3D Visualization with the ArcGIS API for JavaScript

Kristian Ekenes
@kekenes

Kelly Hutchins
@kellyhutchins

Consistency

Principles of 2D viz ≈ 3D viz

- Code is similar
- Cartographic principles/techniques are similar

Overview

- What you can visualize in 3D
- How to do it
- Considerations and pitfalls

Overview

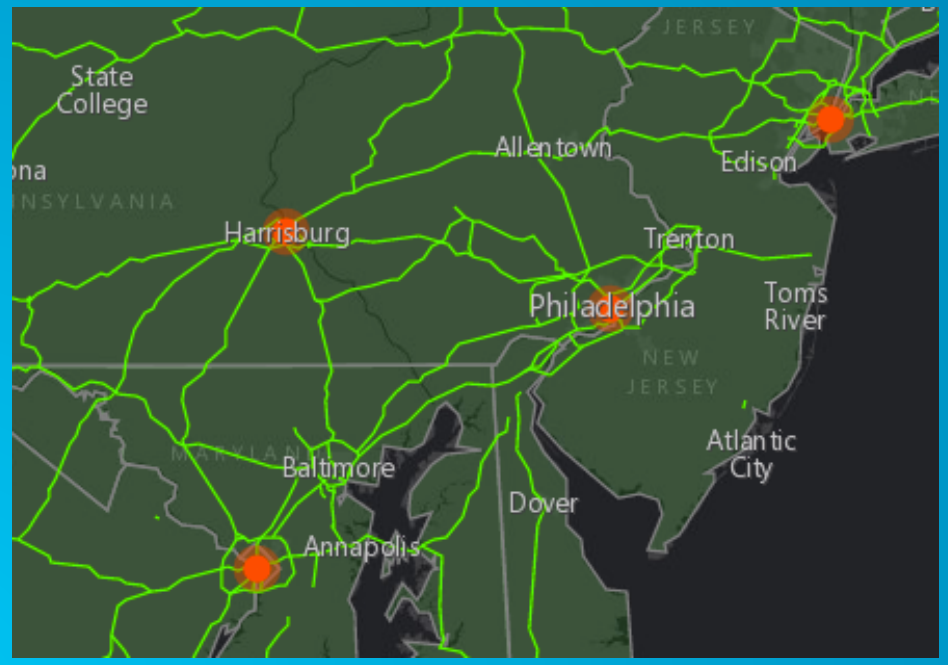
- What you can visualize in 3D
- How to do it
- Considerations and pitfalls

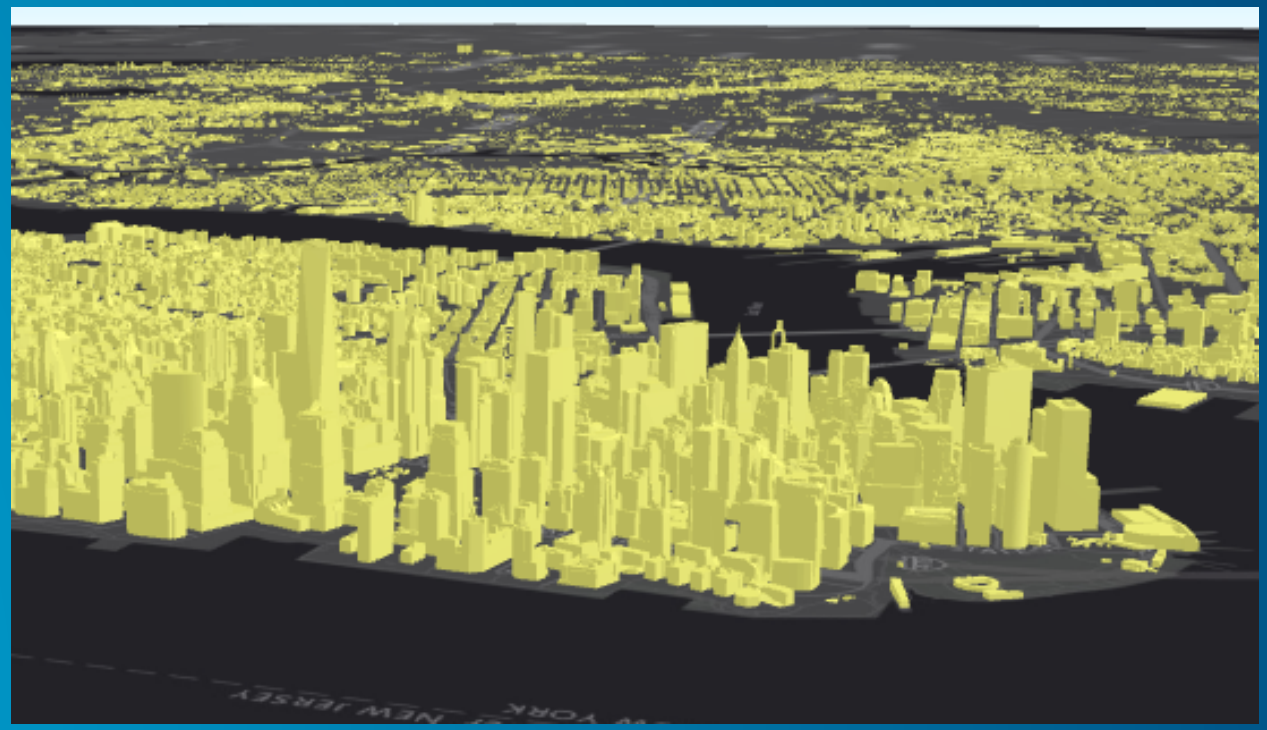
What can we visualize?

- Location
- Types
- Data (numbers)
- Combinations of the above

Location

All features in a layer have same symbol

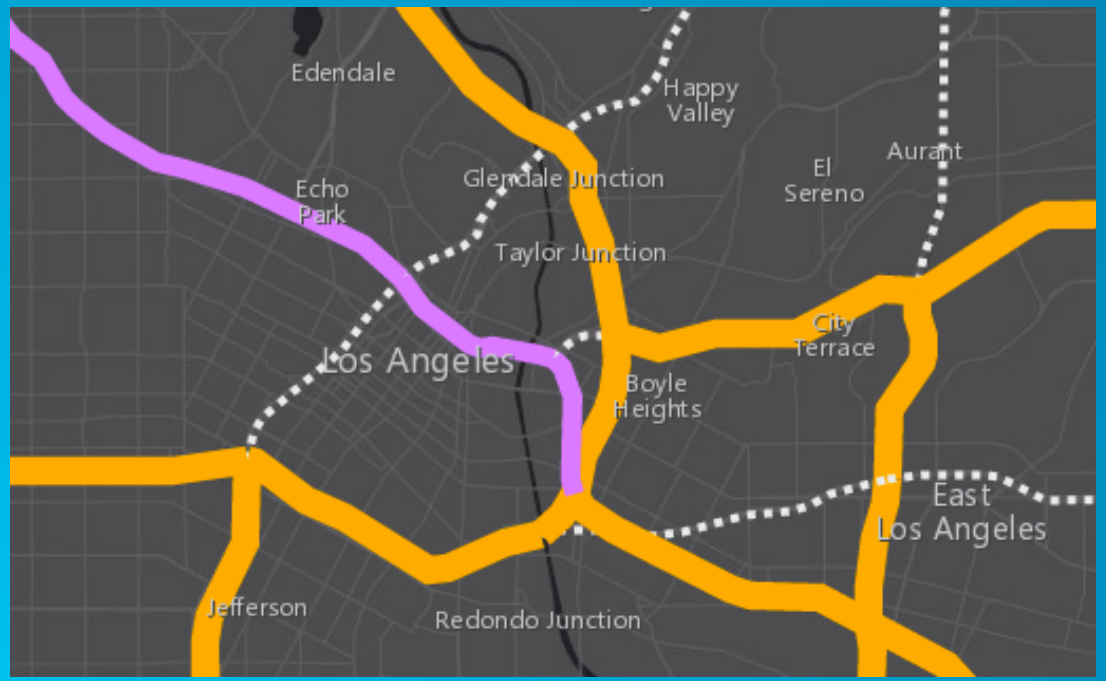




Types

Based on unique (usually text) values

Interstates, highways, major roads, …



Residential, commercial, mixed, …

Numbers

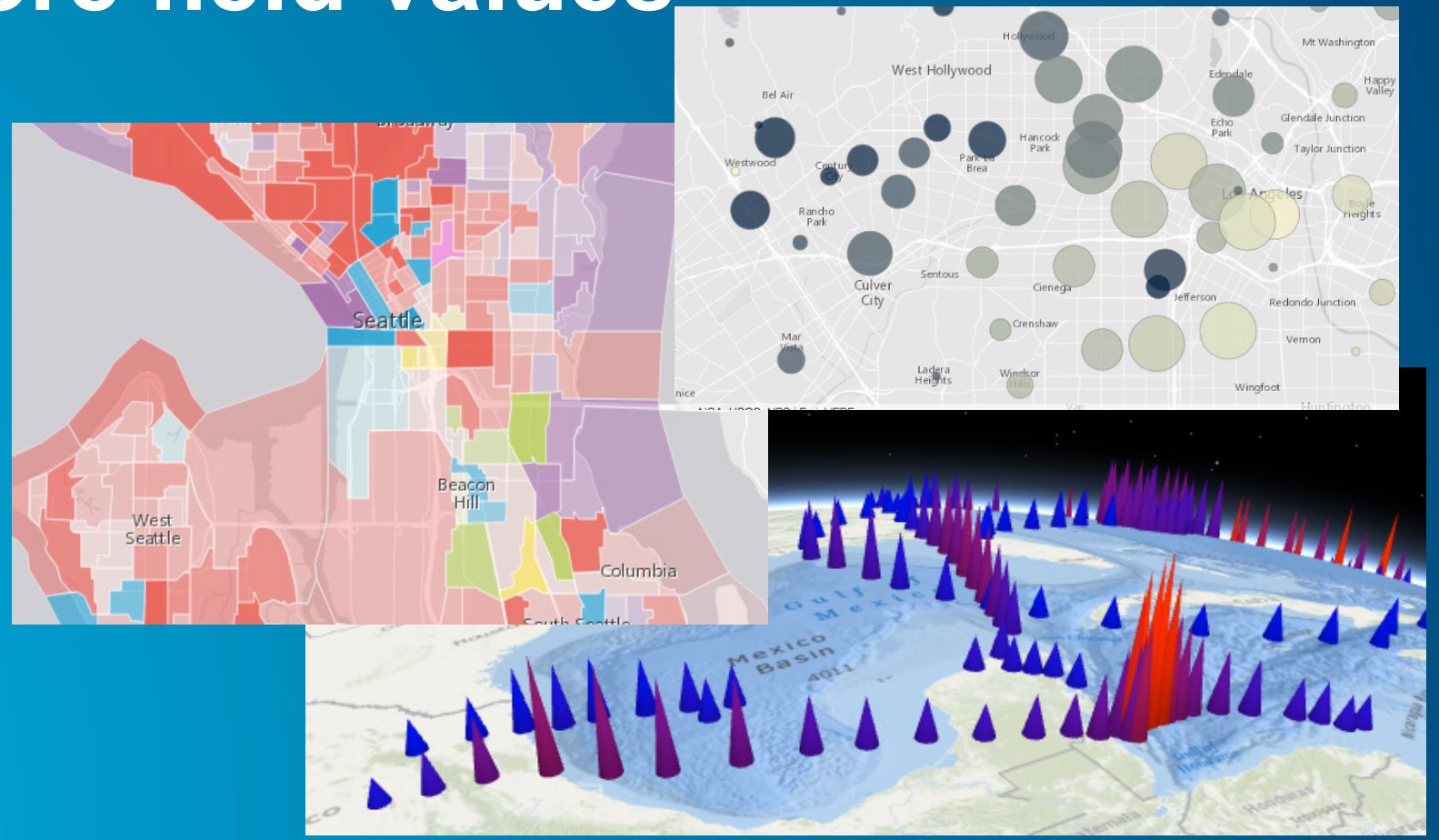
Based on field values or functions

- Color
- Size/Extrusion
- Opacity

Multivariate viz

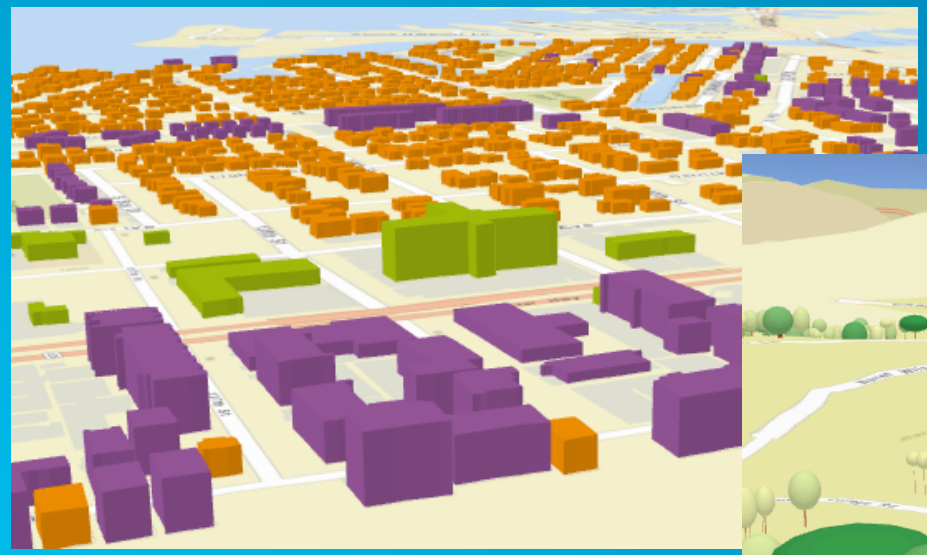
Based two or more field values

- Color + Opacity
- Color + Size
- Size + Opacity
- Size + Size
  - (Height + width)



Hybrid thematic maps

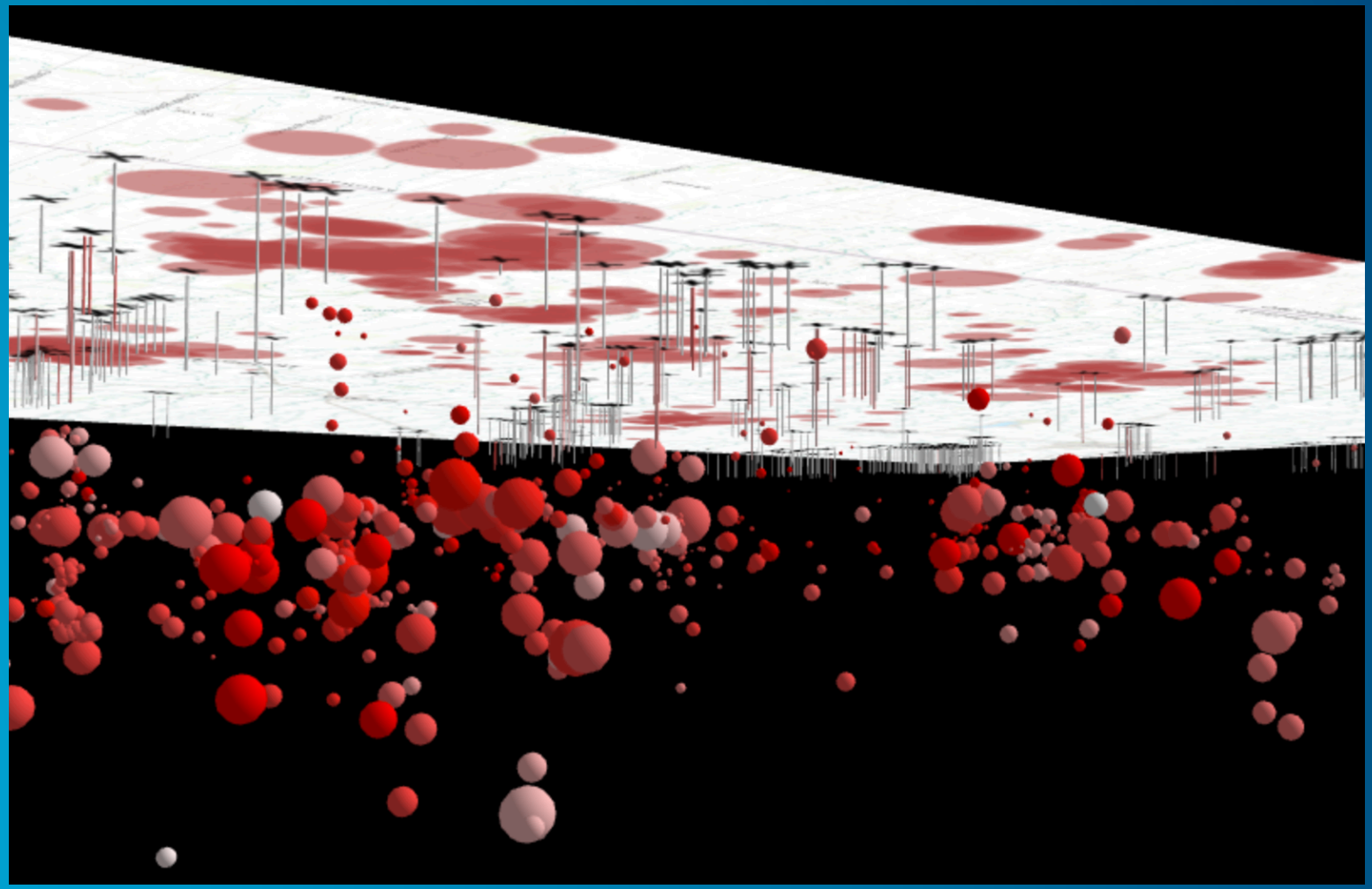
- Size and shape based on real-world measurements
- Color or opacity driven by thematic data



Simplifies or
removes the need for a legend!

