



OpenJS World

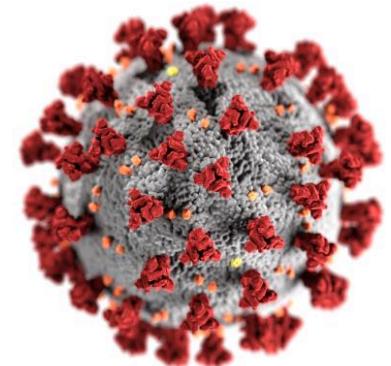
Capacity Analysis. Mapping how interventions to the spread of COVID-19 improve healthcare providers' ability to meet patient demand

Kristian Ekenes





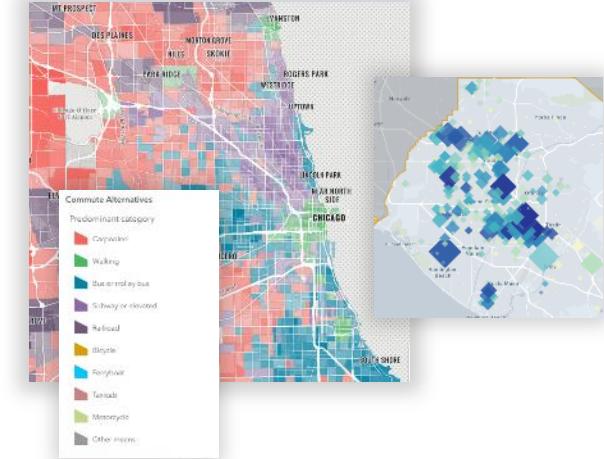
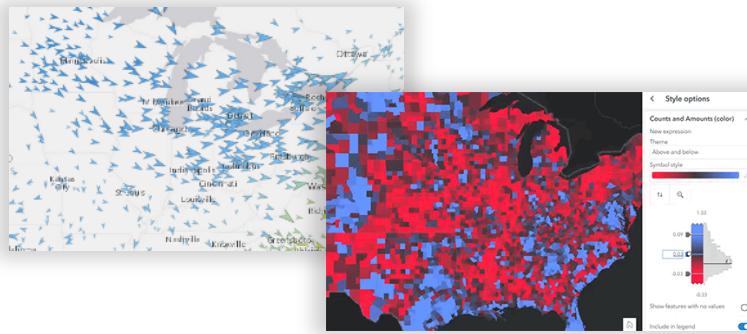
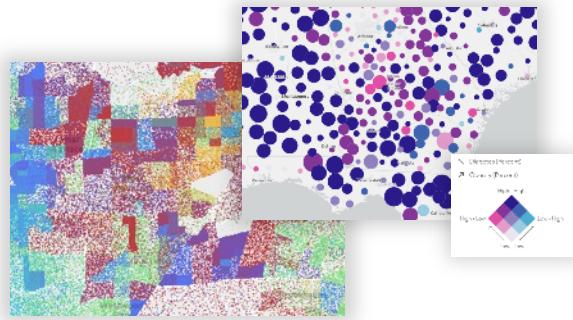
Build a web app that communicates how interventions to the spread of COVID-19, such as physical distancing, reduce hospital stress in an area of interest



