Map Visualization using Leaflet

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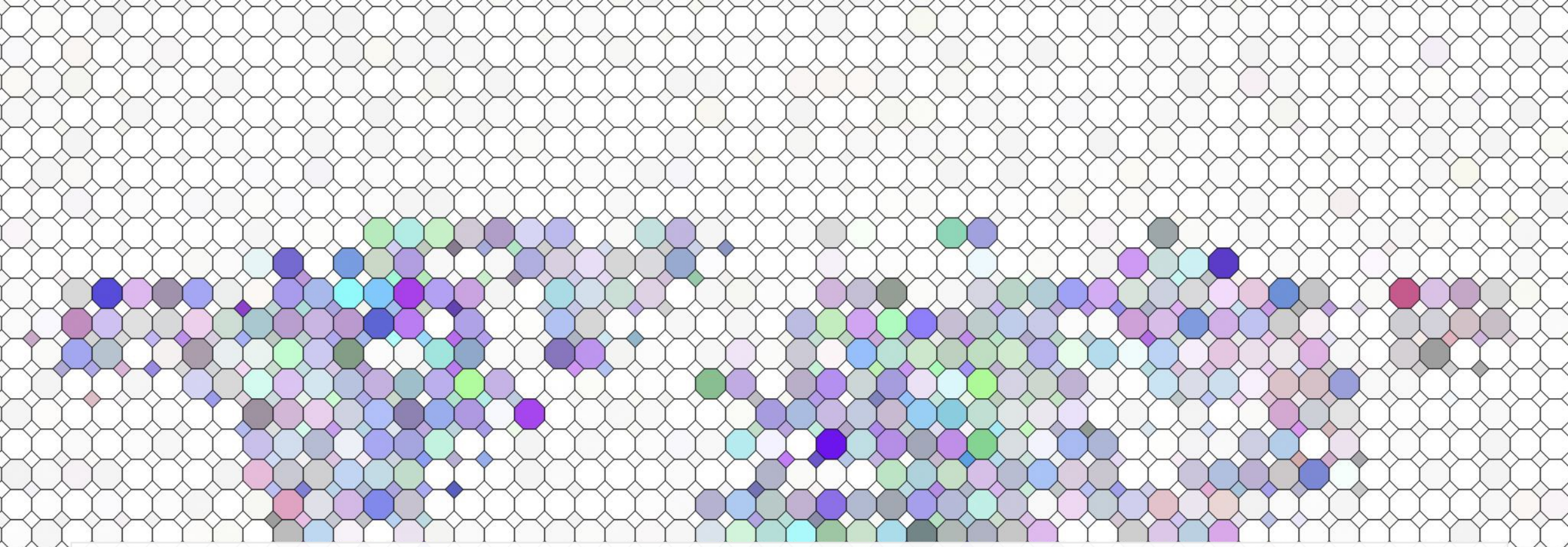


Map Visualization

Map visualization is used to analyze and display the geographically related data and present it in the form of maps. This kind of data expression is clearer and more intuitive. We can visually see the distribution or proportion of data in each region. It is convenient for everyone to mine deeper information and make better decisions.

Our Data

- We have taken our data from United States Geological Survey (USGS) which contains data from 1960 to 2020.
- It includes certain features such as the following:

  - Magnitude: Decimal
  - Place: String
  - Time (1970-01-01T00:00:00.000z): Integer
  - Time zone: Integer
  - url: String
  - Alert: String
  - Status: String
  - Tsunami: Integer
  - Signal: Integer
  - MagError: Decimal
  - MagNst: Integer
  - mmi: Decimal
  - Network: String
  - nph: String
  - rms: Decimal
  - Depth: Decimal
  - dmin: Decimal
  - gap: Decimal

