FIT3179 Data Visualisation

Week 10 Homework

Interactive Charts with Vega-Lite

Introduction

- This is an assessed homework and is worth 1% of your final mark.
- Submission due date: Sunday 25 October, 11:55 pm.
- The late penalty is 25% of the total mark (1%) per day of late submission.

The goal of this homework is to create an interactive visualisation with Vega-Lite that is useful for your Data Visualisation 2 assignment. You will need to (1) create a visualisation with tooltips, text/line annotations, and a filtering option and (2) construct an HTML page that includes at least two visualisations.

You will get feedback about your graph in the Week 11 tutorial, and you can then include an improved version of your visualisation in your submission for the Data Visualisation 2 assignment.

Submission

Important: only Part 3 of this homework is to be submitted. A report must be submitted in PDF format through the submission link on the Week 9 Moodle page. See Part 3 of this document for the required content.

Part 1. Tutorial: Interactions in Vega-Lite

In this part, we will create a bubble plot in Vega-Lite using a COVID-19 dataset, and then add some interactions to the visualisation.

The dataset contains the COVID-19 statistical data of all the countries in the world on 10 Oct 2020. The data is available here: https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interactive_scatter_plot/data/COVID_19_10_Oct_2020.csv

The final visualisation will look like this: https://kanesec.github.io/vega_lite/4_interactive_scatter_plot/

The example GitHub repository is available here: https://github.com/KaneSec/vega_lite/tree/main/4_interactive_scatter_plot

1.1 Building a Bubble Plot

We will first build a basic bubble plot by defining the mark as “circle”, i.e., each circle represents a country. The following visual variables are used to encode four data attributes:

- x-axis (position on a common scale): Confirmed Cases
- y-axis (position on a common scale): Deaths
- Colour hue: Continent
- Size (2D Size, Area): Population

The bubble plot and the corresponding Vega-Lite JSON code is shown below.

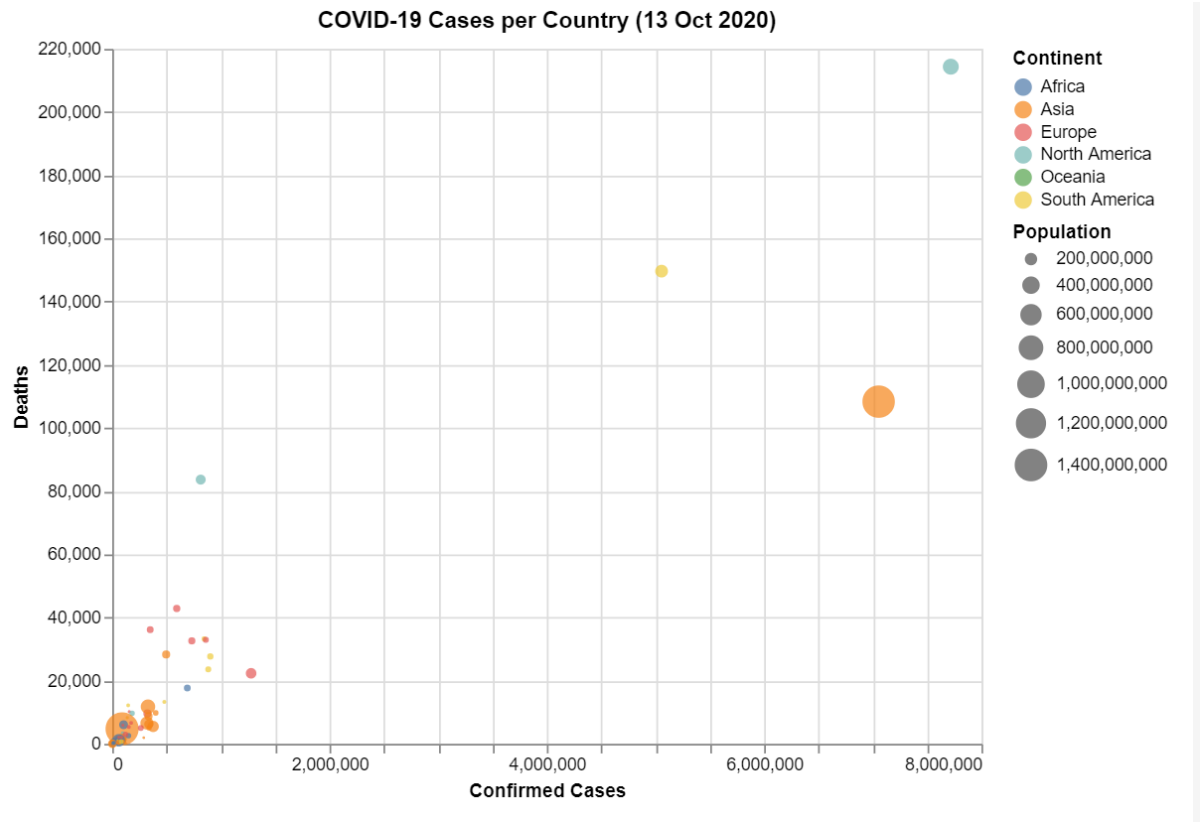


Figure 1. A basic bubble plot

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v4.json",
  "width": 500,
  "height": 400,
  "title": "COVID-19 Cases per Country (13 Oct 2020)",
  "data": {
    "url": "https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interac
tive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "mark": "circle",
  "encoding": {
    "x": {
      "field": "Confirmed",
      "type": "quantitative",
      "title": "Confirmed Cases"
    },
    "y": {
      "field": "Deaths",
      "type": "quantitative"
    },
    "color": {
      "field": "Continent",
      "type": "nominal"
    },
```

```
    "size": {
      "field": "Population",
       "type": "quantitative"
    }
  }
}
```

1.2 Customising the bubble plot

Next, we will change some parameter settings (e.g., colour scales, axis scales, etc.) to make our bubble plot more informative.

1.2.1 x-axis and y-axis

Both the Confirmed Cases and the Deaths data distribution are right-skewed (since some countries such as the US, Brazil, India have significantly larger numbers of cases compared to the other countries). The default axis uses a linear scale, which results in that most countries are clustered in the bottom-left corner (Figure 1). We will use a log scale for both our x-axis and y-axis. The result and the corresponding code are shown below.

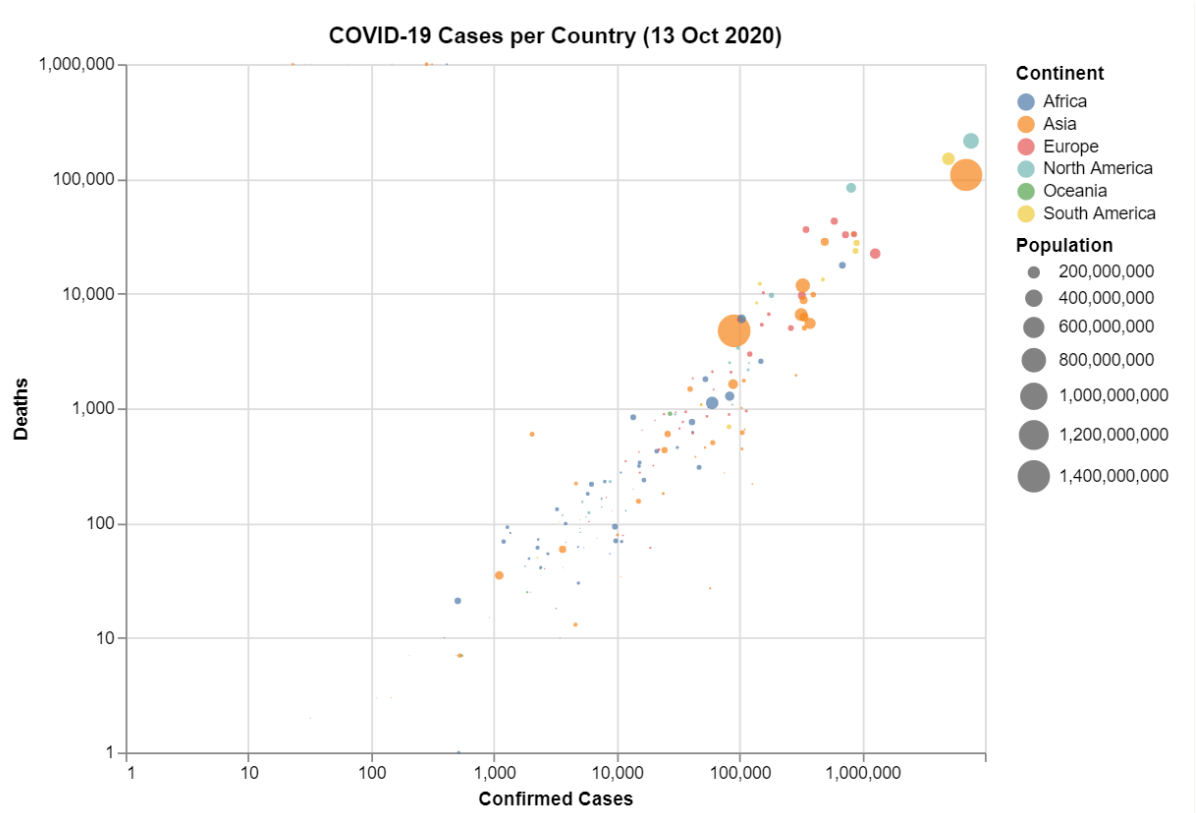


Figure 2. log scales of the x-axis and y-axis.

We need to define a scale with a type of “log”. To remove the complex background grid, we will also change the axis ticks with “tickCount” (which is the total number of ticks of x-axis and y-axis).

