COVID-19, Weather & Census Analysis Dashboard

This project aims to build a dynamic, interactive dashboard in TIBCO Spotfire by integrating data from multiple open APIs. The dashboard includes predictive modeling, geospatial visualizations, calculated metrics, and user-driven interactivity for exploring Census, Temperature, COVID-19 trends and insights.

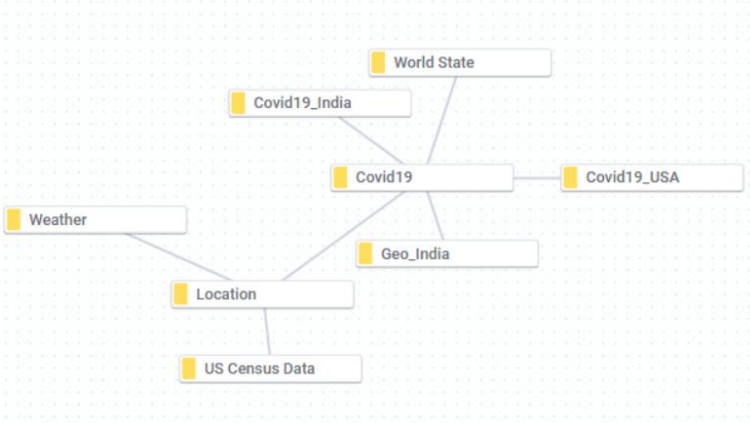
Data Sources

1. **OpenStreet API**
   - **API**: Location API
   - **Format**: JSON/XML
   - **Purpose**: Get the City, state, country, lat, lon
2. **Weather API**
   - **API**: OpenWeatherMap
   - **Format**: JSON
   - **Purpose**: Fetches historical weather data to compare temperature, humidity sunrise, sunset, etc.
3. **COVID-19 API**
   - **API:** [COVID Tracking Project / OWID / Rootnet / etc.]
   - **Format:** JSON
   - **Purpose:** Tracks confirmed cases, deaths, recoveries, testing rates
4. **US Census API**
   - **API:** Official U.S. Census Bureau
   - **Format:** JSON
   - **Purpose:** Tracks Population, age, income, house rent, etc.

Data Integration & Relationships

Composite Data Model

- Created using Spotfire's **Data Canvas** and **relationships**.
- Joined on common keys:
  - Covid19_India and Geo Code on state name for Geo data
  - Location and weather on lat, lon for state, city and country information.
  - Covid19_USA with state table on state code to get state name
- Appended Covid19_India and Covid19_US_data
- Relationship types:
  - Location ↔ Weather: **One-to-Many**
  - Location ↔ Covid19: **One-to-Many**
  - Location ↔ US Census: **One-to-Many**
  - Covid19 ↔ World State: **Many-to-One**
  - Covid19 ↔ Geo_India: **Many-to-One**
  - Covid19_India ↔ Covid19: **Many-to-Many**
  - Covid19_USA ↔ Covid19: **Many-to-Many**



