Declarative Data Visualization with **Vega-Lite** and **Altair**

Kanit "Ham" Wongsuphasawat
@kanitw Apple

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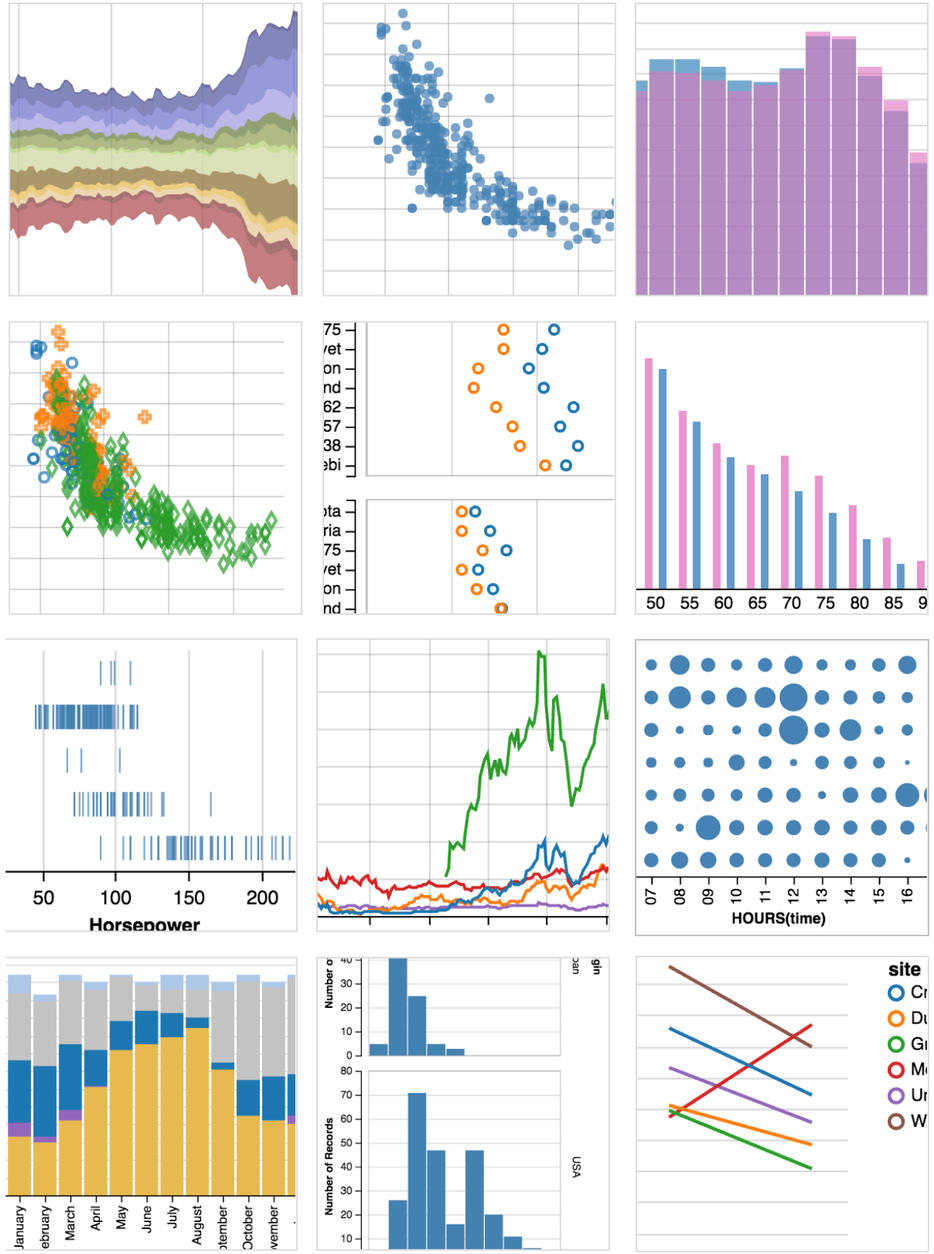
SDSS May 30, 2019
Regency Ballroom EF



Vega and **Altair** Team

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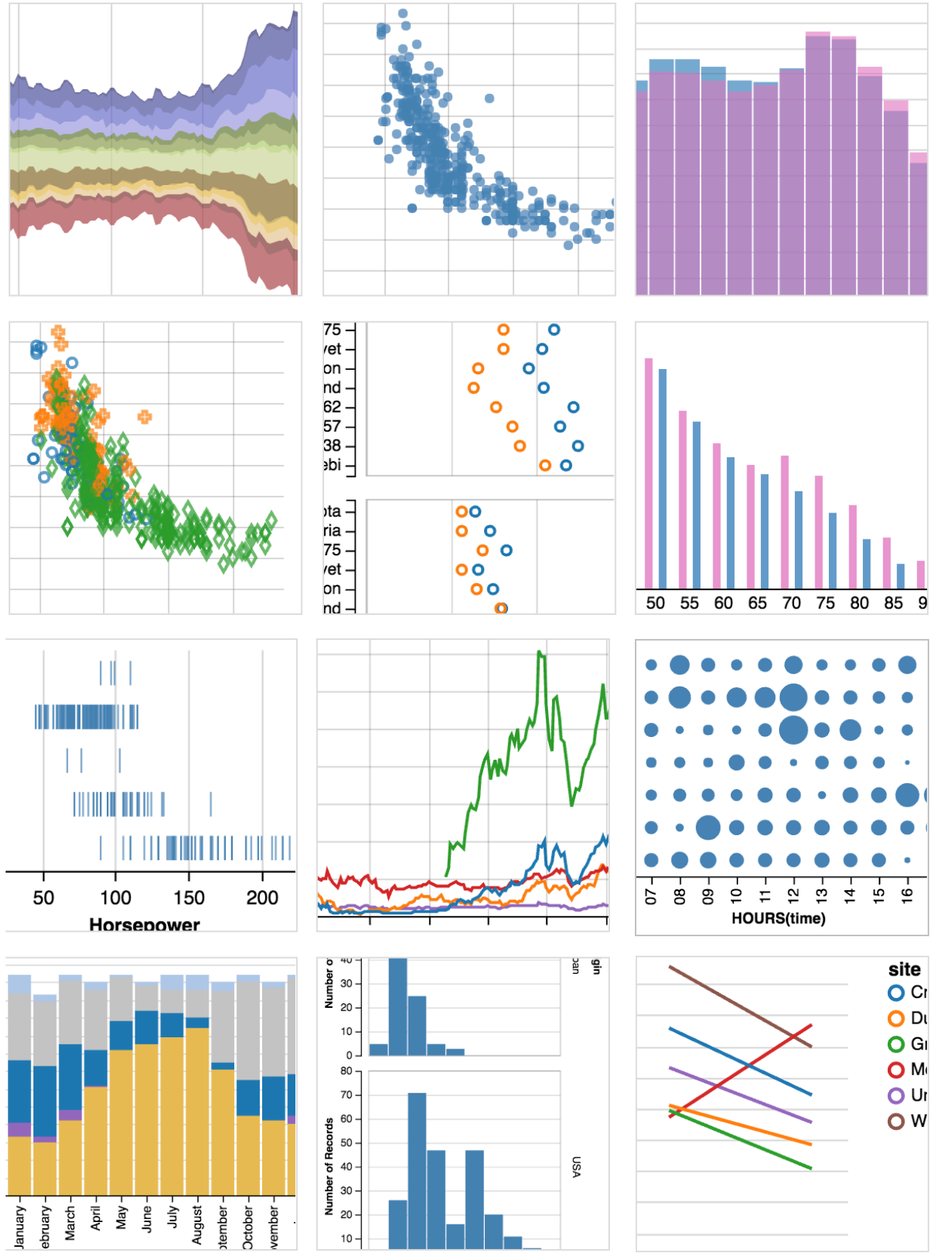
Jeffrey Heer @jeffrey_heer *UW*
Jake Vanderplas @jakevdp *Google*
Brian Granger @ellisonbg *Cal Poly*

and many other contributors!



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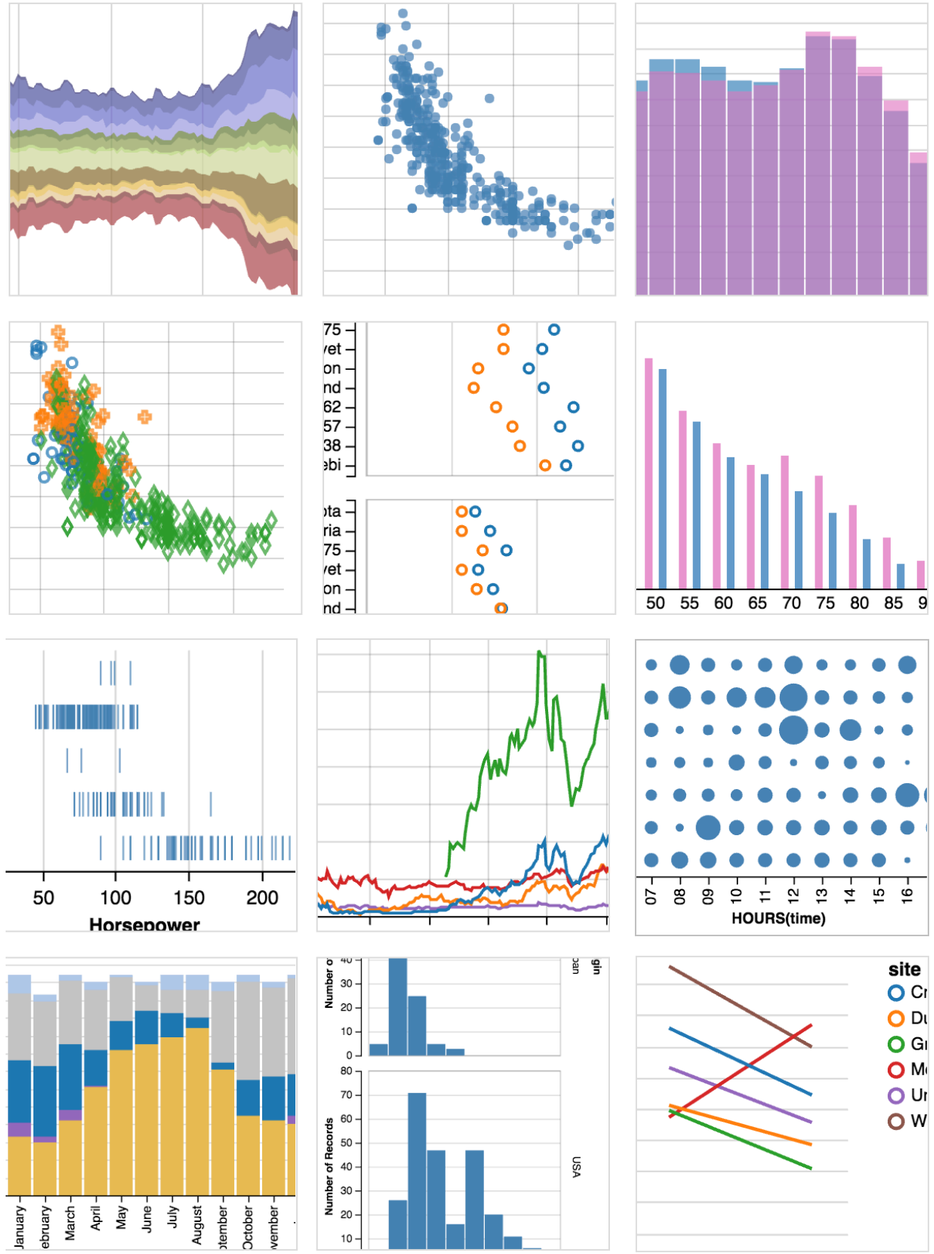


Imperative

- Specify *how* should something be done
- “Put a red circle here and a blue circle here”
- Couple specification with execution

Declarative

- Specify *what* should be done
- “Map <x> and <y> to position-encodings, <z> to color-encoding”
- Separate specification from execution

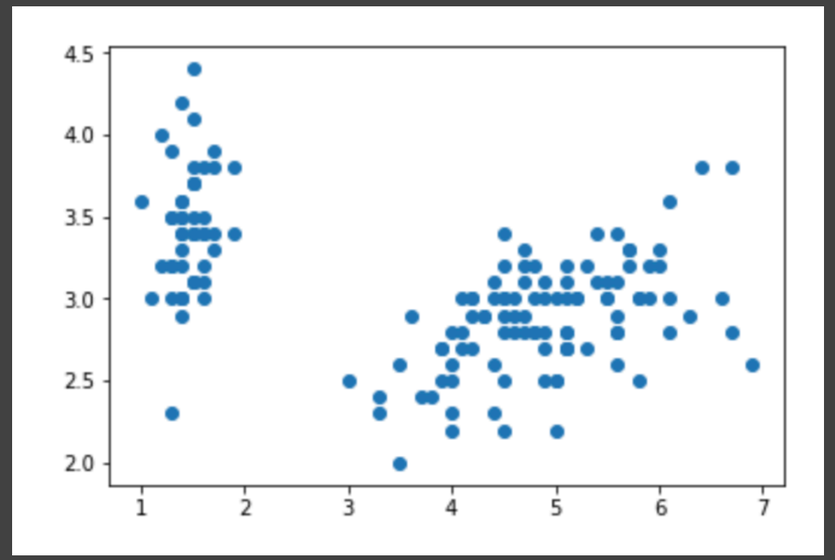
With a declarative language that directly maps code to visualization concepts, we can focus on **data** and **relationships**, rather than incidental details.