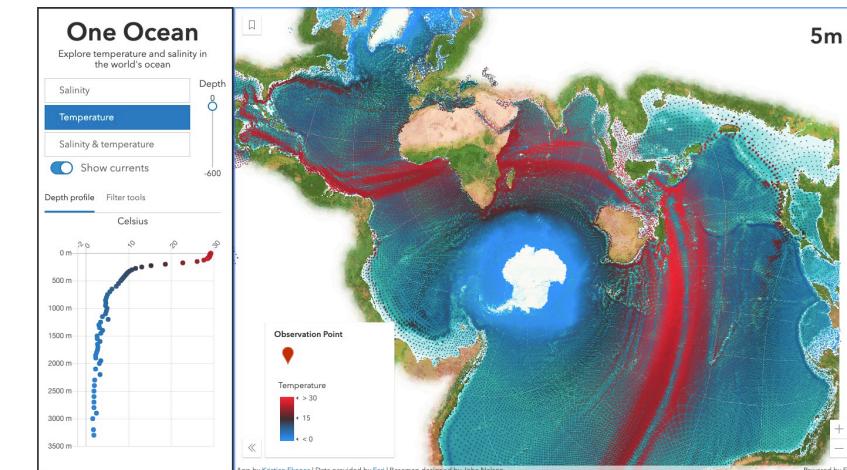
GIS/mapping apps and APIs



OpenJSWorld



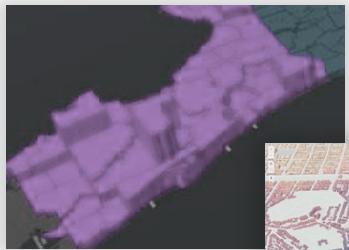
Desktop Apps APIs



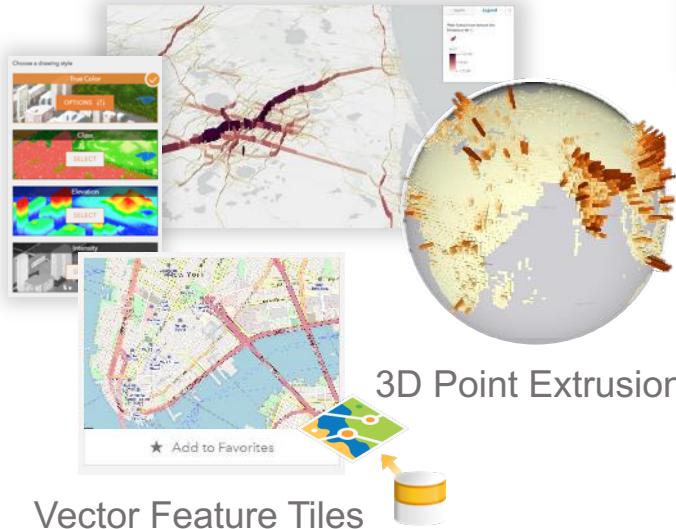
ArcGIS API for JavaScript



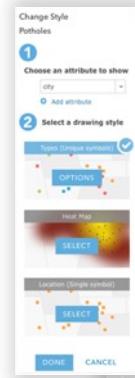
OpenJSWorld



Data-Driven 3D

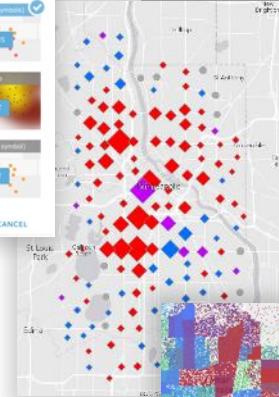


3D Point Extrusion

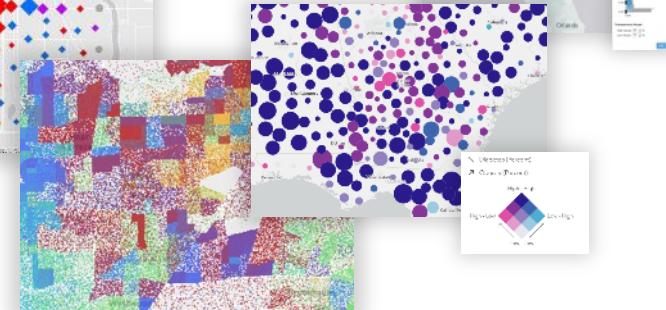


Dynamic Clustering

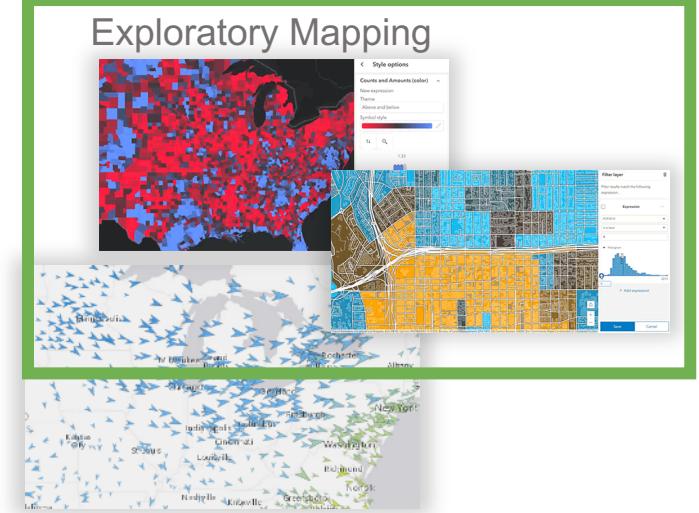
Fast Performance WebGL



Multivariate

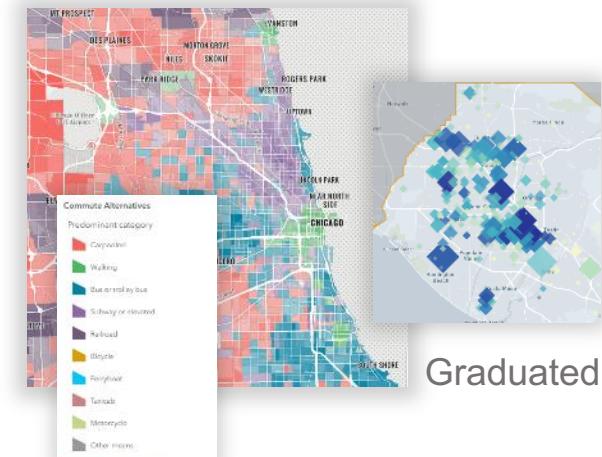


Dot Density



Directional Mapping

Predominance Mapping



Graduated Symbols



Custom and configurable web apps

JOHNS HOPKINS UNIVERSITY & MEDICINE | CORONAVIRUS RESOURCE CENTER

Home Maps & Trends Testing Tracing News & Information COVID-19 Basics Videos & Live Events

World Map U.S. Map Critical Trends

COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)

Total Confirmed
1,804,206

Confirmed Cases by Country/Region/Sovereignty

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514,849 Brazil
414,328 Russia
277,726 United Kingdom
239,638 Spain
233,197 Italy
198,370 India
189,348 France
183,594 Germany
170,039 Peru
164,769 Turkey
154,445 Iran
105,158 Chile
93,197 Canada
90,664 Mexico

Admin0 Admin1 Admin2

Last Updated at (M/D/YYYY)
6/1/2020, 2:44:52 PM

188 countries/regions

Global Deaths
104,799
104,799 deaths US

US State Level Deaths, Recovered

29,833 deaths, 65,934 recovered New York US
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Cumulative Confirmed Cases Active Cases Incidence Rate Case-Fatality Ratio Testing Rate Hospitalization Rate

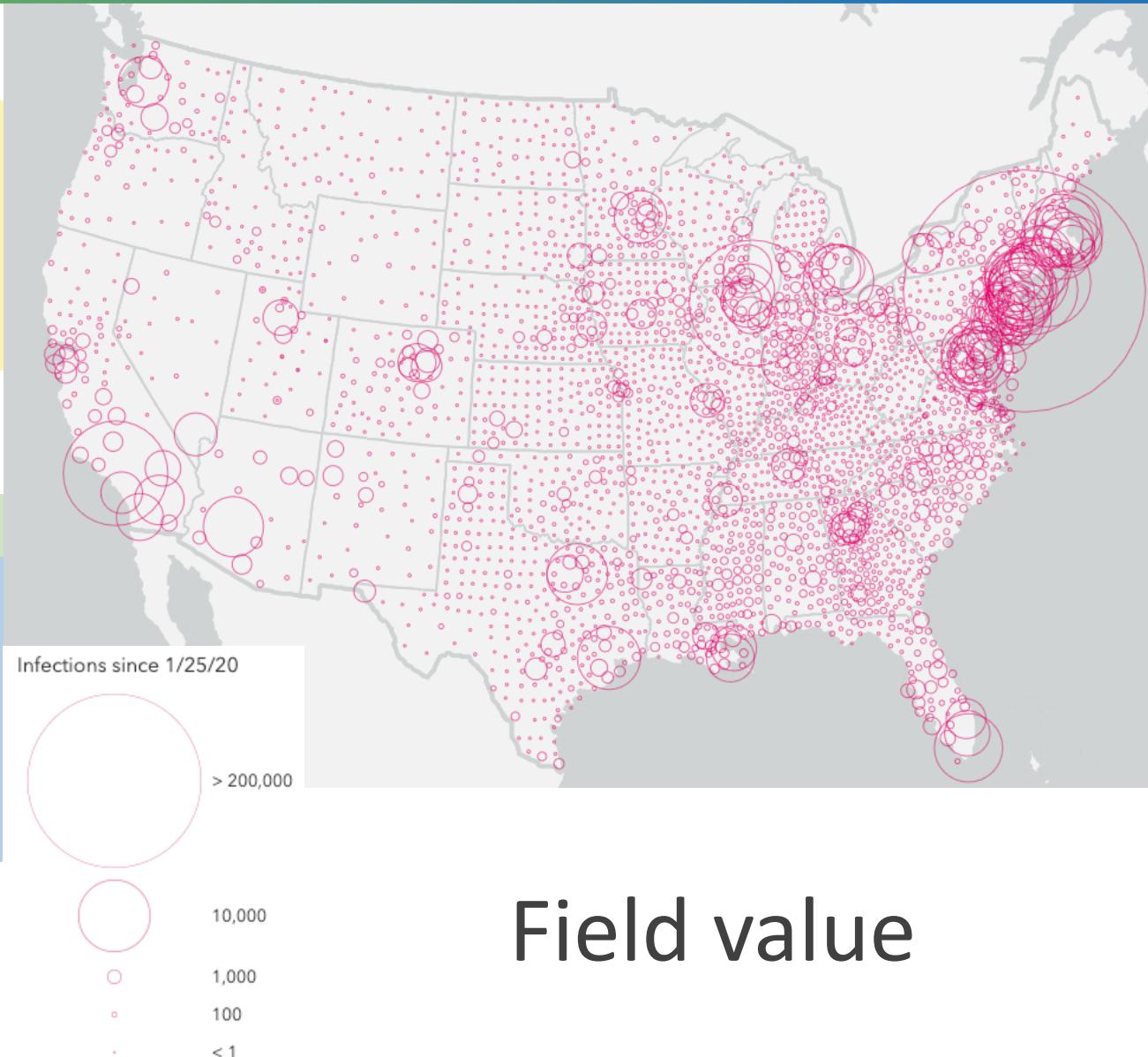
Lancet Inf Dis Article: [Here](#). Mobile Version: [Here](#). Lead by JHU CSSE. Technical Support: Esri Living Atlas team and JHU APL. Financial Support: JHU and NSF. Click [here](#) to donate to the CSSE dashboard team, and other JHU COVID-19 Research Efforts. [FAQ](#). Read more in this [blog](#). Contact Us.

