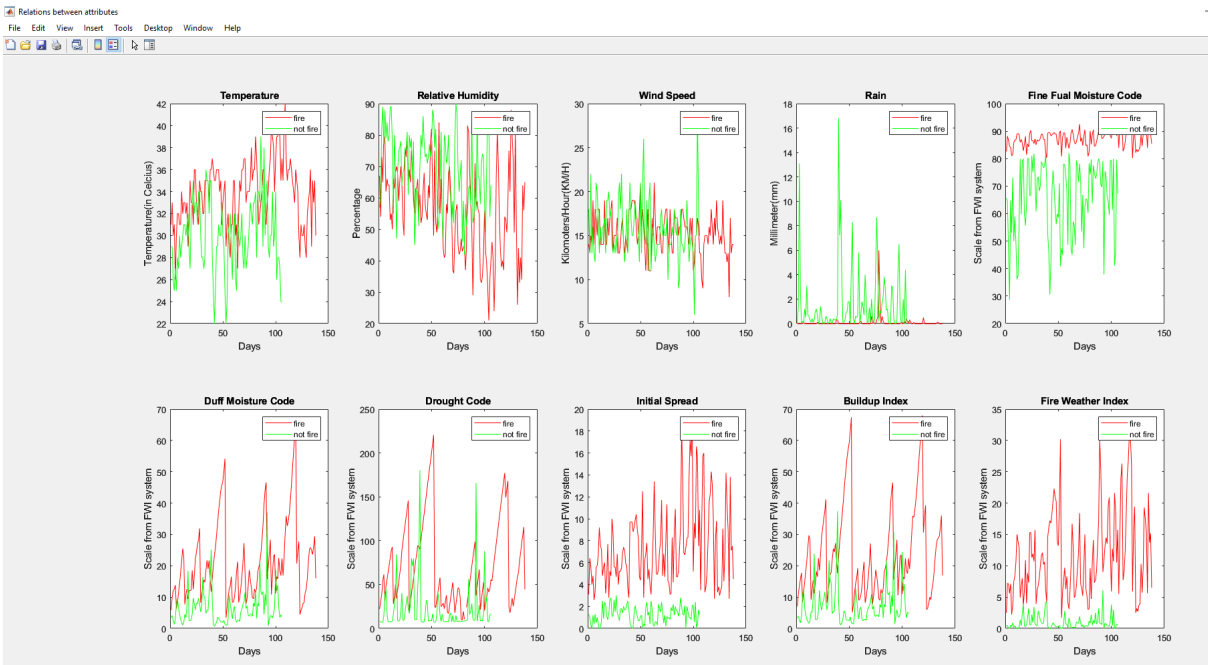
Data analysis

There is no missing data, the only inconsistent data that occurred in the dataset was a missing delimiter in the Bejaia region data (line 171).

We think that the forest fire dataset is best analyzed by separating the fire classes and not fire classes, so we wrote the program in Matlab and we see in the Bejaia Region, there are 59 fires and 43 not fires, and for the Sidi Bel-Abbes region there are 79 fires and 43 that are not fires.

After running the codes in MATLAB, it will display multiple figures of our analysis.

1. **Relationships and Comparisons between attributes** (Michelle)



We created this figure because we think it's easier to see the relationships between attributes. The following comparison/relationship is from the 'Relationship between attributes' figure:

- In the 'Temperature' graph, as we can see, the temperature is slightly higher when there is fire compared to when there is no fire because as the temperature rises, the

forest is more flammable. Statistics and Scientists have shown that “Warmer temperatures and lower relative humidity make the fuels more receptive to ignition.”

- Relative Humidity is also connected to temperature and the forest, as we can see in the graph "Relative Humidity", the data for the two classes are similar, but with a closer look, we see the relative humidity for fire is somewhere lower than for non-fires. Indicating that, yes, the lower the relative humidity is, the more possibility of a fire.
- In the ‘Rain’ graph, the graph indicates there is no fire, with the precipitation reaching to or is 0, compared to when there is fire, the precipitation variates.
- Fine Fuel Moisture Code (FFMC) is a numeric rating of the moisture content of litter and other cured fine fuels, determined by the temperature, relative humidity, wind speed, and rain. As we can see from the "FFMC" graph, the comparison is really obvious: high when there is fire and vice versa.
- Duff Moisture Code (DMC) is a numeric rating of the average moisture content of loosely compacted organic layers of moderate depth. The DMC graph is also an obvious comparison, high DMC leads to fire and vice versa.
- Drought Code (DC) is a numeric rating of the average moisture content of deep, compact organic layers. High DC indicates fire and vice versa.
- Initial Spread Index (ISI) is a numeric rating of the expected rate of fire spread, it’s based on the wind speed and FFMC. High ISI indicates fire and vice versa.
- Buildup Index (BUI) is a numeric rating of the total amount of fuel available for combustion, this is based on the DMC and DC. High BUI indicates fire and vice versa.