{"type":"FeatureCollection","metadata":{"generated":1652030262000,"url":"https://earthquake.usgs.gov/earthquakes/feed/v1.0/summary/all_month.geojson","title":"USGS All Earthquakes, Past Month","status":200,"api":"1.10.3","count":9228},"features":[{"type":"Feature","properties":{"mag":1.3,"place":"54 km SSW of Cantwell, Alaska","time":1652029815909,"updated":1652030014364,"tz":null,"url":"https://earthquake.usgs.gov/earthquakes/eventpage/ak0225vyyyvq","detail":"https://earthquake.usgs.gov/earthquakes/feed/v1.0/detail/ak0225vyyyvq.geojson","felt":null,"cdi":null,"mmi":null,"alert":null,"status":"automatic","tsunami":0,"sig":26,"net":"ak","code":"0225vyyyvq","ids":",ak0225vyyyvq,","sources":",ak,","types":",origin,phase-data,","nst":null,"dmin":null,"rms":0.66,"gap":null,"magType":"ml","type":"earthquake","title":"M 1.3 - 54 km SSW of Cantwell, Alaska"},"geometry":{"type":"Point","coordinates":[-149.4468,62.9613,80.1]},"id":"ak0225vyyyvq"},

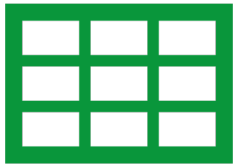
{"type":"Feature","properties":{"mag":1.16,"place":"2km NNW of Palomar Observatory, CA","time":1652028875860,"updated":1652029092178,"tz":null,"url":"https://earthquake.usgs.gov/earthquakes/eventpage/ci40254584","detail":"https://earthquake.usgs.gov/earthquakes/feed/v1.0/detail/ci40254584.geojson","felt":null,"cdi":null,"mmi":null,"alert":null,"status":"automatic","tsunami":0,"sig":21,"net":"ci","code":"40254584","ids":",ci40254584,","sources":",ci,","types":",nearby-cities,origin,phase-data,scitech-link,","nst":37,"dmin":0.02449,"rms":0.26,"gap":43,"magType":"ml","type":"earthquake","title":"M 1.2 - 2km NNW of Palomar Observatory, CA"},"geometry":{"type":"Point","coordinates":[-116.8755,33.3756667,6.65]},"id":"ci40254584"},

{"type":"Feature","properties":{"mag":1.3,"place":"10km NNW of Anza, CA","time":1652027798940,"updated":1652028460070,"tz":null,"url":"https://earthquake.usgs.gov/earthquakes/eventpage/ci40254560","detail":"https://earthquake.usgs.gov/earthquakes/feed/v1.0/detail/ci40254560.geojson","felt":null,"cdi":null,"mmi":null,"alert":null,"status":"automatic","tsunami":0,"sig":26,"net":"ci","code":"40254560","ids":",ci40254560,","sources":",ci,","types":",focal-mechanism,nearby-cities,origin,phase-data,scitech-link,","nst":50,"dmin":0.06456,"rms":0.22,"gap":30,"magType":"ml","type":"earthquake","title":"M 1.3 - 10km NNW of Anza, CA"},"geometry":{"type":"Point","coordinates":[-116.7106667,33.6405,12.92]},"id":"ci40254560"},

{"type":"Feature","properties":{"mag":4.2,"place":"70 km WNW of San Antonio de los Cobres, Argentina","time":1652027502735,"updated":1652030154040,"tz":null,"url":"https://earthquake.usgs.gov/earthquakes/eventpage/us7000h7ys","detail":"https://earthquake.usgs.gov/earthquakes/feed/v1.0/detail/us7000h7ys.geojson","felt":null,"cdi":null,"mmi":null,"alert":null,"status":"reviewed","tsunami":0,"sig":271,"net":"us","code":"7000h7ys","ids":",us7000h7ys,","sources":",us,","types":",origin,phase-data,","nst":null,"dmin":1.511,"rms":0.45,"gap":146,"magType":"mb","type":"earthquake","title":"M 4.2 - 70 km WNW of San Antonio de los Cobres, Argentina"},"geometry":{"type":"Point","coordinates":[-66.9674,-23.9807,231.22]},"id":"us7000h7ys"},

Motivation

Maps are an effective, intuitive way to understand data in some use-cases. Interactive web maps can help us visualize the data better and derive better insights.