Slide adapted from https://speakerdeck.com/jakevdp/altair-tutorial-intro-pycon-2018

Scatterplot in Matplotlib

```
iris = df.read_csv(“iris.csv")

plt.scatter(iris.petalLength, iris.sepalWidth)
```

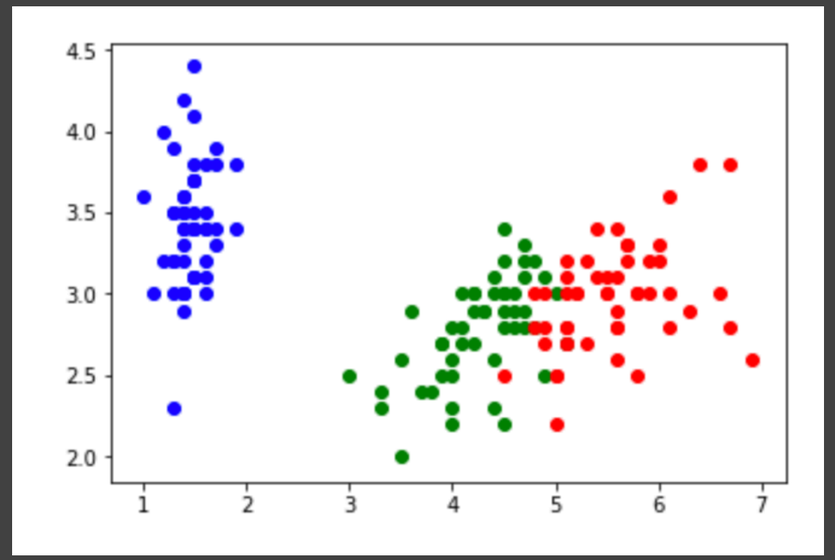
	petalLength	petalWidth	sepalLength	sepalWidth	species
0	1.4	0.2	5.1	3.5	setosa
1	1.4	0.2	4.9	3.0	setosa
2	1.3	0.2	4.7	3.2	setosa
3	1.5	0.2	4.6	3.1	setosa
4	1.4	0.2	5.0	3.6	setosa



Example Adapted from https://speakerdeck.com/jakevdp/altair-tutorial-intro-pycon-2018

Colored Scatterplot in Matplotlib

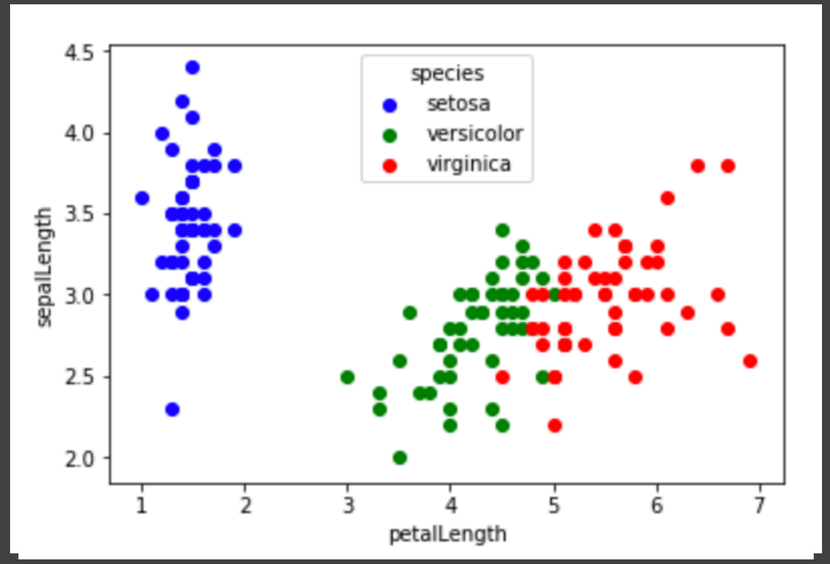
```
iris = df.read_csv(“iris.csv")

# Need to manually specify color map
color_map =  dict(zip(iris.species.unique(), ['blue', 'green', 'red']))

# Adding color involves for loop and groupby
for species, group in iris.groupby('species'):
    plt.scatter(group.petalLength, group.sepalWidth,
color=color_map[species],label=species)
```



Example Adapted from https://speakerdeck.com/jakevdp/altair-tutorial-intro-pycon-2018

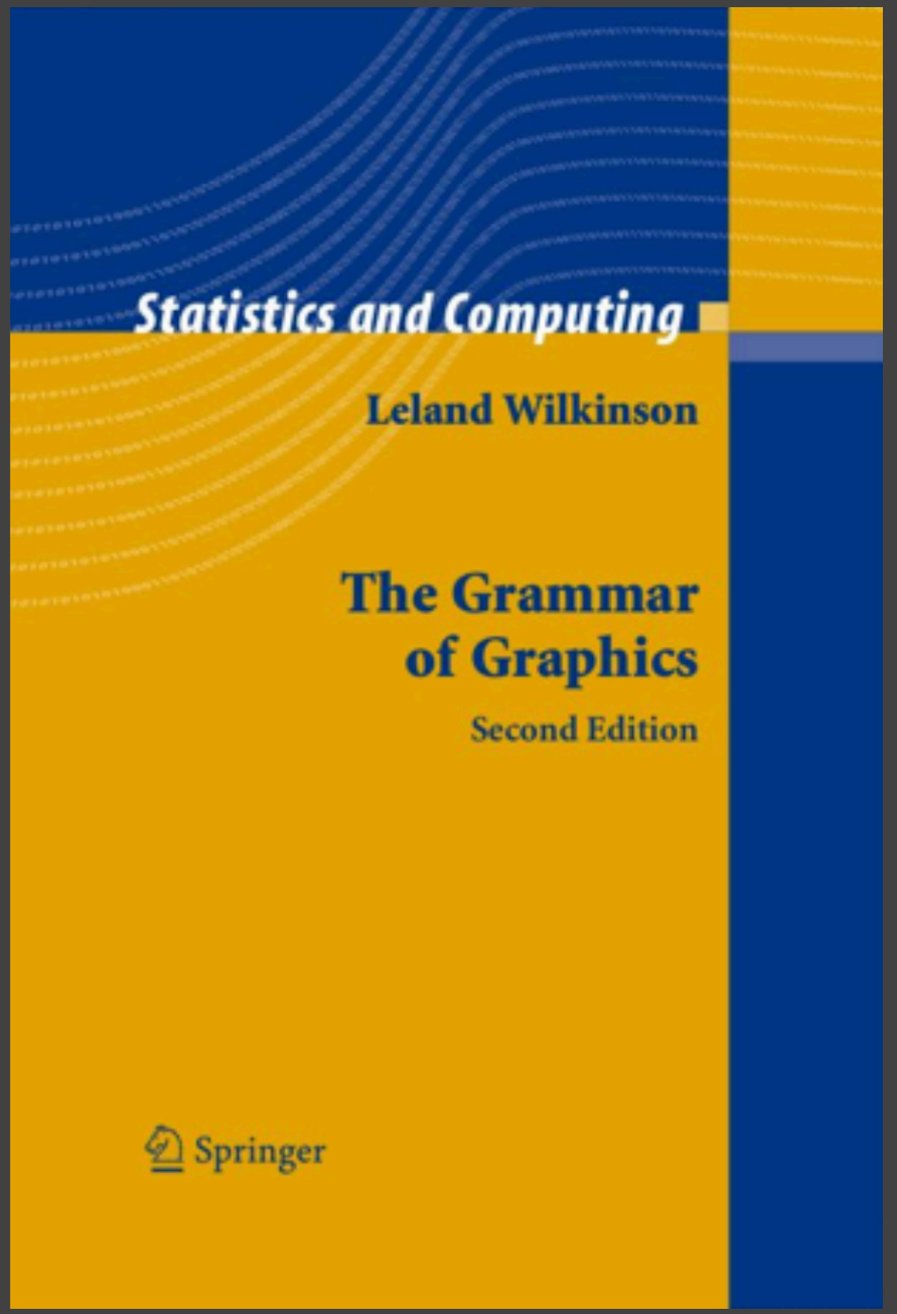
Colored Scatterplot in Matplotlib with Legend & Titles

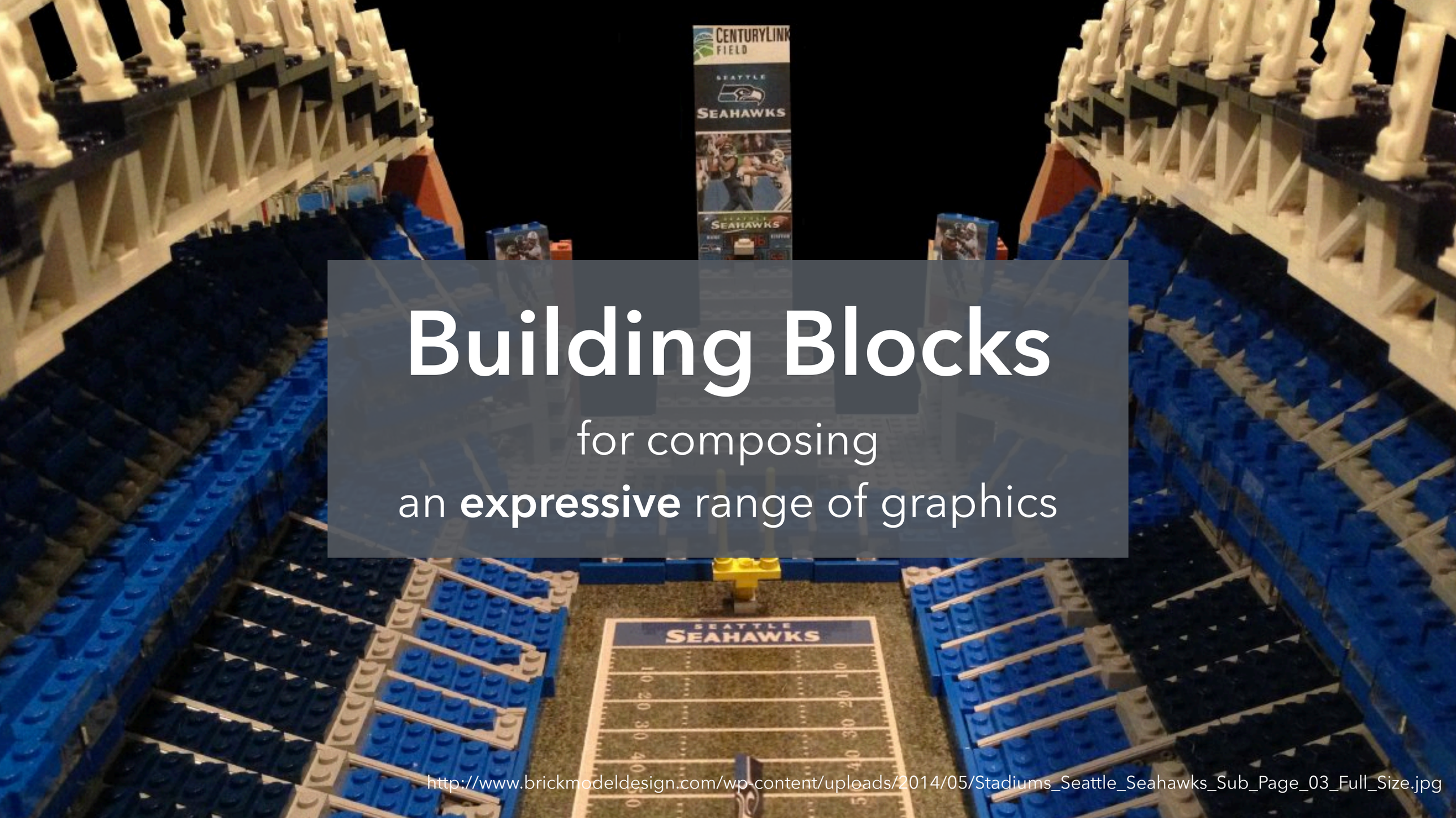
```
iris = df.read_csv(“iris.csv")

# Need to manually specify color map
color_map =  dict(zip(iris.species.unique(), ['blue', 'green', 'red']))

# Adding color involves for loop and groupby
for species, group in iris.groupby('species'):
    plt.scatter(group.petalLength, group.sepalWidth,
color=color_map[species],label=species)

# Need to manually add legend and field titles
plt.legend(frameon=True, title='species')
plt.xlabel('petalLength')
plt.ylabel('sepalLength')
```



Example Adapted from https://speakerdeck.com/jakevdp/altair-tutorial-intro-pycon-2018

Declarative Data Visualization


Statistics and Computing
Leland Wilkinson
The Grammar of Graphics
Second Edition
Springer



Building Blocks

for composing
an **expressive** range of graphics

http://www.brickmodeldesign.com/wp-content/uploads/2014/05/Stadiums_Seattle_Seahawks_Sub_Page_03_Full_Size.jpg

Data Visualization Concepts

Data Input data source to visualize.

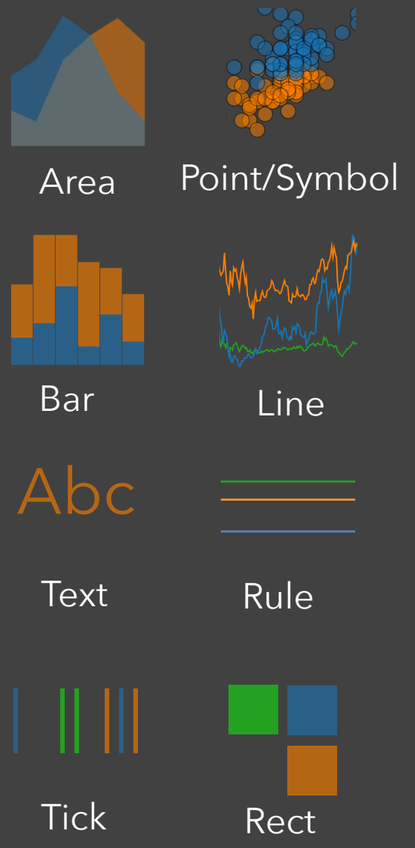
Transform Filter, aggregation, binning, etc.

Mark Data-representative graphics.

Encoding Mapping between data and mark properties.

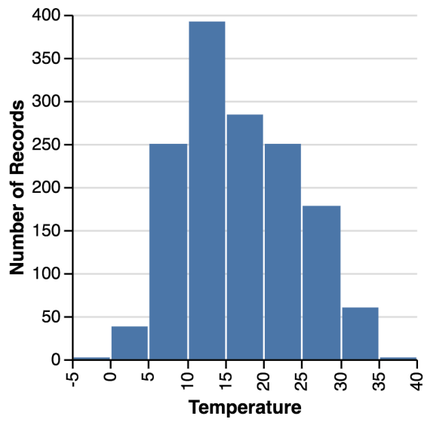
Scale Functions that map data values to visual values.

Guides Axes & legends that visualize scales.