Confirmed Logarithmic Daily Cases



Data driven visualization

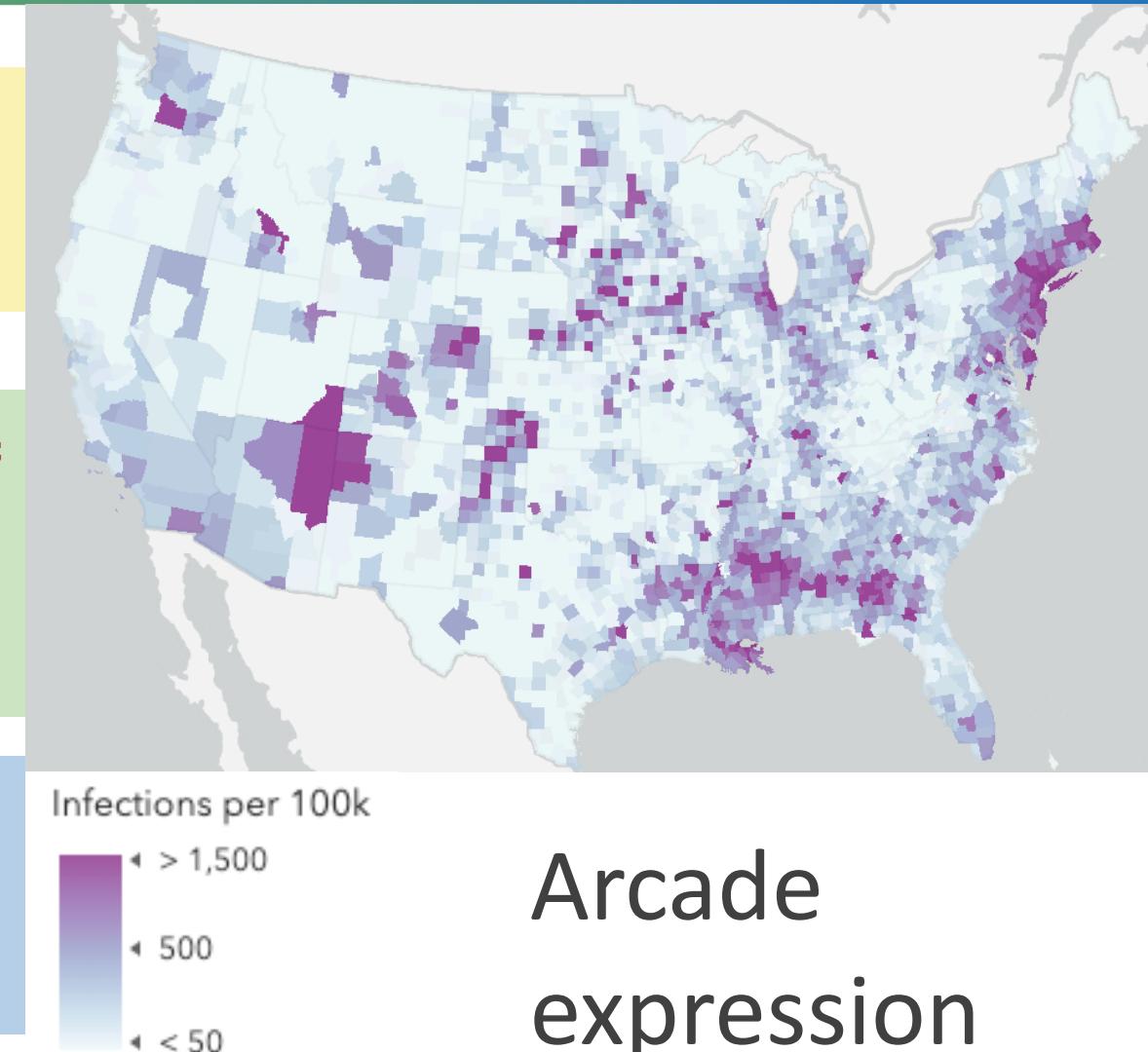
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layer.renderer = new SimpleRenderer({  
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            width: 0.5  
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    }),  
    visualVariables: [  
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                { value: 10000, size: "50px" },  
                { value: 200000, size: "200px" }  
            ]  
        })  
    ]  
});
```





Data driven visualization

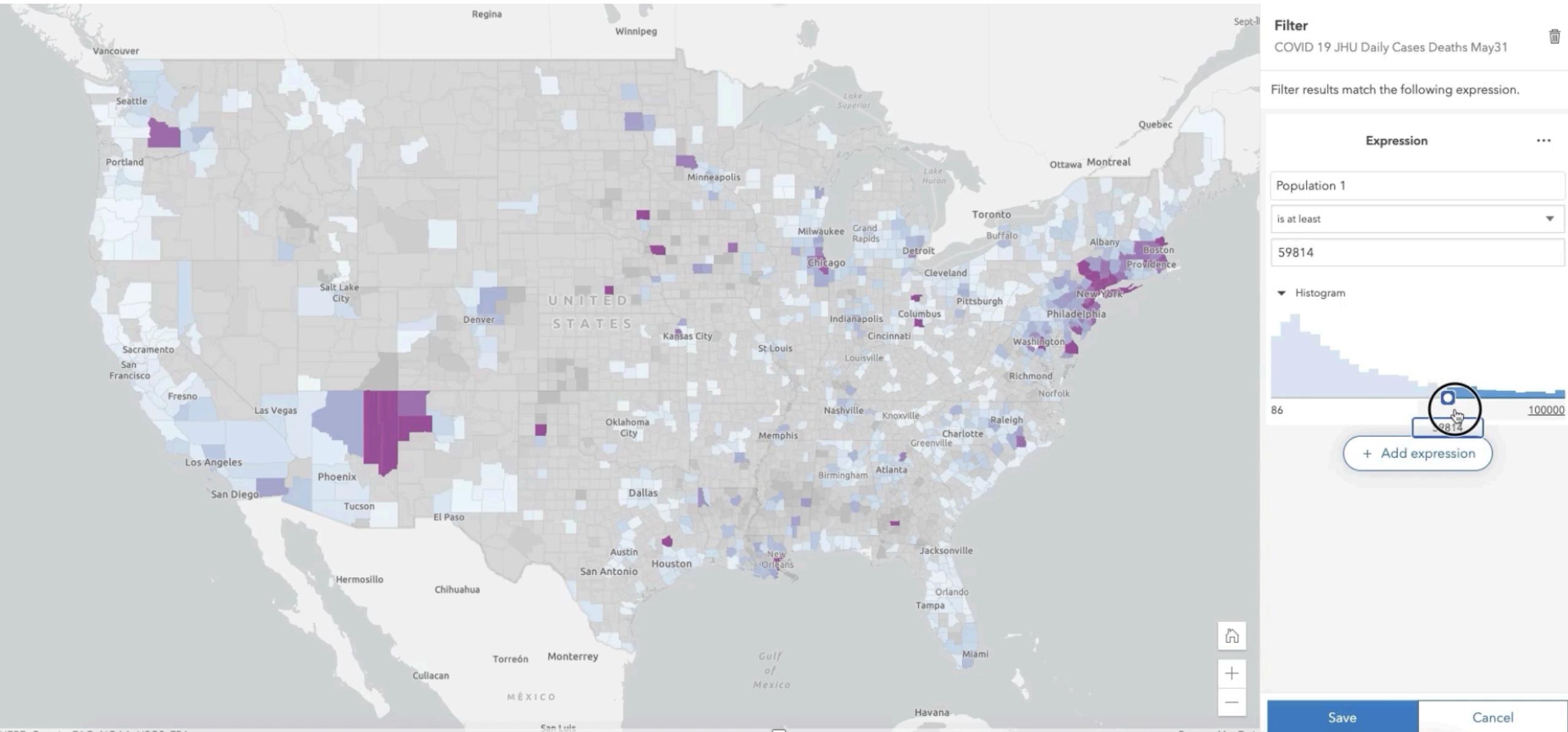
```
layer.renderer = new SimpleRenderer({
  symbol: new SimpleFillSymbol({
    outline: new SimpleLineSymbol({
      color: "rgba(128,128,128,0.4)",
      width: 0
    })
  }),
  visualVariables: [
    new ColorVariable({
      valueExpression: `
        var currentDayValue = $feature["DAYSTRING_05_31_2020"];
        var currentDaySplit = Split(currentDayValue, "|");
        var infections = Number(currentDaySplit[0]);
        var deaths = Number(currentDaySplit[1]);
        var population = $feature.Population_1;
        return (infections / population) * 100000;
      `,
      valueExpressionTitle: `Infections per 100k`,
      stops: [
        { value: 50, color: "#edf8fb" },
        { value: 200, color: "#b3cde3" },
        { value: 500, color: "#8c96c6" },
        { value: 1000, color: "#8856a7" },
        { value: 1500, color: "#810f7c" }
      ]
    })
  ];
});
```



Arcade
expression



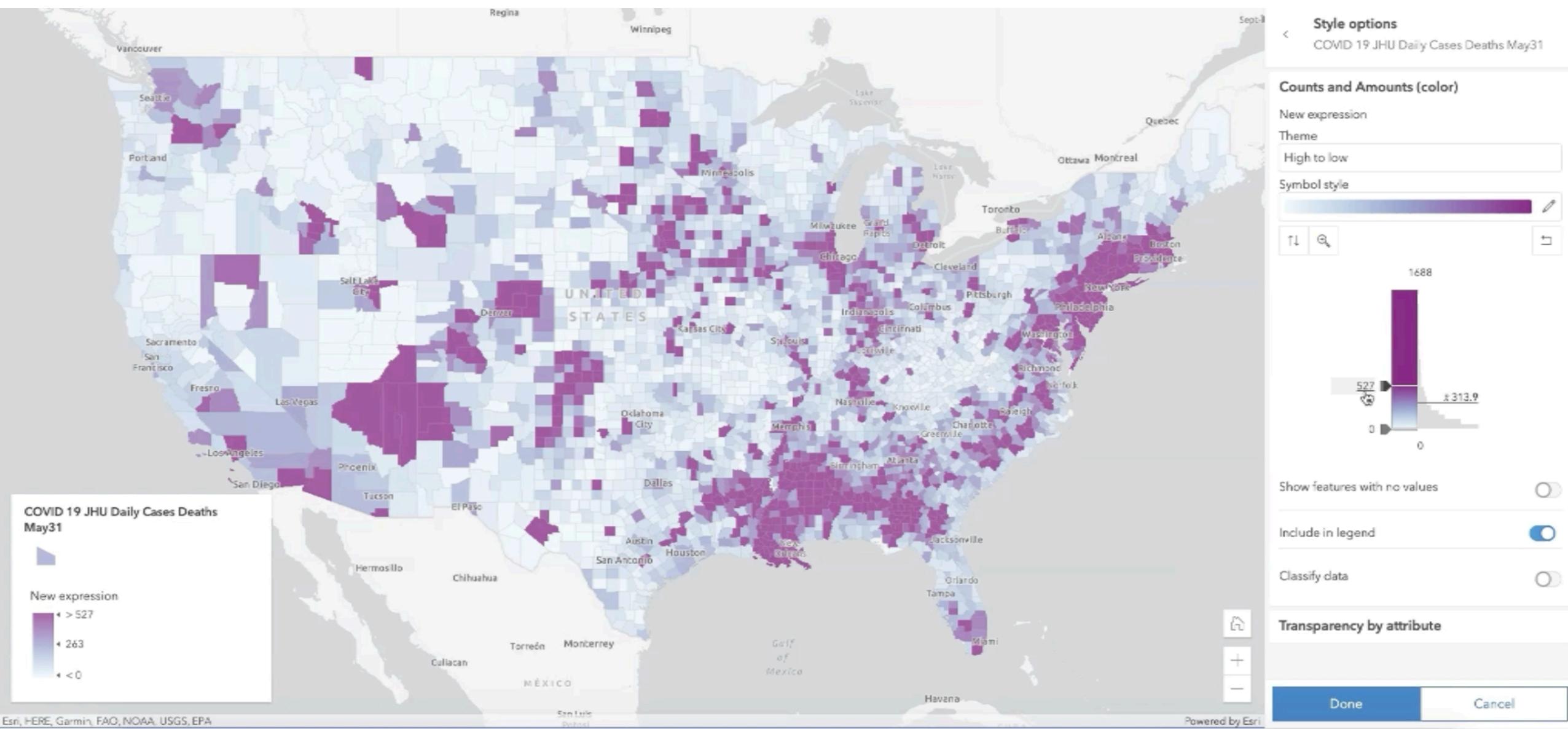
Data Exploration – Filter



Data Exploration – Update visualization



OpenJS World



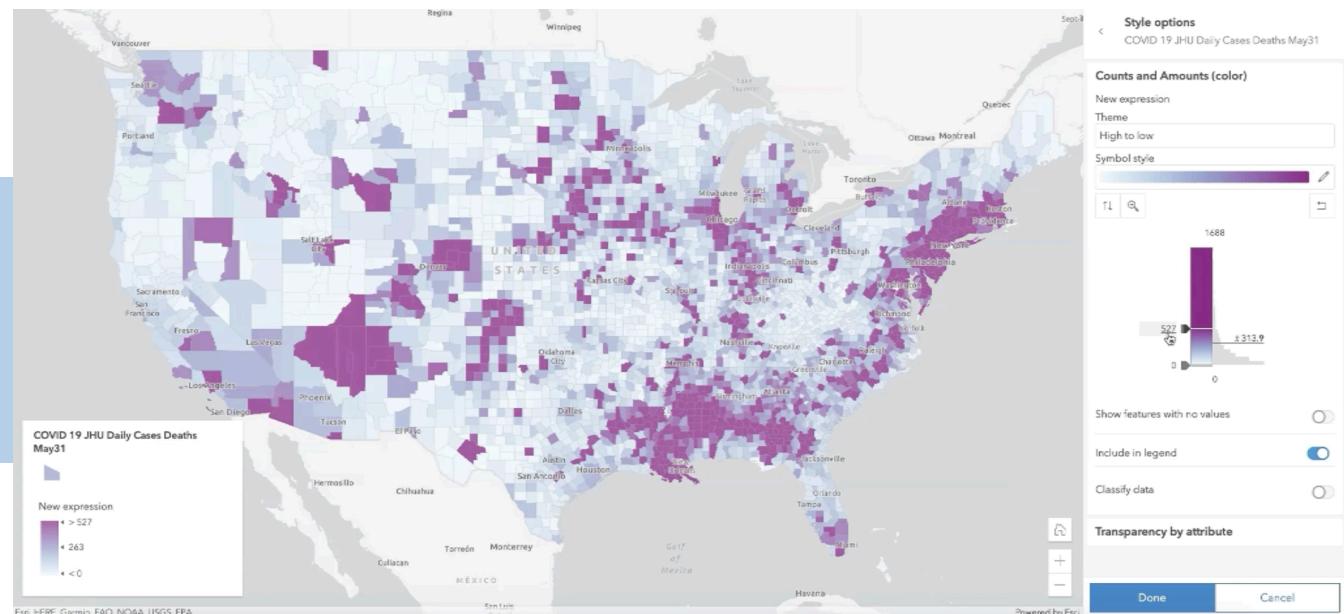


Data Exploration – Update color break points