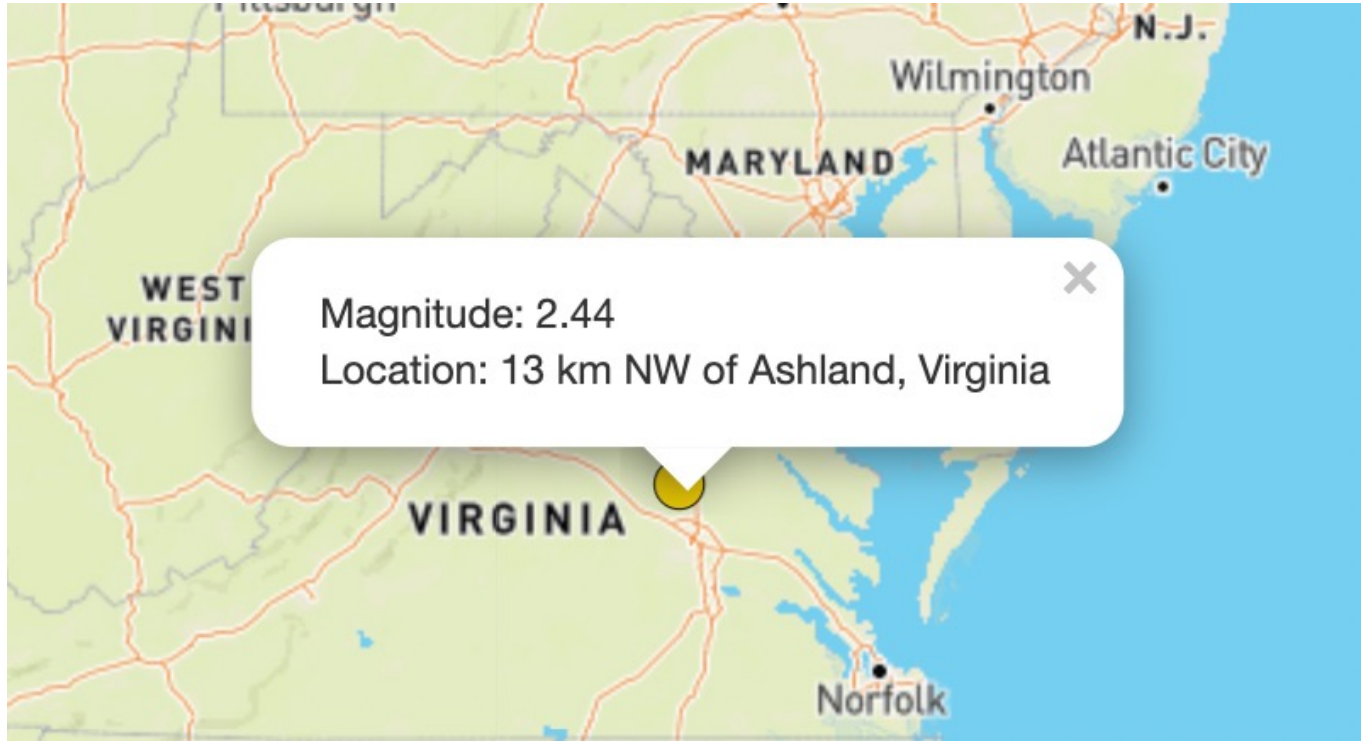


Different map visualizations can highlight different aspects of a dataset. Heatmaps, Choropleth maps and Clustering maps are frequently used for this purpose.

However, we used a powerful JavaScript library Leaflet to build a map.

Method

- Our aim is to visualize earthquake data on map using leaflet library which is an open - source JavaScript library.
- Our leaflet points out the places where an earthquake occurred and also displays its magnitude as shown in the picture below.



Leaflet

- Leaflet is an open - source JavaScript library used to build web mapping applications.
- Leaflet allows developers without a GIS background to very easily display title web apps hosted on a public server, with optional tiled overlays. It can load feature data from GeoJSON files, style it and create interactive layers, such as markers with popups when clicked.

Why leaflet?

- A typical use of Leaflet involves binding a Leaflet "map" element to an HTML element such as a div. Layers and markers are then added to the map element.
- Leaflet is directly comparable with OpenLayers, as both are open source, client-side only JavaScript libraries. The library as a whole is much smaller, around 7,000 lines of code compared to OpenLayers' 230,000.