Subsurface mapping

- Features with negative z values
- Negative extrusions
- Only in local scenes

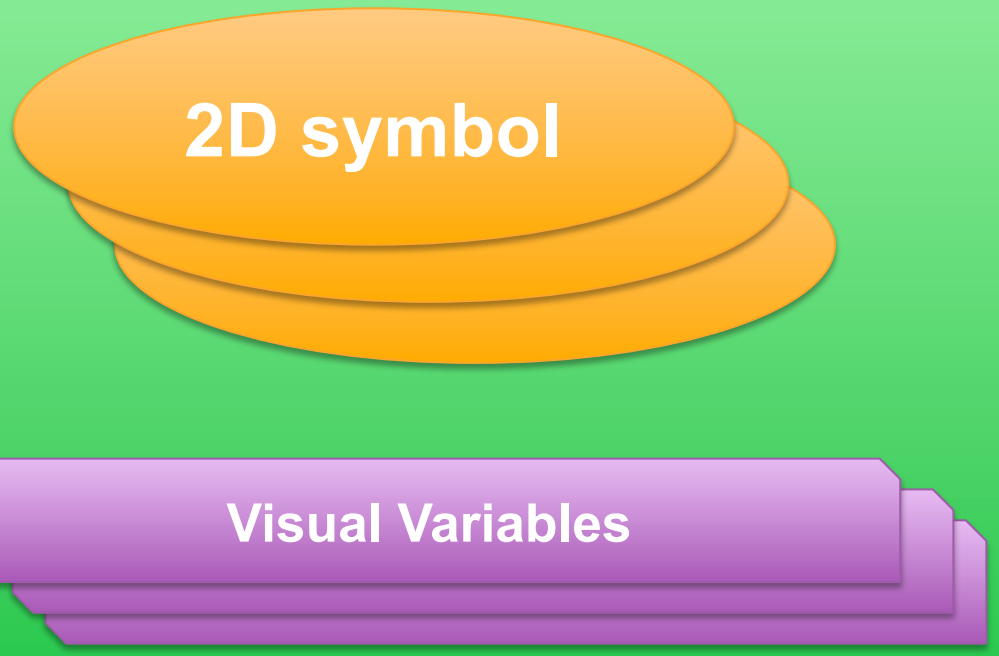


Overview

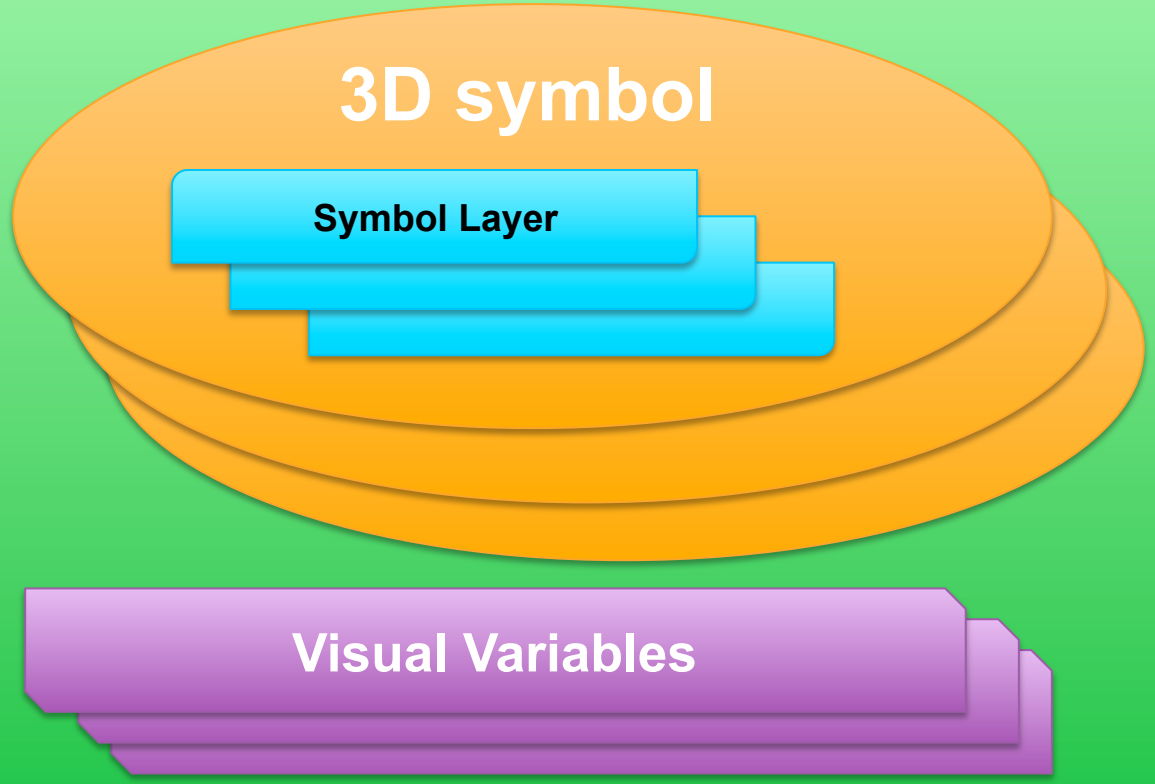
- What you can visualize in 3D
- How to do it
- Considerations and pitfalls

2D visualization vs. 3D visualization

Renderer



Renderer

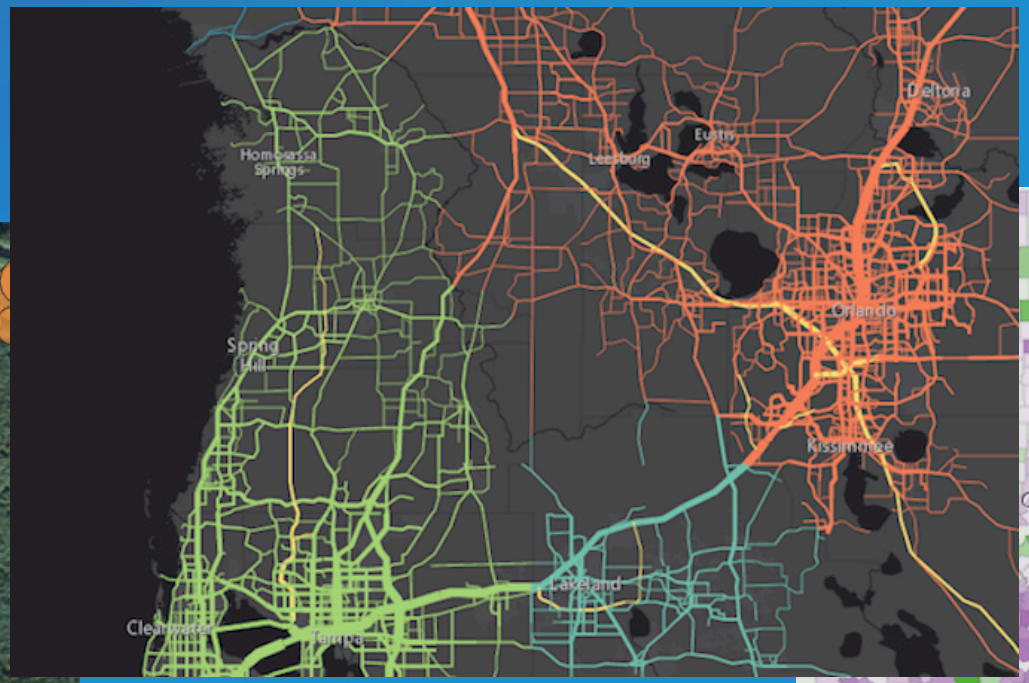


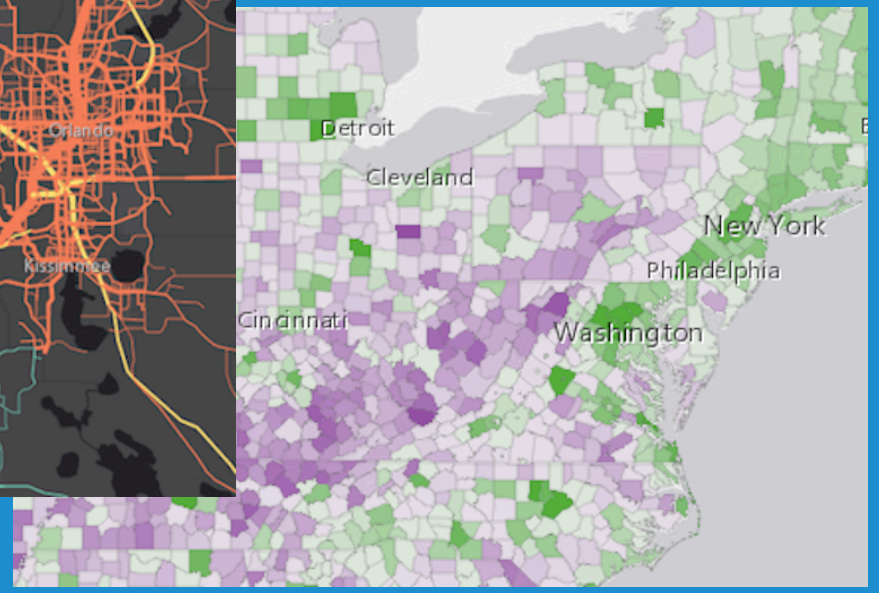
Symbols

2D Symbols

Not recommended!

