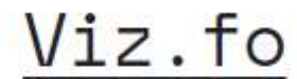


Highly Customized Data Visualizations in Power BI with **Deneb** and **Vega**

Andrzej Leszkiewicz



Sponsors

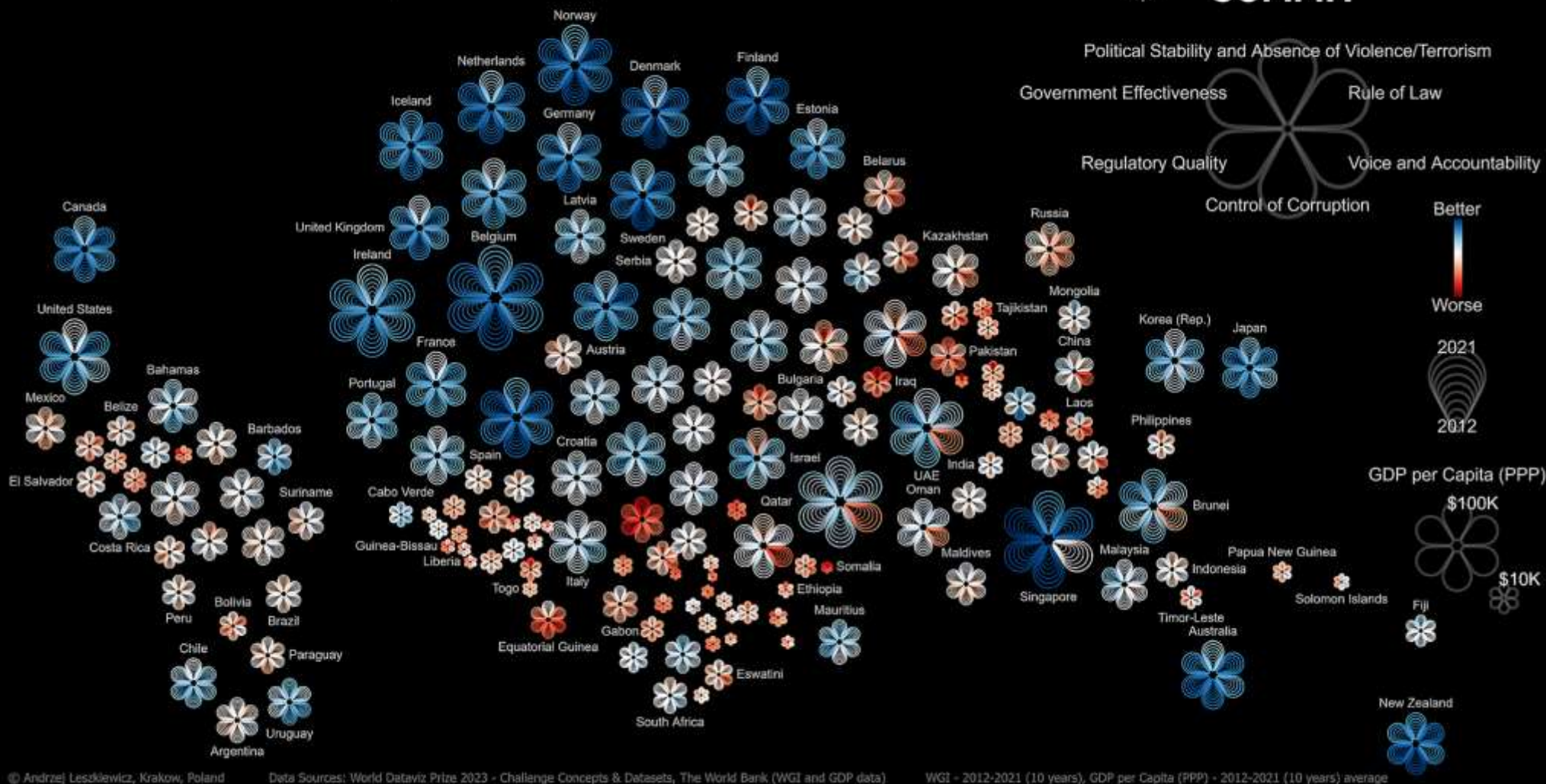


How Do We Govern Our World?

Worldwide Governance Indicators, The World Bank, 2012-2021



**WORLD
GOVERNMENT
SUMMIT**



Earthquakes with magnitude 2.5+, last 30 days (live feed)

Click anywhere to pause/restart rotation

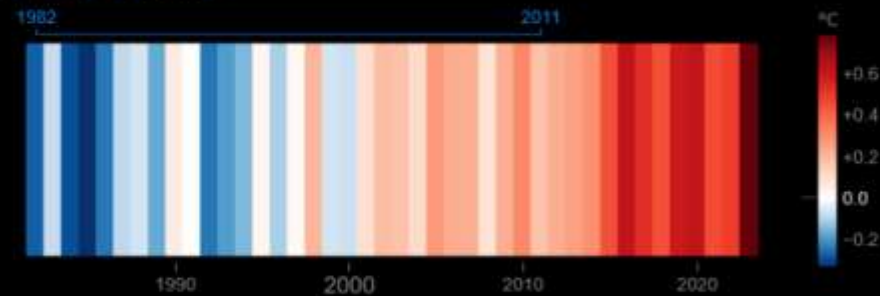
Magnitude



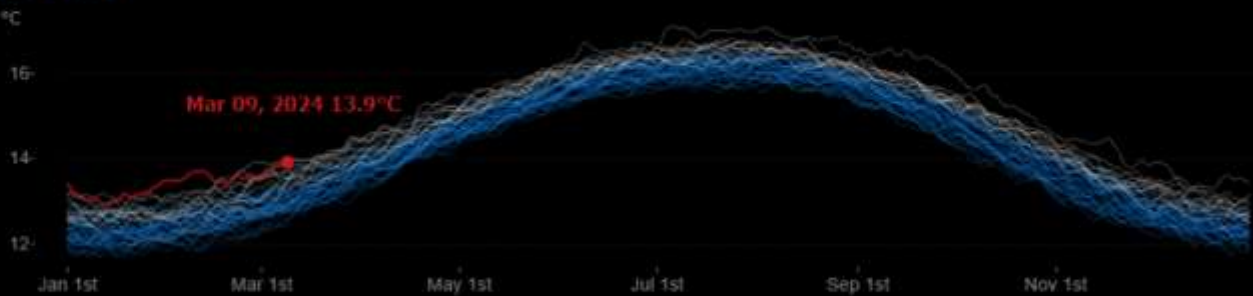
Climate Change: The Day After Tomorrow is Today ●

World (90°S-90°N, 180°W-180°E) 2-meter Air Temperature

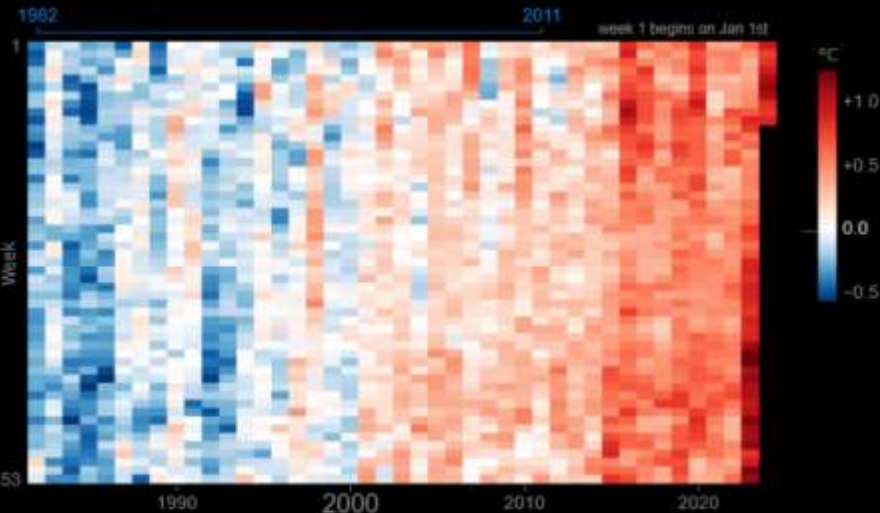
World (90°S-90°N, 180°W-180°E) 2-meter Air Temperature Anomaly, 1982-2022 annual mean [from 1982-2011 base]



