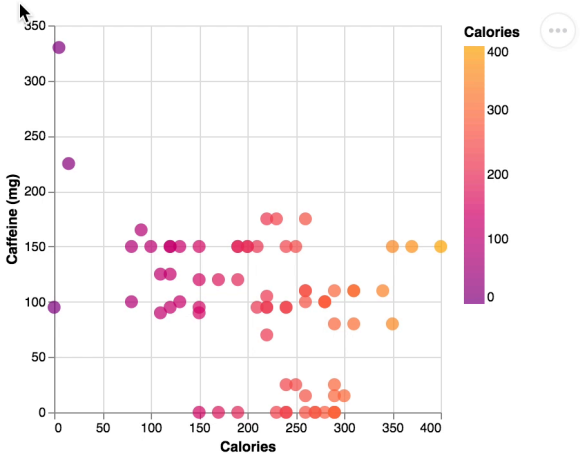
HackAZ Data Visualization Workshop

Agenda:

- Data Vis basics & terminology
- Web Charting with Vega-Lite
- Free experimentationtime



Template/Data for Code-Along:

- https://tinyurl.com/HackAZVisWorkshop

Pre-Survey (Google Form):

- https://tinyurl.com/VisWorkshopPreSurvey

Some Data Terminology

Data Tables

A	B	C	S	T	U
Order ID	Order Date	Order Priority	Product Container	Product Base Margin	Ship Date
3	10/14/06	5-Low	Large Box	0.8	10/21/06
6	2/21/08	4-Not Specified	Small Pack	0.55	2/22/08
32	7/16/07	2-High	Small Pack	0.79	7/17/07
32	7/16/07	2-High	Jumbo Box		7/17/07
32	7/16/07	2-High	Medium Box		7/18/07
32	7/16/07	2-High	Medium Box		7/18/07
35	10/23/07	4-Not Specified	Wrap Bag	0.52	10/24/07
35	10/23/07	4-Not Specified	Small Box	0.58	10/25/07
36	11/3/07	1-Urgent	Small Box	0.55	11/3/07
65	3/18/07	1-Urgent	Small Pack	0.49	3/19/07
66		5-Low	Wrap Bag	0.56	1/20/05
69		4-Not Specified	Small Pack	0.44	6/6/05
69		4-Not Specified	Wrap Bag	0.6	6/6/05
70	12/18/06	5-Low	Small Box	0.59	12/23/06
70	12/18/06	5-Low	Wrap Bag	0.82	12/23/06
96	4/17/05	2-High	Small Box	0.55	4/19/05
97	1/29/06	3-Medium	Small Box	0.38	1/30/06
129	11/19/08	5-Low	Small Box	0.37	11/28/08
130	5/8/08	2-High	Small Box	0.37	5/9/08
130	5/8/08	2-High	Medium Box	0.38	5/10/08
130	5/8/08	2-High	Small Box	0.6	5/11/08
132	6/11/06	3-Medium	Medium Box	0.6	6/12/06
132	6/11/06	3-Medium	Jumbo Box	0.69	6/14/06

attribute

item

cell

Each data point is an **item** (or *records*), usually represented as a row.

Columns contain values of a particular **attribute** (or *field*).

The value of an attribute for a particular item is a **cell** (or *attribute value*).

Types of Attributes

Quantitative data has order and allows mathematical operations

Ordinal data has order but not mathematical relationships

Nominal (a.k.a. Categorical) data has neither order nor mathematical relationships

➔ *Quantitative*

➔ *Ordinal*

➔ *Nominal*

Images from Munzner, Visualization Analysis and Design

Examples

➔ *Quantitative*

- *Lengths*
- *Counts*
- *Pressure*
- *Temperature*
- *Weights*
- *Distances*
- *Dates*
- *Coordinates*

➔ *Ordinal*

- *S, M, L sizes*
- *Letter grades*
- *Rankings*
- *Likert scales (e.g., rate from very satisfied to very dissatisfied)*

➔ *Nominal*

- *Shapes*
- *Colors*
- *Names*
- *Blood types*
- *Countries*
- *Event types*

Images from Munzner, Visualization Analysis and Design

What operations can you do?

➔ *Quantitative*

Compare:
=, ≠, <, >, +, −

Ratio Only:
×, ÷, ratios, proportions

➔ *Ordinal*

Compare:
=, ≠, <, >

➔ *Nominal*

Compare:
=, ≠

Images from Munzner, Visualization Analysis and Design

Quantitative, Ordinal, or Nominal?

