

Chapter 4

(title?)
(Star & what by explaining
will discuss).

Introduction

As stated earlier, we generate required data from the standalone python program with the predictive models and save it as JSON format in file system, because model training and predictions are time consuming tasks and hence inappropriate to dynamically generate the data. We pull the stored data through web API and feed in client-side scripts for drawing charts. Since uncertainty visualization in the form of CA representation is the key component of our research and we needed only the prediction data with model uncertainties. As we have shown the underlying mechanisms, backgrounds, and algorithms in previous chapter, therefore in this chapter we present some real-world charts where we have used CA in different possible ways.

(These are implemented
not yet
an introduction)

4.1 Web Interface

To visualize different charts, we have developed a web application with several html input controls in the top toolbar and all charts are presented in the main container placed just below the toolbar as follows:

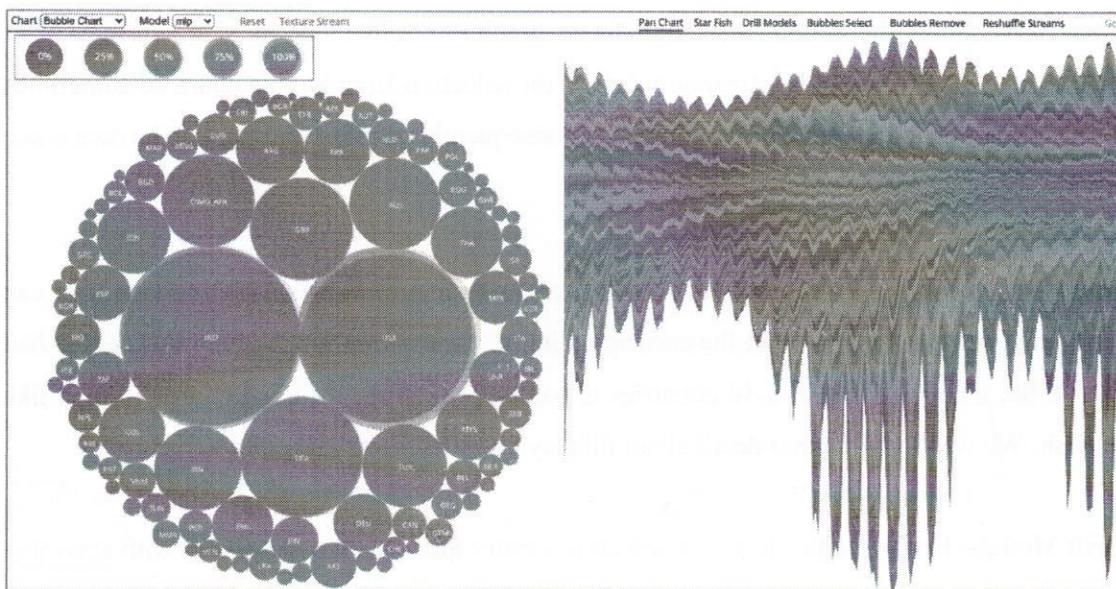


Figure-12: Initial Web Interface (Left - Bubble chart, right – Color Streamgraph)

In the following section, we briefly explain the basic functionalities of the input fields in toolbar.

Chart dropdown: List of chart names, on selection it will automatically draw the corresponding chart in the main container. Bubble chart, Parallel Coordinates, Horizontal chart, Impact Chart, Usage Chart are available options in the list.

Model dropdown: Names of the predictive models for which we have generated data for finding the uncertainties and presenting as chromatic aberration. MLP, CNN, LSTM and ARIMA are the available options for the list.

Reset: Return to the initial state of the drawing for bubble chart. For this chart it has different type of modes listed in the right side of the toolbar.

Texture Stream: This is a toggle button to switch the stream graph from color-based filling to texture based filling, that means instead of flat color flow it uses bullet like textures to fill the stream but still they have different colors for their own country region. More detail is shown in section 4.5.

The followings are available operational modes of bubble chart:

Pan Chart: Since the bubble chart and stream graph are drawn side by side and they work interactively like filtering the streamgraph with the selection from bubble chart, so sometimes it is necessary to zoom-in/out of the charts and consequently panning the charts in its own space is also advantageous.

Star Fish: changes the drawing mode to interact with mouse events. In this mode user can click on country bubble to open the corresponding texture stream graph as a wing of star-fish layout. So, when user select 8-10 countries in each side then the resultant chart will look like starfish. We will show further detail about this layout in later sections.

Drill Models: In this mode when user selects a country then four stream graphs with aberrated textures are shown in the right panel corresponding to the four predictive models. Detailed explanation is shown in later section.

will be provided.

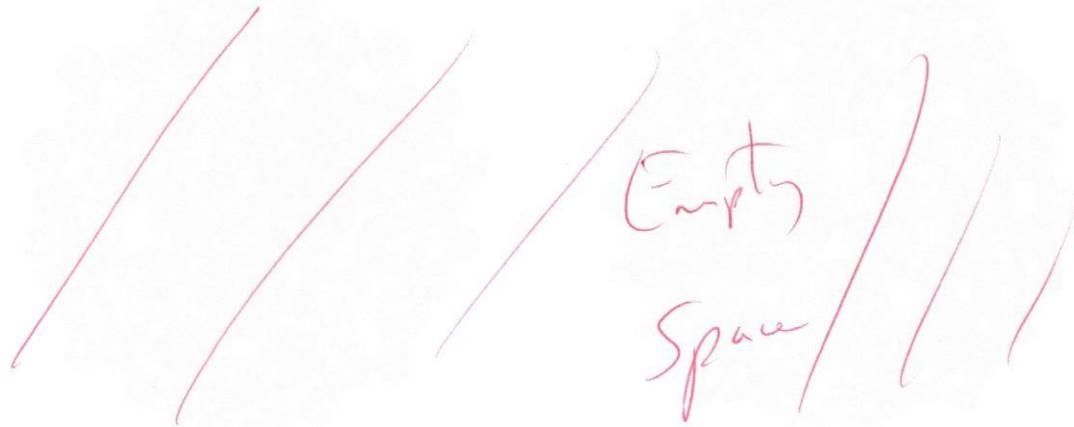
Bubbles Select: Select one or more country from the bubble chart and redraw it with the selected countries only. After selection, 'Go' button will perform the execution of redrawing task. It helps to compare specific countries because aberrations are not clearly perceivable with all countries.

Bubbles Remove: It is opposite feature of bubble select mode. It filters out countries from the bubble chart. In this mode the selected countries are omitted from the chart. After omitting countries on press 'Go' button it redraws with the other countries.

Reshuffle Streams: Allows to draw main streamgraph with the selected countries of interest from bubble chart. This is handy approach to see the bigger picture and compare streamgraph of one or more countries selectively.

4.2 Filtering

We use data for top 100 countries based on the total infection rate. As we see from the Figure-12, it is difficult to read the label of the country and difficult to identify the extent of aberration for the smaller circles having lower uncertainties. That's why we implement a filtering option with different perspectives. In the section below we briefly explain them.