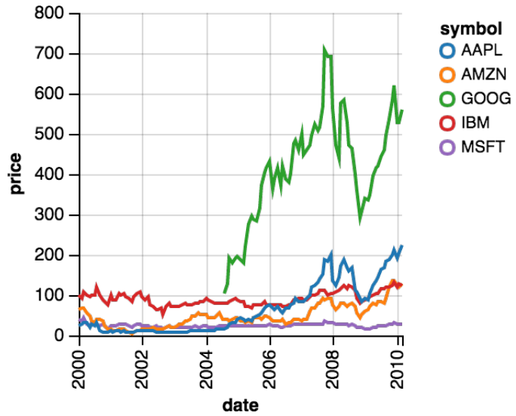


Vega-Lite: a Grammar of Graphics

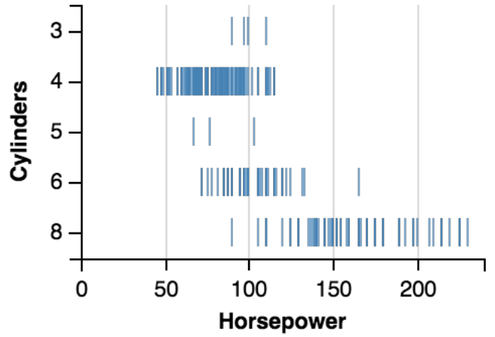
Histogram



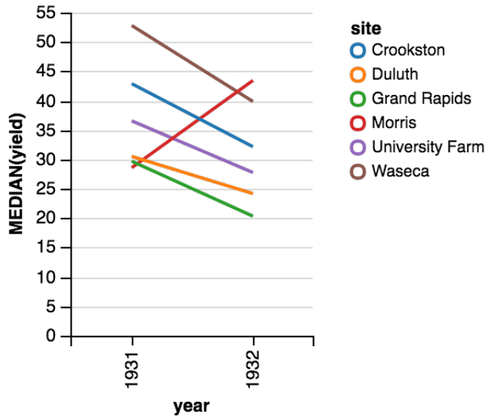
Multi-series Line Chart



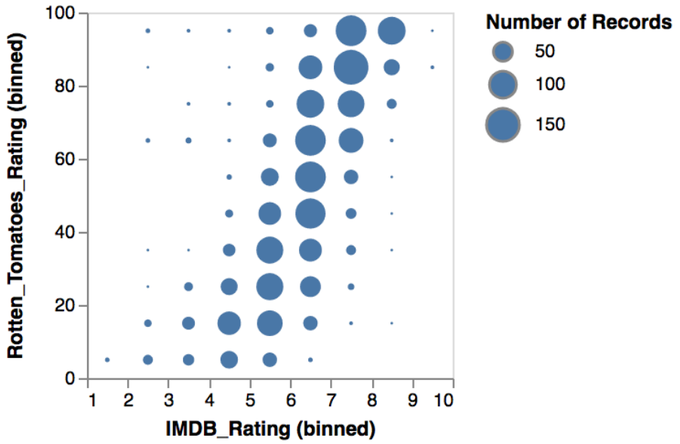
Stripplot



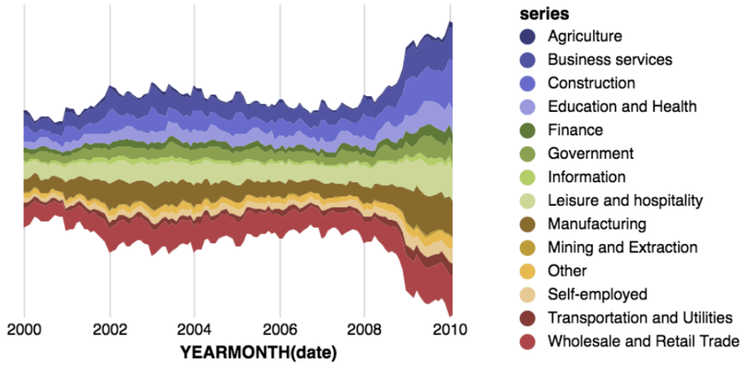
Slope Graph



Binned Scatterplot

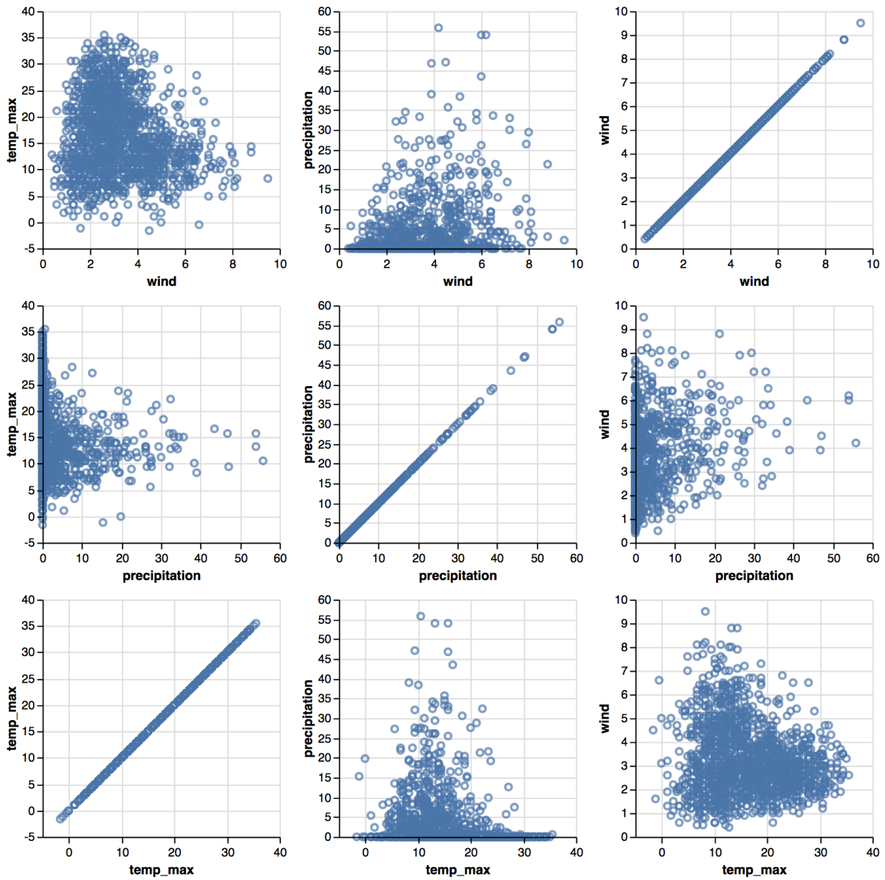


Area Chart

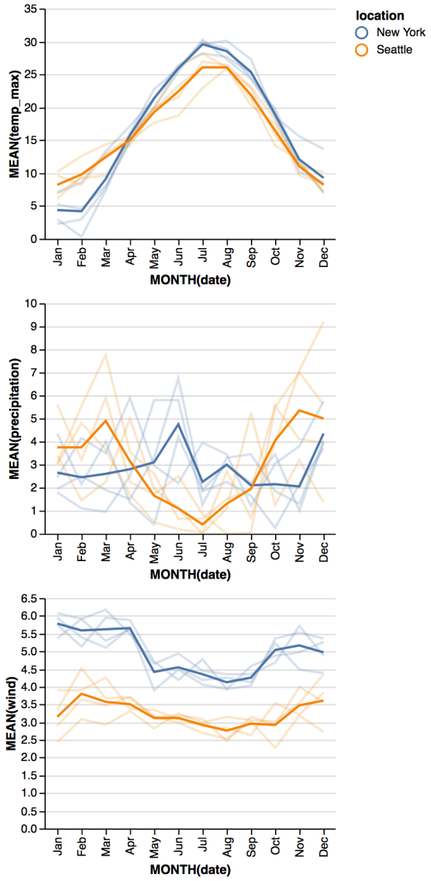


Vega-Lite: a Grammar of Multi-View Graphics

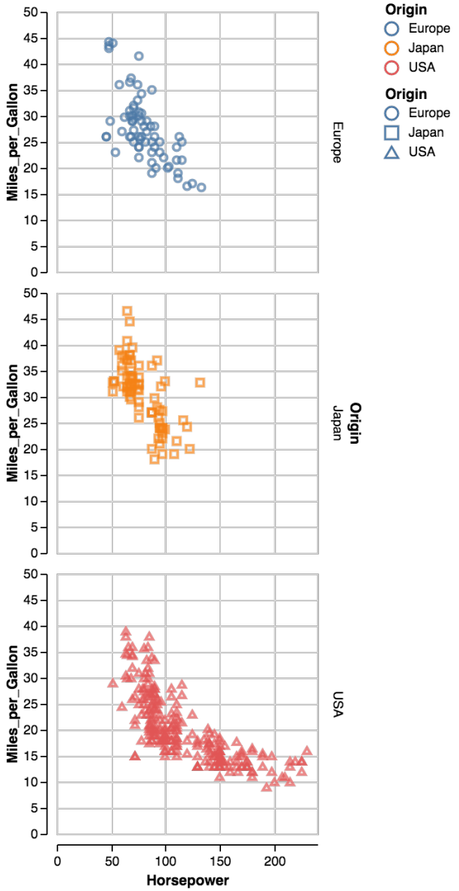
Scatterplot Matrix



Concatenated & Layered View

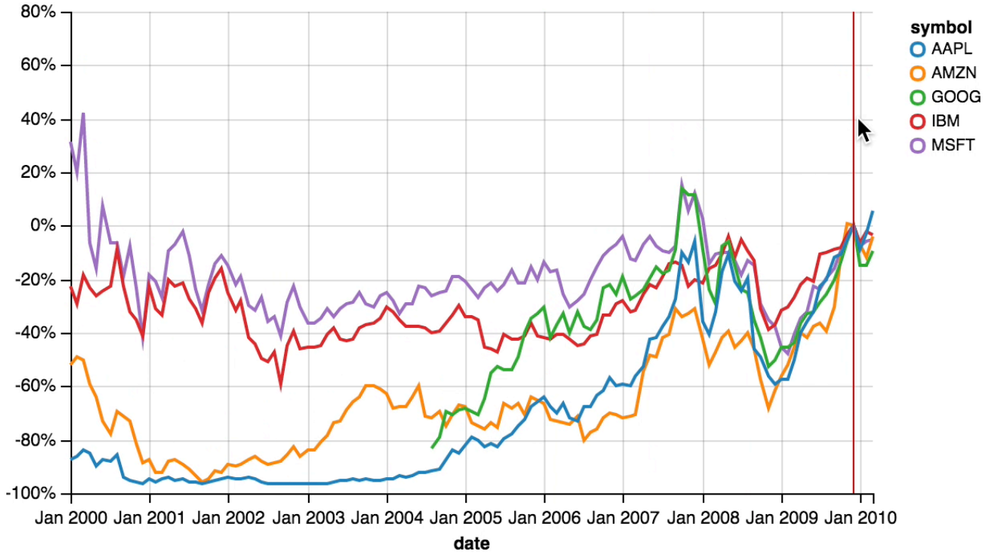


Faceted View

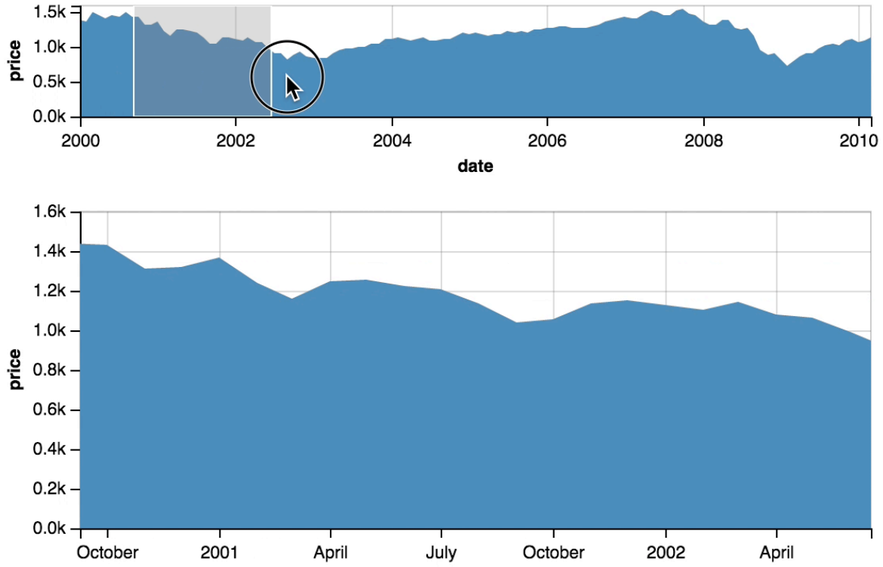


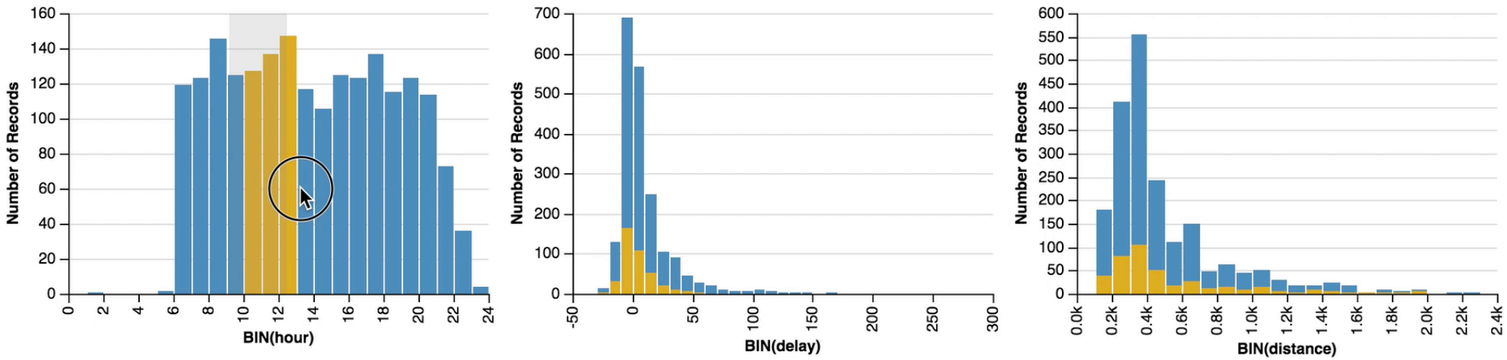
Vega-Lite: a Grammar of Interactive Multi-View Graphics