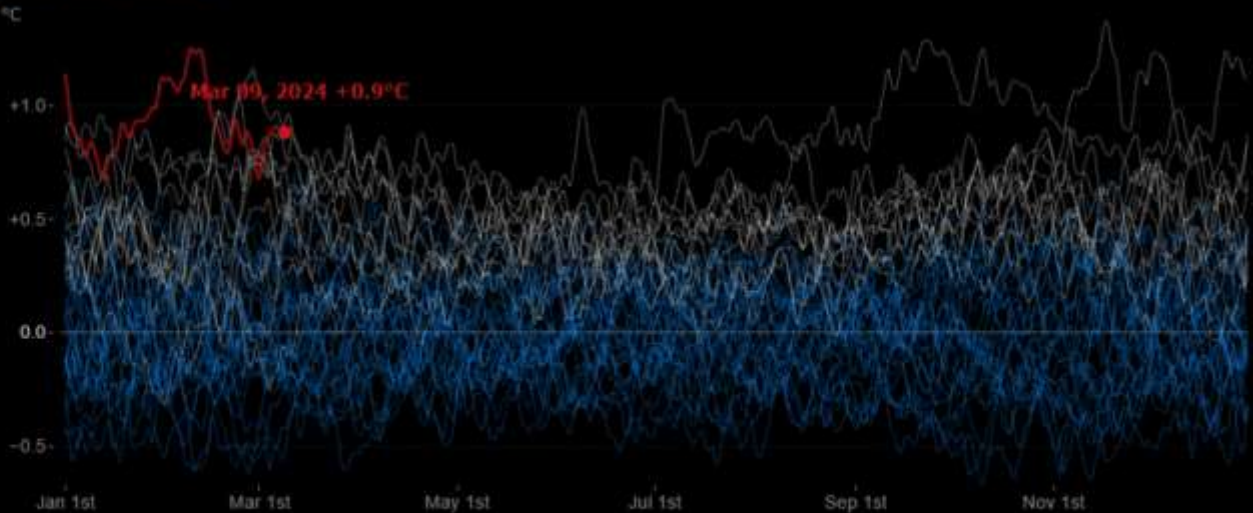
World (90°S-90°N, 180°W-180°E) 2-meter Air Temperature [1982-2011]

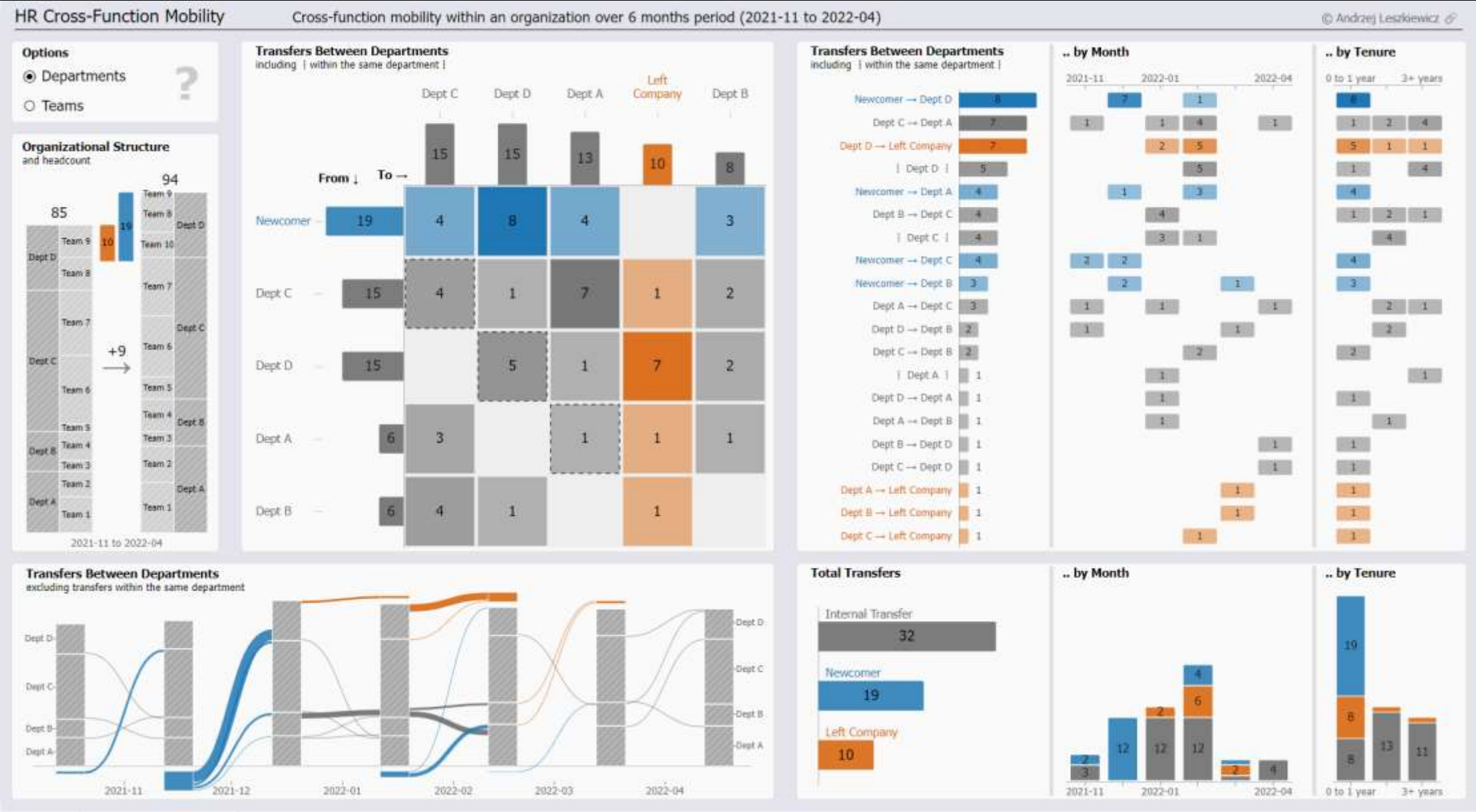


World (90°S-90°N, 180°W-180°E) 2-meter Air Temperature Anomaly, 1982-2024 weekly mean [from 1982-2011 base]



World (90°S-90°N, 180°W-180°E) 2-meter Air Temperature Anomaly, 1982-2024 daily mean [from 1982-2011 base]





Vega

```

1  {
2    "$schema": "https://vega.github.io/schema/vega/v5.json",
3    "description": "A simple bar chart with embedded data.",
4    "background": "white",
5    "padding": 5,
6    "height": 200,
7    "style": "cell",
8    "data": [
9      {
10       "name": "source",
11       "values": [
12         {"a": "A", "b": 28}, {"a": "B", "b": 55}, {"a": "C", "b": 43},
13         {"a": "D", "b": 91}, {"a": "E", "b": 81}, {"a": "F", "b": 53},
14         {"a": "G", "b": 18}, {"a": "H", "b": 87}, {"a": "I", "b": 52}
15       ]
16     },
17     {
18       "name": "data_0",
19       "source": "source",
20       "transform": [
21         {
22           "type": "stack",
23           "groupby": ["a"],
24           "field": "b",
25           "sort": {"field": "b", "order": "descending"},
26           "as": ["b_stack", "b_offset"],
27           "offset": "zero"
28         }
29       ],
30       "type": "fill",
31       "xprn": "isV"
32     }
33   ],
34   "marks": [
35     {
36       "name": "marks",
37       "type": "rect",
38       "style": ["bar"],
39       "from": {"data": "data_0"},
40       "encode": {
41         "update": {
42           "x": {"scale": "x", "field": "a", "type": "nominal", "axis": {"labelAngle": 0}},
43           "y": {"scale": "y", "field": "b_stack", "type": "quantitative", "axis": {"labelAngle": 0}},
44           "y2": {"scale": "y", "field": "b_offset", "type": "quantitative", "axis": {"labelAngle": 0}},
45           "width": {"scale": "x", "field": "a", "type": "nominal", "axis": {"labelAngle": 0}},
46           "height": {"scale": "y", "field": "b_stack", "type": "quantitative", "axis": {"labelAngle": 0}},
47           "paddingInner": 0.05,
48           "paddingOuter": 0.05
49         }
50       }
51     }
52   ],
53   "scales": [
54     {
55       "name": "x",
56       "type": "band",
57       "domain": {"data": "data_0"},
58       "range": {"step": 1},
59       "paddingInner": 0.05,
60       "paddingOuter": 0.05
61     },
62     {
63       "name": "y",
64       "type": "linear",
65       "domain": {"data": "data_0", "fields": ["b_stack", "b_offset"]},
66       "range": [{"signal": "height"}, 0],
67       "nice": true,
68       "zero": true
69     }
70   ],
71   "axes": [
72     {
73       "scale": "x",
74       "orient": "bottom",
75       "grid": false,
76       "title": "a",
77       "labelAngle": 0,
78       "labelBaseline": "top",
79       "zindex": 0
80     },
81     {
82       "scale": "y",
83       "orient": "left",
84       "gridScale": "x",
85       "grid": true,
86       "tickCount": {"signal": "cell(height/40)"},
87       "domain": false,
88       "labels": false,
89       "aria": false,
90       "maxExtent": 0,
91       "minExtent": 0,
92       "ticks": false,
93       "zindex": 0
94     }
95   ]
96 }