Code

```
// Selectable backgrounds of our map - tile layers:
// grayscale background.
var graymap_background = L.tileLayer("https://api.mapbox.com/styles/v1/mapbox/light-v9/tiles/256/{z}/{x}/{y}?" +
  "access_token=pk.eyJ1IjoibWFudWVsYW1hY2hhZG8iLCJhIjoiY2ppczQ0NzBtMWNydTNrdDl6Z2JhdzZidSJ9.BFD3qzgAC2kMoEZirGaDjA");

// satellite background.
var satellitemap_background = L.tileLayer("https://api.mapbox.com/styles/v1/mapbox/satellite-streets-v9/tiles/256/{z}/{x}/{y}?" +
  "access_token=pk.eyJ1IjoibWFudWVsYW1hY2hhZG8iLCJhIjoiY2ppczQ0NzBtMWNydTNrdDl6Z2JhdzZidSJ9.BFD3qzgAC2kMoEZirGaDjA");

// outdoors background.
var outdoors_background = L.tileLayer("https://api.mapbox.com/styles/v1/mapbox/outdoors-v9/tiles/256/{z}/{x}/{y}?" +
  "access_token=pk.eyJ1IjoibWFudWVsYW1hY2hhZG8iLCJhIjoiY2ppczQ0NzBtMWNydTNrdDl6Z2JhdzZidSJ9.BFD3qzgAC2kMoEZirGaDjA");
```

- The above code was used to select backgrounds of our map

```
// retrieve earthquake geoJSON data.
d3.json("https://earthquake.usgs.gov/earthquakes/feed/v1.0/summary/all_month.geojson", function(data) {
```

- The above code was used to retrieve earthquake geoJSON data

```
// add GeoJSON layer to the map
L.geoJson(data, {
  pointToLayer: function(feature, latlng) {
    return L.circleMarker(latlng);
  },
  style: styleInfo,
  onEachFeature: function(feature, layer) {
    layer.bindPopup("Magnitude: " + feature.properties.mag + "<br>Location: " + feature.properties.place);
  }

}).addTo(earthquakes);

earthquakes.addTo(map);
```

- The above code explains the addition of GeoJSON layer to the map.
- The code below shows retrieving Tectonic plate GeoJSON data.

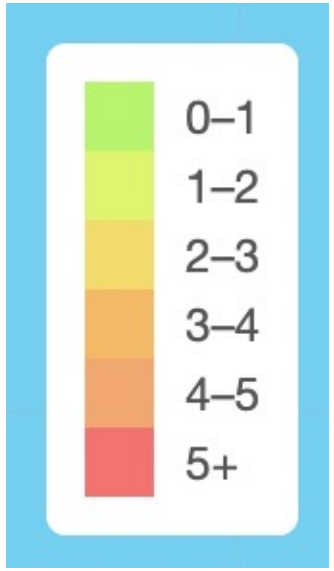
```
// retrive Tectonic Plate geoJSON data.
d3.json("https://raw.githubusercontent.com/fraxen/tectonicplates/master/GeoJSON/PB2002_boundaries.json",
  function(platedata) {

    L.geoJson(platedata, {
      color: "orange",
      weight: 2
    })
    .addTo(tectonicplates);

    // add the tectonicplates layer to the map.
    tectonicplates.addTo(map);
  });
```

- The below code shows defining the color of the marker based on the magnitude.

