INSIGHT AND DERIVING THE SPIRAL VISUALIZATION OF CLIMATE CHANGE

Kripa Sekaran[1], Medha Priyanga S[2], Vaishnavi B[3]
[1] - Assistant Professor, Department of IT, St. Joseph's College of Engineering, Chennai, India, mailto:kripasekaran23@gmail.com
[2] - Department of IT, St. Joseph's College of Engineering, Chennai, India, medhaapr99@gmail.com [3]
- Department of IT, St. Joseph's College of Engineering, Chennai, India, vaishnaviv698@gmail.com

ABSTRACT

Our climate is evolving. Although global and regional temperatures generally have a long-term upward trend, the presence of natural variability means that each year, or a decade, is not necessarily warmer than the last. Communication of the impact of natural fluctuations is vital for decision-makers and for a skeptical public. Progress in understanding and predicting the natural fluctuations in climate offers the potential to test and improve climate models, narrow the uncertainty in climate predictions, and aid adaptation to our evolving climate. Meeting these substantial scientific challenges requires continued investment in global observations, more advanced climate models and better ways of testing climate models against observations. The Spiral Visualization of climate change presents global temperature change in a visually appealing and straightforward way. The pace of change is immediately obvious, especially over the past few decades. The relationship between current global temperatures and the internationally discussed target limits are also clear without much complex interpretation needed.

Keywords: Data cleaning, Data mining, Data Visualization

1. INTRODUCTION:

1.1 DATA VISUALIZATION

Data visualization is a graphical representation of information and data. By using visual elements like charts, graphs, and maps, data visualization tools provide an accessible way to see and understand trends, outliers, and patterns in data. In the world of Big Data, data visualization tools and technologies are essential to analyze massive amounts of information and make data-driven decisions. As the "age of Big data" kicks into high gear visualization is an increasingly key tool to make sense of the trillions of rows of data generated every day. Data visualization helps to tell stories by crusting data into a form easier to understand, highlighting the trends and outliers. A good visualization tells a story, removing the noise from data, and highlighting the useful information. There are dozens of tools available for data visualization and data analysis. These range from simple to complex, from intuitive to obtuse. Not every tool is right for every person looking to learn visualization techniques, and not every tool can scale to industry or enterprise purposes. It's technology, however, that truly lit the fire under data visualization. Computers made it possible to process large amounts of data at lightning-fast speeds. Today, data visualization has become a rapidly evolving blend of science and art that is certain to change the corporate landscape over the next few years.

1.2. SYSTEM OVERVIEW

Visualization is a key technology for analyzing and presenting climate simulations and observations as well as related social and ecological data. Furthermore, mediating research results to decision-makers and to the general public in an easily- understandable way is of growing importance. This paper provides the results of a questionnaire with climate impact researchers using visualization and an overview of the state-of-the-art in climate visualization, incorporating standard visualization techniques, tools, and systems as well as alternative approaches from visualization literature. Furthermore, specific aspects such as the simplified usage of complex visualization systems, climate model, and data quality, and the integration of statistics and visualization will be briefly discussed. From the last hundred years of data, we can further enhance our software to predict and visualize the climate for the next hundred years as well.

1.3. SCOPE OF THE PROJECT

When we think about climate change and global warming, we often think about it as a future problem, but the reality is that climate change is happening right now, and is already having devastating effects. So this is a reminder that there are things that we can do about climate change. We are the generation that can make a difference in the future of our planet. We know the science, we know we're already in the danger zone, we can see the impacts happening, and so we need to make change happen.

2.DISADVANTAGES OF THE EXISTING SYSTEM

- +È Too complex to be understood by a normal user who doesn't know much about climate change.
- +È Exist as a still picture rather than a motion picture.
- +È Doesn't give the user the particular temperature at a particular region.
- +È Doesn't tell us anything about the future climate change.
- +È Doesn't tell us about the preventions and precautions to prevent those climate change disasters.