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66	[illegible]	5-Low	Wrap Bag	0.56	1/20/05
69	[illegible]5	4-Not Specified	Small Pack	0.44	6/6/05
69	[illegible]5	4-Not Specified	Wrap Bag	0.6	6/6/05
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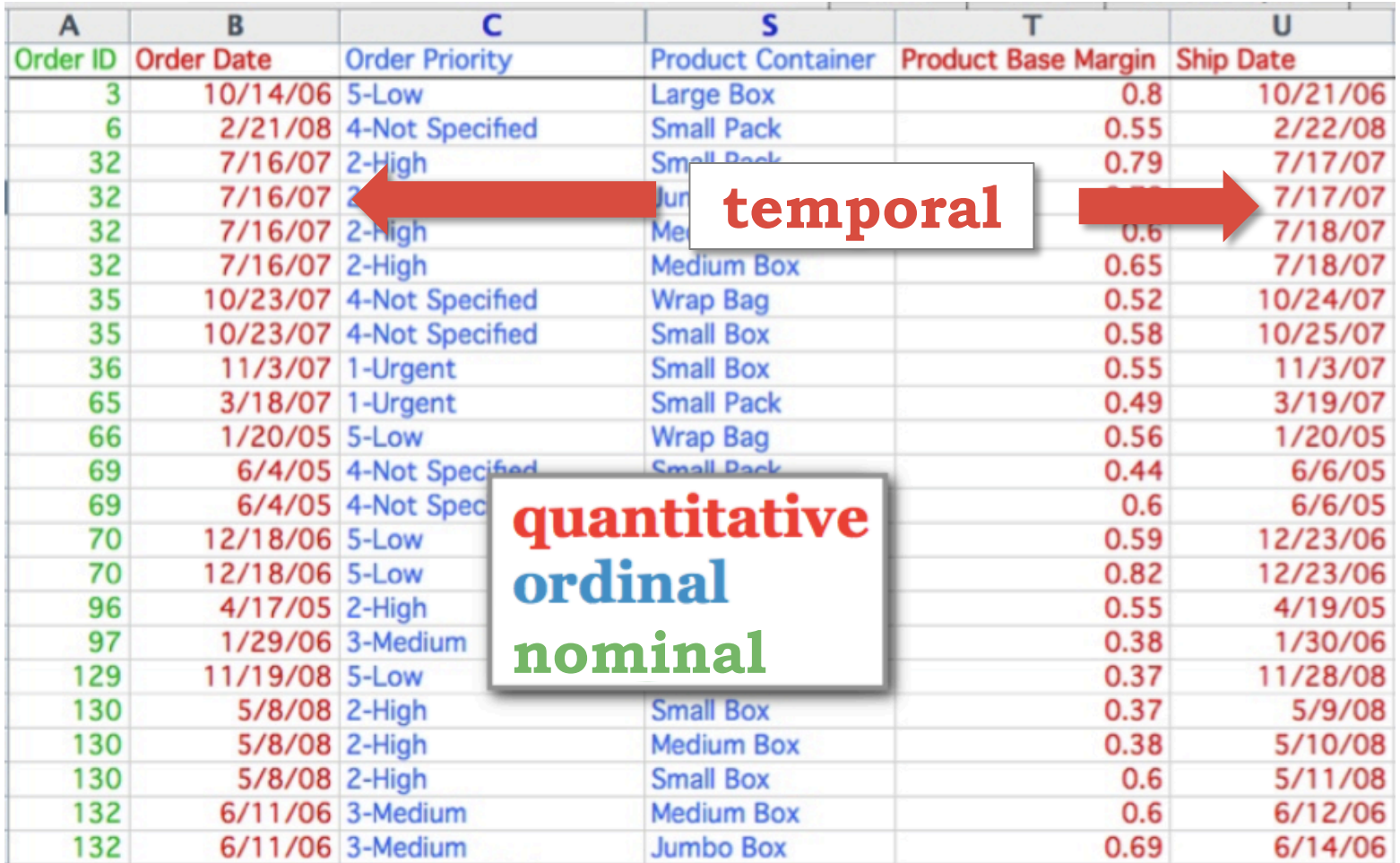
attribute

item

cell

Quantitative, Ordinal, or Nominal?



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70	12/18/06	5-Low		0.59	12/23/06
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132	6/11/06	3-Medium	Jumbo Box	0.69	6/14/06