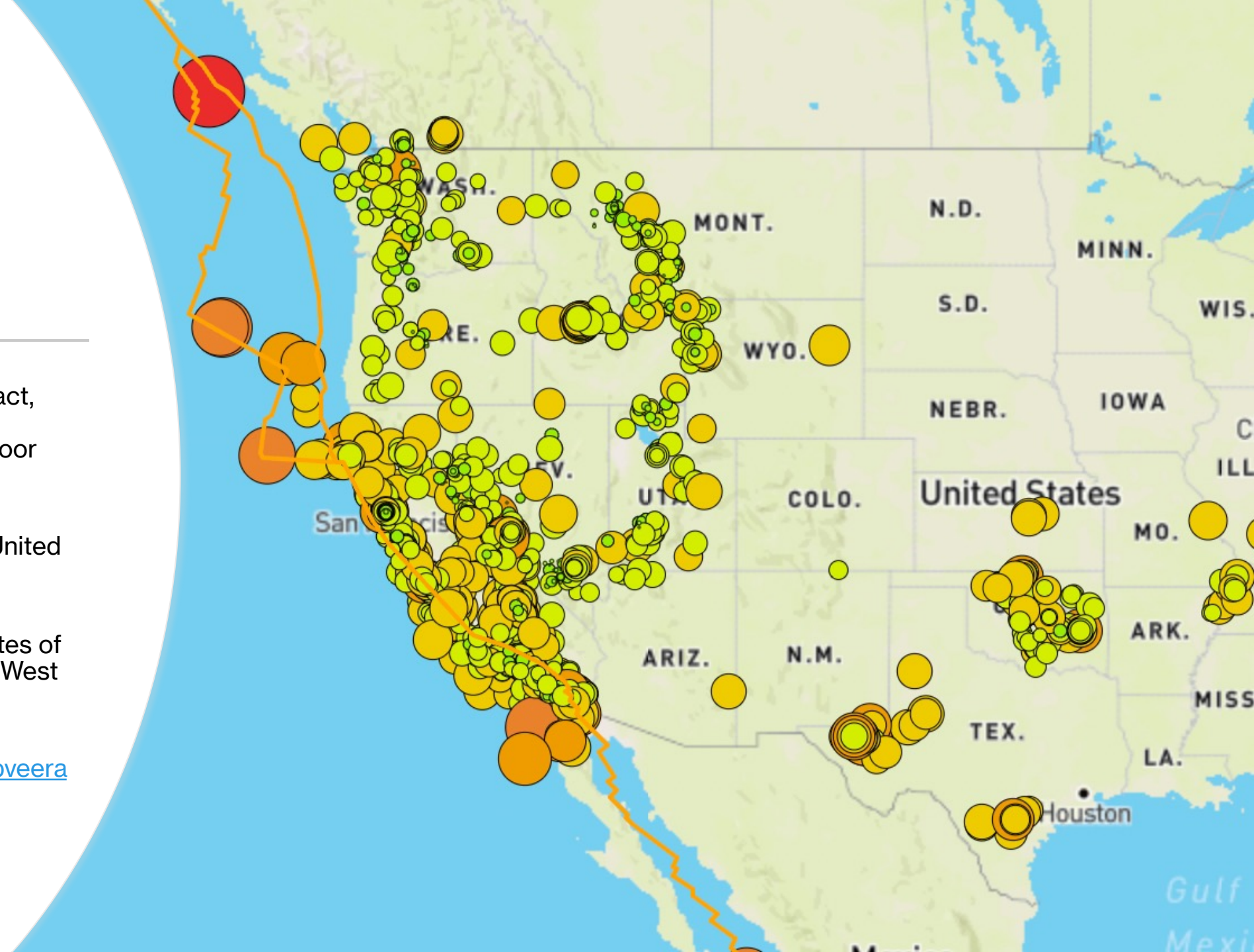
```
// Define the color of the marker based on the magnitude of the earthquake.
function getColor(magnitude) {
  switch (true) {
    case magnitude > 5:
      return "#ea2c2c";
    case magnitude > 4:
      return "#ea822c";
    case magnitude > 3:
      return "#ee9c00";
    case magnitude > 2:
      return "#eecc00";
    case magnitude > 1:
      return "#d4ee00";
    default:
      return "#98ee00";
  }
}
```