4.2.1. Bubble Selection Mode

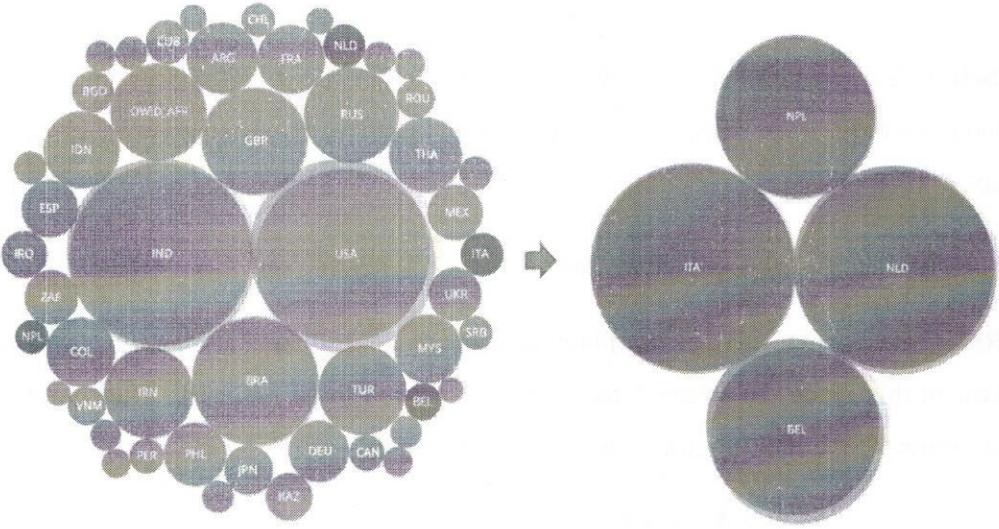


Figure-13: With selected countries of interest

In this mode, it allows users to select the countries of interest on first click and toggles on the next one. So, when all preferred countries are selected the ‘Go’ button redraws the bubbles side by side with comparatively bigger sizes.

4.2.2 Bubble Removal Mode

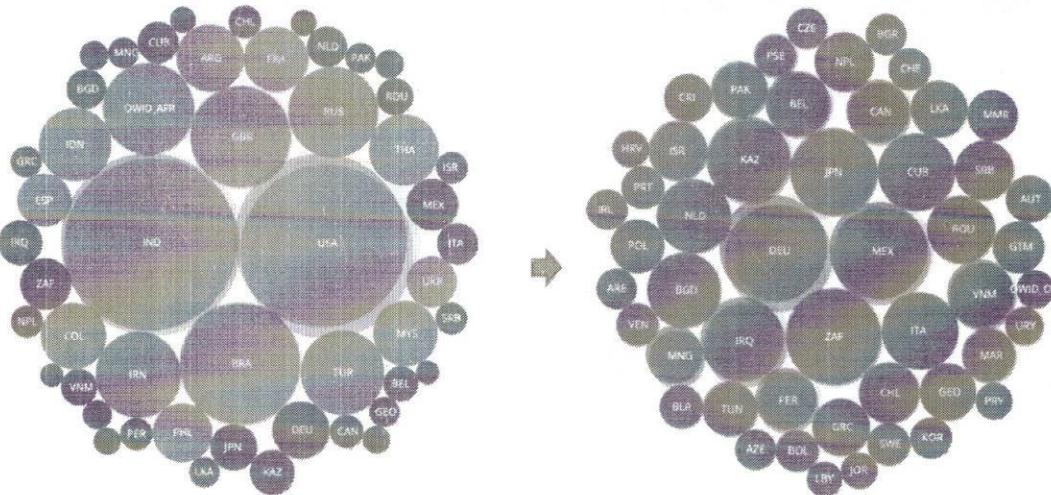


Figure-14: Removal of countries of interest

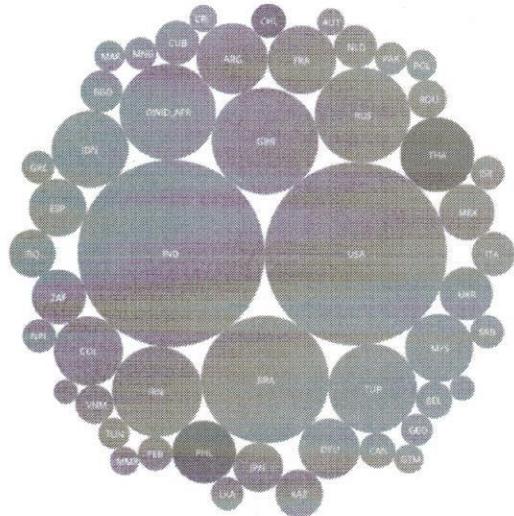
This is the opposite of the *earlier one* where the user can select the countries to remove from the chart, for instance, removing bigger ones help to find the status of the countries having a smaller size.

4.3 Legend

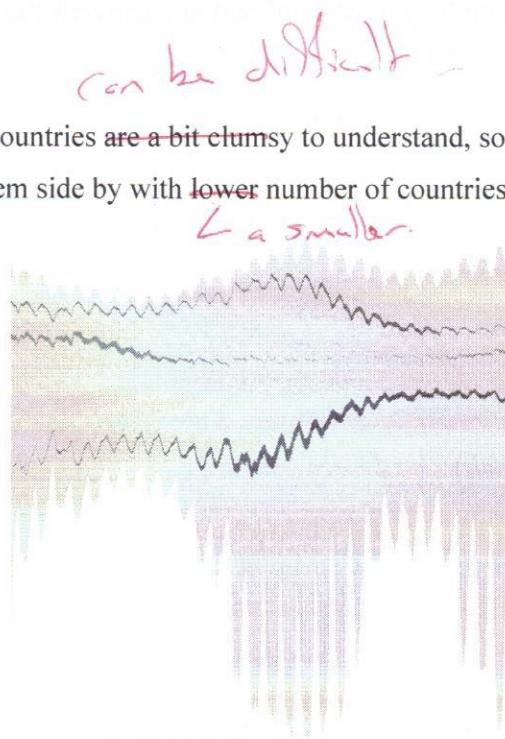
Placed at the top-left corner (Figure-12) just below the toolbar and above the bubble chart with 5 consecutive circles. The circles are drawn for representing 5 different level of chromatic aberrations. The circle with 100% uncertainty represents the maximum uncertainty among all the countries drawn in bubble chart. Therefore, to find the amount of uncertainty for lower uncertainty valued countries, it helps users easier understanding.