- All 2D symbols (except PictureFillSymbol) are supported in 3D

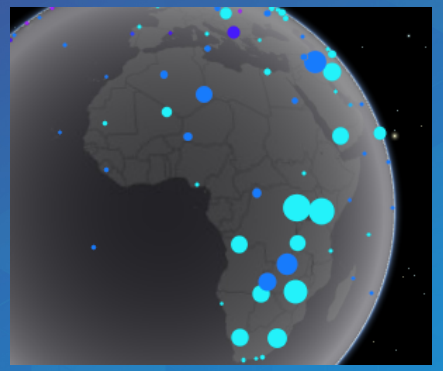




3D Symbols

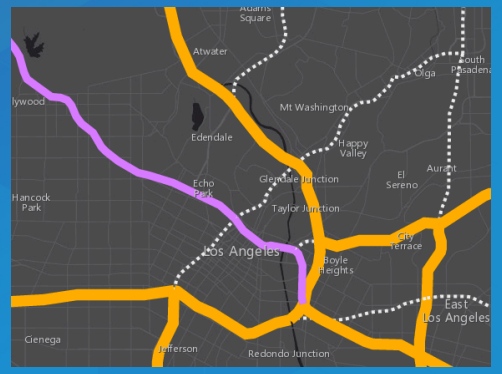
based on geometry type

Points



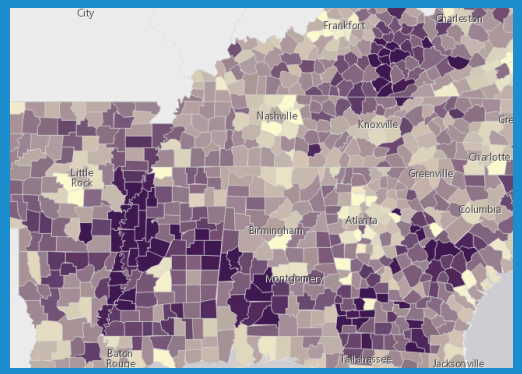
PointSymbol3D

Lines



LineSymbol3D

Polygons



PolygonSymbol3D

Mesh

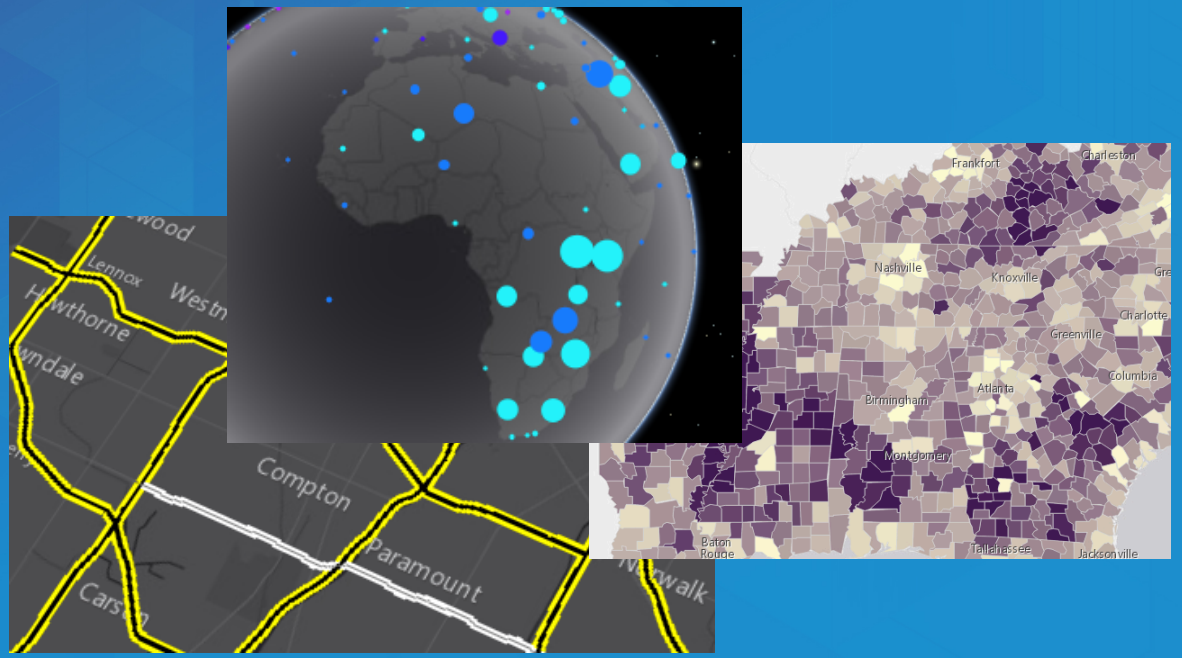
MeshSymbol3D

LabelSymbol3D

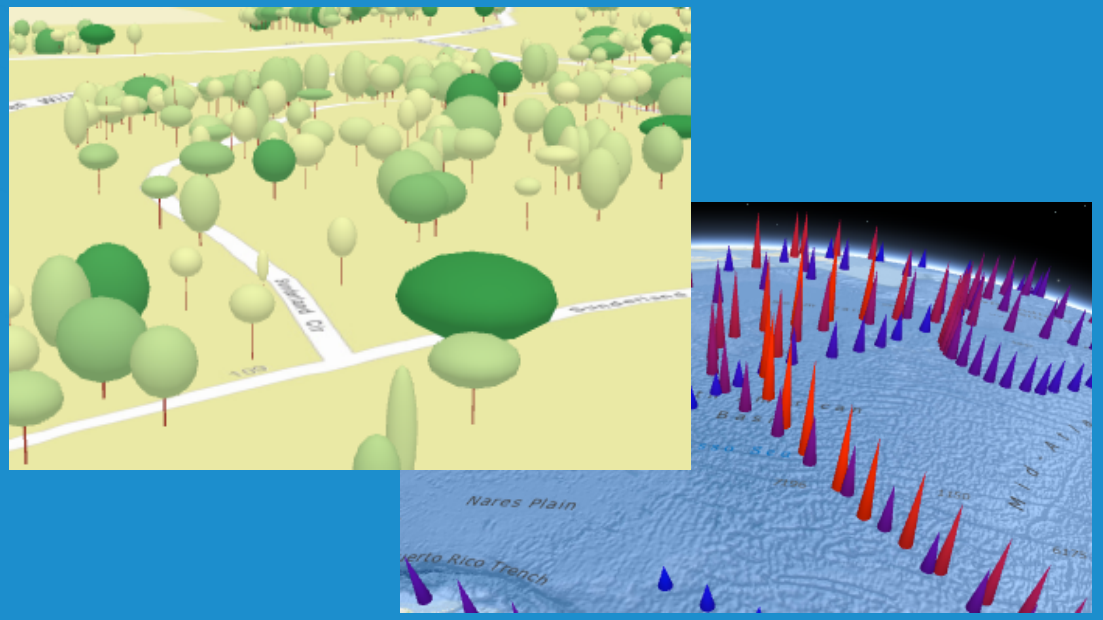
3D Symbols

Each must be composed of one or more symbol layers

Flat



Volumetric

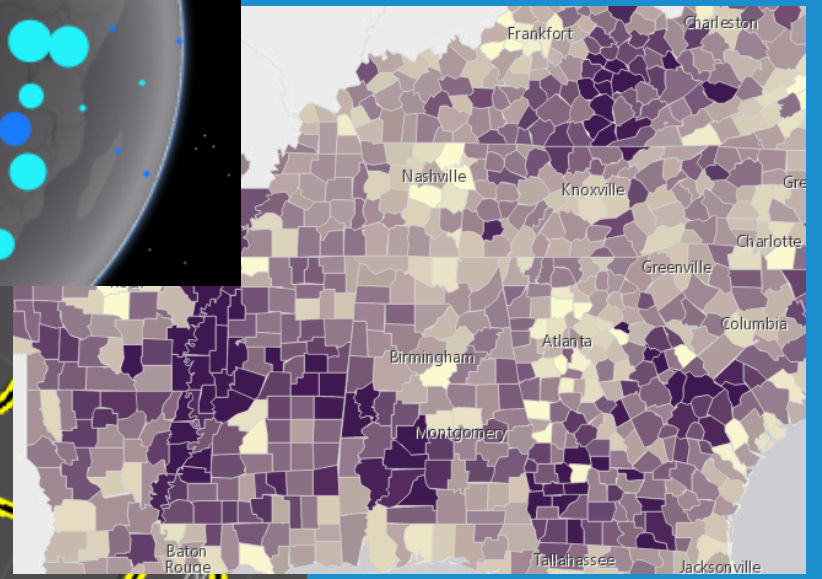


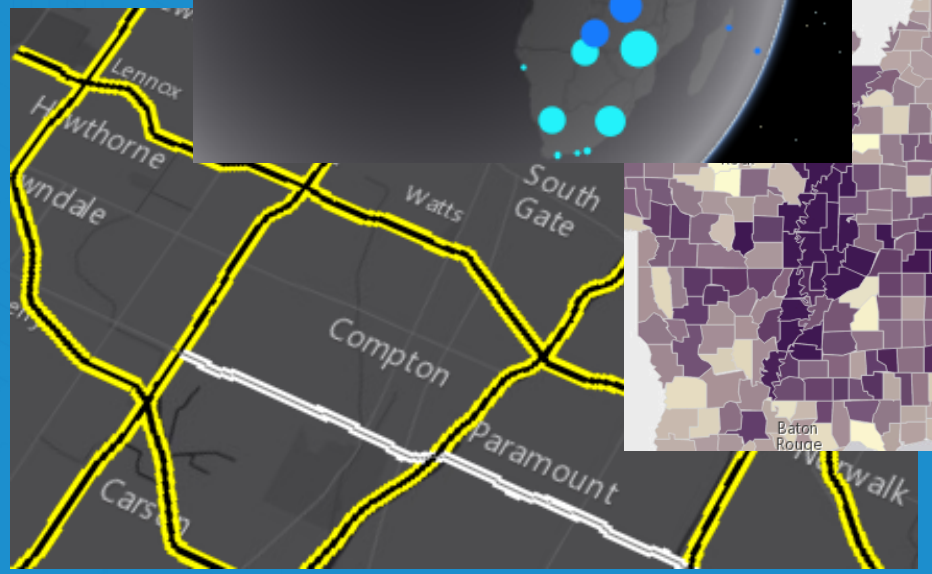
Flat Symbol Layers

- Look like they're 2D
- Size is expressed in screen units
  - pixels or points

IconSymbol3DLayer

FillSymbol3DLayer



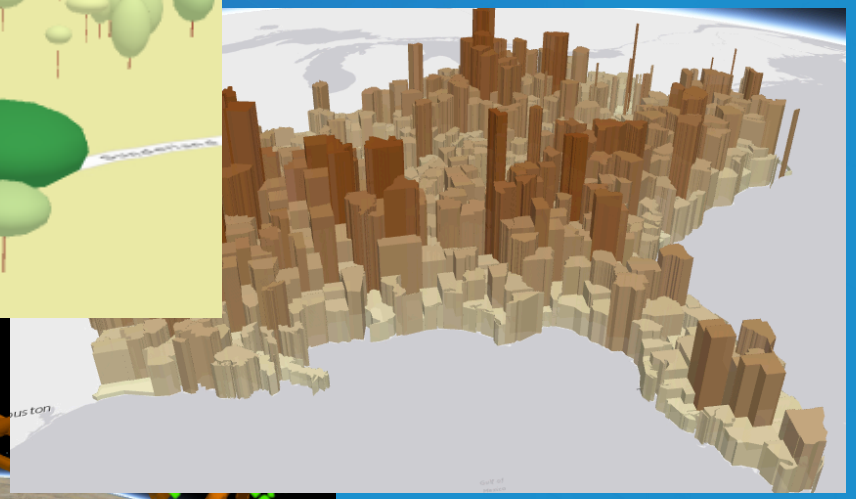


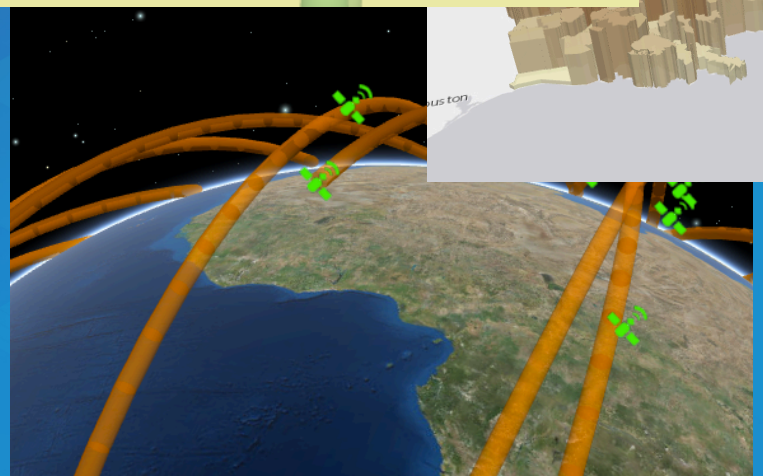
LineSymbol3DLayer

Volumetric Symbol Layers

ObjectSymbol3DLayer

ExtrudeSymbol3DLayer



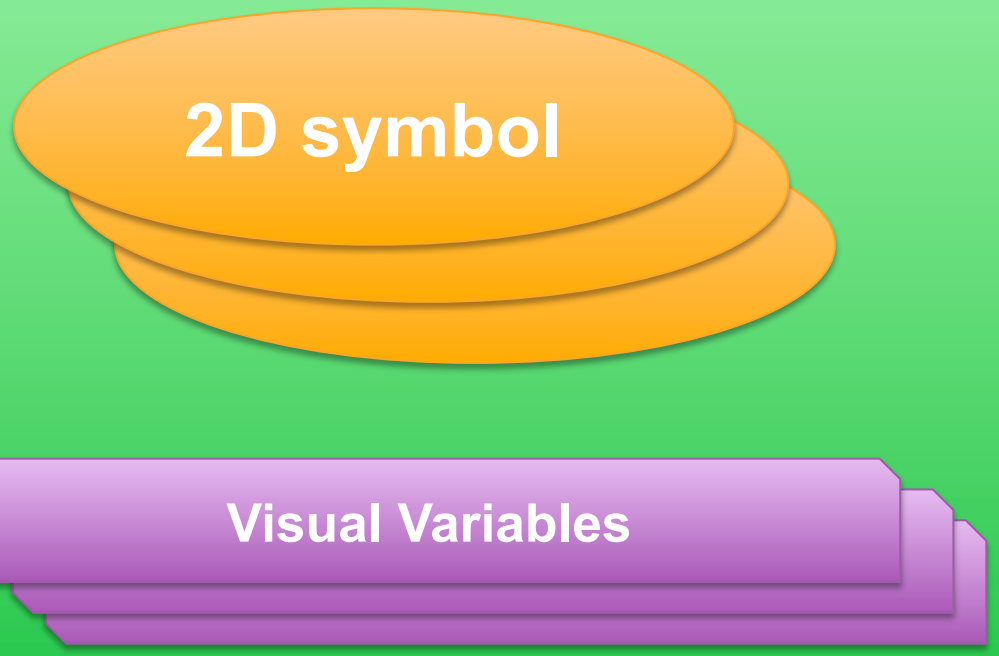


PathSymbol3DLayer

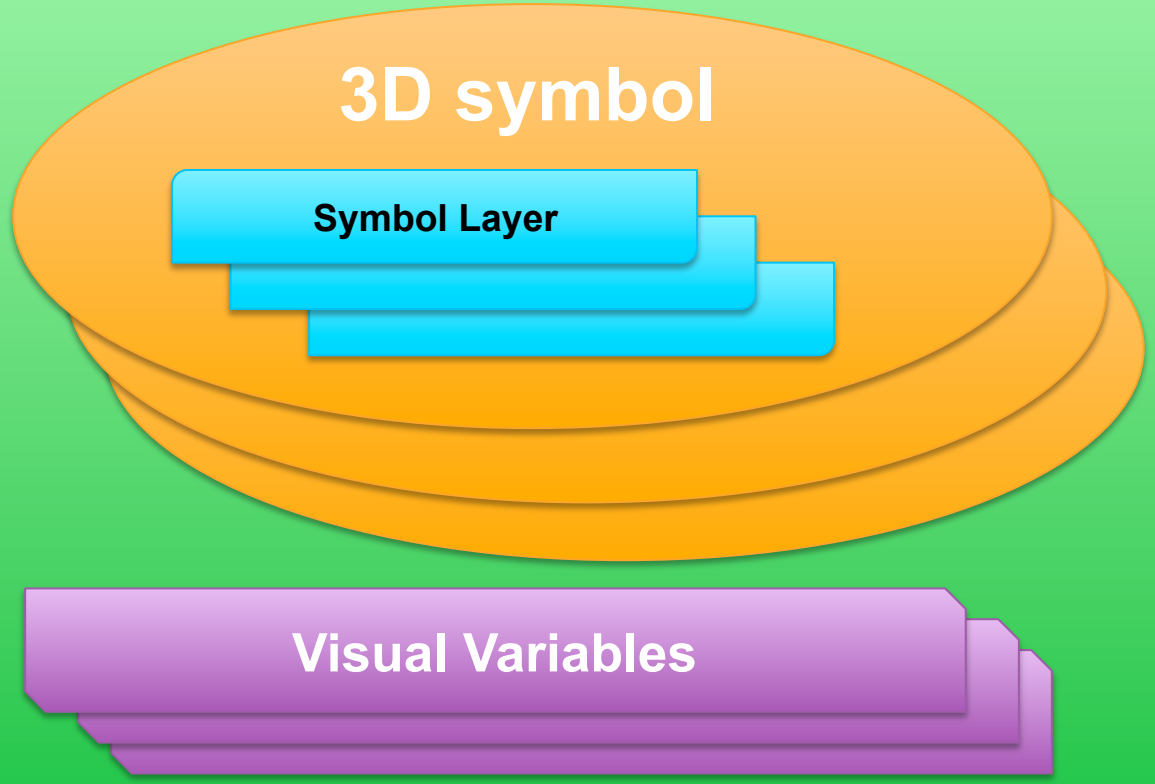
- Look like they're 3D
- Size is expressed in real-world units
  - usually in meters
- Object symbol layers (point features) have an axis to size height, width, and depth

2D visualization vs. 3D visualization

Renderer



Renderer



PointSymbol3D

Only for point features

```
objectSymbol = new PointSymbol3D({
  symbolLayers: [new ObjectSymbol3DLayer({
    width: 70000,
    height: 100000,
    resource: {
      primitive: "cone"
    },
    material: {
      color: "#FFD700"
    }
  })]
});
```

Flat (size in points/pixels)

```
ıSymbol = new PointSymbol3D({
ymbolLayers: [new IconSymbol3DLayer({
 size: 12,
 resource: {
   primitive: "square"
 },
 material: {
   color: "orange"
 },
 outline: {
   color: "white",
   size: 1
 }
})]
});
```

PointSymbol3D

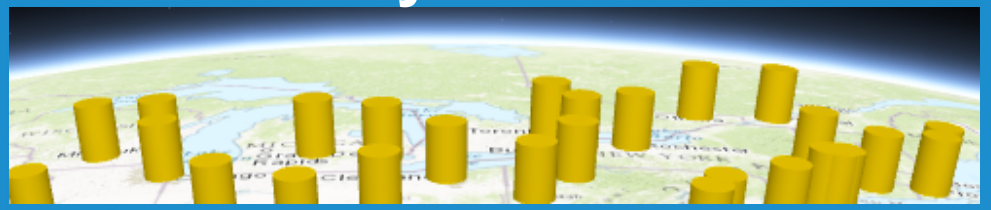
ObjectSymbol3DLayer – resource types

cone

sphere

tetrahedron

cylinder



diamond

cube

PointSymbol3D

IconSymbol3DLayer – resource types

circle

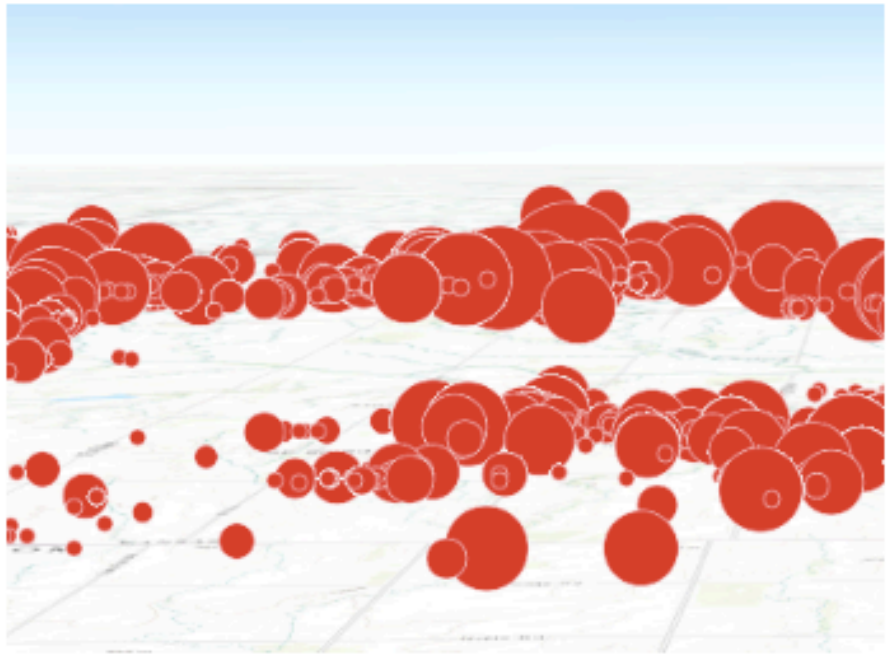
square

kite

cross

x

Keep in mind…

Draped icons	Billboarded icons
	

Sample comparison: When is each appropriate?

LineSymbol3D

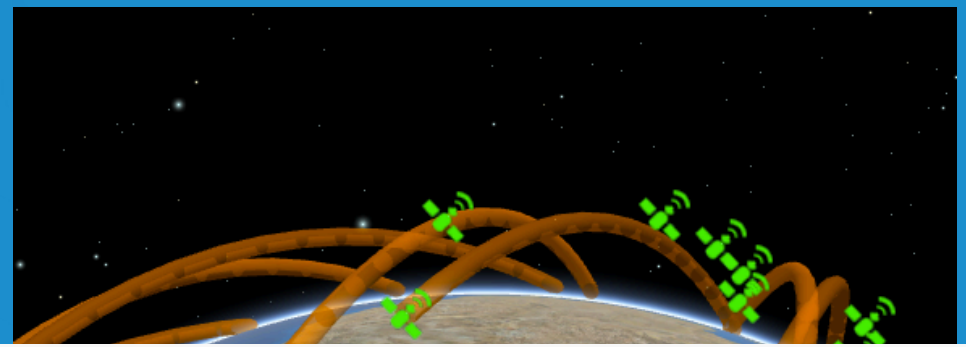
Only for polyline features

LineSymbol3DLayer

```
symbol: new LineSymbol3D({
  symbolLayers: [ new LineSymbol3DLayer({
    material: { color: [192,192,192,0.5] },
    size: 3
  }) ]
})
```

Flat (size in points/pixels)

PathSymbol3DLayer



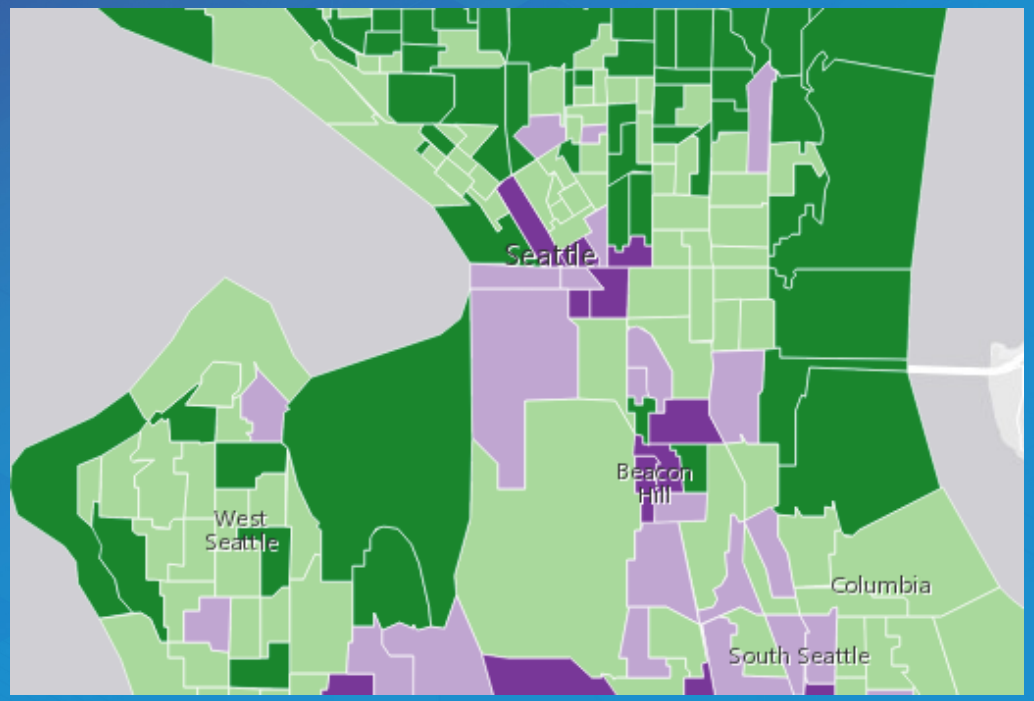
```
symbol: new LineSymbol3D({
  symbolLayers: [ new PathSymbol3DLayer({
    material: { color: [192,192,192,0.5] },
    size: 5000 // meters
  }) ]
})
```

Volumetric (size in meters)

PolygonSymbol3D

Only for polygon features

FillSymbol3DLayer



Flat (no size)

ExtrudeSymbol3DLayer

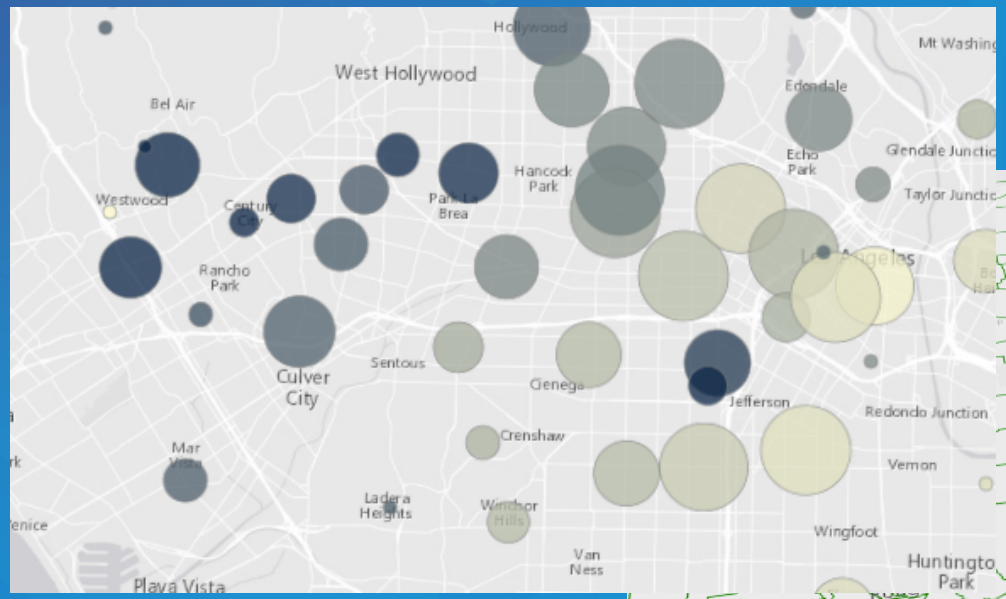
```
var less35 = new PolygonSymbol3D({
  symbolLayers: [
    new FillSymbol3DLayer({
      material: { color: "#7B3294" },
      outline: {
        size: 0.5,
        color: "white"
      }
symbol: new PolygonSymbol3D({
  symbolLayers: [ new ExtrudeSymbol3DLayer() ]
}),
```