Encoding: Mapping Data to Visualization

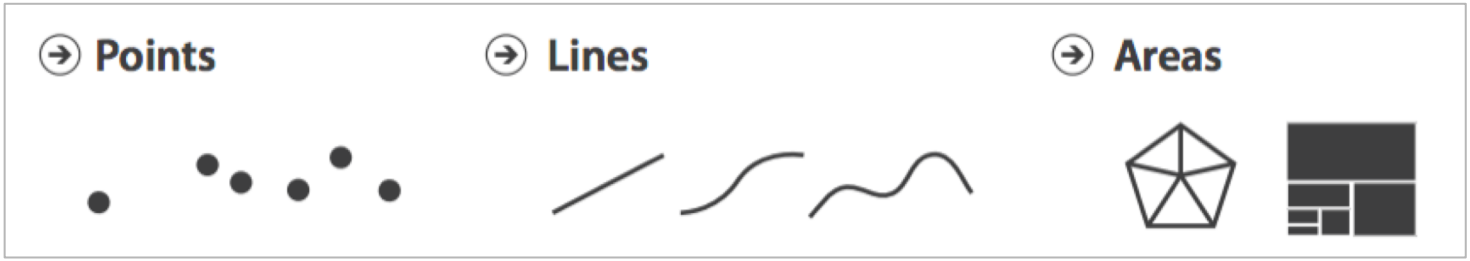
Marks, Channels, & Encoding

Encoding: Map data to visual structure

Marks: Graphical primitives that encode items / entities

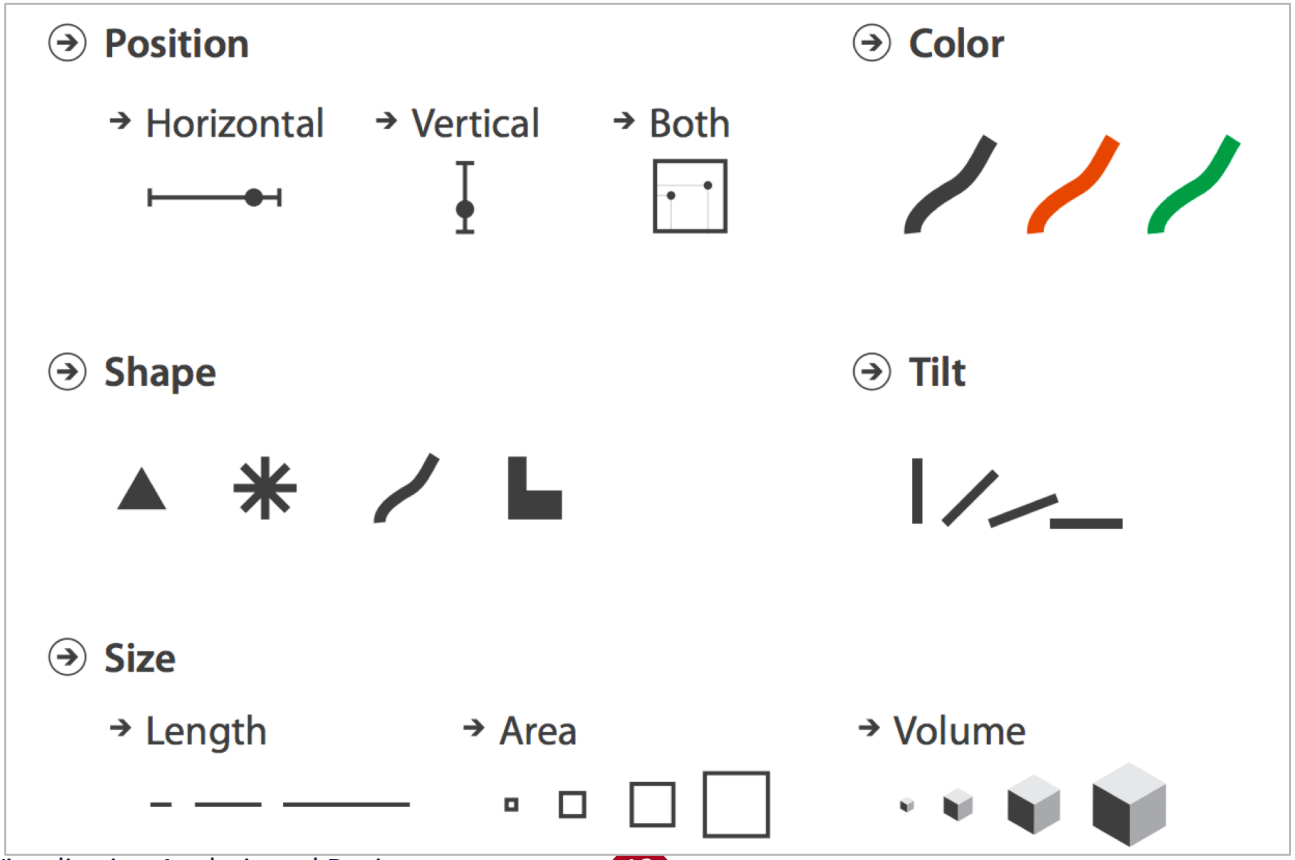
Channels: Properties of mark appearance, often used to encode attributes or other information

Marks: Graphical primitives that encode items or entities



Images from Munzner, Visualization Analysis and Design

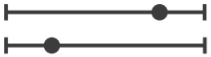
Channels: Properties of mark appearance, often used to encode attributes or other information



Images from Munzner, Visualization Analysis and Design

Magnitude Channels: Ordered Attributes

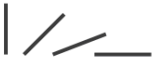
Position on common scale



Position on unaligned scale

Length (1D size)

Tilt/angle



Area (2D size)

Depth (3D position)

Color luminance

Color saturation

Curvature

Volume (3D size)