4.4 Reshuffling Streamgraph

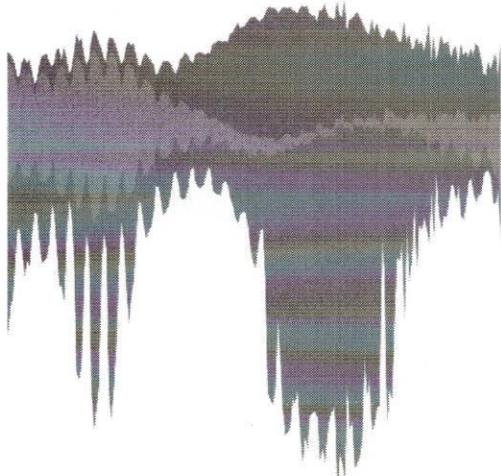
In Figure-12 we found the stream graph with countries are a bit clumsy to understand, so reshuffling is important to see and compare them side by with lower number of countries.



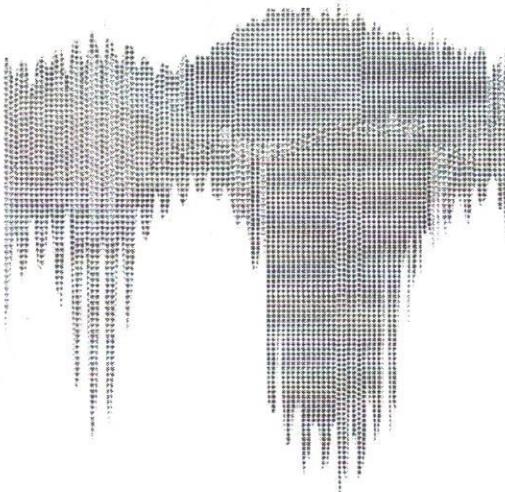
a. Selected countries brightened



b. Highlighted streams



c. Selected Countries Streams



d. Uncertainty employing streams

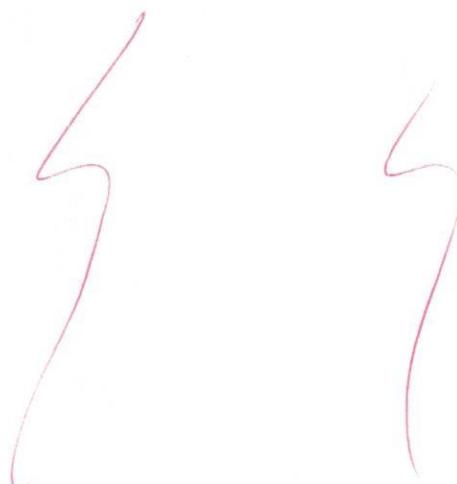
Put on same page as Figure..

Figure-15: Reshuffling Main Streamgraph (a => b => c => d)

To serve that purpose, in this mode, a user can choose the countries from the bubble chart. On select the countries, the corresponding ones brighten on bubble chart and highlighted the relevant ones in the streamgraph to represent the selection and the rest of the country-streams will be grayed out in both charts (a. and b. in Figure-15). Pressing 'Go' button confirms the redraw of streamgraph with the selected countries as shown in the Figure-15 (c). Then on pressing 'texture stream' button it converts the color stream to texture streams as in Figure-15 (d).



4.5 Drill-Down All Model Predictions



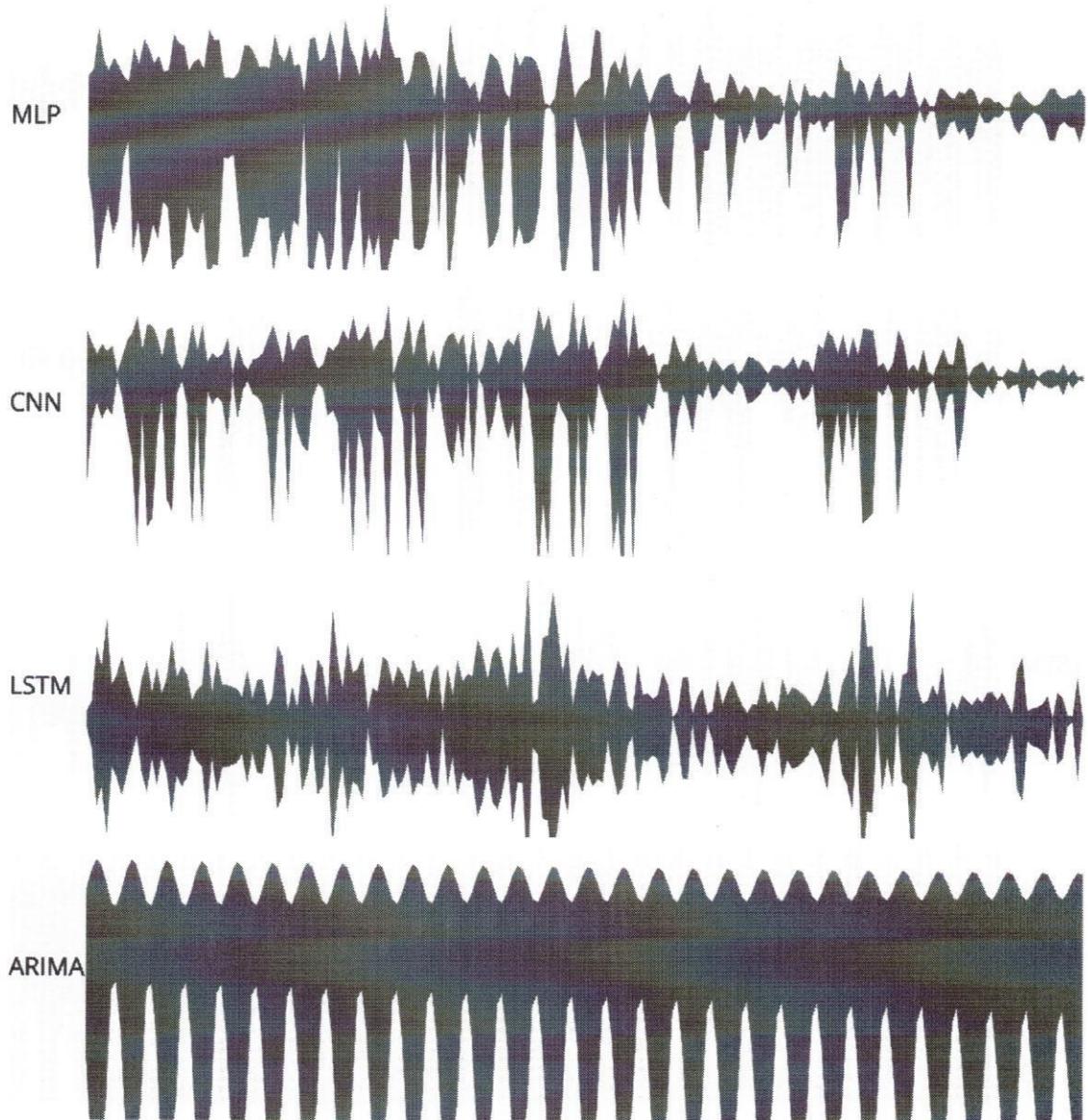


Figure-16: Streamgraphs for all models for Brazil

(are Figures 16 + 17 explained anywhere?)