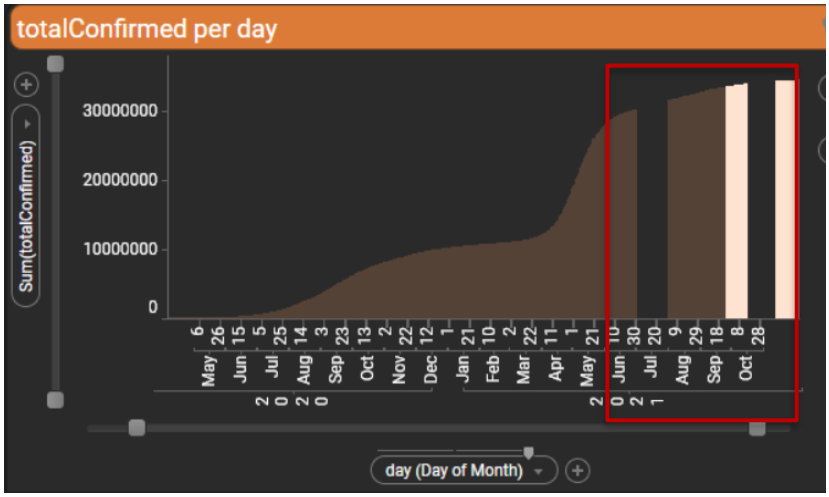
Data Cleaning and Transformation

- **Handling Missing Data**: Used Spotfire's Replace Nulls and Fill Down features.
- **String Parsing**: Removed special characters, extracted city names using calculated columns.
    - **Temp_Cel and feels_like**: Checked for null values and temperature unit and converted it into Celsius.
    - **Date, Day and Time**: Calculated from time stamp.
    - **Name:** Concatenated the city, country and region.
    - **State:** Removed special characters (*, #) from the column and corrected the spelling mistake for the standardized state names for column matching.
- **Imputation**: In case of no records of precipitation in weather API,
    - imputed null values to 0 using python.
    - Predicted confirmed, discharged and death cases for the whole month for Covid19_India table.
- **Date Normalization**: Converted UNIX timestamps with time zone offsets as per the region, standardized to YYYY-MM-DD before the data is loaded in python.
    - Sunrise = datetime.datetime.utcfromtimestamp(data['city']['sunrise']+timezone_offset)
- **Derived Columns**:
    - Covid daily recovered, discharged and death cases from cumulative data.
    - Temperature in Celsius
    - Day, Date, Year from timestamp
    - Concatenated state and city
    - GDP

Exploratory Data Analysis

Performed EDA to detect outliers using scatter plots and analyzed mean values of temperature, humidity, wind speed, and COVID-19 daily cases to identify trends and anomalies across different cities and dates.

- **Missing Data**: COVID-19 data for June 2021 and November 2021 was missing in the Covid19_India table. These gaps were addressed through prediction using regression models during the modeling phase



- **Inconsistent State Names**: The State column in the Covid19_India table contained special characters and incorrect spellings. String cleaning and standardization were applied during the preprocessing stage.

- **Temperature Outliers**: Unusual temperature values were initially detected as outliers. Upon inspection, these were found to be in Kelvin. The values were converted to Celsius during preprocessing after unit verification.

Custom R/ Python Data Functions

1. **Data Loading (Python)**
    a. Location API: Utilized an API to fetch geographic metadata such as state name, country, latitude, and longitude based on user-input city names.
    b. TemperatureAPI: Takes latitude and longitude from Location API as input and retrieves 5-day/3-hour interval meteorological data (e.g., temperature, humidity, wind speed) for the user-specified cities.
    c. Covid19_India: Retrieves cumulative daily state-wise COVID-19 data for India from 2020 to 2021, including confirmed, recovered, and death cases.
    d. Covid19_USA: Provides daily cumulative COVID-19 statistics for each U.S. state from 2020 to 2021, covering confirmed cases, recoveries, and deaths.
    e. US Sensus: Retrieves annual state-level demographic and socio-economic indicators from 2018 to 2023, including population, median income, age, housing values, race distribution, and unemployment rates using the U.S. Census Bureau ACS API.

2. **Time Series Forecasting (Python)**
    a. Library: Scikit-learn
    b. Algorithm: Linear Regression
    c. Target: Predicting daily Confirmed, Discharged and Death cases
    d. Output: Projected values for the 1 month
    e. Description: Used **simple time-based linear regression** to **predict missing daily COVID-19 statistics** (dailyConfirmed, dailyDischarged, and dailyDeaths) **per state** in India for July and Nov 2021 using June and Oct 2021 data as the training window.

3. **Clustering (Python)**
    a. Library: Scikit-learn
    b. Algorithm: K-Means Clustering
    c. Target: Grouping similar records based on numerical features
    d. Output: Cluster labels assigned to each input record
    e. Description: Applied unsupervised **K-Means clustering** to segment the dataset into n_clusters groups using numerical features. The model parameters like **init, n_init, max_iter, and tol** were tuned for **optimal convergence**, and cluster labels were added to the dataset for downstream analysis or visualization.