```

122

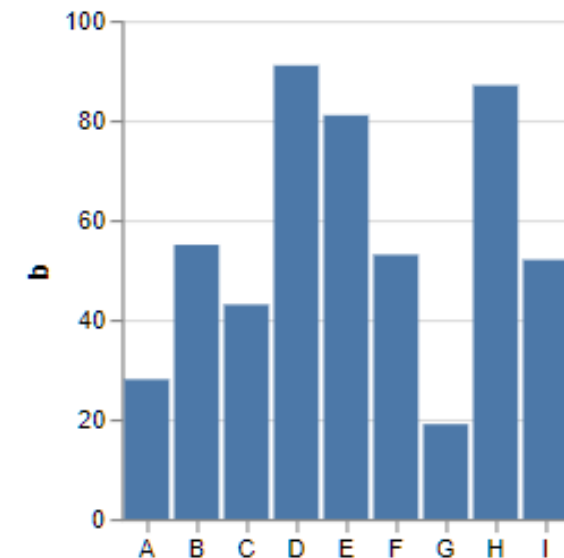
Vega-Lite

```

1  {
2    "$schema": "https://vega.github.io/schema/vega-lite/v5.json",
3    "description": "A simple bar chart with embedded data.",
4    "data": {
5      "values": [
6        {"a": "A", "b": 28}, {"a": "B", "b": 55}, {"a": "C", "b": 43},
7        {"a": "D", "b": 91}, {"a": "E", "b": 81}, {"a": "F", "b": 53},
8        {"a": "G", "b": 18}, {"a": "H", "b": 87}, {"a": "I", "b": 52}
9      ]
10   },
11   "mark": "bar",
12   "encoding": {
13     "x": {"field": "a", "type": "nominal", "axis": {"labelAngle": 0}},
14     "y": {"field": "b", "type": "quantitative"}
15   }
16 }

```

16



Deneb – a certified custom visual

Apps > **Deneb: Declarative Visualization in Power BI**



Deneb: Declarative Visualization in Power BI

by Daniel Marsh-Patrick

 [Power BI visuals](#)

 PBI Certified

★ 5.0 (18 ratings)

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Vega Examples versus Deneb Templates

Vega Examples – Vega JSON

[Official Vega Examples](#) 

[Andrzej's Vega Examples](#) 

Create using...

- ☐ Existing template
- ☐ Vega-Lite
- ☒ Vega

Select your Vega template

- ☒ [empty]
- ☐ [empty (with Power BI theming)]
- ☐ Simple bar chart
- ☐ Interactive bar chart

[Opening the Visual Editor](#) 

Deneb Templates – Vega JSON wrapped up in Deneb Template JSON

[Andrzej's Deneb Templates](#) 

Create using...

- ☒ Existing template
- ☐ Vega-Lite
- ☐ Vega

Import your file

Click to browse for a valid template file, or drag one here to import it. You can also paste a valid template from the clipboard (either as JSON or as a file).

[Selecting a Template](#) 

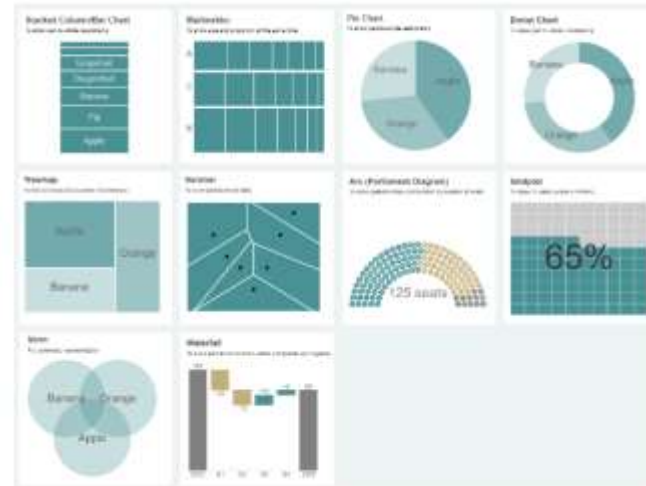
```
{
  "$schema": "https://vega.github.io/sche
  "usermeta": {
    "deneb": {
      "build": "1.4.0.20220831#4f0615e",
      "metaVersion": 1,
      "provider": "vega",
      "providerVersion": "5.22.1"
    },
  },
}
```