Volumetric (size in meters)

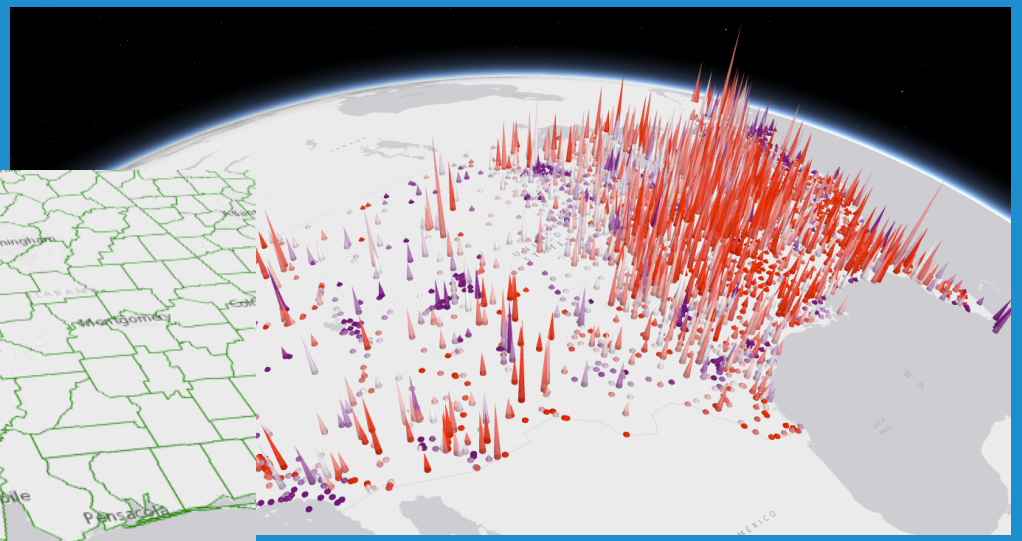
PolygonSymbol3D

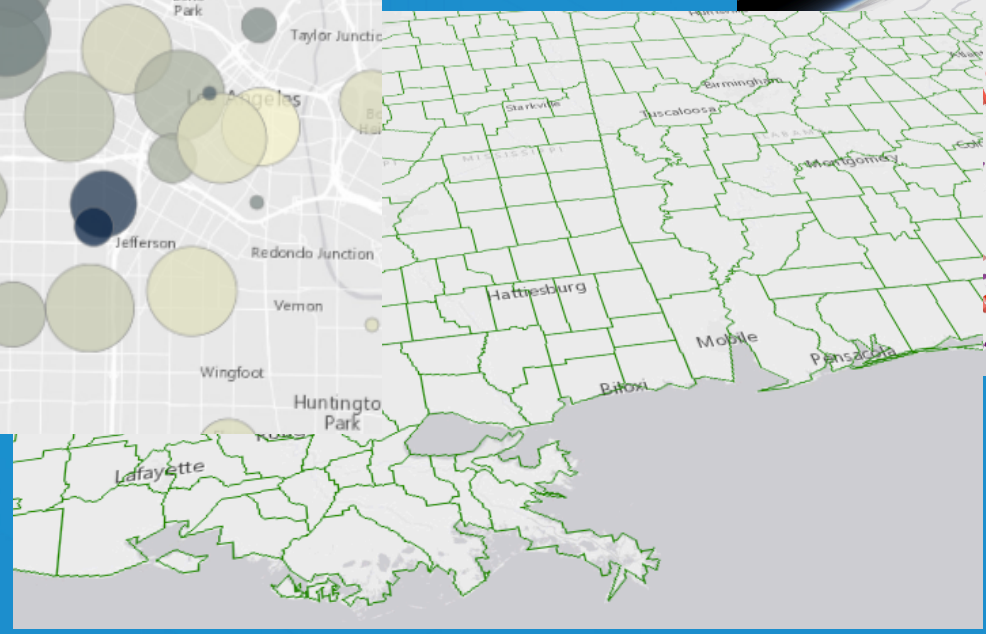
Also supports other symbol layers

IconSymbol3DLayer



ObjectSymbol3DLayer



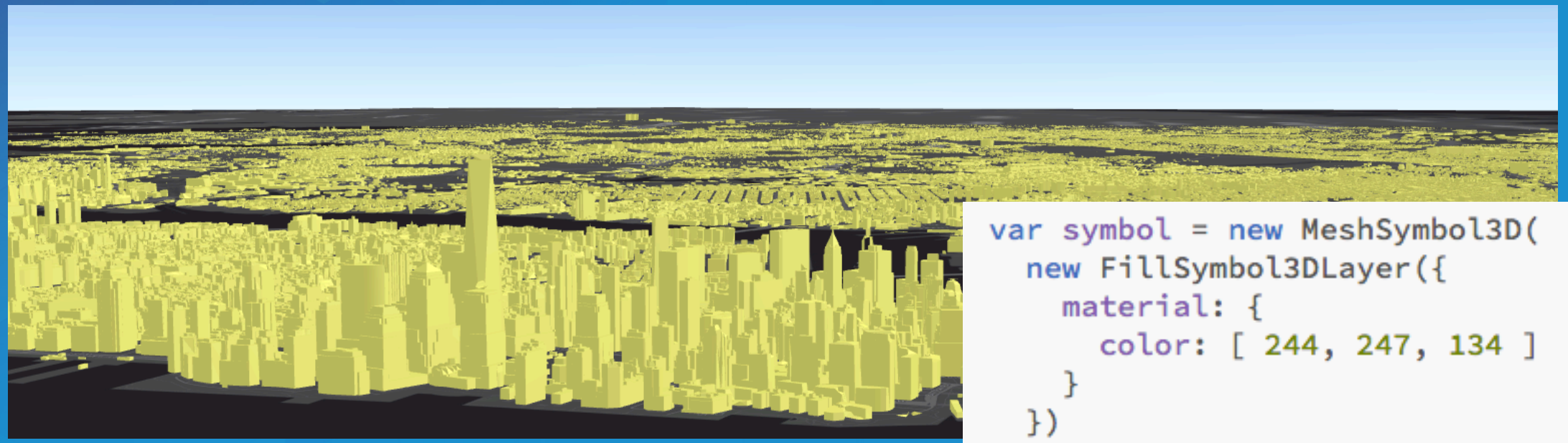


LineSymbol3DLayer

MeshSymbol3D

Only for mesh features (in SceneLayers)

FillSymbol3DLayer



```
var symbol = new MeshSymbol3D(
  new FillSymbol3DLayer({
    material: {
      color: [ 244, 247, 134 ]
    }
  })
);
```

LabelSymbol3D

May be applied to **all** features

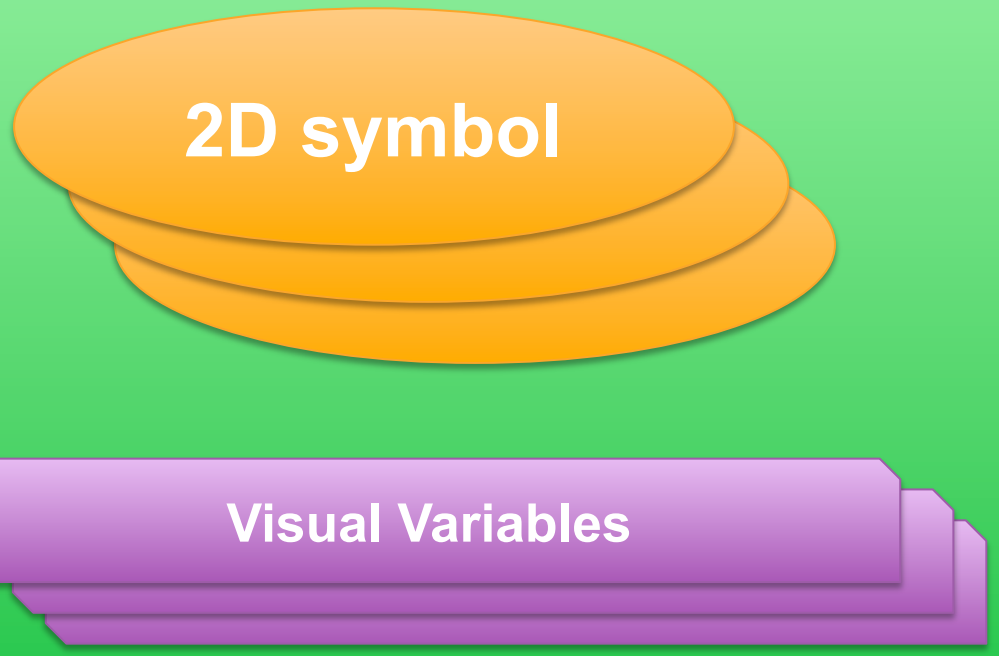
```
var labelSymbol = new LabelSymbol3D({
  symbolLayers: [
    new TextSymbol3DLayer({
      material: { color: "lightgray"  },
      size: 14
    })
  ]
});

var labelClass = new LabelClass({
  labelExpressionInfo: {
    value: "{CITY_NAME}"
  },
  symbol: labelSymbol,
  labelPlacement: "above-right"
});
```