Dashboard Features

- **Performance Optimization**
    - Filtered and fetched only the cities provided by the user as input, reducing unnecessary API calls and data load, resulting in improved efficiency and faster processing.
- **Dynamic Filters**:
    - Drop Down (Cities)
    - Location (State/UT)
    - Date Range
    - Case Type (Confirmed / Deaths / Recovered)
- **Custom Header & Layout**:
    - HTML/CSS injected using Text Areas
    - JavaScript Components Used:
        - Header- Displays the main heading of the COVID-19 analysis page.
        - Card- Summarizes key weather metrics such as latest temperature, humidity, "feels like" temperature, wind speed, etc.
        - Days- Provides a 3-hour interval temperature and weather condition forecast (5-day overview).
        - Search card- Allows users to input and search city names with dropdown selection for user-friendly navigation.
        - Sun card – Displays sunrise and sunset timings in a visually styled layout.
- **Drilldown Capabilities**:
    - Select the city → Filter state of that city on second page
    - Click on state → filters visuals
- **Geospatial Layers**:
    - Choropleth + Markers based on severity

Visualizations

How It Works:

- **Step 1**: Enter **all locations** (cities) you want to load data for and click **Search button**.
- **Step 2**: It is required to use the **dropdown** to select **one specific location** and **click GO**. This selected location will populate the data on the overview and drilldown pages.
- The pages — **Weather**, **Covid19 Drilldown**, and **US Census Drilldown** are **interconnected**.
- All three pages will display data based on the **selected location**.
- The **Covid19** and **US Census** pages show **full datasets** for deeper analysis of the selected city/state.

Page 1:

Location Filter

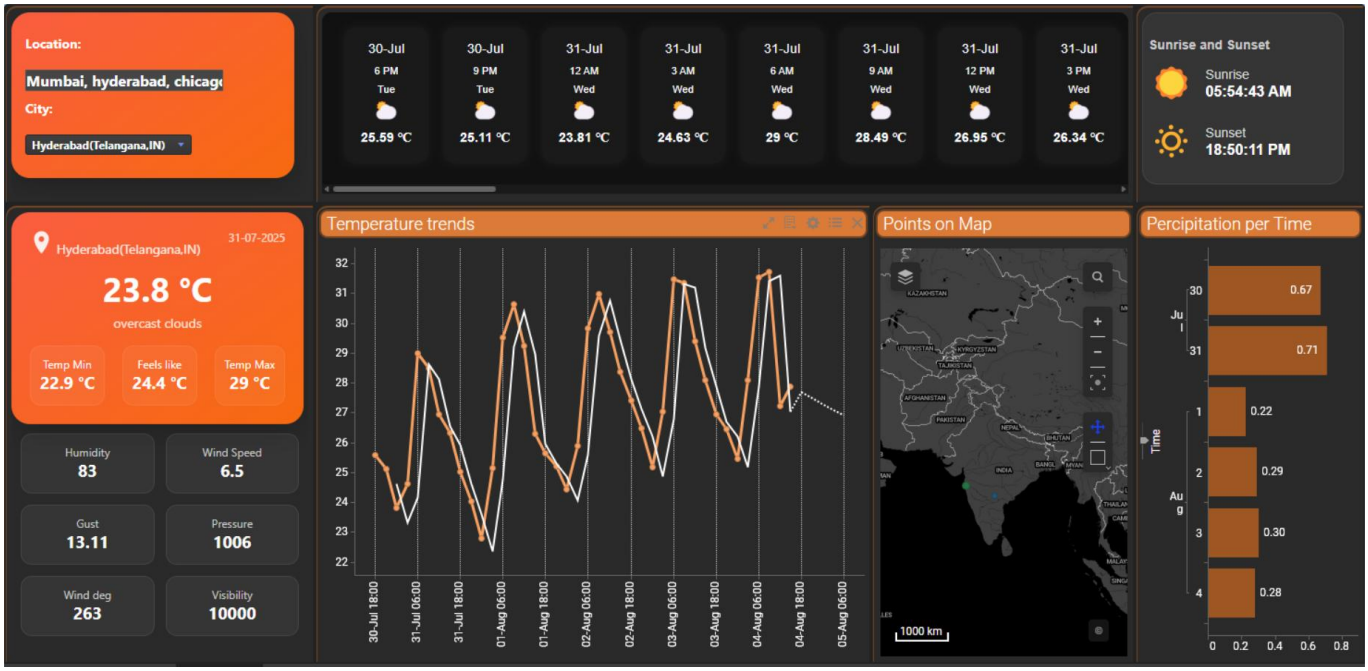
- Let's users input and select multiple cities (e.g., Mumbai, Hyderabad, Chicago).
- Enables filtering and dynamic update of weather details and charts based on selected locations.