Indexed Chart



Focus+Context

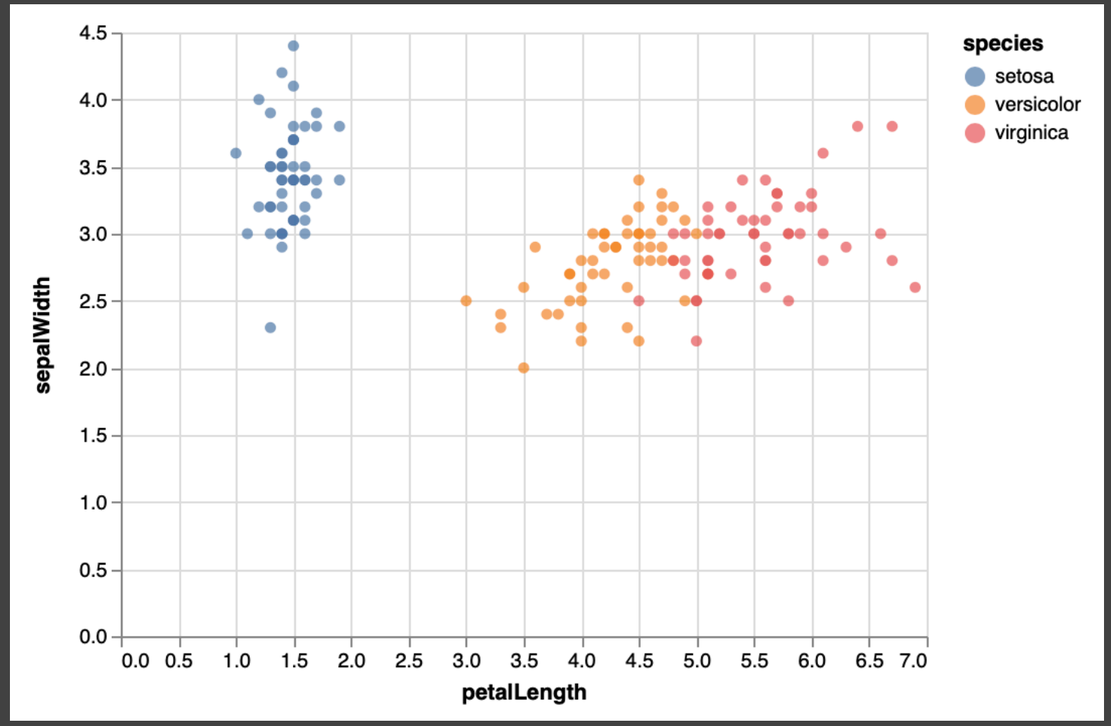




Cross-filtering

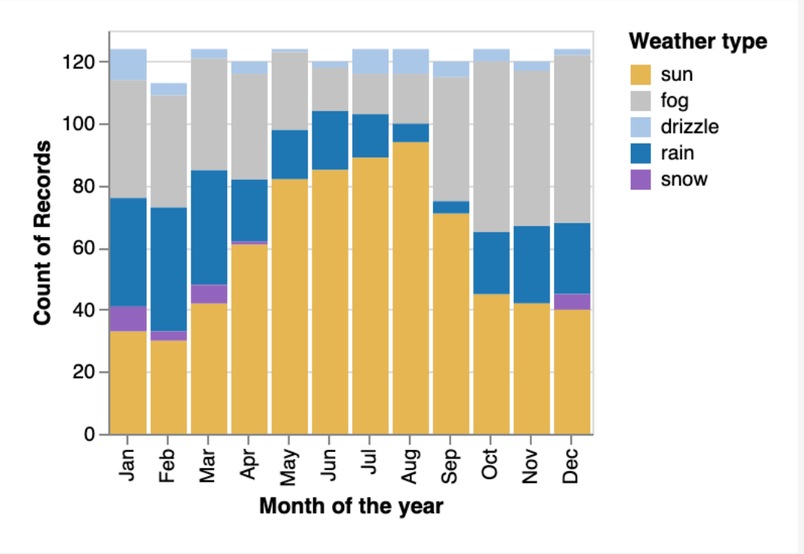
Vega-Lite: Declarative Visualization in JSON

```
{
  "data": {"url": "data/iris.json"},
  "mark": "circle",
  "encoding": {
    "x": {"field": "petalLength", "type": "quantitative"},
    "y": {"field": "sepalLength", "type": "quantitative"},
    "color": {"field": "species", "type": "nominal"}
  }
}
```



Vega-Lite | Clear | Format | Run (Auto) | Export | Share | Examples | Gist | Vega-Lite Docs

```
{
  "$schema": "https://vega.github.io/schema/vega-lite/v3.json",
  "data": {"url": "data/seattle-weather.csv"},
  "mark": "bar",
  "encoding": {
    "x": {
      "timeUnit": "month",
      "field": "date",
      "type": "ordinal",
      "axis": {"title": "Month of the year"}
    },
    "y": {
      "aggregate": "count",
      "type": "quantitative"
    },
    "color": {
      "field": "weather",
      "type": "nominal",
      "scale": {
        "domain": ["sun","fog","drizzle","rain","snow"],
        "range": ["#e7ba52","#c7c7c7","#aec7e8","#1f77b4","#9467bd"]
      },
      "legend": {"title": "Weather type"}
    }
  }
}
```



Vega-Lite version 3.2.1 | Renderer: SVG

LOGS (0) | DATA VIEWER | SIGNAL VIEWER

source_0 | < 1 2 >

month_date	weather	__count	__count_start	__count_end
Mon, 01 Jan 1900 08:00:00 GMT	"drizzle"	10	114	124
Mon, 01 Jan 1900 08:00:00 GMT	"rain"	35	41	76
Mon, 01 Jan 1900 08:00:00 GMT	"sun"	33	0	33
Mon, 01 Jan 1900 08:00:00 GMT	"snow"	8	33	41
Thu, 01 Feb 1900 08:00:00 GMT	"rain"	40	33	73
Thu, 01 Feb 1900 08:00:00 GMT	"sun"	30	0	30

Compiled Vega

Online Editor

vega.github.io/editor

Altair

3.0.0

Search docs

GETTING STARTED

Overview

Installation

Basic Statistical Visualization

GALLERY

Example Gallery

USER GUIDE

Specifying Data with Pandas

Encodings

Marks

Data Transformations

Bindings, Selections, Conditions

Docs » Altair: Declarative Visualization in Python

View page source

Altair: Declarative Visualization in Python

Altair is a declarative statistical visualization library for Python, based on Vega and Vega-Lite, and the source is available on GitHub.

With Altair, you can spend more time understanding your data and its meaning. Altair's API is simple, friendly and consistent and built on top of the powerful Vega-Lite JSON specification. This elegant simplicity produces beautiful and effective visualizations with a minimal amount of code.

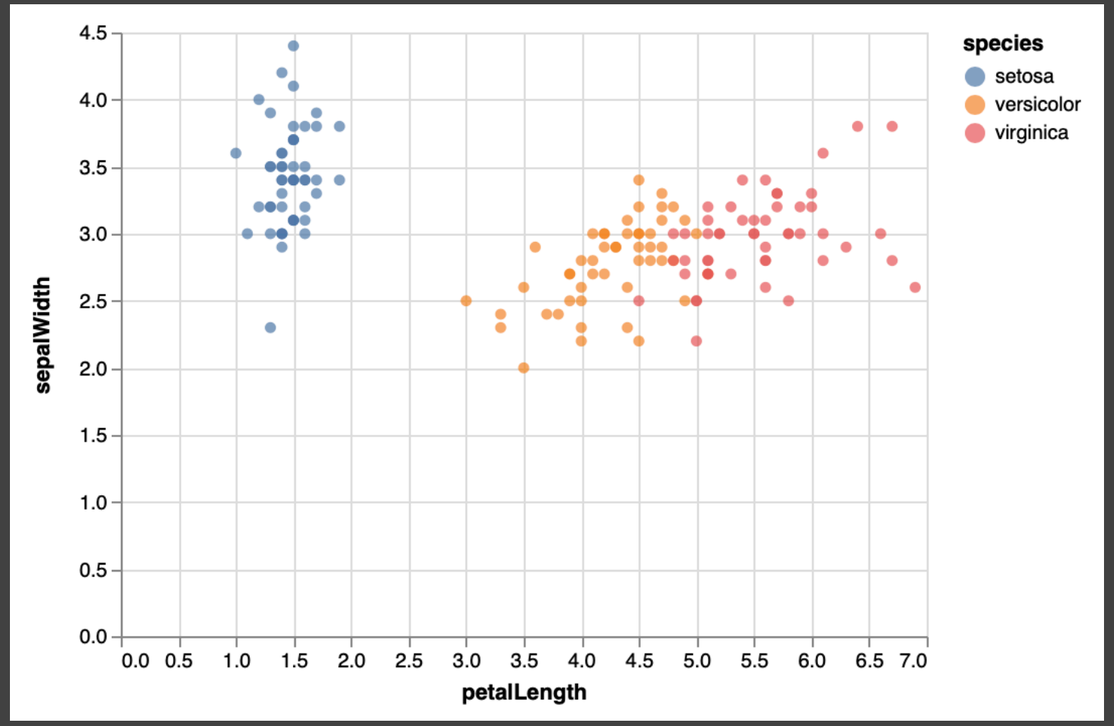
Altair: Vega-Lite in Python

Led by Jake VanderPlas and Brian Granger.

Colored Scatterplot in Vega-Lite & Altair

```
{
  "data": {"url": "data/iris.json"},
  "mark": "circle",
  "encoding": {
    "x": {"field": "petalLength", "type": "quantitative"},
    "y": {"field": "sepalLength", "type": "quantitative"},
    "color": {"field": "species", "type": "nominal"}
  }
}
```

```
alt.Chart(iris).mark_circle().encode(
    x='petalLength',
    y='sepalWidth',
    color='species'
)
```



Outline

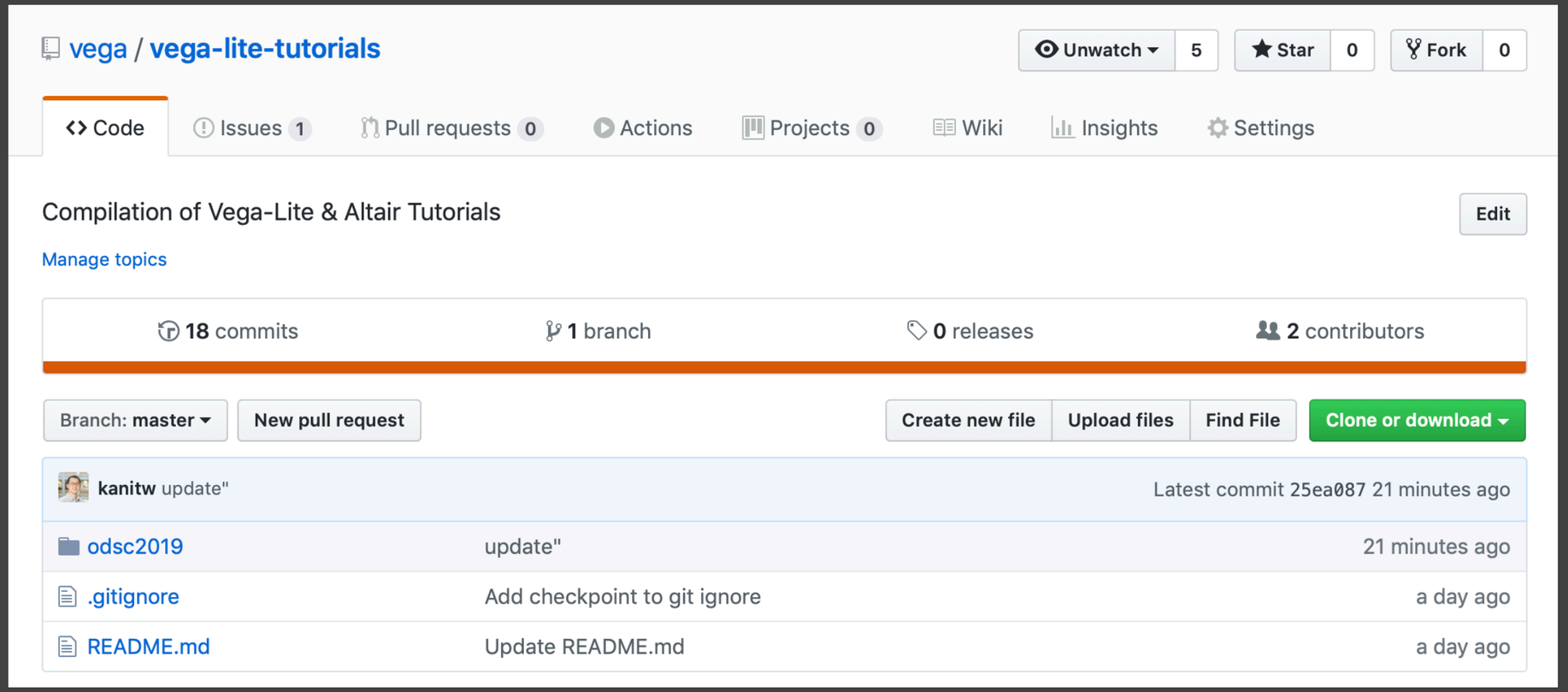
Vega-Lite & Altair

Hands-on Altair

- **Single View** Specification
- **Layered** and **Multi-view** Composition
- **Interactions** with Selections and Tooltip