```
  "x": {
     "field": "Confirmed",
     "type": "quantitative",
     "title": "Confirmed Cases",
     "axis": {"tickCount": 7},
     "scale": {"type": "log", "domain": [1, 10000000]}
   },
   "y": {
     "field": "Deaths",
     "type": "quantitative",
     "axis": {"tickCount": 6},
     "scale": {"type": "log", "domain": [1, 1000000]}
   }
```

Since log transformation does not work for zero or negative numbers, we define a “filter” to filter out such values. To do so, we just need to define a “filter” inside the “transform” list, which can be added after the data loading part. See the code below:

```
  "data": {
    "url": "https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interac
tive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "transform": [
    {"filter": "datum.Active > 0"},
    {"filter": "datum.Deaths > 0"}
  ]
```

Note: Vega-Lite is capable of some basic data cleaning and aggregations. For more complicated data cleaning and integration, we can use JavaScript to pre-process the data and then send them for visualisation. If you are not familiar with JavaScript, it is recommended that you clean or integrate your data first before uploading them for visualisation in Vega-Lite.

1.2.2 Classification: changing the scale for “size”

Another parameter we would like to tune is the size of the points, which encodes the population of each country. Here we define a classification scale, similar to

what we had in our week-9 homework. The result and the code are shown below:

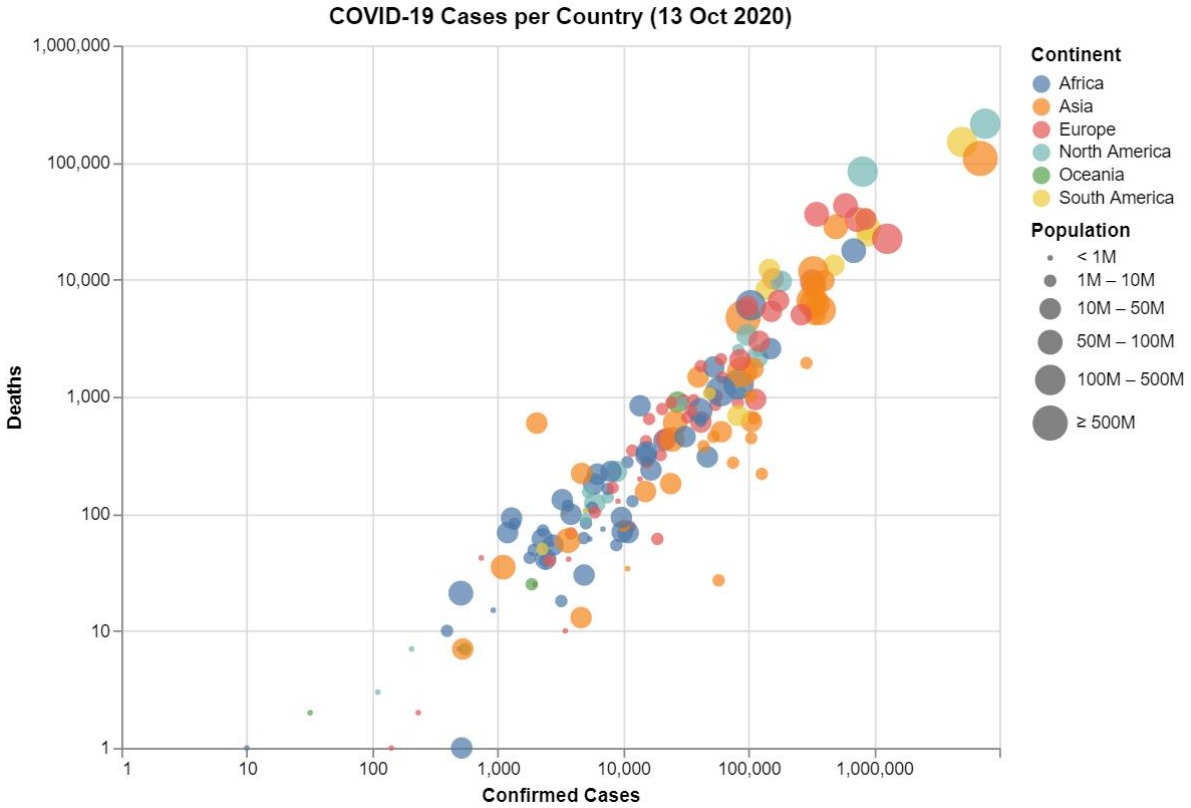


Figure 3. Classification scale for size.

Here the scale type is defined as “threshold”. Then we use five thresholds to divide the domain into six classes. The correspondences are:

- Population below 1M -> size of the bubble is 10
- Population between 1M and 10M -> size of the bubble is 50
- ...
- Population above 500M -> the bubble size is 400

We also define the number format to make the legend easier to read (Figure 3). “.1s” means SI-prefix with two significant digits: e.g., 1000000 will be represented as 1M. If you change the format to “.2s”, then 1000000 will be represented as 1.0M. A format of “,” will give you “1,000,000”. For more details of format in Vega-lite, please check it here: https://vega.github.io/vega-lite/docs/format.html.

```
"size": {
    "field": "Population",
    "type": "quantitative",
```

```
      "scale": {
        "type": "threshold",
        "domain": [1000000, 10000000, 50000000, 100000000, 500000000],
        "range": [10, 50, 150, 200, 300, 400]
      },
      "legend": {"format": ".1s"}
    }
```

1.2.3 Color scale

The default colour is already effective but could be further improved. Here we change the colour scale of each continent and try to differentiate those continents that are doing well in handling COVID-19 (e.g., Asia, Oceania) and those that are struggling (e.g., North America, Europe, etc.).

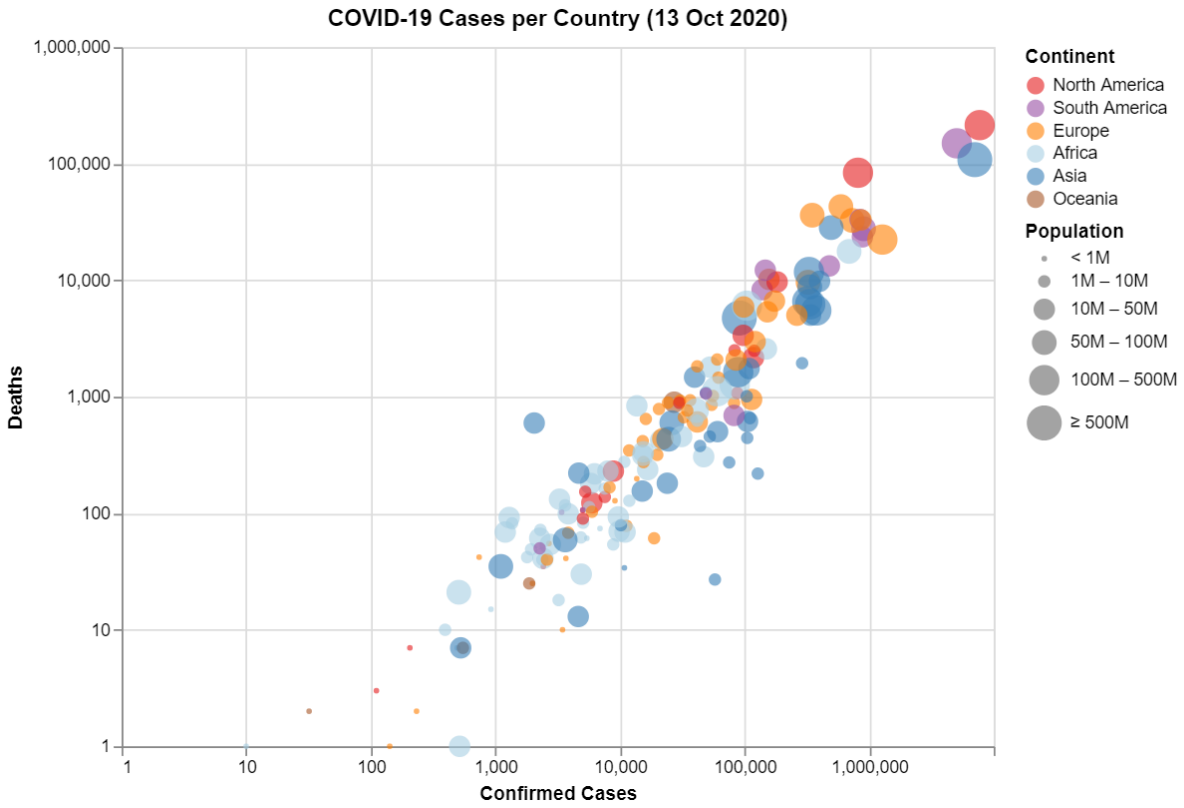


Figure 4. Changing the colour scale.

The code is shown below. We customise the colour scale with colours picked from https://colorbrewer2.org/. We can also define the transparency of the bubbles ("opacity") to reduce visual clutter.