Weather Forecast Cards

- Shows 3-hour interval forecasts for temperature and weather conditions (icons) from 30th July to 31st July.
- Provides a short-term outlook to help users visualize upcoming temperature fluctuations and sky conditions.

Sunrise and Sunset

- Displays the local sunrise and sunset time for the selected city.
- Useful for understanding daylight hours, which impacts weather analysis and planning for outdoor activities.



Current Weather Snapshot

- Shows current weather conditions like temperature, humidity, wind speed/direction, pressure, visibility, etc., for the selected city.

- Offers a complete snapshot of real-time atmospheric parameters useful for immediate weather monitoring.

Temperature Trends (Line Chart)

- Line chart displaying variation in temperature over time for the selected cities.
- Helps identify patterns, peaks, and drops in daily temperatures to assess consistency or volatility.

Points on Map

- Plots the selected cities on a map using latitude and longitude.
- Geographical visualization helps in spatial analysis and better understanding of location-specific weather patterns.

Precipitation per Time (Bar Chart)

- Displays the predicted precipitation in millimeters for each day.
- Helps track rain trends and identify wet or dry periods, useful for planning and environmental monitoring.

Page 2:

Total Confirmed Gauge

- Displays the total number of confirmed COVID-19 cases
- Helps provide a quick snapshot of the pandemic's overall impact across selected regions.

Discharged Gauge

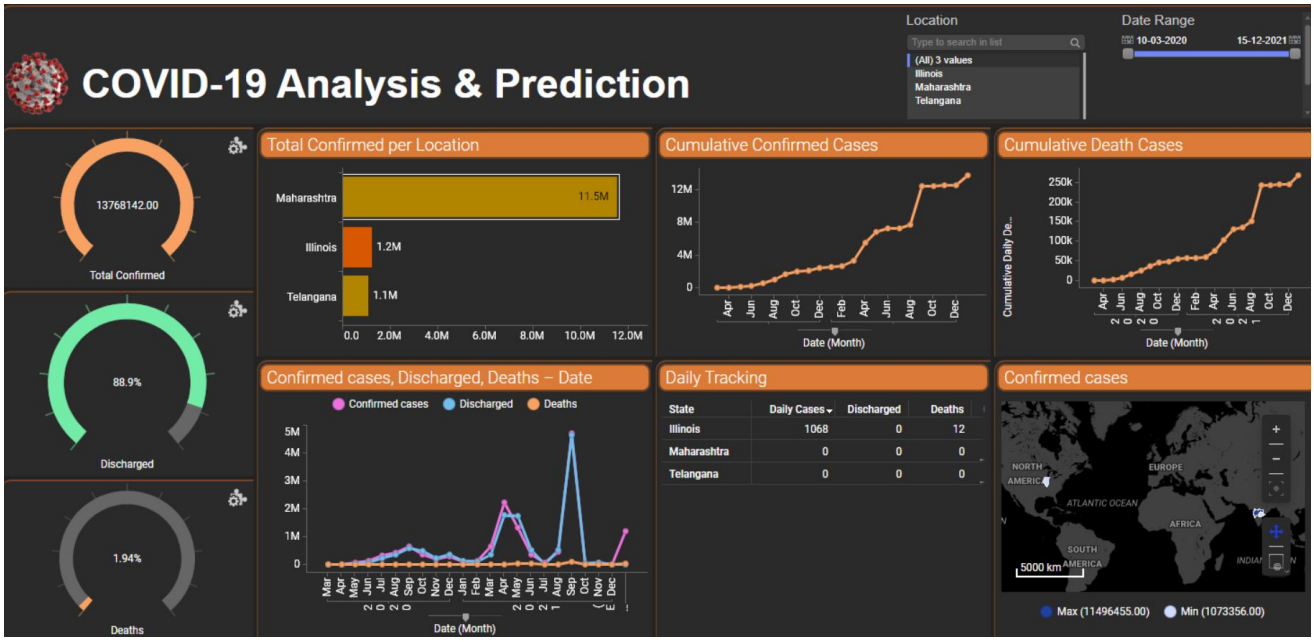
- Shows the percentage of recovered/discharged patients from the total confirmed cases.
- Indicates recovery rate effectiveness and gives insights into healthcare response.