```
layer.renderer = new SimpleRenderer({
  symbol: new SimpleFillSymbol({
    outline: new SimpleLineSymbol({
      color: "rgba(128,128,128,0.4)",
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        { value: 1000, color: "#8856a7" },
        { value: 1500, color: "#810f7c" }
      ]
    })
  ]
});
```

Color
driven
by data

User updates visual
variable **stops**, not data
values.

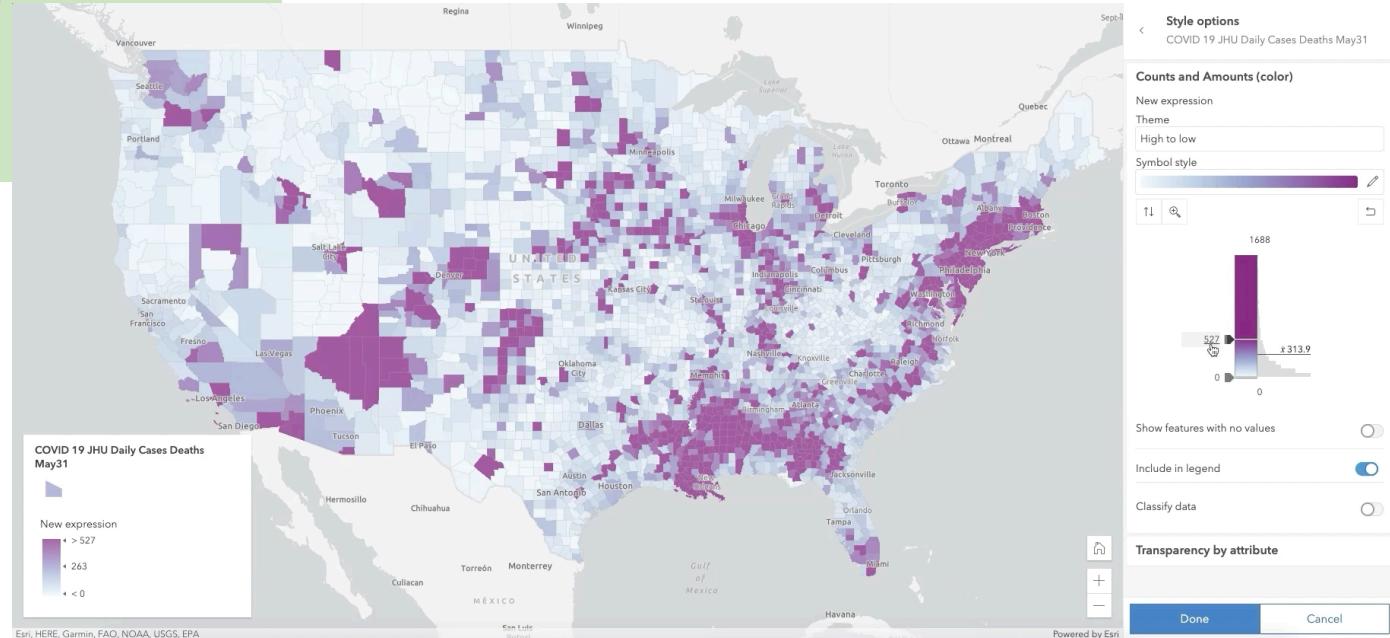




Data Exploration – Update data values