Deneb Templates for FT Visual Vocabulary

Magnitude



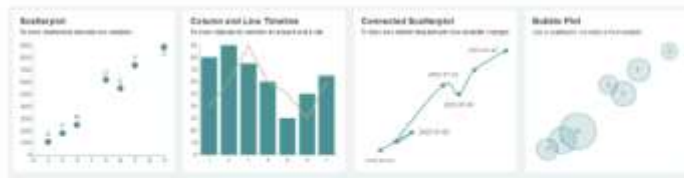
Part-to-Whole



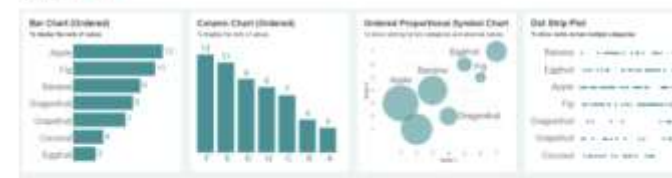
Spatial



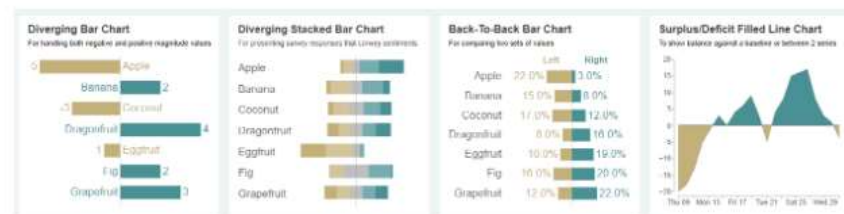
Correlation



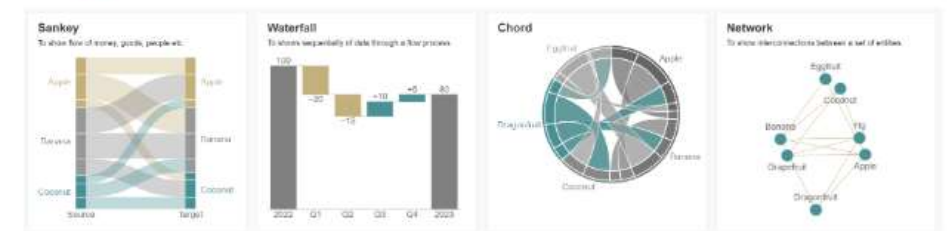
Ranking



Deviation



Flow

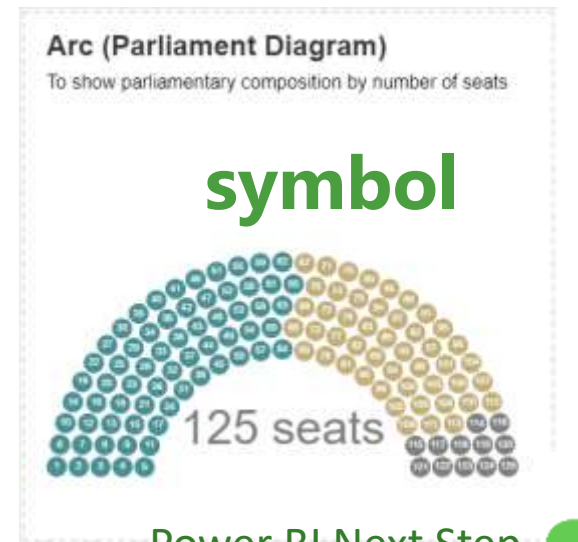
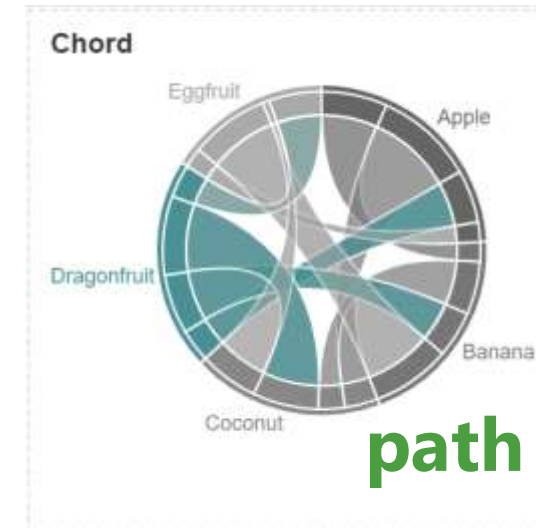
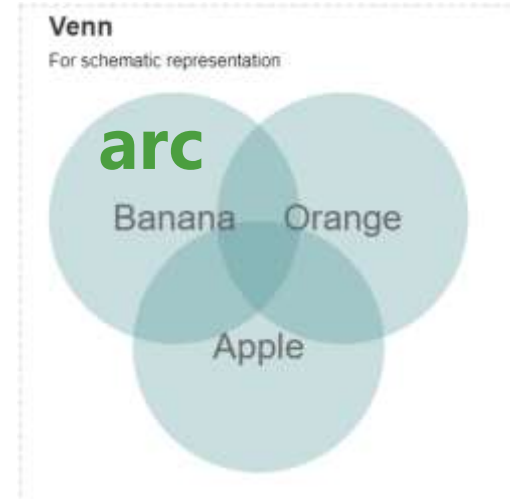
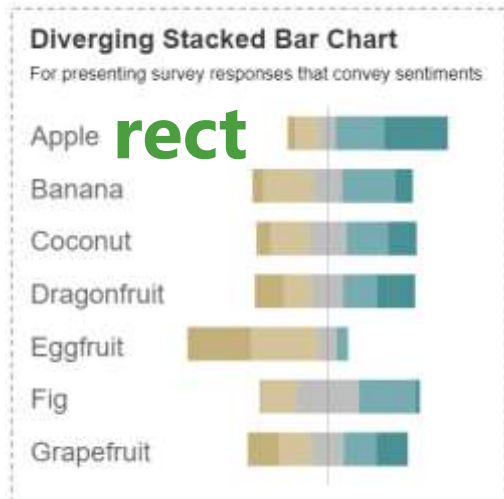
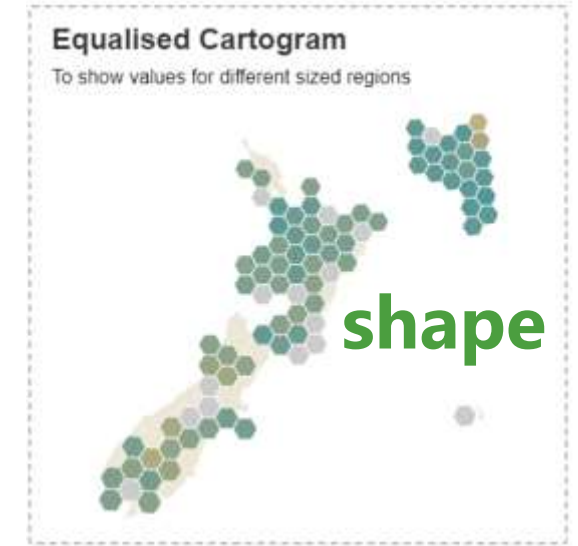
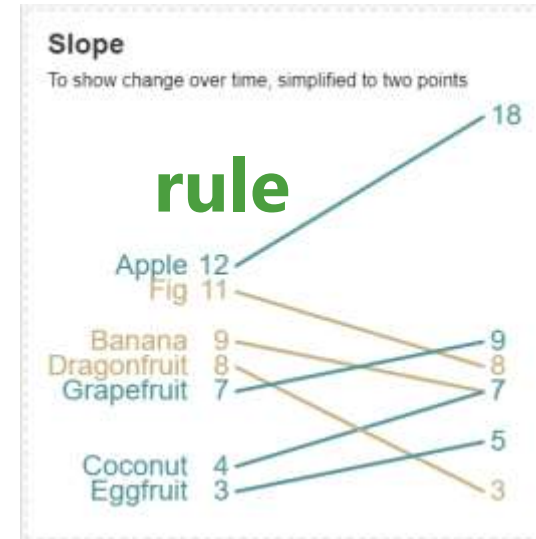
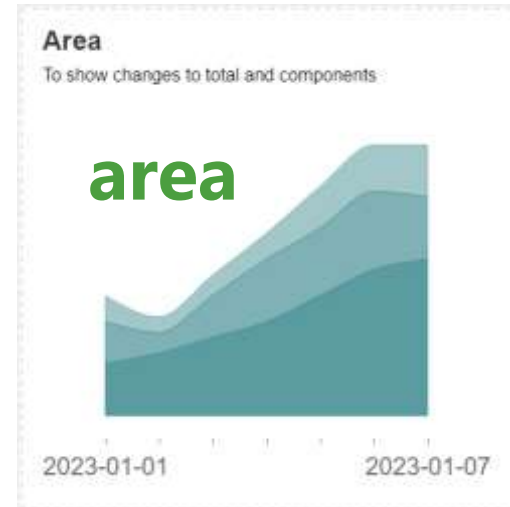
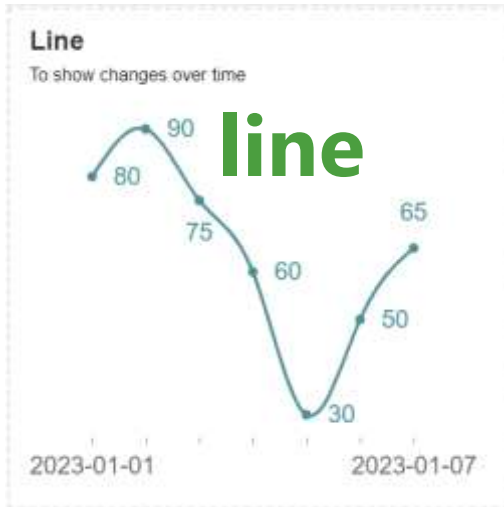


Key **Vega** features that extend Power BI capabilities

- Various visual elements (“**mark**” properties) [!\[\]\(38441ceaa711016e0bf2ad46ad394ff4_img.jpg\)](#)
- Multiple **scales** [!\[\]\(6e027340d4263908f264926b1ad81c5e_img.jpg\)](#) and **axes** [!\[\]\(781510d64f329bf3c880acf086e884d6_img.jpg\)](#) per visual
- Various data **transforms** [!\[\]\(93cdf5b84f2bfec404f7441e84b6ba5c_img.jpg\)](#)
- Lack of 3,500 data rows limit [!\[\]\(0f0f932ce3b5577a82f34ad23239a6e5_img.jpg\)](#)
- “**group**” marks [!\[\]\(eae2be0f6c865f0a2febc97c99fc2475_img.jpg\)](#)
- Custom **tooltips** [!\[\]\(beb73fa08c38b910d1745a8873b27d81_img.jpg\)](#) (including based on the “group” marks [!\[\]\(b5401e964162c76526213b8e70b40c2e_img.jpg\)](#))
- **Interactive labels and helper layers** (using “group” marks [!\[\]\(865f2722fc1818c7fea1a14e09a6e1a6_img.jpg\)](#))
- **Interactivity** (event streams) [!\[\]\(40e8be9c7fbc03824b9e3a0db89df497_img.jpg\)](#)
- **Animation** („timer” event) [!\[\]\(ac93afa5970ce35aafca08e0a61927af_img.jpg\)](#)

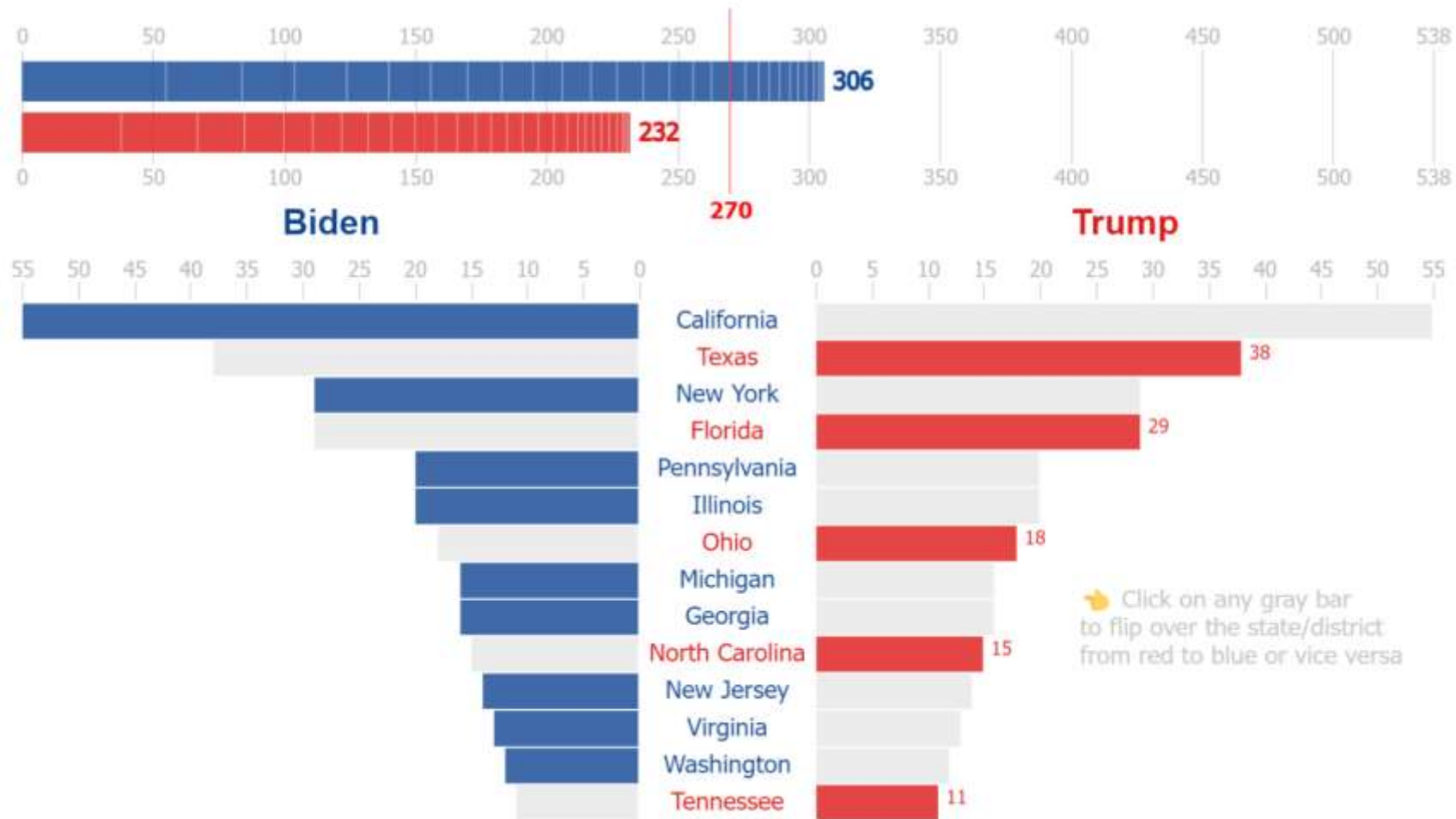


Various visual elements (“mark” properties)