```
  "color": {
      "field": "Continent",
```

```
        "type": "nominal",
        "scale": {
          "domain": [
            "North America",
            "South America",
            "Europe",
            "Africa",
            "Asia",
            "Oceania"
          ],
          "range": [
            "#e41a1c",
            "#984ea3",
            "#ff7f00",
            "#a6cee3",
            "#377eb8",
            "#a65628"
          ]
        }
      },
    "opacity": {
          "value": 0.6
        }
```

End of 1.2: Let's wrap up the code that we have so far. You can copy the following JSON code to the Vega Editor and view the result.

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v4.json",
  "width": 500,
  "height": 400,
  "title": "COVID-19 Cases per Country (13 Oct 2020)",
  "data": {
    "url": "https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interac
tive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "transform": [
    {"filter": "datum.Active > 0"},
    {"filter": "datum.Deaths > 0"}],
  "mark": "circle",
  "encoding": {
    "x": {
      "field": "Confirmed",
      "type": "quantitative",
      "title": "Confirmed Cases",
      "axis": {"tickCount": 7},
      "scale": {"type": "log", "domain": [1, 10000000]}
```

```
    },
    "y": {
      "field": "Deaths",
      "type": "quantitative",
      "axis": {"tickCount": 6},
      "scale": {"type": "log", "domain": [1, 1000000]}
    },
    "color": {
          "field": "Continent",
          "type": "nominal",
          "scale": {
            "domain": [
              "North America",
              "South America",
              "Europe",
              "Africa",
              "Asia",
              "Oceania"
            ],
            "range": [
              "#e41a1c",
              "#984ea3",
              "#ff7f00",
              "#a6cee3",
              "#377eb8",
              "#a65628"
            ]
          }
        },
    "opacity": {
      "value": 0.6
    },
    "size": {
          "field": "Population",
          "type": "quantitative",
          "scale": {
            "type": "threshold",
            "domain": [1000000, 10000000, 50000000, 100000000, 500000000],
            "range": [10, 50, 150, 200, 300, 400]
          },
          "legend": {"format": ".1s"}
        }
  }
}
```

1.3 Adding a tooltip

In this section, we will add a tooltip to our bubble plot. Tooltips can provide some detailed information when users hover over the data points (countries) in our bubble plot. The information that we would like to show in our tooltip includes:

- Country name
- Confirmed cases, Active case, Deaths, Recovered number, and
- Cases per 10,000 Population

We have no information related to “Cases per 10,000 Population” yet, so we will need to calculate this first. To do so, we can add the following code to the “transform” part:

```
{
  "calculate": "datum.Confirmed/datum.Population * 10000",
  "as": "Cases per 10,000 Population"
}
```

Then, we can use the following code to define our tooltip. They should be part of the “encoding”.

```
 "tooltip": [
      {"field": "Country", "type": "nominal"},
      {"field": "Confirmed", "type": "quantitative", "format": ","},
      {"field": "Active", "type": "quantitative", "format": ","},
      {"field": "Deaths", "type": "quantitative", "format": ","},
      {"field": "Recovered", "type": "quantitative", "format": ","},
      {
        "field": "Cases per 10,000 Population",
        "type": "quantitative",
        "format": ".2f"
      }
    ]
```

The result is shown below. We can see a nicely formatted tooltip when we hover over a point in our bubble plot.

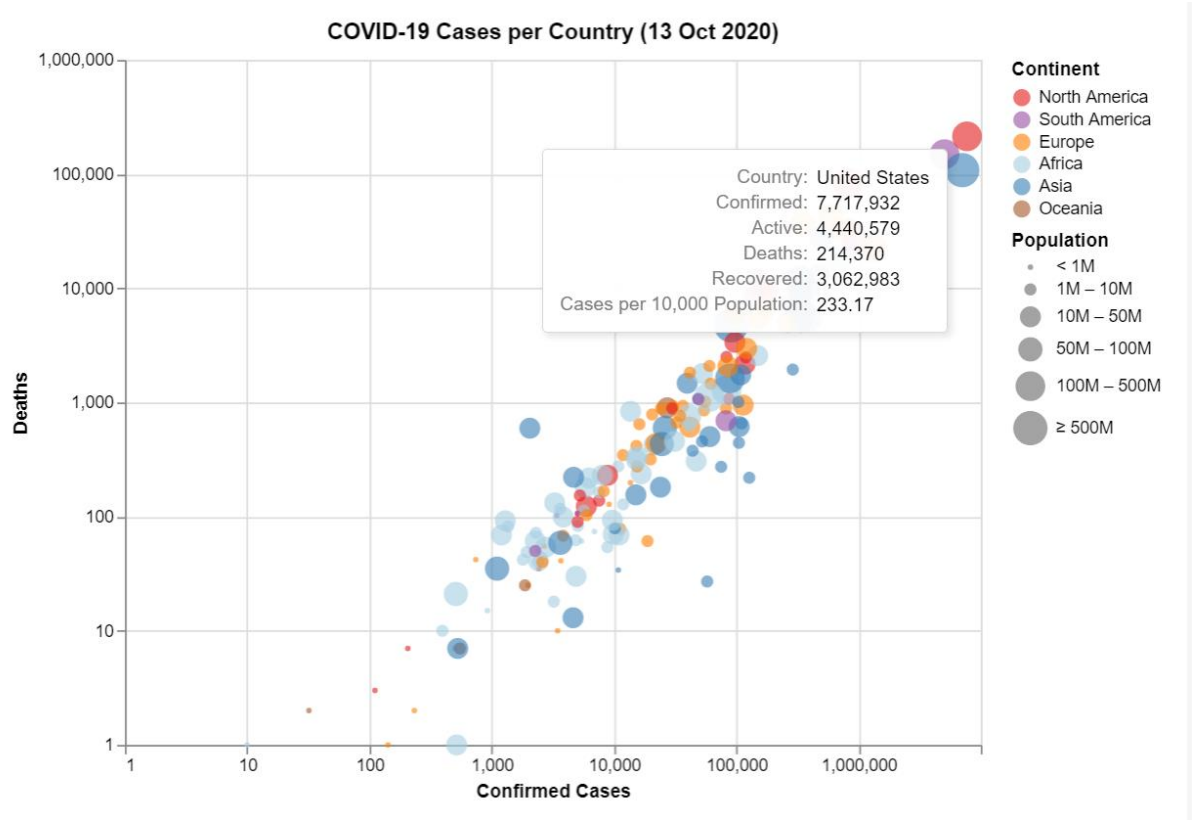


Figure 5. Adding a tooltip

The complete code is presented below:

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v4.json",
  "width": 500,
  "height": 400,
  "title": "COVID-19 Cases per Country (13 Oct 2020)",
  "data": {
    "url": "https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interac
tive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "transform": [
    {"filter": "datum.Active > 0"},
    {"filter": "datum.Deaths > 0"},
    {
      "calculate": "datum.Confirmed/datum.Population * 10000",
      "as": "Cases per 10,000 Population"
    }],
  "mark": "circle",
  "encoding": {
    "x": {
      "field": "Confirmed",
      "type": "quantitative",
      "title": "Confirmed Cases",
```