Deaths Gauge

- Displays the death rate as a percentage of total confirmed cases.
- Highlights the fatality rate, essential for assessing pandemic severity and healthcare strain.

Total Confirmed per Location (Bar Chart)

- Compares the total number of confirmed cases across different selected states.
- Useful to identify hotspots and understand which regions are most impacted.



Cumulative Confirmed Cases (Line Chart)

- Shows the growth trend of cumulative confirmed cases over time.
- Helps track the progression of the outbreak and assess peaks/waves.

Cumulative Death Cases (Line Chart)

- Displays the accumulation of death cases over time.
- Reasoning: Allows monitoring of mortality trends and evaluating the effectiveness of interventions.

Confirmed, Discharged, Deaths Over Time (Multi-line Chart)

- Plots confirmed, recovered, and death cases together over time.
- Reasoning: Offers a comparative view of how these key metrics change in relation to one another.

Daily Tracking Table

- Tabular representation of daily confirmed, discharged, and death cases per state.
- Enables detailed tracking and supports day-to-day monitoring of new cases and trends.

Confirmed Cases Map (Geographical Visualization)

- A map highlighting confirmed case concentrations by location.
- Provides spatial understanding of virus spread and regional intensity.

Date Range & Location Filter Panel

- Allows selection of specific states and date ranges for dynamic filtering.
- Enables targeted analysis by location and time period for better decision-making.

Page 3:

LEFT PANEL: Filters

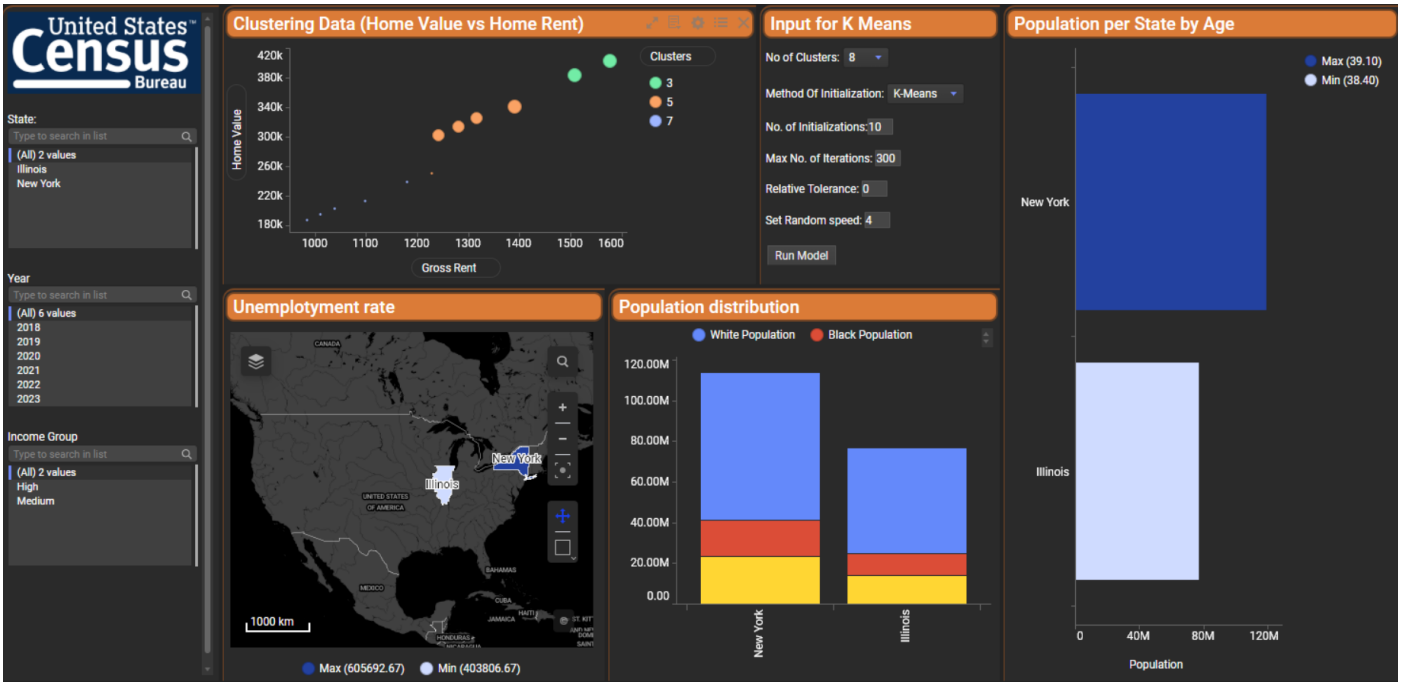
- **State, Year, Income Group**
    - User input controls to filter all visualizations across the dashboard
    - Interactivity ensures comparisons (like New York vs. Illinois) are based on user-defined selections and subsets of ACS data.