Multiple [scales](#) and [axes](#) per visual

2020 US Presidential Election



Various data transforms

aggregate

```
{ "type": "aggregate",  
  "groupby": ["category"] }
```

collect

```
{ "type": "collect",  
  "sort": {"field": "a"} }
```

filter

```
{ "type": "filter", "expr":  
  "datum.x > 10" }
```

formula

```
{ "type": "formula", "as": "hr",  
  "expr": "hours(datum.date)" }
```

window

```
{ "type": "window",  
  "sort": {"field": "key",  
    "order": "ascending"},  
  "ops": ["prev_value"],  
  "fields": ["value"],  
  "as": ["value"] }
```

lookup

```
{ "type": "lookup",  
  "from": "names",  
  "key": "id",  
  "fields": ["foo"],  
  "values": ["name"],  
  "as": ["obj"],  
  "default": "some label" }
```

pie

```
{ "type": "pie", "field": "price" }
```

stack

```
{ "type": "stack", "groupby":  
  ["x"], "field": "y", "sort":  
    {"field": "v", "order":  
      "descending"} }
```

label

```
{ "type": "label", "avoidMarks": ["trend"],  
  "anchor": ["top", "bottom", "right", "left"],  
  "offset": [1], "size": {"signal": "[width + 60, height]"} }
```

geoshape

```
{ "type": "geoshape",  
  "projection":  
    "projection" }
```

linkpath

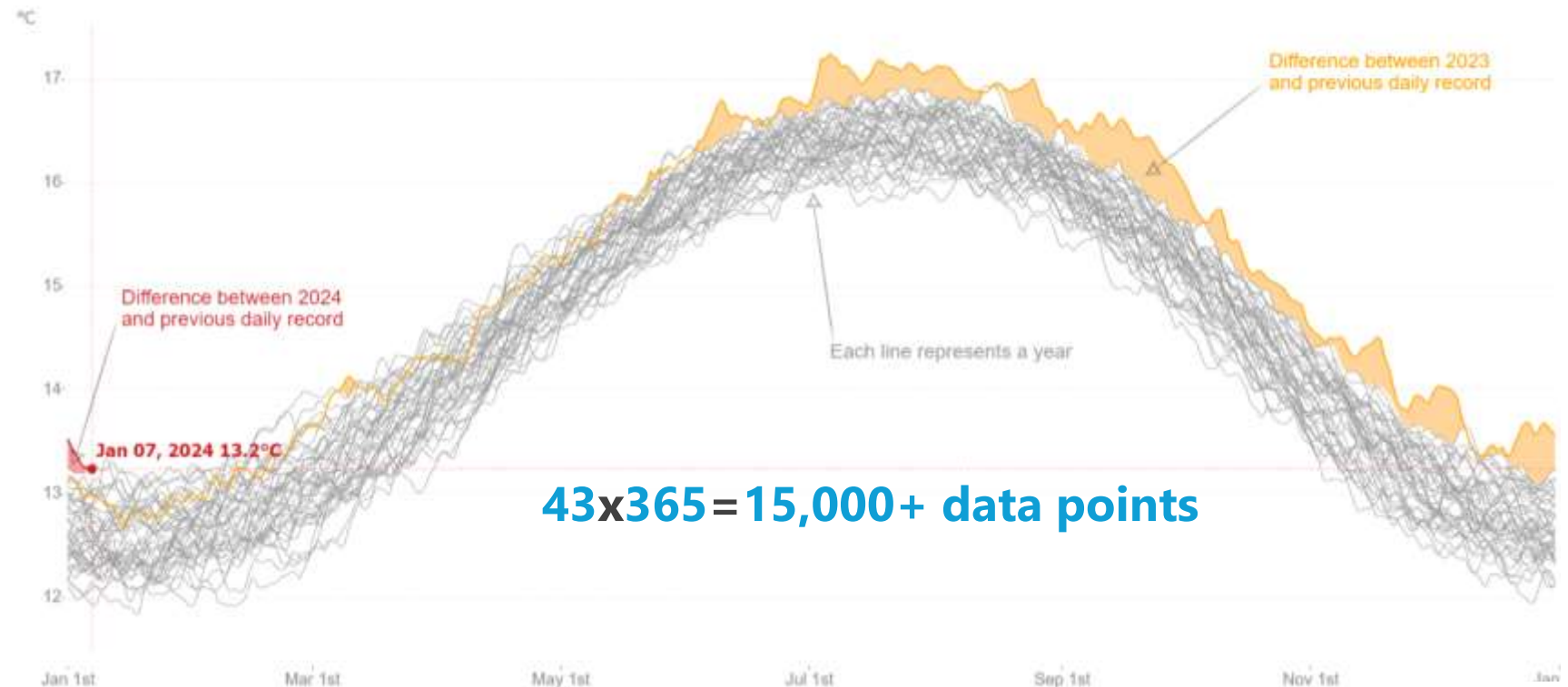
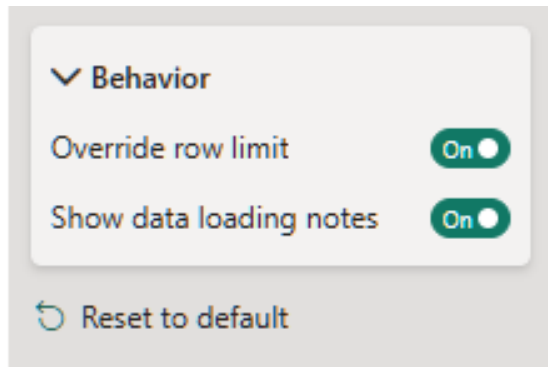
```
{ "type": "linkpath" }
```



Lack of 3,500 data rows limit

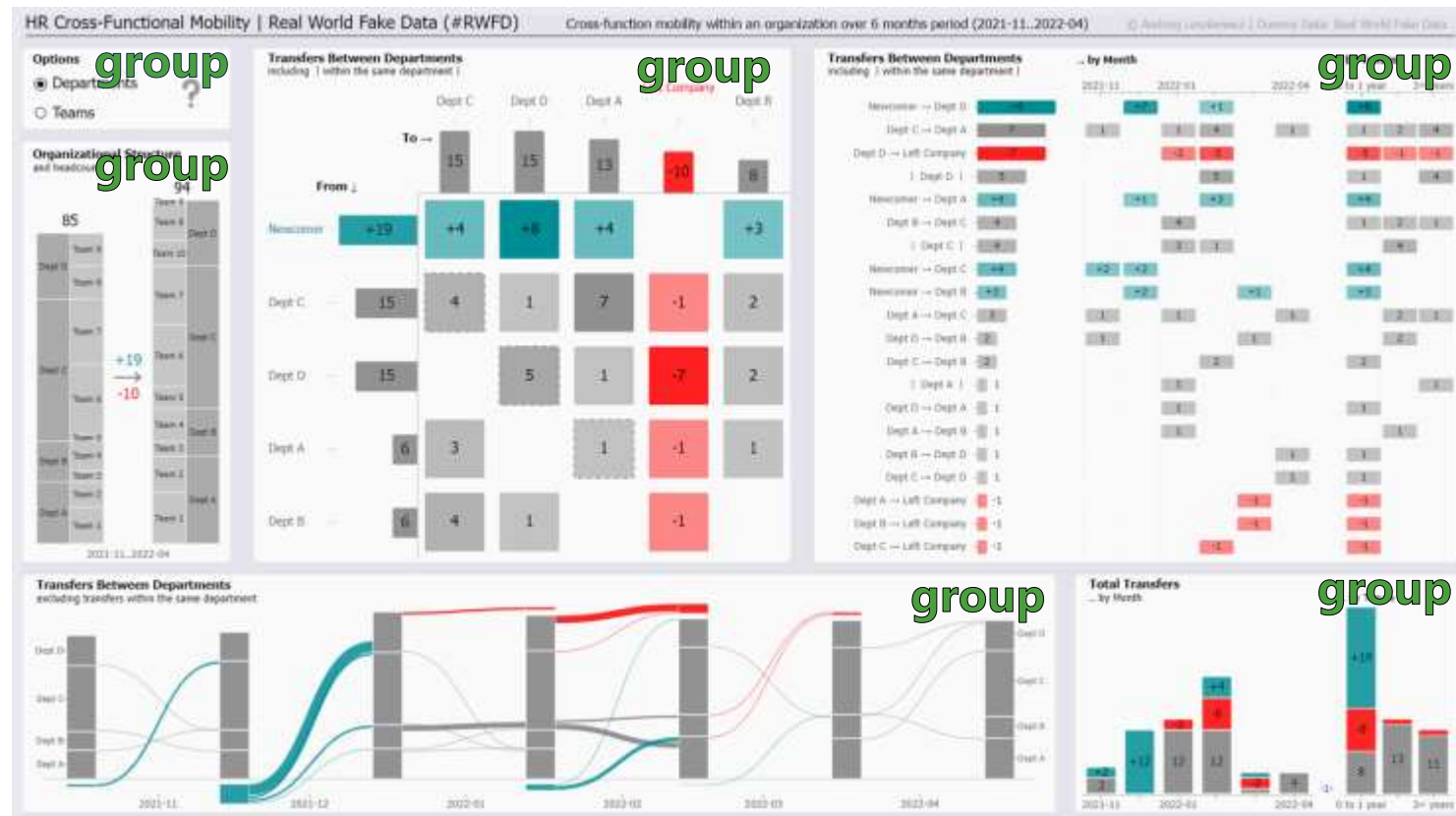
Core Visuals: 3,500 data points displayed on most visuals, maximum 60 series 