```
  "axis": {"tickCount": 7},
  "scale": {"type": "log", "domain": [1, 10000000]}
},
"y": {
  "field": "Deaths",
  "type": "quantitative",
  "axis": {"tickCount": 6},
  "scale": {"type": "log", "domain": [1, 1000000]}
},
"color": {
      "field": "Continent",
      "type": "nominal",
      "scale": {
        "domain": [
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "range": [
          "#e41a1c",
          "#984ea3",
          "#ff7f00",
          "#a6cee3",
          "#377eb8",
          "#a65628"
        ]
      }
    },
"opacity": {
  "value": 0.6
},
"size": {
      "field": "Population",
      "type": "quantitative",
      "scale": {
        "type": "threshold",
        "domain": [1000000, 10000000, 50000000, 100000000, 500000000],
        "range": [10, 50, 150, 200, 300, 400]
      },
      "legend": {"format": ".1s"}
},
"tooltip": [
      {"field": "Country", "type": "nominal"},
      {"field": "Confirmed", "type": "quantitative", "format": ","},
      {"field": "Active", "type": "quantitative", "format": ","},
      {"field": "Deaths", "type": "quantitative", "format": ","},
```

```
          {"field": "Recovered", "type": "quantitative", "format": ","},
          {
            "field": "Cases per 10,000 Population",
            "type": "quantitative",
            "format": ".2f"
          }
        ]
  }
}
```

1.4 Filtering/Selections

Overview first, zoom and filter, then details-on-demand.
[Visual information seeking Mantra, Shneiderman]

Another powerful interaction technique is filtering/selection. In this section, we will demonstrate three different types of filtering/selection implementation supported in Vega-Lite, including selection with a legend, a selection menu, and a slider. For other types of selections, please check the corresponding Vega-Lite documentation: https://vega.github.io/vega-lite/docs/selection.html.

1.4.1 Direct selection on the legend

The first selection that we are going to implement is based on the legend. When the user clicks on a continent (in the legend), we will highlight all the countries belonging to the selected continent. To achieve this, we first define a "selection" before the mark ("points") is described.

```
    "selection": {
       "continent_highlight": {
         "type": "multi",
         "fields": ["Continent"],
         "bind": "legend"
       }
     },
```

Then, we change the opacity of the mark based on the legend selection. We define a condition to do so: if the countries satisfy the condition, the opacity value is 0.6; otherwise, the opacity value will be 0.2.

```
    "opacity": {
          "condition": {"selection": "continent_highlight", "value": 0.6},
          "value": 0.2
```

}

The visualisation result is shown below:

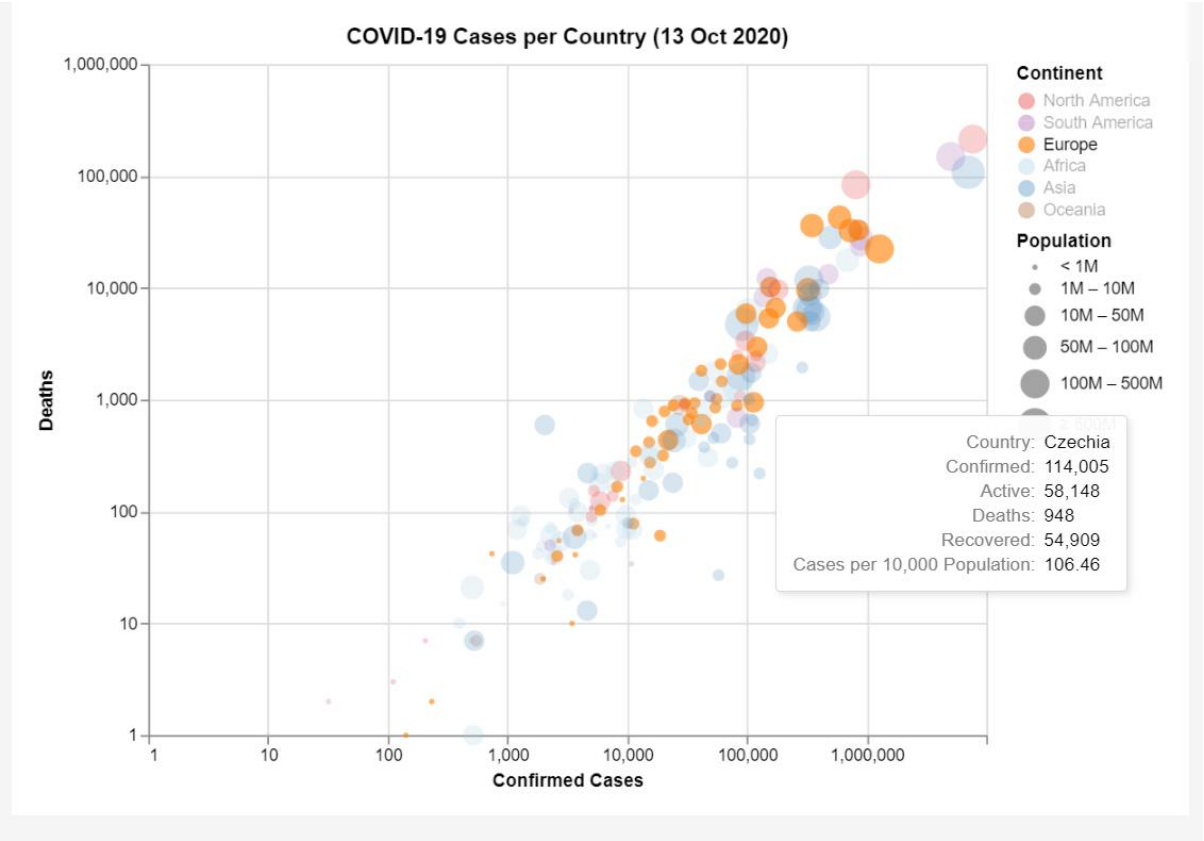


Figure 6. Legend Selection.

The full code is shown below:

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v4.json",
  "width": 500,
  "height": 400,
  "title": "COVID-19 Cases per Country (13 Oct 2020)",
  "data": {
    "url": "https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interac
tive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "transform": [
    {"filter": "datum.Active > 0"},
    {"filter": "datum.Deaths > 0"},
    {
      "calculate": "datum.Confirmed/datum.Population * 10000",
      "as": "Cases per 10,000 Population"
    }],
```

```
"selection": {
      "continent_highlight": {
        "type": "multi",
        "fields": ["Continent"],
        "bind": "legend"
      }
    },
"mark": "circle",
"encoding": {
  "x": {
    "field": "Confirmed",
    "type": "quantitative",
    "title": "Confirmed Cases",
    "axis": {"tickCount": 7},
    "scale": {"type": "log", "domain": [1, 10000000]}
  },
  "y": {
    "field": "Deaths",
    "type": "quantitative",
    "axis": {"tickCount": 6},
    "scale": {"type": "log", "domain": [1, 1000000]}
  },
  "color": {
        "field": "Continent",
        "type": "nominal",
        "scale": {
          "domain": [
            "North America",
            "South America",
            "Europe",
            "Africa",
            "Asia",
            "Oceania"
          ],
          "range": [
            "#e41a1c",
            "#984ea3",
            "#ff7f00",
            "#a6cee3",
            "#377eb8",
            "#a65628"
          ]
        }
      },
  "opacity": {
        "condition": {"selection": "continent_highlight", "value": 0.6},
        "value": 0.2
  },
  "size": {
```

```
            "field": "Population",
            "type": "quantitative",
            "scale": {
              "type": "threshold",
              "domain": [1000000, 10000000, 50000000, 100000000, 500000000],
              "range": [10, 50, 150, 200, 300, 400]
            },
            "legend": {"format": ".1s"}
    },
    "tooltip": [
            {"field": "Country", "type": "nominal"},
            {"field": "Confirmed", "type": "quantitative", "format": ","},
            {"field": "Active", "type": "quantitative", "format": ","},
            {"field": "Deaths", "type": "quantitative", "format": ","},
            {"field": "Recovered", "type": "quantitative", "format": ","},
            {
              "field": "Cases per 10,000 Population",
              "type": "quantitative",
              "format": ".2f"
            }
        ]
  }
}
```

1.4.2 Filtering with a selection menu

We can also define a selection menu outside the legend to filter out some countries. Here we will still use “Continent” as an example. We will define a list of “params”, and then add a param which is our continent selection. We add a “select” bind, and define the options as different continents. We also add a *null* option. *null* is a reserved keyword which means no-selection. To reduce the confusion of *null*, we change the label of this selection to “Show All” in our “labels”, which controls the options that we show on the screen. For more details regarding binding in vague-lite, please check it here: https://vega.github.io/vega-lite/docs/bind.html.