TextSymbol3DLayer

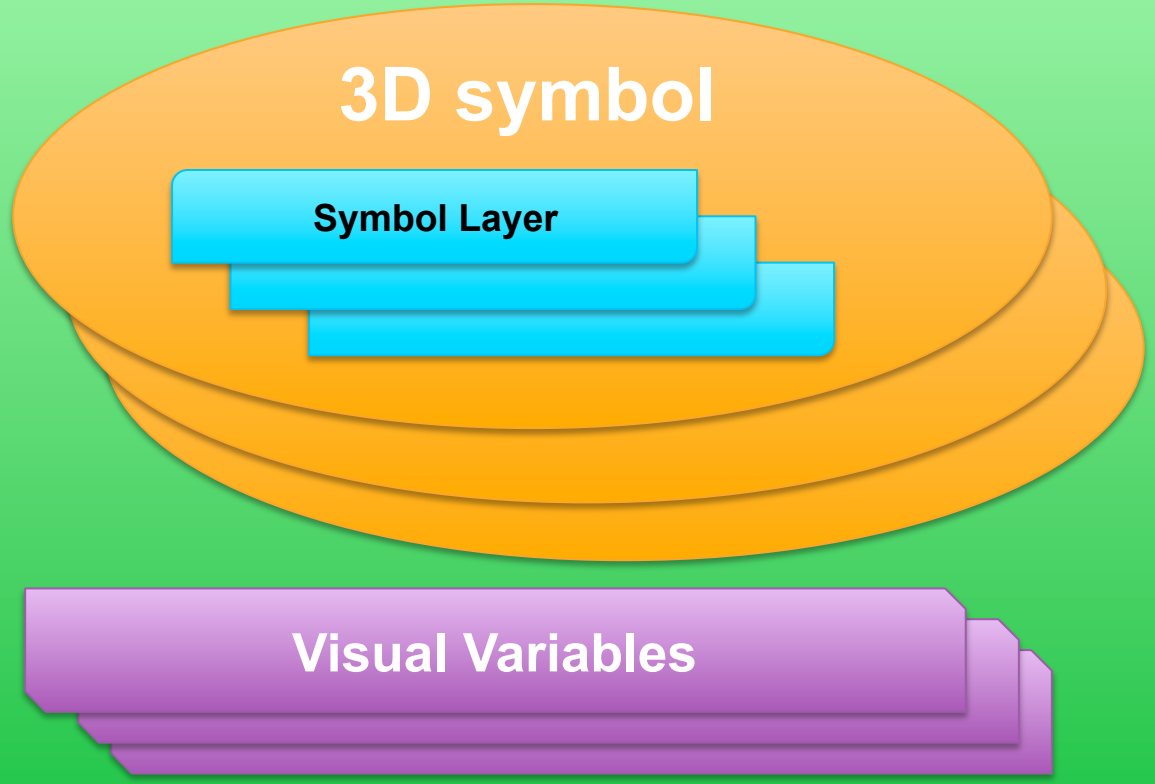
Renderers

2D visualization vs. 3D visualization

Renderer

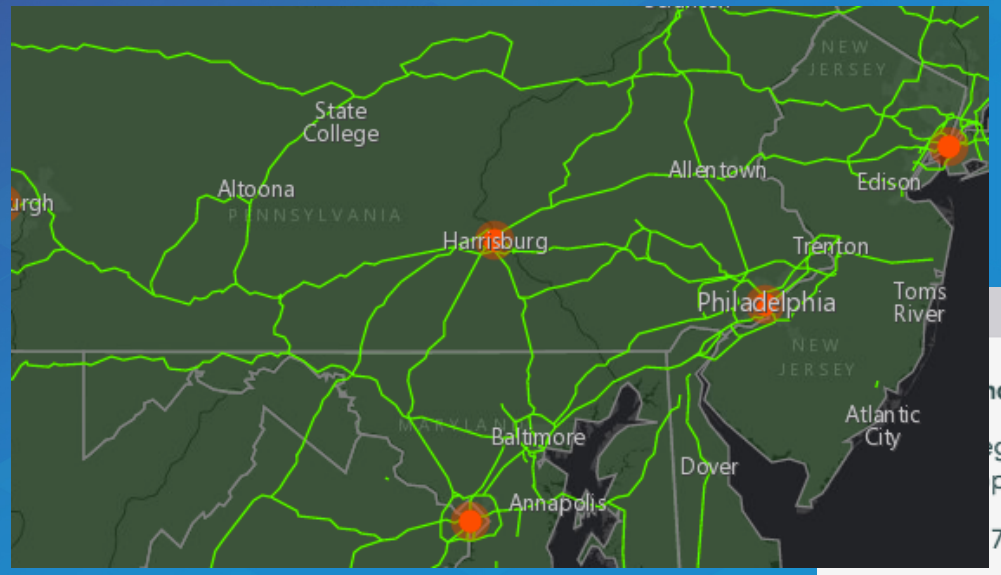


Renderer



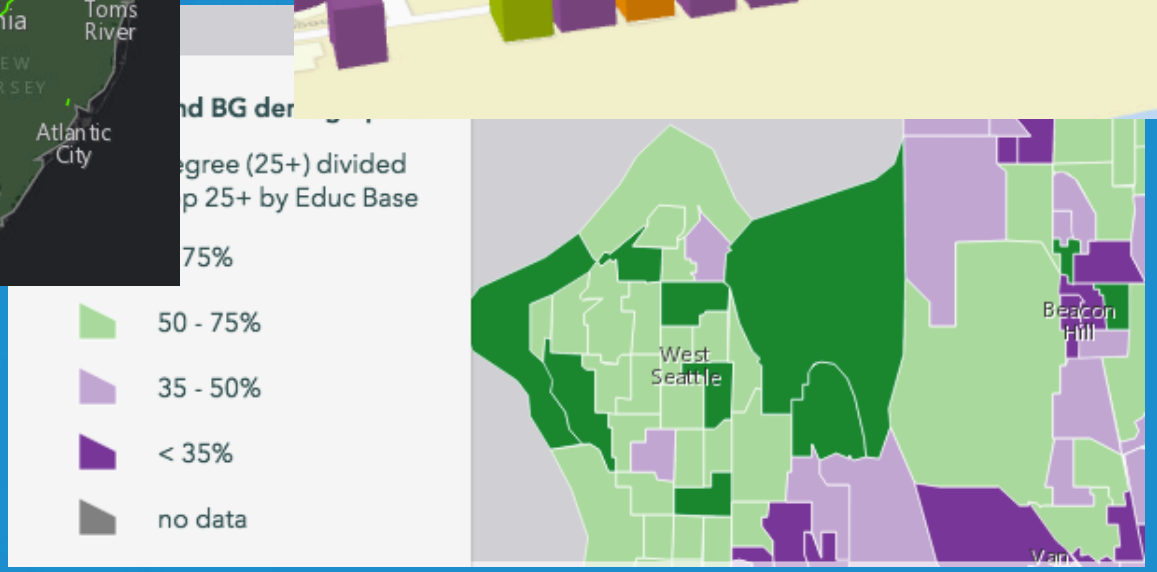
Renderers

SimpleRenderer



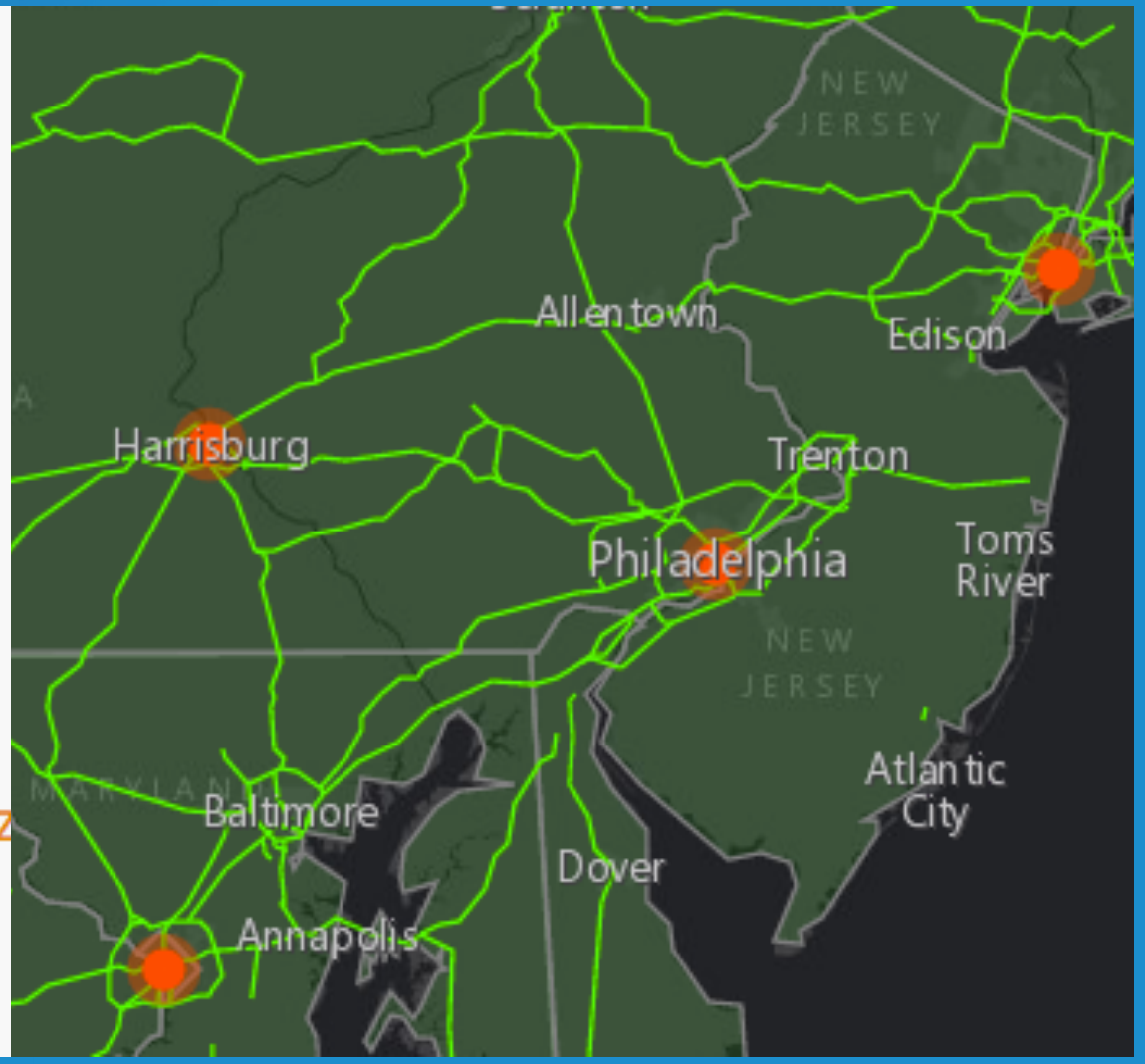
UniqueValueRenderer

ClassBreaksRenderer



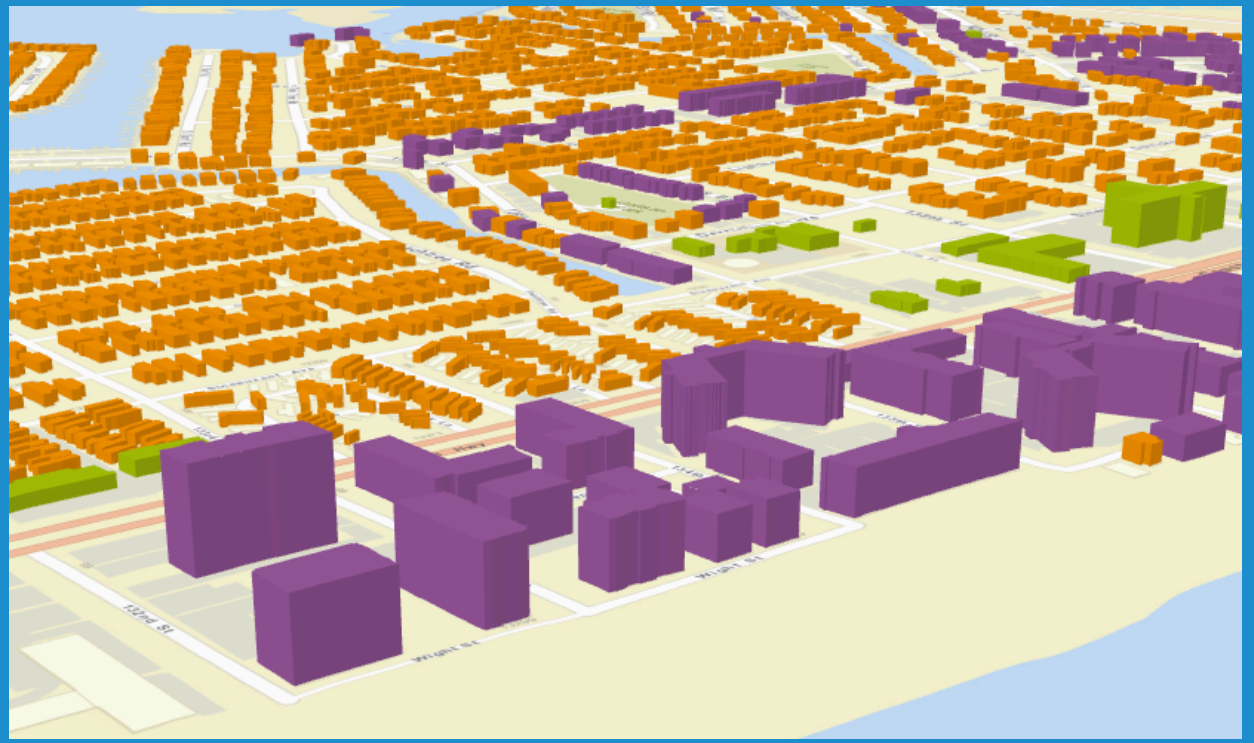
SimpleRenderer

```
var citiesRenderer = new SimpleRenderer({
  symbol: new SimpleMarkerSymbol({
    size: 10,
    color: "#FF4000",
    // autocasts as new SimpleLineSymbol()
    outline: {
      // autocasts as new Color()
      color: [ 255, 64, 0, 0.4 ],
      width: 7
    }
  })
});

var citiesLyr = new FeatureLayer({
  url: "https://services.arcgis.com/V6ZHFr6zdgNZ
  renderer: citiesRenderer,
  popupTemplate: { content: "{*}" }
});
```



UniqueValueRenderer

Buildings with real-world height



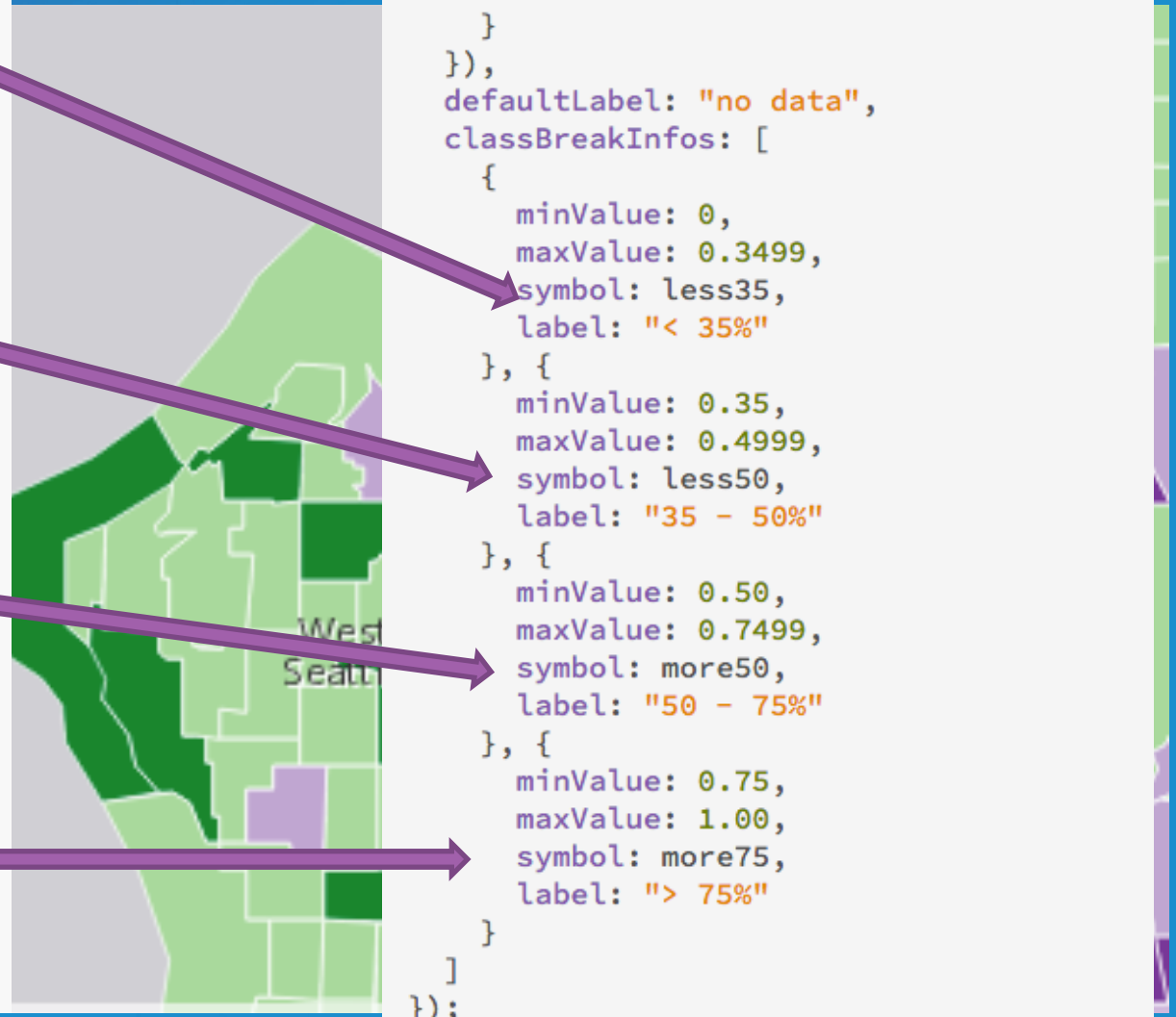
Buildings with real-world height

```
var resSym = new PolygonSymbol3D({
  symbolLayers: [
    new ExtrudeSymbol3DLayer({
      material: {
        color: "#FC921F"
      }
    })
  ]
});

var condoSym = new PolygonSymbol3D({
  symbolLayers: [
    new ExtrudeSymbol3DLayer({
      material: {
        color: "#9E559C"
      }
    })
  ]
});
```

```
var renderer = new UniqueValueRenderer({
  defaultSymbol: new PolygonSymbol3D({
    symbolLayers: [new ExtrudeSymbol3DLayer({
      material: {
        color: "#A7C636"
      }
    })]
  }),
  defaultLabel: "Other",
  field: "DESCLU",
  uniqueValueInfos: [
  {
    value: "Residential",
    symbol: resSym,
    label: "Residential"
  }, {
    value: "Residential Condominium",
    symbol: condoSym,
    label: "Condominium"
  }],
  visualVariables: [{
    type: "size",
    field: "ELEVATION",
    valueUnit: "feet" // Converts and extrudes all
                      // data values in feet
  }]
});
```

ClassBreaksRenderer

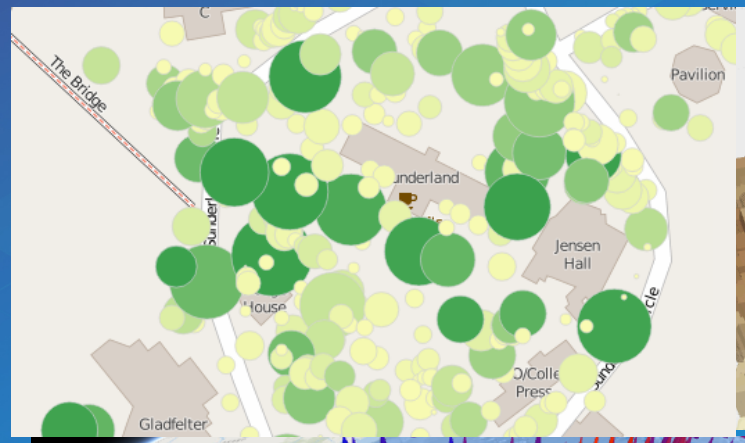
```
var less35 = new SimpleFillSymbol({
  color: "#7B3294",
  style: "solid",
  outline: { width: 0.5, color: "white" }
});

var less50 = new SimpleFillSymbol({
  color: "#C2A5CF",
  style: "solid",
  outline: { width: 0.5, color: "white" }
});

var more50 = new SimpleFillSymbol({
  color: "#A6DBA0",
  style: "solid",
  outline: { width: 0.5, color: "white" }
});

var more75 = new SimpleFillSymbol({
  color: "#008837",
  style: "solid",
  outline: { width: 0.5, color: "white" }
});
```

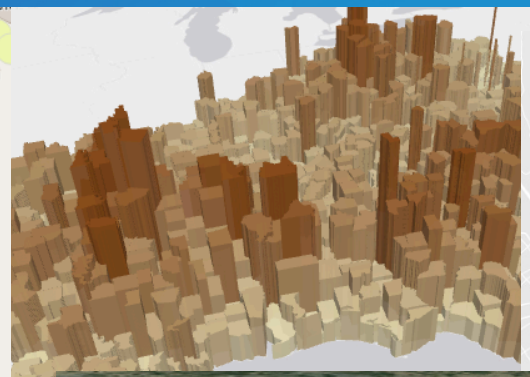


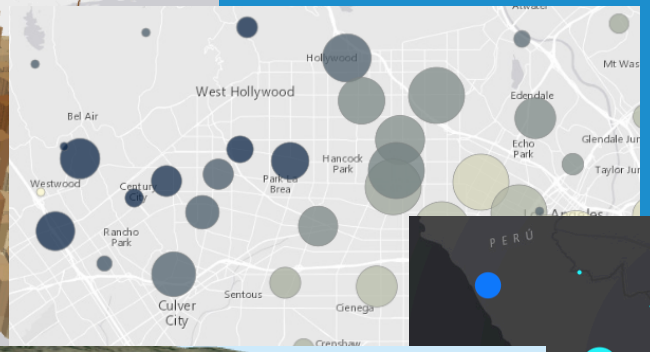
```
var renderer = new ClassBreaksRenderer({
  field: "COL_DEG",
  normalizationField: "EDUCBASECY",
  defaultSymbol: new SimpleFillSymbol({
    color: "gray",
    outline: {
      width: 0.5,
      color: "white"
    }
  }),
  defaultLabel: "no data",
  classBreakInfos: [
    {
      minValue: 0,
      maxValue: 0.3499,
      symbol: less35,
      label: "< 35%"
    }, {
      minValue: 0.35,
      maxValue: 0.4999,
      symbol: less50,
      label: "35 - 50%"
    }, {
      minValue: 0.50,
      maxValue: 0.7499,
      symbol: more50,
      label: "50 - 75%"
    }, {
      minValue: 0.75,
      maxValue: 1.00,
      symbol: more75,
      label: "> 75%"
    }
  ]
});
```

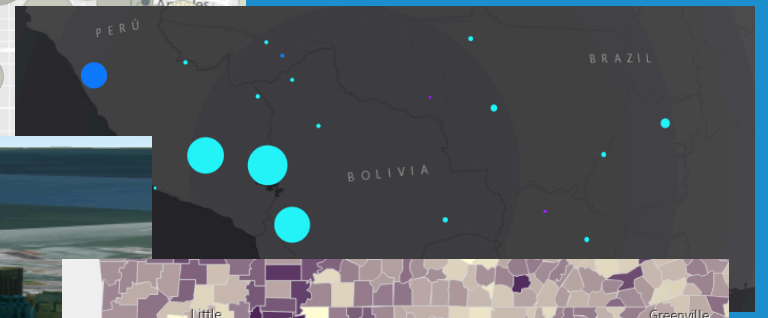
Visual Variables

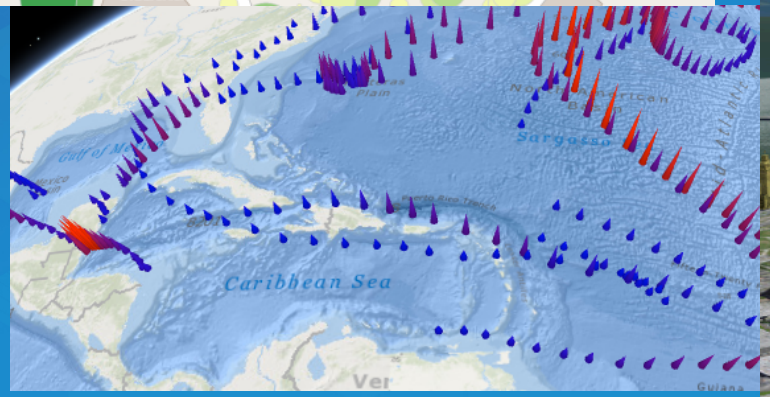
- A property of the renderer
- For numeric data-driven continuous visualizations