Results

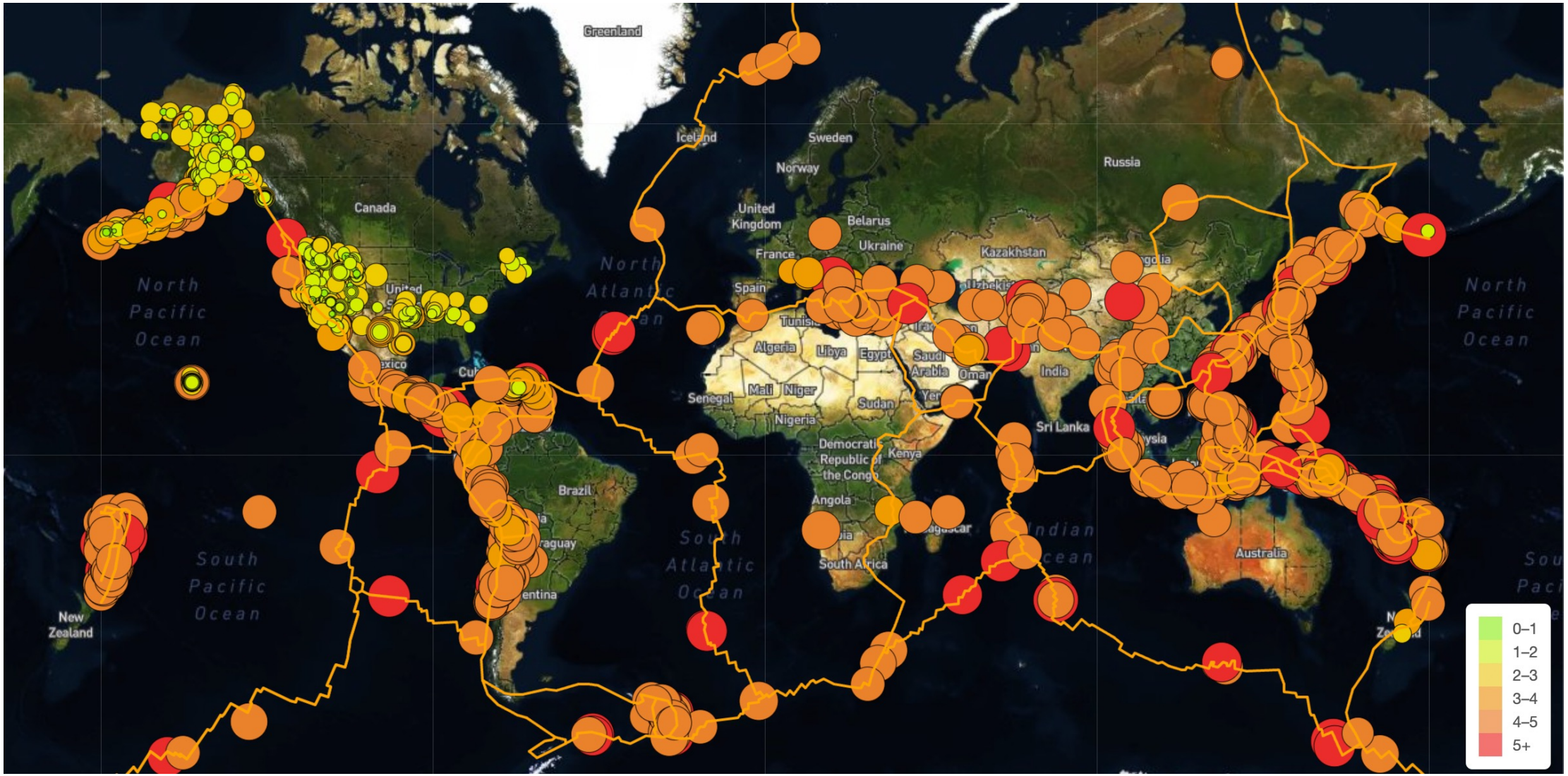
- The circle represents the impact, and the color represents the magnitude. It depicts the outdoor view.
- This picture just includes the earthquakes occurred in the United States of America.
- We observed that most of the earthquakes in the United States of America have occurred in the West Coast.