Please note that, there are two names here. The first “name” is the selection name that we are going to use to reference this selection result in our later code; the second “name” is the value that is displayed on our page (in front of the selection menu), as shown in Figure 7.

```
  "params": [
    {
      "name": "Continent_selection",
```

```
      "bind": {
        "input": "select",
        "options": [
          null,
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "labels":[
          "Show All",
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],

        "name": "Continent Selection: "
      }
    }
  ]
```

Then, just inside the “transform”, we add another filter option to show only the continent that is selected, or we will show all the continents if the selection is *null*. (Please note that: here we should use the value in the “Options” not the labels.)

```
    {"filter": "Continent_selection == null || datum.Continent == Continent_se
lection"}
```

The visualisation is shown in Figure 7. Only European countries are displayed after the selection.

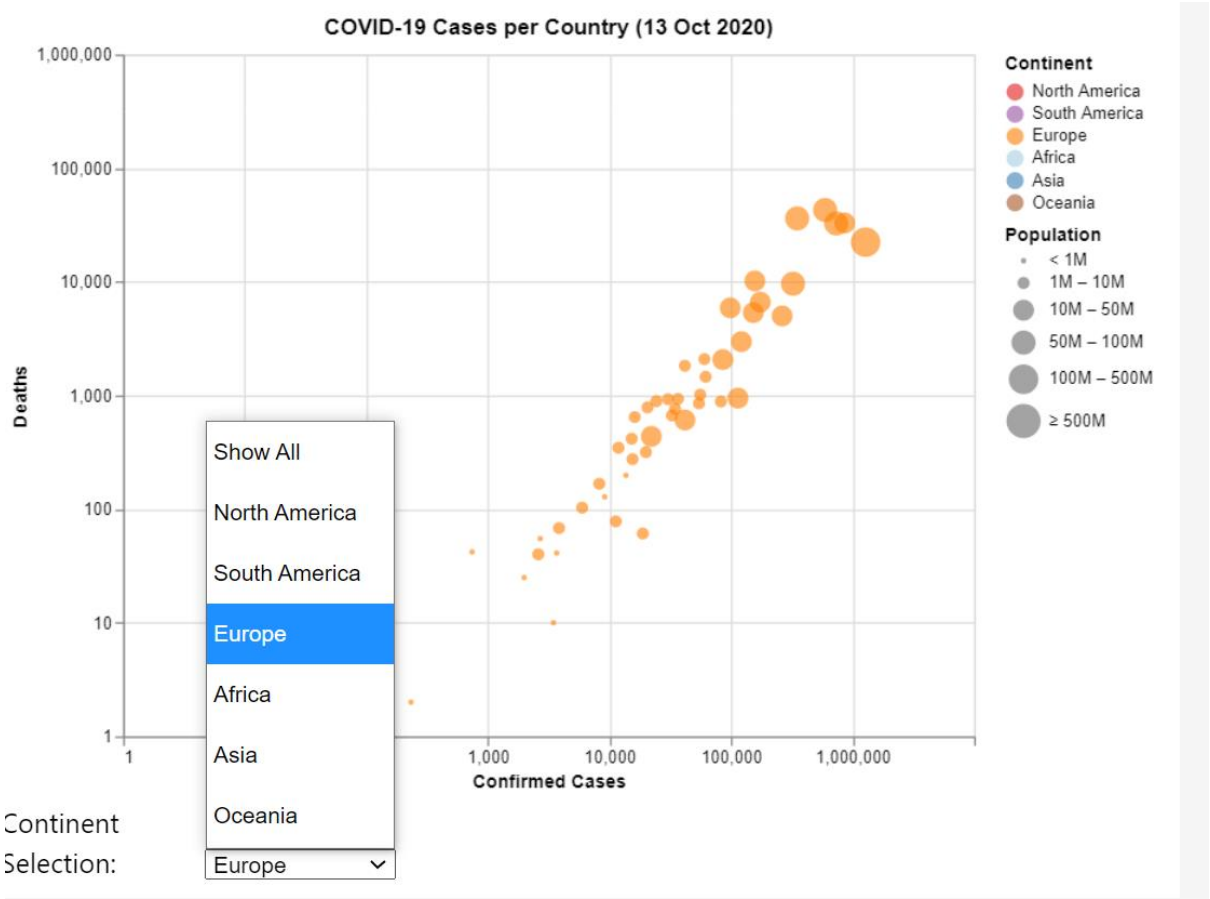


Figure 7. Selection menu.

The full code so far is shown below.

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v4.json",
  "width": 500,
  "height": 400,
  "title": "COVID-19 Cases per Country (13 Oct 2020)",
  "data": {
    "url": "https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interac
tive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "params": [
    {
      "name": "Continent_selection",
      "bind": {
        "input": "select",
        "options": [
          null,
          "North America",
          "South America",
          "Europe",
```

```
          "Africa",
          "Asia",
          "Oceania"
        ],
        "labels":[
          "Show All",
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "name": "Continent Selection: "
      }
    }
  ],
  "transform": [
    {"filter": "datum.Active > 0"},
    {"filter": "datum.Deaths > 0"},
    {"filter": "Continent_selection == null || datum.Continent == Continent_se
lection"},
    {
      "calculate": "datum.Confirmed/datum.Population * 10000",
      "as": "Cases per 10,000 Population"
    }],
  "selection": {
        "continent_highlight": {
          "type": "multi",
          "fields": ["Continent"],
          "bind": "legend"
        }
      },
  "mark": "circle",
  "encoding": {
    "x": {
      "field": "Confirmed",
      "type": "quantitative",
      "title": "Confirmed Cases",
      "axis": {"tickCount": 7},
      "scale": {"type": "log", "domain": [1, 10000000]}
    },
    "y": {
      "field": "Deaths",
      "type": "quantitative",
      "axis": {"tickCount": 6},
      "scale": {"type": "log", "domain": [1, 1000000]}
```

```
},
"color": {
      "field": "Continent",
      "type": "nominal",
      "scale": {
        "domain": [
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "range": [
          "#e41a1c",
          "#984ea3",
          "#ff7f00",
          "#a6cee3",
          "#377eb8",
          "#a65628"
        ]
      }
    },
"opacity": {
      "condition": {"selection": "continent_highlight", "value": 0.6},
      "value": 0.2
},
"size": {
      "field": "Population",
      "type": "quantitative",
      "scale": {
        "type": "threshold",
        "domain": [1000000, 10000000, 50000000, 100000000, 500000000],
        "range": [10, 50, 150, 200, 300, 400]
      },
      "legend": {"format": ".1s"}
},
"tooltip": [
      {"field": "Country", "type": "nominal"},
      {"field": "Confirmed", "type": "quantitative", "format": ","},
      {"field": "Active", "type": "quantitative", "format": ","},
      {"field": "Deaths", "type": "quantitative", "format": ","},
      {"field": "Recovered", "type": "quantitative", "format": ","},
      {
        "field": "Cases per 10,000 Population",
        "type": "quantitative",
        "format": ".2f"
      }
    ]
```

```
  }
}
```

1.4.3 Filtering with a slider

Another filtering option is to use a slider – this is more suitable for quantitative attributes (e.g., the population). Here we define a range bind to filter out the countries with a population value above a given threshold , which is defined by the slider. The code and the result are shown below.