Identity Channels: Categorical Attributes

Spatial region

Color hue

Motion

Shape

We can Construct a Mapping of Data Values to Perceptual Channels

Images from Munzner, Visual Analysis and Design

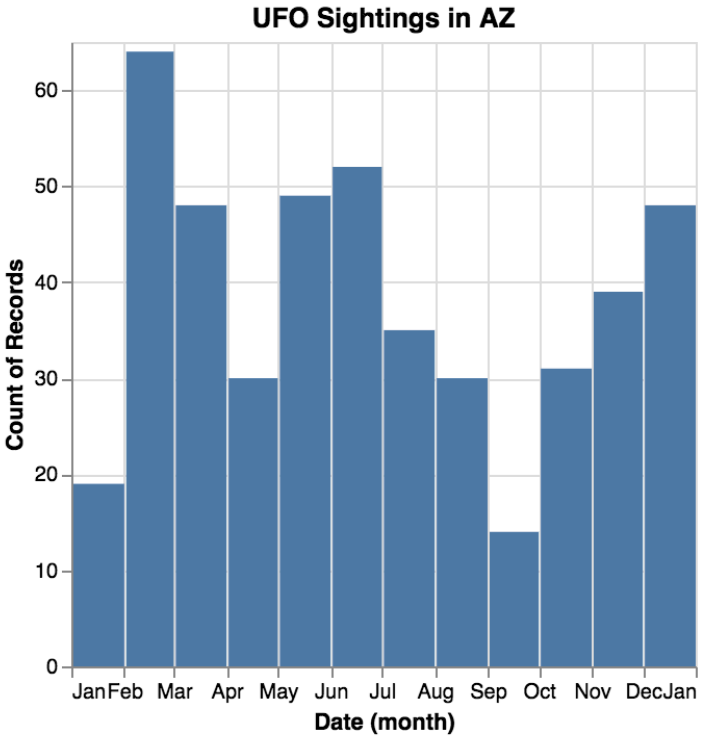
Encodings of Common Charts

Bar Chart: Show relative counts

Marks: rectangles

Encoding: quantitative value is mapped to height of rectangle on a common scale

Nominal value is mapped to x-position

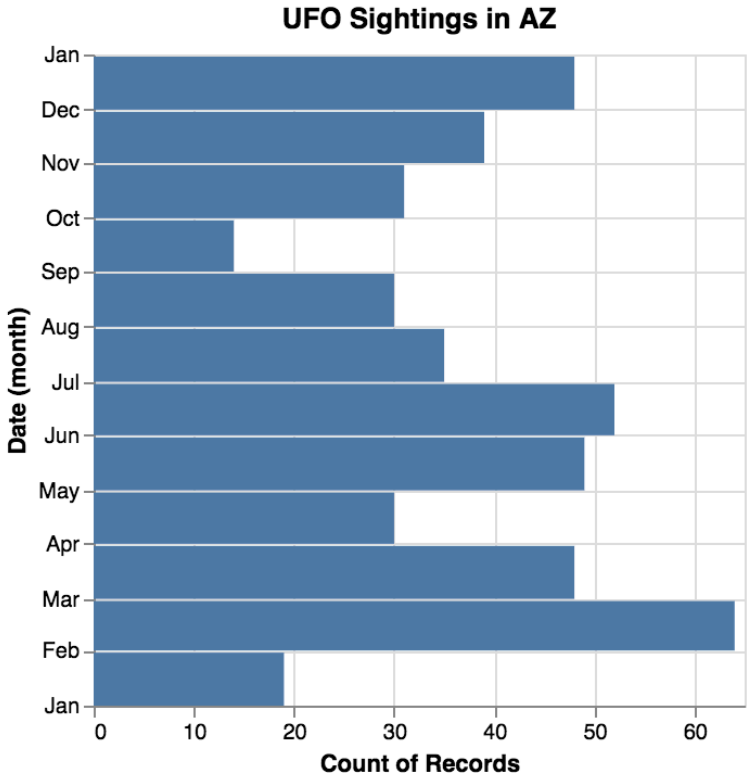


Consider rotating for text readability

Marks: rectangles

Encoding: quantitative value is mapped to width of rectangle on a common scale

Nominal value is mapped to y-position

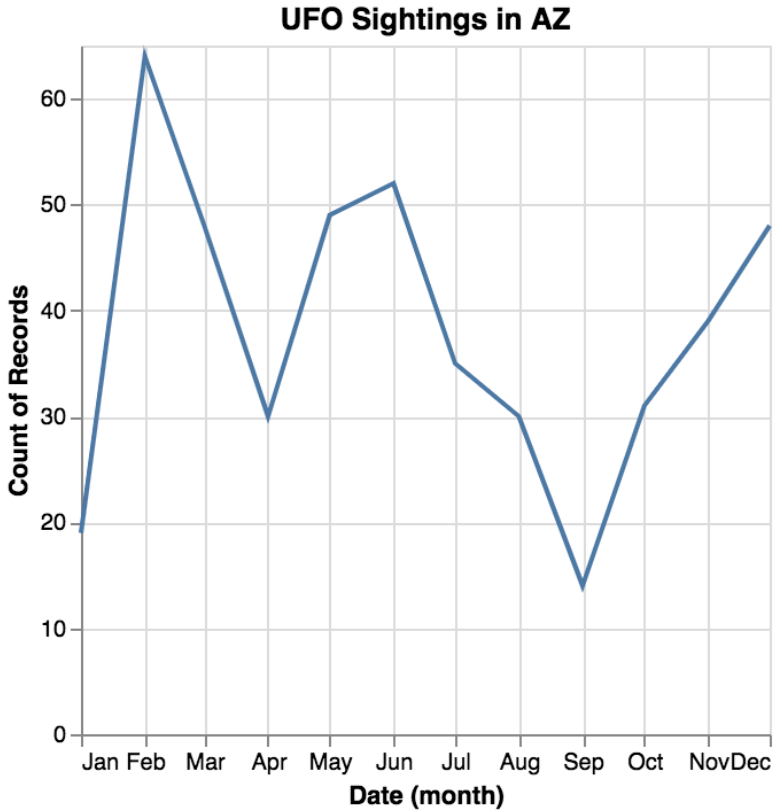


Line Charts: Show trends

Marks: lines

Encoding: quantitative value is mapped to y-position of line endpoint.

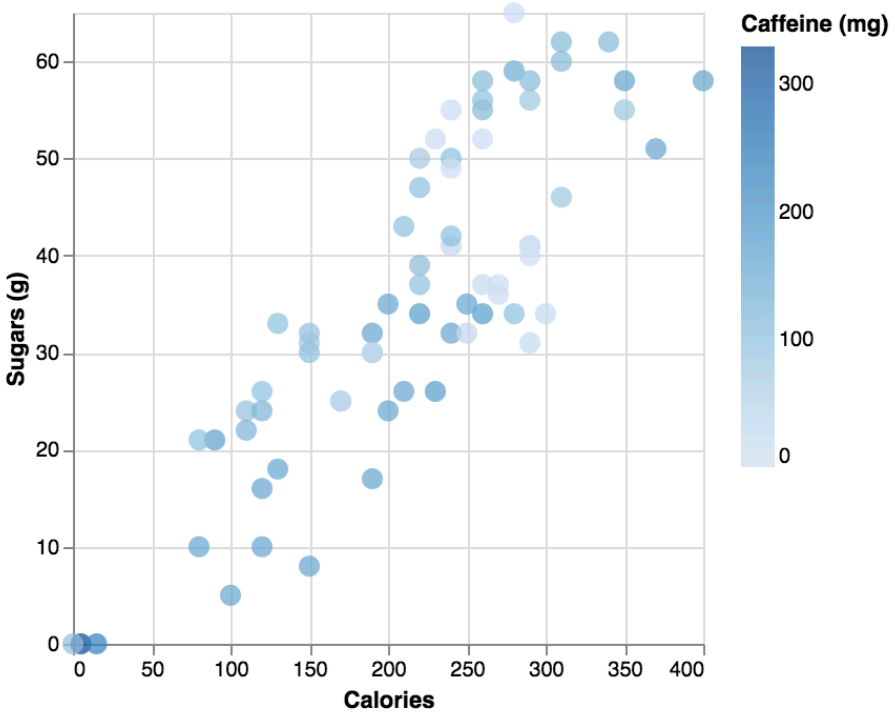
Temporal value is mapped to x-position



Scatter Plots: show correlation

Marks: points

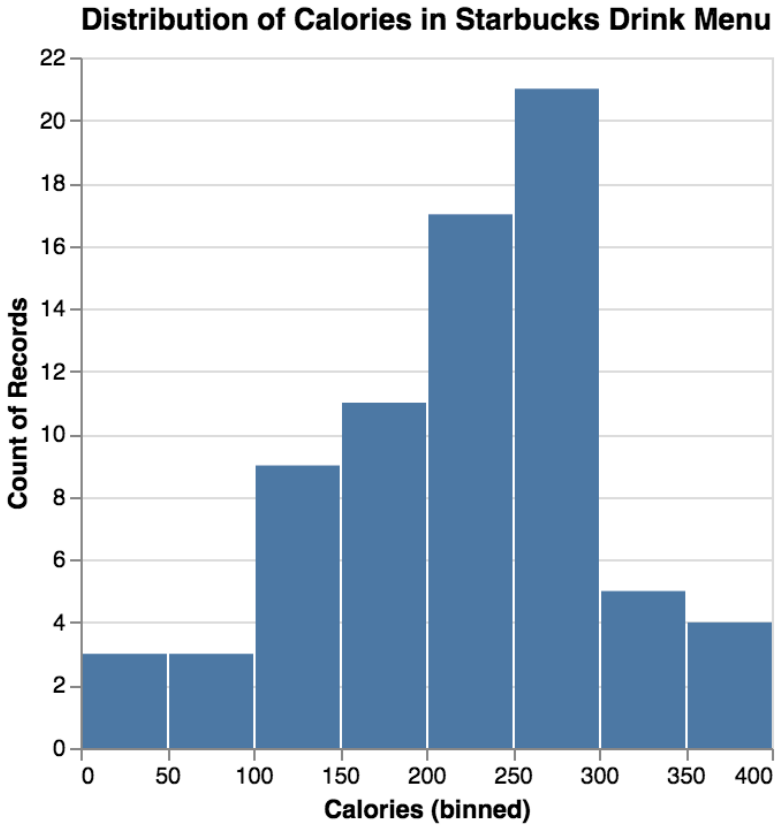
Encoding: two quantitative value is mapped to x and y position respectively