- Fire Weather Index (FWI) is a numeric rating of the fire intensity, based on the ISI and the BUI, it's used as a general index of fire danger. Obviously, the higher the FWI, the more dangerous fire there is.

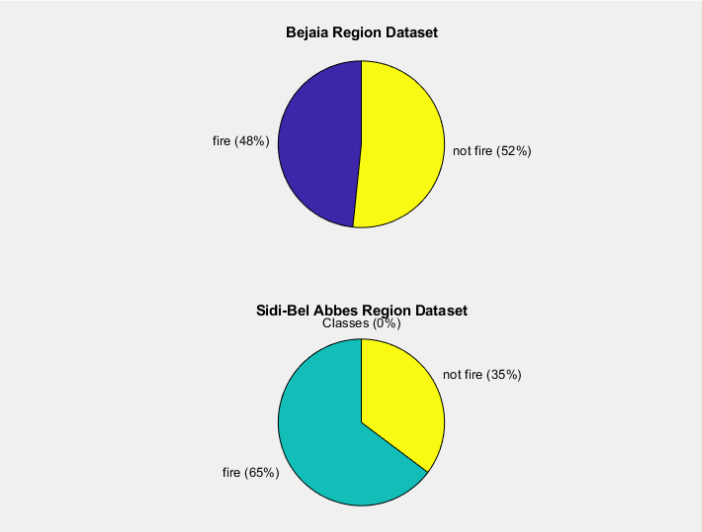
2. **Statistics of each attribution** (Michelle)

We've created a summary table available in MATLAB workspace, it is a table summary table, called 'fire_data_summary' and 'not_fire_summary', we also separated the regions, for the Bejaia region, we have: 'fire_bejaia_summary' and 'not_fire_bejaia_summary'; for the Sidibel region, we have: 'fire_sidibel_summary' and 'not_fire_sidibel_summary'. To make it easier to see, I've also made a table in this report, but the data I have for the following table is from the MATLAB script we wrote. Standard deviation is also calculated and stored in the workspace while running MATLAB. We've created two tables for each region's standard deviation, and another two tables for fire and not fire classes.

Class/Attributes (Min, Median, Max)	Temp	RH	WS	Rain	FFMC	DMC	DC	ISI	BUI	FWI
Fires	26/34/42	21/56/88	8/15/21	0/0/6	80.2/87.8/96	3.4/17.9/65/9	9.7/54.2/220.4	2.6/6.9/19	5.1/19.2/68	1.7/10.5/31.1
Not Fires	22/30/39	42/71/90	6/15/29	0/0.6/16.8	28.6/68.3/82	0.7/4.8/37	6.9/9.7/180.4	1.2/3/0	1.1/5.6/37/4	0/0.6/6.1