```
  {
    "name": "Population_Above",
    "value": 0,
    "bind": {
      "input": "range",
      "min": 0,
      "max": 100000000,
      "step": 1000000,
      "name": "Minimum Population: "
    }
  }

  {"filter": "datum.Population > Population_Above"}
```

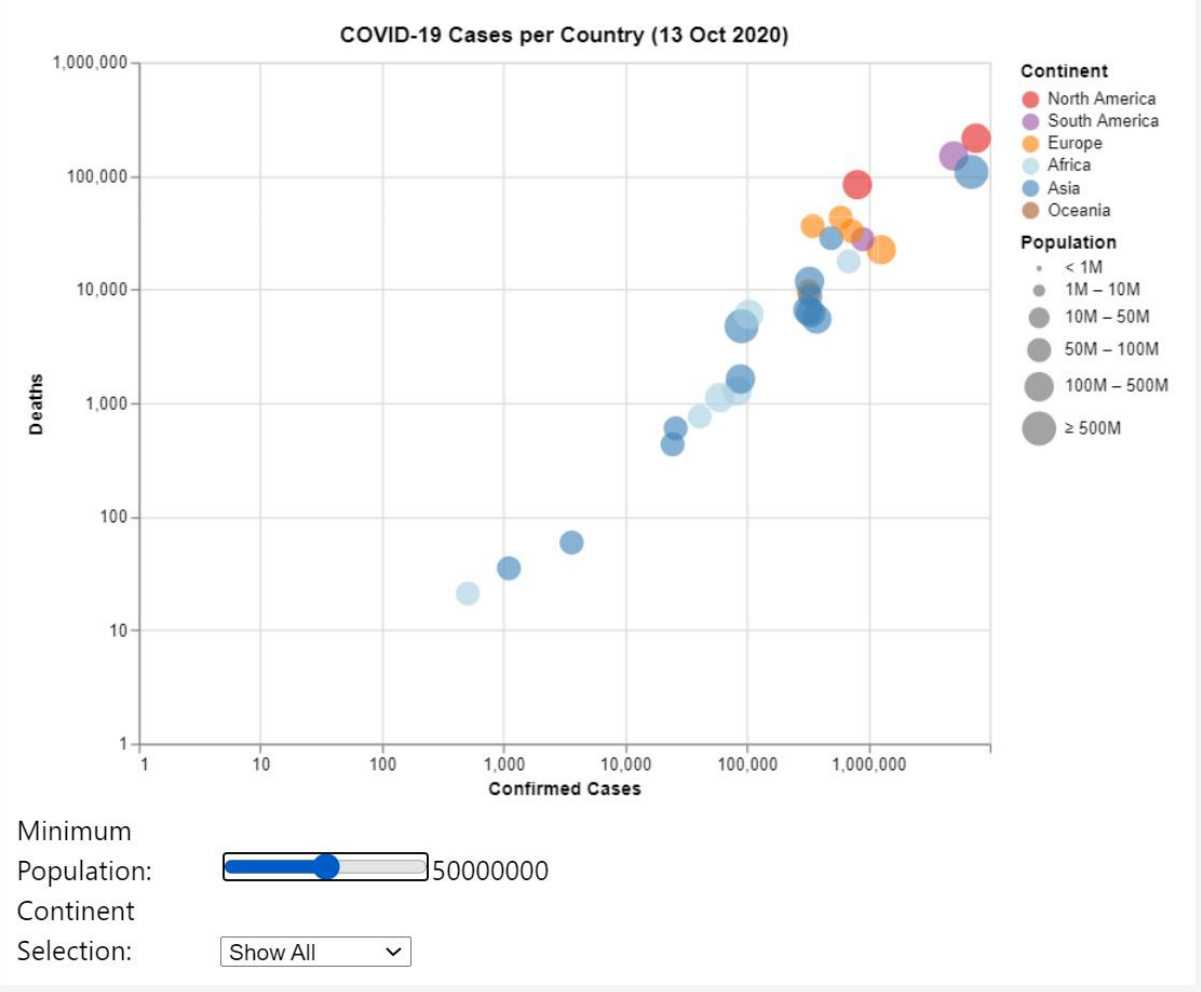


Figure 8. Filtering with a Slider.

The code that we have so far is shown below.

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v4.json",
  "width": 500,
  "height": 400,
  "title": "COVID-19 Cases per Country (13 Oct 2020)",
  "data": {
    "url": "https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interac
tive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "params": [
    {
      "name": "Population_Above",
      "value": 0,
      "bind": {
        "input": "range",
        "min": 0,
        "max": 100000000,
```

```
        "step": 1000000,
        "name": "Minimum Population: "
      }
    },
    {
      "name": "Continent_selection",
      "bind": {
        "input": "select",
        "options": [
          null,
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "labels":[
          "Show All",
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],

        "name": "Continent Selection: "
      }
    }
  ],
  "transform": [
    {"filter": "datum.Active > 0"},
    {"filter": "datum.Deaths > 0"},
    {"filter": "datum.Population > Population_Above"},
    {"filter": "Continent_selection == null || datum.Continent == Continent_se
lection"},
    {
      "calculate": "datum.Confirmed/datum.Population * 10000",
      "as": "Cases per 10,000 Population"
    }],
  "selection": {
        "continent_highlight": {
          "type": "multi",
          "fields": ["Continent"],
          "bind": "legend"
        }
```

```
    },
"mark": "circle",
"encoding": {
  "x": {
    "field": "Confirmed",
    "type": "quantitative",
    "title": "Confirmed Cases",
    "axis": {"tickCount": 7},
    "scale": {"type": "log", "domain": [1, 10000000]}
  },
  "y": {
    "field": "Deaths",
    "type": "quantitative",
    "axis": {"tickCount": 6},
    "scale": {"type": "log", "domain": [1, 1000000]}
  },
  "color": {
        "field": "Continent",
        "type": "nominal",
        "scale": {
          "domain": [
            "North America",
            "South America",
            "Europe",
            "Africa",
            "Asia",
            "Oceania"
          ],
          "range": [
            "#e41a1c",
            "#984ea3",
            "#ff7f00",
            "#a6cee3",
            "#377eb8",
            "#a65628"
          ]
        }
      },
  "opacity": {
        "condition": {"selection": "continent_highlight", "value": 0.6},
        "value": 0.2
  },
  "size": {
        "field": "Population",
        "type": "quantitative",
        "scale": {
          "type": "threshold",
          "domain": [1000000, 10000000, 50000000, 100000000, 500000000],
          "range": [10, 50, 150, 200, 300, 400]
```

```
            },
            "legend": {"format": ".1s"}
    },
    "tooltip": [
            {"field": "Country", "type": "nominal"},
            {"field": "Confirmed", "type": "quantitative", "format": ","},
            {"field": "Active", "type": "quantitative", "format": ","},
            {"field": "Deaths", "type": "quantitative", "format": ","},
            {"field": "Recovered", "type": "quantitative", "format": ","},
            {
              "field": "Cases per 10,000 Population",
              "type": "quantitative",
              "format": ".2f"
            }
          ]
  }
}
```

1.5 Text Annotations

Annotations can normally be used to provide some key information on top of the existing graph. Vega-Lite provides both text and line annotations. In this section, we will add text annotations on top of our bubble plot. For more examples related to other types of annotations, please check the Vega-Lite documentation here: https://vega.github.io/vega-lite/examples/.

To add an annotation, we need to define layers first: our original bubble plot will be our bottom layer, and the text annotations will be our top layer. We add a selection of country names on top of the bubble plot. As the points in the bubble plot and the text annotation share the same location, we can have the x and y encoding outside the layers. The code structure is shown below:

```
  "encoding": {
    "x": …
    "y":
  },
  "layer": [
      {
            Layer 1: bubble plot
      },
      {
            Layer 2: text annotations
      }
   ]
```

The following code creates the text annotation layer. We define the type of the mark as “text” and then adjust the position, alignment, and the font. Under “encoding”, we will use the attribute “Country” (Country name) as our annotated text. We also define a test condition (https://vega.github.io/vega-lite/docs/condition.html) to only show those countries that we selected (other countries have an opacity of 0). We also add a tooltip to our text. Some additional information can be presented when users hover over either the points or the texts on the bubble plot.

```
   {
      "mark": {
        "type": "text",
        "align": "right",
        "baseline": "middle",
        "dx": -12,
        "fontSize": 11.5,
        "fontStyle": "italic"
      },
      "encoding": {
        "text": {"field": "Country", "type": "nominal"},
        "color": {"value": "black"},
        "opacity": {
          "condition": {
            "test": "datum['Country'] == 'China' || datum['Country'] == 'Singa
pore' || datum['Country'] == 'Australia' || datum['Country'] == 'New Zealand'
|| datum['Country'] == 'Italy' || datum['Country'] == 'Yemen' ||  datum['Count
ry'] == 'United States'",
            "value": 1
          },
          "value": 0
        },
        "tooltip": [
          {"field": "Country", "type": "nominal"},
          {"field": "Confirmed", "type": "quantitative", "format": ","},
          {"field": "Active", "type": "quantitative", "format": ","},
          {"field": "Deaths", "type": "quantitative", "format": ","},
          {"field": "Recovered", "type": "quantitative", "format": ","},
          {
            "field": "Cases per 10,000 Population",
            "type": "quantitative",
            "format": ".2f"
          }
        ]
      }
    }
```

The resulting visualisation is shown below. An interactive version is available at https://kanesec.github.io/vega_lite/4_interactive_scatter_plot/.