Deneb: 10,000 data points – the default data row limit, which can be overridden



“group” marks – multiple visualizations in One Visual

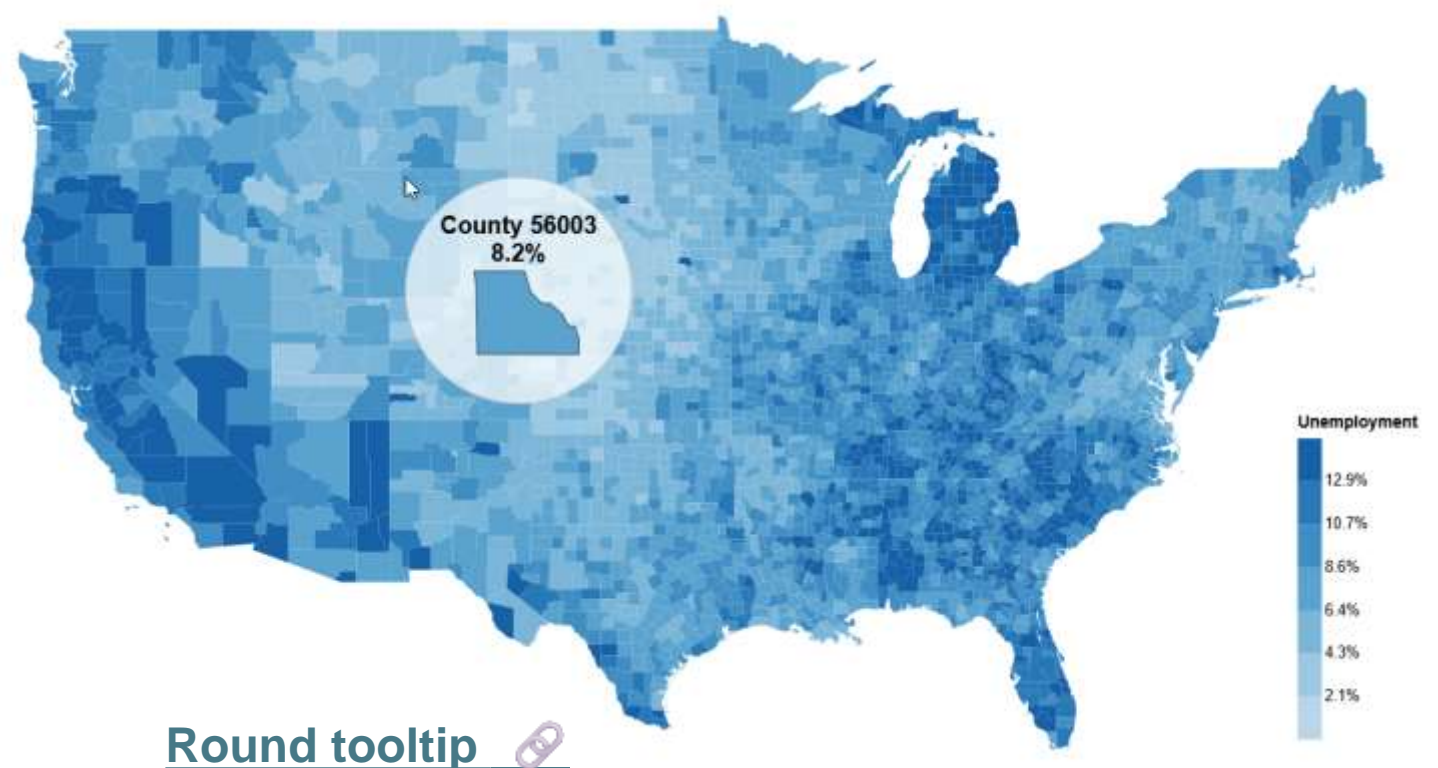
Vega **group** marks are containers for other marks, and used to create visualizations with multiple views or layers



Custom **tooltips** (including based on the “group” marks)

With Deneb you can use native Power BI report page tooltips, Vega **tooltip** property tooltips, and highly customized **tooltips created as a group of marks**. Tooltips can be: opaque or semi-transparent, of any shape (round, triangle), resize automatically, follow the cursor or be docked.

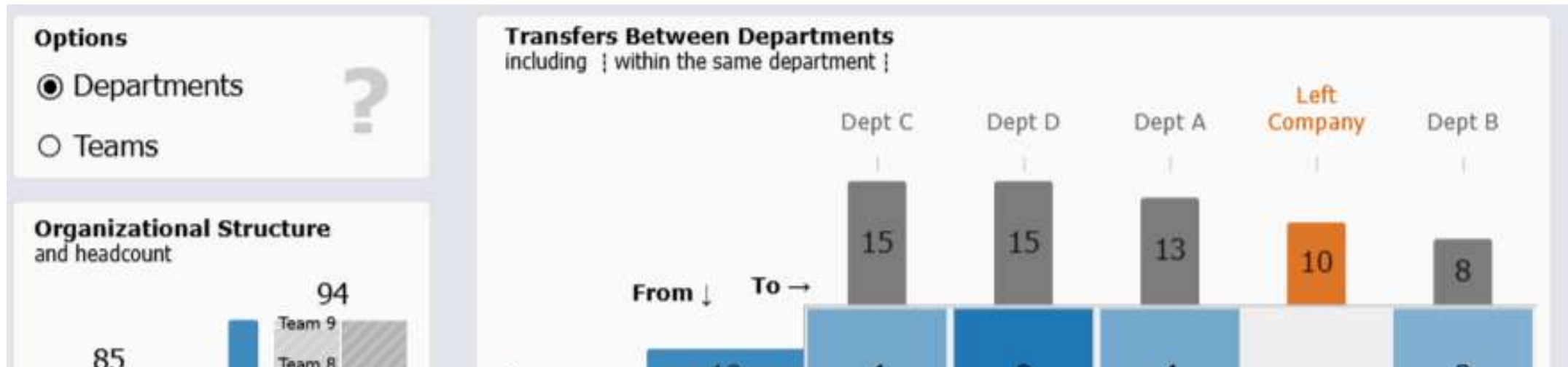
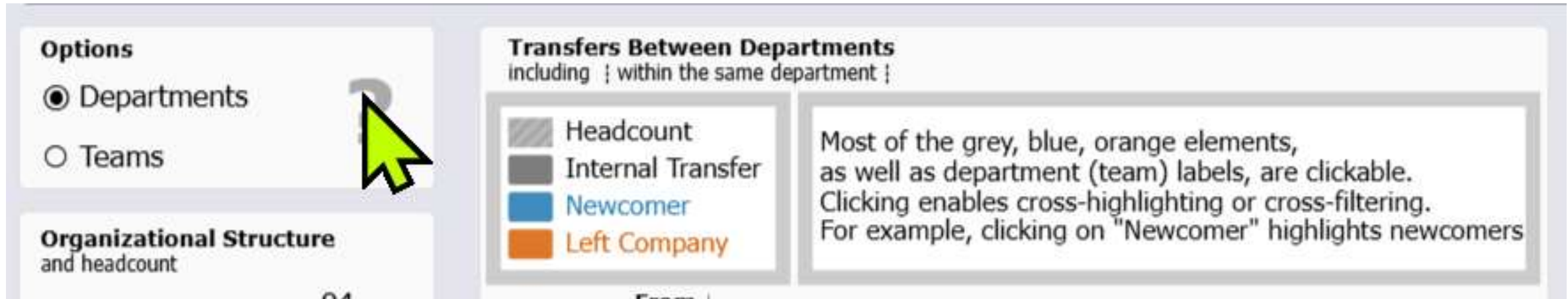
```
{
  "name": "grpTooltip",
  "type": "group",
  "zindex": 1,
  "encode": {
    "enter": {
      "clip": {"signal": "true"},
      "cornerRadius": {"signal": "100"},
      "strokeWidth": {"signal": "tooltipStrokeWidth"},
      "stroke": {"signal": "tooltipStroke"},
      "fill": {"signal": "tooltipFill"},
      "fillOpacity": {"signal": "tooltipFillOpacity"}
    },
    "update": {
      "x": {"signal": "mousePositionXY[0]"},
      "y": {"signal": "mousePositionXY[1]"},
      "width": {
        "signal": "county==null || mousePositionXY[0] == null ? 0
          : tooltipSize"
      },
      "height": {
        "signal": "county==null || mousePositionXY[1] == null ? 0
          : tooltipSize"
      }
    }
  },
  "marks": [
```