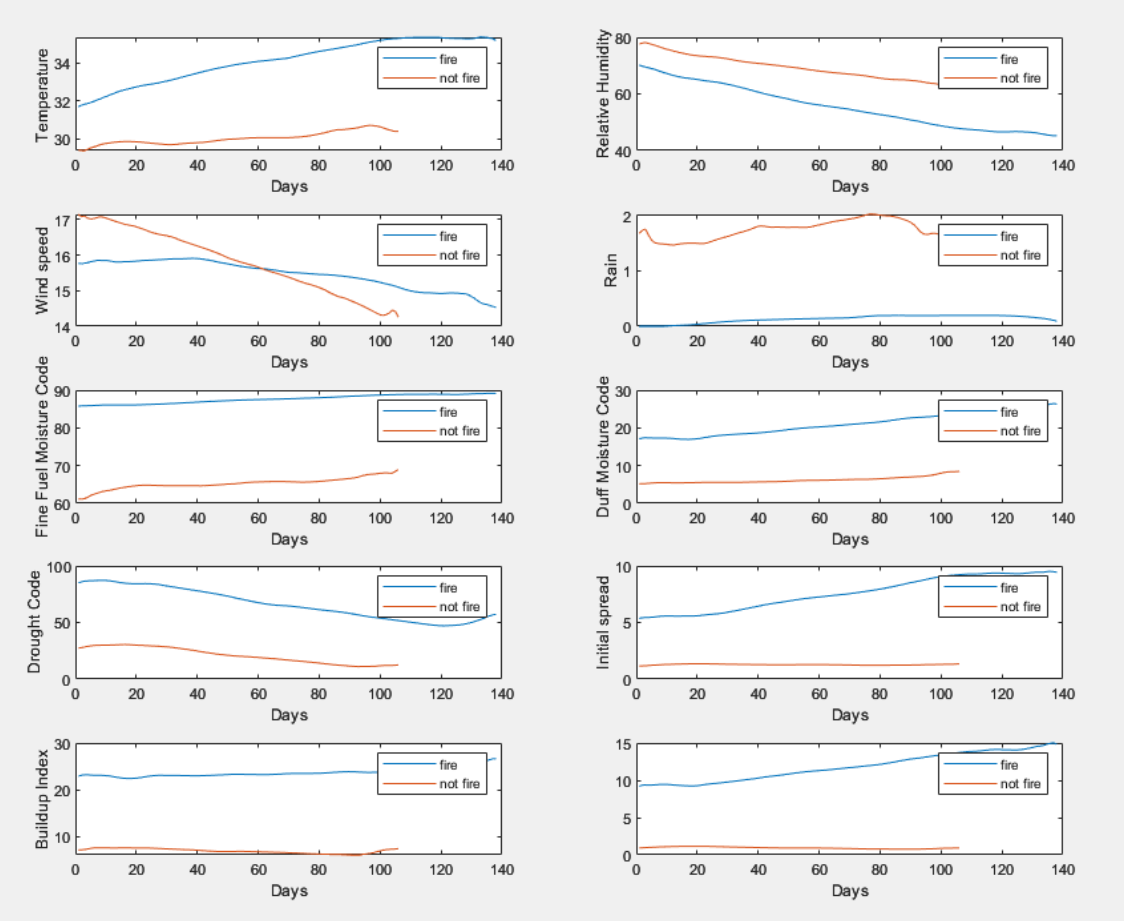
3. **Pie chart indicating amount of fire and not fire in each region** (Dongwang)

From the data in the pie chart, it can be seen that the probability of a fire in the Bejaia Region Dataset is relatively small, but it has reached a probability of 48%, which is close to half. The Sidi-Bel Abbes Region has a higher probability of catching fire, reaching 65%



4. **Trend of each attributes between fire and not fire classes**

We decided to create a trend graph for each attribute between fire and not fire situation in order to see more clearly of the relationship and the differences there are between fire and not fire situation.



5. Forecast

From the 122 days of recorded regional data that is available to us that dates from June to September 2012 and the graphs we have developed from that data, throughout the span of time we can see the certain factors that cause the fires more consistently but is not limited too, is when the temperature is averaging 32 deg celsius, humidity was around 65% on average, 17 km/hr wind speeds were the sweet spot that carried the flames to spread and coexist, the FFMC,DMC,DC chart were off the charts statistics that in hand shows why the FWI chart was so high. As mentioned before, the FFMC indicates the litter for the ignition and spread of the fire, the DMC and DC indicate fire intensity, and ISI indicates the correlation to the fire velocity spread.[2]. Forest fires occur every summer in Algeria, and its devastating impacts increase due to climate change which establishes acceleration requirements by severe drought and heat waves. With the global temperatures increasing, and the effects of climate change strengthening, these fires can be forecasted to occur more frequently than ever before and break historic records!

[2] "Ask the Scientist: How Can the Weather Spark and Spread Wildfires?" *National Oceanic and Atmospheric Administration*, https://www.noaa.gov/stories/ask-scientist-how-can-weather-spark-and-spread-wildfires.

Conclusion

In this report, we analyzed the Algeria Forest Fire Dataset using MATLAB, we showed the relationships between the forest fire and each attribute/cause and what region of patterns tend to be the sweet spot for the fires becoming more frequent.

We concluded that when there is a fire, it indicates: warm weather (high temperature), low humidity, relatively higher wind speed, almost no rain, and high FFMC, DMC, DC, ISI, BUI, and FWI.

References

The original dataset website:

"Forest Fires in Algeria - Situation Report, September 3, 2022 - Algeria." *ReliefWeb*, 3 Sept. 2022, https://reliefweb.int/report/algeria/forest-fires-algeria-situation-report-september-3-2022.

Matlab's Mathwork Help Center:

"Documentation." *Documentation - MATLAB & Simulink*, https://www.mathworks.com/help/index.html.

Meaning/definition of some of the attributes:

Canada, Natural Resources. "Canadian Wildland Fire Information System: Canadian Forest Fire Weather Index (FWI) System." *Canadian Wildland Fire Information System | Canadian Forest Fire Weather Index (FWI) System*, https://cwfis.cfs.nrcan.gc.ca/background/summary/fwi#:~:text=The%20Fine%20Fuel%20Moisture%20Code,the%20flammability%20of%20fine%20fuel.