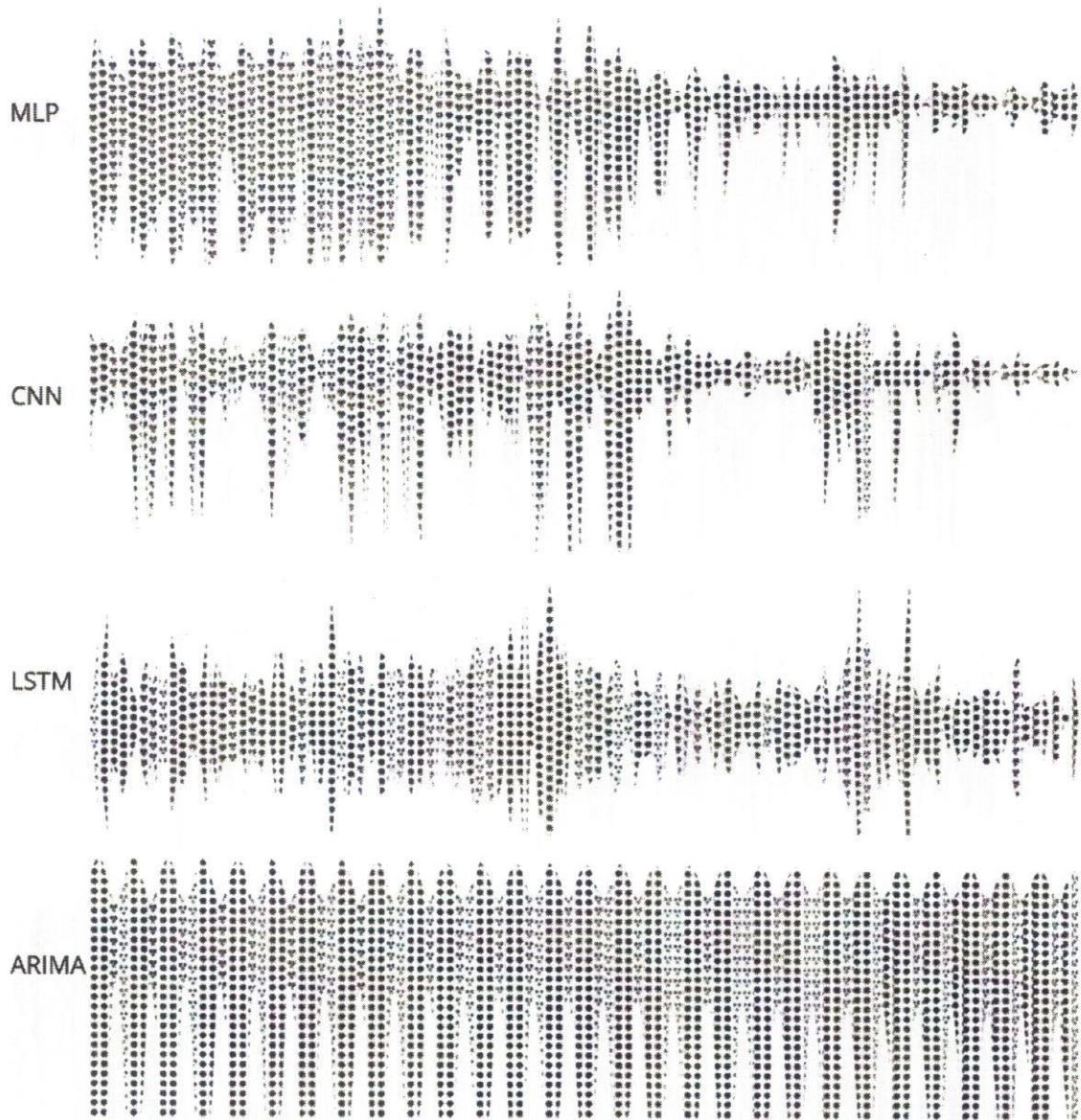


Figure-17: Texture based conversion of Figure-16 by introducing uncertainty presentation