3. METHODOLOGY

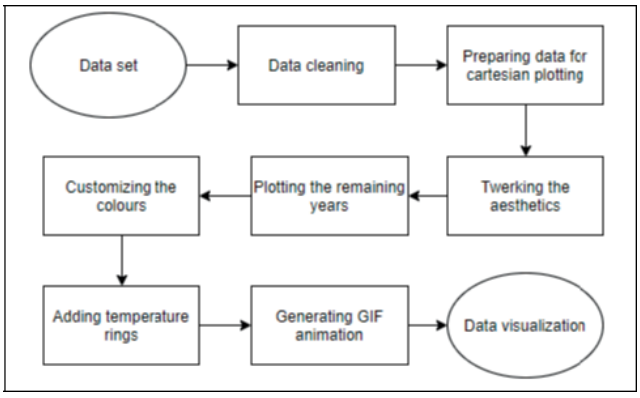


Fig: 3.1 System architecture

In this figure 3.1 system architecture, shows the architecture of the proposed system. Firstly the data set is cleaned to make them structured data useful for the analysis and the visualization techniques. Then two co-ordinate systems cartesian and polar are both tested to find which is efficient and then continued to plot the remaining points in the same manner after tweaking the aesthetics. We are adding some customized colors and some additional temperature rings to emphasize our findings and knowledge and the final animated GIF is created to be visualized.

4. PROPOSED SYSTEM

In this proposed system we are taking the data from the past 100 years and above and doing a data cleaning process to get structured data and then data visualization is done by plotting these data points in the polar coordinate system and trying to plot the remaining years. We also adding some customized colors to our visualization to make it easier to understand a normal user. A few more temperature rings are added and are generated as a GIF animation. From these data, we can predict how the climate is going to change for the next hundred years and so. This will really propagate the danger of global warming and climate change to a normal user and helping them with prevention measures and precautions.

5. MODULES

5.1. DATA CLEANING

This data is usually not necessary or helpful when it comes to analyzing data because it may hinder the process or provide inaccurate results. There are several methods for cleaning data depending on how it is stored along with the answers being sought. Some of the data cleaning techniques include Monitor errors, Standardize your process, Validate accuracy, Scrub for duplicate data, Analyze, Communicate with the team.

5.2. CARTESIAN VERSUS POLAR COORDINATE SYSTEM

In the Cartesian coordinate system, a point is represented by its distance from X and Y axes respectively, denoted by (X, Y).In the polar coordinate system, a point is represented by its distance from the origin (r) and the angle made by the line joining origin and the point with X-axis, denoted by (r, theta). There are a few key phrases to recreating GIF:

- È To plot on a polar coordinate system
- È Transforming the data for polar visualization
- È Customizing the aesthetics of the plot
- È Stepping through the visualization year-by-year and turning the plot into a GIF.

Year	Month	Value
1850	1	-0.386559
1850	2	-0.027441
1850	3	-0.418559
1850	4	-0.249559
1850	5	-0.013559

Table 5.2.1 Sample Data

5.3. POLAR PLOTTING OF DATA

To subset the data by year and use the following coordinates r: temperature value for a given month, adjusted to contain no negative values. theta: generate 12 equally spaced angle values that span from 0 to 2*pi. Add 1 to all temperature values, so they'll be positive but there's still some space reserved. Generate 12 evenly spaced values from 0 to 2*pi and use the first 12 as the theta values.

5.4. TWEAKING THE AESTHETICS

We need the background color within the polar plot to be black, and the color surrounding the polar

plot to be gray. We actually used an image editing tool to find the exact black and gray color values, as hex values:

Gray: #323331

Black: #000100

We can use fig.set_facecolor() to set the foreground color and Axes.set_axis_bgcolor() to set the background color of the plot.The title is added using Axes.set_title().

5.5. PLOTTING THE REMAINING YEARS

To plot the spirals for the remaining years, we need to repeat what we just did but for all of the years in the dataset. The one tweak we should make here is to manually set the axis limit for(or y in matplotlib). This is because matplotlib scales the size of the plot automatically based on the data that's used. This is why, in the last step, we observed that the data for just 1850 was displayed at the edge of the plotting area. Let's calculate the maximum temperature value in the entire dataset and add a generous amount of padding. We can use a loop to generate the rest of the data.

5.6. GENERATION OF THE GIF ANIMATION

We use the color (or c) parameter when calling the Axes.plot() method and draw colors from plt.cm.This will result in the plot having sequential colors.

The animation is a series of images that are displayed in rapid succession.