Clustering Data (Home Value vs Home Rent)

- A scatter plot where each point represents a location (state, county, or tract), showing the relationship between **gross rent** and **home value**.
- **Color by**: Cluster number (e.g. 3, 5, 7)
- It reveals how different regions cluster economically — areas with high home values also tend to have high rents, but clustering helps detect **outliers**, **affordability gaps**, and **distinct economic segments**.

Input for K-Means

- An interactive form to define K-means clustering model parameters:
    - Number of clusters
    - Initialization method
    - Iteration limits
    - Random seed, etc.
- It allows users to dynamically explore how changing parameters affects the clustering logic used in the **scatter plot above**.



Population per State by Age

- Vertical bar chart comparing total **population by state**, segmented by **age bracket or average age** (based on the color legend showing Max and Min).
- This helps compare population sizes and aging trends. A higher average age could indicate an older population, influencing policy needs like healthcare, retirement planning, or labor force shifts.

Unemployment Rate

- A **choropleth** or shaded map showing unemployment rates by state (e.g., Illinois and New York are highlighted).
- Offers geographic insight into which states are facing higher unemployment, supporting **labor market comparisons** or **policy impact evaluations**.

Population Distribution

- A **stacked bar chart** showing the **racial breakdown** of population by state. Each bar is split between:
  - White Population
  - Black Population

  (Possibly more races if dataset includes them)

Insights and Analysis

Weather

- **Forecast Trends:** Hourly and 4-day temperature forecasts reveal **cyclical weather patterns**.
- **Sunrise/Sunset:** Daily light hours could relate to **public activity patterns or solar planning**.
- **high humidity + temperature** might correlate with **disease patterns** or **energy demands**.

Covid 19

- A high discharge rate with low death rate indicates effective clinical management.
- **Death Rate:** Very low mortality (~1.94%), suggesting manageable fatality levels despite high case volume.
- Trend charts can be used for **predictive modeling** — estimating future outbreaks or resource needs.

US Census

- **Clustering (Rent vs Home Value):** Strong correlation; higher rent aligns with higher home values. Clustering reveals economic segmentation.
- **Unemployment:** New York and Illinois show different rates, highlighting **regional economic differences**.
- **Population Distribution:** New York has a **higher population overall**, with more racial diversity (larger Black and White populations).
- **Age Analysis:** New York has a higher average age — could impact workforce trends or aging-related services.

Github Repository

- **Link: https://github.com/sagar221996/AIQ_Assignment.git**
- **Contents**:
  - Assignment_Dashboard.dxp
  - Solution.doc
  - scripts/ (R, Python)
    - K_Means_Cluserting
    - India Predicted values