Round tooltip 

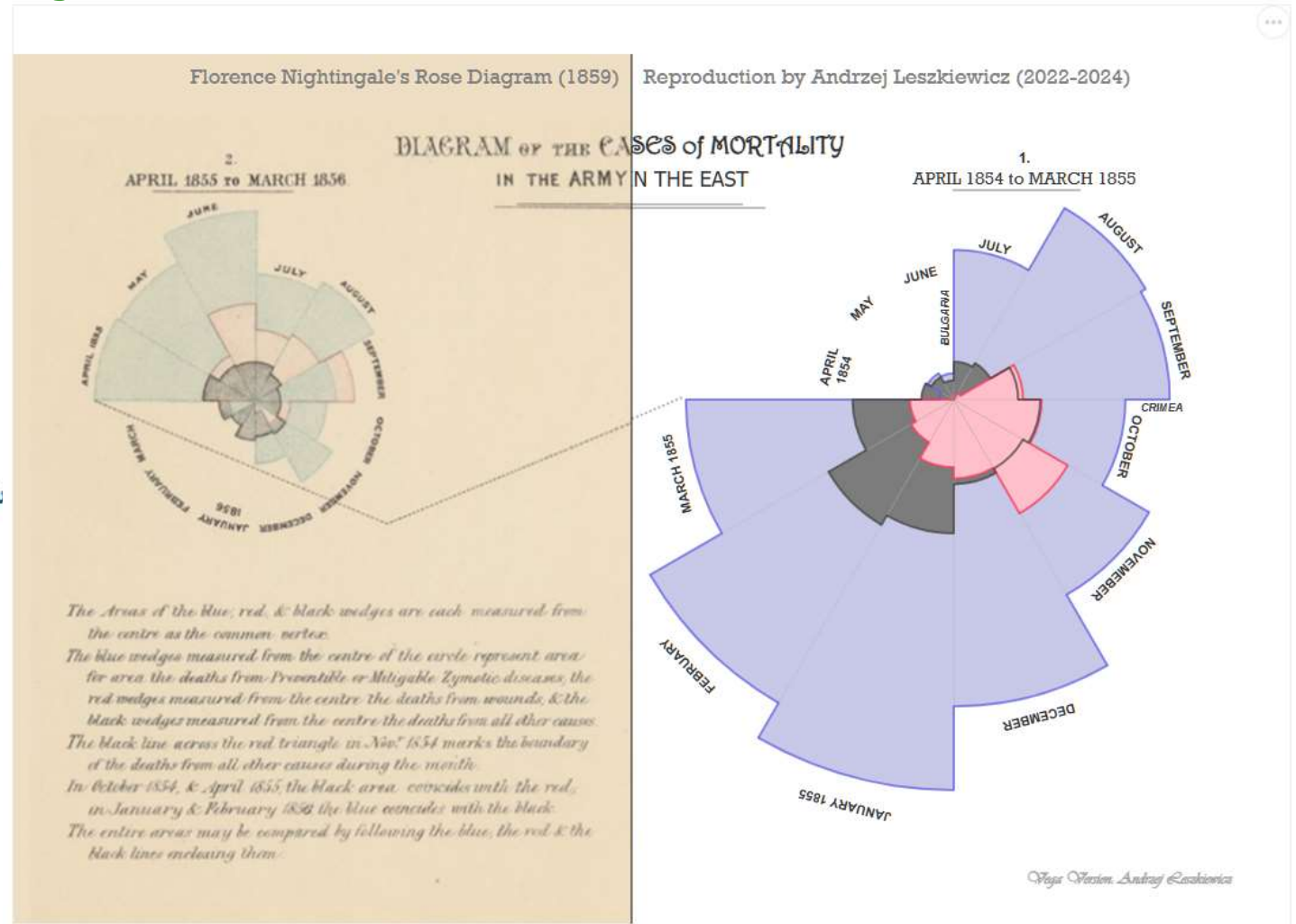


Interactive labels and helper layers (using “group” marks)



Interactivity (event streams)

```
{
  "name": "dividerMouseDragX",
  "description": "x position of the split screen",
  "init": "-200",
  "on": [
    {
      "events": "[@rule-divider-wide:pointerdown,
        window:pointerup] > window:pointermove",
      "update": "round(clamp(x(), -200, 835))",
      "force": true
    }
  ]
}
```

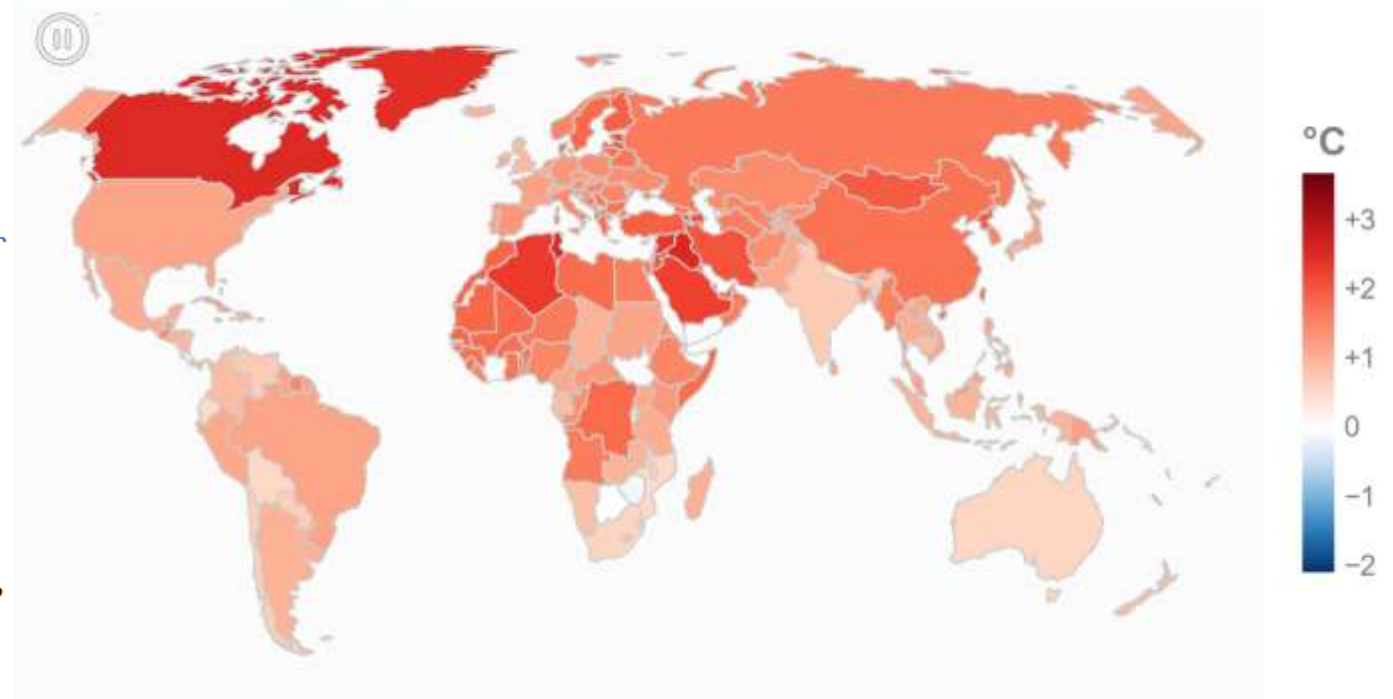


Split View 

Animation („timer” event)

Annual Surface Temperature Change (compared to 1951-1980 average)
2021: +0.85°C

```
{
  "name": "year",
  "init": "19610",
  "on": [
    {
      "events": {"type": "timer", "throttle": 500},
      "update": "pauseClicked?year:(year>=19610&&year<=19619)?year+1:year<20210?year+10:year<=20218?year+1:19610"
    },
    {
      "events": "@buttonLeft:click,@buttonLeftBackground:click",
      "update": "year==19610?year:year-10",
      "force": true
    },
    {
      "events": "@buttonRight:click,@buttonRightBackground:click",
      "update": "year==20210?year:year+10",
      "force": true
    }
  ]
},
```



Warming Map 



Deneb features that extend Vega capabilities

- **Support of Power BI Theme Colors** [!\[\]\(38441ceaa711016e0bf2ad46ad394ff4_img.jpg\)](#)
- **Vega Color Schemes** [!\[\]\(6e027340d4263908f264926b1ad81c5e_img.jpg\)](#)
- **Pattern Fills** [!\[\]\(781510d64f329bf3c880acf086e884d6_img.jpg\)](#)
- **Scrolling** [!\[\]\(93cdf5b84f2bfec404f7441e84b6ba5c_img.jpg\)](#)
- **Cross-Filtering** [!\[\]\(0f0f932ce3b5577a82f34ad23239a6e5_img.jpg\)](#) **and Cross-Highlighting** [!\[\]\(eae2be0f6c865f0a2febc97c99fc2475_img.jpg\)](#)
- **Advanced Cross-Filtering and Cross-Highlighting** [!\[\]\(beb73fa08c38b910d1745a8873b27d81_img.jpg\)](#)



Support of Power BI Theme Colors

`pbiColor(index|name, shadePercent = 0)`

`pbiColorNominal`

`pbiColorOrdinal`

`pbiColorLinear`

`pbiColorDivergent`

Theme colors

Color 1



Color 2



Color 3



Color 4



Color 5



Color 6



Color 7



Color 8



Sentiment colors ⓘ

Negative



Positive



Neutral



Page: "Color Schemes"



Vega Color Schemes

Categorical Schemes

Categorical color schemes can be used to encode discrete data values, each representing a distinct category.