Additional Resources

Materials for the Workshop Today

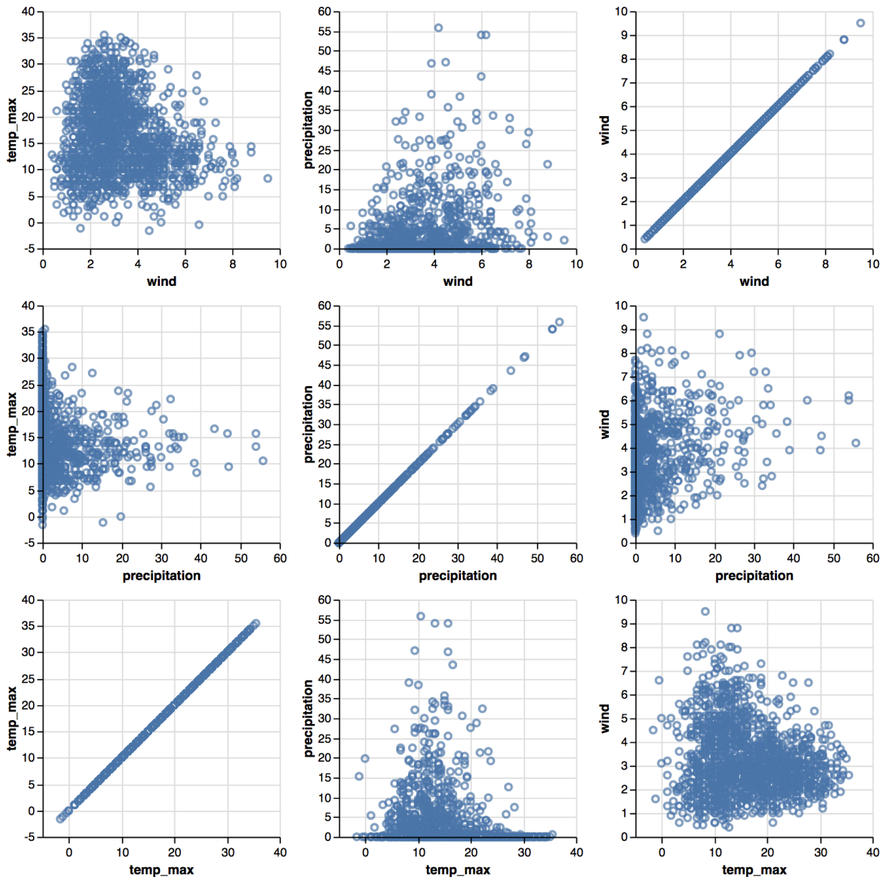


https://github.com/vega/vega-lite-tutorials

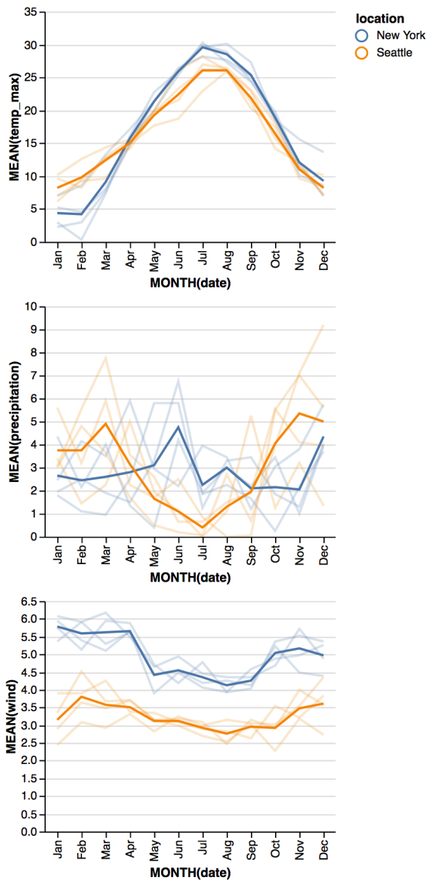
Notebook 1: Introduction

Altair: Multi-View Graphics

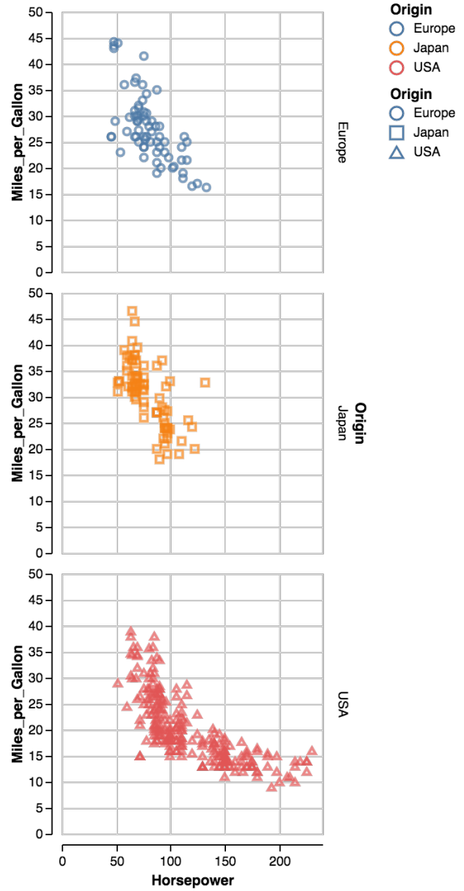
Scatterplot Matrix



Concatenated & Layered View



Faceted View

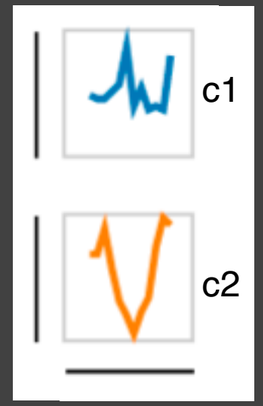


View Composition Operators

View Composition Operators

facet row: C

=



View Composition Operators

facet row: C

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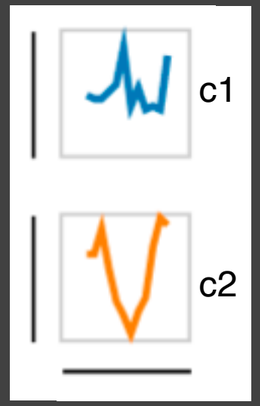
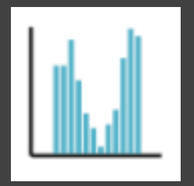
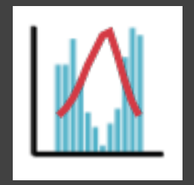


layer: [ , ] =



View Composition Operators

facet row: C

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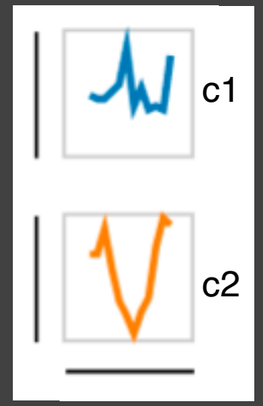
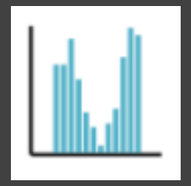
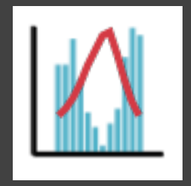
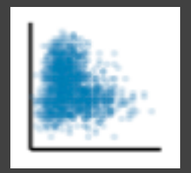
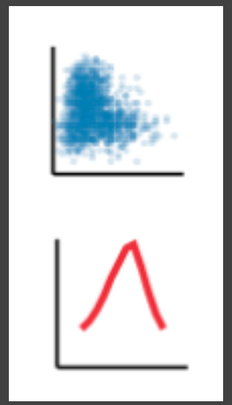


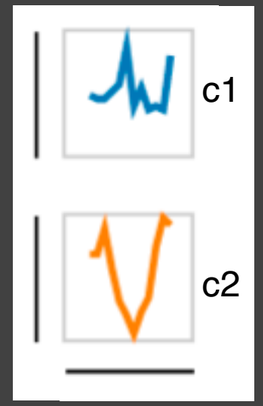
layer: [ , ] = 

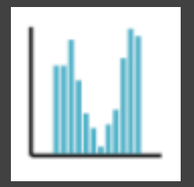
vconcat: [ , ] = 

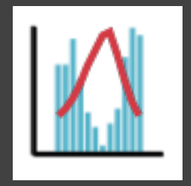
View Composition Operators

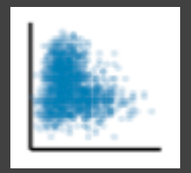
facet row: C

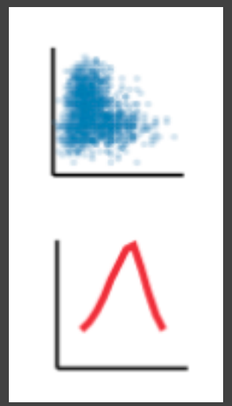
=



layer: [ , ] =



vconcat: [ , ] =



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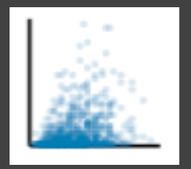

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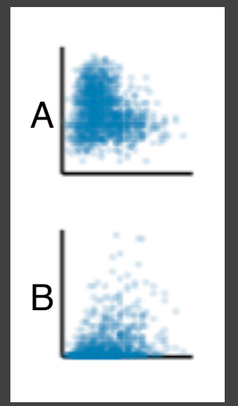
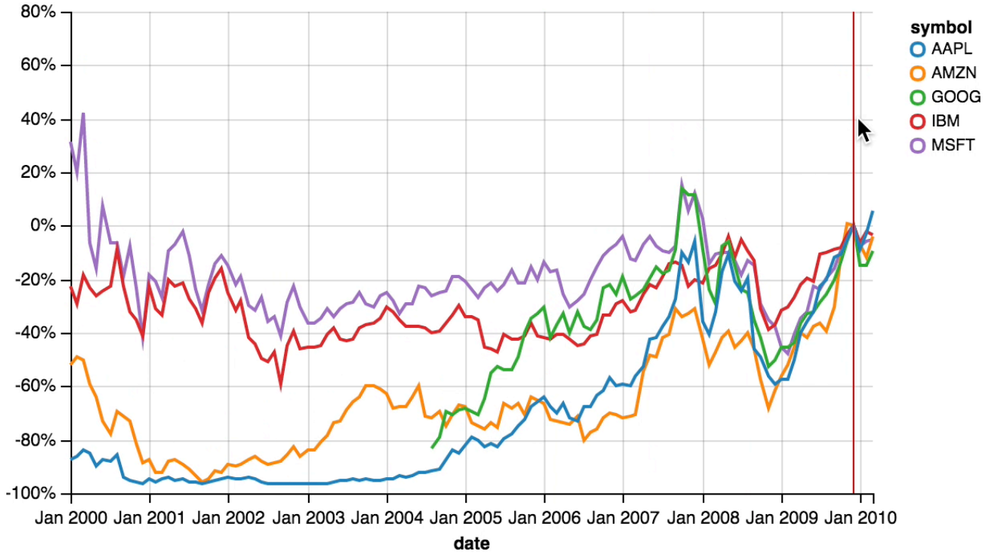


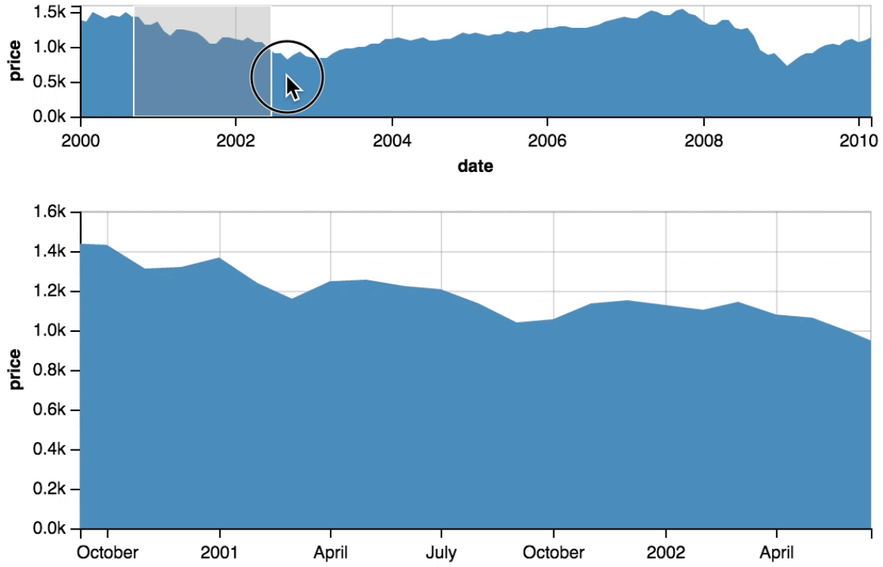
Notebook 2: View Composition

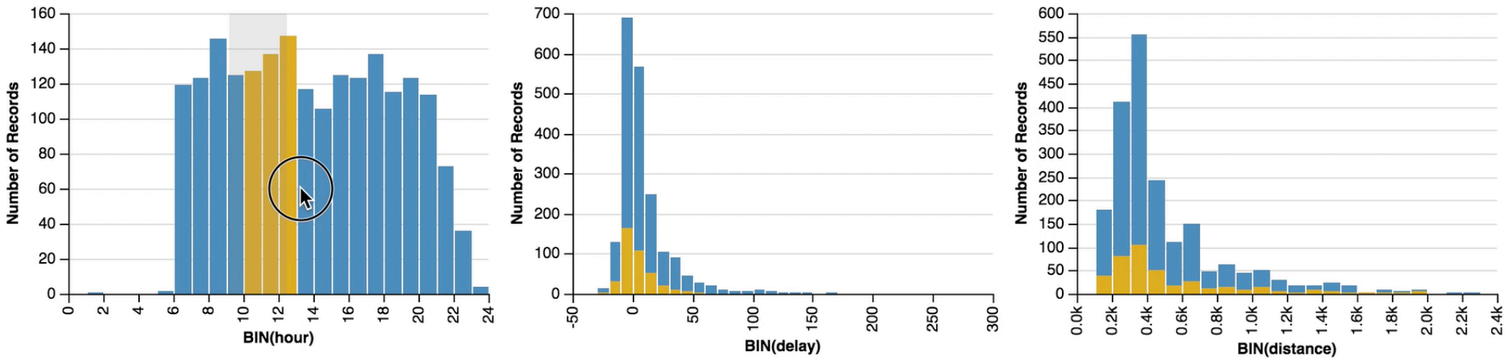
Altair: Interactive Multi-View Graphics

Indexed Chart



Focus+Context





Cross-filtering

Selections

Selections

The core interactive building blocks. Define three components:

1. Event processing – how does the interaction occur?
2. Points of interest – which marks/data points were interacted with?
3. Predicate function – what is the full set of selected marks/data points?