Histograms: show distribution

Marks: bars

Encoding: x position denotes range of calories, y position denotes number of drinks in that calorie range



Vega-Lite

Why Vega-Lite?

Last HackAZ, I noticed most projects with visualization used basic charts and some projects had streaming data

Vega-Lite is a lightweight, robust library when it comes to quickly creating basic charts from data.

Vega-Lite has support for streaming data (not covered in this workshop)

Let’s go through this together!

If you have not already, download the workshop files:
https://tinyurl.com/HackAZVisWorkshop

Unzip the file and open “template.html” in a web browser

Veg—Lite can be embedded in a webpage

```
<!DOCTYPE html>
<html>
  <head>…</head>
  <body>
    <div id="vis"></div>
    <script>
      var spec = { …JSON specification here… };
      vegaEmbed('#vis', spec);
    </script>
  </body>
</html>
```

General JSON Syntax

JSON has two structures, an unordered **object {}** of key-value pairs and an ordered **list []** of items, both are comma separated

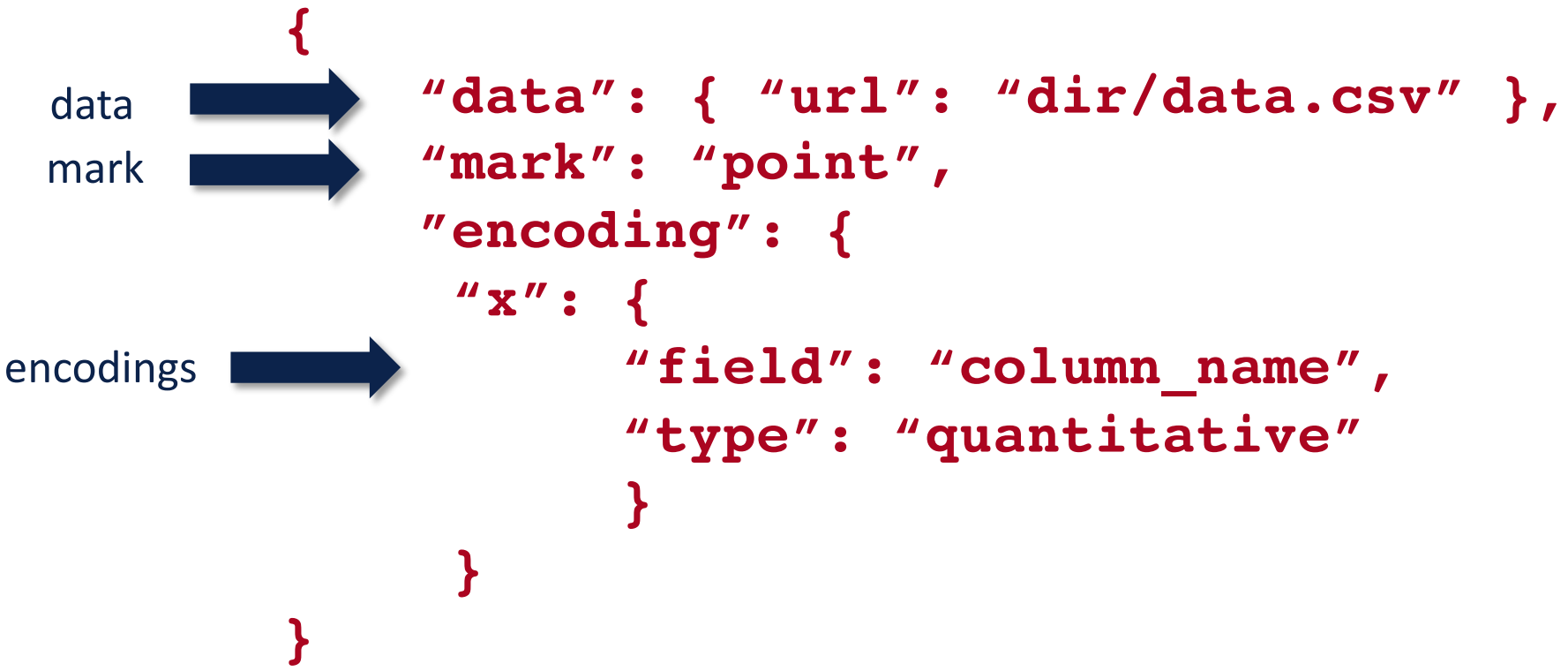
Object Example

```
{
  "key1": 12.2,
  "key2": "text here",
  "key3": [1, 2, 3],
  "key4": { "key1": 0.0 },
  "key5": true
}
```

List Example

```
[
  { "id": 0,
    "name": "foo"
  },
  { "id": 1,
    "name": "bar"
  }
]
```

Anatomy of a Vega-Lite specification



Data can be a URL/file or inline

```
"data": { "url": "data/mydata.json" }

"data": {
  values: [
     { "id": 0, "foo": 7, "bar": "peas" },
     { "id": 1, "foo": 3, "bar": "carrots" },
     { "id": 2, "foo": 6, "bar": "carrots" },
     { "id": 3, "foo": 5.5, "bar": "peas" }
  ]
}
```