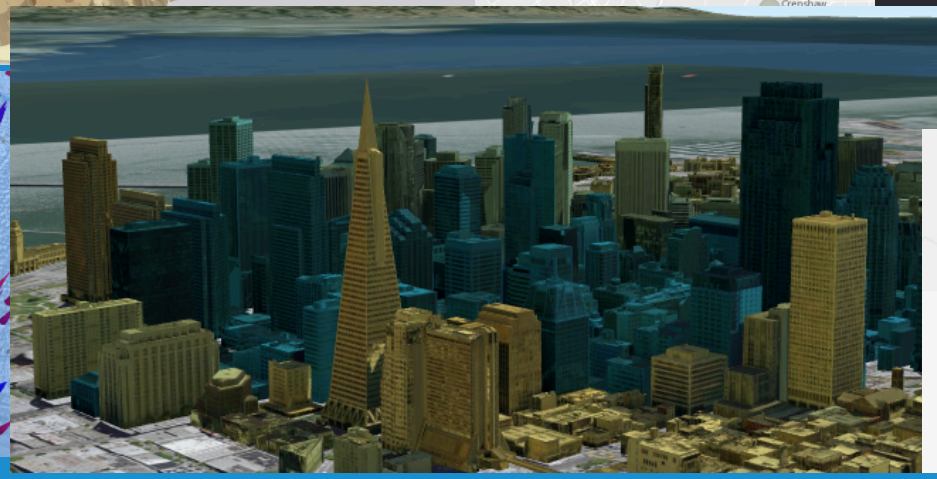


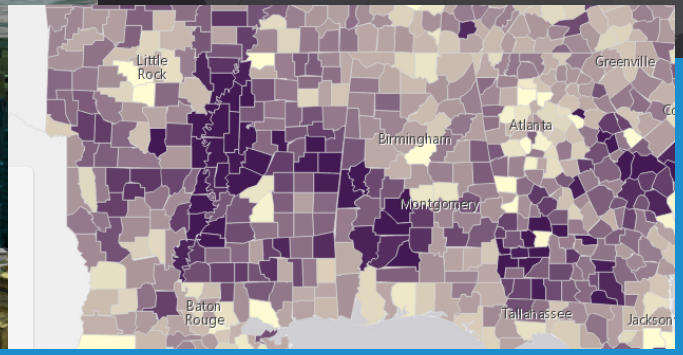






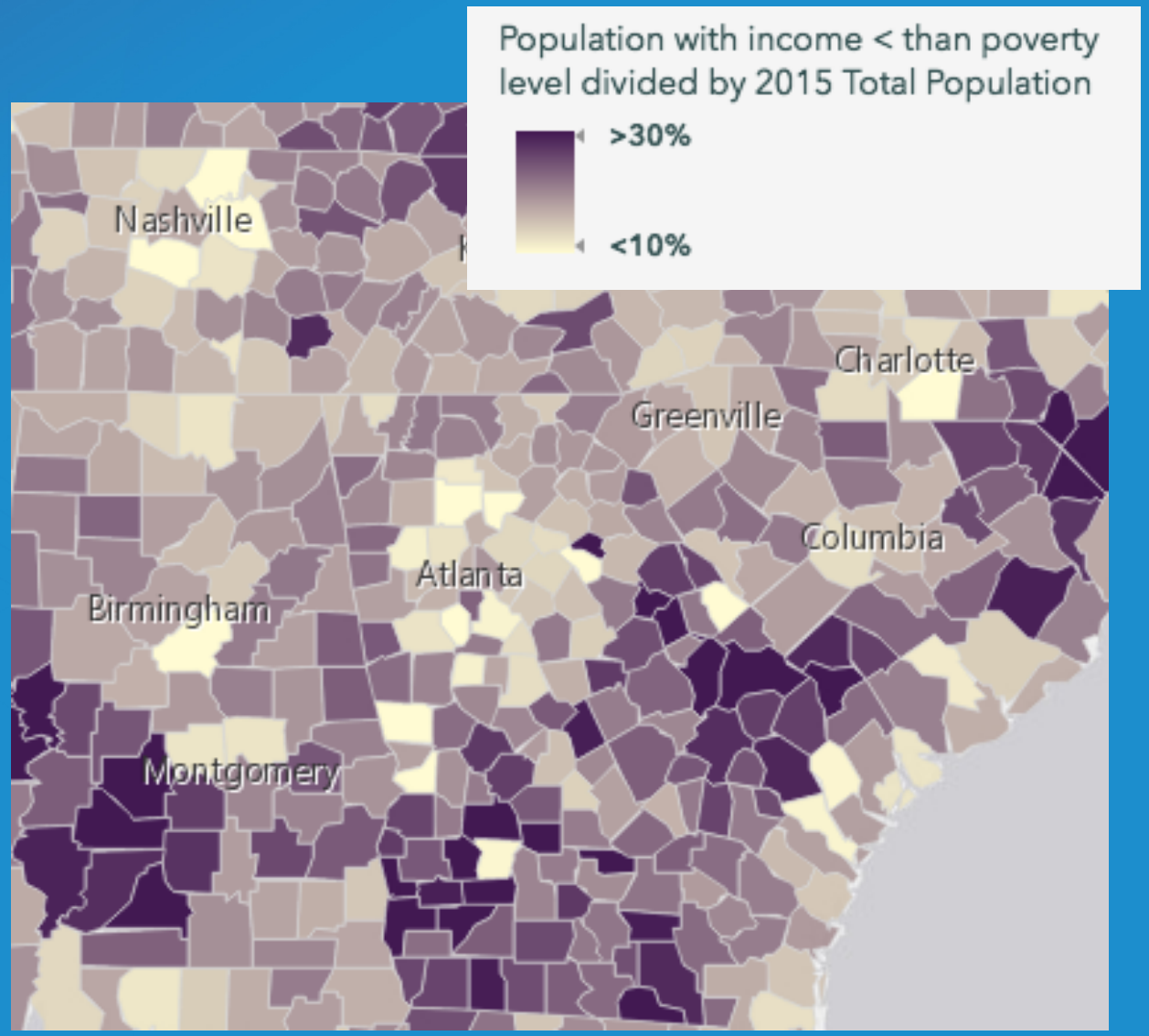






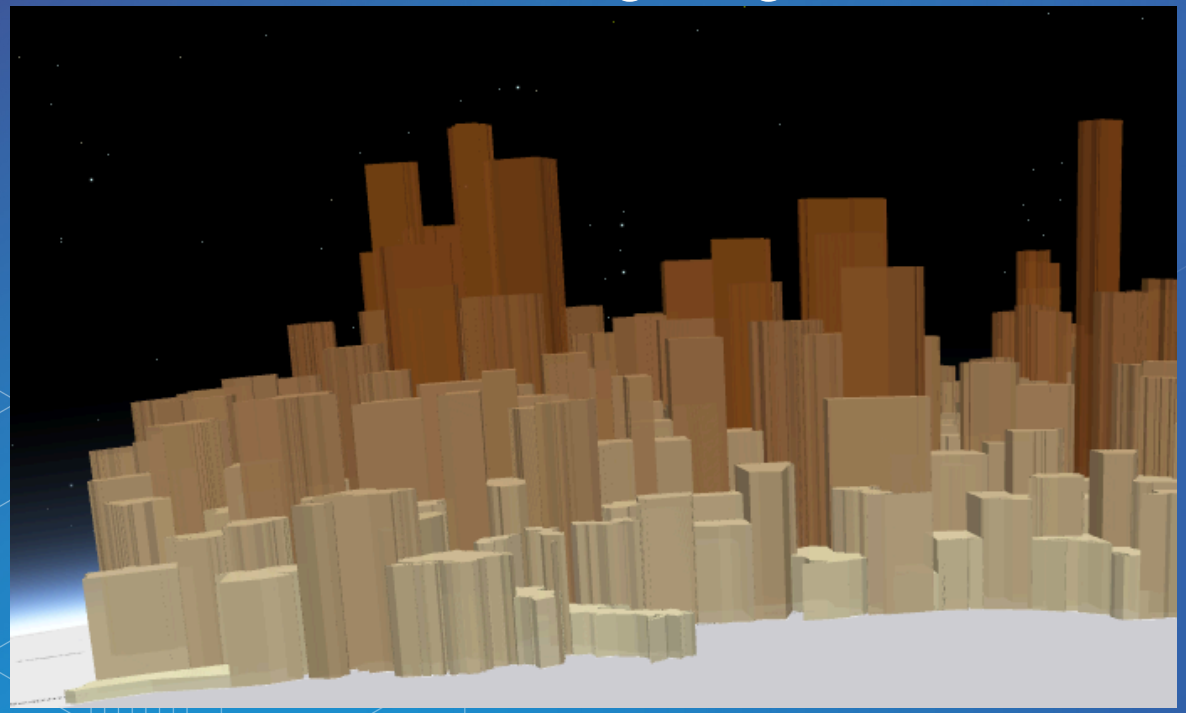
Visual Variables: Color

```
var colorVV = {
  type: “color”,
  field: “POP_POVERTY”,
  normalizationField: “TOTPOP_CY”,
  stops: [
    { value: 0.1, color: “#FFFCD4” },
    { value: 0.3, color: “#350242” }
  ]
};
```

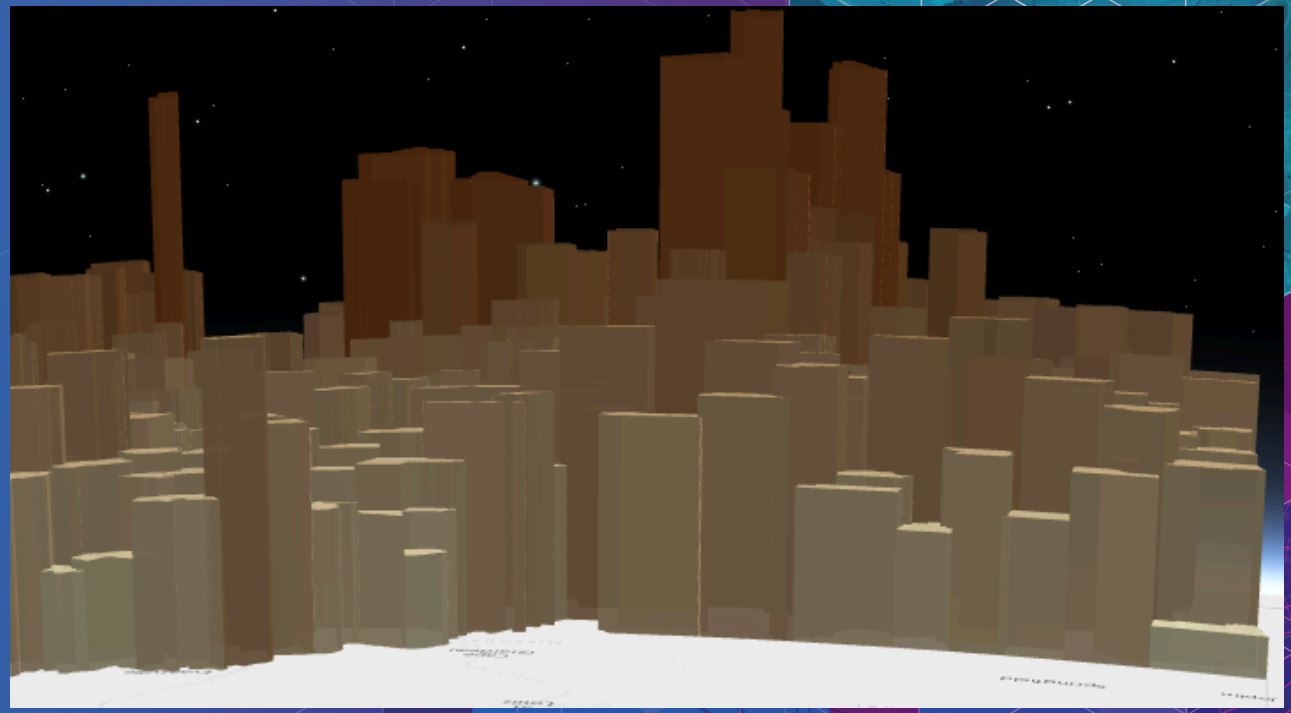


Keep in mind…

Direct lighting

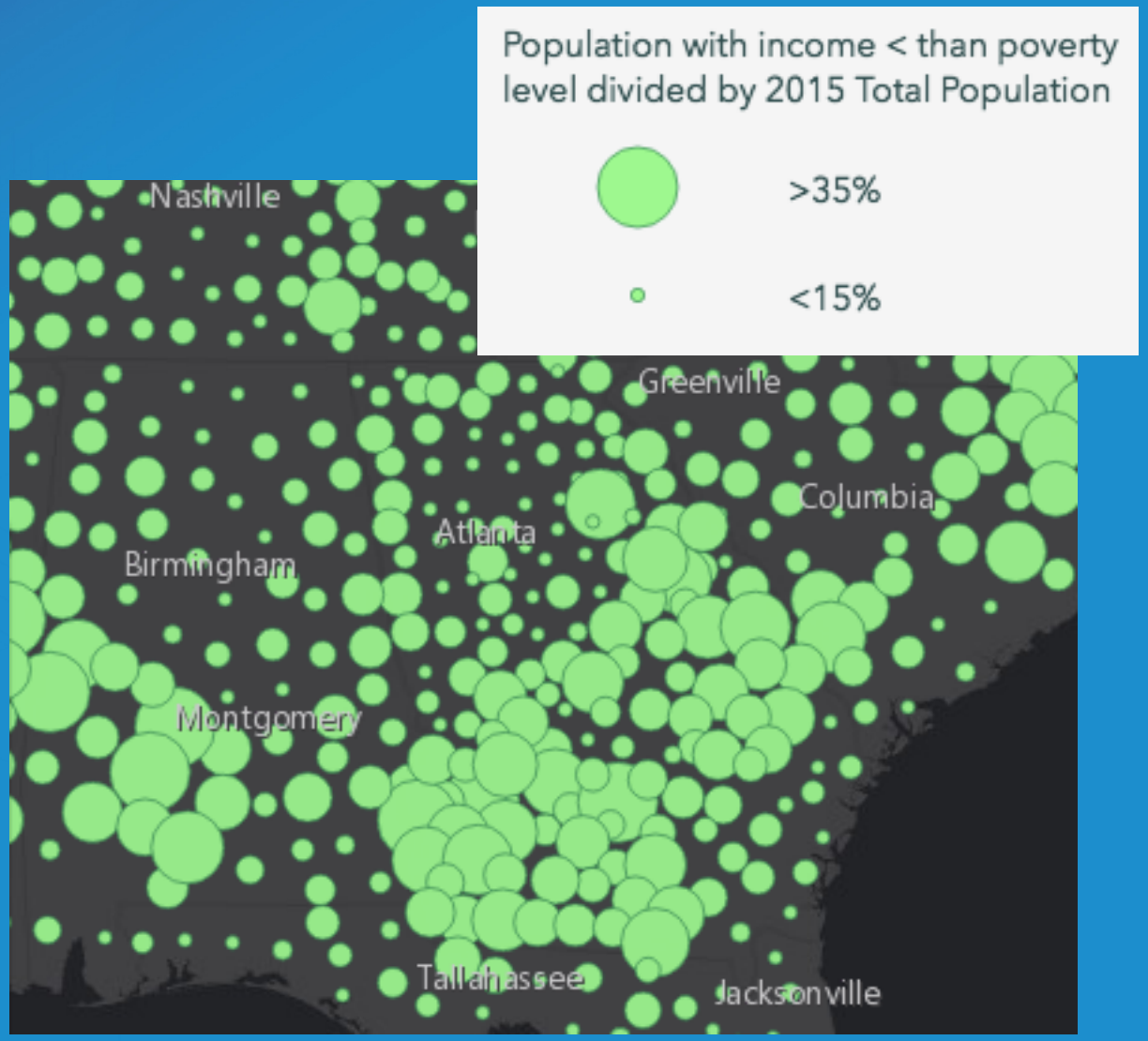


Shade



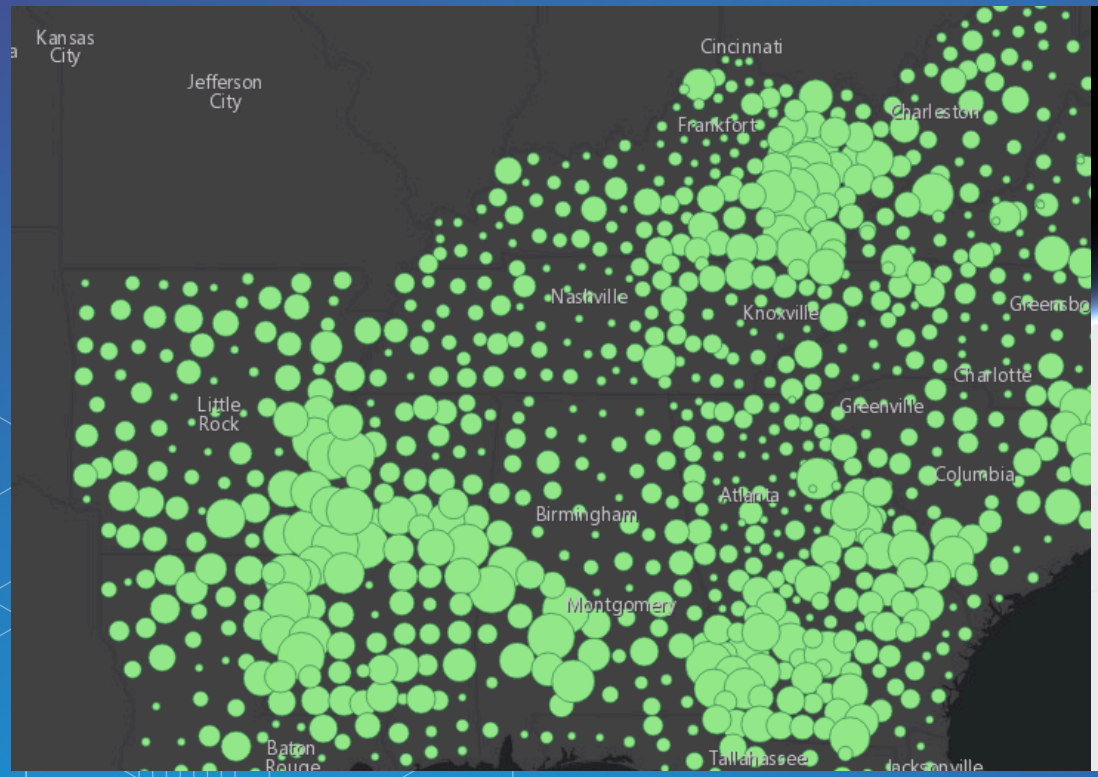
Visual Variables: Size

```
var sizeVV = {
  type: “size”,
  field: “POP_POVERTY”,
  normalizationField: “TOTPOP_CY”,
  stops: [
    {  value: 0.20,  size: “4px”  },
    {  value: 0.65,  size: “60px”  }
  ]
};
```