Notebook 3: Selection

Outline

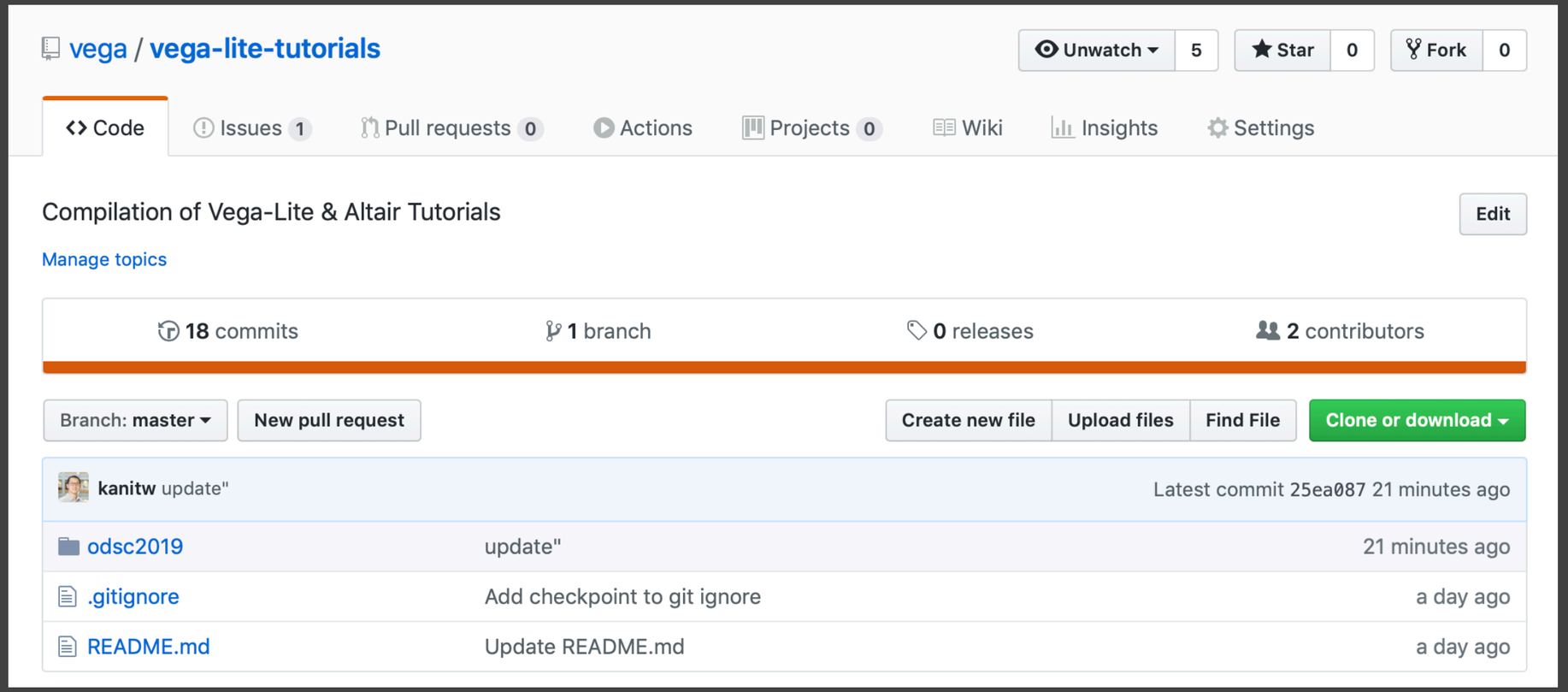
Vega-Lite & Altair

Hands-on Altair

- **Single View** Specification
- **Layered** and **Multi-view** Composition
- **Interactions** with Selections and Tooltip

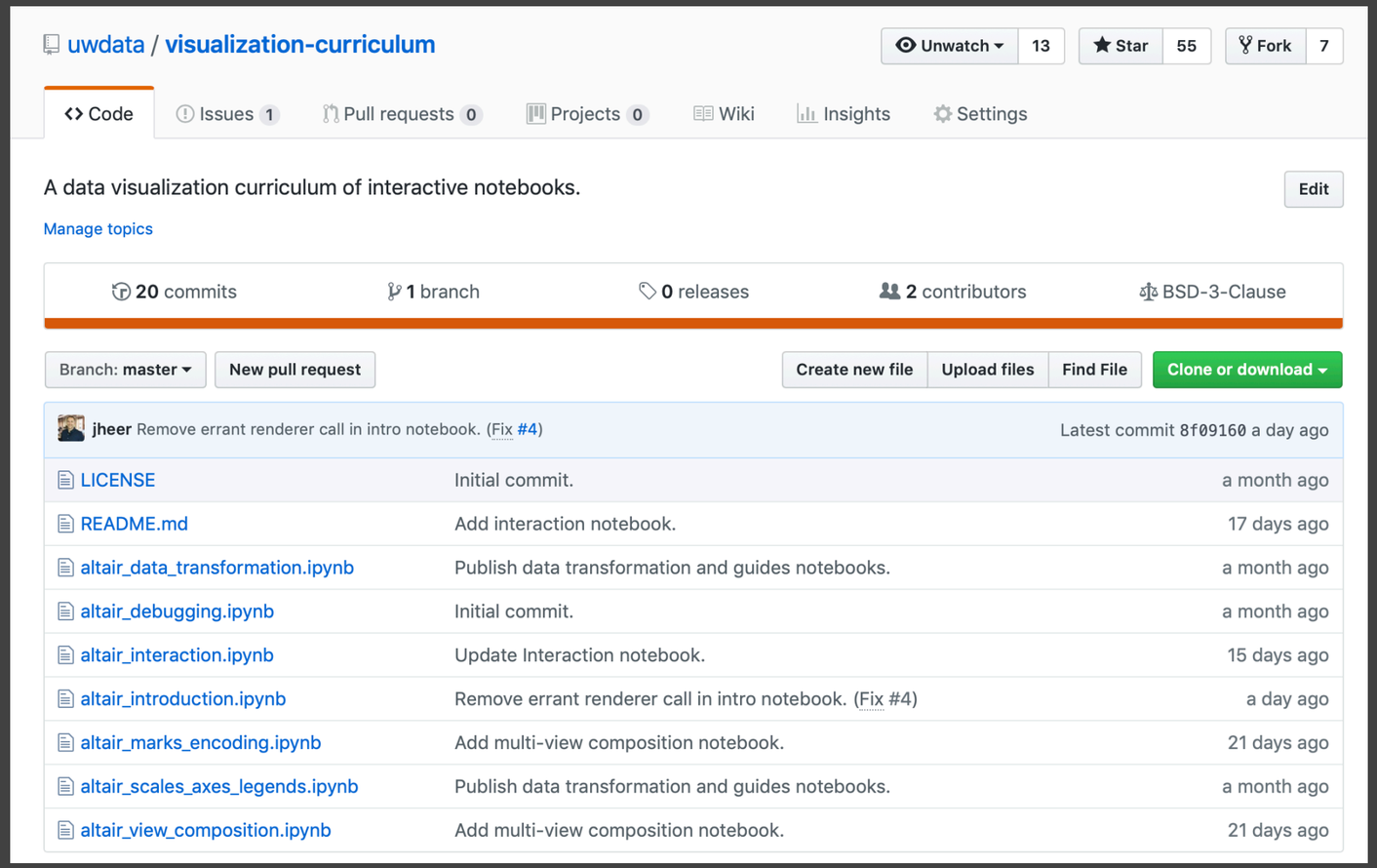
Additional Resources

Materials for the Workshop Today



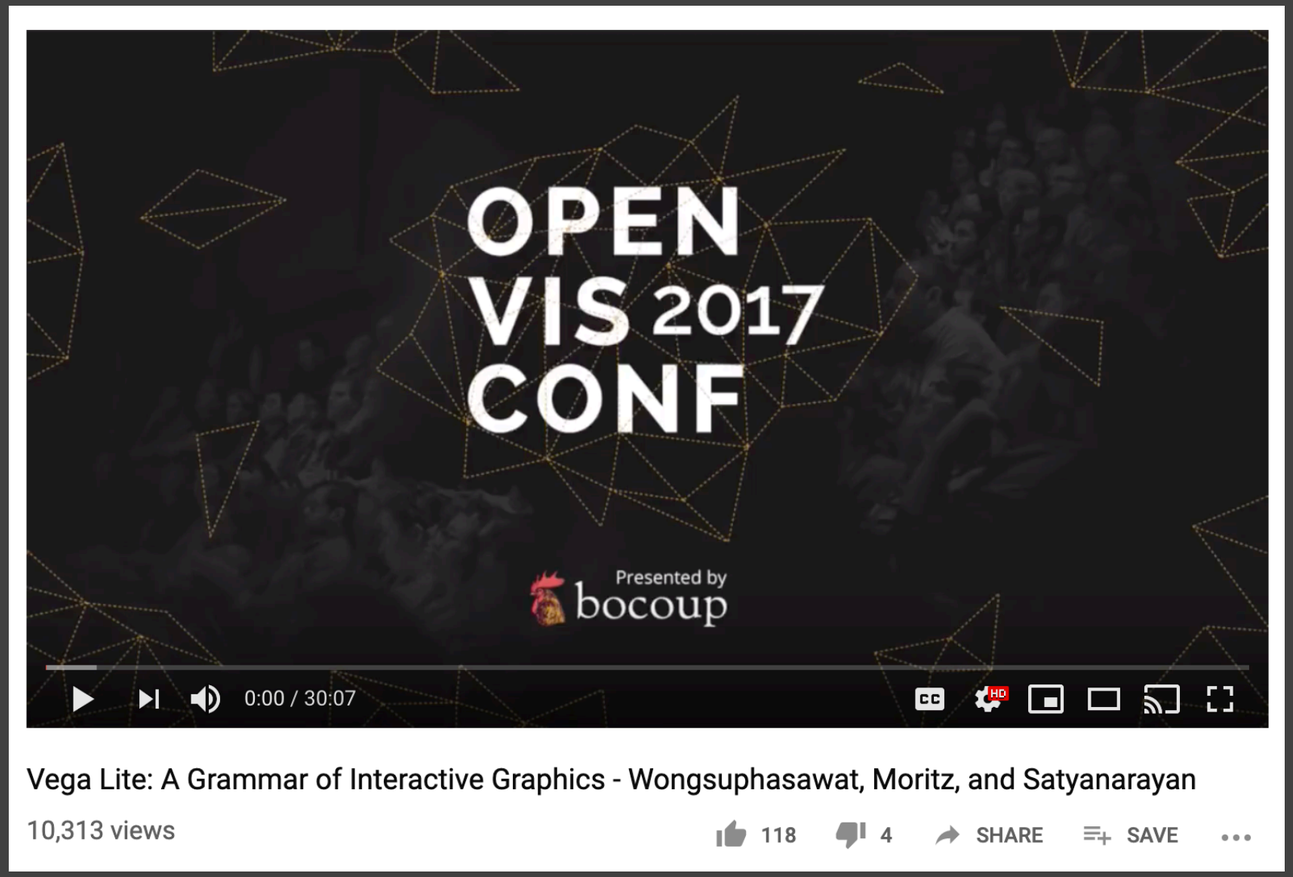
https://github.com/vega/vega-lite-tutorials

UW's Visualization Curriculum



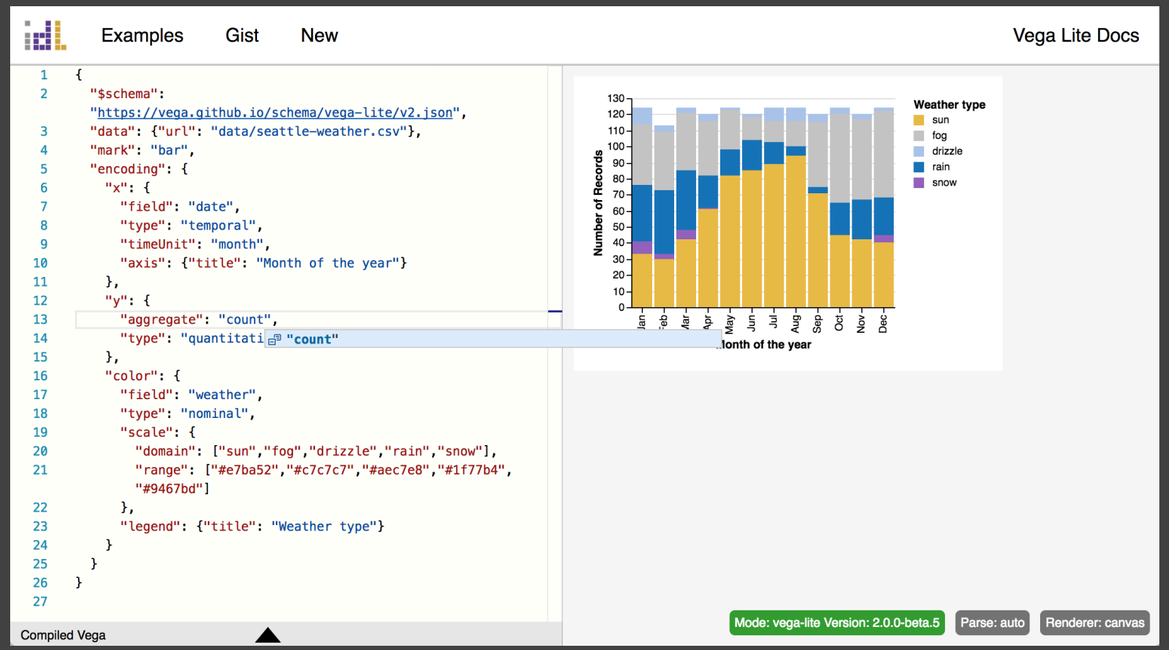
https://github.com/uwdata/visualization-curriculum