Several marks available

```
{
    “mark”: “point”,
}
```

area
bar
circle
line
point
rule
square
tick

rect
text
geoshape
boxplot
errorbar
errorband

Tooltips

From encodings:

```
{
    mark: { type: “point”, tooltip: true }
}
```

From data:

```
{
    mark: { type: “point”,
     tooltip: { content: “data” }
    }
}
```

Aggregation of Data

```
count
sum
mean
average
median
variance
stdev
stderr
```

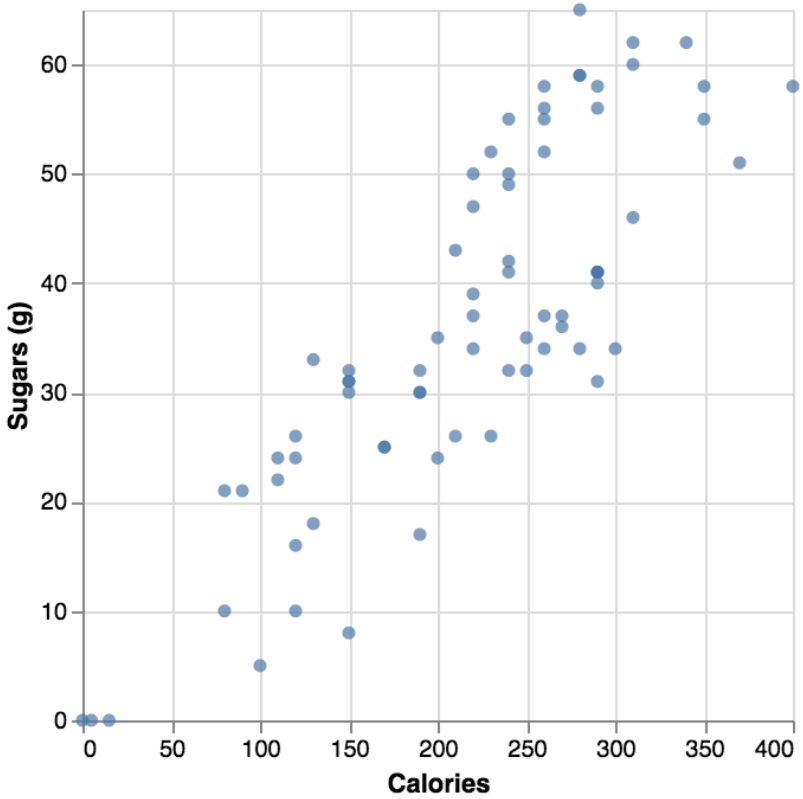
```
min
max
valid
missing
distinct
…more…
```

See also binning (histograms) and other transforms…

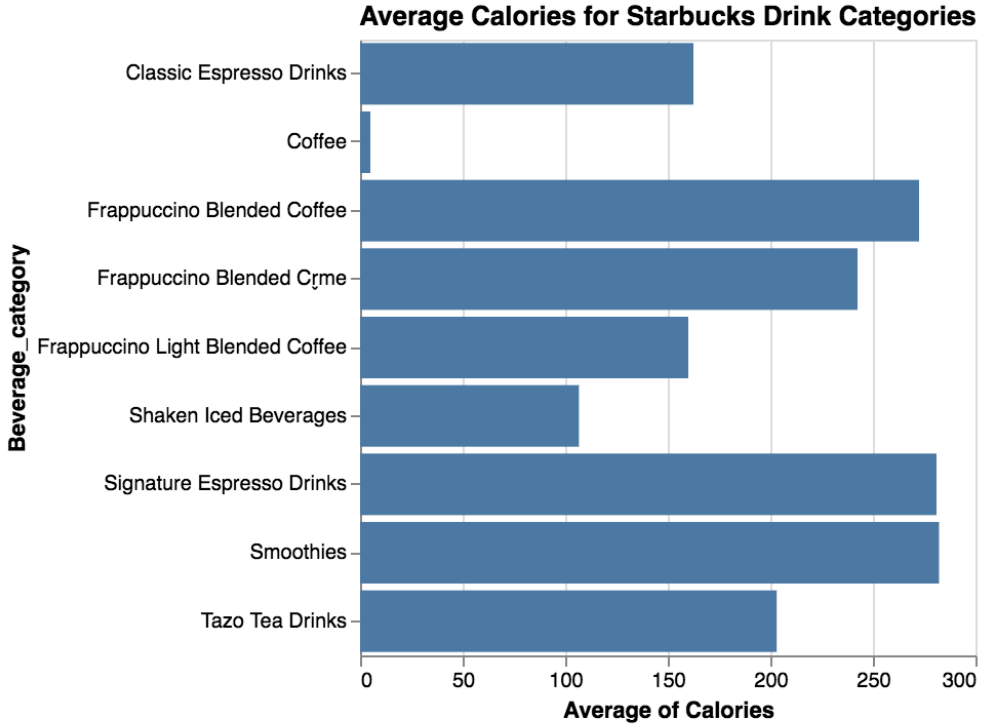
Exercise: Now that we've seen the small dataset, try a larger one