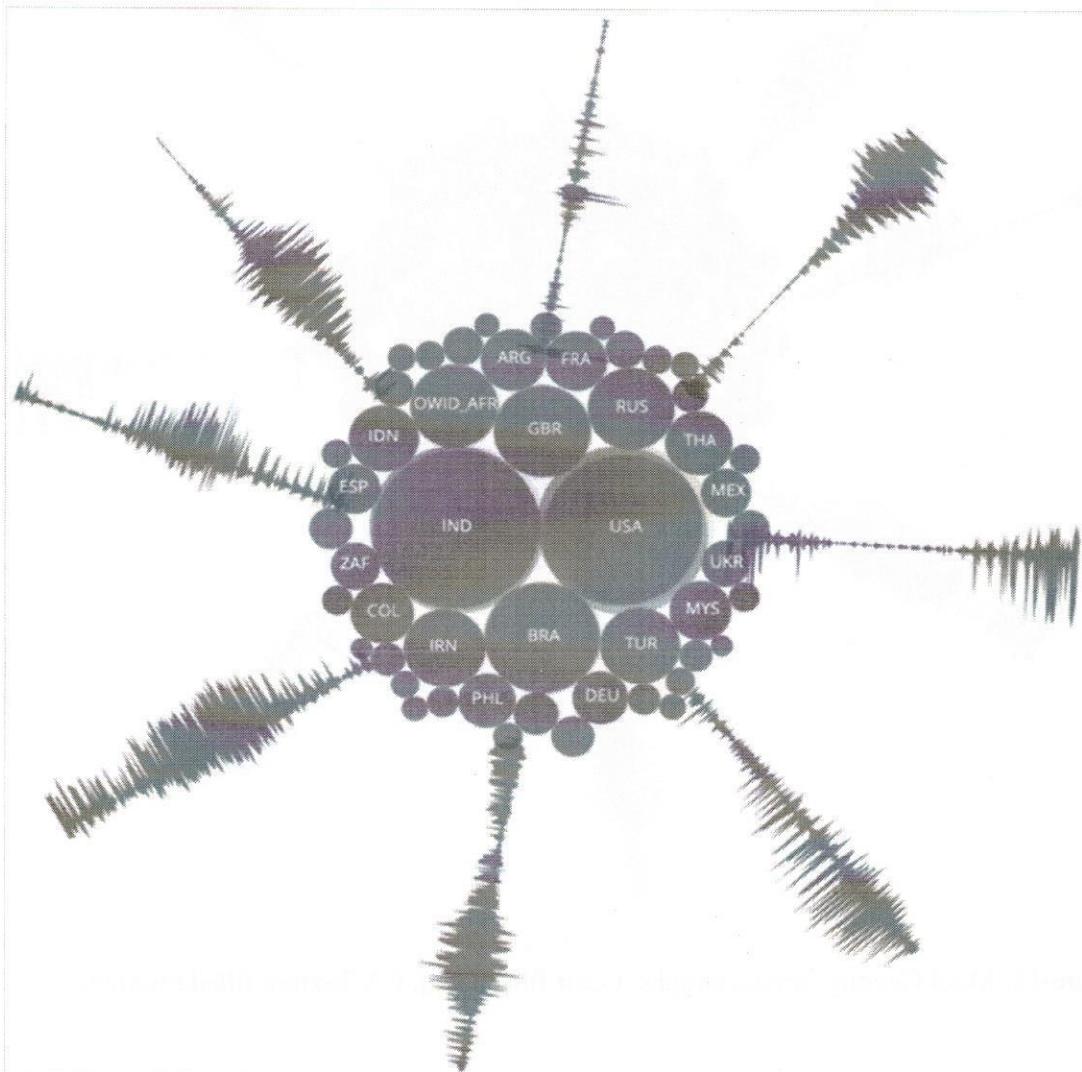
Inspired Design

4.6 Star Fish Inspiration

In this approach, user can draw multiple stream graphs around bubble chart and the system serves this by dynamically calculating the rotation angle of the stream based on the position of the country cell in respect to center of the map. Then it sets the start point of the stream at the bubble center and rotation is introduced to ensure the avoidance of overlapping the other countries' streams and by which it attains 'Star Fish' layout presentation. If we call each individual stream as a wing, then the benefit of this chart is it allows to draw multiple charts in

The R (do star fish have wings or legs?).

The
compact way. If user needs to explore certain stream more deeply then it allows to do so by panning and zooming the map. To clear the drawn streams user can click reset button and again select more countries to draw another start with other countries.



↗ (Separate this figure into two,
each with its own caption).

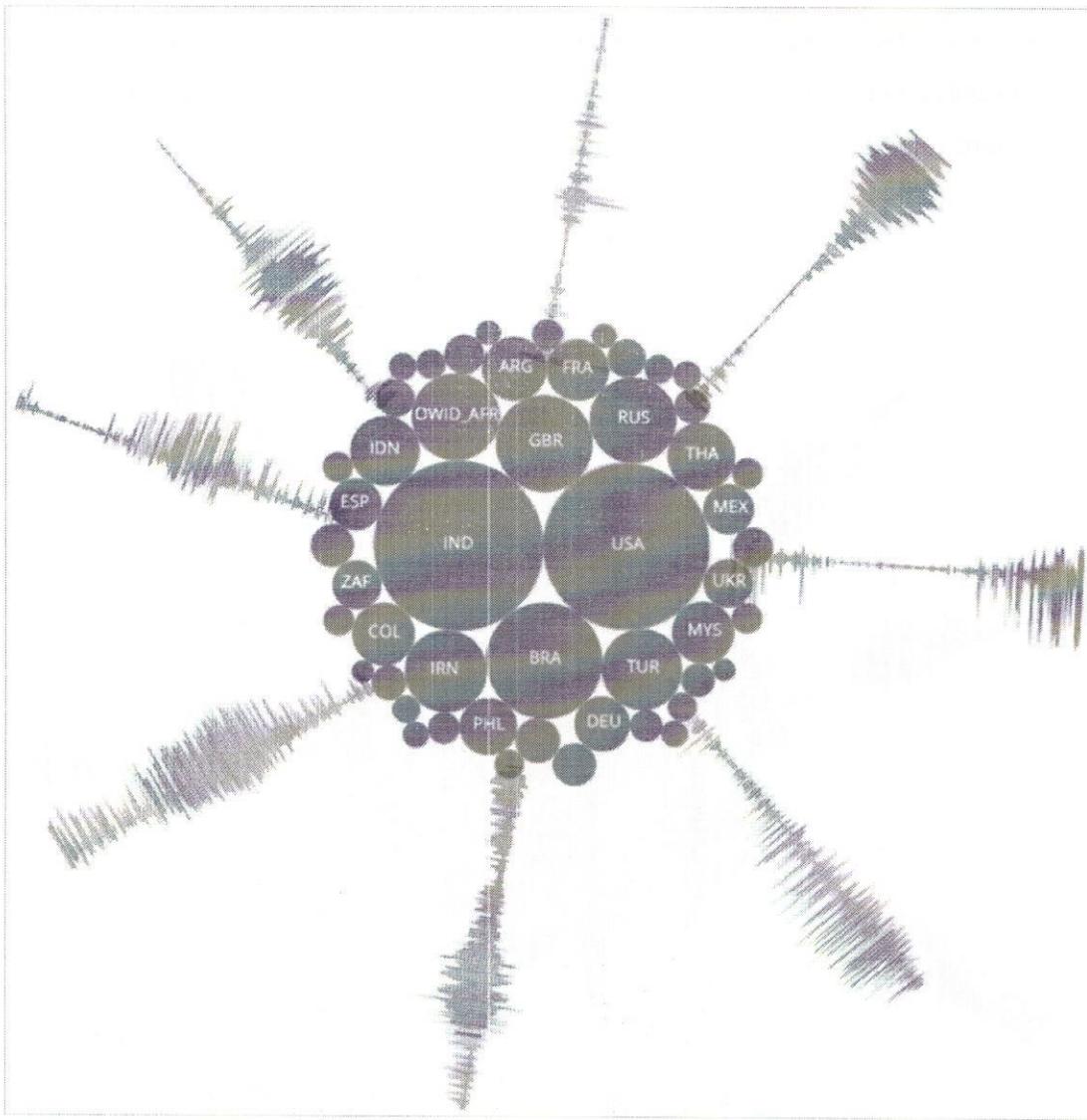


Figure-18: Multi Country Stream Graphs. Color filled (top), CA Texture filled (bottom)

4.7 Parallel Coordinates Chart

Parallel plots or parallel coordinates plots allows one to compare the features of several individual observations (series) on a set of numeric variables. Each horizontal axis represents a variable and often has its own scale. The units can be different, that is the strength of this special kind of plots. The main advantage offered by parallel coordinate is the representation of high dimensional data as a 2-dimensional visualization. Data is represented in the form of a polyline, and it becomes possible to perceive trends shown by data entries from the

visualization.