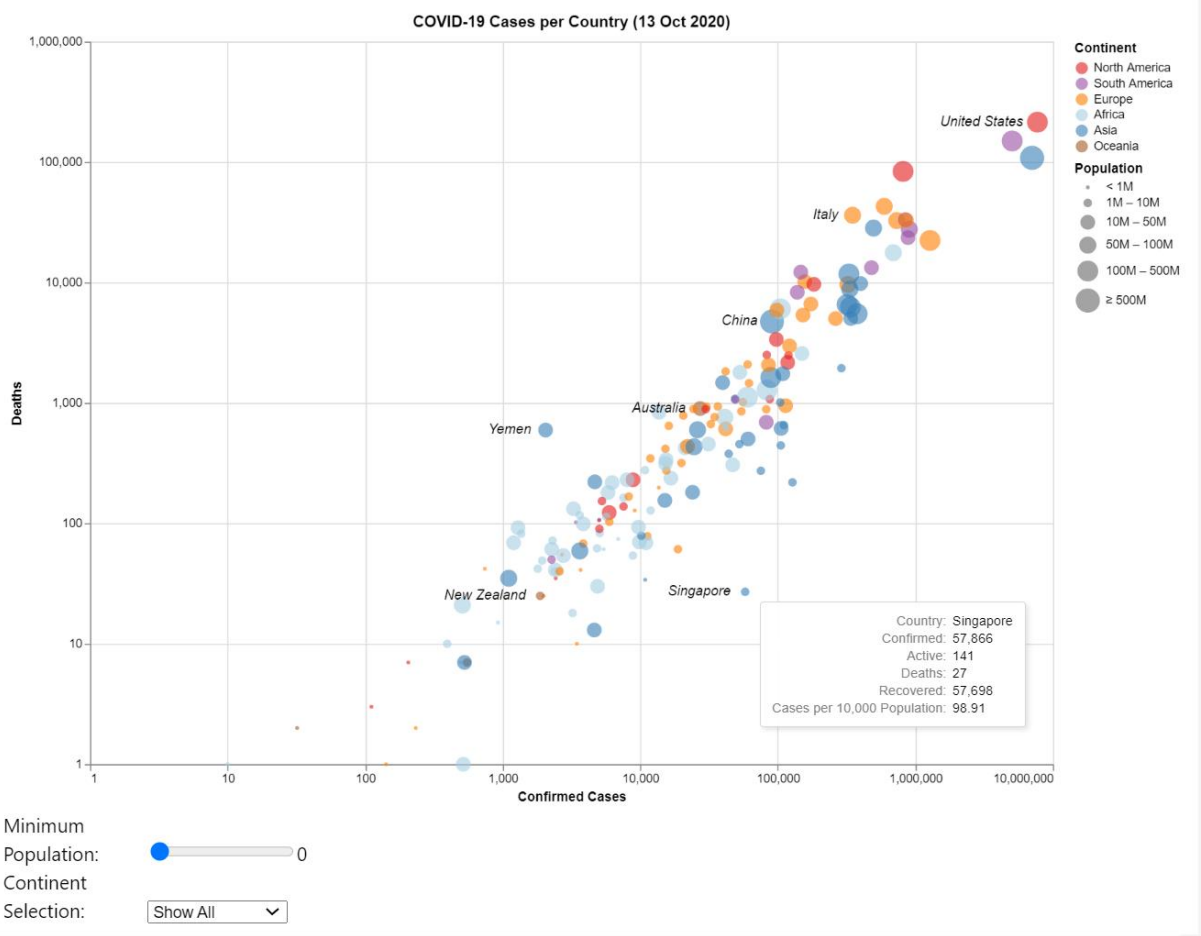


Figure 9. The final interactive visualisation.

The full code is shown below.

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v4.json",
  "width": 800,
  "height": 600,
  "title": "COVID-19 Cases per Country (13 Oct 2020)",
  "data": {
    "url":
"https://raw.githubusercontent.com/KaneSec/vega_lite/main/4_interactive_scatter_plot/data/COVID_19_10_Oct_2020.csv"
  },
  "params": [
    {
```

```
      "name": "Population_Above",
      "value": 0,
      "bind": {
        "input": "range",
        "min": 0,
        "max": 100000000,
        "step": 1000000,
        "name": "Minimum Population: "
      }
    },
    {
      "name": "Continent_selection",
      "bind": {
        "input": "select",
        "options": [
          null,
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "labels":[
          "Show All",
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "name": "Continent Selection: "
      }
    }
  ],
  "transform": [
    {"filter": "datum.Active > 0"},
    {"filter": "datum.Deaths > 0"},
    {"filter": "datum.Population > Population_Above"},
    {"filter": "Continent_selection == null || datum.Continent ==
Continent_selection"},
```

```
    {
      "calculate": "datum.Confirmed/datum.Population * 10000",
      "as": "Cases per 10,000 Population"
    }
  ],
  "encoding": {
    "x": {
      "field": "Confirmed",
      "type": "quantitative",
      "title": "Confirmed Cases",
      "axis": {"tickCount": 7},
      "scale": {"type": "log", "domain": [1, 10000000]}
    },
    "y": {
      "field": "Deaths",
      "type": "quantitative",
      "axis": {"tickCount": 6},
      "scale": {"type": "log", "domain": [1, 1000000]}
    }
  },
  "layer": [
    {
      "selection": {
        "continent_highlight": {
          "type": "multi",
          "fields": ["Continent"],
          "bind": "legend"
        }
      },
      "mark": "circle",
      "encoding": {
        "size": {
          "field": "Population",
          "type": "quantitative",
          "scale": {
            "type": "threshold",
            "domain": [1000000, 10000000, 50000000, 100000000, 500000000],
            "range": [10, 50, 150, 200, 300, 400]
          },
          "legend": {"format": ".1s"}
        },
        "color": {
```

```
      "field": "Continent",
      "type": "nominal",
      "scale": {
        "domain": [
          "North America",
          "South America",
          "Europe",
          "Africa",
          "Asia",
          "Oceania"
        ],
        "range": [
          "#e41a1c",
          "#984ea3",
          "#ff7f00",
          "#a6cee3",
          "#377eb8",
          "#a65628"
        ]
      }
    },
    "opacity": {
      "condition": {"selection": "continent_highlight", "value": 0.6},
      "value": 0.2
    },
    "tooltip": [
      {"field": "Country", "type": "nominal"},
      {"field": "Confirmed", "type": "quantitative", "format": ","},
      {"field": "Active", "type": "quantitative", "format": ","},
      {"field": "Deaths", "type": "quantitative", "format": ","},
      {"field": "Recovered", "type": "quantitative", "format": ","},
      {
        "field": "Cases per 10,000 Population",
        "type": "quantitative",
        "format": ".2f"
      }
    ]
  }
},
{
  "mark": {
    "type": "text",
```