Sequential Single-Hue Schemes

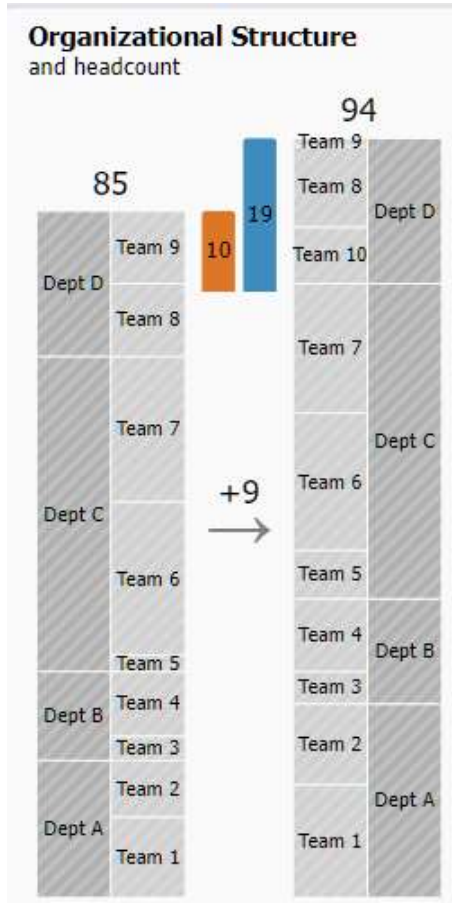
Sequential color schemes can be used to encode quantitative values. These color ramps are designed to encode increasing numeric values. Hover over a scheme and click the "View Discrete" link to toggle display of discretized palettes suitable for quantile, quantize, threshold, or ordinal scales.



```
"scheme": [
  "#67000D",
  "#A50F15",
  "#CB181D",
  "#EF3B2C",
  "#FB6A4A",
  "#FC9272",
  "#FCBBA1",
  "#FEE0D2",
  "#FFFFFF",
  "#DEEBF7",
  "#C6DBEF",
  "#9ECAE1",
  "#6BAED6",
  "#4292C6",
  "#2171B5",
  "#08519C",
  "#08306B"
]
```

Page: "Color Schemes"

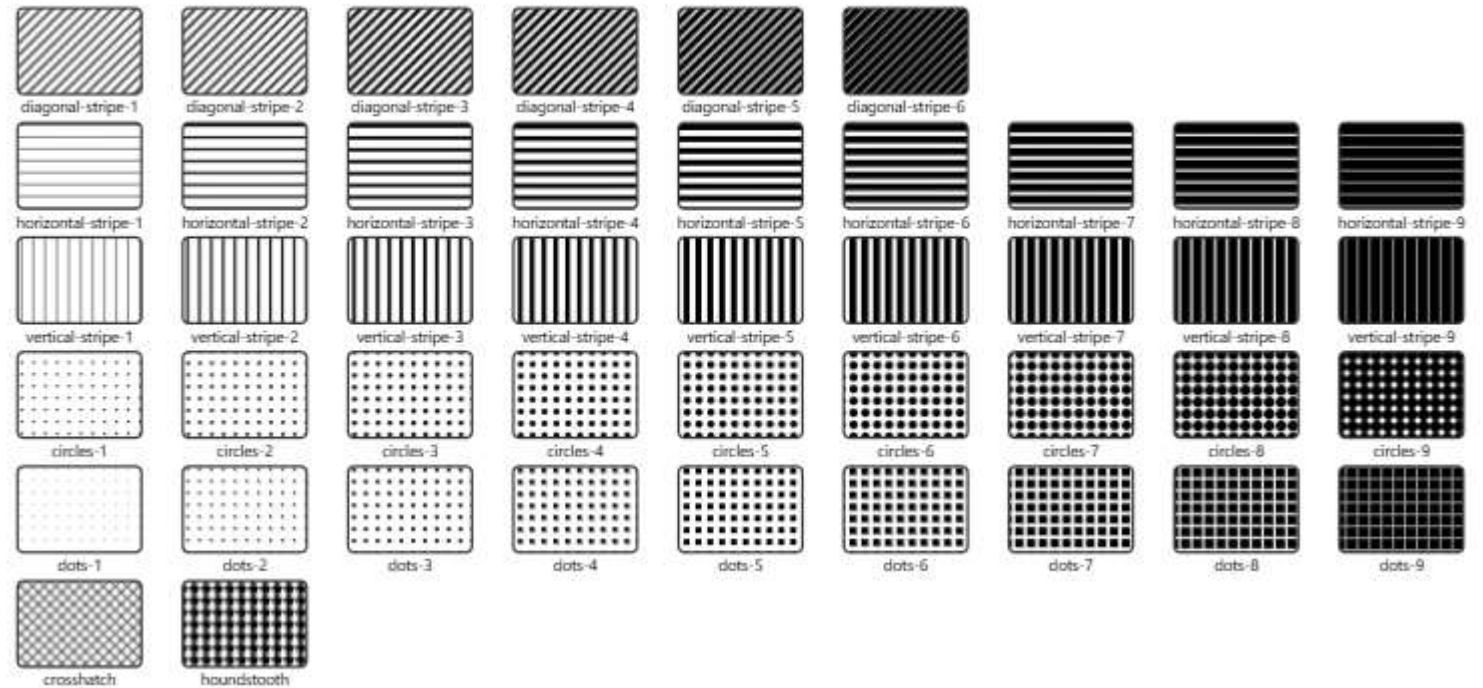




Pattern Fills

"fill": "url(#diagonal-stripe-1)"

Deneb: Pre-Defined (Default) SVG Fill Patterns



Page: "Color Schemes"

Scrolling

pbiContainer signal


```
{  
  "height":300,  
  "width":417,  
  "scrollHeight":505,  
  "scrollWidth":424,  
  "scrollTop":0,  
  "scrollLeft":0  
}
```





Page: "Scrolling"

▼ Rendered visual


▼ Scrollbars

Scrollbar color
 ▼

Scrollbar opacity
50 % 

Scrollbar radius
0 px 

▼ Container scroll events

Throttle time
5 ms 



Cross-Filtering and Cross-Highlighting

Source Visual

```
datum.__selected__=='on' ? 'red' : 'blue'
```

Target Visual

```
datum.Quantity__highlightStatus=='on' &&  
datum.Quantity__highlightComparator=='eq'
```



Page: "Cross-Highlighting and Filtering"



Advanced Cross-Filtering and Cross-Highlighting

`pbiCrossFilterSelection` signal

`pbiCrossFilterApply()`

`pbiCrossFilterClear()`



Page: "Cross-Filtering: Advanced"

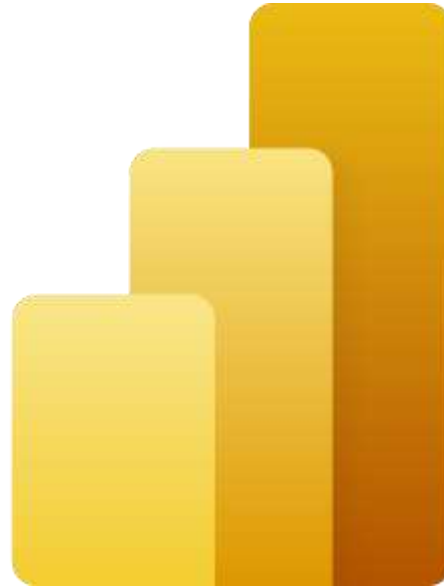


Resources to learn Deneb and Vega

- [Vega and Vega-Lite](#) (Examples, Online Editor, Documentation)
- [Deneb Custom Visual](#) Documentation and Community Support
 - [Andrzej's Support](#) (GitHub)
- [Deneb Templates for FT Visual Vocabulary Chart Types](#)
- [Custom Vega Visualizations](#) (Examples)
- [YouTube: Data Visualization in Power BI and Beyond](#) (Deneb and Vega)
- [YouTube: Power BI Guy](#) (Vega-Lite)
- [More resources...](#)



Download .PBIX file
with the examples used during the session [!\[\]\(919a2cb85b99741a73c0c31a427236a8_img.jpg\)](#)



Raffle prizes from the sponsors