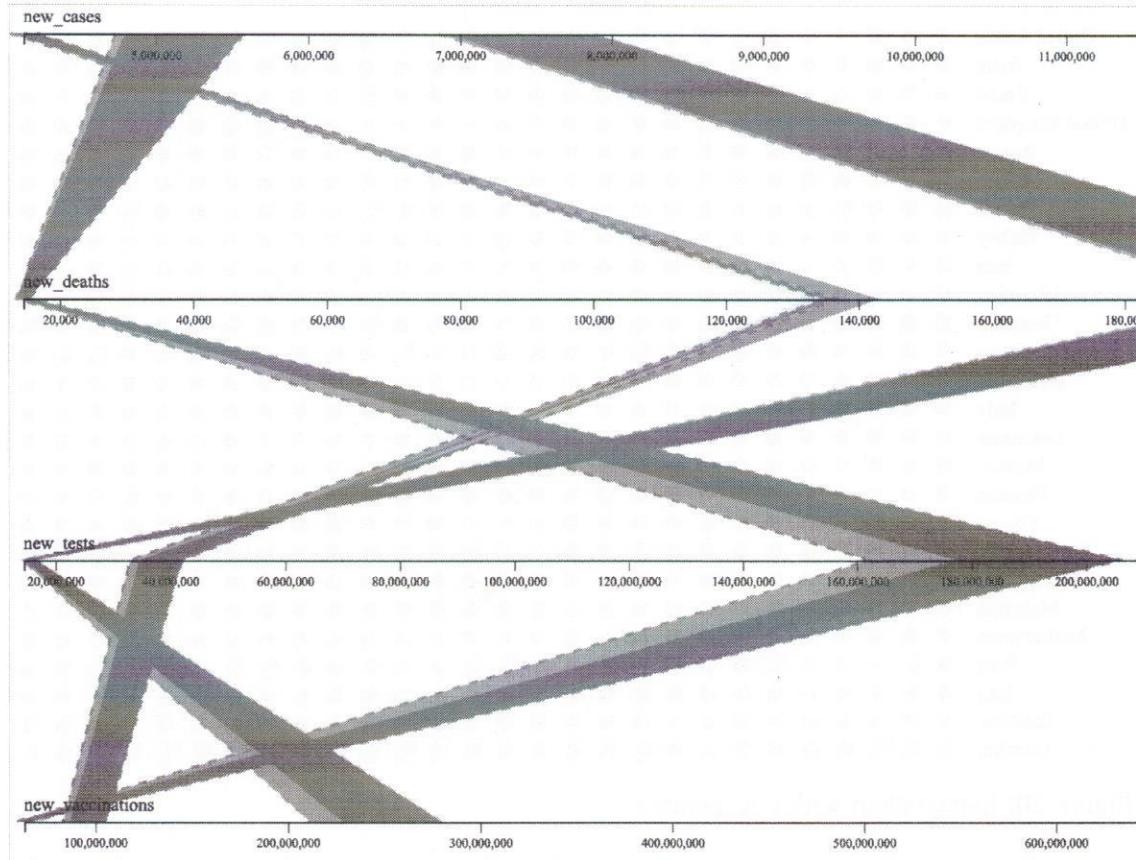


Figure-19: Parallel coordinates chart

This plot is helpful in our presentation because we have several variables together to visualize one after another and showing the relationships between them. For example, you can compare number of total cases(total_cases) with hospitalized patients (hosp_patients) facilitated by a tooltip showing the country name. Also, it can show the predicted flow (thinner line) along with actual counts (thicker line). The limitation of this chart is frequent overlaps for multi-variable and multi-

Cell?) → (not really sure what this one is called).

4.8 Impact Chart

This chart helps to indicate daily uncertainty presentation for every country as a cell. In this way a user can perceive trends for certain day or a set of consecutive days. In other words, the chart provides a useful platform that helps you decide which uncertainty requires your attention. This chart is helpful to gives quick insight to the users about daily basis prediction uncertainties for all countries.

gives information

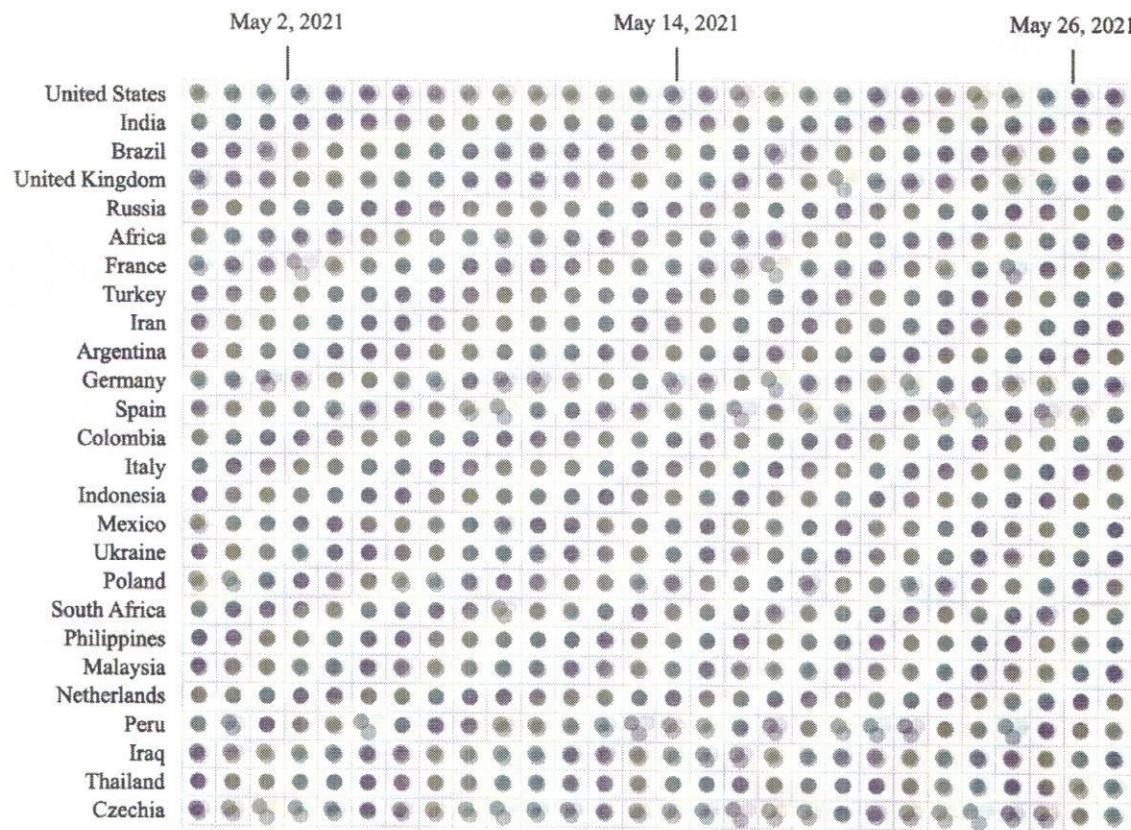


Figure-20: Impact chart with CA textures

4.9 Horizontal Chart

Horizontal charts are small-multiple area charts that allow greater precision for a given vertical space by using colored bands. These charts can also be used with diverging color scales to differentiate positive and negative values.