```
layer.renderer = new SimpleRenderer({
  symbol: new SimpleFillSymbol({
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      ]
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});
```

DAYSTRING_05_31_2020



What about data that changes over time, or some other dimension?

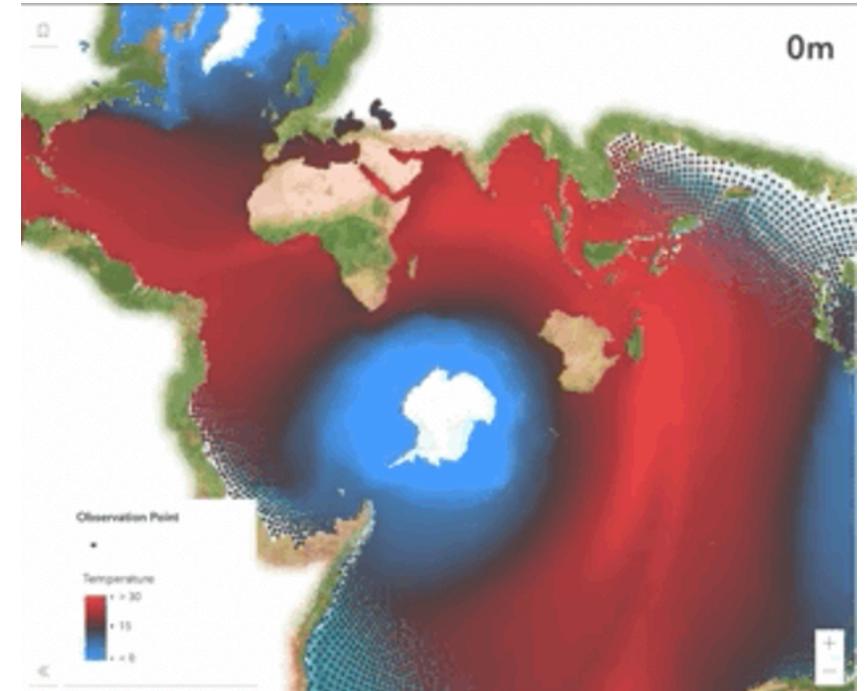
Location + variable + ...

Time

Age cohorts

Income brackets

Depth/Elevation



Multidimensional data exploration – Time



The answers
depend on
where...

Future

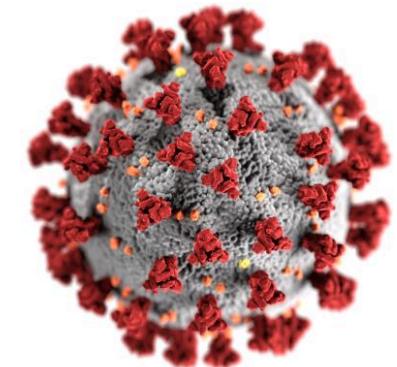
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Are we prepared to handle a novel coronavirus?

Present

How many people are currently sick?
How many people died today?

Past

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How many have recovered?
How many total people died?





Staying in the present – What's happening now?

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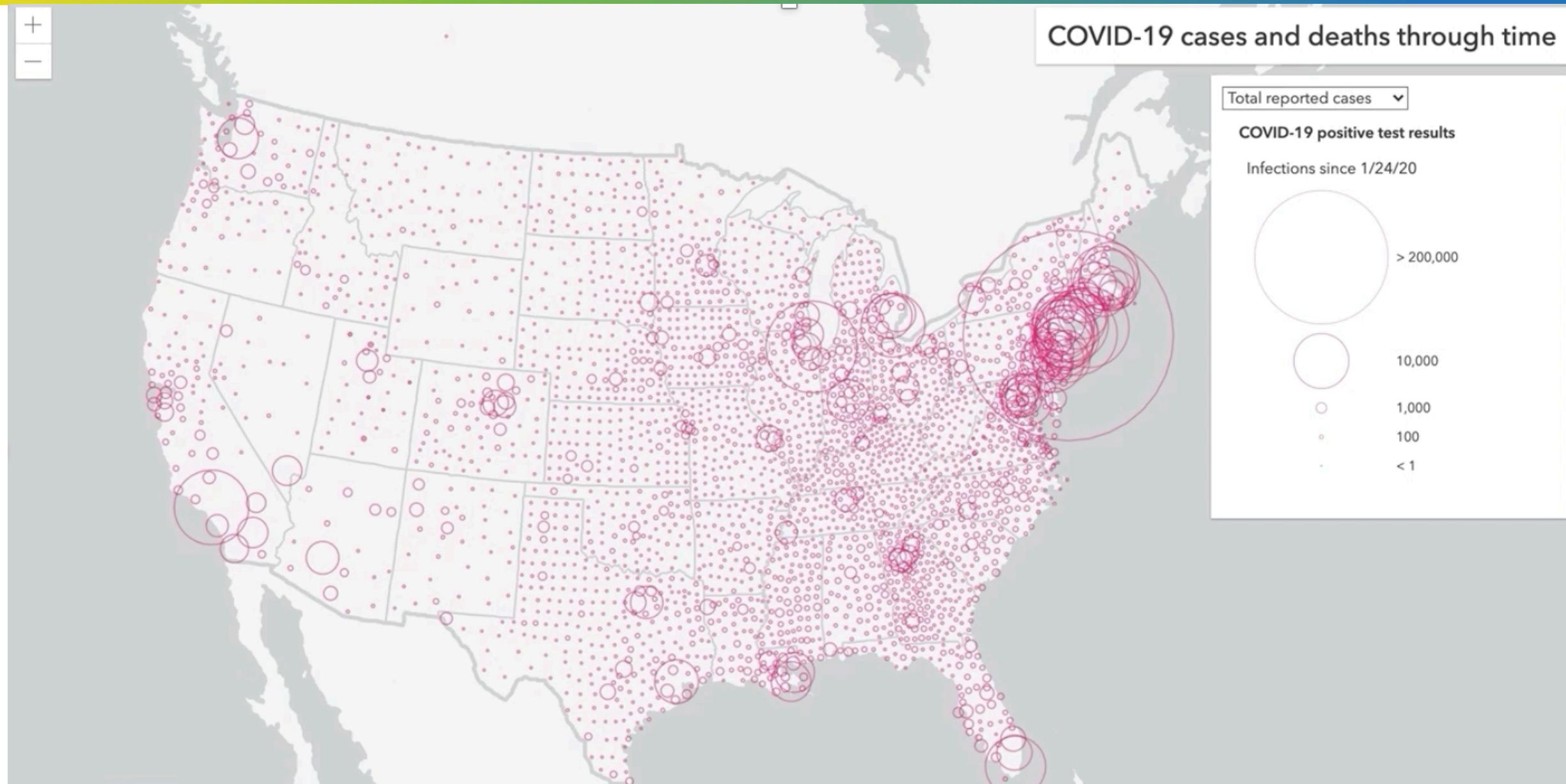
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Global Deaths

Confirmed Logarithmic Daily Cases



Past – Mapping historic data as a time-series



Past – Mapping historic data as a time-series



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    visualVariables: [
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            field: "4/1/2020",
            stops: [
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                { value: 200000, size: "200px" }
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        })
    ]
});
```

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,283,290,292

Future – Forecast demand for hospital resources



OpenJSWorld

It depends on
where...