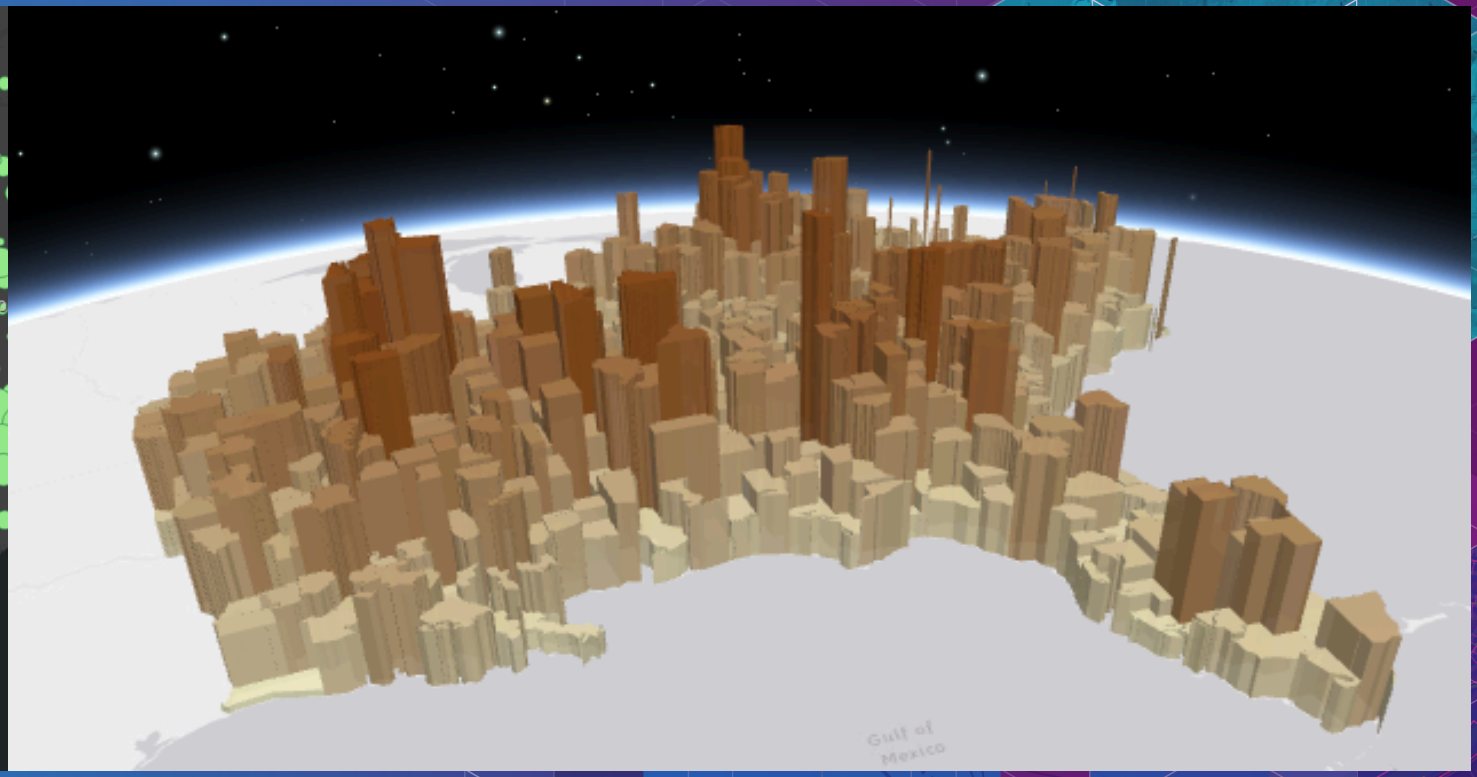
Keep in mind…

Flat symbols (pixels or points)



Good for multiple scale levels

Volumetric symbols (meters)



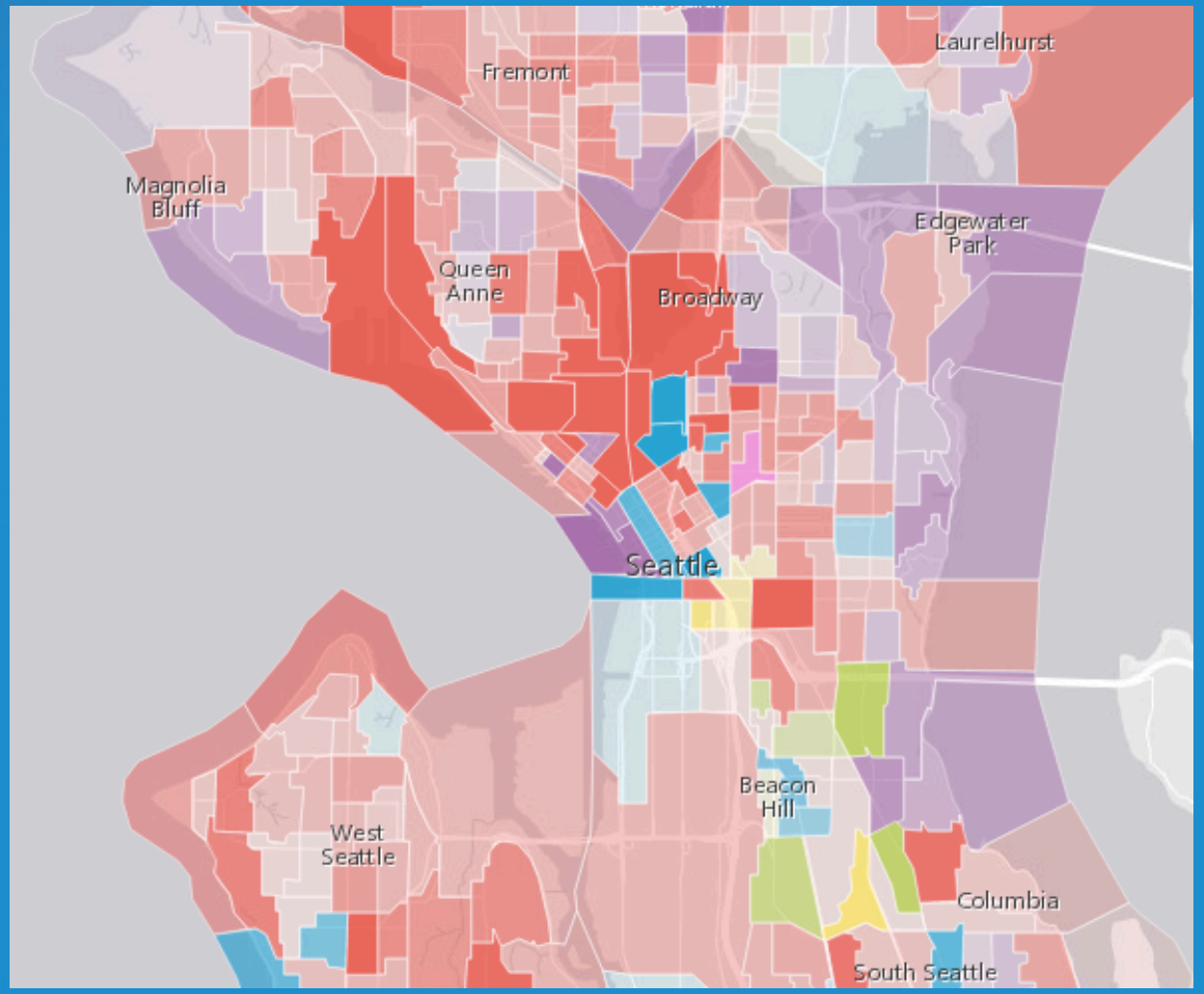
Good for one or two scale levels

Visual Variables: Size (real-world units)

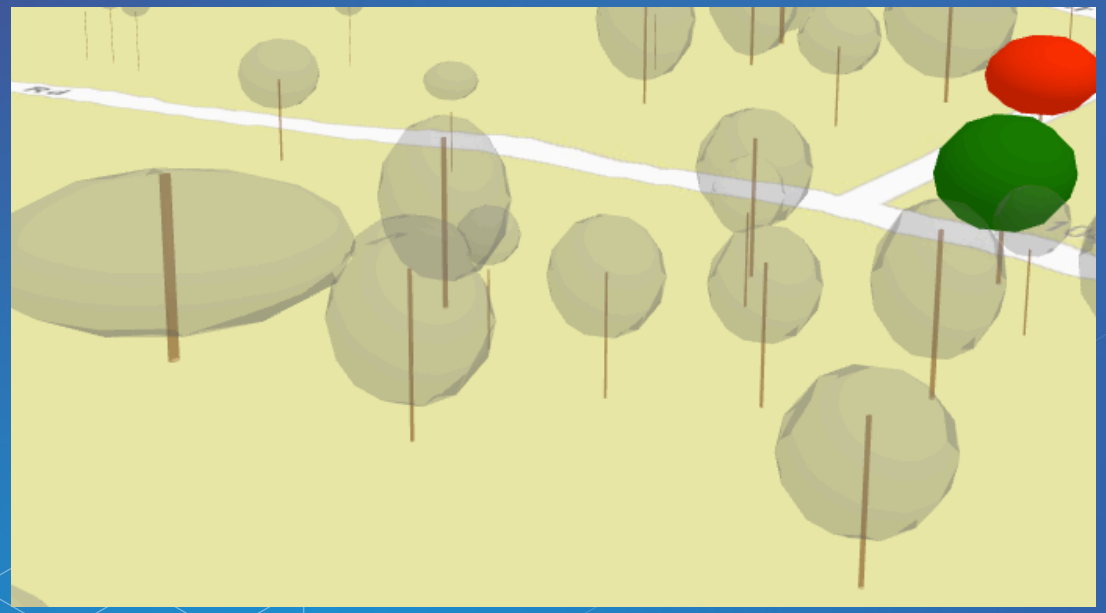
```
var heightVV = {
  type: “size”,
  field: “HEIGHT”,
  valueUnit: “feet”,
  axis: “height”
  // axis is only relevant for
 // ObjectSymbol3DLayer
};

var widthVV = {
  type: “size”,
  axis: “width-and-depth”,
  valueUnit: “inches”
};
```

Visual Variables: Opacity

```
var opacityVV = {
  type: “opacity”,
  field: “EDUCBASECY”,
  stops: [
    {  value: 700,  opacity: 0.1 },
    {  value: 1500,  opacity: 0.9 }
  ]
};
```

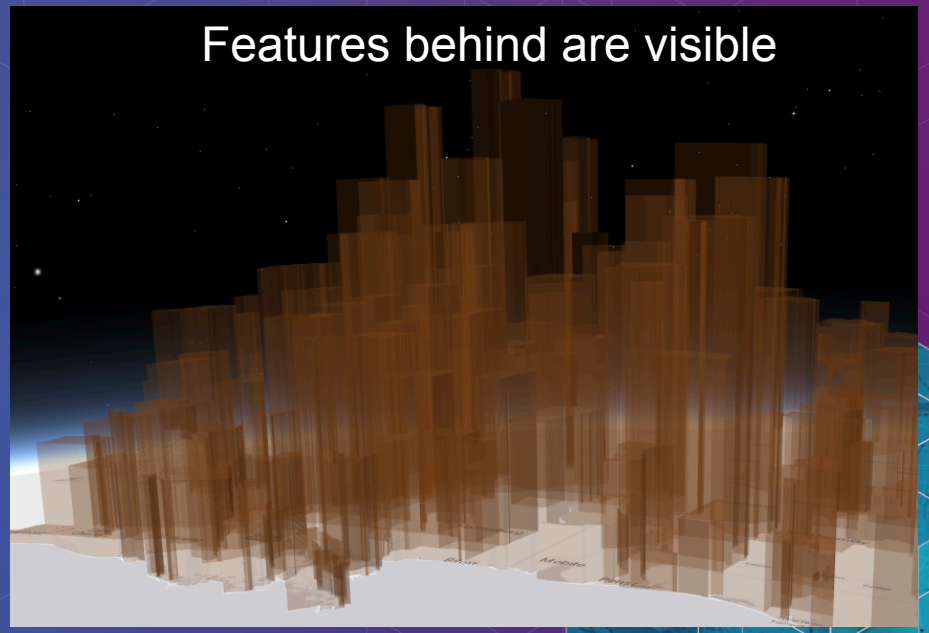


Keep in mind…

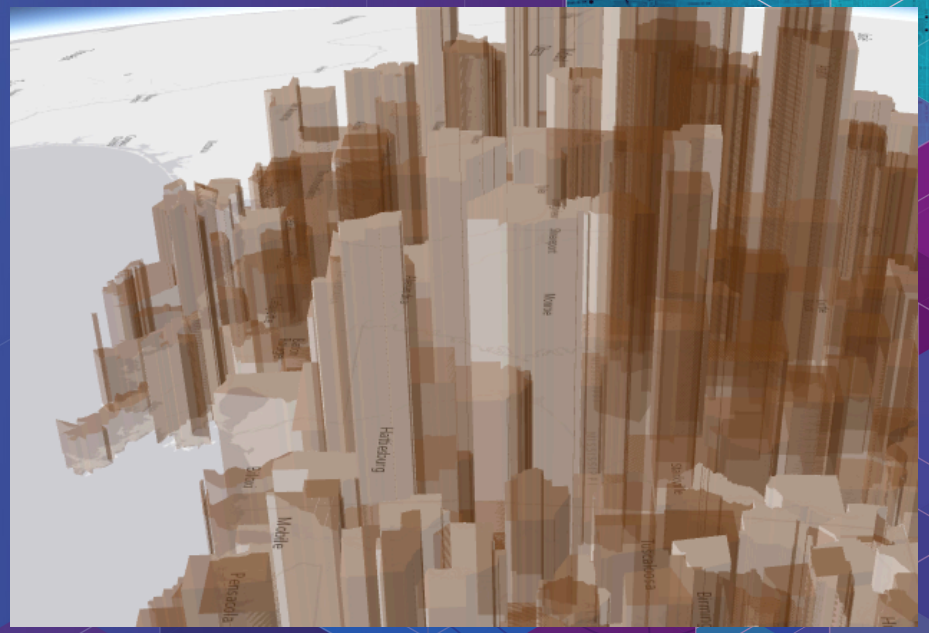


Opacity tends to look better in 3D space when there are relatively few features spread out

Features behind are visible



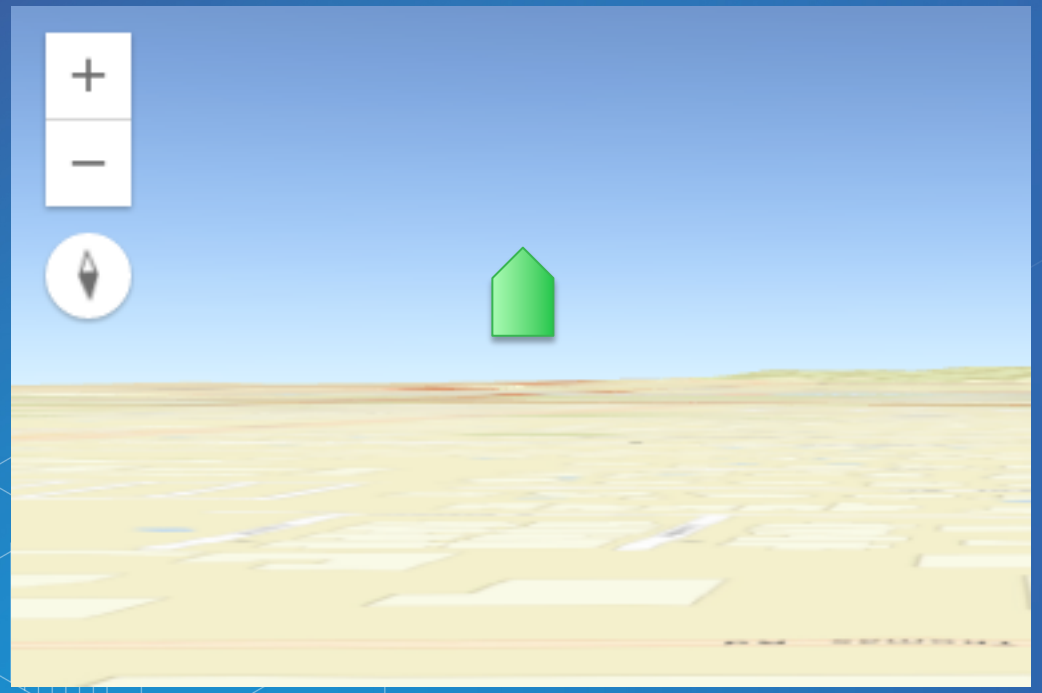
Features behind are not visible



Rotation

No 3D support yet!

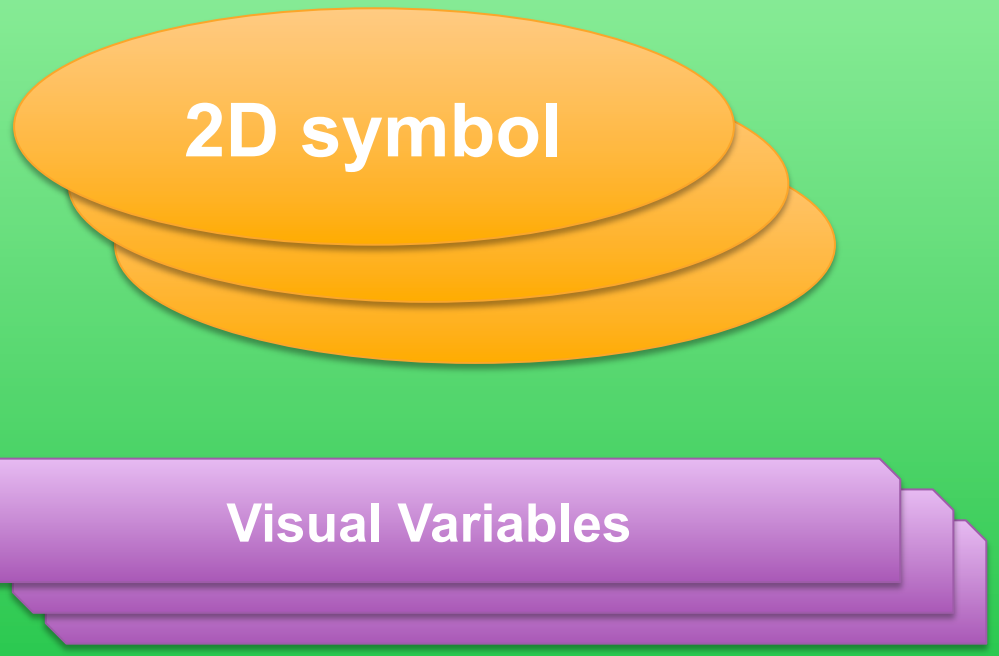
Which direction is this symbol pointing?