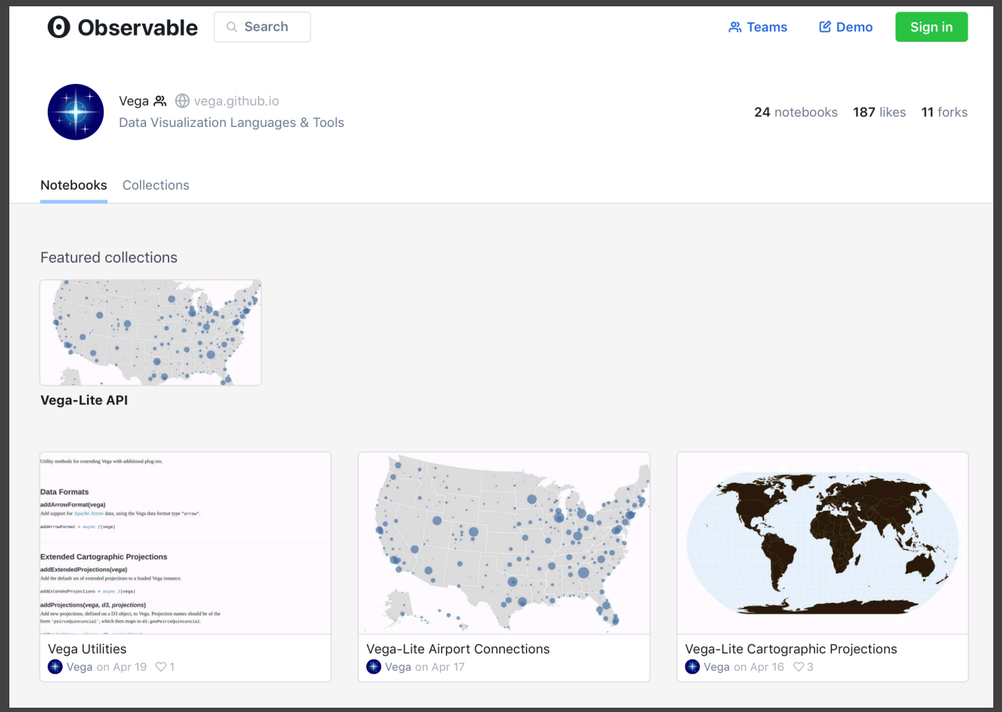
Vega-Lite (JSON) version of this talk



http://bit.ly/vega-lite-talk

Play with Vega-Lite online

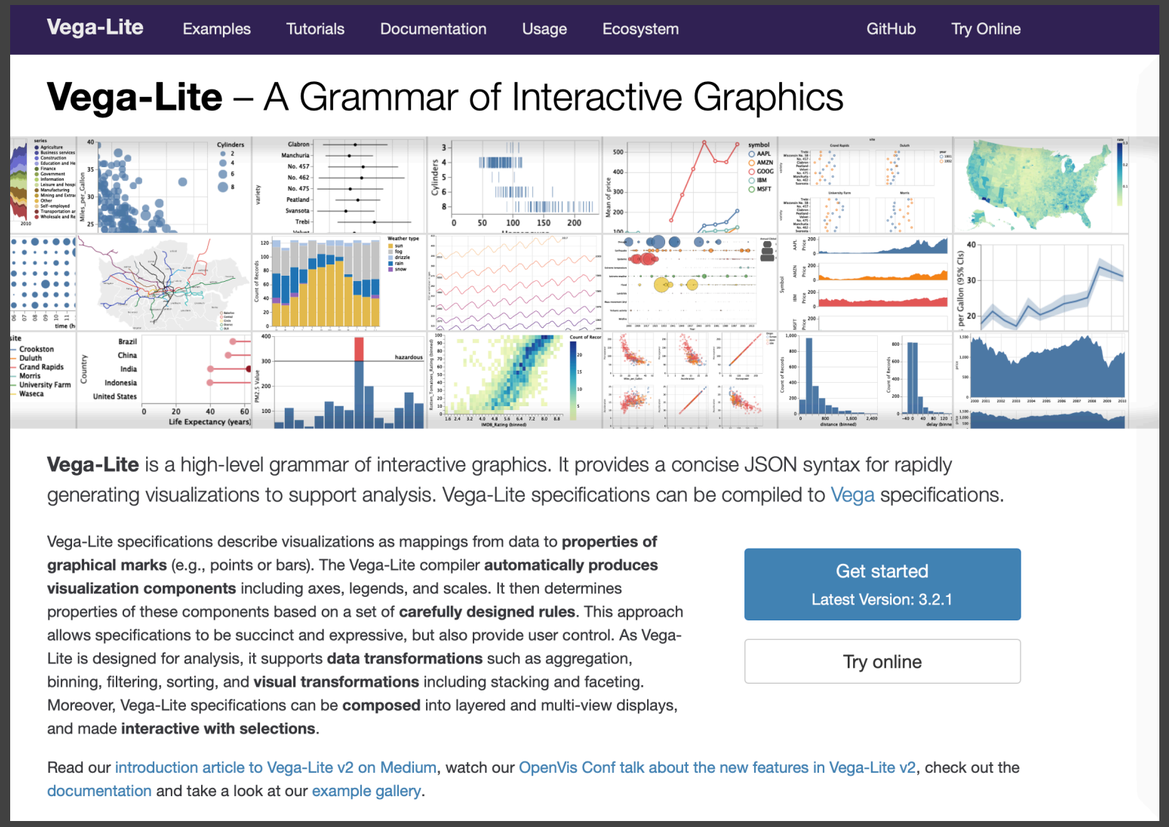




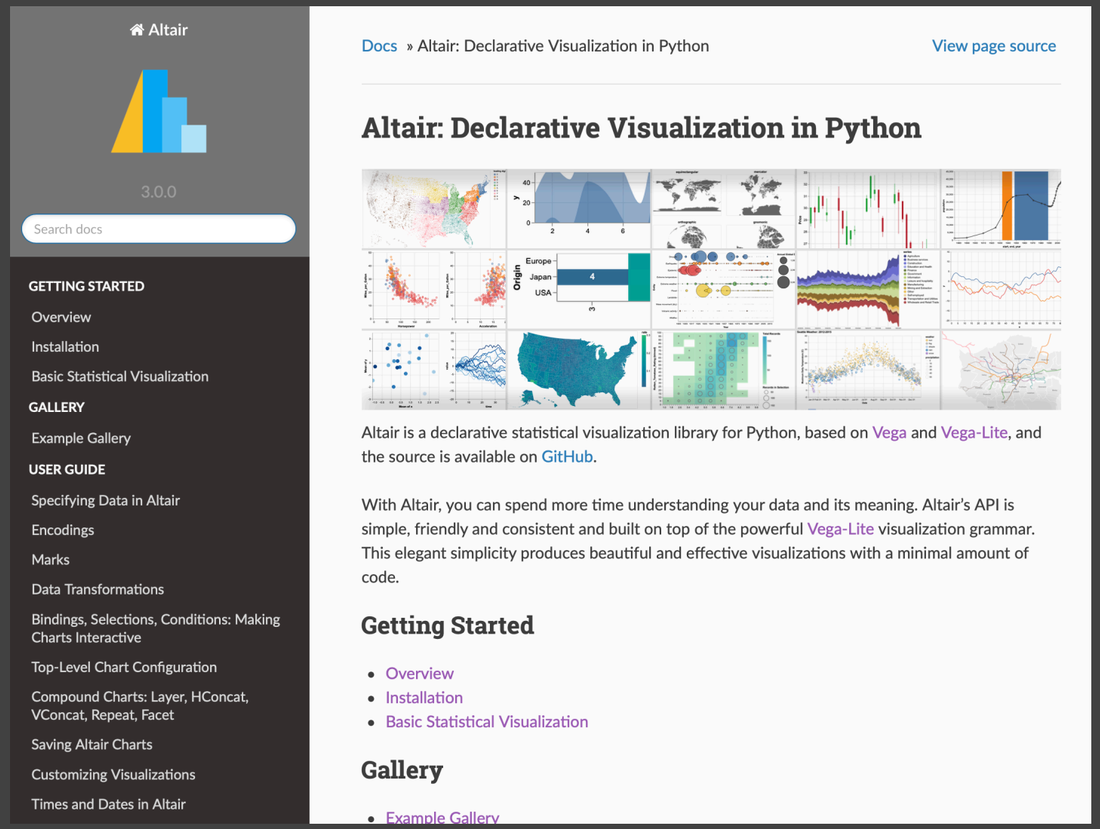
http://vega.github.io/editor

https://observablehq.com/@vega

Documentation



http://vega.github.io/vega-lite



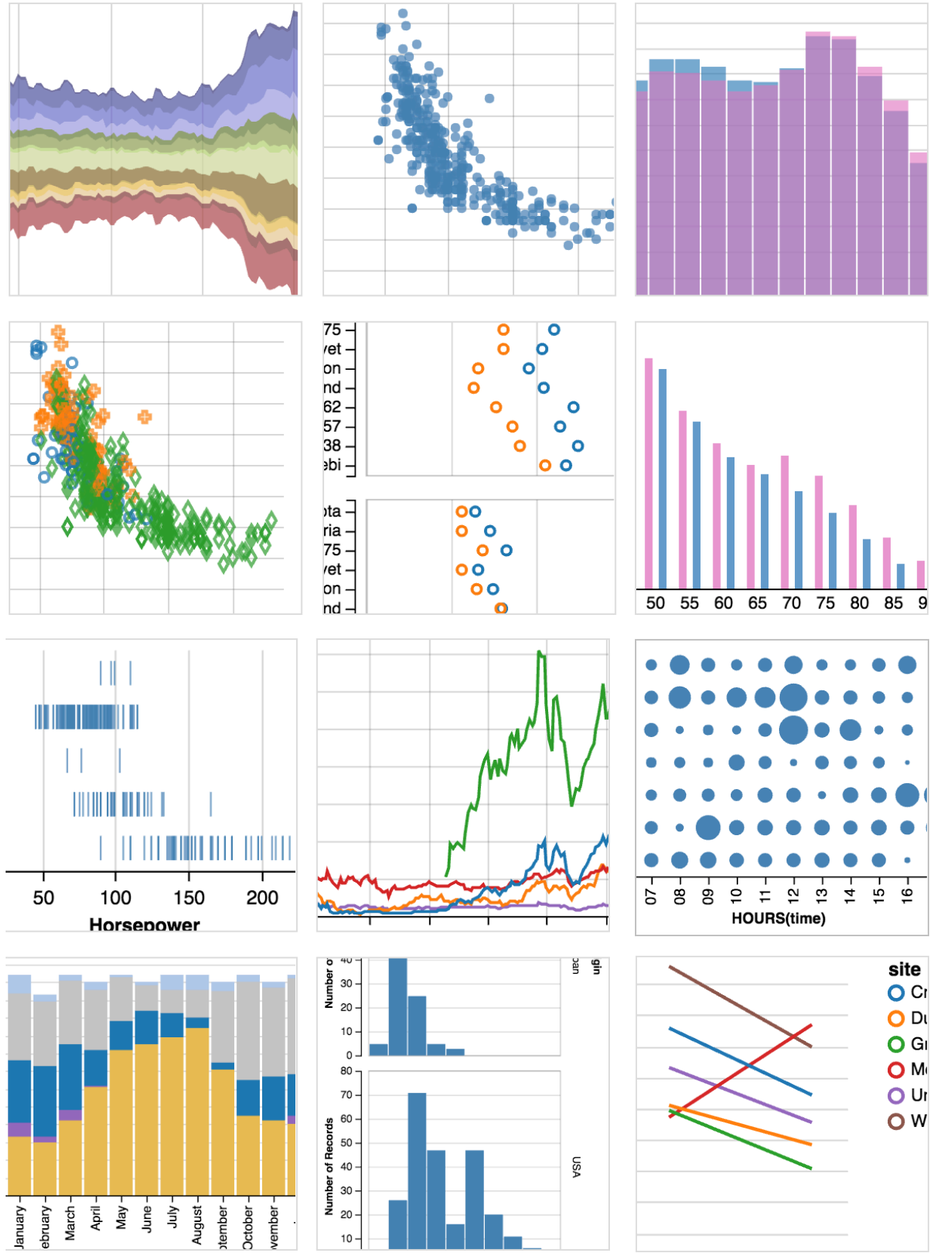
http://altair-viz.github.io

Declarative Data Visualization with **Vega-Lite** and **Altair**

Kanit "Ham" Wongsuphasawat
@kanitw Apple

Dominik Moritz
@domoritz UW


SDSS May 30, 2019
Regency Ballroom EF



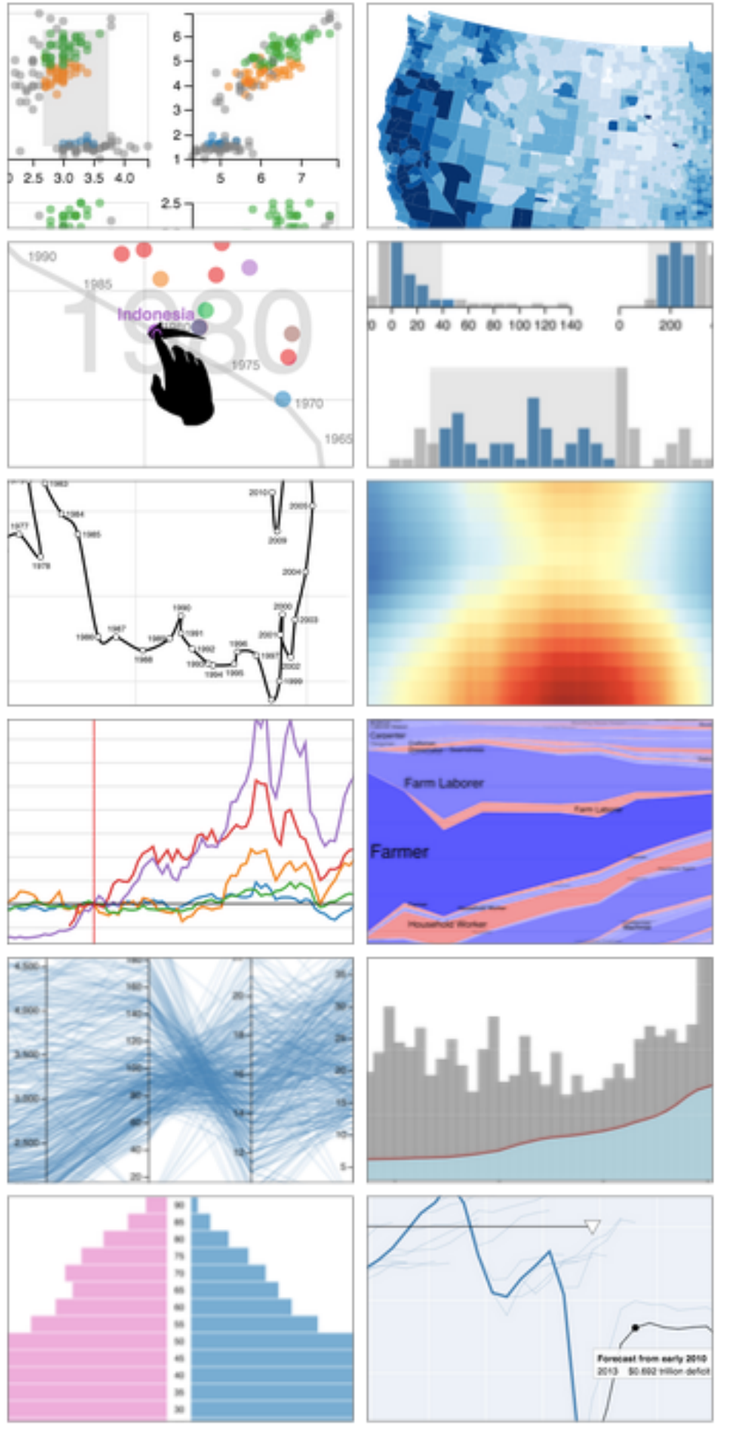
Extra Materials

What is

Vega

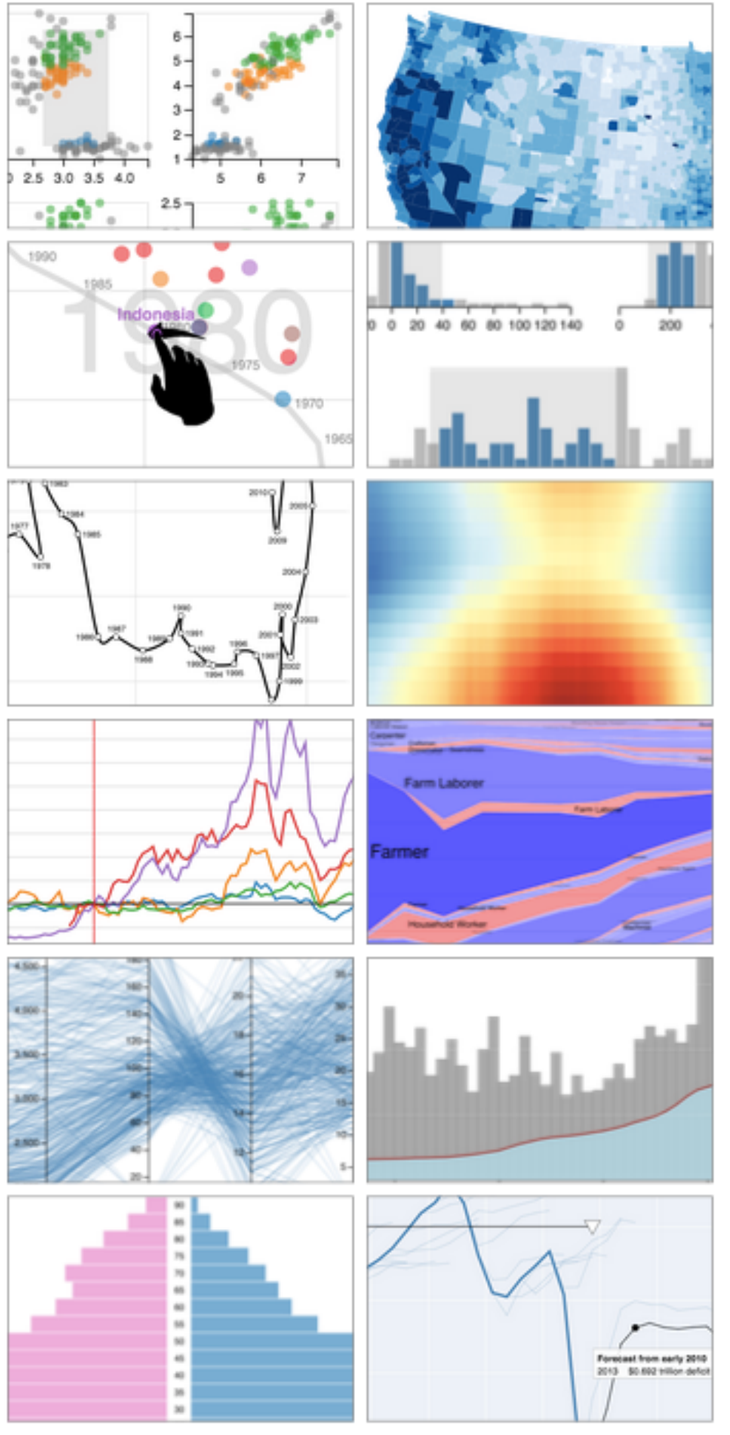

N
Vega Light!
Vega
Deneb
Altair

Vega is a *Visualization Grammar*



Vega is a *Visualization Grammar*