Future

How many people will be infected?

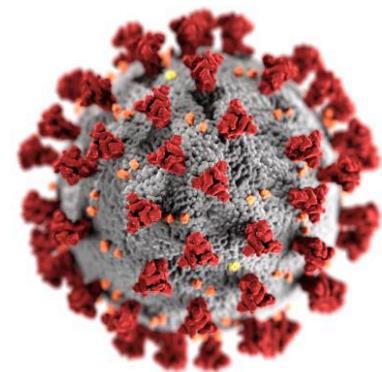
**How many will require admission to a hospital?
Are we prepared to handle a novel coronavirus?**

Present

How many people are currently sick?
How many people died today?

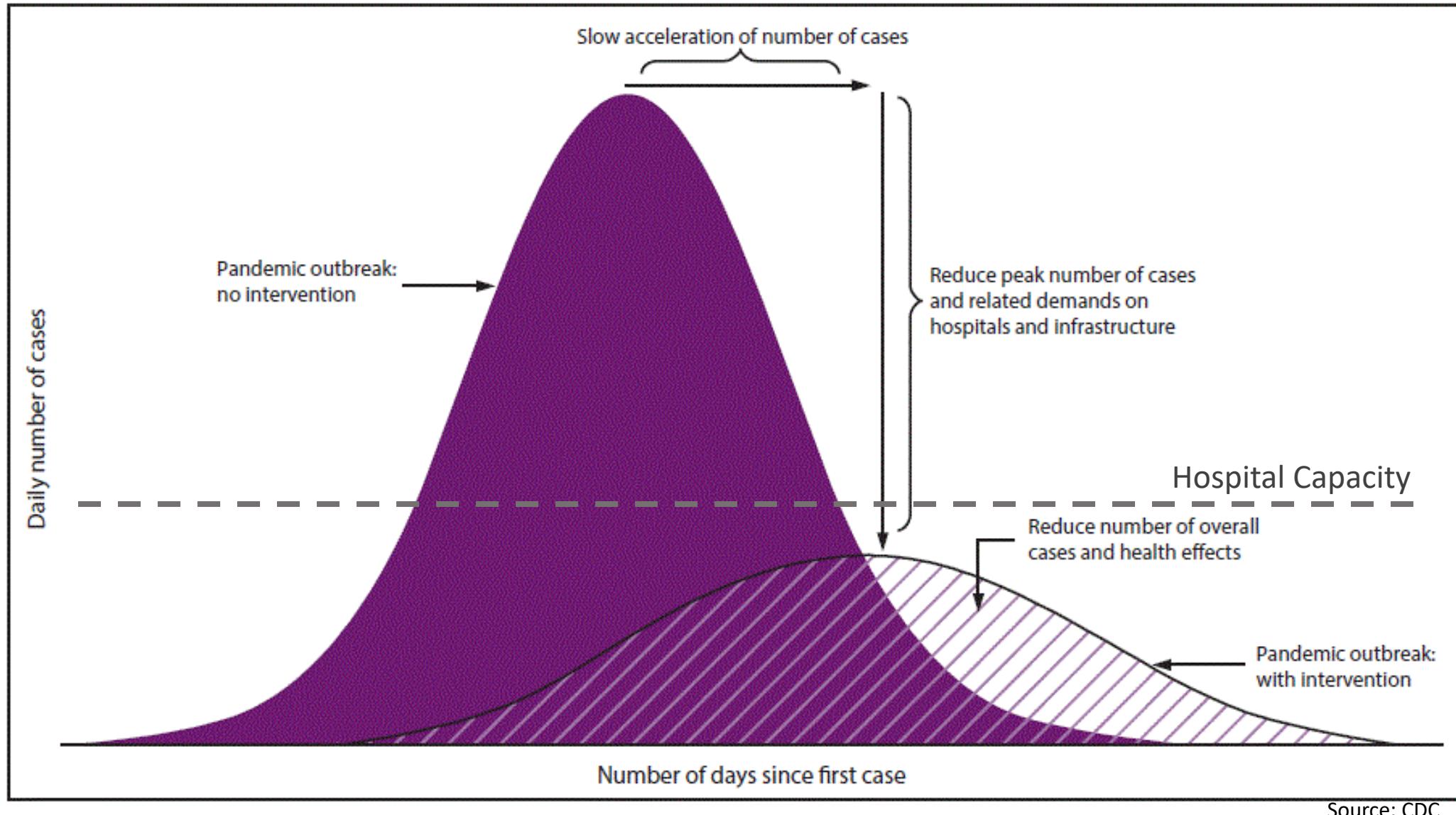
Past

How many people have been infected?
How many have recovered?
How many total people died?





Flatten the curve



Forecast by comparing various model outputs



How can we flatten the curve?

When can we get back to normal?

Physical distancing?

Phased reopening?

Wear masks, other PPE?

Reopen everything now?

Shelter in place guidelines?

Based on what-if scenarios, we can...

- Properly allocate hospital resources
- Know where test facilities should be located
- Compare scenarios for making informed decisions on reopening
- Transparently communicate results to the public



Forecast by comparing various model outputs

Penn Medicine's CHIME

(COVID-19 Hospital Impact Model for Epidemics)

- Susceptible, infected, recovered (SIR) model
- Params
 - Current cases
 - Recent cases
 - Susceptible population
 - Current hospitalizations/hospitalization rate
 - Number of days to project
 - **% compliance to social distancing/shelter in place orders**
 - Hospital resources

Hospital beds
ICU beds
Ventilators

CDC's COVID-19Surge

Params

- Current cases
- Recent cases
- Susceptible population
- New infections per case
- **Hospital resources**
- Hospital stays
- **Staged interventions**

Hospital beds
ICU beds
Ventilators



Forecast by comparing various model outputs

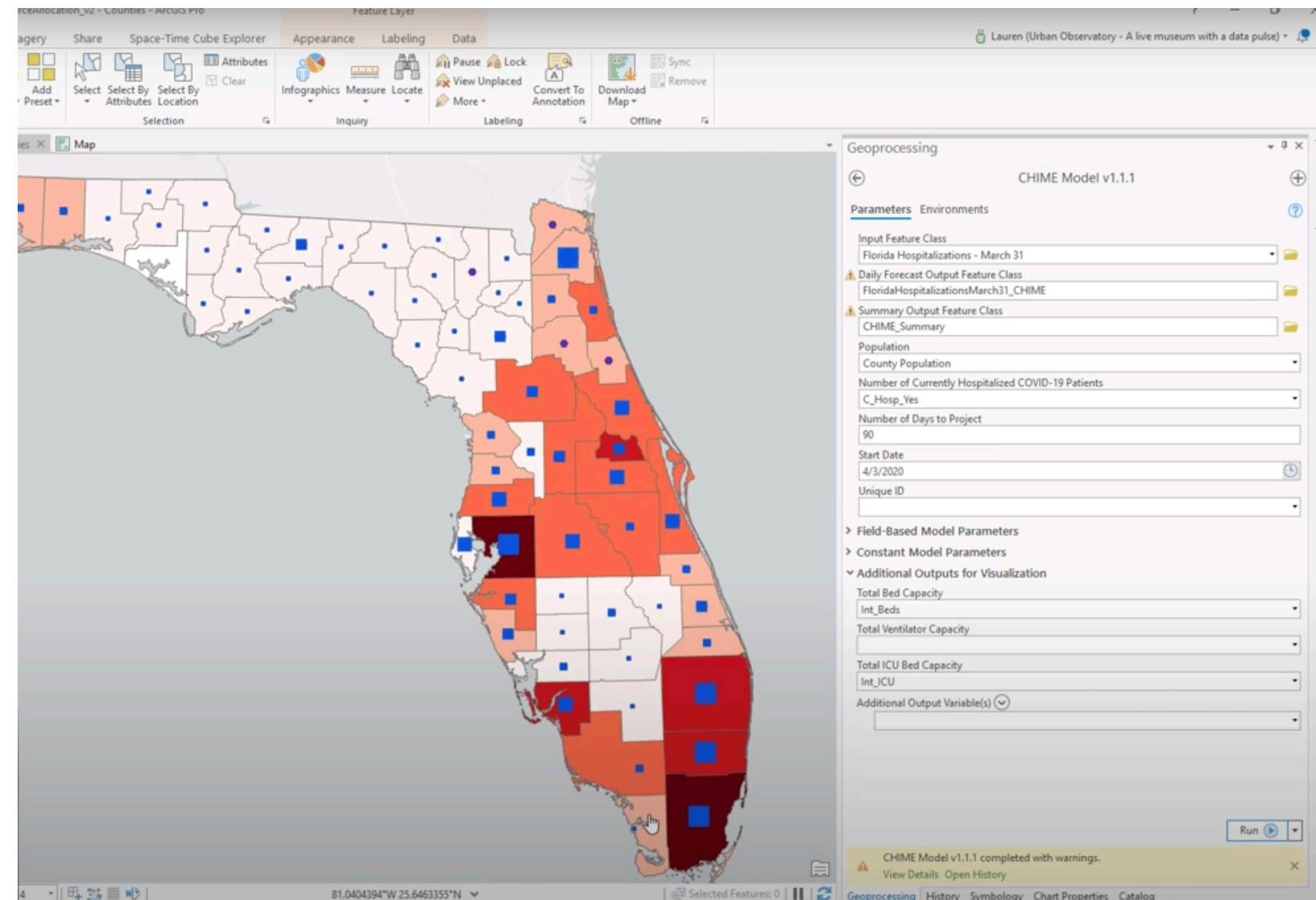
CHIME and COVID-19Surge models were deployed as geoprocessing tools in ArcGIS Pro.