```
        "align": "right",
        "baseline": "middle",
        "dx": -12,
        "fontSize": 11.5,
        "fontStyle": "italic"
      },
      "encoding": {
        "text": {"field": "Country", "type": "nominal"},
        "color": {"value": "black"},
        "opacity": {
          "condition": {
            "test": "datum['Country'] == 'China' || datum['Country'] ==
'Singapore' || datum['Country'] == 'Australia' || datum['Country'] == 'New
Zealand' || datum['Country'] == 'Italy' || datum['Country'] == 'Yemen' ||
datum['Country'] == 'United States'",
            "value": 1
          },
          "value": 0
        },
        "tooltip": [
          {"field": "Country", "type": "nominal"},
          {"field": "Confirmed", "type": "quantitative", "format": ","},
          {"field": "Active", "type": "quantitative", "format": ","},
          {"field": "Deaths", "type": "quantitative", "format": ","},
          {"field": "Recovered", "type": "quantitative", "format": ","},
          {
            "field": "Cases per 10,000 Population",
            "type": "quantitative",
            "format": ".2f"
          }
        ]
      }
    }
  ]
}
```

Part 2. Examples: Multiple Visualisations

Similar to a Tableau dashboard, we can include multiple visualisations in the same webpage with Vega-Lite. There are a few options for creating multiple

visualisations. One of the simplest options is to use the HTML layout. The following example will help you understand the HTML layout for multiple visualisations on the same page. Please check the corresponding .html file for details.

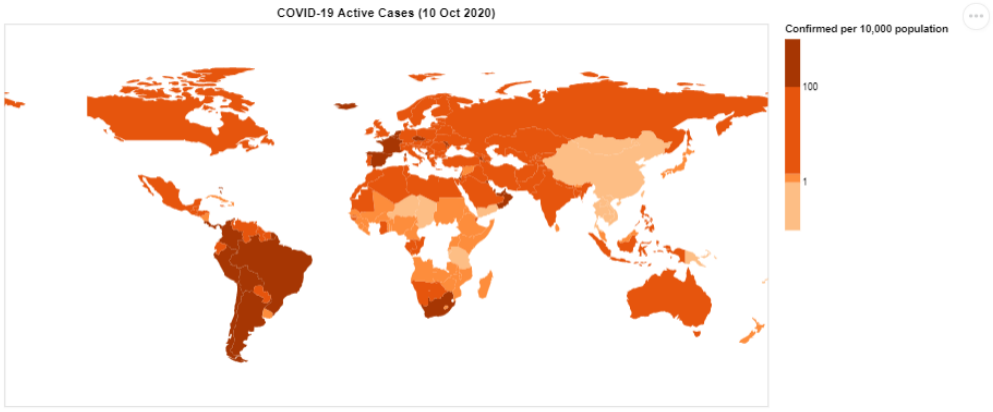
- Example 1: A basic example that combines the choropleth map we created in Week-9 Homework and the bubble plot that we made this week (Figure 10):
  - Example Page: https://kanesec.github.io/vega_lite/5_multiple_charts_html/
  - Github: https://github.com/KaneSec/vega_lite/tree/main/5_multiple_charts_html

- Example 2: A more stylised page with Pure.css (Figure 11):
  - Example Page: https://kadeksatriadi.github.io/vega-lite-examples/examples/using_pure_css.html
  - Github: https://github.com/KadekSatriadi/vega-lite-examples

Vega-Lite itself also provides some options for multi-view displays (faceting) and interactive multi-view displays. For more details and examples, please check this page: https://vega.github.io/vega-lite/examples/.

An Example of Multiple Visualisations

This is the first visualisation



This is the second visualisation

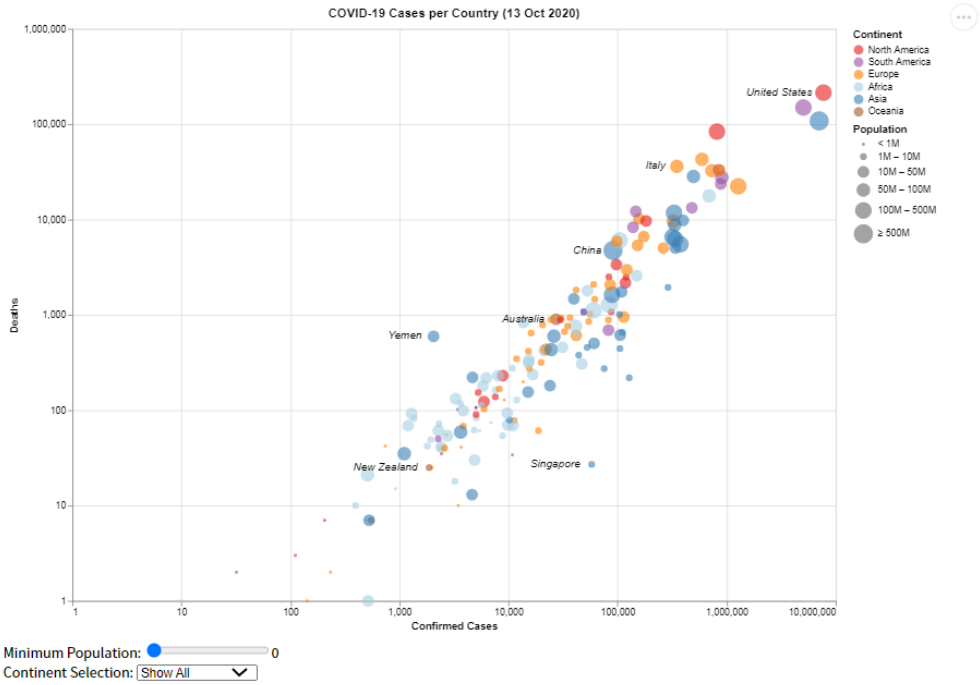


Figure 10. https://kanesec.github.io/vega_lite/5_multiple_charts_html/

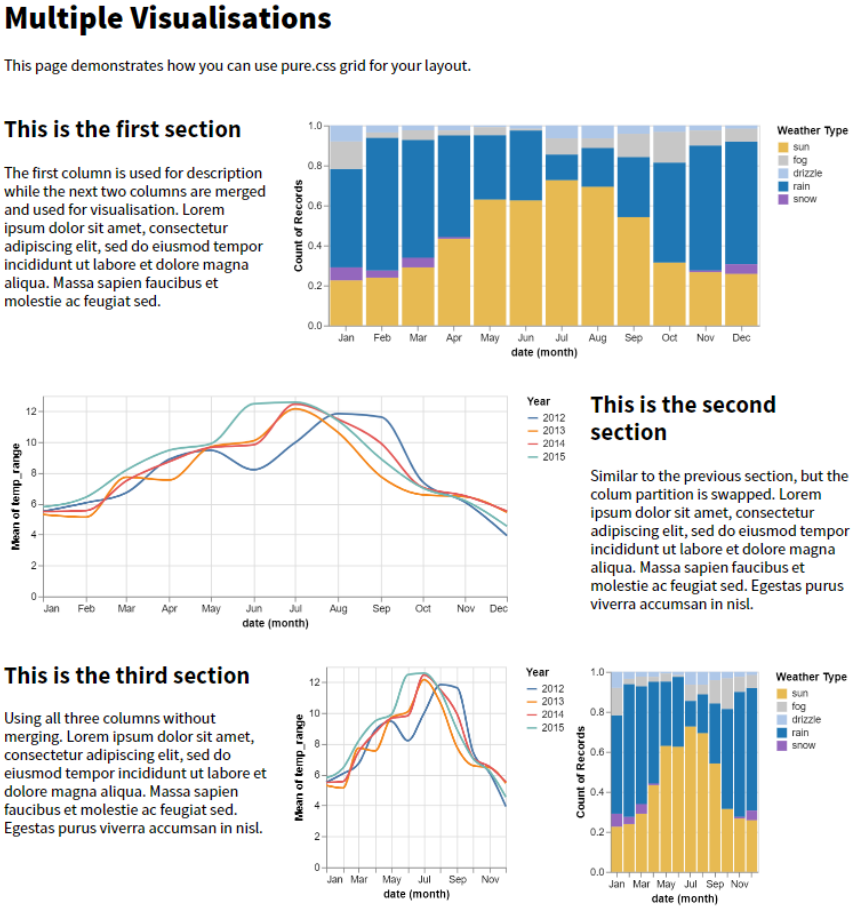


Figure 11. https://kadeksatriadi.github.io/vega-lite-examples/examples/using_pure_css.html

Part 3: Create your own interactive visualisation

Part 3 of this homework is assessed and is to be submitted.

Task 1: Visualisation

Create a visualisation of your choice with the following interactions:

- Tooltips,
- Text/line annotations, and
- One of the following filtering options
    - Selection on the legend (1.4.1)
    - Filtering with a selection menu (1.4.2)
    - Filtering with a slider

Task 2: HTML Page

Construct an HTML page that includes at least two visualisations. This could be the map that you created in the week 9 homework and the visualisation you created in Task 1 of this homework.

Submission Requirement

A report must be submitted in PDF format through the submission link on the Week 9 Moodle page. The page limit of the report content is two pages. Write a report with the following content:

- Your identity (name, Monash student ID, lab, tutor name)
- Screen capture of your interactive visualisation created in Task 1.
- The outcome of your Task 2: A URL of your publicly accessible web page on GitHub. Note that a link to the JSON definition of the visualisation is not accepted; a URL of an HTML web page is required instead. Refer to the Week 8 homework for publishing a Vega-Lite visualisation with a GitHub page.
- One short bullet point for each of the following items:
    - The domain of your Data Visualisation 2
    - The visualised dataset (attribute types, source and author, etc.)
    - A justification for the type of visualisation idiom used (that is, why are you creating a bubble plot, stacked bar chart, etc.)?