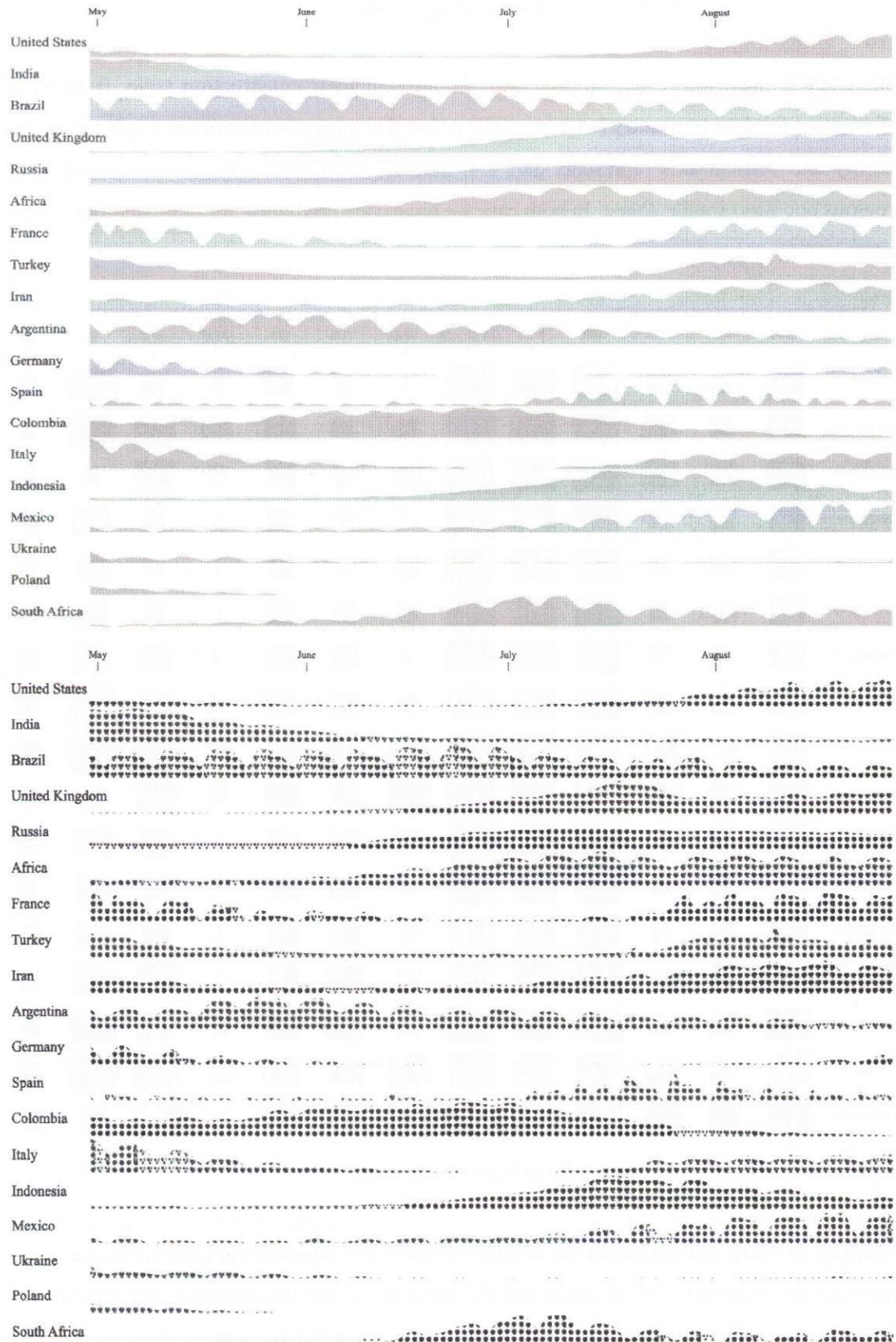


Figure-21: Horizontal chart (Color filled – top, CA Texture filled – bottom)

4.10 Usage Chart

(is this just a cell chart
with square elements?)

This chart is much more like impact chart because of their construction style. Both show information for date vs country but in opposite order, that means here horizontal axis represents country and vertical axis represents date and here we used rectangular shapes whereas the previous one was circular shape. In both case we have used prediction for daily number of new cases.

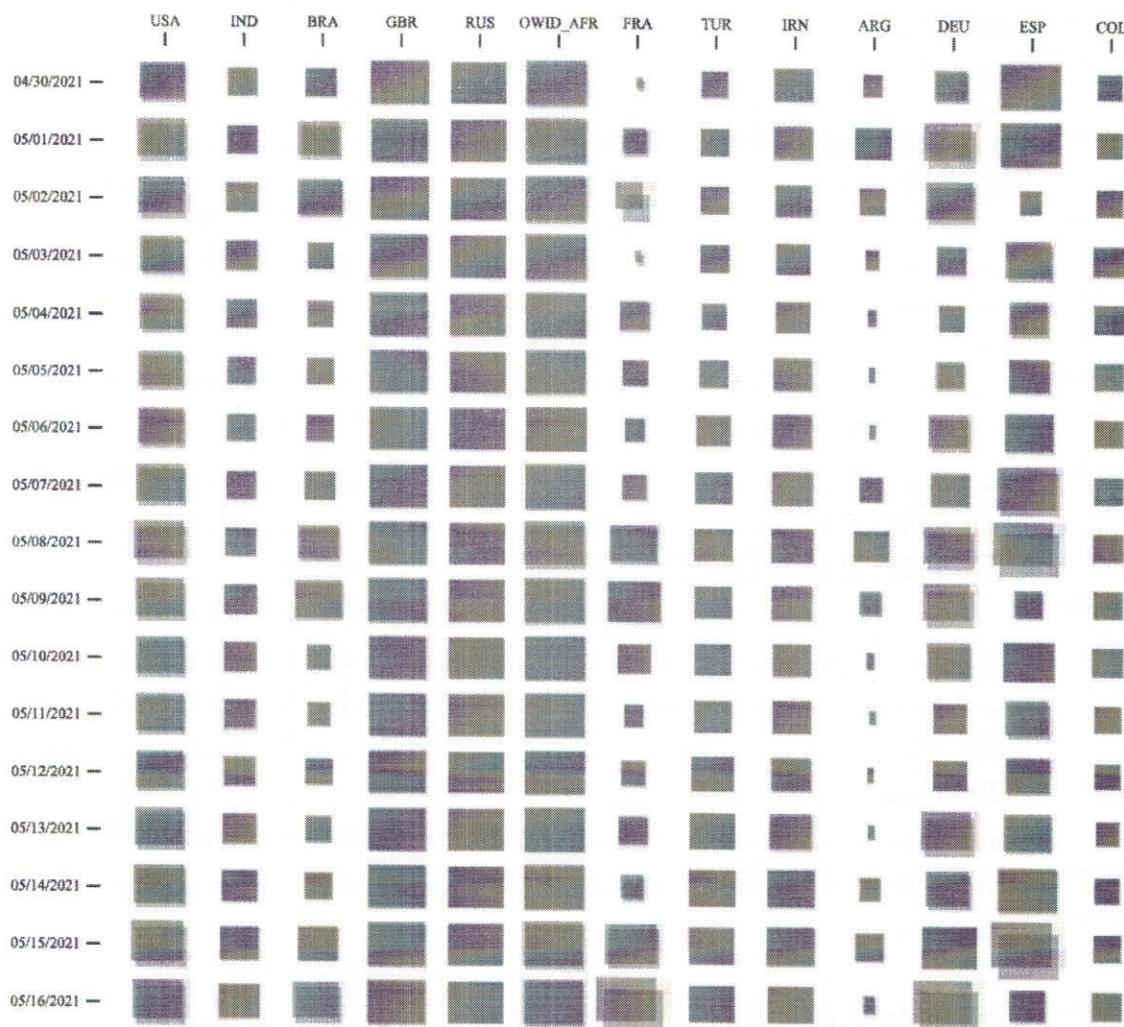


Figure-22: Charts of Daily Counts for different countries.