Similar in spirit to how SQL provides a language for expressing database queries, Vega is a high-level language for describing visualizations.



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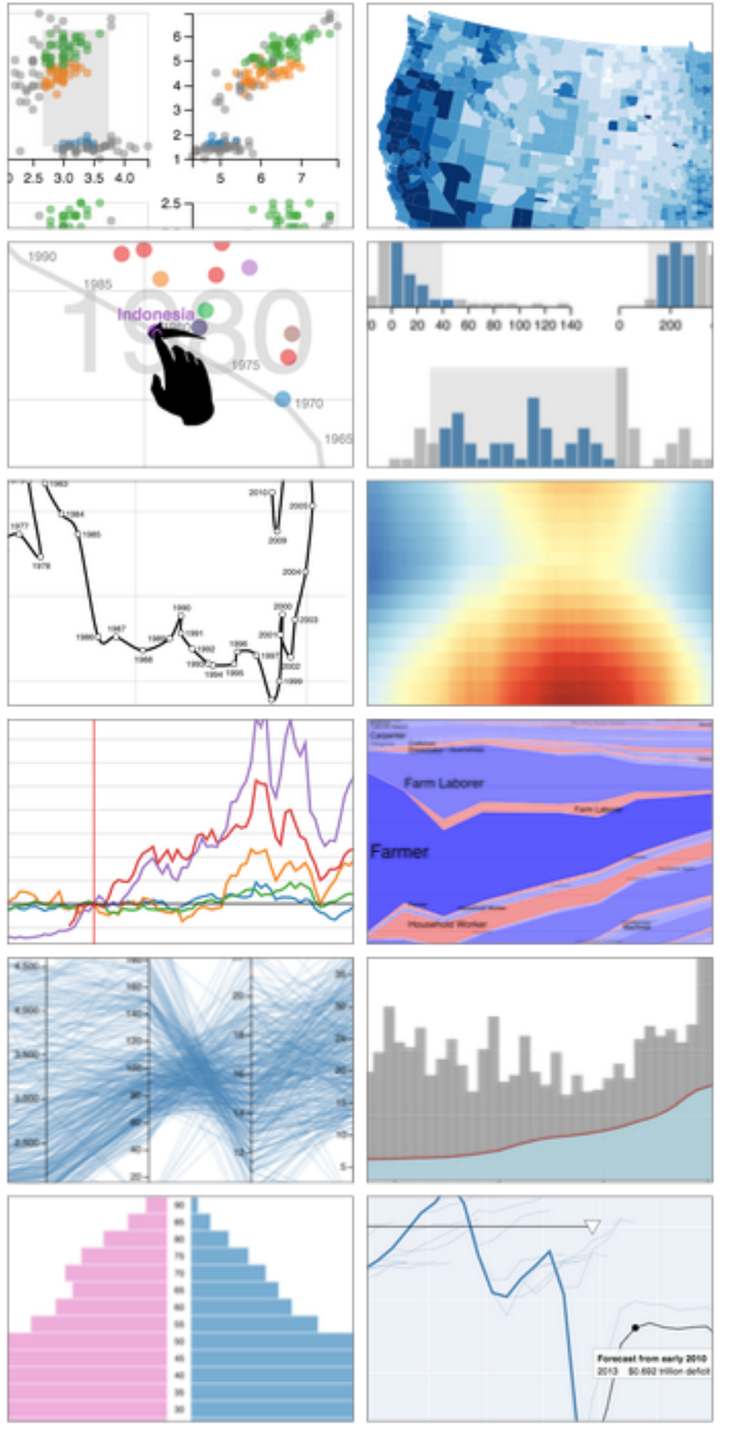
Vega provides a formal model for enumerating and reasoning about visualization designs.



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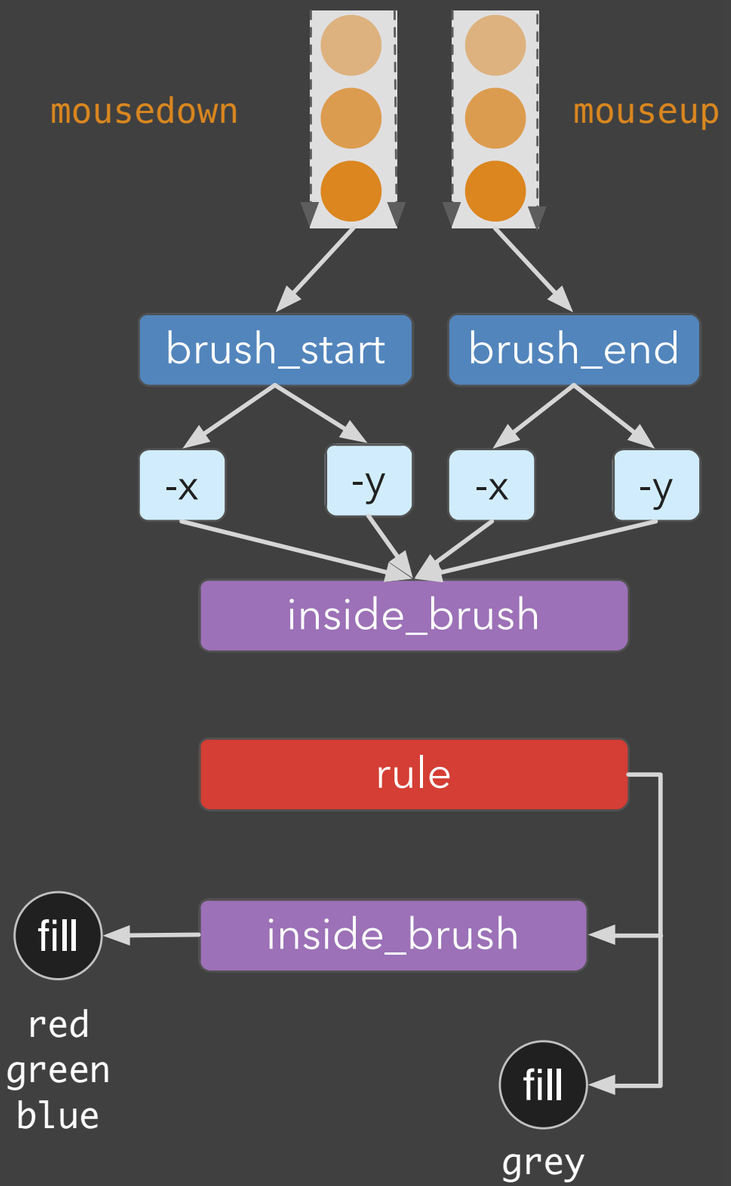
First comprehensive approach for declarative specification of interaction techniques.



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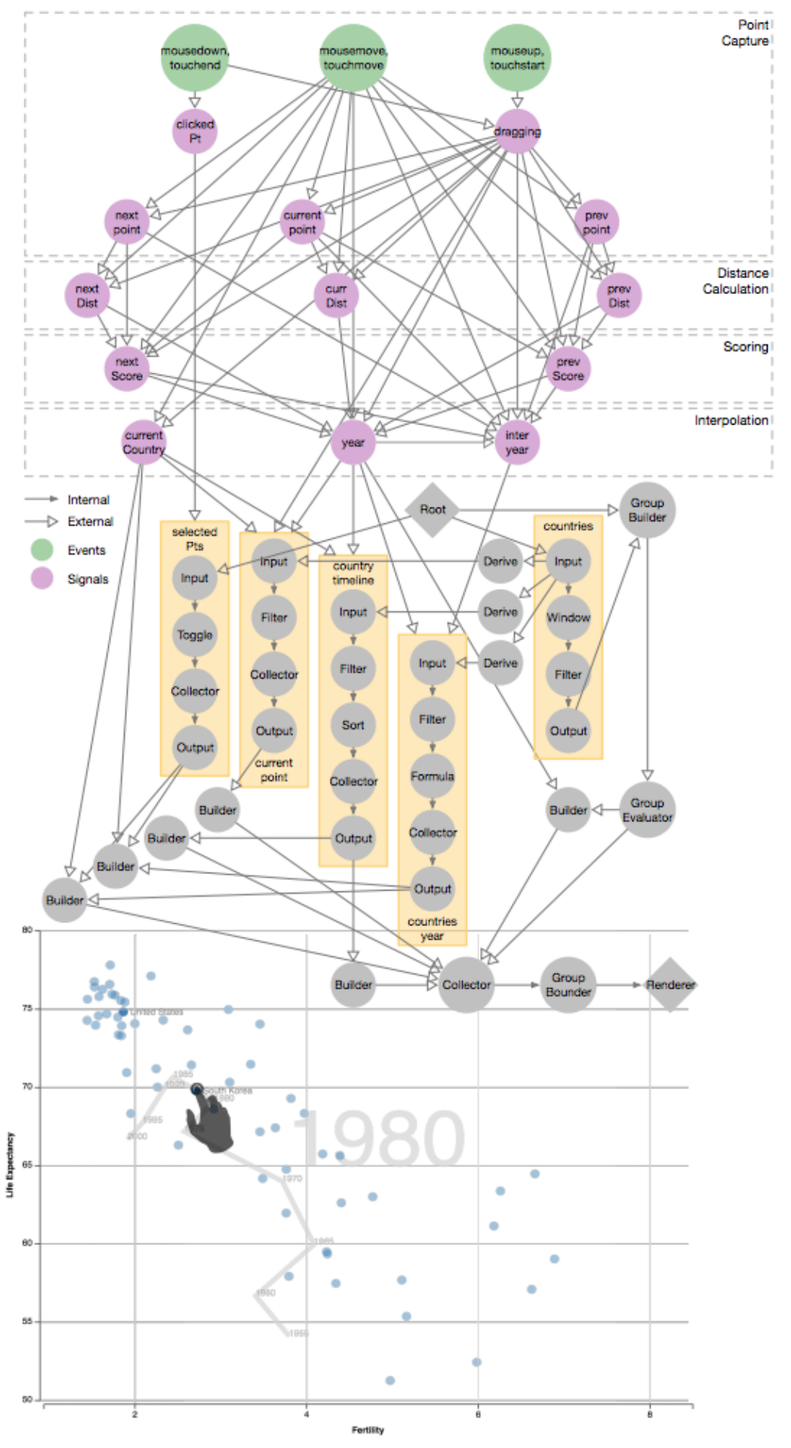

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First comprehensive approach for declarative specification of interaction techniques.

Compiles JSON description to a reactive dataflow graph with efficient, incremental processing.

Vega's dataflow graph generates a scenegraph that is then rendered using Canvas or SVG.