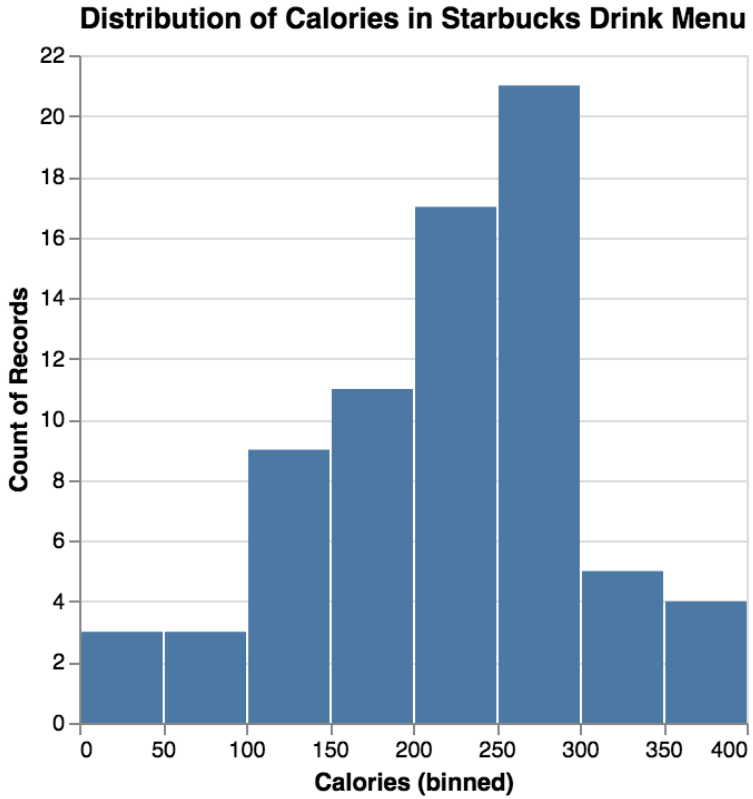
Replicate this plot with the Kaggle Starbucks nutritional information data. Don't forget to add a tooltip!

```
"data": {
  values: drinks
}
```



Exercise: Can you replicate these charts with the Starbucks Data?

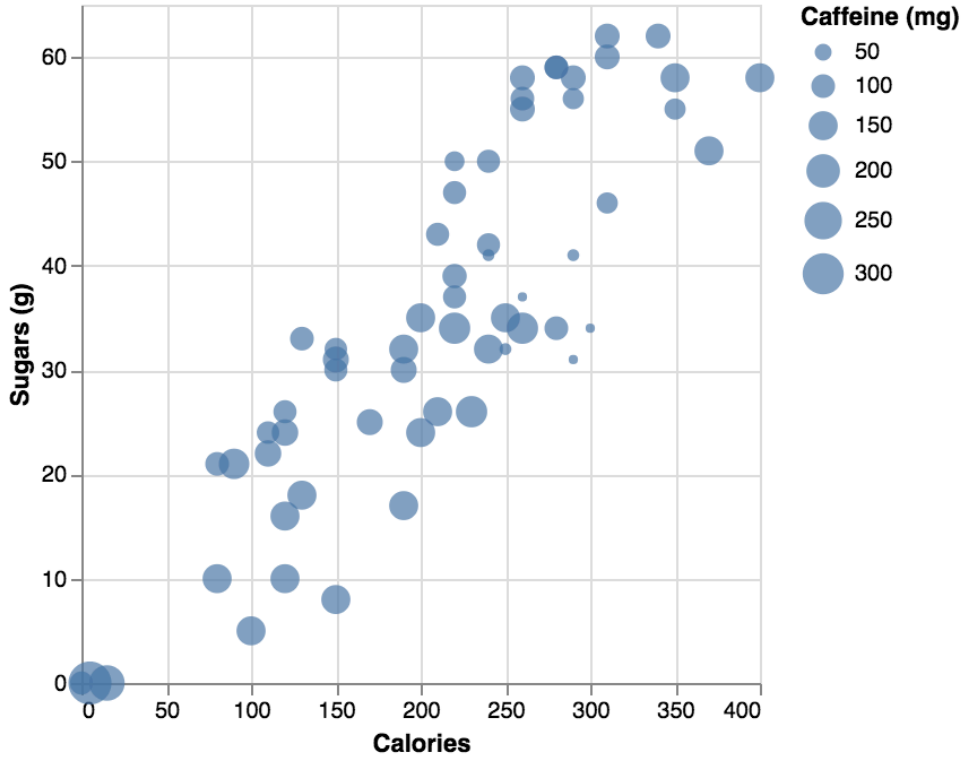


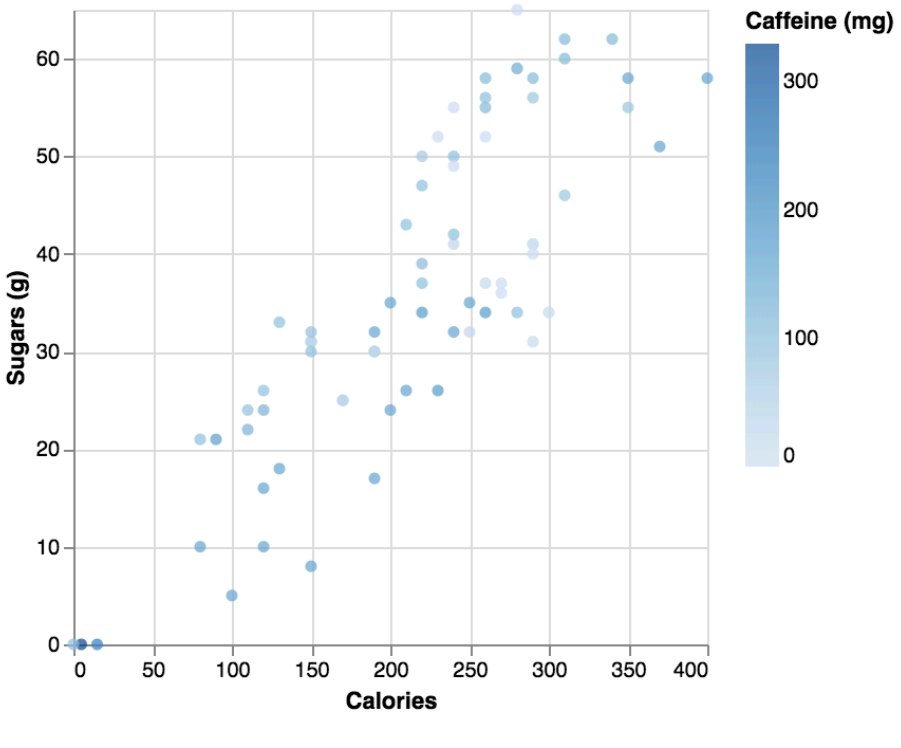


Encoding: Mapping Data to Channels

x	color	text
y	opacity	tooltip
x2	fillOpacity	href
y2	strokeOpacity	…more…
xError	strokeWidth	
yError	size	
xError2	shape	
yError2		