Define hypothetical scenarios...

What is the expected peak hospital bed, ICU bed, ventilator usage by day if...

...only 30% of the population observe physical distancing?

...we re-open businesses in three phases versus no phases?

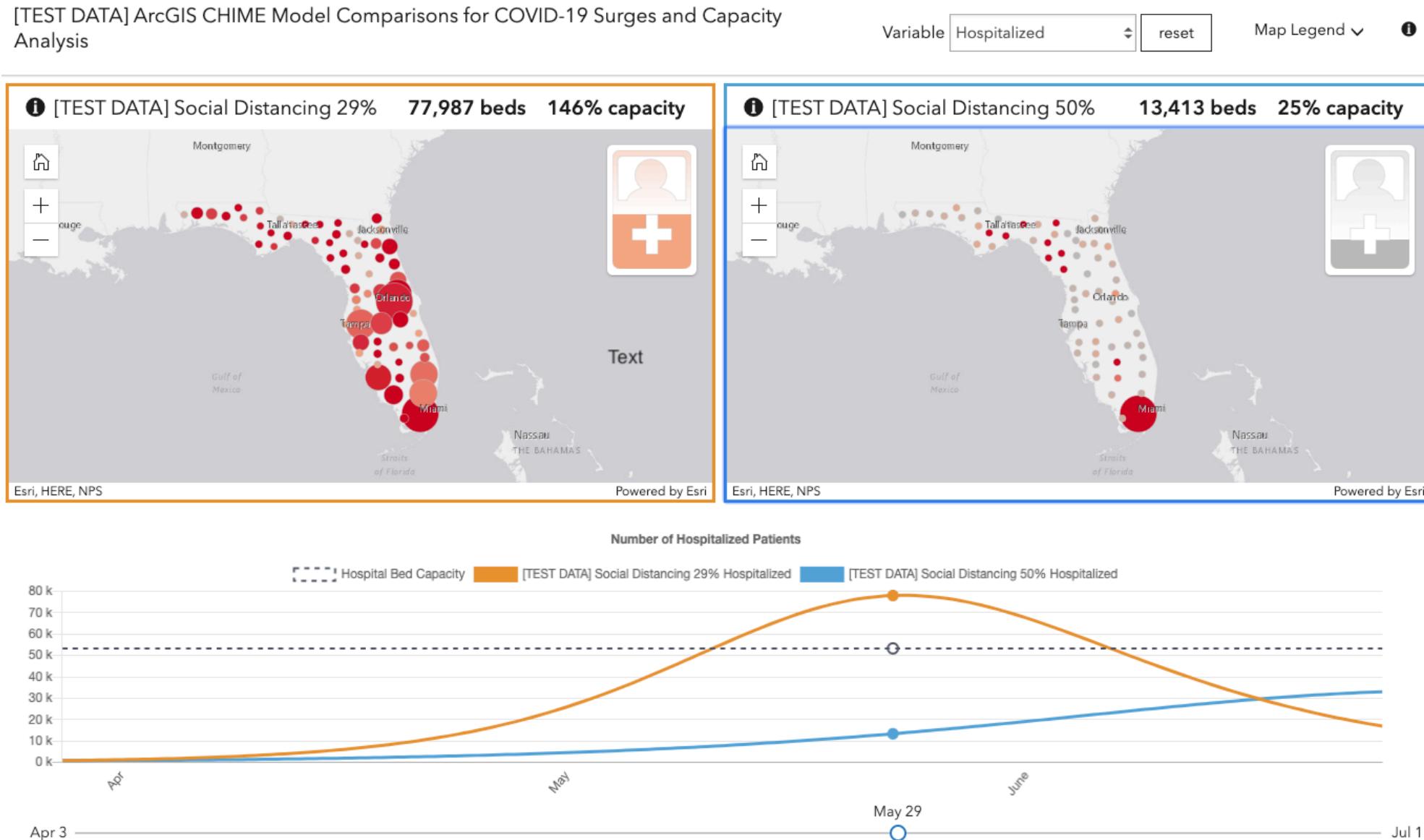




Capacity Analysis – Comparing two CHIME outputs

Capacity Analysis is a web app that helps us understand the impact of various methods of intervention based on accepted models.

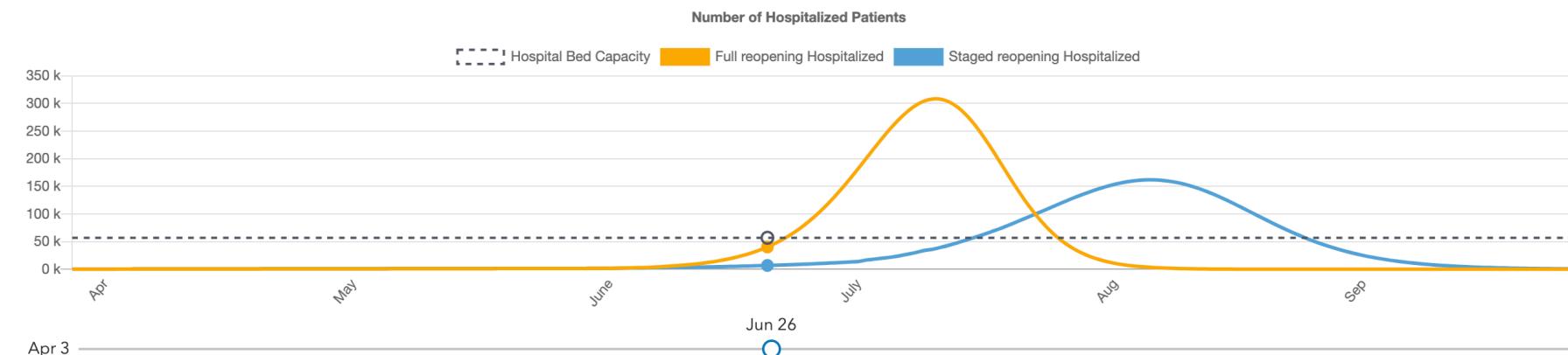
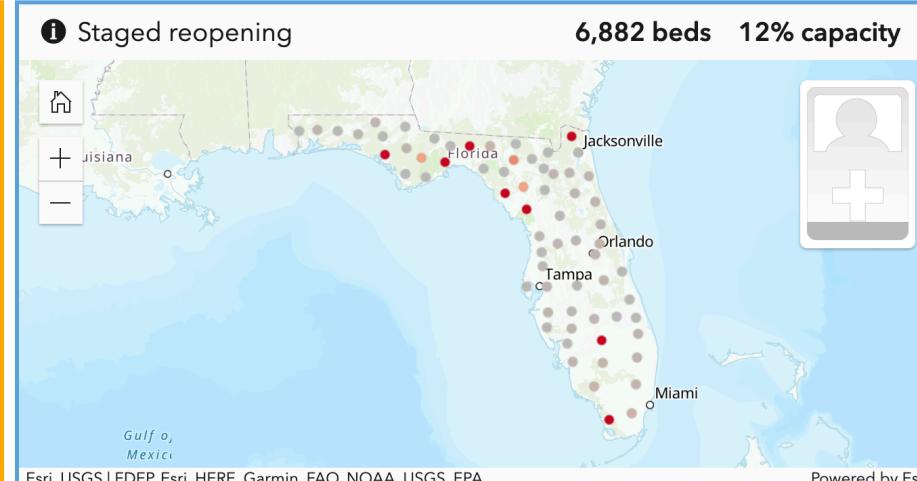
- Run the geoprocessing tool twice with varying params.
- Compare the output layers side by side to observe differences.