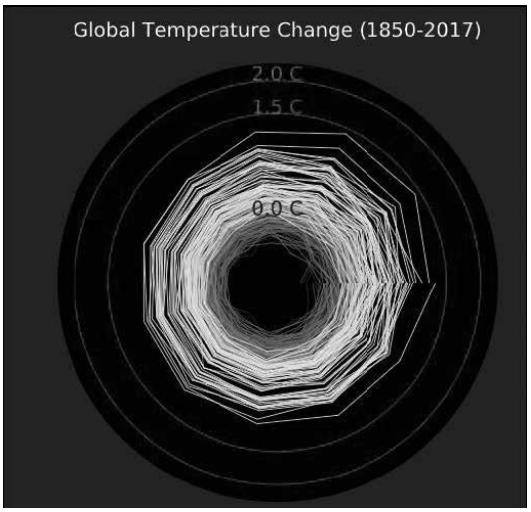
Steps:

+È defines the base plot appearance and
properties +È updates the plot between each
frame with new data +È Required Parameters:
+È fig: the matplotlib Figure object
+È func: the update function that's called between each frame
+È frames: the number of frames (we want one for each year)
+È interval: the number of milliseconds each frame is displayed (there are 1000 milliseconds in a second)

6. ADVANTAGES OF THE PROPOSED SYSTEM

+È Graphical visualizations have the potential to engage diverse audiences in understanding the changes to our climate Effective communication of how and why our climate is changing is challenging
+È The year counter was placed in the center of the graphic to ensure visibility, and the colors were chosen to aid interpretation and add to the message
+È The animation is not too long, ensuring attention is maintained, and as the temperatures rise substantially it influences emotions by providing a visual surprise at the end.
+È The animated nature of the graphic is fundamental: it tells a story to the viewer about how temperatures are changing

RESULT



Global Temperature Change (1850-2017)

CONCLUSION

This project gets most of the way to recreating the excellent climate spiral GIF Ed Hawkins originally released. It is also focused on how to plot on a polar coordinate system, how to customize the text in a polar plot, and how to generate GIF animations by interpolating multiple plots. Further, this project consider adding month values to the outer rim of the polar plot and adding the current year value in the center of the plot as the animation is created. Further using the machine learning teaching this project will help in predicting the climate change for the next coming years, which will help the climate activist, scientist and our governments to take the necessary measure to preserve our beloved planet. This prediction will also help us preserve our natural resources in a effective way and help to save our future generation from major exploitation.

REFERENCES

1. Alley, Richard B., Kerry A. Emanuel, and Fuqing Zhang. "Advances in weather prediction." Science 363.6425 (2019): 342- 344..
2. Andreas Miller, Micheal A kopera, Simone Marras, Lucas C Wilcox, Finamore, Antonella & Calderaro, Vito & Galdi, Vincenzo & Piccolo, Antonio & Conio, Gaspare. (2019). A Day-ahead Wind Speed Prediction Based on Meteorological Data and the Seasonality of Weather Fronts. 915-920. 10.1109/ GTDAsia.2019.8715985.
3. Le Roux, R., Katurji, M., Zawar-Reza, P., Quénol, H., & Sturman, A. (2019). Analysis of Spatio-temporal bias of Weather Research and Forecasting temperatures based on weather pattern classification. International Journal of Climatology, 39(1), 89-100.
4. Narvekar, Meera, and Priyanca Fargose. "Daily weather forecasting using artificial neural network." International Journal of computer applications 121.22 (2015).
5. Naveen L., Mohan H.S. (2019) High-Resolution Weather Prediction Using Modified Neural Network Approach Over the Districts of Karnataka State.
6. Smys S., Bestak R., Chen JZ., Kotuliak I. (eds) International Conference on Computer Networks and Communication Technologies. Lecture Notes on Data Engineering and Communications Technologies, vol 15.

7. Seo, S., Mohegh, A., Ban-Weiss, G., & Liu, Y. (2018). Automatically Inferring Data Quality for Spatiotemporal Forecasting.
8. Silvestro, F., Rossi, L., Campo, L., Parodi, A., Fiori, E., Rudari R., Ferraris.L(2019)Impact-based flash-flood forecasting system: Sensitivity to high-resolution numerical weather prediction systems and soil moisture. Journal of Hydrology, 572, 388-402.
9. Soares, Eduardo, Pyramo Costa Jr, Bruno Costa, and Daniel Leite. "Ensemble of evolving data clouds and fuzzy models for weather time series prediction." Applied Soft Computing 64 (2018): 445-453.
10. Tobin Isaac, Francis X Giraldo, “Strong scaling for numerical weather prediction at petascale with the atmospheric model NUMA” April 5, 2018