Exercise: Let's encode Caffeine (mg) with size or color

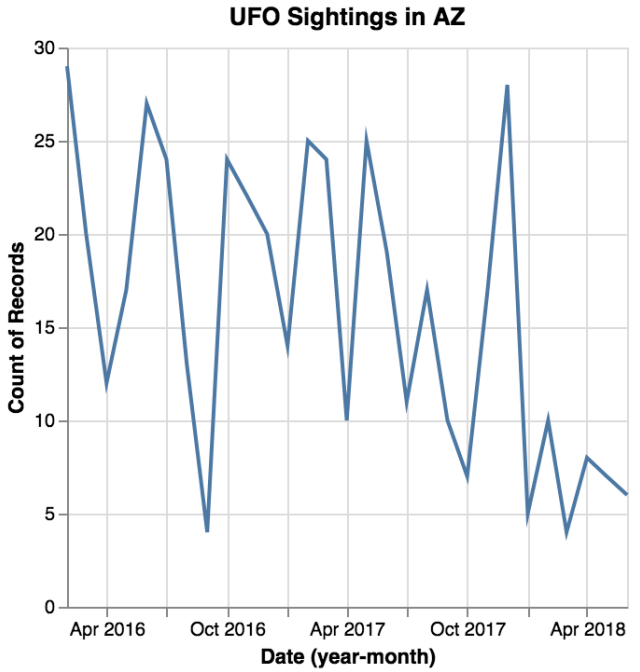




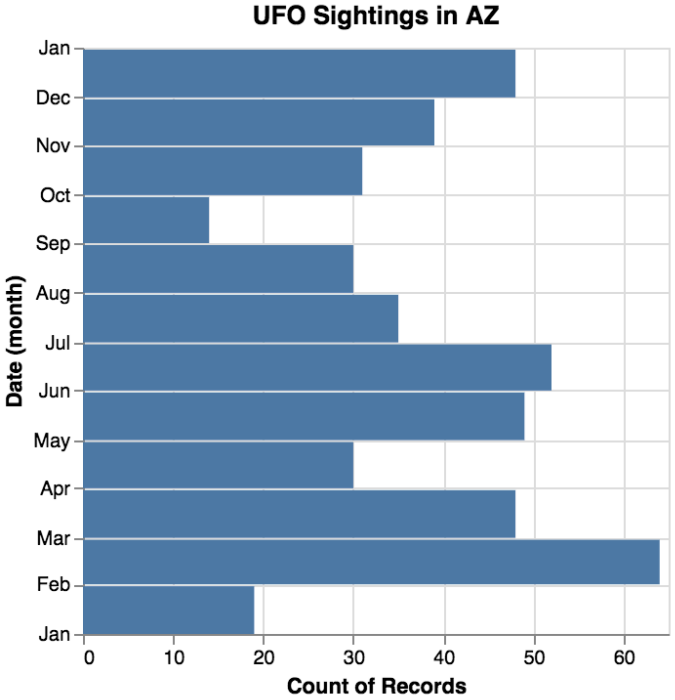
Temporal Data

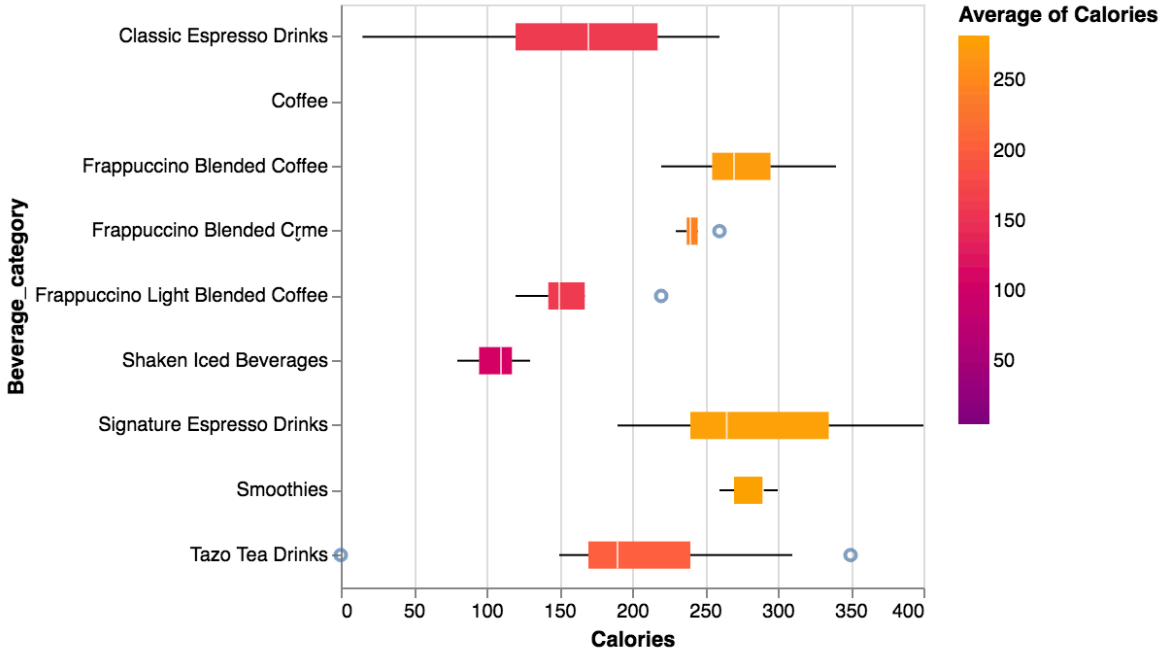
We can set a timeUnit in the encoding to group data and then represent its aggregate:

```
"x": {
    "field": "Date",
    "timeUnit": "yearmonth"
    "type": "temporal"
}
"y": {
    "aggregate": "count",
    "type": "quantative"
}
```



Exercise: UFO Data & Drinks Data





Acknowledgements

This workshop is based on the tutorials and documentation at https://vega.github.io

Data Visualization basics are based on Visualization Analysis and Design, by Tamara Munzner

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