Working link to our interface: https://webpages.charlotte.edu/pveeram1/VisIndex.html

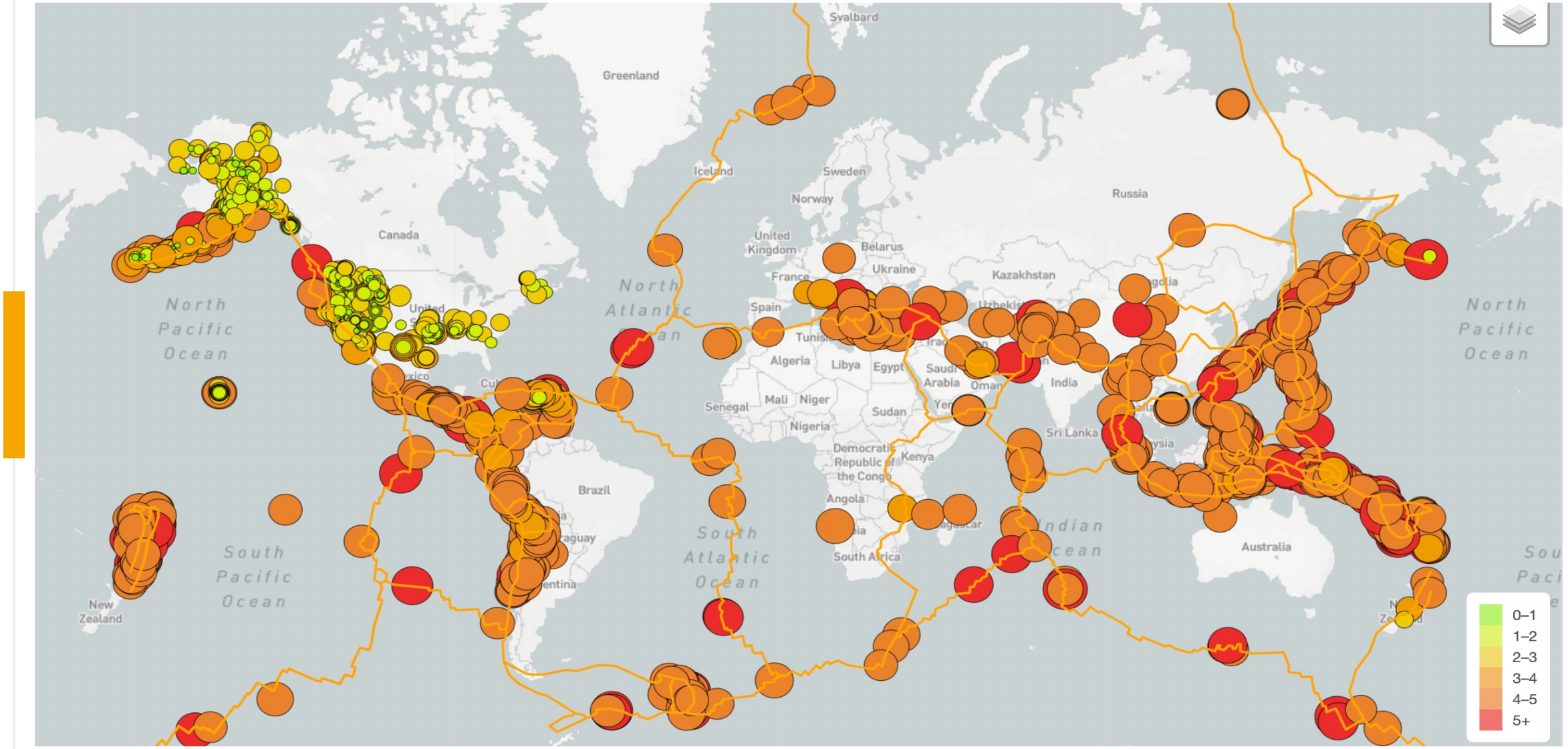


Observations/Insights

- The circum-Pacific belt is home to 80% of all earthquakes, the majority of which are caused by convergent margin activity.
- The Mediterranean-Asian belt accounts for 15% of the total earthquakes, with the remaining 5% occurring in plate interiors and spreading ridge centers.
- Each year, more than 150,000 earthquakes large enough to be felt are reported.



The above picture depicts the satellite view



The above picture depicts the greyscale view

Tectonic Plates

Conclusion

- From the visualization map we generated using Leaflet, we observed that major earthquakes occurred in the West coast of the United States of America, Japan, and Philippines.
- We can conclude by saying that the most affected areas due to an earthquake belong to coastal regions.
- The average magnitude range for an earthquake is between 4 and 5 while the mild earthquakes whose magnitude ranged between 0 and 2 occurred in North America continent.


Thank you!