Here, size of every cell represents the number of new cases where is the colorful border-side represents the uncertainty of the prediction for that date against the corresponding country. The interesting thing is uncertainty is independent of the predicted count, so there are some smaller cells convey high uncertainty and some bigger cells show lower uncertainty.

whereas chromatic aberration.

4.11 World Map ^a

This is another version of bubble chart that we have exemplified in previous section. In that case, we congregate all circles in a single container and associate closely with each other. The countries are identified by the label over the circle but in this case all circles are drawn over the respective areas regarding their geographical position on world map.

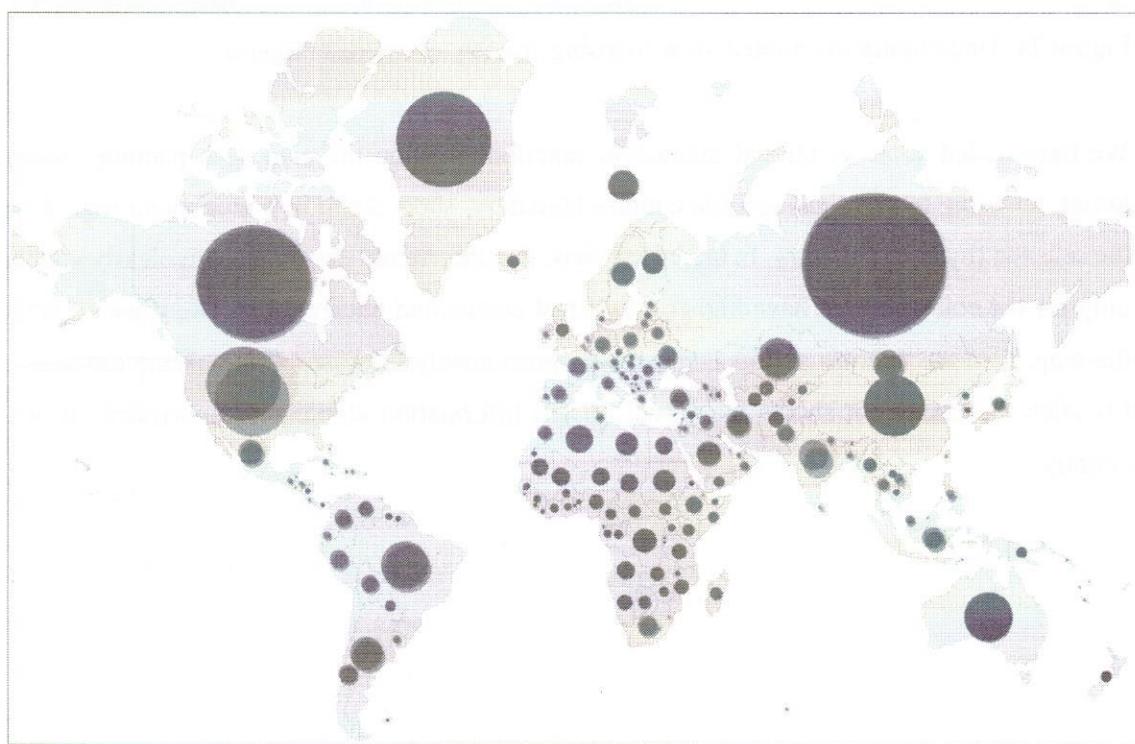


Figure 23: Uncertainty in World view

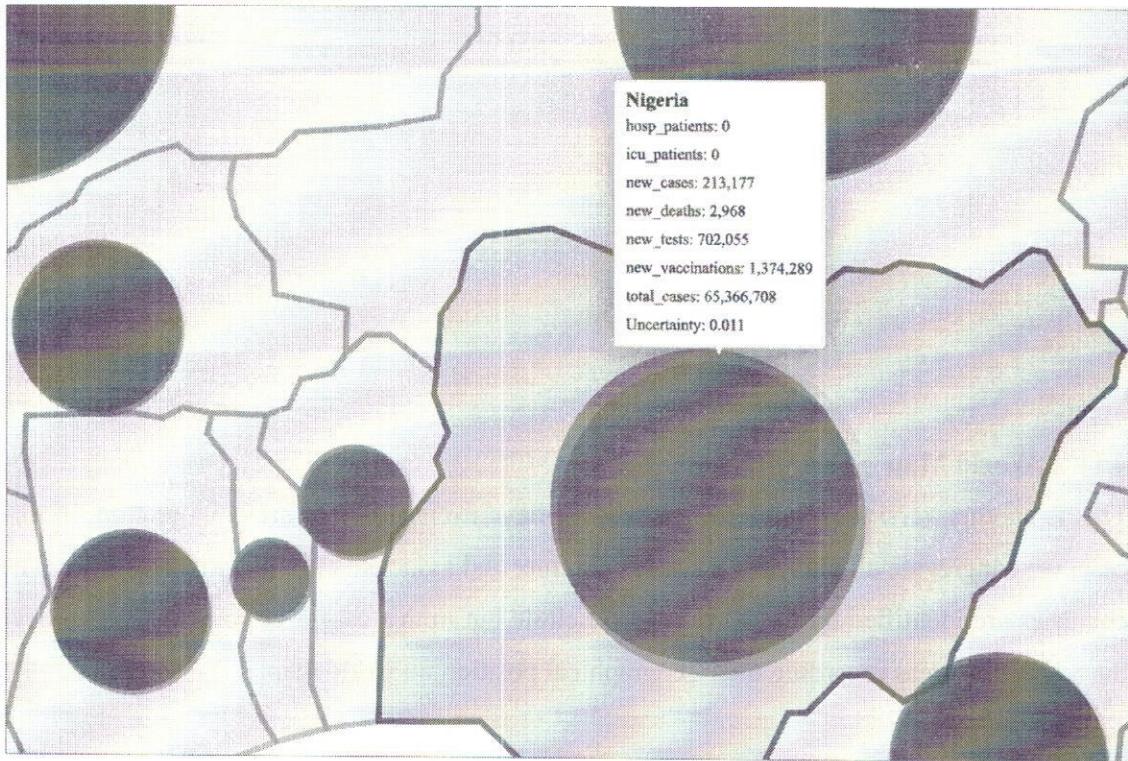


Figure 24: Uncertainty in zoomed view focusing country of interest Nigeria

We have added some additional interactive functionalities on the map such panning, zoom in/out, hovering to highlight specific country boundary, show detail in popup menu regarding the selected (by click) country. In the initial view, the uncertainty presentation is clearly visible only for the countries that have higher number of counts and uncertainties. So, if user zooms the map, then the bubbles and its edges are proportionately increased and makes more sense. On click the country it shows the Covid related information along with uncertainty of the country.