Capacity Analysis – Comparing two CHIME outputs

web_chosp:	0 0 0 1 1 1 1 2 2 2 3 3 3 3 4 4 5 5 6 6 7 8 9 10 11 12 13 14 16 17
web_cicu:	0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 4 4 5 5 6 6 7 7 8 9
web_cvent:	0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 3 3 3 4 4 4 5 5 6 6 7



Three key table columns containing daily numbers for projected...

- Hospital beds
- ICU beds
- Ventilators

Required for COVID-19 patients



Dynamically update renderer from slider position

```
slider.on(["thumb-change", "thumb-drag"], sliderEvt => {
  const day = slider.values[0];

  requestAnimationFrame(() => {
    updateChartDay(day);
    updatePopupTemplates(day);
    updateRenderers({
      day,
      variable // selected by user "beds" | "icu" | "ventilators"
    });
  });
});
```



Dynamically update renderer from slider position

```
layer.renderer.visualVariables = [ new ColorVariable({
  valueExpression: getPercentCapacityExpression({
    // e.g. "hospital beds", 5
    variable, day
  }),
  valueExpressionTitle: "Hospital Stress",
  stops: [{ value: 0, color: "#bababa", label: "under capacity" },
    { value: 100, color: "#f4a582", label: "100% capacity" },
    { value: 200, color: "#ca0020", label: "> 200% capacity" }]
), new SizeVariable({
  valueExpressionTitle: "Number of patients above capacity",
  valueExpression: getOveragesExpression({
    // e.g. "hospital beds", 5
    variable, day
  }),
  minDataValue: 1, minSize: 2,
  maxDataValue: overagesMax, maxSize: 32
})];
```



Dynamically update renderer from slider position

```
const getPercentCapacityExpression = function ({ variable, day }) {  
  
    // web_chosp - Projected number of hospital patients  
    const countsField = variableFields[variable].COUNTS;  
  
    // oc_hos_num - Total number of available hospital beds  
    const capacityField = variableFields[variable].CAPACITY;  
  
    return `  
        $feature.${countsField};  
        $feature.${capacityField};  
        var hospitalized = Max(0,Number(Split($feature.${countsField}, '|')[${day}]));  
        var capacity = IIF(  
            $feature.${capacityField} < 1, 1, $feature.${capacityField}  
        );  
        return (hospitalized / capacity) * 100;  
    `;  
};
```



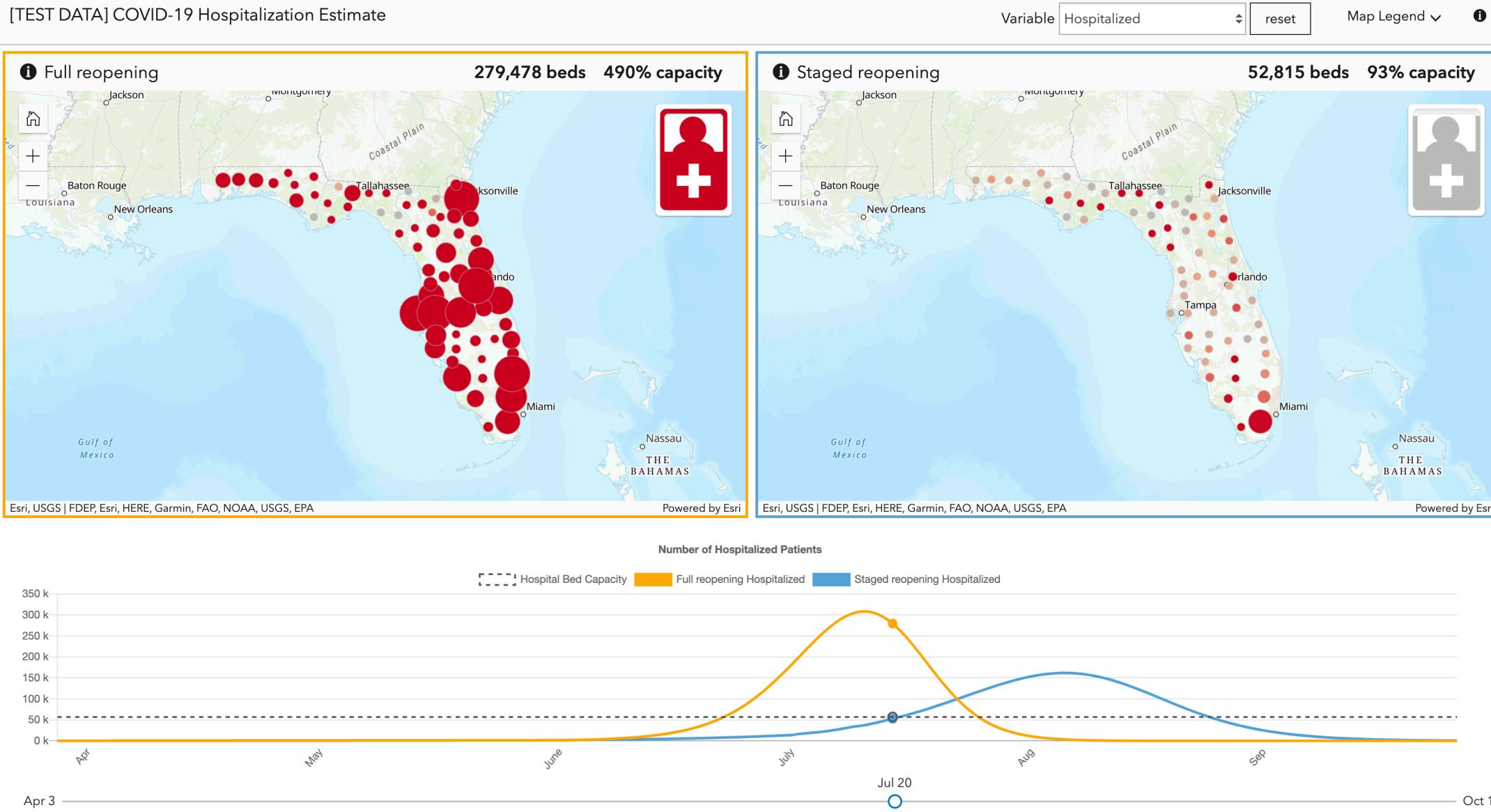
Dynamically update renderer from slider position

```
const getOveragesExpression = function ({ variable, day }) {  
  
    const countsField = analysisParameters.variableFields[variable].COUNTS;  
    const capacityField = analysisParameters.variableFields[variable].CAPACITY;  
  
    return `  
        $feature.${countsField};  
        $feature.${capacityField};  
  
        var hospitalized = Max(0,Number(Split($feature.${countsField}, '|')[${day}]));  
        var capacity = IIF(  
            $feature.${capacityField} < 1, 1, $feature.${capacityField}  
        );  
        return (hospitalized - capacity);  
    `;  
};
```



Conclusion

Interactive.
Clear.
Personal.



Conclusion



Thank you!

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