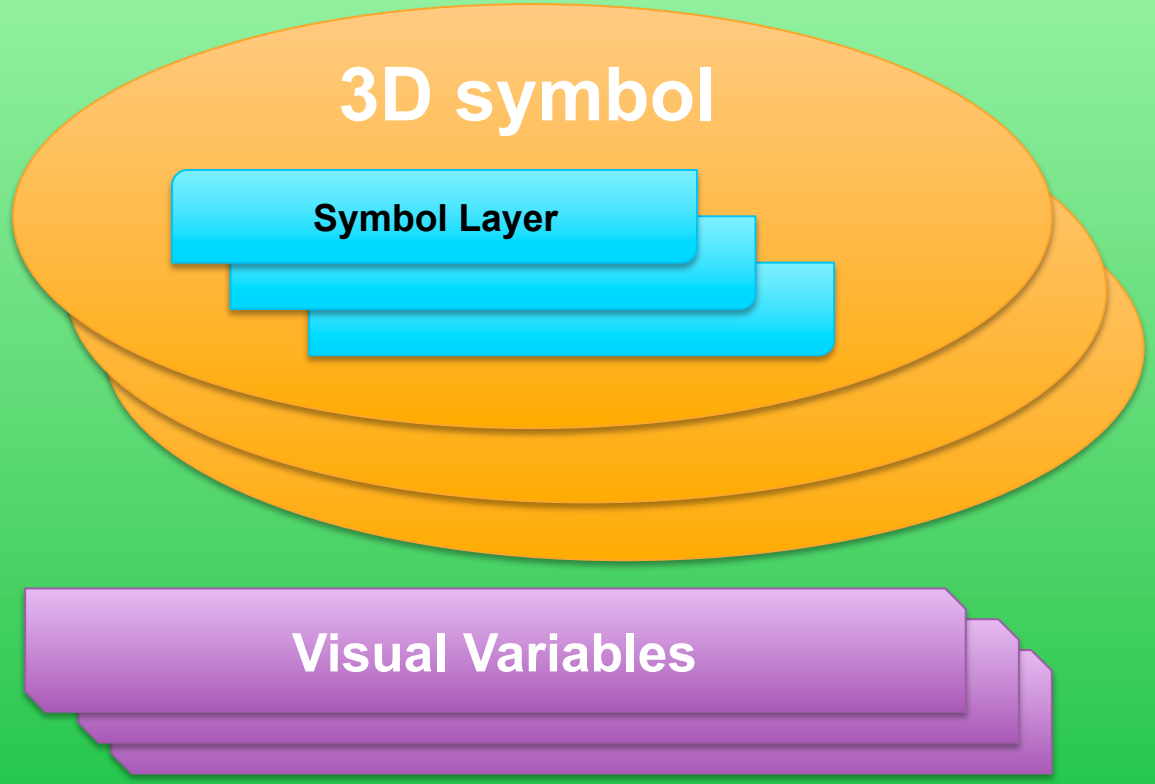
Easier to interpret in 2D where tilt doesn't interfere

2D visualization vs. 3D visualization

Renderer

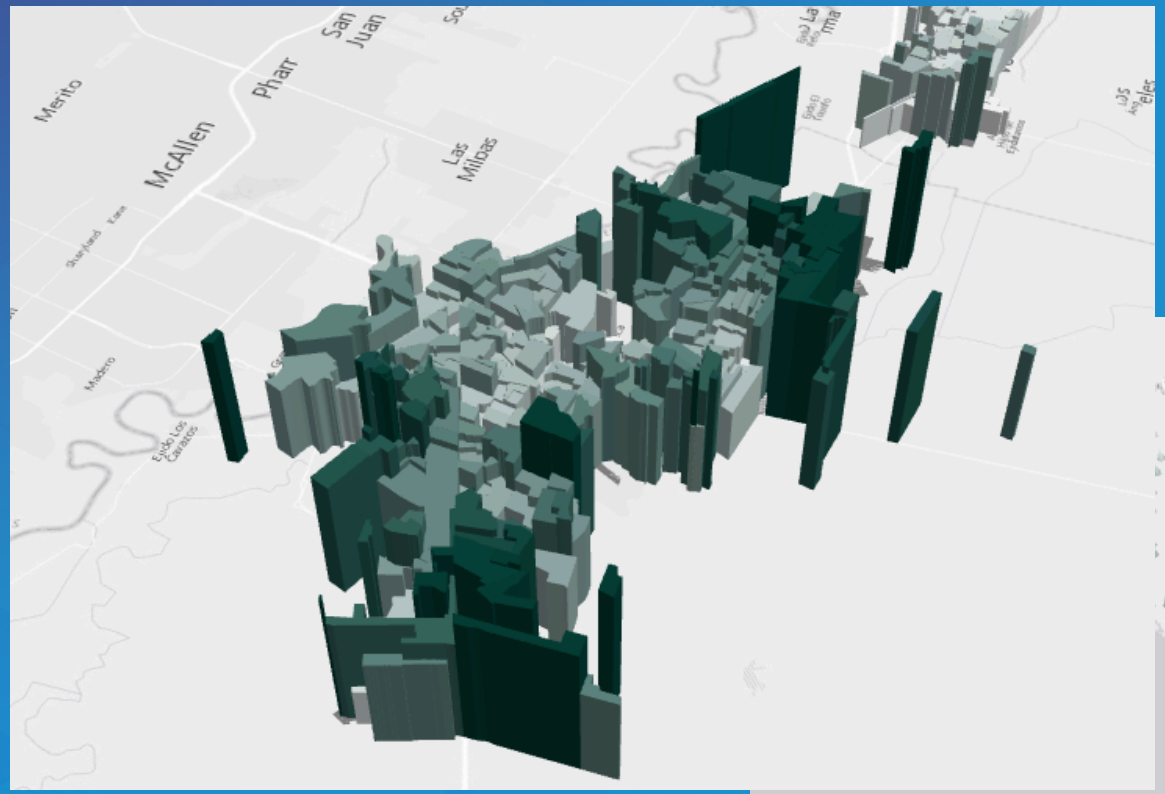


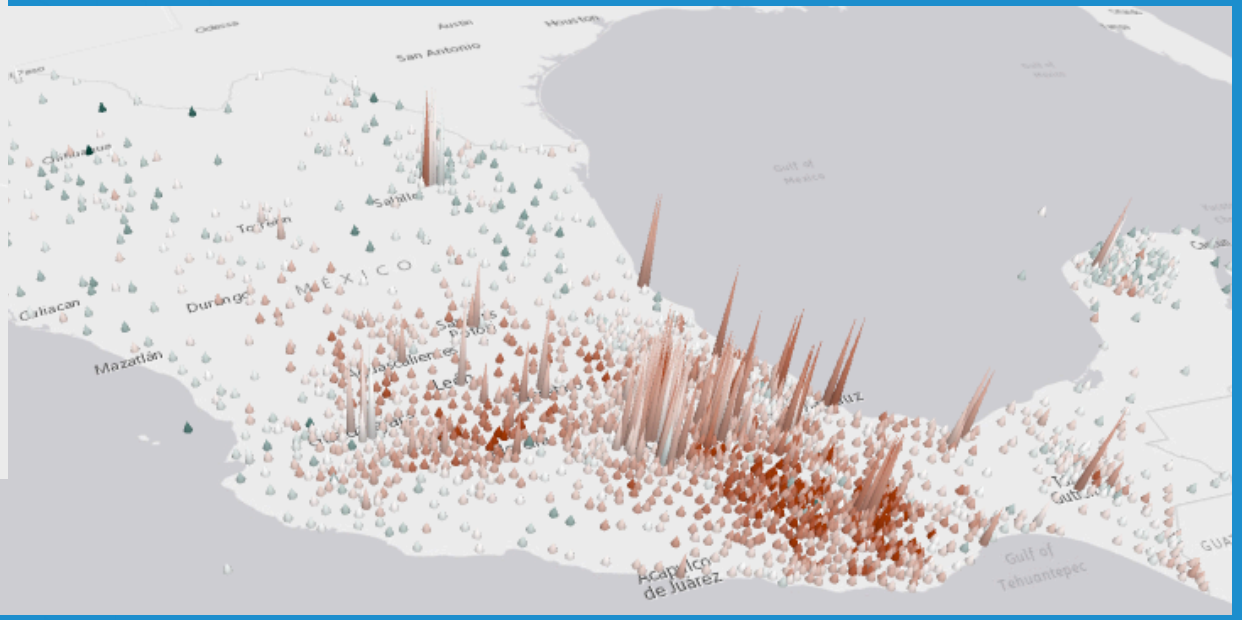
Renderer



Example

Thematic extrusion





Thematic extrusions

Renderer

Default symbol

Size visual variable

Color visual variable

```
var layer = new FeatureLayer({
  portalItem: { // autocasts as new PortalItem()
    id: "17fe61e6077b4ff39916f2c11546f05d"
  },
  outFields: [ MORTALITY, POP, FOREIGN, MOVED, ILLITERATE ],
  definitionExpression: MOVED + ">= 0 AND " + POP + ">= 0",
  renderer: new SimpleRenderer({
    symbol: new PolygonSymbol3D({
      symbolLayers: [new ExtrudeSymbol3DLayer()]
    }),
    label: "City",
    visualVariables: [{
      type: "size",
      field: MOVED,
      normalizationField: POP,
      stops: [
        { value: .15, size: 1000 },
        { value: .50, size: 5000 }
      ]
    }, {
      type: "color",
      field: MOVED,
      normalizationField: POP,
      stops: [
        { value: .15, color: "#ffffff" },
        { value: .50, color: "#004238" }
      ]
    }]
  }),
```

Overview

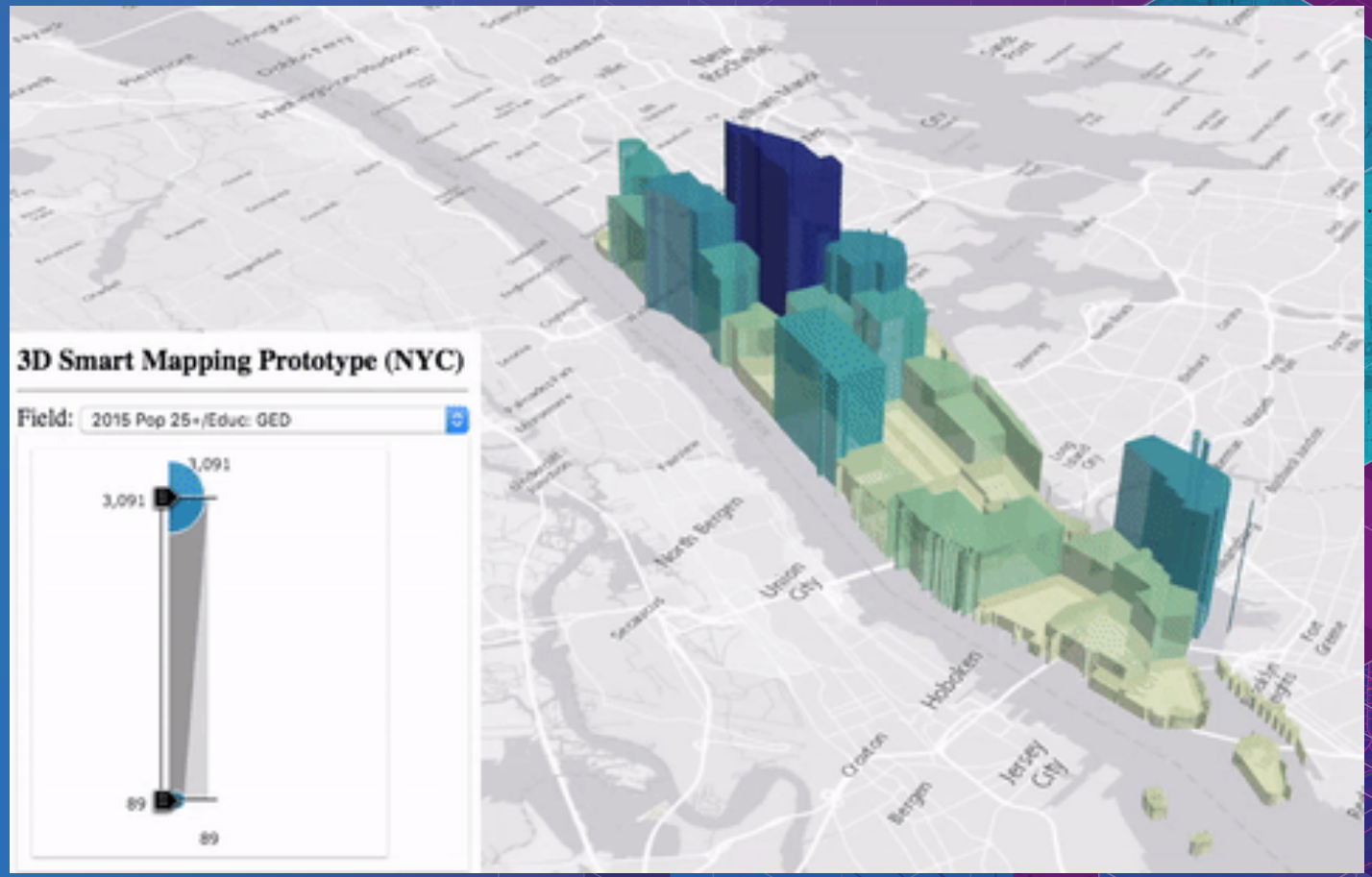
- What you can visualize in 3D
- How to do it
- Considerations and pitfalls

Pitfalls

- Too many variables = confusion
- Be aware of scale (generalize when you need to)

Look forward to…

- **SmartMapping in 3D**
- No need to guess “good” values.
- Generates visually appealing defaults to thematic visualizations in the SceneViewer



Helpful Resources

- Get started with visualization

- ArcGIS Blog
  - Icons, lines, fills
  - Objects, paths, extrusion
  - Real world sizes

- Documentation
  - Renderer
  - Symbol3D
  - Symbol3DLayer

Other Sessions to attend

SESSION DETAILS

Building 3D GIS Applications for the Browser Using JavaScript

Wednesday, June 29

3:15 PM – 4:30 PM

Room 16 A

San Diego Convention Center

SESSION DETAILS

Create and Visualize 3D Layers with ArcGIS

Tuesday, June 28

11:30 AM – 12:15 PM

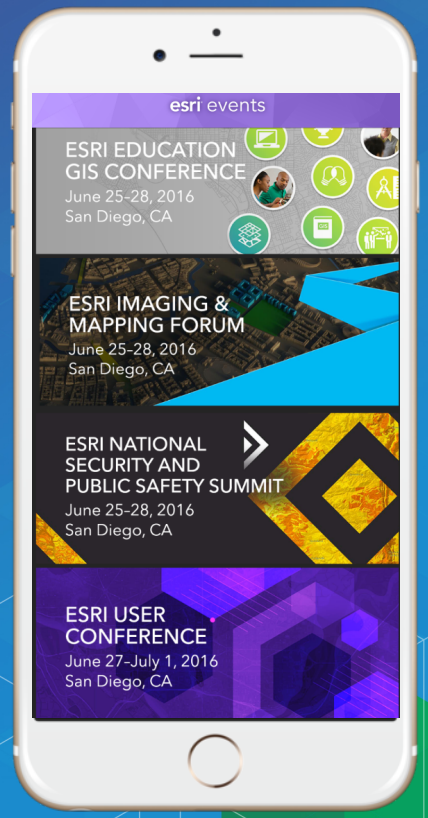
Demo Theater 5 - Content & Real-Time Big Data

San Diego Convention Center

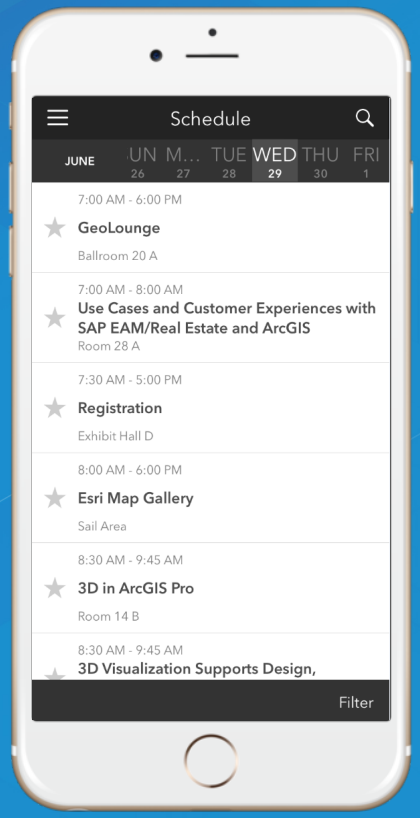
Please take our Survey

Your feedback allows us to help maintain high standards and to help presenters

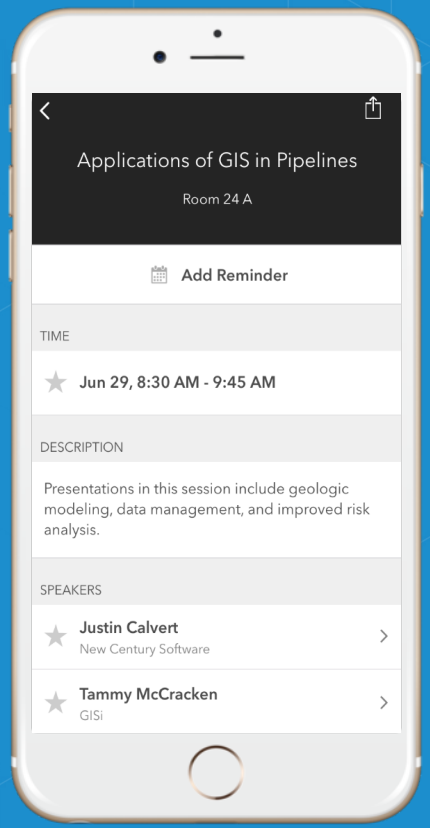
Find your event in the Esri Events App



Find the session you want to review



Scroll down to the bottom of the session



Answer survey questions and submit